MASON
(BUILDING CONSTRUCTOR)

NSQF LEVEL - 3

TRADE THEORY

SECTOR : CONSTRUCTION

(As per revised syllabus July 2022 - 1200Hrs)

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Sector : Construction

Duration : 1 Year

Trade : Mason (Building Constructor) - Trade Theory - NSQF Level - 3 (Revised 2022)

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of comprising various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Mason (Building Constructor) - Trade Theory NSQF Level - 3 (Revised 2022) in Construction Sector under** under Annual pattern. The NSQF Level - 3 (Revised 2022) Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 3 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 3 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

Addl.Secretary/Director General (Training)
Ministry of Skill Development & Entrepreneurship,
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New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Directorate General of Training, Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of Federal Republic of Germany. The prime objective of this Institute is to develop and provide instructional materials for various trades as per the prescribed syllabi under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

In order to perform the skills in a productive manner instructional videos are embedded in QR code of the exercise in this instructional material so as to integrate the skill learning with the procedural practical steps given in the exercise. The instructional videos will improve the quality of standard on practical training and will motivate the trainees to focus and perform the skill seamlessly.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

Chennai - 600 032 **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisation to bring out this IMP **(Trade Theory)** for the trade of **Mason (Building Constructor)** under the **Construction** Sector for ITIs.

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NIMI records its appreciation of the Data Entry, CAD, DTP Operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks, the invaluable efforts rendered by all other staff who have contributed for the development of this Instructional Material.

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in workshop. It consists of a series of practical exercises to be completed by the trainees during the course of the **Mason (Building constructor)** trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 3 (Revised 2022).

Module 1	Safety
Module 2	Carpenter Works
Module 3	Brick Masonry
Module 4	R.C.C. Construction
Module 5	Layout Marking and Levelling
Module 6	Plastering and flooring
Module 7	Drainage
Module 8	Sanitary Fittings
Module 9	Masonry Work
Module 10	Finishing Work
	Project work

The skill training in the shop floor is planned through a series of practical exercises centred around some practical project. However, there are few instances where the individual exercise does not form a part of project.

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI, looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theoretical information for the course of the **Mason (Building constructor)** Trade. The contents are sequenced according to the practical exercise contained in the manual on Trade practical. Attempt has been made to relate the theortical aspects with the skill covered in each exercise to the extent possible. This co-relation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The Trade theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indicating about the corresponding practical exercise are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not the purpose of self learning and should be considered as supplementary to class room instruction.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

Sl.No.	Learning Outcome	Exercise No
1	Perform wood work with carpenter's tools following safety precautions.	1.1.01 - 1.2.16
2	Plan and organize the work to make masonry brick wall as per drawing and specification applying different types of tools, materials and check for dimensional accuracy.	1.3.17 - 1.3.28
3	Construct wall leaving space for door & window opening.	1.4.29 - 1.4.36
4	Perform R.C.C casting, rod cutting in different sizes, bending, binding & placing. Mixing & compaction of Concrete with different proportions.	
5	Perform Construction of cavity wall.	1.4.29 - 1.4.36
6	Perform Laying out of building plan, diagonal check-up, fixing up of excavation lines	1.5.37 & 1.5.38
7	Perform wall & ceiling plastering with application of mortar, smoothening the surface by using of screeds & floats.	1.6.39 - 1.6.43
8	Make different types of floor with determination and formation of Slope.	1.6.39 - 1.6.43
9	Lay drain pipe, jointing, fittings & fixing of W.C. pan, urinals, gully trap, construction of manhole etc.	1.7.44 - 1.7.50
10	Construct septic tank.	1.8.51 - 1.8.53
11	Perform fixing & fittings of wash basin, flushing cistern, sink, vent pipe, etc.	1.8.51 - 1.8.53
12	Lay marble on floor& stair with marking, cutting &complete setting.	1.9.54 - 1.9.57
13	Construct circular brick wall & hollow block walls.	1.10.58 - 1.10.64
14	Prepare & mix of concrete, formwork, cutting & bending of bar, casting of roof slab, beams, lintels, stair, column etc.	1.10.58 - 1.10.64
15	Cut & set glazed tiles to walls.	1.10.58 - 1.10.64
16	Lay mosaic, terrazzo & tile flooring.	1.10.58 - 1.10.64
17	Perform Construction of R.C.C. & Brick stairs.	1.10.58 - 1.10.64

SYLLABUS FOR MASON (BUILDING CONSTRUCTOR)

Duration: One Year

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
Professional Skill 76 Hrs; Professional Knowledge 14 Hrs	Perform wood work with carpenter's tools following safety precautions.	1. Familiarization with Institute, administrative setup of Institute. (3 hrs.) 2. Rules & resolutions of attendance with leave facility. (3 hrs.) 3. Importance of Trade training, instruments & equipment's used. (5 hrs.) 4. Importance of trade training, List of tools & Machinery used in the trade. (4 hrs.) 5. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). (5 hrs.) 6. First Aid Method and basic training. (4 hrs.) 7. Safe disposal of waste materials like Pieces of wood, rod, stone, mud, etc. (2 hrs.) 8. Hazard identification and avoidance. (2 hrs.) 9. Safety signs for Danger, Warning, caution & personal safety message. (3hrs.) 10. Preventive measures for electrical accidents & steps to be taken in such accidents. (5 hrs.) 11. Use of Fire extinguishers. (9 hrs.) 12. Practice and understand precautions to be followed while working in mason jobs. (3 hrs.) 13. Safe use of tools and equipments used in the trade. (2 hrs.)	• Importance of safety and general precautions required for the trade. • Importance of the trade. • Types of work to be done by trainees in the institute. • Scope of a mason work. • Types of services has to plan. • Role of a mason, nature of job done by masons(7 hrs) • Video demo chapter -3
		Carpenter works :- 14. Demonstrate uses of Carpenter's hand tools. (10 hrs.) 15. Centering work. Uses of nails, screws, nuts & bolts, hinges etc. (7 hrs.) 16. Perform centering & form work. (9 hrs.)	• Common types of wood- their description and use. • Carpenter's hand tools, their names and uses. Grinding of tools &precautions to be taken • Carpentry joints and their uses. Use of nails, screws, dowels, etc.(7 hrs)
Professional Skill 150 Hrs;	Plan and organize the work to make masonry brick wall as per	17. Handling of brick, turning of brick for stretcher & header faces. (4 hrs.) 18. Cutting of brick with brick hammer as desire shape & size. (8 hrs.)	• Technical terms used in brick masonry. Necessity of bonding bricks. Types of bond Types of mortars, different grades of sand

Professional Knowledge 23Hrs.	drawing and specification applying different types of tools, materials and check for dimensional accuracy.	19. Shaping mortar, spreading on the bed joining bricks. (10 hrs.) 20. Preparation of various types of mortars according to the ratio of ingredients. (6 hrs.) 21. Building 4½ straight wall about 6 courses high with one end stepped and the other racked back. (24 hrs.) 22. Building 4½ quoin wall with one end stepped and the other racked back. Use of plumb rule. (26 hrs.) 23. Construct of 1 &1 ½ brick walljunctions in English & Flemish bonds. Racking out the joints &finishing it flush. (24 hrs.) 24. Construction of 1 brick thick walls inEnglish & Flemish garden bonds. (24 hrs.) 25. Construct of detached brick pillars with footings square & rectangular types. (24 hrs.)	for brick work & plastering. Grades of cement. • Brickwork-racking back & toothing. Differences between English & Flemish bonds. Details of English & Flemish bond for 1 and 1½ brick walls. Precautions at quoins. • Cross wall-method of construction. Grouting of mortar, jointing and finishing of brickwork. Types of pointing & tools used. Details of bonding & special precautions at 'T', 'L' and cross junctions. Types of copings-weathering & throating. • Pillars: Necessity, types, relation between cross section & height. Details of reinforcement for square &rectangular pillars. • Types of cement, sand & lime. English & Flemish garden wall bonds. PWD specification on brickwork. • Foundation: Definition, purpose, types,important terms, causes of failure of foundations. (23 hrs)
Professional Skill 25 Hrs; Professional Knowledge 06 Hrs	Construct wall leaving space for door & window opening.	26. Form a door opening in a wall of English bond. Bonding of jambs & reveals. (10 hrs.) 27. Form a window opening in a wall in English bond. (7 hrs.) 28. Construction of sill with over Sailingcourses. Use of gauge rod Fixing door & window frames. (8 hrs.)	• Purpose of arch centering & form work. Different types of bricks &their sizes.Characteristics of good bricks Sizes of mortar joints for different works. Stretcher & header (6 hrs)
Professional Skill 50 Hrs; Professional Knowledge 7 Hrs	Perform R.C.C casting, rod cutting in different sizes, bending, binding & placing. Mixing & compaction of Concrete with different proportions.	29. Demonstrate R.C.C, re-enforcement of different dia. With unit weight. Cutting, bending & binding of bar. (4 hrs.) 30. Perform Pre-casting a lintel-compacting, curing & setting the same in position. Check for equal bearing. (8 hrs.) 31. Spanning of opening by casting a lintel in site. (10 hrs.)	• RCC lintels: Materials required, • Method of construction, precast lintels, • Method of construction of formwork, details of reinforcement. • Arches: Purpose,technical terms & types. Setting out an arch. (7 hrs)

		32. Making of shuttering &supports with uprights and wedges. (7 hrs.) 33. Cutting, bending & placing ofreinforcement. (4 hrs.) 34. Mixing, placing & compacting concrete. (2 hrs.) 35. Spanning of opening with a semi-circular arch, making centering, cutting of templates for voussoirs & preparing voussoirs, setting uprights of arch. Construction of arch &removing centering. (15 hrs.)	
Professional Skill 25 Hrs; Professional Knowledge 04 Hrs	Perform Construction of cavity wall.	36. Construct cavity walls, setting out both leaves, provision of wall ties and use of cavity rods. (25 hrs.)	• Cavity wall: Technical terms, advantages,constructional details, precautions to be taken at the bottom of cavity.
Professional Skill 50 Hrs; Professional Knowledge 10 Hrs	Perform Laying out of building plan, diagonal check-up, fixing up of excavation lines.	37. Setting out a building: Obtaining first,second, third & fourth lines, marking diagonals,setting out cross walls & offsets. (30 hrs.) 38. Marking excavation lines & fixing of plinth & floor levels. (20 hrs.)	• Steps in setting out & marking centre line, excavation line & other lines-use of deadman-checking accuracy & precautions. Windows & ventilators: Including steel windows & ventilators, fixtures & fastenings used.(10hrs)
Professional Skill70 Hrs; Professional Knowledge 12 Hrs	Perform wall & ceiling plastering with application of mortar, smoothening the surface by using of screeds & floats.	39. Plastering of walls-setting of spots-applying mortar-use of screeds &floats. (25 hrs.) 40. Fixing of screeds to soffits of door & window openings-reversing the screeds & squaring. (20 hrs.) 41. Plastering of ceiling: Application of mortar, strengthening and finishing (Improvise a roof with stone or concrete slab for the purpose ofdemonstration). (25 hrs.)	• Plastering: Tools used, necessity of screeds & their fixing, • Steps in plastering. • Concrete: Ingredients, selection of materials, various ratios of mix, their uses, measuring of materials for mixing. (12 hrs) • Video demo chapter -5
Professional Skill 50 Hrs; Professional Knowledge 7 Hrs	Make different types of floor with determination and formation of Slope.	42. Flooring practice: Determination and formation of slope, application of slurry for finishing, setting out of skirting, formation of spots for skirting. (30 hrs.) 43. Use of screeds, formation of curve at the junction of skirting & floor. (20 hrs.)	" Floors: Types, constructional details such as consolidation of bed, sand filling, concrete base & finishing. Granolithic flooring. Local Municipal byelaws. (07 hrs)
Professional Skill 100 Hrs; Professional Knowledge 20 Hrs	Lay drain pipe, jointing, fittings& fixing of W.C. pan, urinals, gully trap. Construction of manhole etc.	44 Drainage: Set out a drainage line including position of manhole & gully trap. (22 hrs.) 45 Practice in setting up and reading of dumpy level. (16 hrs.) 46 Lay out drainage to required gradients with the help of dumpy level and/or boning rod and layingits surface with bricks. (26 hrs.) 47 Laying of concrete foundation fordrainage pipes and jointing. Check-	• Purpose of drainage, different systems, their advantages & disadvantages, method of collection, carriage & final disposal of wastage, various types of constructions required. Roofs: Classification, parts, trussed roof, covering materials. • House drainage system-normal layout of drainage. • Traps-gully, nahani, etc.-their description.

		ing of alignment. Cutting thepipe to the required length. (10 hrs.) 48 Covering of drain pipe with concrete as per PWD specification. (4hrs.) 49 Laying out foundation concrete andconstruction of manhole. (12hrs.) 50 Method of providing footrests, Formingofdrain and benching.(10 hrs.)	• Purpose & method of fixing sanitary fittings such as WC, urinal, washbasin, kitchen sink, etc. • Construction of surface drains and laying its surface with bricks. • Drainage pipes: Types, materials, sizes, gradient for different diameters, method of laying & jointing, importance of water tightness, concrete base and covering. (20 hrs)
Professional Skill 50 Hrs; Professional Knowledge 6Hrs	Construct septic tank. Perform fixing& fittings of wash basin, flushing cistern, sink, vent pipe, etc.	51 Construct Septic tank conforming PWD norms, Bonding &waterproofing of tank walls, lining field drains with bricks. Shoring for deep trenches following proper Safety precautions. (30 hrs.) 52 Fix brackets for washbasinand flushing cistern. (06 hrs.) 53 Fix WC pan, kitchen & bathroom traps, sinks, etc. Fixing of vent pipe to walls. (14hrs.)	• Septic tank: Purpose, parts and method ofconstruction. (6 hrs) • Video chapter -6
Professional Skill 30Hrs; Professional Knowledge 7 Hrs	Lay marble on floor& stair with marking, cutting &complete setting.	54. Marble work: Method of cutting and setting on stair, floor, wall &pillar. (30 hrs.)	" Marble floor: types, constructional details..(07hrs)
Professional Skill 25 Hrs; Professional Knowledge 12 Hrs	Construct circular brick wall & hollow block walls.	55 Construct a 4½" dia. x 9" thick circular brick wall 4 layers. (15 hrs.) 56 Construct circular gate pillars with Brick / stone/ tile/ concrete. (10 hrs.)	• Circular walls: Details of construction. Purpose-made bricks. • Setting out and construction of circular gate pillars with brick/stone/tile/concrete. • Hollow block masonry: Laying of hollow blocks for walls & columns. • Use of structural clay tile for partition. • Precast concrete partition, metal lathe partition and concrete block partition. (12hrs)
Professional Skill 64 Hrs; Professional Knowledge 15 Hrs	Prepare & mix of concrete, formwork, cutting & bending of bar, casting of roof slab, beams, lintels, stair, column etc.	57 Construct roof with R.C.C. slab and beam (64 hrs.)	• Introduction to RCC: Uses, materials, properties and formwork, bending of bars & construction. • Reference to ISI code. Reinforced brickwork. • Brief description of slabs, beams, lintels, stairs, columns, etc. • RCC work: Mixing of concrete.

			• Laying, compacting &Curing of concrete. • Thumb rule for percentage of reinforcement for lintels, slabs, beams & columns. • Necessity hook & cranking. Shear reinforcement.(15 hrs)
Professional Skill 25 Hrs; Professional Knowledge 07 Hrs	Cut & set glazed tiles to walls.	**Finishing works:** 58 External / internal wall finishing practice by plastering or Pointing. (10 hrs.) 59 Fixing cement concrete jelly.(2 hrs.) 60 Laying of glazed tiles.(8 hrs.) 61 Fixing the thread, filling betweenends,plumbing, setting out a jamb, bonding. (3 hrs.) 62 Marking & cutting tiles. (2 hrs.)	• Method of finishing-factors to be kept in mind, PWD specification on the above. • Use of glazed tiles for wall facing, steps in fixing, precautions. • Construction & expansion joints-method of filling-repair of cracks.(7 hrs)
Professional Skill 50 Hrs; Professional Knowledge 14 Hrs	Lay mosaic, terrazzo & tile flooring. Perform Construction of R.C.C. & Brick stairs	63 Flooring: Mosaic, terrazzo, and tileflooring. (30 hrs.) 64 Laying out a stair on the ground.(20 hrs.)	• Stairs: Technical terms, relation between tread & rise, • Types of stairs, construction details of brick, stone & RCC stairs. • Spiral stairs with precast concrete steps. • Formwork & shuttering-their removal-precautions-PWD specifications.(14 hrs)

In plant training / Project work

Broad areas:

a Install a W.C. pan.

b Construct of a circular brick wall.

c Construct a manhole.

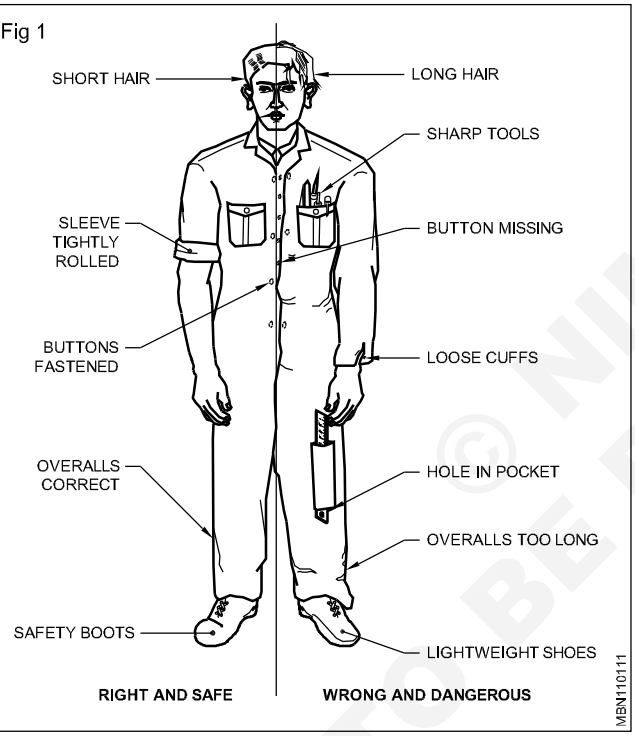
d Set glazed tiles on wall.

Safety

Objectives: At the end of this lesson you shall be able to
- **state the importance of safety**
- **list out the safety precautions to be observed in a machine shop**
- **list out the personal safety precautions to be observed**
- **list out the safety precautions to be observed while working on the machines.**

Generally accidents do not happen; they are caused. Most accidents are avoidable. A good craftsman, having a knowledge of various safety precautions, can avoid accidents to himself and to his fellow workers and protect the equipment from any damage. To achieve this, it is essential that every person should follow safety procedure. (Fig 1)

Fig 1



Safety in a workshop can be broadly classified into 3 categories.

- General safety
- Personal safety
- Machine safety

General safety

Keep the floor and gangways clean and clear.

Move with care in the workshop, do not run.

Don't leave the machine which is in motion.

Don't touch or handle any equipment/ machine unless authorised to do so.

Don't walk under suspended loads.

Don't cut practical jokes while on work.

Use the correct tools for the job.

Keep the tools at their proper place.

Wipe out split oil immediately.

Replace worn out or damaged tools immediately.

Never direct compressed air at yourself or at your co-worker.

Ensure adequate light in the workshop.

Clean the machine only when it is not in motion.

Sweep away the metal cuttings.

Know everything about the machine before you start it.

Personal safety

Wear a one piece overall or boiler suit.

Keep the overall buttons fastened.

Don't use ties and scarves.

Roll up the sleeves tightly above the elbow.

Wear safety shoes or boots or chain.

Cut the hair short.

Don't wear a ring, watch or chain.

Never lean on the machine.

Don't clean hands in the coolant fluid.

Don't remove guards when the machine is in motion.

Don't use cracked or chipped tools.

Don't start the machine until

- the work piece is securely mounted
- the feed machinery is in the neutral
- the work area is clear.

Don't adjust clamps or holding devices while the machine is in motion.

Never touch the electrical equipment with wet hands.

Don't use any faulty electrical equipment.

Ensure that electrical connections are made by an authorised electrician only.

Concentrate on your work. Have a calm attitude.

Do things in a methodical way.

Don't engage yourself in conversation with others while concentrating on your job.

Don't distract the attention of others.

Don't try to stop a running machine with hands.

Machine safety

Switch off the machine immediately if something goes wrong.

Keep the machine clean.

Replace any worn out or damaged accessories, holding devices, nuts, bolts etc as soon as possible.

Do not attempt operating the machine until you know how to operate it properly.

Do not adjust tool or the work piece unless the power is off.

Stop the machine before changing the speed.

Disengage the automatic feeds before switching off.

Check the oil level before starting the machine.

Never start a machine unless all the safety guards are in position.

Take measurements only after stopping the machine.

Use wooden planks over the bed while loading and unloading heavy jobs.

Safety is a concept, understand it. Safety is a habit, cultivate it.

Organisation of the industrial training institute

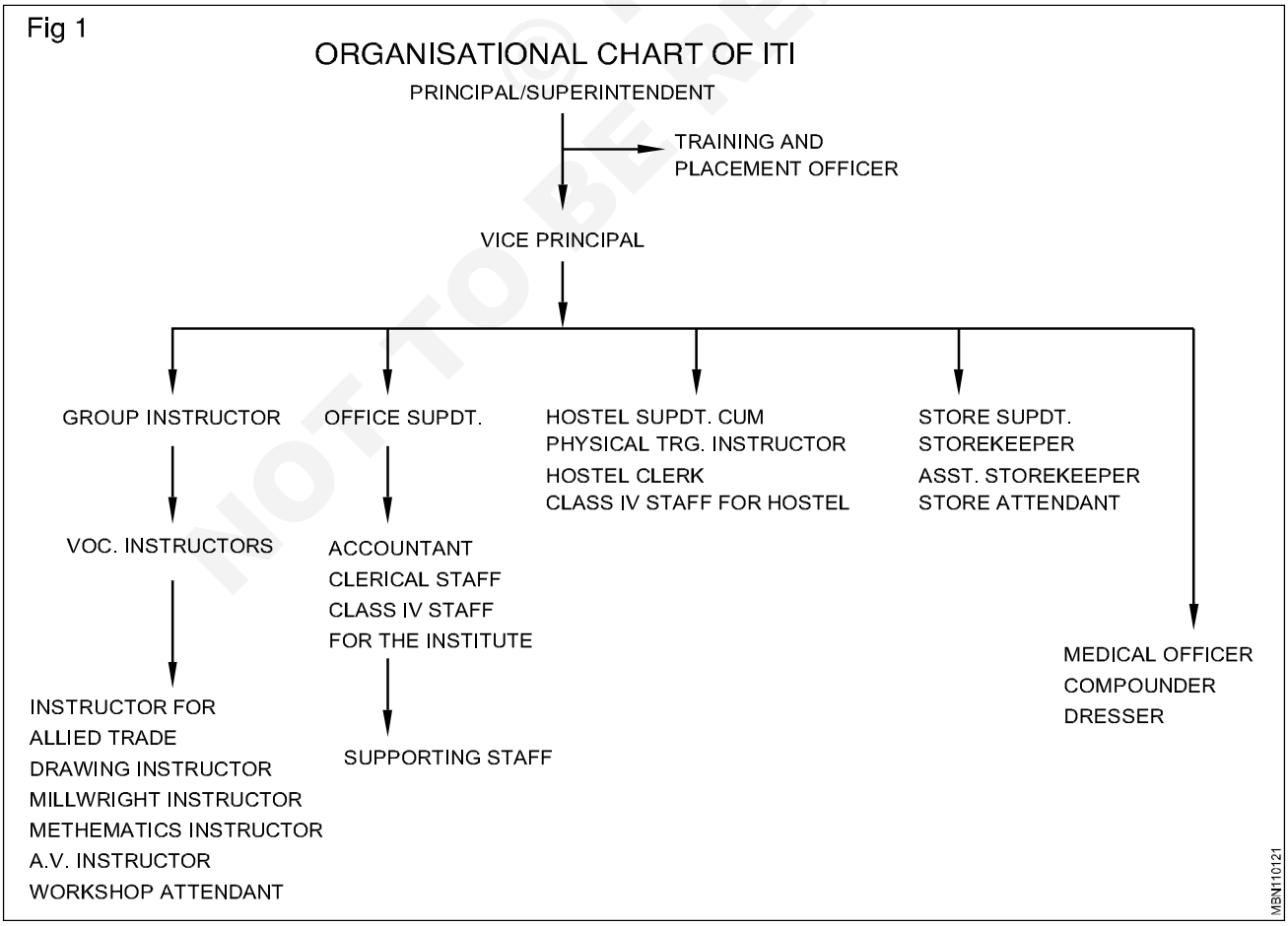
Objectives: At the end of this lesson you shall be able to
- **identify the staff structure of the institute**
- **identify the available trades in the institute and their functions.**

The industrial training institute throughout India follow the same syllabus pattern a given by the National Council for Vocational Training (NCVT) Board. In India there are about Govt. ITIs and Private ITIs. Based on the Govt. of India, Ministry of Labour's Annual report of 2011-2012. The Govt. ITIs in each state work under the Directorate of Employment and Training which is a department under the Labour Ministry in most of the states. Some of the ITIs are under the Central Government and are attached to the Advanced Training Institute which are named as Model Training Institutes.

The head of the industrial training institute is the Principal, under whom there is one Vice-Principal, group instructor and a number of trade instructors as shown in the organisation chart of ITI. (Fig 1)

Even though there are 62 trades selected for instructional training and 135 trades identified for apprentice training, according to the requirement of industrial needs, area and finance a few selected trades are established under each ITI. The trainees are advised to make a list of the trades available in their ITI, the type of training and the scope of these trades in getting self or job employment in the rural and urban areas.

Fig 1



Rules and regulation of institute and trade safety

Objective: At the end of this lesson you shall be able to
• **rules and regulation of the institute and trade.**

Rules and regulation of the institute and trade

- The trainees who are all got admission in I.T. has to follow same general rates stipulated by the institution, and those are given below.
- He should try to earn good room from the institution.
- The trainees should attend the institution to the correction in punctuality should be maintained.
- He should be very sincere and faithful not only to this instructor but also other instructors and staff the institute.
- He should attend were proper formal dress as specified by the institute.
- He should not wear loose clothes and this may be the cause for accident while crossing in shops floor.
- He should have good attitude and behave with good manner to all the staff members his fellow students and to this senior students.
- He should take part in the activities of the institute.
- He should maintain discipline of the class room and institution.
- He should not spoil the environment of institute.

Leave Facility

- 80% of attendance is required to appear in the trade test.
- One day casual leave can avail every month.
- Ten days medical leave have can avail for every one year.

Note: The above rules and regulation are also compulsory for the Gril traineess to adhere

Description of mason trade

Objectives : At the end of this lesson you shall be able to
- **state the masons tools and its uses and safety**
- **state the building materials and its uses**
- **state the construction of corner wall and 'T' junction walls with brick and concrete block**
- **state construction of piers and plaster**
- **state fixing of doors and windows**
- **state construction of foundation upto DPC level and floors**
- **state construction of man hole and estimate.**

Identify the masons tools uses and its safety

- Mason should be able to identify, select and practically use of the following masonry tools.
- Trowel - jointing board - steel square - spirit level- boat level - plumb rule - straight edge - gauge rule - line and pins - bolster - club hammer - square and bevel - axe - masons saw - carborundom stone - pointing trowel - steel or wooden Hawk - wooden float - internal angle tool - external angle tool.
- Mason should be able to know safety precaution of the following.
- Safety for personal -safety for colleague and others safety for tools and equipments - safety for materials - general safety precautions.

Identify and selection of the building materials also uses of the materials.

Brick: Qualities of good bricks -clamp brick, kiln bricks - sizes of bricks.

Stone: Good qualities of building stone - classification of stone - uses of stones - natural bed of stone.

Sand: Pit sand - river sand - sea sand - qualities of good sand - classification of sand such as - fine sand - coarse sand - Metal sand - gravelly sand - bulking of sand.

Cement: Composition of ordinary cement and its function - storage of cement - types of cement uses of cement.

Classification of lime: good qualities of lime

Lime: Types of lime - high calcium lime

Magnesia lime: Hydraulic lime.

Timber: Classification of trees - method of cutting and felling of timber - defects in timber - good qualities of timber - uses of timber - plywood - uses and advantages of plywood.

Concrete: Types of concrete mixture - grade of concrete -slumps of concrete - method of mixing concrete - curing the concrete.

Construction of corner wall and 'T' - junction wall with brick and concrete block

- Mason should be able to construct the concrete wall in English and Flemish bond in various thickness (one brick and one and half brick thick)
- Mason should be able to construct one and half brick and one brick 'T' junction in English and Flemish bond to a height of 3 feet or twelve courses.

Construction of piers and plaster

- Mason should be able to construct attached pier and detached pier in English and Flemish bond.
- Mason should be able to plastering work with cement mortar.

Fixing of door and windows

- Mason should be able to the method of fixing doors and window frames.

Construction of foundation upto D.P.C level and floor

- Mason should be able to construct a foundation up to the D.P.C level
- Mason should be able to lay IPS, mosaic floor and tiled floor.

Construction of man hole

Mason should be able to construction of man hole.

Estimate

Mason should be able to calculate or estimate the quantity of materials required for specific work.

Role of mason

Objective: At the end of this lesson you shall be able to
• the role of mason.

- Any designing and construction project such as residential building, public, Industrial building, construction of canals, bridges, dams, drainage, water supply etc. are constructed by the mason.

The role of mason

Excavation of soil

The mason excavate the soil foundation.

Mixing of concrete

The mason mix the concrete according to prescribed ratio for P.C.C and R.C.C work.

Mixing of mortar

The mason mix the cement mortar according to the prescribed ratio of cement mortar for mason work, plastering.

Laying of bricks and block

The mason lay the brick or concrete block according to the bond such as English bond, Flemish bond etc.

Laying of types of walls

The masons lay the corner wall, cross wall, T-Junction, straight wall, obtuse wall, acute wall, pillars etc.

Plastering the surface of wall

The mason prepare the surface wall for plastering and also plastering the surface.

Laying D.P.C and rain water pipe

The mason laying different D.P.C materials and fix rain water pipe and also weathering course in building.

Temporary structure

The mason fix the temporary structure of scaffolding, racking shore, dead shore, etc. Set out and lay house drainage, construct a rubble masonry wall. Construct a R.C.C stair construct types of flooring.

Accident & safety

Objectives: At the end of this lesson you shall be able to
- **state the base principle for protective equipment**
- **state the accident prevention technique**
- **describe the controls of accidents & safety measures.**

Basic Principles for Protective Equipment (PPE)

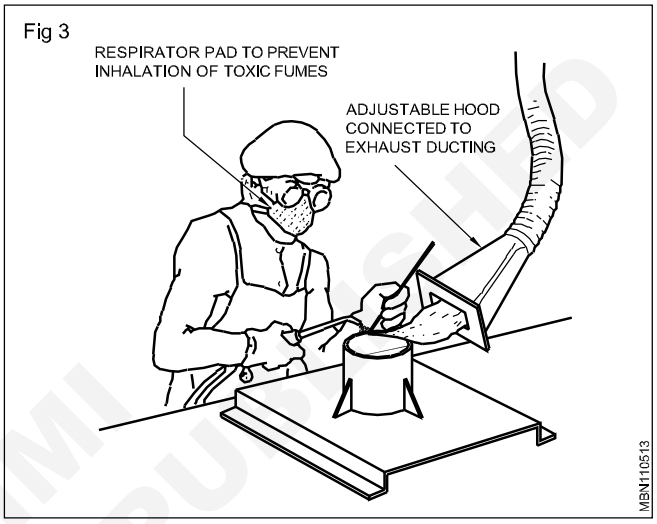
Personal protective equipment, commonly referred to as "PPE", is a equipment worn to minimize exposure to serious workplace injuries and illnesses. (Fig 1) These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical or other workplace hazards. Personal protective equipment may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators or coveralls, vests and full body suits. (Fig2&3)

Fig 1

Fig 2

Use of personal protective equipment : All personal protective equipment should be of safe design and construction, and should be maintained in a clean and reliable fashion. It should fit well and be comfortable to wear, encouraging worker use. If the personal protective equipment does not fit properly, it can make the difference between being safely covered or dangerously exposed. When engineering, work practice and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment to their workers and ensure its proper use. Employers are also required to train each worker required to use personal protective equipment to know:

Fig 3



- When it is necessary?
- What kind is necessary?
- How to properly put it on, adjust, wear and take if off.
- The limitations of the equipment
- Proper care, maintenance, useful life and disposal of the equipment.

If PPE is to be used, a PPE program should be implemented. This program should address the hazards present; the selection, maintenance and use of PPE; the training of employees and monitoring of the program to ensure its ongoing effectiveness.

Accident prevention techniques-control of accidents and safety measures

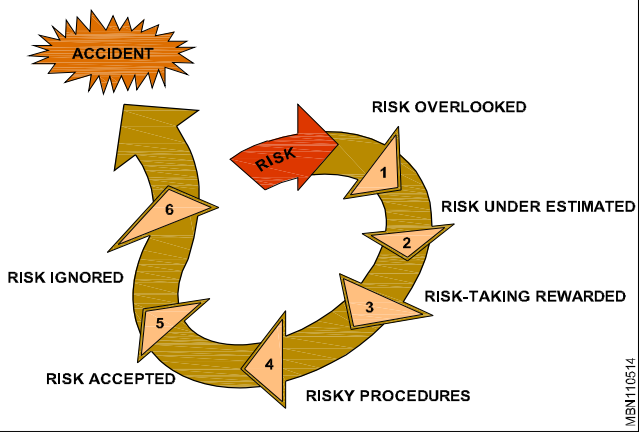
Accident are unplanned, undesired event, not necessarily resulting in an injury or illness, but damaging property and/or interrupting the activity in process. Accident happen at all jobs. There are certain accidents that are common to a job. All employees should be trained and reminded how to do their job correctly to prevent unnecessary injuries while at work. An accident can occur when a machine malfunction or a person isn't paying attention to the work they are suppose to be doing. Even a small accident can cause major problems for an employee and their employer. The best practice to avoid all types of accidents is to teach and promote a safe and happy workplace. (Fig 4)

Accidents can happen anytime at any place they are more likely to happen when a person is participating in an unsafe

act. That is why it is important to follow all safety rules and guidelines while working. If a taking a few more minutes to do the job safe is worth saving your life.

Overexertion in the workplace is a serious issue. Prevent damage to your back, knees and arms is very important. Train all employees on how to prevent overexertion by following safety rules and guidelines while completing workplace task.

Fig 4

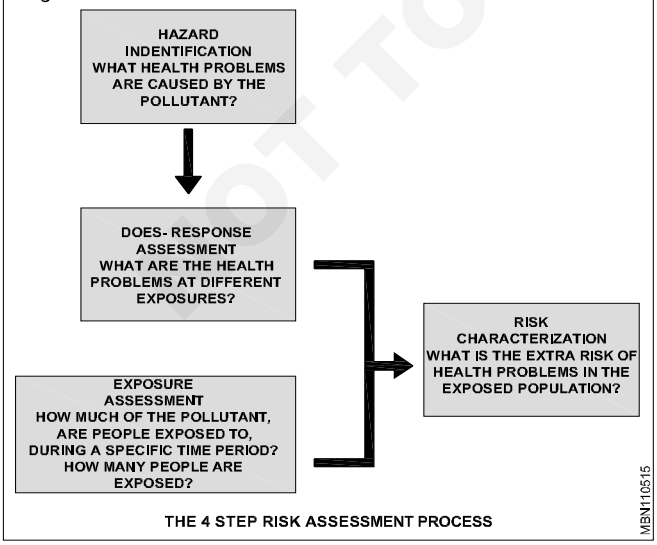


Control of accidents are done by reducing exposure to a hazards through engineering, work practices, administration or protective equipment.

Responsibilities

At department level the supervisors are made to instruct their employees regarding the requirements of this program, effectively enforce compliance of this program's procedures, including the use of disciplinary action, for any violations or deviations from the procedures outlined in this program; assure that the equipment required for compliance with this program is in proper working order, inspected and tested as required, and made available for use to their employees, promptly investigate and report all on-the-job accidents or job related health problems. (Fig 5)

Fig 5



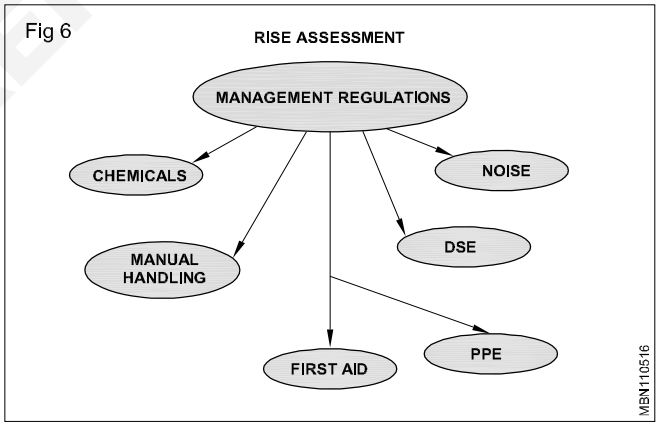
THE 4 STEP RISK ASSESSMENT PROCESS

Recognizing and controlling hazards

Engineering controls minimize employee exposure by either reducing or removing the hazard at the source or isolating the worker from the hazard. Engineering controls include eliminating toxic chemical and substituting non-toxic chemicals, enclosing work processes or confining work operations, and the installation of general and local ventilation systems. Work practice controls alter the manner in which a task is performed. Some fundamental and easily implemented work practice, controls include changing existing work practices to follow proper procedures that minimize exposures. While operating production and control equipment, inspecting and maintaining process and control equipment on a regular basis, implementing good housekeeping procedures, providing good supervision and mandating that eating, drinking, smoking, chewing tobacco or gum, and applying cosmetics in regulated areas be prohibited.

Administrative controls, include controlling employees' exposure by scheduling production and tasks, or both, in ways the minimize exposure levels. (Fig 6) For example, the employer might schedule operations with the highest exposure potential during periods when the fewest employees are present. When effective work practices or engineering controls are not feasible or while such controls are being instituted, appropriate personal protective equipment must be used. Examples of personal protective equipment are gloves, safety goggles, helmets, safety shoes, protective clothing and respirators. To be effective, personal protective equipment must be individually selected, properly fitted and periodically refitted, consciously and properly worn, regularly maintained and replaced, as necessary.

Fig 6



The employees have to comply with the procedures of this program, consult with their supervisor, when they have questions regarding the safety and health conditions of their workplace, report any accidents or job related injuries or illnesses to their supervisor and seek prompt medical treatment, if necessary.

Employees are responsible for exercising appropriate care and good judgment in preventing injuries and illnesses, adhering to all safety and health rules, policies and procedures and reporting all unsafe conditions, malfunctioning or unsafe equipment, work related accidents, injuries and illnesses, and unsafe work practices to their immediate supervisor. If that is not feasible, a report should be made to the head of their department, the plant operations safety officer, or a member of the work safe/be well committee.

Basic first-aid

Objectives: At the end of this lesson you shall be able to
- **state what is first aid**
- **list the key aims of first aid**
- **explain the ABC of the first aid**
- **brief how to give first-aid for a victim who need first aid.**

First aid is defined as the immediate care and support given to an acutely injured or ill person, primarily to save life, prevent further deterioration or injury, plan to shift the victims to safer places, provide best possible comfort and finally help them to reach the medical centre/ hospital through all available means. It is an immediate life-saving procedure using all resources available within reach.

Imparting knowledge and skill through institutional teaching at younger age group in schools, colleges, entry point at industry level is now given much importance. Inculcating such habits at early age, helps to build good healthcare habits among people.

First aid procedure often consists of simple and basic life saving techniques that an individual performs with proper training and knowledge.

The key aims of first aid can be summarized in three key points:

- **Preserve life:** If the patient was breathing, a first aider would normally place them in the recovery position, with the patient leant over on their side, which also has the effect of clearing the tongue from the pharynx. It also avoids a common cause of death in unconscious patients, which is choking on regurgitated stomach contents. The airway can also become blocked through a foreign object becoming lodged in the pharynx or larynx, commonly called choking. The first aider will be taught to deal with this through a combination of 'back slaps' and 'abdominal thrusts'. Once the airway has been opened, the first aider would assess to see if the patient is breathing.
- **Prevent further harm:** Also sometimes called prevent the condition from worsening, or danger of further injury, this covers both external factors, such as moving a patient away from any cause of harm, and applying first aid techniques to prevent worsening of the condition, such as applying pressure to stop a bleed becoming dangerous.
- **Promote recovery:** First aid also involves trying to start the recovery process from the illness or injury, and in some cases might involve completing a treatment, such as in the case of applying a plaster to a small wound.

Training

Basic principles, such as knowing to use an adhesive bandage or applying direct pressure on a bleed, are often acquired passively through life experiences. However, to provide effective, life-saving first aid interventions requires instruction and practical training. This is especially true where it relates to potentially fatal illnesses and injuries, such as those that require cardiopulmonary resuscitation (CPR); these procedures may be invasive, and carry a risk of further injury to the patient and the provider. As with any training, it is more useful if it occurs before an actual emergency, and in many countries, emergency ambulance dispatchers may give basic first aid instructions over the phone while the ambulance is on the way. Training is generally provided by attending a course, typically leading to certification. Due to regular changes in procedures and protocols, based on updated clinical knowledge, and to maintain skill, attendance at regular refresher courses or re-certification is often necessary. First aid training is often available through community organization such as the Red cross and St. John ambulance.

ABC of first aid

ABC stands for airway, breathing and circulation.

- **Airway:** Attention must first be brought to the airway to ensure it is clear. Obstruction (choking) is a life-threatening emergency.
- **Breathing:** Breathing if stops, the victim may die soon. Hence means of providing support for breathing is an important next steps. There are several methods practiced in first aid.
- **Circulation:** Blood circulation is vital to keep person alive. The first aiders now trained to go straight to chest compressions through CPR methods.

When providing first aid one needs to follow some rule. There are certain basic norms in teaching and training students in the approach and administration of first aid to sick and injured.

Not to get panic

Panic is one emotion that can make the situation more worse. People often make mistake because they get panic. Panic clouds thinking and causes mistakes. First aider need calm and collective approach. If the first aider himself is in a state of fear and panic gross mistakes may result. It's far easier to help the suffering, when they know what they are doing, even if unprepared to encounter a situation. Emotional approach and response always lead to wrong doing and may cause one to do wrong procedures. Hence be calm and focus on the given institution. Quick and confident approach can lessen the effect of injury.

Call medical emergencies

If the situation demands, quickly call for medical assistance. Prompt approach may save the life.

Surroundings play vital role

Different surroundings require different approach. Hence first aider should study the surrounding carefully. In other words, one need to make sure that they are safe and are not in any danger as it would be of no help that the first aider himself get injured.

Do no harm

Most often over enthusiastically practiced first aid viz. administering water when the victim is unconscious, wiping clotted blood (which acts as plug to reduce bleeding), correcting fractures, mishandling injured parts etc., would leads to more complication. Patients often die due to wrong FIRST AID methods, who may otherwise easily survive. Do not move the injured person unless the situation demands. It is best to make him lie wherever he is because if the patient has back, head or neck injury, moving him would causes more harm.

This does not mean do nothing. It means to make sure that to do something the care givers feel confident through training would make matters safe. If the first aider is not confident of correct handling it is better not to intervene to do it. Hence moving a trauma victim, especially an unconscious one, needs very careful assessment. Removal of an embedded objects (Like a knife, nail) from the wound may precipitate more harm (e.g. increased bleeding). Always it is better to call for help.

Reassurance

Reassure the victim by speaking encouragingly with him.

Stop the bleeding

If the victim is bleeding, try to stop the bleeding by applying pressure over the injured part.

Golden hours

India have best of technology made available in hospitals to treat devastating medical problem viz. head injury, multiple trauma, heart attack, strokes etc, but patients often do poorly because they don't gain access to that technology in time. The risk of dying from these conditions, is greatest in the first 30 minutes, often instantly. This period is referred to as Golden period. By the time the patient reach hospitals, they would have passed that critical period. First aid care come handy to save lives. It helps to get to the nearest emergency room as quickly as possible through safe handling and transportation. The shorter the time, the more likely the best treatment applied.

Maintain the hygiene

Most importantly, first aider need to wash hands and dry before giving and first aid treatment to the patient or wear gloves in order to prevent infection.

Cleaning and dressing

Always clean the wound thoroughly before applying the bandage lightly wash the wound with clean water.

Not to use local medications on cuts or open wounds

They are more irritating to tissue than it is helpful. Simple dry cleaning or with water and some kind of bandage are best.

CPR (Cardio-Pulmonary Resuscitation) can be life-sustaining

CPR can be life sustaining. If one is trained in CPR and the person is suffering from choking or finds difficulty in breathing, immediately begin CPR. However, if one is not trained in CPR, do not attempt as you can cause further injury. But some people do it wrong. This is a difficult procedure to do in a crowded area. Also there are many studies to suggest that no survival advantage when bystanders deliver breaths to victims compared to when they only do chest compressions. Second, it is very difficult to carry right maneuver in wrong places. But CPR, if carefully done by highly skilled first aiders is a bridge that keeps vital organs oxygenated until medical team arrives.

Declaring death

It is not correct to declare the victim's death at the accident site. It has to be done by qualified medical doctors.

How to report an emergency?

Reporting an emergency is one of those things that seems simple enough, until actually when put to use in emergency situations. A sense of shock prevail at the accident sites. Large crowd gather around only with inquisitive nature, but not to extend helping hands to the victims. This is common in road side injuries. No passer-by would like to get involved to assist the victims. Hence first aid management is often very difficult to attend to the injured persons. The first aiders need to adapt multi-task strategy to control the crowd around, communicate to the rescue team, call ambulance etc., all to be done simultaneously. The mobile phones helps to a greater deal for such emergencies. Few guidelines are given below to approach the problems.

Assess the urgency of the situation. Before you report an emergency, make sure the situation is genuinely urgent. Call for emergency services if you believe that a situation is life-threatening or otherwise extremely disruptive.

- A crime, especially one that is currently in progress. If you're reporting a crime, give a physical description of the person committing the crime.
- A fire - If you're reporting a fire, describe how the fire stated and where exactly it is located. If someone has already been injured or is missing, report that as well.
- A life-threatening medical emergency, explain how the incident occurred and what symptoms the person currently displays.
- A car crash - Location, serious nature of injures, vehicle's details and registration, number of people involved etc.

Call emergency service

The emergency number varies - 100 for Police & Fire, 108 for Ambulance.

Report your location

The first thing the emergency dispatcher will ask is where you are located, so the emergency services can get there as quickly as possible. Give the exact street address, if you're not sure of the exact address, give approximate information.

Give the dispatcher your phone number

This information is also imperative for the dispatcher to have, so that he or she is able to call back if necessary.

Describe the nature of the emergency

Speak in a calm, clear voice and tell the dispatcher why you are calling. Give the most important details first, then answer the dispatcher's follow-up question as best as you can.

Do not hang up the phone until you are instructed to do so. Then follow the instructions you were given.

How to do basic first aid?

Basic first aid refers to the initial process of assessing and addressing the needs of someone who has been injured or is in physiological distress due to choking, a heart attack, allergic reactions, drugs or other medical emergencies. Basic first aid allows one to quickly determine a person's physical condition and the correct course of treatment.

Important guideline for first aiders

Evaluate the situation

Are there things that might put the first aider at risk. When faced with accidents like fire, toxic smoke, gasses, an unstable building, live electrical wires or other dangerous scenario, the first aider should be very careful not to rush into a situation, which may prove to be fatal.

Remember A-B-Cs

The ABCs of first aid refer to the three critical things the first aiders need to look for.

- Airway - Does the person have an unobstructed airway?
- Breathing - Is the person breathing?
- Circulation - Does the person show a pulse at major pulse points (wrist, carotid artery, groin)

Avoid moving the victim

Avoid moving the victim unless they are immediate danger. Moving a victim will often make injuries worse, especially in the case of spinal cord injuries.

Call emergency services

Call for help or tell someone else to call for help as soon as possible. If alone at the accident scene, try to establish breathing before calling for help, and do not leave the victim alone unattended.

Determine responsiveness

If a person is unconscious, try to rouse them by gently shaking and speaking to them.

If the person remains unresponsive, carefully roll them on the side (recovery position) and open his airway.

- Keep head and neck aligned.
- Carefully roll them onto their back while holding his head.
- Open the airway by lifting the chin.(Fig 1)

Fig 1

MBN110611

Look, listen and feel for signs of breathing

Look for the victim's chest to raise and fall, listen for sounds of breathing.

If the victim is not breathing, see the section below

- If the victim is breathing, but unconscious, roll them onto their side, keeping the head and neck aligned with the body. This will help drain the mouth and prevent the tongue or vomit from blocking the airway.

Check the victim's circulation

Look at the victim's colour and check their pulse (the carotid artery is a good option; it is located on either side of the neck, below the jaw bone). If the victim does not have a pulse, start CPR.

Treat bleeding, shock and other problems as needed

After establishing that the victim is breathing and has a pulse, next priority should be to control any bleeding. Particularly in the case of trauma, preventing shock is the priority.

- **Stop bleeding:** Control of bleeding is one of the most important things to save a trauma victim. Use direct pressure on a wound before trying any other method of managing bleeding.
- **Treat shock:** Shock, a loss of blood flow from the body, frequently follows physical and occasionally psychological trauma. A person in shock will frequently have ice cold skin, be agitated or have an altered mental status, and have pale colour to the skin around the face and lips. Untreated, shock can be fatal. Anyone who has suffered a severe injury or life-threatening situation is at risk for shock.
- **Choking victim:** Choking can cause death or permanent brain damage within minutes.
- **Treat a burn:** Treat first and second degree burns by immersing or flushing with cool water. Don't use creams, butter or other ointments, and do not pop blisters. Third degree burns should be covered with a damp cloth. Remove clothing and jewellery from the burn, but do not try to remove charred clothing that is stuck to burns.

- **Treat a concussion:** If the victim has suffered a blow to the head, look for signs of concussion. Common symptoms are: loss of consciousness following the injury, disorientation or memory impairment, vertigo, nausea, and lethargy.
- **Treat a spinal injury victim:** If a spinal injury is suspected, it is especially critical, not move the victim's head, neck or back unless they are in immediate danger.

Stay with the victim until help arrives

Try to be a calming presence for the victim until assistance can arrive.

Unconsciousness (COMA)

Unconscious also referred as Coma, is a serious life threatening condition, when a person lie totally senseless and do not respond to calls, external stimulus. But the basic heart, breathing, blood circulation may be still intact, or they may also be failing. If unattended it may lead to death.

The condition arises due to interruption of normal brain activity. The causes are too many.

- Shock (Cardiogenic, Neurogenic)
- Head injury (Concussion, Compression)
- Asphyxia (obstruction to air passage)
- Extreme of body temperature (Heat, Cold)
- Cardiac arrest (Heart attack)
- Stroke (Cerbro-vascular accident)
- Blood loss (Hemorrhage)
- Dehydration (Diarrhea & vomiting)
- Diabetes (Low or high sugar)
- Blood pressure (Very low or very high)
- Over dose of alcohol, drugs
- Poisoning (Gas, Pesticides, Bites)
- Epileptic fits (Fits)
- Hysteria (Emotional, Psychological)

The following symptoms may occur after a person has been unconscious:

- Confusion
- Drowsiness
- Headache
- Inability to speak or move parts of his or her body (see stroke symptoms)
- Light headedness
- Loss of bowel or bladder control (incontinence)
- Rapid heartbeat (palpitation)
- Stupor

First aid

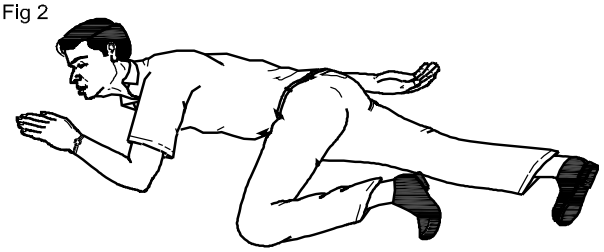
- Call EMERGENCY number.
- Check the person's airway, breathing, and pulse frequently. If necessary, begin rescue breathing and CPR.
- If the person is breathing and lying on the back and after ruling out spinal injury, carefully roll the person onto the side, preferably left side. Bend the top leg so both hip and knee are at right angles. Gently tilt the head back to keep the airway open. If breathing or pulse stops at any time, roll the person on to his back and begin CPR.
- If there is a spinal injury, the victims position may have to be carefully assessed. If the person vomits, roll the entire body at one time to the side. Support the neck and back to keep the head and body in the same position while you roll.
- Keep the person warm until medical help arrives.
- If you see a person fainting, try to prevent a fall. Lay the person flat on the floor and raise the level of feet above and support.
- If fainting is likely due to low blood sugar, give the person something sweet to eat or drink when they become conscious.

DO NOT

- Do not give an unconscious person any food or drink.
- Do not leave the person alone.
- Do not place a pillow under the head of an unconscious person.
- Do not slap an unconscious person's face or splash water on the face to try to revive him.

Loss of consciousness may threaten life if the person is on his back and the tongue has dropped to the back of the throat, blocking the airway. Make certain that the person is breathing before looking for the cause of unconsciousness. If the injuries permit, place the casualty in the recovery position(fig 2) with the neck extended. Never give anything by mouth to an unconscious casulaty.

Fig 2



How to diagnose an unconscious injured person

- **Consider alcohol:** look for signs of drinking, like empty bottles or the smell of alcohol.
- **Consider epilepsy:** are there signs of a violent seizure, such as saliva around the mouth or a generally disheveled scene?

- **Think insulin:** might the person be suffering from insulin shock (see 'How to diagnose and treat insulin shock")?
- **Think about drugs:** was there an overdose? Or might the person have under dosed - that is not taken enough of a prescribed medication?
- **Consider trauma:** is the person physically injured?
- **Look for signs of infection:** redness and/ or red streaks around a wound.
- **Look around for signs of poison:** an empty bottle of pills or a snakebite wound.
- **Consider the possibility of psychological trauma:** might the person have a psychological disorder of some sort?
- **Consider stroke:** particularly for elderly people.
- Treat according to what you diagnose.

Shock (Fig 3)

A severe loss of body fluid will lead to a drop in blood pressure. Eventually the blood's circulation will deteriorate and the remaining blood flow will be directed to the vital organs such as the brain. Blood will therefore be directed away from the outer area of the body, so the victim will appear pale and the skin will feel ice cold.

Fig 3

Safe disposal of waste materials

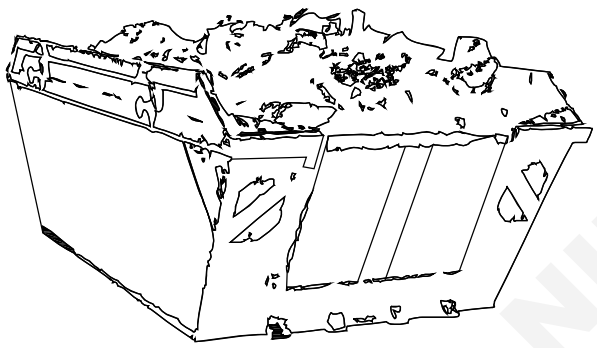
Objectives: At the end of this lesson you shall be able to
- **safe disposal of waste**
- **disposal of construction waste**
- **do's and don'ts in disposing construction waste.**

Safe Disposal of Waste

Construction waste consists of unwanted material generated as a result of construction work.

This includes building materials such as bricks, mortar, cables and wires, insulation, nails, wood and concrete. It also includes materials like debris, tree stumps, and rubble. (Fig 1)

Fig 1



CONSTRUCTION WASTE

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Construction waste may contain materials that are hazardous or harmful to environment, and health and safety of the workers such as lead, asbestos etc. For example when wires are burned in open it release fumes that are toxic in nature. A toxic substance means any chemical or mixture that may be harmful to the environment and to human health if inhaled, swallowed, or absorbed through the skin.

In order to avoid damage to health, safety and environment, construction waste material should be reduced, reused and recycled. Materials that cannot be used should be disposed and managed in a right manner.

Assistant Electrician should inform the supervisor about the waste accumulated at the site to seek guidance for appropriate ways of reuse, reduce, recycle and disposal.

For example,

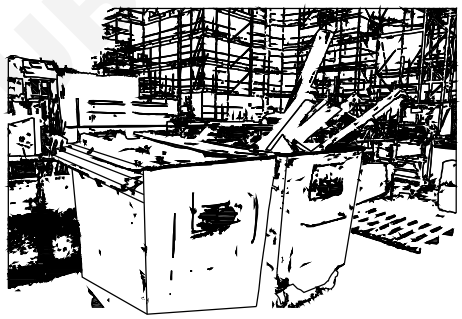
1 Debris, rubble, concrete can be used for landfills and new site formation.

2 Concrete, mortar, bricks can be recycled for construction work.

3 Packaging waste, wood can be reused or recycled.

Construction waste can be classified into the following types: (Fig 2)

Fig 2



SEGREGATION OF CONSTRUCTION WASTE

MBN110712

1 **Wood:** Plywood or sawdust (Fig 3)

2 **Masonry:** Brick, concrete, mortar

3 **Metal:** Rebars, pipes, beams

4 **Plastic:** Plumbing pipes, PVC, plastic sheets

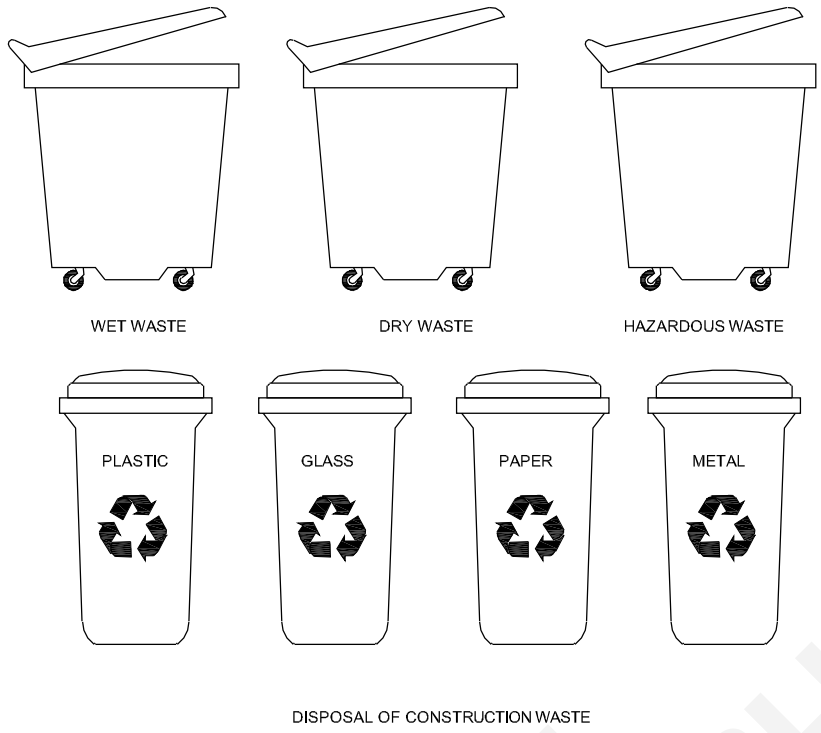
5 **Cardboard:** Cardboard packaging material

6 **Electrical:** Wires, cables and other material

7 **Other** such as paper, fibre glass etc.,

This waste needs to be disposed of in a suitable environmental friendly way.

Fig 3



DISPOSAL OF CONSTRUCTION WASTE

DO's and Don'ts in disposing construction waste

Do's	Don'ts
• Eliminate waste by storing materials and avoiding damage or loss.	• Do not put waste into wrong waste container.
• Reduce the amount of waste by keeping materials their packaging to protect from damage.	• Do not open new cans or prepare mortar in large amount before the ones is used or empty.
• Reuse materials like wood or plastic for alternative purposes.	• Do not leave the material in rain or ground as they may get damaged.
• Recycle materials whenever possible packaging paper and cardboard.	• Do not burn wires as they may emit hazardous fumes.
• Segregate waste into different types like wires, wood, plastic.	• Do not mix different types of waste as it may prevent from recycling and reusing.
• Store waste as marked on the waste container kept at site.	
• Follow instructions about waste disposal laid by the organisation or supervisor.	

Guidelines for good shop floor maintenance

Objectives: At the end of this lesson you shall be able to
- **list the benefits of a shop floor maintenance**
- **state what is 5S**
- **list the benefits of 5S.**

Benefits of a shop floor maintenance

Some of the benefits which may be derived from the utilization of a good Shop Floor Maintenance are as follows:

- Improved Productivity.
- Improved operator efficiencies.
- Improved support operations such as replenishment moves and transportation of work in process and finished goods .
- Reduction of scrap.
- Better control of your manufacturing process.
- More timely information to assist shop floor supervisors in managing their assigned production responsibilities.
- Reduction of down time due to better machine and tool monitoring.
- Better control of Work In Progress inventory, what is and where it is improved on time schedule performance.

5S Concept

5S is a Japanese methodology for work place organisation. In Japanese it stands for seiri (SORT), seiton (SET), seiso (SHINE), seiketsu(STANDARDIZE), and shitsuke (SUSTAIN).

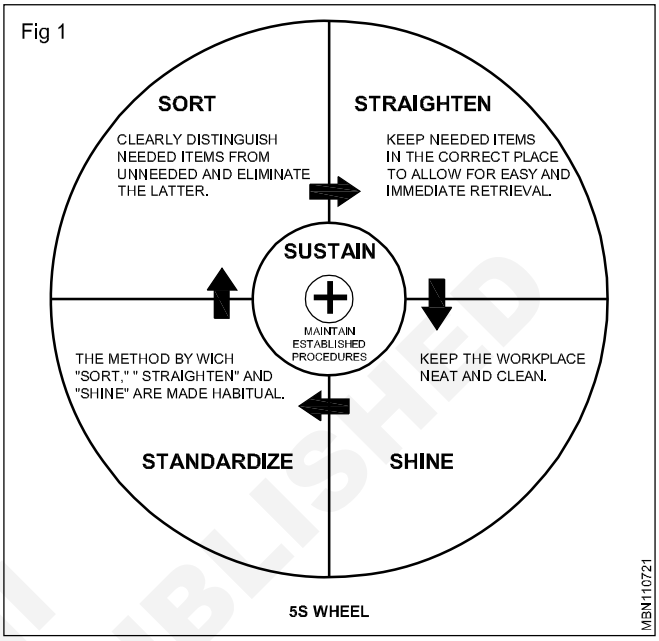
The list describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order. The list describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order.

5S Wheel (Fig 1)

The Benefits of the 5s system

- Increases in productivity
- Increases in quality
- Reduction in cost

Fig 1



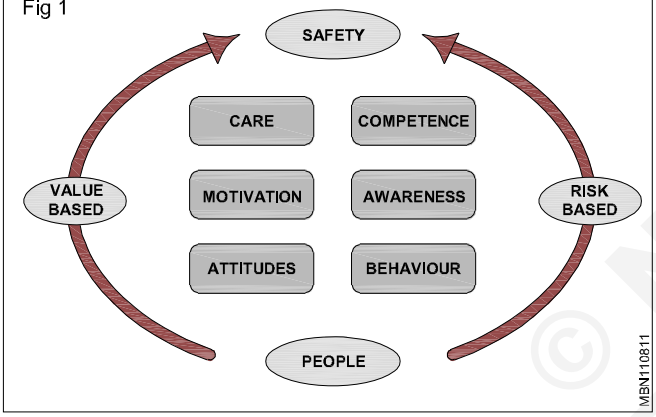
Occupational safety and health

Objectives: At the end of this lesson you shall be able to
- **define occupational safety and health**
- **state the importance of safety and health at workplace**
- **state the role of employer, trade union & employee for health & safety program.**

Occupational Safety and Health (OSH) is an area concerned with protecting the safety, health and welfare of people engaged in co-workers, family members, employees, customers, and many others who might be affected by the workspace environment.

Workspace safety : Owner/Occupier of industries have to comply with legal directions to take care for the safety, health and welfare of their employees. Equally the workers have moral responsibilities to follow all safety norms and healthy on the shop- floor (Fig 1).

Fig 1



Occupational health : Health at work is also called occupational health. It is concerned with enabling an individual to undertake their day to day work fully knowing the health hazards they are exposed to and preventing them at the workspace.

Good safety and health practices can also reduce employee injury and illness related costs, including medical care, sick leave and disability benefit costs. (Fig 2)

Fig 2

The joint ILO/WHO committee on occupational health (1995) main focus in occupational health is on three different objectives.

i The maintenance and promotion of workers health and working capacity.

ii The improvement of working environment and work to become conductive to safety and health.

iii Development of work organization and working cultures in a direction which supports health and safety at work and in doing so also promotes a positive social climate and smooth operation and may enhance productivity of the undertakings.

Employment and working conditions in the formal or informal economy embrace other important determinants, including working hours, salary, workspace policies concerning maternity leave, health promotion and protection provisions etc.

The health of the workers has several determinants, including risk factors at the workspace leading to accidents, musculoskeletal diseases, respiratory diseases, hearing loss, circulatory diseases, stress related disorders and communicable diseases and others.

Creating safe and healthy working conditions is a challenge to all industries, as the new technologies and new patterns of work are fast growing. The challenges, changes resulting new risks and disorders are many. When safety and health measures are not followed or fail, accidents, injuries, diseases and even deaths may occur.

Victims of workspace injuries and occupational diseases have to be compensated properly. Prevention actions at workspace are needed so that similar cases will be prevented. The industries and the working population and their families including the dependent population will benefit from the good practice of occupational safety and health.

Safety problems in work settings range from immediate threats like toxic substances and grievous bodily injuries to subtle progressive dangers such as repetitive motion injuries, high noise levels, and air quality. In general, workplace hazards can be categorized into three groups:

1 **Chemical hazards,** in which the body absorbs toxins.

2 **Ergonomic hazards,** in which the body is strained or injured, often over an extended period, because of the nature (design) of the task, its frequency, or intensity.

3 Physical hazards, in which the worker is exposed to harmful elements or physical dangers, such as heat or moving parts.

In the modern context, corporate management increasingly has viewed industrial safety measures as an investment - one that may save money in the long run by way of reducing disability pay, improving productivity and avoiding lawsuits.

Prevention is better than cure :

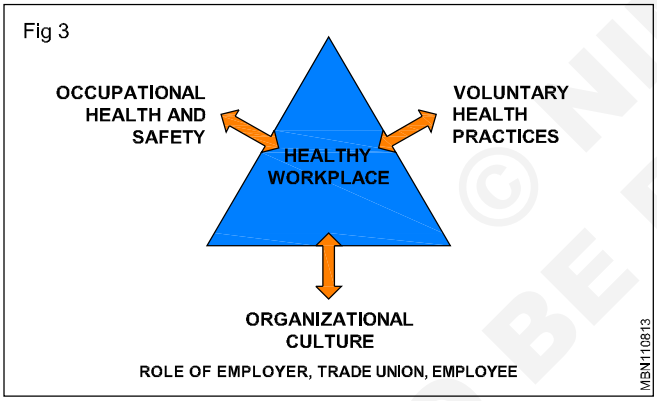
No place of work can always be completely safe all the time and whilst some work places present greater risks than others. Industry nowhere is immune to the possibility of an accident. Hence all industries should develop the ability to carry out risk assessment processes and to take all precautionary steps to ensure the safety of the workforce. It is a group collective effort that includes each and every member of the workforce. Employers should always ensure they do the following.

- Provide adequate control of the health and safety risks.
- Consult with employees on matters affecting their health and safety.
- Provide and maintain safe plant and equipment.
- Ensure safe handing and use of substances.
- Provide information, instruction, supervision and training so that employees are competent to carry out their role.
- Review and revise all these policies regularly.

Health and Safety programmes

For all of the reasons (Fig 3), it is crucial that employers, workers and unions are committed to health and safety, addressing the following areas.

Fig 3



- Workplace hazards are controlled - at the source whenever possible ;
- Records of any exposure are maintained for many years.
- Both workers and employers are informed about health and safety risks in the workplace.
- Establish an active and effective health and safety committee that includes both workers and management.
- To observe that the workers' health and safety efforts are ongoing.

Effective workplace health and safety programmes can help to save the lives of workers by reducing hazards and their consequences. Health and safety programmes also have positive effects on both worker morale and productivity, which are important benefits. At the same time, effective programmes can save employers a great deal of money.

Healthy workplace, hazard free work environment, zero accident work-life can help to save the lives of workers by reducing hazards and diseases. Effective programmes can also have positive effects on both worker morale and productivity. All put together enhance the human values at work and prosperity of the nation.

1 Occupational health and safety encompasses the social, mental and physical well-being of workers in all occupations.

2 Poor working conditions have the potential to affect a worker's health and safety.

3 Unhealthy or unsafe working conditions can be found anywhere, whether the workplace is indoor or outdoor.

4 Poor working conditions can affect the environment workers live in. This means that workers, their families, other people in the community, and the physical environment around the workplace, can all be at risk from exposure to workplace hazards.

5 Employers have a moral and often legal responsibility to protect workers.

6 Work-related accidents and diseases are common in all parts of the world and often have many direct and indirect negative consequences for workers and their families. A single accident or illness can mean enormous financial loss to both worker and employers.

7 Effective workplace health and safety programmes can help to save the lives of workers by reducing hazards and their consequences.

8 Effective programmes can also have positive effects on both worker morale and productivity, and can save employers a great deal of money.

Occupational hazard

Objectives: At the end of this lesson you shall be able to
- **explain various occupational hazard**
- **state occupational hygiene**
- **describe occupational disease disorders and its prevention.**

All jobs, primarily provides many economic and other benefits, But equally there are a wide varieties of workplace dangers and hazards, which are risky to the health and safety of people at work.

Basic hazards

Employers have a responsibility to protect workers against health and safety hazards at work. Workers have the right to know about potential hazards and to refuse work that they believe is dangerous. Workers also have a

responsibility to work safely with hazardous materials. Health and Safety hazards exist in every workplace. Some are easily identified and corrected, while others create extremely dangerous situations that could be a threat to your life or long-term health. The best way to protect oneself is to learn to recognize and prevent hazards in the workplaces.

Physical hazards are the most common hazards and are present in most workplace at some point of time. Examples include; live electrical cords, unguarded machinery, exposed moving parts, constant load noise, vibrations, working from ladders, scaffolding or heights, spills, tripping hazards. Physical hazards are a common source of injuries in many industries. Noise and vibration, Electricity, Heat, Ventilation, Illumination, Pressure, Radiation etc.

- **Ventilation** and air circulation have major say on the health and working comfort of the worker. There must be good ventilation, a supply of fresh, clean air drawn from outside is required. It must be uncontaminated and circulated around the workspace. Closed of confined spaces also present a work hazard, which has limited openings for entry and exit and unfavorable natural ventilation, and which is not intended for continuous employee occupancy.

Spaces of this kind can include storage tanks, ship compartments, sewers, and pipelines. Asphyxiation is another potential work hazard in certain situations. Confined spaces can pose a hazard not just to workers, but also to people who try to rescue them.

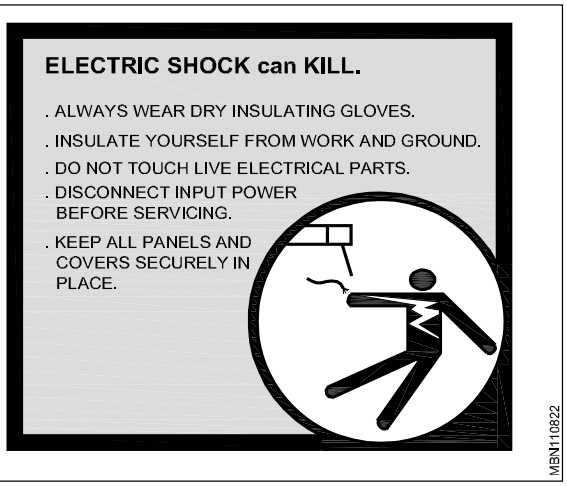
- **Noise and Vibration :** Noise and vibration are both fluctuations in the pressure of air (or other media) which affect the human body. Vibrations that are detected by the human ear are classified as sound. We use the term 'noise to indicate unwanted sound. Noise and vibration can harm workers when they occur at high levels, or continue for a long time. (Fig 1)

Fig 1

- **Electricity** poses a danger to many workers. Electrical injuries caused by contact with electric energy can be divided into four types
- fatal electrocution,
- electric shock,
- burns,
- falls .

Wires and electrical equipment pose safety threats in the workspace. When employees mishandle electrical equipment and wires, they are taking risks. (Fig 2)

Fig 2



- **Temperature (Heat Stress) :** A reasonable working temperature, for strenuous work, local heating or cooling where a comfortable temperature is to be maintained which is safe and does not give off dangerous or offensive fumes, Thermal clothing and rest facilities where necessary (for example, for 'hot work' or work in cold storage areas). Sufficient space in workrooms etc. are under the legislation for implementation by the owner of the factories.
- **Illumination (lighting) :** Good light lighting is essential for productivity Natural light is preferred where possible. Glare and flickering should be avoided.

HEAT EXHAUSTION/HEAT STROKE & TREATMENT

- **NORMAL BODY CORE TEMPERATURE - 37°C**
- **HEAT EXHAUSTION - 38°C - 40°C**
- **HEAT STROKE 41°C AND HIGHER**

SIGNS AND SYMPTOMS

HEAT EXHAUSTION	HEAT STROKE
• RESTLESS	• REDUCED LEVEL OF CONCIOUSNESS
• WEAK	• IRRITABLE
• DIZZY	• MUSCULAR PAIN
• RAPID PULSE	• RAPID PULSE
• LOW BLOOD PRESSURE	• HIGH BLOOD PRESSURE
• NAUSEA	• NAUSEA
• VOMITTING	• VOMITTING
• MENTAL STATUS - NORMAL	• MENTAL STATUS - CONFUSED
• BEHAVIOR - NORMAL	• BEHAVIOUR - ERRATIC
	• HOT, DAY, RED SKIN
	• DEATH

TREATMENT

• LAY PERSON DOWN & ELEVATE LEGS	• MOVE PERSON TO COOL VENTILATED AREA
• ENSURE NORMAL BREATHING	• CHECK FOR BREATHING, PULSE & CIRCULATION
• IF THIRSTY GIVE WATER TO DRINK	• IF POSSIBLE COVER THE PERSON WITH ICE PACKS OR COLD WATER TO REDUCE THE BODY TEMPERATURE
• REPORT INCIDENT TO SUPERVISOR	• GIVE WATER TO DRINK
	• MONITOR VITAL SIGNS
	• GET PERSON TO HOSPITAL
	• REPORT INCIDENT TO SUPERVISOR

Chemical hazards are present when you are exposed to any chemical preparation (solid, liquid or gas) in the workplace. Examples include: cleaning products and solvents, vapours and fumes, carbon monoxide or other gases, gasoline or other flammable materials. Chemicals hazards are the major causes of concern. Many chemicals are used not on generic names but on brands. The chemicals have biological effects on the human body if digested, inhaled or if direct skin contact with the chemicals, injuries occurs.

Accidents involving chemical spills, exposure and inhalation can lead to burns, blindness, rashes and other ailments. Most of them cause acute poisoning when taken orally, eye-skin irritation, Respiratory injuries etc. Long term effects of chemicals on blood, nerve, bones, kidneys, livers etc., my lead to serious diseases/disorders. The only way is to understand their chemical nature and handle them very carefully.

CHEMICAL POISONING

Poison : An agent or substances which may cause structural damage or functional disorders when introduced into the body by :

- **Ingestion**
- **Inhalation**
- **Absorption or**
- **Injection**

Biological hazards (Fig 3) come for working with people, animals or infectious plant material. Examples include; blood or other bodily fluids, bacteria and viruses, insect bites, animal and bird droppings. Biological hazards are due agent like bacteria, virus, fungi, mold, blood-borne pathogens etc., are main agents to cause various illness. (Fig 4)

Fig 3

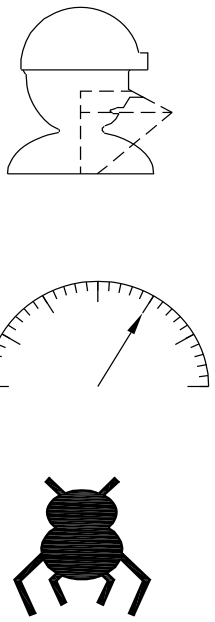
BIOLOGICAL HAZARD

MBN110823

Ergonomic hazards (Fig 5)

Ergonomic hazards occur when the type of work you do, your body position and/or your working conditions put a strain on your body. They are difficult to identify because you don't immediately recognize the harm they are doing to your health. Examples include: poor lighting, improperly adjusted workstations and chairs, frequent lifting, repetitive or awkward movements. Muscular Skeletal Disorders (MSDs) affect the muscles, nerves and tendons. Work related MSDs are one of the leading causes injury and illness.

Fig 4



BIOLOGICAL HAZARD

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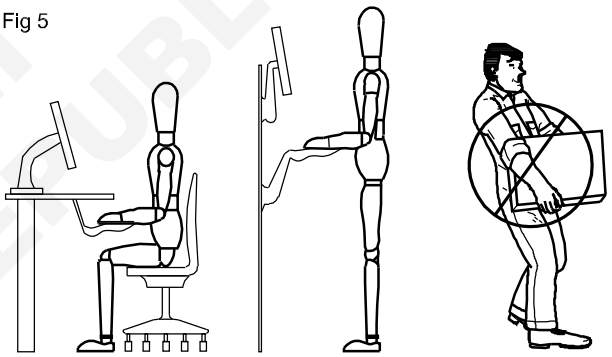
Fig 5



ERGONOMIC HAZARDS

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Workers in many different industries and occupations can be exposed to risk factors at work, such as lifting heavy items, bending, reaching overhead, pushing and pulling heavy loads, working in awkward body postures and performing the same or similar tasks repetitively. Exposure to these known risk factors for MSDs increases a worker's risk of injury.

Mechanical hazards are factor arise out of varieties of machines in industries including manufacturing, mining, construction and agriculture. They are dangerous to the worker when operated without training and experience. Operating machines can be risky business, especially large, dangerous machines. When employees don't know how to properly use machinery or equipment, they risk such injuries as broken bones, amputated limbs and crushed fingers. Many machines involve moving parts, sharp edges, hot surfaces and other hazards with the potential to crush, burn, cut, shear, stab or otherwise strike or wound workers if used unsafely.

Various safety measures exists to minimize these hazards, lockout-tag out procedures for machine maintenance and roll over protection systems for vehicles.

Machines are also often involved indirectly in worker deaths and injuries, such as in cases in which a worker slips and falls, possibly upon a sharp or pointed object. Safeguarding machinery decreases accidents and keeps employees who use the machine safer.

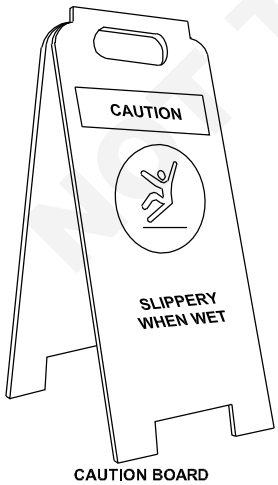
Falls (Fig 6) are a common cause of occupational injuries and fatalities, especially in construction, extraction, transportation, healthcare, and building cleaning and maintenance. Slips and falls to be the leading cause of workplace injuries and fatalities. From slippery surfaces to un-railed staircases, the possibility of slipping, tripping or falling on the job is a workplace safety hazard. Broken bones, fractures, sprained wrists and twisted ankles constitute some of the physical injuries caused by falling accidents.

Fig 6

MBN110826

Falls in the workplace is effectively prevented by putting caution signs around slippery surfaces (Fig 7), having rails on every staircase and making sure that wires on the floor are covered to avoid tripping. They are perhaps unavoidable in certain industries, such as construction and mining, but over time people have developed safety methods and procedures to manage the risks of physical danger in the workplace. Employment of children may pose special problems.

Fig 7



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Psychosocial hazards : psychosocial hazards are related to the way work is designed, organized and managed, as well as the economic and social contexts of work and are associated with psychiatric, psychological and/or physical injury or illness. Linked to psychosocial risks are issues such as occupational stress and workplace violence which are becoming a major challenge to occupational health and safety.

Workplace inspections prevent hazards

Regular workplace inspections are another important factor in preventing injuries and illnesses. By critically examining all aspects of the workplace, inspections identify and record hazards that must be addressed and corrected.

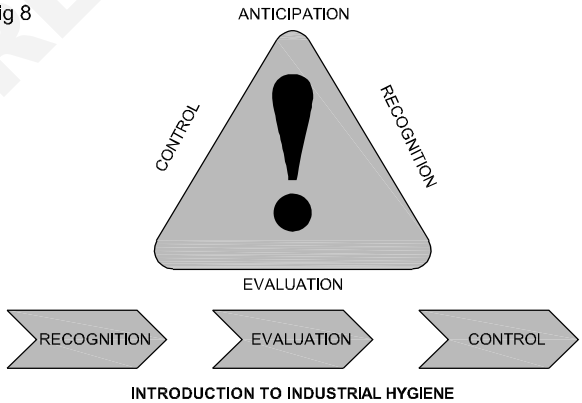
A workplace inspection should include

- Listening to the concerns of workers and supervisors.
- Gaining further understanding of jobs and tasks.
- Identifying existing and potential hazards.
- Determining underlying causes of hazards.
- Monitoring hazard controls (Personal protective equipment, engineering controls, policies, procedures)
- Recommending corrective action.

Occupational hygiene

Occupational hygiene (Industrial hygiene) (Fig 8) is the discipline of anticipating, recognizing, evaluating and controlling health hazards in the working environment with the objective of protecting worker health and well-being and safeguarding the community at large.

Fig 8



MBN110828

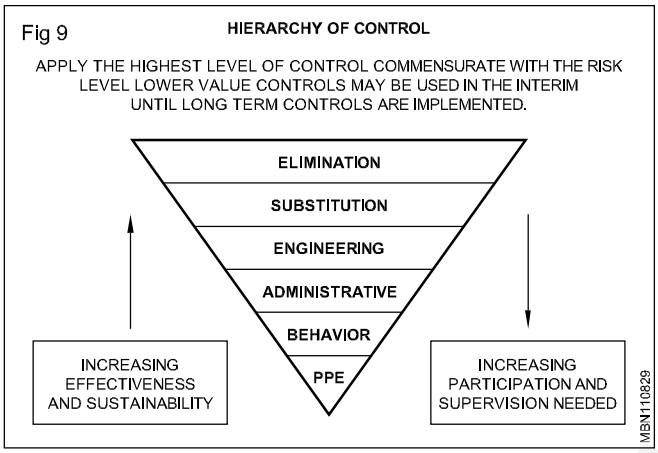
Occupational hygiene uses science and engineering to prevent ill health caused by the environment in which people work. It helps employers and employees to understand the risks and improve working conditions and working practices. (Fig 9)

Occupational disease/Disorders & its prevention

Occupational disease, illness incurred because of the conditions or environment of employment. Unlike with accidents, some time usually elapses between exposure to the cause and development of symptoms. In some instances, symptoms may not become evident for may years and hence the relationship between work and disease is ignored.

Among the environmental causes of occupational disease are subjection to extremes of temperature leading to heatstroke, air contaminants of dust, gas, fumes causing diseases of the respiratory tract, skin, or muscles and joints or changes in atmospheric pressure causing decompression sickness, excessive noise causing hearing loss, exposure to infrared or ultraviolet radiation or to radioactive substances. The widespread use of X rays, radium and materials essential to the production of nuclear power has led to an special awareness of the dangers of radiation sickness. Hence careful checking of equipment and the proper protection of all personnel are now mandatory.

Fig 9 HIERARCHY OF CONTROL



In addition there are industries in which metal dusts, chemical substances, and unusual exposure to infective substances constitute occupational hazards. The most common of the dust and fiber inspired disorders are the lung diseases caused by silica, beryllium, bauxite and iron ore to which miners, granite workers and many others are exposed causing pneumoconiosis and those caused by asbestos is cancer - mesothelioma, Fumes, Smoke and Toxic liquids from a great number of chemicals are other occupational dangers. Carbon monoxide, Carbon tetrachloride, Chlorine, Creosote, Cyanides, Dinitrobenzene, Mercury, Lead Phosphorus and nitrous chloride are but a few of the substances that on entering through the skin, respiratory tract or digestive tract cause serious and often fatal illness.

Occupational hazards also are presented by infective sources. Persons who come into contact with infected animals in a living or deceased state are in danger of acquiring such diseases as anthrax. Doctors, Nurses and other hospital personnel are prime targets for the tuberculosis bacillus and for many other infectious organisms.

Road safety

Objectives: At the end of this lesson you shall be able to
- **list three kinds of road sign**
- **describe the marking on the road**
- **describe the various police traffic hand signal and light signal**
- **list the collision causes.**

In older days road locomotive carrying a red flag by day and red lantern by night. Safety is the prime motive of every traffic.

Kinds of road signs

Mandatory

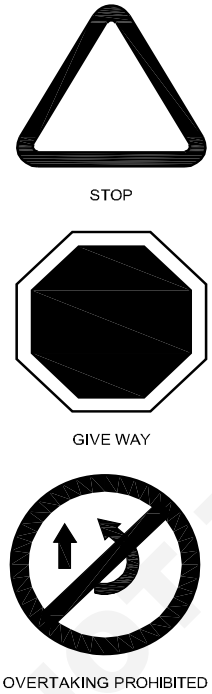
Cautionary and

Informatory

Mandatory sign (Fig 1)

Violation of mandatory sign can lead to penalties. Ex. Stop, give way, limits, prohibited, no parking and compulsory sign.

Fig 1



Cautionary signs (Fig 2)

Cautionary/ warming signs are especially safe. Do's and don't's for pedestrians, cyclists, bus passengers and motorists.

Information signs (Fig 3)

Information signs as especially benefit to the passengers and two wheelers.

Marking lines on road (Fig 4)

- Marking lines are directing or warn to the moving vehicles, cyclist and pedestrians to follow the law.

Fig 2

Fig 3

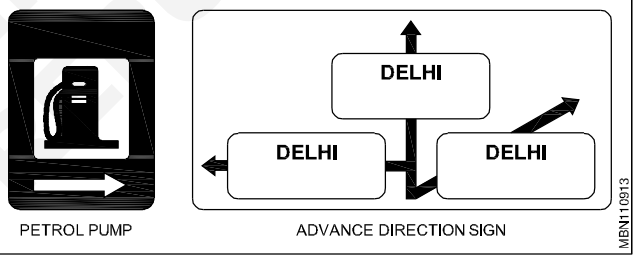
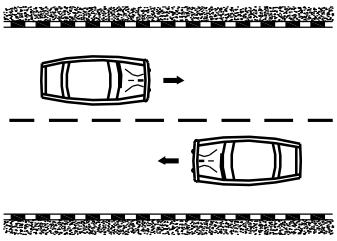


Fig 4



- Single and short broken lines with middle of the road allow the vehicle to cross the dotted lines safely overtake whenever required.
- When moving vehicle approaching pedestrian crossing, be ready to slow down or stop to let people cross.
- Do not overtake in the vicinity of pedestrian crossing.

Police signals

To stop a vehicle approaching from behind. (Fig 5(1))

To stop a vehicle coming from front. (Fig 5(2))

To stop vehicles approaching simultaneously from front and behind. (Fig 5(3))

To stop traffic approaching from left and wanting to turn right. (Fig 5(4))

To stop traffic approaching from the right to allow traffic from left to turn right. (Fig 5(5))

To allow traffic coming from the right and turning right by stopping traffic approaching from the left. (Fig 5(6))

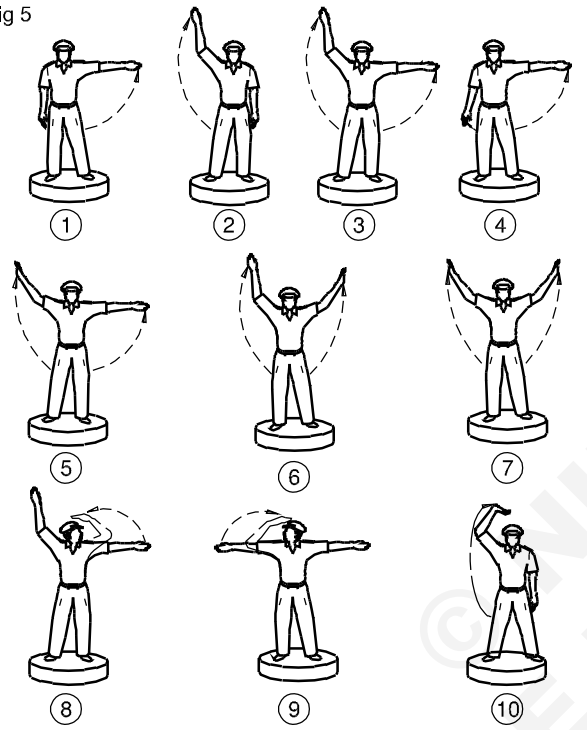
Warning signal closing all traffic. (Fig 5(7))

Beckoning on vehicles approaching from left. (Fig 5(8))

Beckoning on vehicles approaching from right. (Fig 5(9))

Beckoning on vehicles from front. (Fig 5(10))

Fig 5



POLICE SIGNALS

MBN110915

Traffic light signals

Red means stop. Wait behind the stop line on the carriage way. (Fig 6(1))

Red and amber also means stop. Do not pass through or start until green shows. (Fig 6(2))

Green means you may go on if the way is clear. Take special care if you mean to turn left or right and give way to pedestrians who are crossing. (Fig 6(3))

Amber means stop at the stop line. you may only go on if the amber appears after you have crossed the stop line or so close to it that to pull up may not be possible. (Fig 6(4))

Green arrow means that you may go in the direction shown by the arrow. You may do this whatever other lights may be showing. (Fig 6(5))

Pedestrians - do not cross. (Fig 6(6))

Pedestrians - cross now. (Fig 6(7))

Flashing red means stop at the stop line and if the way is clear proceed with caution. (Fig 6(8))

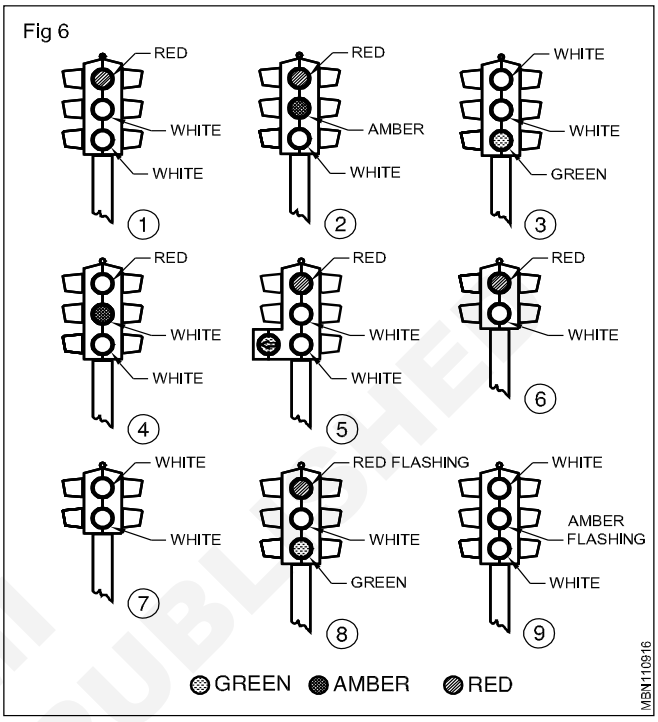
Flashing amber means proceed with caution. (Fig 6(9))

Collision causes

Three factors are responsible for collision

- Roads
- Vehicles and
- Drivers.

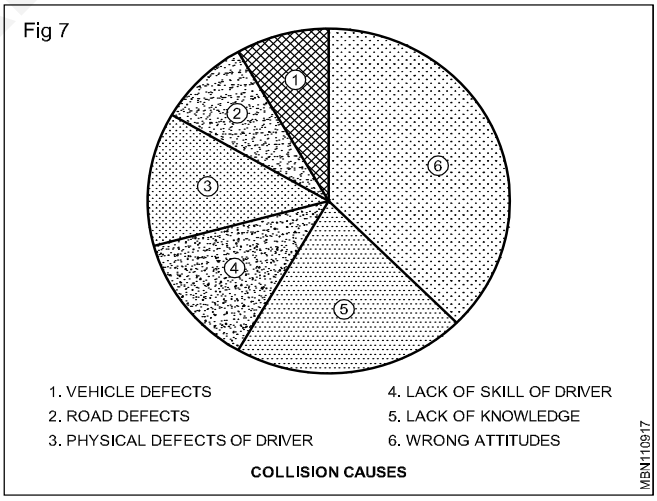
Fig 6



MBN110916

The (Fig 7) shows approximately proportionate causes of collision. In wrong attitudes such that avoid foolish acts at the wheel. Driving time is not play time. (Fig 8)

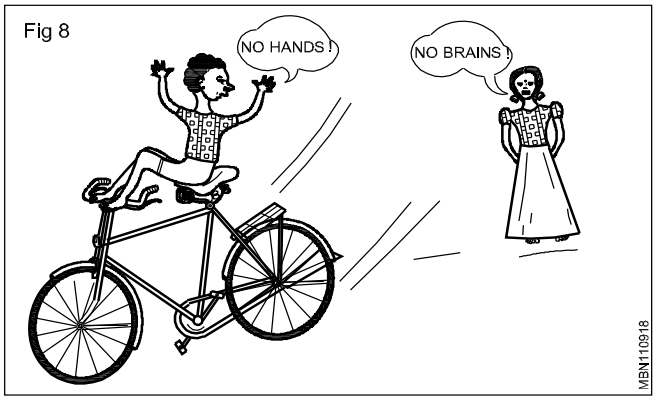
Fig 7



COLLISION CAUSES

MBN110917

Fig 8



MBN110918

Electrical safety

Objective: At the end of this lesson you shall be able to
- **rescue a person who is in contact with a live wire.**

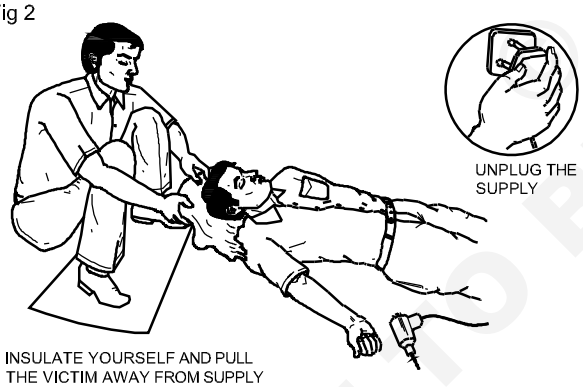
The severity of an electric shock will depend on the level of current which passes through the body and the body and the length of time of contact. Do not delay, act at once. Make sure that the electric current has been disconnected.

If the casualty is still in contact with the supply- break the contact either by switching off the power, removing the plug or wrenching the cable free. If not, stand on some insulating material such as dry wood, rubber or plastic, or using whatever is at hand to insulate yourself and break the contact by pushing or pulling the person free.(Fig1 &2)

Fig 1

MBN111011

Fig 2



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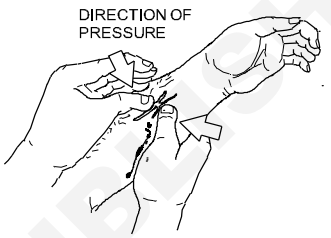
If you remain un-insulated, do not touch the victim with your bare hands until the circuit is made dead or he is moved away from the equipment.

If the victim is aloft, measures must be taken to prevent him from falling or at least make him fall safe.

Electric burns on the victim may not cover a big area but may be deep seated. All you can do is to cover the area with a clean, sterile dressing and treat for shock. Get expert help as quickly as possible.

If the casualty is unconscious but is breathing, loosen the clothing about the neck, chest and waist and place the casualty in the recovery position. (Fig 3)

Fig 3

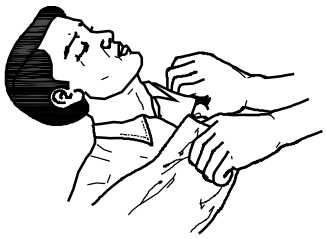


MBN111013

Keep a constant check on the breathing and pulse rate.

Keep the casualty warm and comfortable. (Fig 4)

Fig 4



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Send for help.

Do not give an unconscious person anything by mouth.

Do not leave an unconscious person unattended.

If the casualty is not breathing - Act at once - don't waste time!

Safety practice - First aid

Objective: At the end of this lesson you shall be able to
- **treat a person for electric shock/injury.**

Electric shock: The severity of an electric shock will depend on the level of the cut tent which passes through the body and the length of time of the contact.

Other factors that contribute to the severity of shock are:

- age of the person
- not wearing insulating footwear or wearing wet foot-wear.
- floor is wet or dry
- weather condition
- mains voltage etc.

Effects of electric shock: The effect of current at very low levels may only be an unpleasant tingling sensation, but this in itself may be sufficient to cause one to lose his balance and fall.

At higher levels of current, the person receiving the shock may be thrown off his feet and will experience severe pain, and possibly minor burns at the point of contact.

At an excessive level of current flow, the muscles may contract and the person unable to release his grip on the conductor. He may lose consciousness and the muscles of the heart may contract spasmodically (fibrillation). This may be fatal.

Electric shock can also cause burning of the skin at the point of contact.

Treatment of electric shock

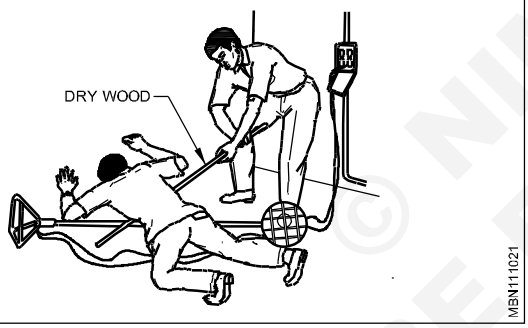
Prompt treatment is essential.

If assistance is close at hand, send for medical aid, then carry on with emergency treatment.

If you are alone, proceed with treatment at once.

Switch off the current, if this can be done without undue delay. Otherwise, remove the victim from contact with the levee conductor, using dry non-conducting materials such as a wooden bar, rope, a scarf, the victim's coat-tails, any dry article of clothing, a belt, rolled-up newspaper, non-metallic hose, PVC tubing, bakelised paper, tube etc. (Fig 1)

Fig 1



Avoid direct contact with the victim. Wrap your hands in dry material if rubber gloves are not available.

Electrical burns: A person receiving an electric shock easy also sustain burns when the current passes through his body. Do not waste time by applying first aid to the burns until breathing has been restored and the patient can breathe normally-unaided.

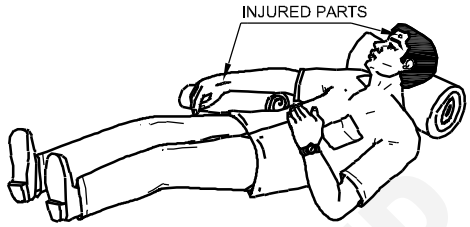
Burns and scalds: Burns are very painful. If a large area of the body is burnt, give no treatment, except to exclude the air, eg. by covering with water, clean paper, or a clean shirt. This relieves the pain.

Severe bleeding: Any wound which is bleeding profusely especially in the wrist, hand or fingers must be considered serious and must receive professional attention. As an immediate first aid measure, pressure on the wound itself is the best means of stopping the bleeding and avoiding infection.

Immediate action: Always in cases of severe bleeding:

- make the patient lie down and rest
- if possible, raise the injured part above the level of the body (Fig 2)

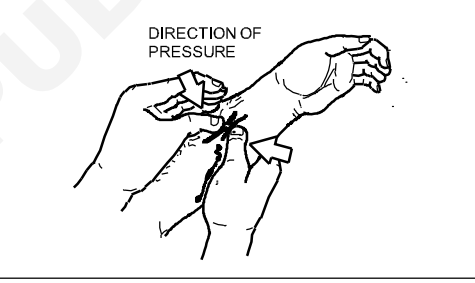
Fig 2



- apply pressure to the wound
- summon assistance.

To control severe bleeding: Squeeze together the sides of the wound. Apply pressure as long as it is necessary to stop bleeding. When the bleeding has stopped, put a dressing over the wound, and cover it with a pad of soft material. (Fig 3)

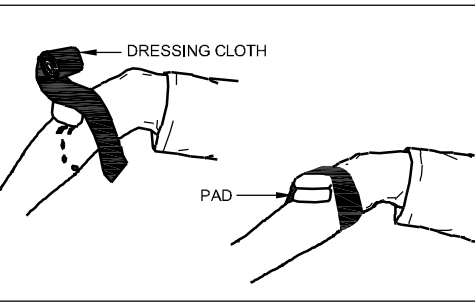
Fig 3



For an abdominal stab wound, such as may be caused by falling on a sharp tool, keep the patient bending over the wound to stop internal bleeding.

Large wound: Apply a clean pad (preferably an individual dressing) and bandage firmly in place. If bleeding is very severe apply more than one dressing.(Fig 4)

Fig 4



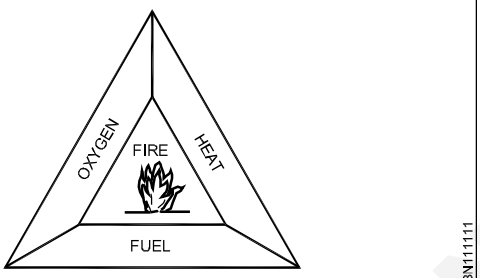
Safety practice - Fire extinguishers

Objectives: At the end of this lesson you shall be able to
- **state the effects of a fire breakout**
- **state the causes for fire in the workshop**
- **state the conditions required for combustion relevant to fire prevention**
- **state the general precautionary measures to be taken for fire prevention.**

Fire is the burning of combustible material. A fire in an unwanted place and on an unwanted occasion and in uncontrollable quantity can cause damage or destroy property and materials. Fires injure people, and sometimes, cause loss of life. Hence, every effort must be made to prevent fire. When a fire outbreak is discovered, it must be controlled and extinguished by immediate correct action.

Is it possible to prevent fire? Yes, by eliminating anyone of the three factors that cause fire. (Fig 1)

Fig 1



The factors that must be present in combination for a fire to continue to burn are as follows.

Fuel Any substance, liquid, solid, or gas will burn if given oxygen and high enough temperature.

Heat Every fuel will begin to burn at a certain temperature. Solids and liquids give off vapour when heated and it is this vapour which ignites. Some liquids give off vapour even at normal room temperature say 15°C, eg. petrol.

Oxygen Usually it exists in sufficient quantity in air to keep a fire burning.

EXTINGUISHING OF FIRES

Isolating or removing any of these factors from the combination will extinguish the fire. There are three basic ways of achieving this.

- Starving the fire of fuel by removing the fuel in the vicinity of fire.
- Smothering - i.e. by isolating the fire from the supply of oxygen by blanketing it with foam, sand etc.
- Cooling - i.e. by using water to lower the temperature.

Preventing fires

The majority of fires begin with small outbreaks which burn unnoticed until they become big fires of uncontrollable magnitude. Most of the fires could be prevented with more care and by following some rules of simple common sense.

Accumulation of combustible refuse (cotton waste soaked with oil, scrap wood, paper, etc.) in odd corners are of fire risk. Refuse should be removed to collection points.

The cause of fire in electrical equipment is misuse or neglect. Loose connections, wrongly rated fuses or cables, overloaded circuits cause over heating which may in turn lead to fire. Damage to insulation between conductors in cables also causes fire.

Clothing and anything else which might catch fire should be kept well away from heaters. Make sure the heater is shut off at the end of a working day.

Highly flammable liquids and petroleum mixtures (Thinner, Adhesive solutions, Solvents, Kerosene, Spirit, LPG Gas etc.) should be stored in a separate place called the flammable material storage area.

Blowlamps and torches must not be left burning when they are not in use.

Classification of fires and recommended extinguishing agents.

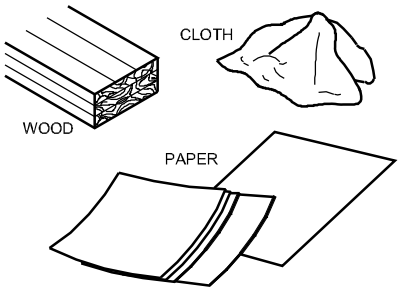
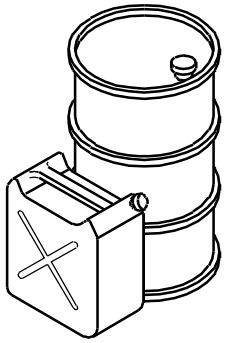
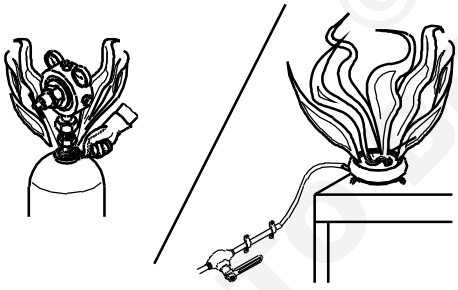
Fires are classified into four types in terms of the nature of fuel.

Different types of fire have to be dealt with different ways and with different extinguishing agents.

An agent is the material or substance used to put out the fire, and is usually (but not always) contained in a fire extinguisher with a mechanism for spraying into the fire.

It is important to know the right type of agent for a particular type of fire; using the wrong one can make things worse.

There is no classification for 'electrical fires' as such, since these are only fires in materials where electricity is present.

Fuel		Extinguishing
CLASS 'A' Fire	Wood, paper, cloth etc. Solid materials. 	Most effective i.e. cooling with water. Jets of water should be sprayed on the base of the fire and then gradually upwards.
CLASS 'B' Fire	Flammable liquids & liquefiable solids 	Should be smothered. The aim is to cover the entire surface of the burning liquid. This has the effect of cutting off the supply of oxygen to the fire. Water should never be used on burning liquids. Foam, dry powder or CO_2 may be used on this type of fire.
CLASS 'C' Fire	Gas and liquefied gas 	Extreme caution is necessary in dealing with liquefied gases. There is a risk of explosion and sudden spreading of fire in the entire vicinity. If an appliance fed from a cylinder catches fire - shut off the supply of gas. The safest course is to raise an alarm and leave the fire to be dealt with by trained personnel. Dry powder extinguishers are used on this type of fire. Special powders have now been developed which are capable of controlling and/ or extinguishing this type of fire.
CLASS 'D' Fire	Involving metals 	The standard range of fire extinguishing agents is inadequate or dangerous when dealing with metal fires. Fire on electrical equipment. Carbon dioxide, dry powder and vapourising liquid (CTC) extinguishers can be used to deal with fires in electrical equipment. Foam or liquid (e.g. Water) extinguishers must not be used on electrical equipment under any circumstances.

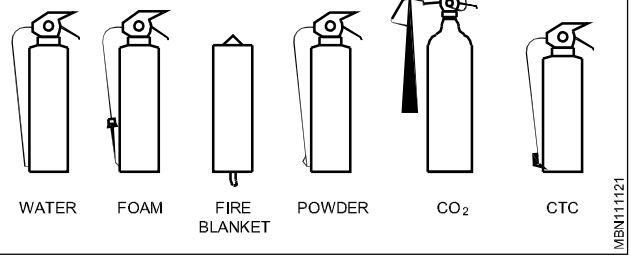
Types of fire extinguishers

Objectives: At the end of this lesson you shall be able to
- **distinguish different types of fire extinguishers**
- **determine the correct type of fire extinguisher to be used based on the class of fire**
- **describe the general procedure to be adopted in the event of a fire.**

A fire extinguisher, flame extinguisher or simply extinguisher is an active fire protection device used to extinguish or control small fires, often in emergency situation. It is not intended for use on an out off control fire.

Many types of fire extinguishers are available with different extinguishing 'agents' to deal with different classes of fires. (Fig 1)

Fig 1

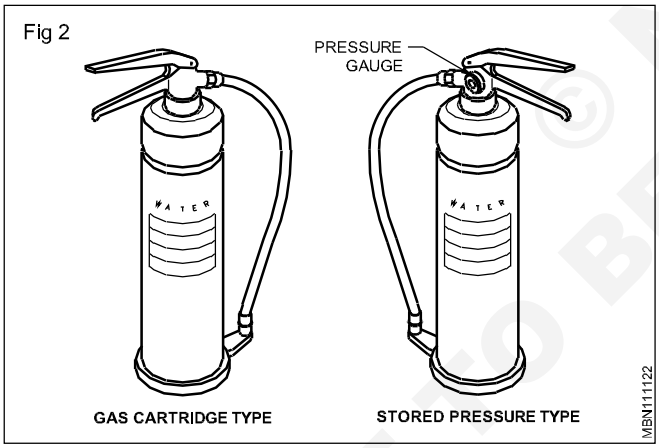


Water-filled extinguishers

There are two methods of operation. (Fig 2)

- Gas cartridge type
- Stored pressure type

Fig 2



With both methods of operation the discharge can be interrupted as required, conserving the contact and preventing unnecessary water damage.

Foam extinguishers (Fig 3)

These may be of stored pressure or gas cartridge types.

Always check the operating instructions on the extinguisher before use.

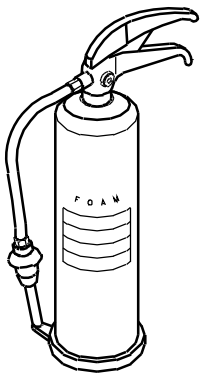
Foam extinguishers are most suitable for:

- flammable liquid fires

- running liquid fires

Must not be used where electrical equipment is involved.

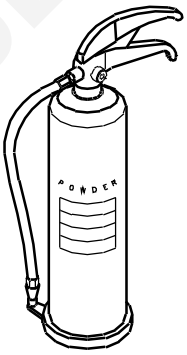
Fig 3



Dry powder extinguishers (Fig 4)

Extinguishers fitted with dry powder may be of the gas cartridge or stored pressure type. Appearance and method of operation is the same as that of the water-filled one. The main distinguishing feature is the fork-shaped nozzle. Powders have been developed to deal with class D fires.

Fig 4



Carbon dioxide (CO_2)

This type is easily distinguished by the distinctively shaped discharge horn. (Fig 5)

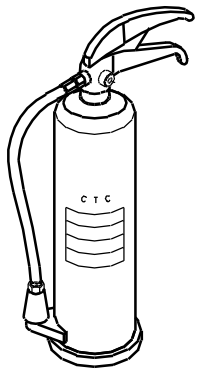
Fig 5

Suitable for class B fires. Best suited where contamination by deposits must be avoided. Not generally effective in open air.

Always check the operating instructions on the container before use. Available with different gadgets of operation such as - plunger, lever, trigger etc.

Halon extinguishers (Fig 6)

Fig 6



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These extinguishers may be filled with carbon tetrachloride and bromochlorodifluoro methene (BCF). They may be of either gas cartridge or stored pressure type.

They are more effective in extinguishing small fires involving pouring liquids. These extinguishers are particularly suitable and safe to use on electrical equipment as the chemicals are electrically non-conductive.

The fumes given off by these extinguishers are dangerous, especially in confined space.

General procedure to be adopted in the event of a fire to be adopted.

- Raise an alarm.
- Turn off all machinery and power (gas and electricity).
- Close the doors and windows, but do not lock or bolt them. This will limit the oxygen fed to the fire and prevent its spreading.
- Try to deal with the fire if you can do so safely. Do not risk getting trapped.
- Anybody not involved in fighting the fire should leave calmly using the emergency exits and go to the designated assembly point. Failure to do this may mean that some person is unaccounted for and others may have to put themselves to the trouble of searching for him or her at risk to themselves.

General precautions and safety measures while working in masonry jobs

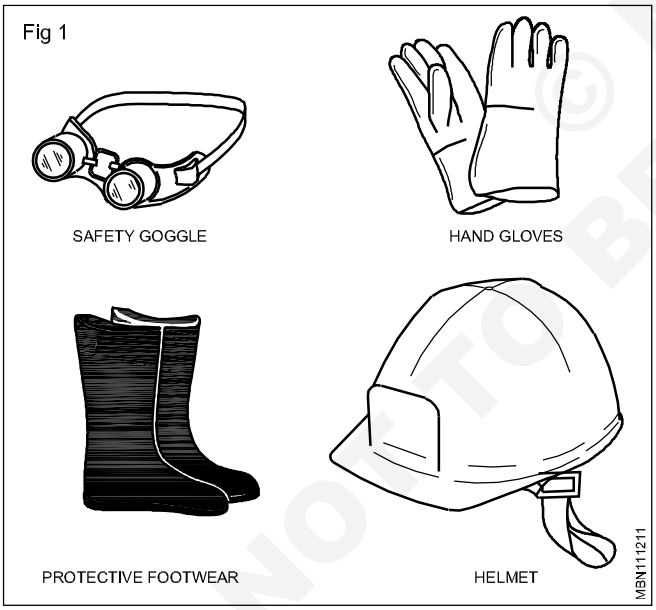
Objective: At the end of this lesson you shall be able to
- **describe the general precautions to be observed in a masonry (building constructor) yard.**

- The general precautions to be observed in a masonry Yard or workshop.
- Accidents are quite frequent in the building industry.
- These accidents often result in lost time or the job, partial or total disability or even loss of life.
- Accidents can be reduced if each person works safely and uses the precautions that the nature work requires.
- Safety precautions can be classified;
  - Safety for self
  - Safety for colleague and others
  - Safety for tools and equipments
  - Safety for materials.

1 Safety for Personal

- Always avoid loose clothing.
- Wear goggles while grinding the tools.
- Wear the safety shoes. (Fig 1)

Fig 1



- Do not through any sharp instruments.
- Do not through brick or brick bats from top.
- Check the scaffolding before you climb up.

2 Safety for colleague and others

- Give caution before lifting heavy units.
- Lifting heavy units by crow bar put some lever underneath the crow bar.
- Combined job is carried out give caution time to time and do safe work.

3 Safety for Tools and equipment

- Use proper tools for proper work.
- Do not throw any tools either from top or at bottom.
- All the tools should be washed and oiled after use.
- All the tools should be cleaned and washed and kept in a safe place.

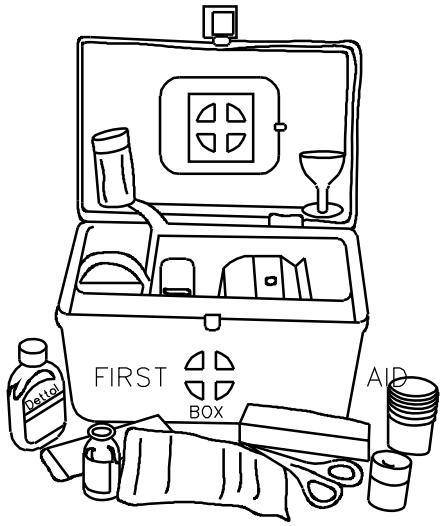
4 Safety for Materials

- Bricks should be stacked properly and bricks should not be allowed to be scattered on the work place.
- Cement bags are staked properly on the wooden planks placed on the floor.
- Provide sufficient space say 0.5 meter away from wall and place cement bags.
- Cement godown should be free from air tight, otherwise cement may get spoiled.

General safety measures

- Electric wire / cables
- High tension / Low tension electric line passing near by the slab, care should be taken while placing reinforcement by working persons.
- While placing concrete it may affect working persons.
- Throwing of waste materials bricks bats, broken blocks may lead to injury to persons working below.
- Scaffolding should be erected firmly and properly braced.
- Walking on parapet wall may fall down due to in balance condition.
- Take more care while using the ladders because it may slip and fall down.
- The lift pit is left unguarded the children of workers may fall in the resulting in fatal accident.
- Bar bending work helpers of bar benders to follow short cut method throw surplus steel pieces form top floor to ground and may cause fatal injuries.
- Do not use faulty tools and equipment. Repair or replace these tools.
- Keep the working area clean, many accidents are caused by litter underfoot.
- Personal safety protective kit (Fig 2)
- Protecting workmen from injury during the execution job, safety precautions play a vital role.

Fig 2



- **Safety gloves:** Used for material handling welding machine, gas cutter etc. (Fig 1)
- **Safety Helmets:** Use where site work is going on at different levels. (Fig 1)
- **Gumboots:** For cutting hard rock, concreting works, Asphalting etc. (Fig 1)
- **Safety Belt:** Used for workmen working on height, on outer sides of the building.
- **Safety Goggles:** Used for while grinding for gas welding, breaking of pavements etc as shown in figure.
- Site or work spot should have a list of following emergency telephone numbers.
- Fire 101
- Ambulance 108
- Police 100
- Nearest doctor xxxxx

First Aid

- First aid is an immediate and temporary care given to the victim of an accident, or sudden illness till the treatment from the doctor is made available.
- First aid kit (Fig 2)
- Cotton dressing
- General medicine
- Triangular bandage
- Potassium permanganate
- Pocket of cotton wool
- Roller bandage 25 mm
- Roller bandage 75 mm
- Iodine bottle
- Dettol
- Safety pins
- Scissors
- Knife
- Blade

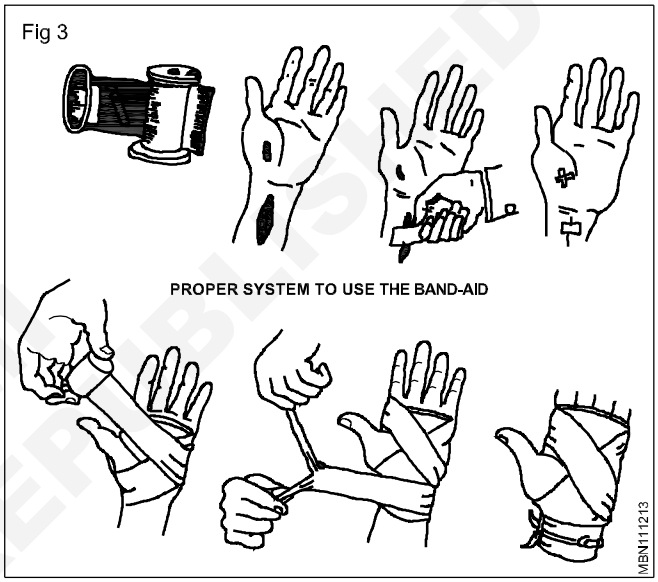
Major possible injuries at site

- In construction work major injuries may causes in the following
- Bleeding
- Sudden stoppage of respiration
- Fracture.

Bleeding

- Usually bleeding can be controlled by direct pressure applied to the wound with a sterile dressing or any cloth. As shown in (Fig 3).

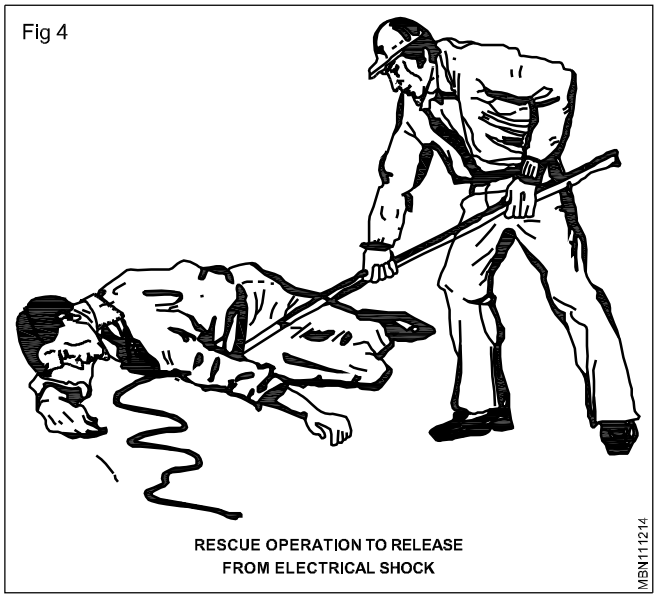
Fig 3



Sudden Respiratory Blockage

- In the case of electric shock, gas poisoning, suffocation etc, where breathing is stopped immediate action is necessary. As shown in (Fig 4).

Fig 4



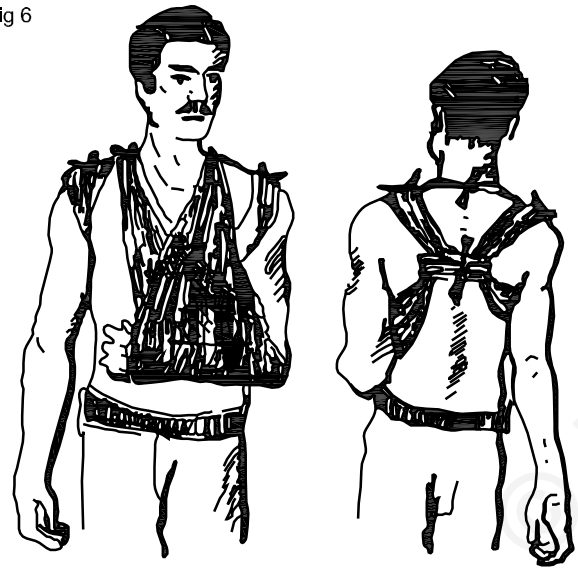
- Mouth to mouth respiration should be started as quickly as possible without any time loss. As shown in (Fig 5).

Fig 5

Fractures

- In the case of visible fractures and even a fracture is suspected, the adjacent joints should be immobilized.
- If the fracture is with bleeding it should be controlled.
- Care should be taken not to disturb the fractured bone. As shown in (Fig 6).

Fig 6



TEMPORARY BANDAGE FOR FRACTURE

- Excavation of soil for column footings and for deep trenches.
- Sliding of earth or soil from sides of column pits or deep trenches. As shown in (Fig 7).

Fig 7

WE HAVE TAKEN ALL THE SAFETY PRECAUTIONS ON THIS SITE SIR !

Snake bite Precautions and First aid

- Snake bite is the most common accident observed on construction site.
- One should know whether bitten snake was poisonous or non - poisonous. As shown in (Fig 8).

Fig 8

DANGER OF SNAKES WHILE EXCAVATION

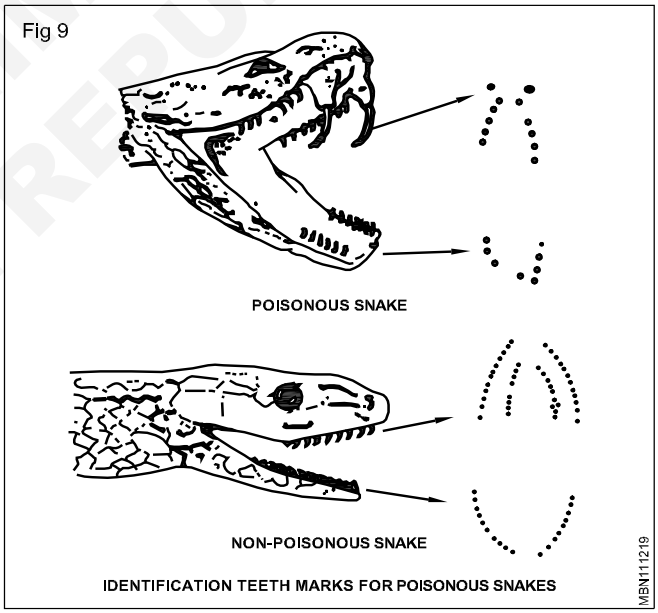
Poisonous Snake

- Only two prominent.
- Marks of the fangs can be seen after the bite.

Non - Poisonous Snake

Two rows of marking of small teeth can be seen after biting. As shown in (Fig 9).

Fig 9



IDENTIFICATION TEETH MARKS FOR POISONOUS SNAKES

- First Aid treatment on snake bite
- Tie a cloth immediately around the patient in resting position.
- Do not allow the affected portion of the body to move.
- Wash the wound with clear water.
- Take for medical treatment. As shown in (Fig 10).

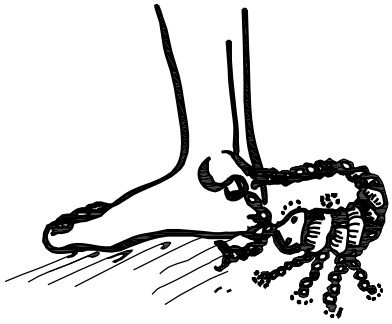
Scorpion stings (Fig 11)

- Usually two types of scorpions red and black.
- Tie the cloth immediately upper portion.
- Take for medical treatment nearest doctor.

Fig 10

MBN11121A

Fig 11



MBN11121B

- Accidents during slab concreting.
- Column reinforcement cage may collapse.
- Lift scaffolding means vertical probs not fixed well may collapse while concreting.
- Wrong signal to lift operator and misoperation of lift may lead to accident. As shown in (Fig 12).

Fig 12

MBN11121C

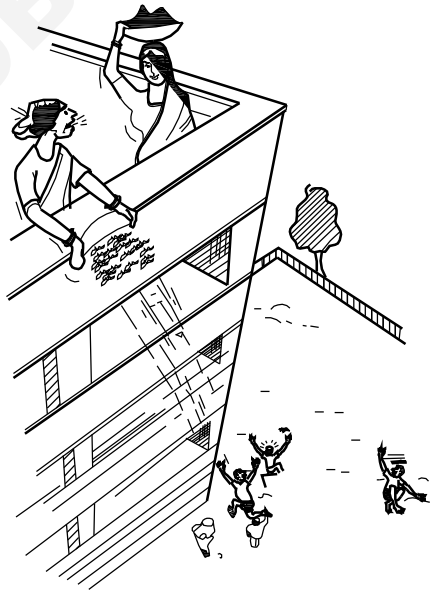
Accidents due to Electric cables

- Careful working near cable area. All the necessary precaution to be taken. Otherwise accidents may happens as shown in (Fig 13).
- In construction site the waste materials such as broken brick bats, waste concrete or other debris should not be thrown from top to the bottom of the ground. Otherwise accidents may cause as shown in (Fig 14).

Fig 13

MBN11121D

Fig 14



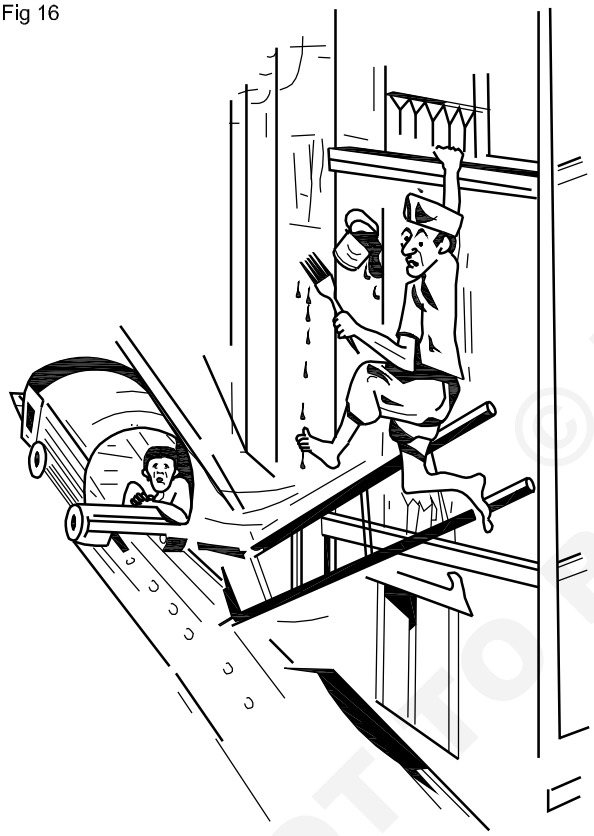
MBN11121E

- Careless way of curing may cause accidents as shown in (Fig 15).
- Working on ladder may slip and painter may fall.
- Use safety belt anchored to hooks.
- Co-worker to hold the ladder firmly.
- Ladder should be anchored properly as shown in (Fig 16).
- Causes of Electrical accidents
- The common causes of Electrical accidents at site.

Fig 15

MBN11121F

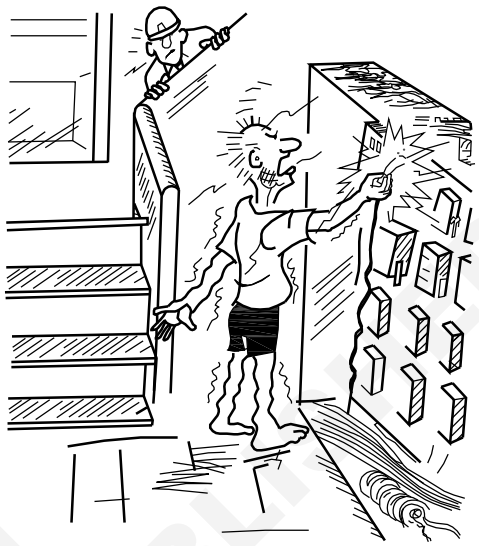
Fig 16



MBN11121G

- Insertion of the loose wires in sockets without a plug pin.
- This is the most common practice, and the cause of most of the electrical accidents at construction site.
- Insertion of loose wires is mostly done by the unskilled workers, helpers, etc. As shown in (Fig 17).

Fig 17



CAUSES OF ELECTRICAL ACCIDENTS

MBN11121H

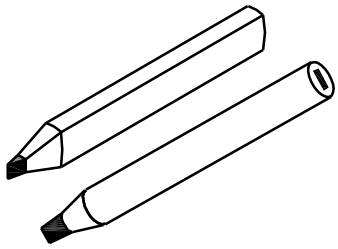
Carpenter's pencil & marking instruments (Tools)

Objectives: At the end of this lesson you shall be able to
- **state the meaning of marking**
- **state the uses of pencil**
- **state constructional features and uses of steel rule**
- **state constructional features and uses of collapsible rule and folding rule**
- **state the uses of measuring tape.**

Marking off or layout is carried out to indicate the location of operation to be done and provide guidance during sequence of operations.

- Marking out is done with pencil or scriber.
- Carpenter's pencil usually is an oval cross-section. (Fig 1)

Fig 1



CARPENTER'S PENCIL

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- It is sharpened with a chisel.
- The pencil is not used for an accurate work.
- Suitable pencil hardness for marking out on 'H.B' 'H' and 'F'.

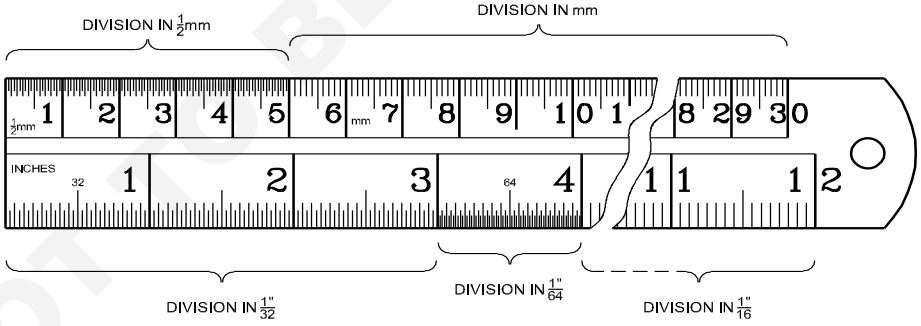
The Rule (Steel) (Fig 2)

- In the workshop wooden or steel rules are used.
- The division in cm is 30cm long and sub divided in mm (2) and half mm (3).
- The division in inches is 12 inches (12") long twelve inches equals one english foot 12" = 1'.
- The Sub division is accurate in 1/16" Fig 4 in 1/32" (5) and In 1/64" (6).
- For the conversion of parts of an Inch in to the metric system (with units: m, cm, mm) a conversion table might be useful.

Collapsible Carpenter's rule (Zig-Zag) (Fig 3) : It is also called Zig-Zag rule. It consists of 10 pieces each loosely rivetted to one another. Each piece is 10cm long and total length is 1 metre.

Longer distances can be measured with this rule. Some times it contains British system measurements on the other side.

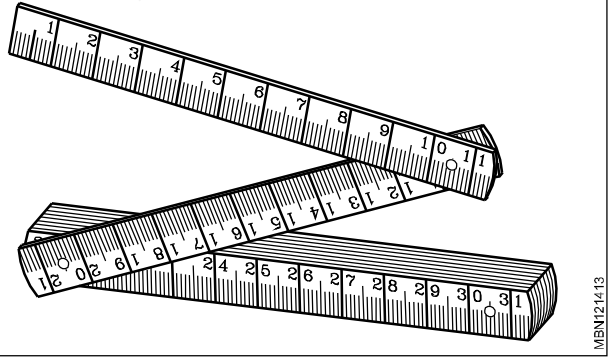
Fig 2



METAL (STEEL) BENCH RULE

MBN121412

Fig 3



MBN121413

Folding Rule (Fig 4) : It has four folds each of which is 6 inches or 150mm long. It is joined in a plastic a metallic hinge. After taking measurement, keep the scale folded and free from dust. It is easily carried in packets.

Tape measurement Fig (5)

- Tape measures are used for longer measurements. The tape is made of steel and is durable and accurate. When not in use, the tape should be kept in the box. Division are made in centimeters or in inches.
- Tape measure has a sliding end piece for inside and outside measurement.

Fig 4

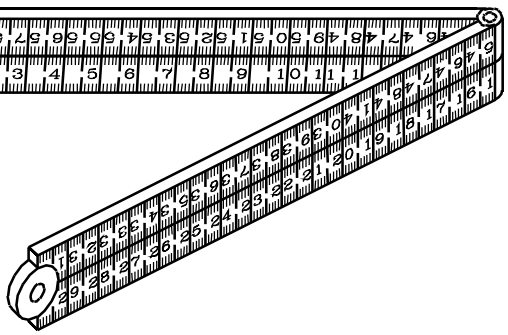


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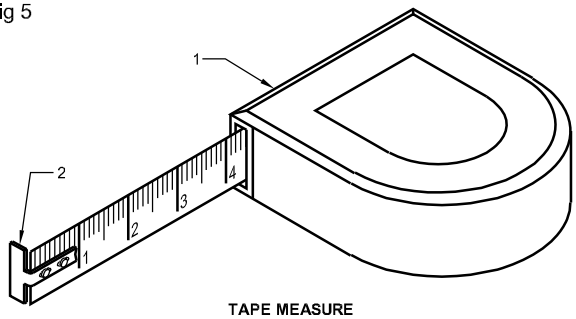
Fig 5



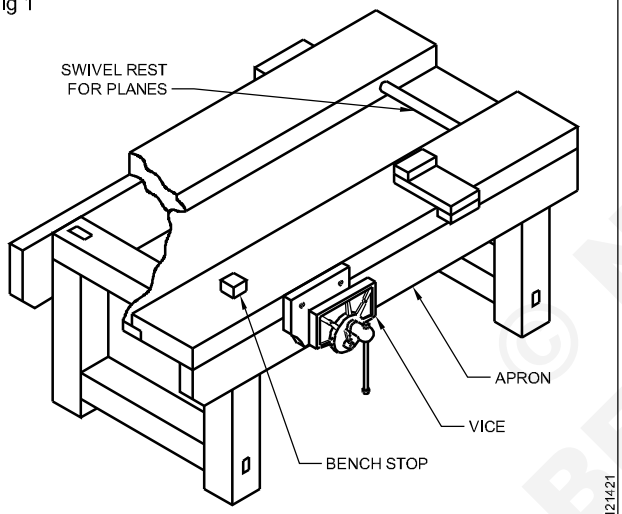
MBN121415

Carpenter's work bench

Objectives: At the end of this lesson you shall be able to
- **state constructional feature of work bench**
- **state the uses of work bench**
- **state the specification of work bench for single and double man working.**

Work bench (Fig 1)

Fig 1

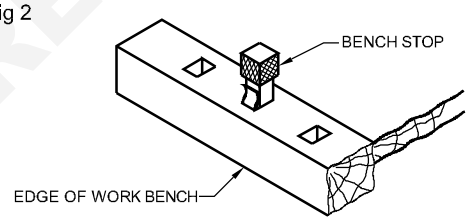


WORK BENCH

MBN121421

- It is a heavy table of rigid construction made of hard wood. Two or four carpenters vices are fitted on the opposite sides to hold the jobs. One Jaw of the vice is secured to the table and the other is kept movable.
- Shelves or racks can also be provided on the table.
- The length is 120cm to 180 cm and width 90 cm for single man work bench and the width is 120 cm for double man work bench.
- The bench is mostly useful to cut and saw the woods, to plane the woods, ripping tenons, chiseling out wastes and for all other wood working purposes.
- The tool well is in the middle for the work bench and is slightly in lower level to accommodate the working tools.
- To avoid slipping while planning operations a bench stop is fixed which can be raised or lowered. Bench stops are made of wood pieces and has teeth at its one end. It is used for supporting the work during wood working operations. (Fig 2)

Fig 2



MBN121422

- Swivel rest is provided to keep the planes when it is idle and not in use.
- Apron is the longer piece of wood nailed on the longer side of the work bench for rigidity.
- The level of the work bench surface would be uniform and even.
- Care should be taken to see that while nailing sawing and chiseling there would not be any marks left on the surface.

Carpenter's vice

At the end of this lesson you shall be able to
- **state the constructional features of carpenter vice**
- **state the uses of carpenter vice**
- **state the size of carpenter vice.**

Wood must be held steadily. If it is to be accurately sawn, chiseled and planed.

- For this reason carpenter's work bench consist different types of vice.
- Most commonly fitted bench vice consist of two metal Jaws to hold the work.
- One Jaw of the vice is fixed to the work bench.
- The other Jaw is movable parallel to the fixed jaw.

- To operate this there is a threaded shaft and a handle.
- Two wooden blocks are used inside the Jaws to protect the work from damage.

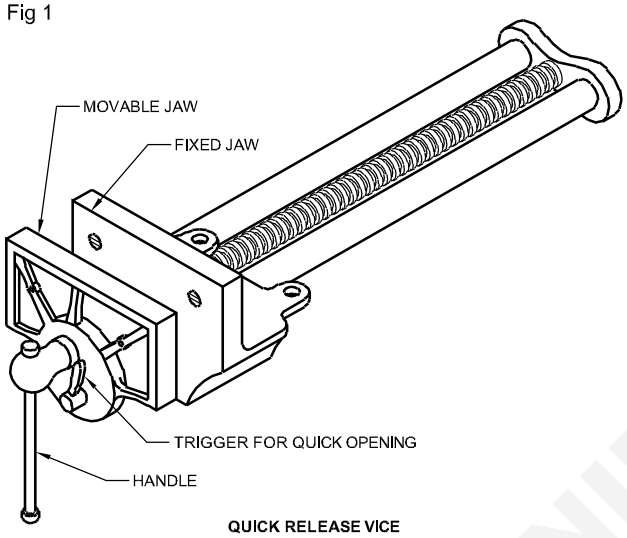
There are two types of vice

1 Quick release vice

2 Saw vice

- In the quick release vice moveable jaw is quickly released and get clamped with fixed Jaw.
- A box nut is provided in its threaded shafts for the quick release system (Fig 1).

Fig 1



QUICK RELEASE VICE

- The jaw is made of cast iron.
- The threaded shaft is made of steel.
- The vice is specified by the width of the Jaw.

Precautions

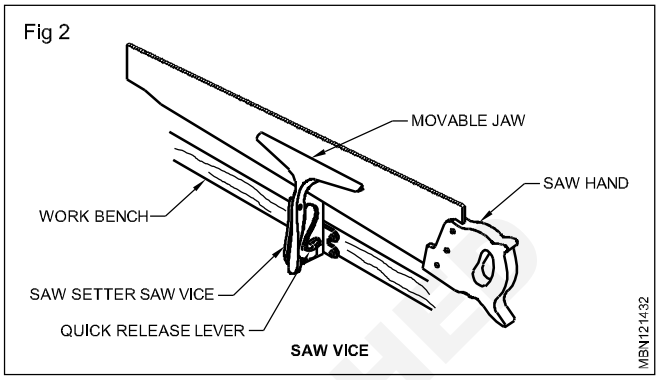
1 Vices should not be used as ANVIL.

2 The thread shaft and box nut should lubricated.

3 The handles should not be hammered to tighten the jaw.

Constructional feature of saw vice. (Fig 2)

Fig 2



SAW VICE

- It is made of wood or steel the Jaws are long enough to hold the saws while sharpening as teeth.
- The Jaws are hinged so as to make ways to close and open the Jaw.
- It is not useful for any other kind of works.

Purpose of Saw vice

- The sharpening of saw teeth the shaping of saw teeth and setting of teeth are done with the aid of this vice
- The Jaws of the saw clamp , should grip the saw 2-3 mm below gullet teeth.

Try square and mitre square

Objectives: At the end of this lesson you shall be able to
- **name the parts of try square**
- **state the use of try square**
- **name the parts of mitre square**
- **state the use of mitre square.**

Try square

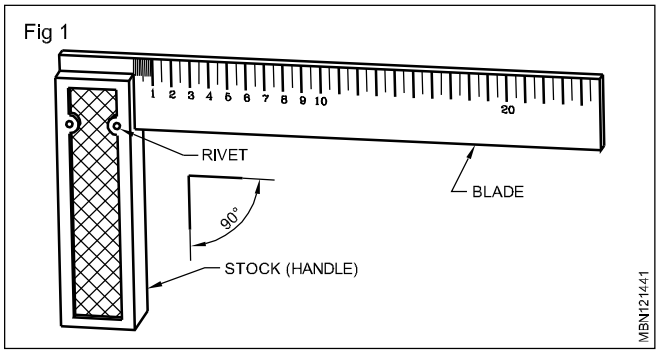
The try square is a precision Instrument.

- Which is used to check squareness of a surface.
- The accuracy of measurements by a try square about 0.002 mm per 100 mm length.
- Which is accurate enough for most work shop purposes.
- The blade is fixed to the stock at 90°. (Fig 1)

Uses

- The try square is used
- To check the flatness of the surface.
- To check the squareness of edge.
- To check the inside squareness.
- Try squares are made of hardened steel.
- The stock is made of hard wood or cast iron a mild steel.
- The try squares are specified according to their lengths.
- Try square blade lengths are available in 100, 150, 200, 250mm and 300mm.

Fig 1



Straight edge

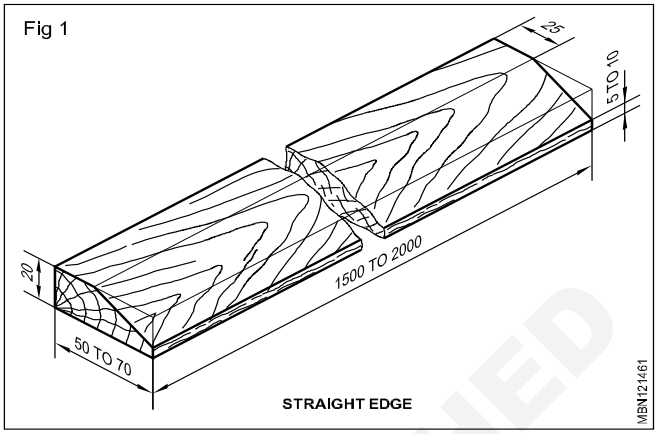
Objectives : At the end of this lesson you shall be able to
- **state the constructional features of straight edge**
- **state the uses of straight edge**
- **state the size of the straight edge.**

- Straight edge made of steel or wood with perfectly straight parallel edges, although some times has only one straight edge. (Fig 1)

Uses: For testing the straightness of surface and edges.

Its length is 1500mm to 2000mm breadth 50mm to 70mm and thickness 20mm.

Fig 1

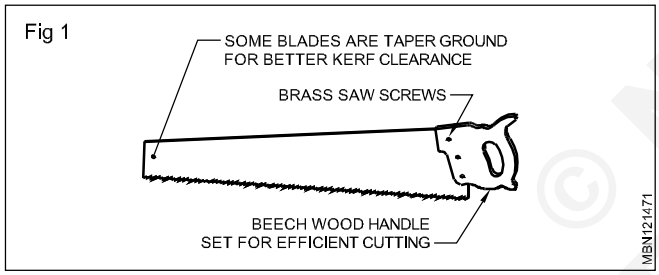


Kinds of saws

Objectives: At the end of this lesson you shall be able to
- **state straight cutting saw**
- **state curve cutting saw.**

Rip Saw (Fig 1)

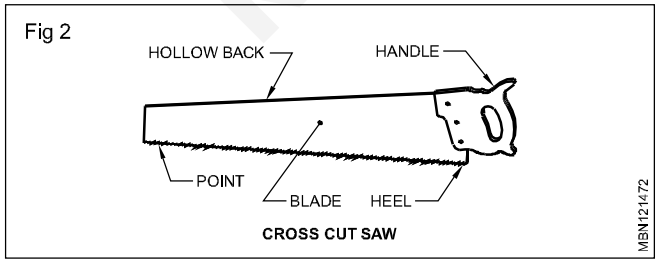
Fig 1



- Used for sawing along the grain.
- Teeth of rip saw vary in size as per the need of the fitness of work to be done.
- It has two teeth per centimetre length.
- Length of the blade is 50 to 70 cm.
- Specified by its length.
- Teeth angle is less than 90°.
- It has 3 to 5 teeth per cm.

Cross cut saw (Fig 2)

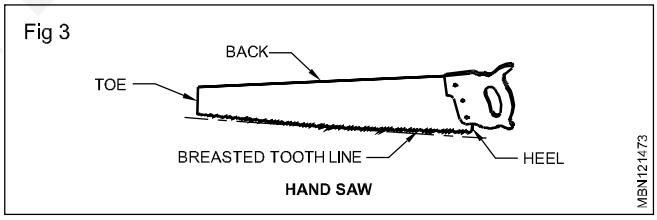
Fig 2



- Used for cutting across the grains.
- Length of blade is 50 to 70 cm.
- It has 3 to 4 teeth per cm.
- Cutting angle of the teeth 90°.
- Teeth has different shape to that of rip saw.
- Finer pitch blade is preferred for hard wood. Blade with course pitch is used for soft wood.

Hand Saw (Fig 3)

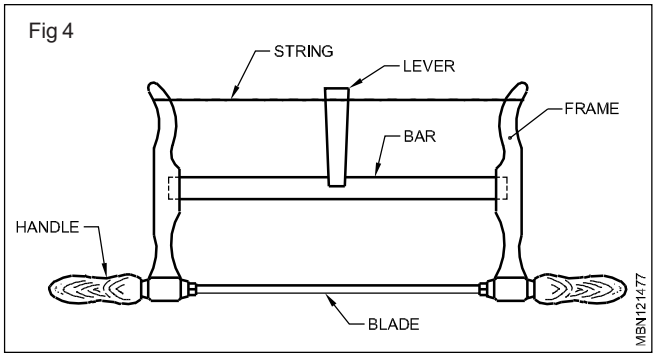
Fig 3



- Length of the blade is less in hand saw than in the rip saw.
- Which is used for lighter work.

Bow saw (Fig 4)

Fig 4



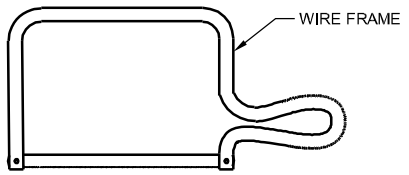
- It consists of frame made of wood, carrying, connecting bar a string, lever and two handles on both sides.

- Used to cut thin curves and profiles having quick bends.
- Length of blades 20 to 30 cm and carries 6 points/cm.

Coping saw (Fig 5)

- Has very fine blade held in stiff wire frame.
- Used for cutting sharp and quick curves Internal and externally.
- Length of blade is 25cm.

Fig 5



COPING SAW

MBN121478

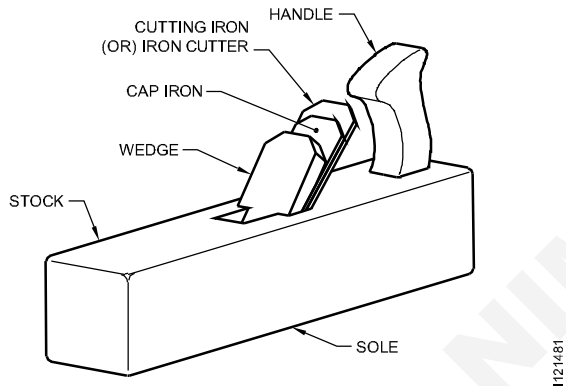
Planes

Objectives: At the end of this lesson you shall be able to
- **state jack plane**
- **state smoothing plane.**

A plane is a hand tool used for smoothing or shaping pieces of wood.

1 Jack plane (Fig 1)

Fig 1



WOODEN JACK PLANE

MBN121481

This plane is used for planning the job to size quickly and truly.

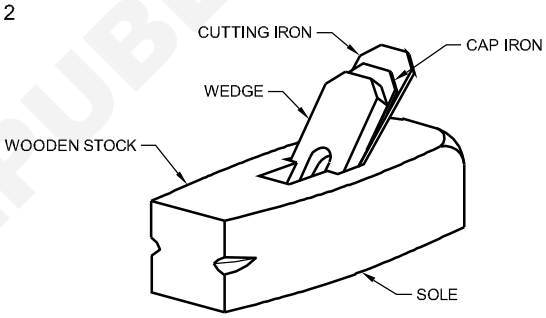
The size is 240 mm x 66 x 47mm. The angle of cutting iron is 45° and the cutting iron is sharpened in a curve. The mouth of the plane is big enough to accommodate thicker wood shavings. The cutting iron further projects outside than in other planes.

2 Smoothing plane (Fig 2)

This is used when the surface has to be planed further to smoothness.

- The size is 240 x 66 x 65 mm.
- The width of cutting iron is 48 mm.
- The cutting edge is sharpened slightly oval across the iron. The angle of the cutting iron is 30°.

Fig 2



SMOOTHING PLANE

MBN121482

Marking gauge

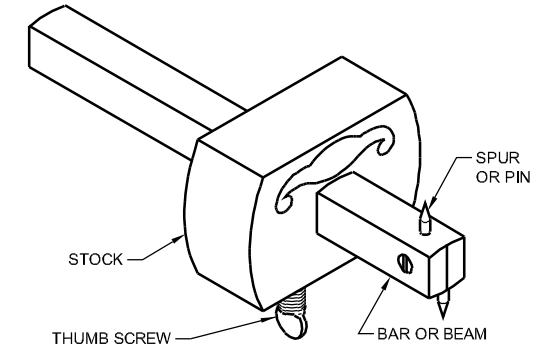
Objectives : At the end of this lesson you shall be able to
- **state the uses of marking gauge**
- **state constructional features of marking gauge.**

For layout lines parallel to one edge of work piece marking gauge is used.

Construction (Fig 1)

The marking gauge can be made of wood or steel. The gauge consists of square, wooden bar or beam on which wooden block or stock is sliding. This block can be fastened at any required measurement by use of a thumb screw.

Fig 1



MBN121491

Carpenter's hammer

Objectives: At the end of this lesson you shall be able to
- **state the uses of an carpenter's hammer**
- **identify the parts of a carpenter's hammer and state their function**
- **name the type of carpenter's hammers**
- **specify the carpenters hammer.**

A carpenter's hammer is a hand tool used for striking purpose while

1 punching

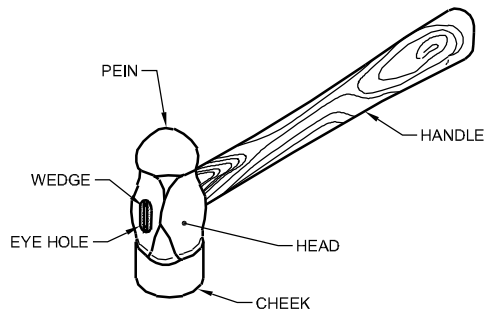
2 striking

3 pulling

- The major parts of a hammer are a head and a handle.
- The head is made of drop-forged carbon steel.
- The wooden handle must be capable of absorbing shock.

Parts of Hammer head (Fig 1)

Fig 1



Handle Pein

Cheek Eye hole

Cheek

The cheek is the striking portion slight convexly is given to it to avoid digging of the edge.

Pein (Fig 2)

The pein is the other end of the head.

It is used for shapping and forming. Work like Rivetting and bending the pein is of different shapes like

1 Ball pein (hammer)

2 Cross pein (hammer)

3 Straight pein (hammer)

4 Claw (hammer)

5 Tacks (hammer)

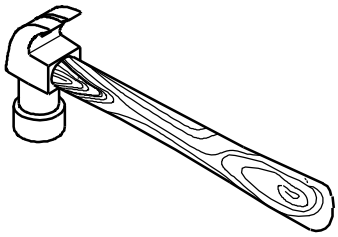
Eye hole

An eye hole is meant for the handle. It is shaped to fit the handle rigidly. The wedges fix the handle in the eye hole.

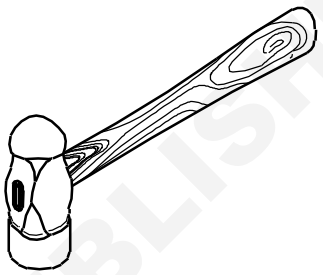
Specification

Carpenter's hammer's are specified by their weight and the shape of the pein. Their weight varies from 125gms to 1500gms.

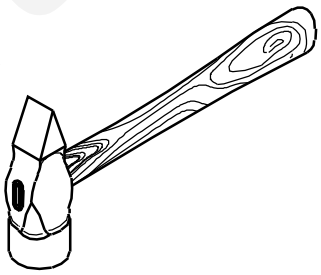
Fig 2



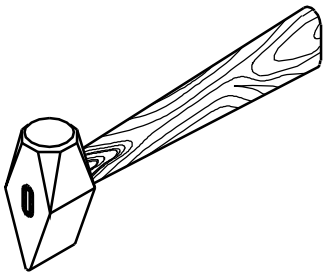
CLAW HAMMER



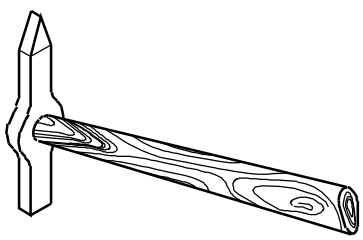
BALL PEIN HAMMER



CROSS PEIN HAMMER



STRAIGHT PEIN HAMMER



TACKS HAMMER

MBN1214A2

Chisels commonly used in carpentry

Objectives: At the end of this lesson you shall be able to
- **name various types of chisels commonly used**
- **state the uses of various types of chisels**
- **specify the chisels.**

All chisels consist of four main parts

1 The handle

2 The blade

3 Tang

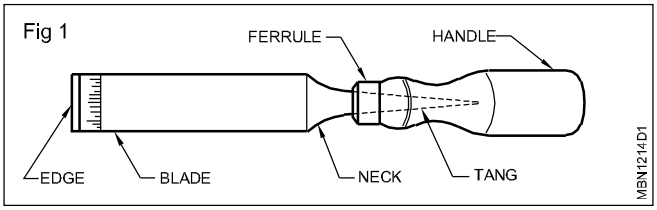
4 Ferrule

The blade of a chisel is made of forged tool steel The cutting angle is 25°.

Types of chisels

1 Bench firmer chisel (Fig 1)

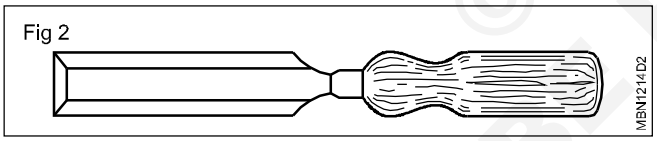
Fig 1



This is used for general chiseling purposes. Strongly made, it can be used for light chiseling with a mallet. The blade is rectangular in section. The handle is made of beech or ash. It has a brass ferrule. Tang is fixed inside the ferrule. It is available from 3mm to 50mm. (Fig 1)

2 Bevel edge firmer chisel (Fig 2)

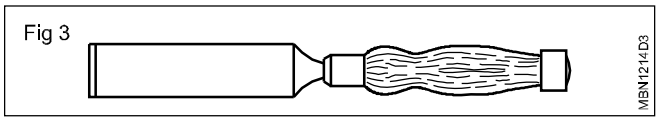
Fig 2



It is more convenient for lighter works and paring works, and in place were ordinary firmer chisel cannot be used such as cleaning up corners and joints. Bevel edge firmer chisel has two edges bevelled along its length which makes it lighter and the edges thinner. Size varies from 3mm to 50mm.

3 Registered firmer chisel (Fig 3)

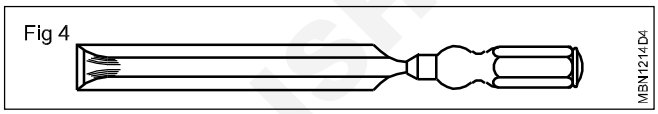
Fig 3



It is used for heavy work such as mortising. The use of mallet is necessary here. It is stronger than ordinary firmer chisel. It has a thicker blade and iron ferrule, at both ends of handle. A leather washer is provided between the shoulder of the blade and the handle to act as shock absorber when the chisel is hit by the mallet.

4 Paring chisel (Fig 4)

Fig 4

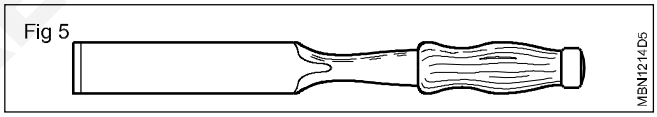


It is most suitable for all paring work such as finishing off joints. It has an extra long thin blade with bevelled edges. It should never be used with a mallet. The handle is made of beech and octagonal in section.

Size varies from 3mm to 50mm.

5 Socket firmer or socket mortise (Fig 5)

Fig 5



It is used for extra heavy work, the blade is thicker and stronger than other chisels. It is able to withstand the blows of the mallet, and level out the cover of mortises. The ash handle provided with ferrule is fitted in socket in the blade. Size varies from 3mm to 50mm.

Marking tools

Objectives: At the end of this lesson you shall be able to
- **state constructional features of marking knife and steel scriber**
- **state uses of marking knife and steel scriber.**

Marking knife (Fig 1) : It is made of steel fashioned to a point at one end and a sharp blade at the other end to form a cutting edge. The blade or knife is used for marking cut lines where a vertical shoulder is to be cut with a saw or chisel. The point is used for marking distances and scribing lines.

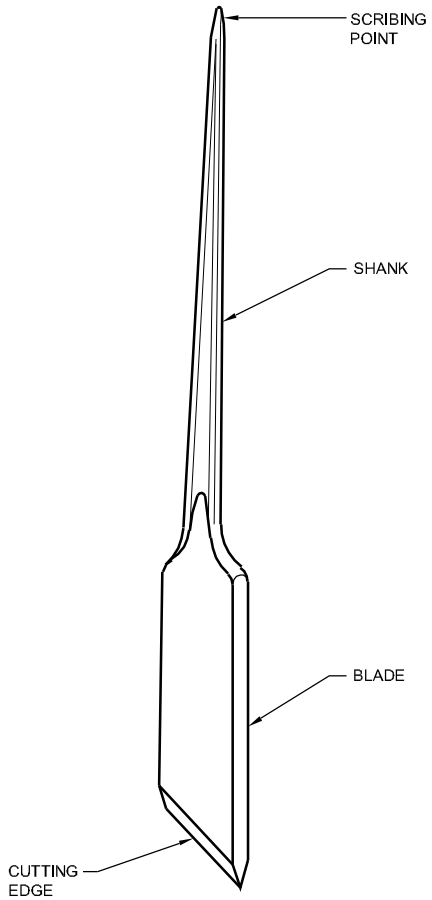
Steel scriber (Fig 2) : A steel scriber should be sharp at its point. It is used for scribing lines on which a chisel cut or a saw cut is made.

The scriber should not be used as an awl. Do not strike the handle with a hammer.

Marking knife (Fig 3)

Marking knife is also used for marking and scribing. It is a steel blade fixed in a wooden handle. It serves the same purpose as that of scriber.

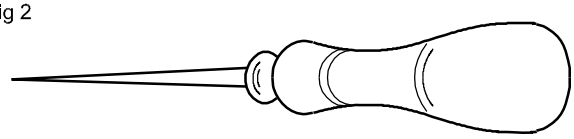
Fig 1



MARKING KNIFE (OR STRIKING KNIFE)

MBN1214F1

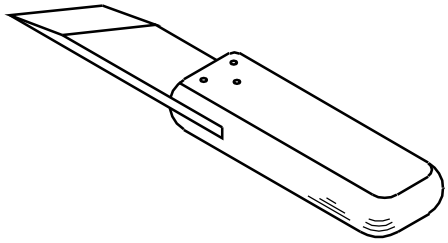
Fig 2



STEEL SCRIBER

MBN1214F2

Fig 3



MARKING KNIFE

MBN1214F3

The Mallet

Objectives: At the end of this lesson you shall be able to
- **state the constructional feature of mallet**
- **state the use of mallets**
- **state specification of mallets.**

The mallets are made of hard wood and it is used in place of hammer. But the difference is head only.

Mallet are used for driving wood chisels and for adjusting wooden planes. It is used for assembling and dismantling wooden works and for adjusting stop dogs in the work bench.

The handle is made of beech or ash with straight grained fibres. The head is made of hard wood with twisted fibres. This prevents splitting of the wood.

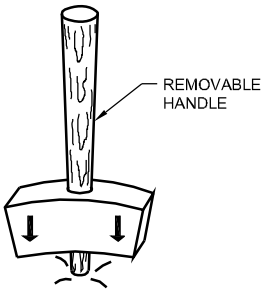
A special type of mallet is made of 'Ligno stone' which is made of special wood that is treated with heat and high pressure.

Some mallets have removable handles (Fig 1) which can be taken out of the head easily so that parts can be stored easily. (Fig 2).

The striking faces of mallet heads are so bevelled so that they can hit the chisel. For most purposes a head of 110 mm long, 80mm wide and 60 mm thick is suitable. The handle is driven in from the top and is tapered in its width. Its head is either round or square. (Fig 3)

The mallet is held upside down and dropped once or twice on the work bench, the head of the mallet will be tightened on the handle.

Fig 1



MBN1214G1

Fig 2

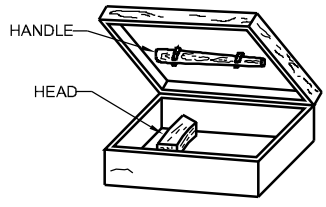


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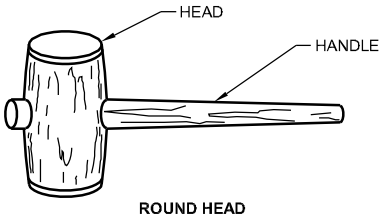
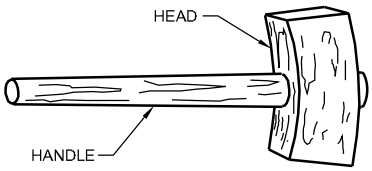
Fig 3



ROUND HEAD



SQUARE HEAD

MBN1214G3

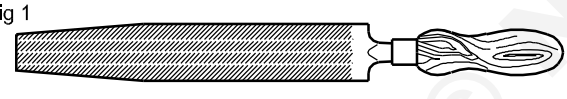
Files and rasps

Objectives: At the end of this lesson you shall be able to
- **state the difference between file and rasp**
- **state the parts of file**
- **state the classification of files**
- **explain the method of cleaning wood file and rasp.**

Files and rasps are used generally in the wood working trade for shaping and forming irregular pieces and curves, for which plane cannot be used.

File: The wood file is used for smoothing roughly prepared surfaces. (Fig 1)

Fig 1

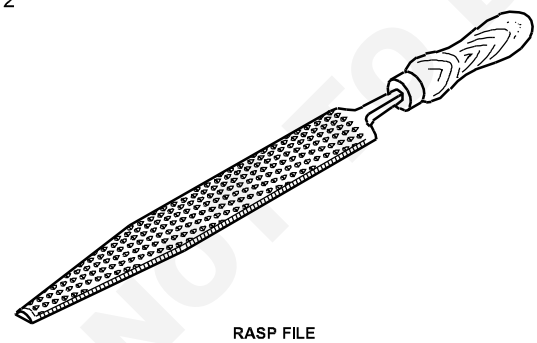


WOOD FILE

MBN1214Q1

Rasp: The rasp is used for quick removal of much wood. (Fig 2)

Fig 2



RASP FILE

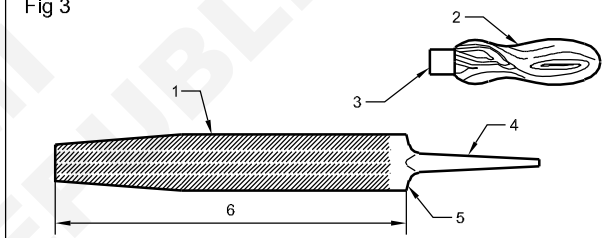
MBN1214Q2

Difference between a rasp and file is (1) The teeth for a rasp are completely separated from each other. (2) The rasp is used for roughening and for quick removing of a thick layer of wood.

Parts of a file (Fig 3)

1 Blade

Fig 3



PARTS OF A FILE

MBN1214Q3

2 Handle

3 Steel ferrule

4 Tang

5 Shoulder (heel)

6 Length on inches

The file is a tool consisting of a blade of steel with fine cutting teeth on its surface.

This surface is hardened.

The tang is hammered out a point, which is not hardened.

The tang is fastened into the handle.

The handle is made of beech or ash and provided with steel ferrule.

The ferrule avoids the handle from cracking.

Identification of timber

Objectives: At the end of this lesson you shall be able to
- **state the method of identifying timber**
- **study the features of timber with aid of punched card system (IS4970:1973).**

The timber are identified by the appearance, smell, colour, hardness, density, grain, texture and lustre.

Colour

Colour in wood shows a wide range of variation. The colour of the same kind of timber changes depending upon whether it is freshly cut or has been exposed. Sap wood and heart wood change colour due to oxidation by exposure.

Sap wood is lighter in colour than heart wood. This could be seen in Chir, Sissoo and Kokko. Some timbers like spruce, fir etc show on such distinction.

The colour of wood may be uniform, mottled or streaked. The colour may vary from creamy white to jet black through varying shades of gray, yellow, pink red, brown and purple.

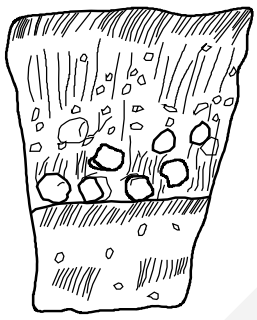
In general a darker colour in wood indicates greater durability due to the presence of natural toxic substances.

Smell

Most woods do not have any characteristic in order to differentiate them from others. The odour disappears on exposure when freshly cut odour is smelt. Deodar has a pungent aromatic scent and teak has a smell of old leather.

Hardness (Fig 1)

Fig 1



HARD WOOD MAGNIFIED STRUCTURE

MBN1214S1

Hardness is defined as resistance of the material to indentation or penetration by a foreign body. This considerably varies from timber to timber. However rough guide is shown below.

Soft to very soft

Readily indented by finger nail, like semul and papita.

Moderately hard

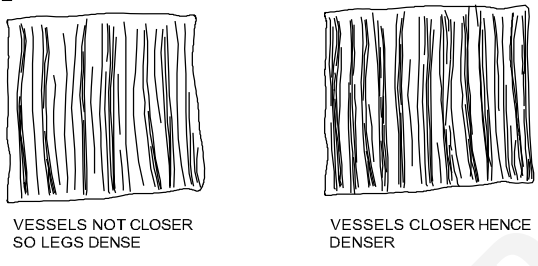
Not readily indented by finger nail but readily cut with a knife like poon and pali.

Hard to very hard

Not indented by finger nail and cut with knife with some difficulty like ebony.

Density (Fig 2)

Fig 2



Density varies considerably in different timbers. A dense timber means in general a strong timber. Density depends upon:

1 weight of wood substance

2 dissolved substance

3 air in the cavities

4 moisture content.

Timber may be grouped into 3 varieties

Light to very light = Density 500 kg/cm^3

Example : Papita, Semul, Spruce

Moderate to heavy : 550 -750 kg/cm^3

Example : Kokko and Deodar

Heavy to very heavy: Above 750 kg/cm^3

Example: Shishan, Sal.

The density values are determined at a specific moisture content of 12%

Grain

Grain in timber refers to the general direction or alignment of wood cells.

Grain may be straight, spiral interlocked, wavy or irregular. Particular type of grain may commonly be found in some species like interlocked grain in sal.

Spiral grain is a natural defect due to irregularities in formation of the fibres.

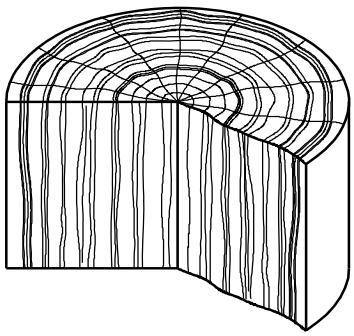
Interlocked grain is the name given to the timber in which the grain changes direction to left and right. This is useful veneering when radially cut (Fig 3)

Wavy grain weakens the timber but many times is valuable for the beautiful figure on the cut surface.

Texture

Texture is due to the size of cells, distribution and proportion of various cells. This should not be confused with grains. In hard wood the texture depends upon the size and rays. In soft woods it depends upon the size and distribution of tracheids. Based upon the texture timber can be classified as

Fig 3



INTERLOCKED GRAIN

MBN1214S4

Fine textured - e.g. Haldu, Gradenia

Medium coarse textured :- Kanju, pali

Coarse textured :- Semul, Kikko

The way a timber feels to the touch is due to the texture only. Majority of woods have even-textured

Teak has uneven texture due to difference in size and vessels in different parts of growth ring.

Lustre

It is due to the light reflecting property of the cells in timber.

The rays reflect light more than others.

Eg. Silver grain in oak which is bright in appearance.

The punch card system as per IS 4970: 1973

The punch card system is the best system of identification of timber, though it is laborious to make such a system. The cards are available on payment from the Bureau of Indian Standards(BIS).

For Indian timbers the cards are of size 14 x 11.5 cm

Each card contain a series of holes 2mm in dia. All along the four sides.

Classification of timbers

Objective: At the end of this lesson you shall be able to
- **state different classification of timber.**

Trees can be basically classified into two groups exogenous (hexogens) which grow outward. Example: Sal, Teak etc.,

The other main botanical group consists of endogens which grow inward. Example: Bamboo, Coconut, Palm etc.,

Another important classification of timber is di cotyledons (hard woods) and conifers (soft woods)

The di cotyledons or angiosperms are broad leaved trees and are enforcely different in characteristic than the conifers (gymnosperms) which have needle shaped leaves and grow in temperature regions and in high altitudes.

Other methods of classification of timber

1 Based upon modules of elasticity

Group A: Modulus of elasticity in bending above 125t/cm^2

Group B: Modules of elasticity above 98t/cm^2 and below 125t/cm^2.

Group C: Modulus of elasticity in bending above 56t/cm^2 and below 98t/cm^2 .

2 Grading of structural timber (IS 883-1970)

Structural timber can be graded into 3 classes: Select grade, grade I and Grade II.

This classification is based upon characteristics like permissible stresses, defects etc.,

3 Based upon availability (IS 399-1963)

X - Most common 1415m^3 or more per year.

Y - Common, 355m^3 to 1415 m^3 per year.

Z - Less common below 355m^3 per year.

4 Durability

High durability

Timbers having average life of 120 months and over.

Moderate durability

Timber having average life of less than 120 months but of 60 months or more.

Low durability

Timber having average life of less than 60 months.

5 Seasoning characteristic

Highly refractory (class A).

These are slow and difficult to season-free from defects.

Moderately refractory (Class B)

These may be seasoned free from surface defects etc. if some protection is given against rapid drying.

Non refractory (Class C)

These can be rapidly seasoned free from defects.

Mahagony

Its colour is shining reddish brown. It takes a good polish. It is easy to work. it is durable under water. Its weight after seasoning is about 7200 N/mm^3

Sandal

Its colour is white or red. It give out pleasant smell. Its weight after seasoning is about 9300N/m3. It is found in Assam, Nagpur and Bengal.

Bamboo

It is an endogenous tree it is flexible strong and durable. It is found in most of the part of the country.

Benteak

It is strong and take up a smooth surface. Its weight after seasoning at 12% moisture content is 6750 N/m^3. It is found in Kerala, Madras and Maharashtra.

Teak

Its colour is deep yellow to dark brown it is modernly hard. It is durable and fire resistant. It can be easily seasoned and worked. It takes up a good polish. It is not attacked by white ants and dry rot. It most valuable timber tree of the world. Its weight after seasoning at 20% moisture content is about 6250N/m^3. It is found in centre. India and southern India. It is used for house construction. Railway carriages, flooring, furniture's etc.

Common types of wood, their description and their uses:

Indian Timber Trees

Iron wood	Jack
Mahagony	Mango
Mulbery	Oak
Pine	red colour
Rose wood and black wood	Sal
Sandal	Tamarind
Teak	Toon
Bamboo	Benteak

Nails

Objectives: At the end of this lesson you shall be able to
- **list the different types of nails**
- **state the uses of nails**
- **state the sizes of nails.**

Nails posses a head, shank and point.

They are usually made of wire or plate metal and mild steel.

For special purposes such as boat building, where nails may be in contact with water, copper and brass nails are used.

Mild steel wire nails are galvanized (coated with zinc) to prevent them from rusting.

For securing pieces of timber together or materials to wood.

Varieties or types : Nails generally obtain their names according to shape of head.

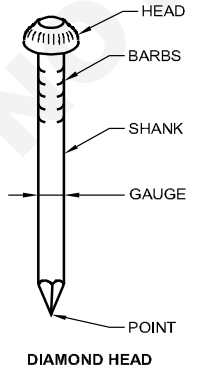
Shape of head

Shape of cross section

Their uses.

Diamond head nail (Fig 1)

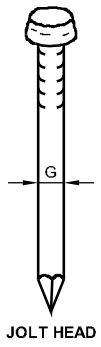
Fig 1



A round wire nail with a diamond shaped head used for general constructional work, securing flooring boards, living boards and packing case construction etc.

Jolt head or bullet head (Fig 2)

Fig 2

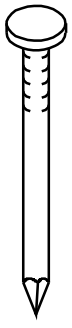


A round wire nail with a round head, which enters the timber cleanly leaving a smaller hole than the diamond head.

Used for same as diamond head.

Flat head round (Fig 3)

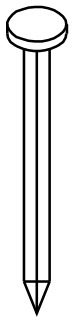
Fig 3



A round wire nail with a large round flat heads used for packing case construction (fruit cases) etc.,

Flat head square (Fig 4)

Fig 4



FLAT HEAD SQUARE

MBN1214T4

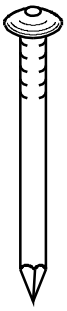
Similar to the flat head round except that it has a square shank which is sometimes twisted to give greater holding power.

Used for packing cases and boxes etc.,

Size : Range from 20mm to 150mm.

Roofing nail (Fig 5)

Fig 5



SPRING HEAD

MBN1214T5

Made of iron and galvanized to prevent rusting.

It has a large - dome - shaped head.

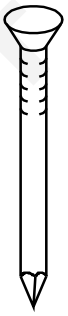
Sometimes it has square twisted shanks.

Size 45mm to 65mm.

Used for fixing corrugated galvanized roofing iron.

Panel pin (Fig 6)

Fig 6



PANEL PIN

MBN1214T6

A thin wire nail with an inverted cone shaped head.

For securing mouldings, fixing plywood to frames not likely to split the wood.

Generally used for work which is also glued.

Size: 12mm to 50mm.

Veneer pin (Fig 7)

Fig 7

VENEER PIN

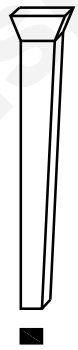
MBN1214T7

A very thin wire nail similar to the panel pin, but sometimes headless.

To hold veneer in position while setting out and cutting or gluing and for fixing very small moulding.

Finishing or cut nail (Fig 8)

Fig 8



FINISHING NAIL

MBN1214T8

A small nail, rectangular in cross section.

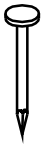
Made from sheet metal with little or no head and no point.

Used for securing mouldings to frame such as the mouldings surrounding door panels.

Size from 12mm to 40mm.

Clout head (Fig 9)

Fig 9



CLOUT HEAD

MBN1214T9

Similar to the flat head round nail, usually shorter in length

It is having large flat head

it is galvanized to prevent rusting.

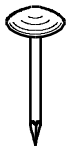
Used for securing thin sheet metal and other materials such as roofing felt and leather to wood.

Size: 9mm to 40mm.

Upholstery nail (Fig 10)

A thin nail with a dome-shaped head.

Fig 10



UPHOLSTERY NAIL

MBN1214TA

This nail usually made of brass or iron nickel plated or oxidized to suit the work.

For fixing materials such as resin, leather etc to wood as in chair, theatre seats and up holstery in trains and cars etc.,

Size 12mm to 40mm.

Cut tack (Fig 11)

Fig 11

CUT TACK

MBN1214TB

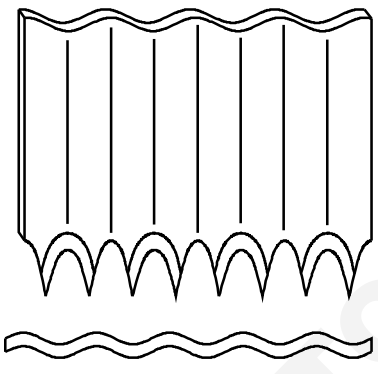
A short flat head nail with a tapering point.

To secure thin materials and fabrics to wood as used by motor car trimmers and up holsters etc.

Size 6mm to 25mm.

Corrugated fastener (Fig 12)

Fig 12



139 CORRUGATED BOX FASTENER OR WIGGLE NAIL

MBN1214TC

Made of corrugated plate iron with parallel or divergent corrugations with plain or saw teeth edges.

It is used for strengthening edge to edge joints as in sides of packing a case etc.

For holding the framed cores of cheap flush panel doors.

For holding together the parts of split patterns while turning.

Size 6mm to 25mm long with the to server corrugations.

Ordering nails

Nails usually sold by weight. When ordering state length, type and gauge.

Length is governed by the amount of nail inserted into the timber, which includes the head. The length is give in mm.

Types of name

It is determined by the shape of head, or use and the kind of metal used.

Gauge

Is the thickness of the nail and is indicted by a number based on a standard wire gauge number.

The higher the number the thinner the nail.

Common size wire nails range from 12mm to 150mm.

Holding power of the nail

Nails hold better when driven across the grain than along the grain.

Square nails with twisted shanks have greater holding power.

Greater holding power when driven obliquely or dovetailed.

Nails with large flat heads have greater holding power.

Experiments have shown that if the shanks are cement coated there is greater holding power.

Miscellaneous hand tools

Objectives: At the end of this lesson you shall be able to
- **state the use of the crow bar**
- **state the function and use of awls**
- **state the function and use of butt gauge.**

The crow bar (Fig 1)

This is an iron bar with a forged end used for pulling big nails out of timber and as a tool to move heavy objects. Other uses are to open crates or to loosen boards of concrete forms.

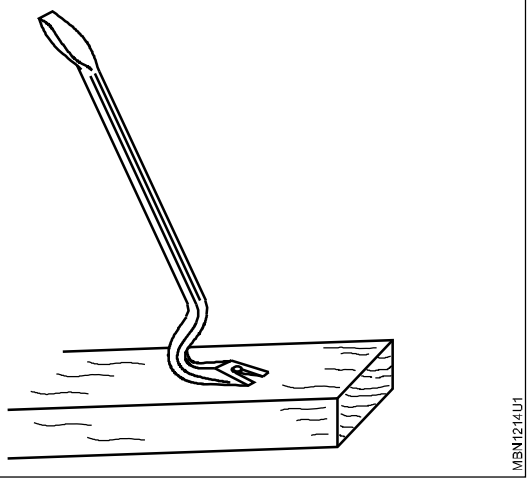
When a lot of force is needed to get out of a nail use a crow bar so as not to break the handle of your hammer.

For lifting very heavy jobs an iron bar should be used in place of smaller crow bar.

Awl

An awl is a thin pointed steel rod which is fitted with wooden or plastic handle. Awls are used for marking or piercing holes in wood. The tip can be either square or rounded.

Fig 1

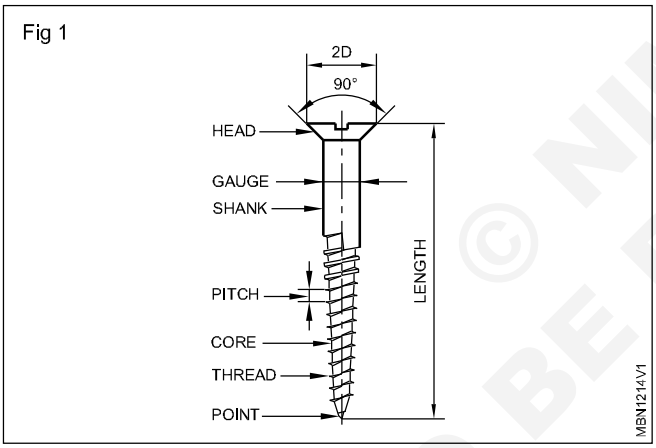


Screws used in wood

Objectives: At the end of this lesson you shall be able to
- **list the different types of screws**
- **state the uses of screws**
- **state the sizes of screws.**

Wood screws are mostly made of mild steel, copper, brass and aluminum. (Fig 1)

Fig 1



They consist of head, shank and thread.

Available in various sizes.

HEAD the shape of which gives the screws its name.

The head of most screws are slotted to take the blade of screw driver.

Shank

Beneath the head about 2/3rds of which is threaded to a point.

Thread

Draws the screws into the timber and gives the screw greater holding power than nails.

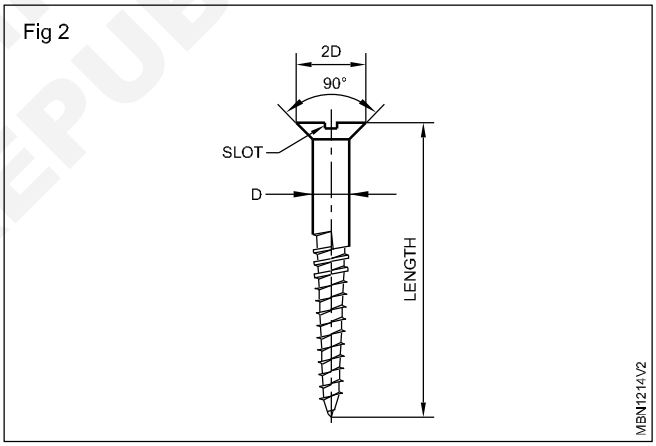
Mild steel screws are often galvanised (use in damp condition) nickel plated, blued, japanned oxidized to match the fittings they secure.

Phillips or recessed head screw have a crossed slot requiring a special screw driver.

Types and its uses

Counter sunk or flat head. (Fig 2)

Fig 2



The common counter sunk screw is made of mild steel.

It is used in damp conditions it is advisable to use the screws that have been galvanised or screws made of copper or brass.

Copper and brass screws must be driven carefully as they are easily broken.

Uses

For general screwing purpose where it is necessary for the head to be flush with the surrounding surface.

Table top, chair seats, boxes and metal fitting to wood such as hinges.

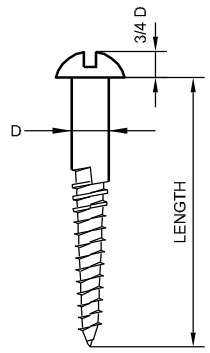
Size: 12mm to 150mm length.

Round head (Fig 3)

Has a rounded head which is flat underneath.

Made of steel, copper or brass.

Fig 3



ROUND HEAD

MBN1214V3

Brass and steel screws may be either nickel plated blued, black jappaned or oxidized to match the fittings being secured.

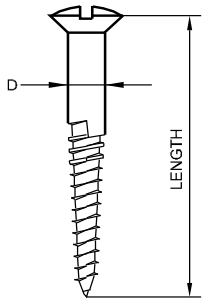
Uses

Where the head of the screw is visible as on ornament, or where the metal is too thin to allow counter sinking.

Galvanised steel round head screws with lead washer are sometimes used for fixing roofing iron.

Raised head or Oval head (Fig 4)

Fig 4



RAISED HEAD

MBN1214V4

A combination of the counter sunk and round head screw.

it is made of the same metal and similar finishes as the round head screw.

Being contersunk it is much stronger than round head.

Uses

For securing thick sheet metal and metal fitting to wood, where strength as well as ornamentation is required.

It is often used by motor body builders with a small counter sunk cup or washer under the head for fixing metal panels and moulding.

Coach screw or square head (Fig 5)

It is much stronger form of screw.

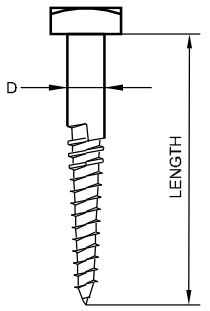
Made of mild steel (sometimes galvanised).

Being larger has to be driven with a spanner.

Made from 6mm dia to 20mm dia and from 40mm long.

Uses: For rough work, bridge construction, fixing gate hinges, coach and carriage construction and for fixing machinery to bases etc.

Fig 5



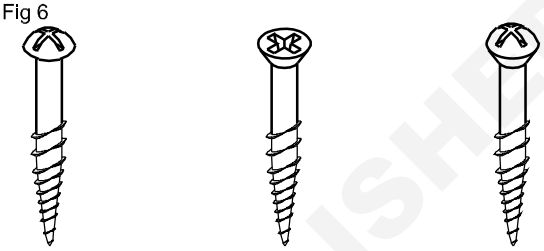
COACH OR SQUARE HEAD

MBN1214V5

Size 50mm to 150mm length.

Phillips or cross point head (Fig 6)

Fig 6



PHILLIPS OR CROSS POINT SCREW HEAD

MBN1214V6

These screws have a flat, oval or round head with two slots at right angles each other.

It provides more screw head surface against the screw driver tip than an ordinary screw does.

A special screw driver is needed.

Nail screw (Fig 7)

Fig 7

MBN1214V7

Nail screws have a very steep thread and can, therefore be driven with a hammer instead of a screw driver. They are commonly used for flooring, roofing and framing of rough work.

Screw eyes, screw hooks, square screw, hooks and cup hooks are made in many sizes. (Fig 8)

They are made from steel, brass or of galvanised iron and are used from special purposes, such as for hanging pictures, curtains, kitchen utensils keys etc.,

Large screws or wrench bolts (Fig 9)

Large screws or wrench bolts are used for heavy joinery work and where greater holding power is needed. A wrench

is used to drive these into a pilot hole that has been drilled into the wood.

Fig 8

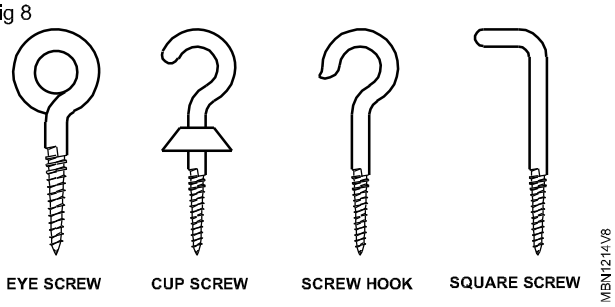


Fig 9

Ordering screws

Screws are usually sold in packets containing 100 Nos. and 200 Nos.

They can be brought by number.

When ordering state

- length
- kind, shape of head
- metal and finish.

Length

The length of screw is determined by the amount of the screw inserted into the timber.

The length of the counter sunk screw includes the head.

In case of round head the head is not included.

Gauge

The gauge thickness or diameter of the shank is indicated by the number (not based on a standard wire gauge).

- Higher numbers indicate larger diameters.
- Lower number for smaller diameters.

Kind

It is determined by the shape of the head.

Metal

Steel (whether oxide japanned and nickels, brass, copper and aluminum).

Screws should be used in preference (heading) to nail when,

- Greater holding power is required.
- The appearance of the work may be spoiled by nails.
- The stock of driving a nail may damage the work.
- Vibration may weaken the holding power of nails.

General classification of joints

Objectives: At the end of this lesson you shall be able to
- **state the various classification of joint used in wood work**
- **state the places where the joints are used.**

Lengthening joints

These joints are used for joining small lengths of wood pieces end-to-end to obtain large lengths many lap, butt and scarf joints come under this category.

Widening joints

These joints are used for joining wood pieces along their edges in order to obtain increased width. Rebate, butt, tongue and groove are quite commonly used for this purpose.

Framing joints

These joints are used to connect wood pieces at desired inclinations and commonly employed in frame work. This category includes, mortise and tenon, bridle, rafter, mitre, lap dovetail, notched and scarf joints.

Box joints

These joints enable joining of wooden planks and scantlings at desired inclination so as to obtain box shaped structures and wooden cases. Lap rebated open and secret dovetail, corner having mitre haunched mortise and tenon and corner locking joints are commonly used for this purpose.

Circular joint

These joints are used for connecting wood pieces to form a hollow cylindrical structure. The joints commonly used for this purpose are butt, hammer head key, blind mortise tenon scarf and dowelled joints.

Some common joints

Dowel joint

Dowels are thin small round sticks made from hard wood and are employed in various ways. Some common uses of dowels include their use as reinforcements for butt and mitre joints as a substitute for mortise and tenon joints in small articles in securing loose parts to a product and as strengtheners to circular, square and irregular forms. While making a dowel joint it should be ensured that the locations in the dowel holes in the two mating part are in perfect alignment.

Grooved joints

Many types of grooved joints are used in wood work. In some other the grooves run parallel to the grains and in other across the grains called 'dadoes'. some of the grooved joints are concealed and some are open. A common example of this is tongue and grooved joint, which you can easily notice in filling of door panels. Other grooved joints include rebate and spline joints.

Mitre joints

These joints can be readily noted on the corners of picture frames. Their use facilitates such joints at which no end grains of the wood pieces are visible. Apart from glueing, these joints are usually strengthened by means of dowels, nails or hard wood splines etc.

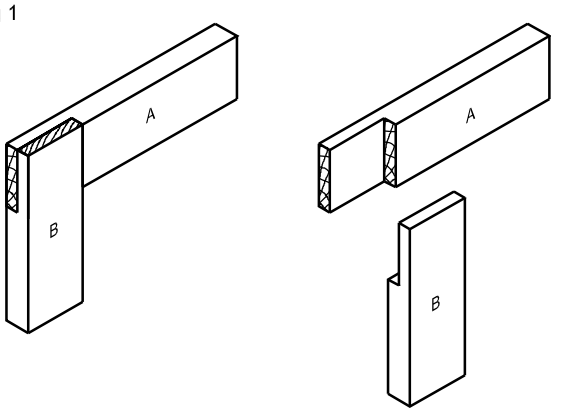
Half lap joints

Objectives: At the end of this lesson you shall be able to
- **state meaning of half lap joints**
- **state various types half-lap joints**
- **state purpose and uses of half lap joints.**

Half lap joints

- A half lap joint consists of half the thickness cut away from one component and half the thickness cut away from the other.
- In flat frame construction, leg and rail construction for lengthening posts, when building sheds, the corner half lap joints is stronger than the tee-half lap.
- Half lap joints are frequently used to connect two wooden pieces such as boards, frames where an even surface is required.
- When the intersecting member cross each other at centre they are known as centre half lap joint or cross half lap joint.
- When it is fixed at the ends it is known corner half lap joint. (Fig 1)
- If it is in dovetail joint it is called half-lap dovetail joint.
- Dove tails joints are always stronger and offer greater resistance to tension.
- Half lap joints are glued and if needed are reinforced by means of concealed screws.

Fig 1



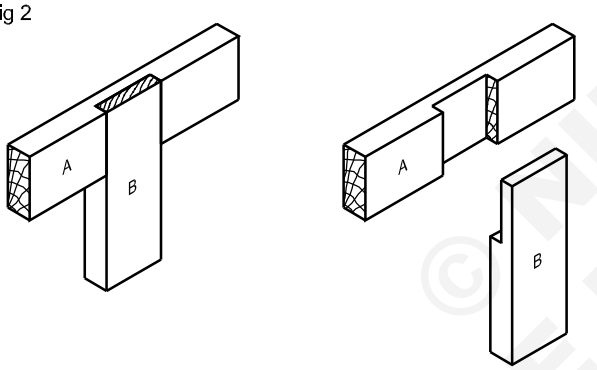
- It is to be noted that a halved joint is always lapped but a lapped joint is not always halved.

Tee-half lap Joint

It is used in frames where the end of a rail meets another piece some distance from the end both faces of the pieces finishing flush.

The joint is used in cabinet frames and where a strong joint is not required. (Fig 2)

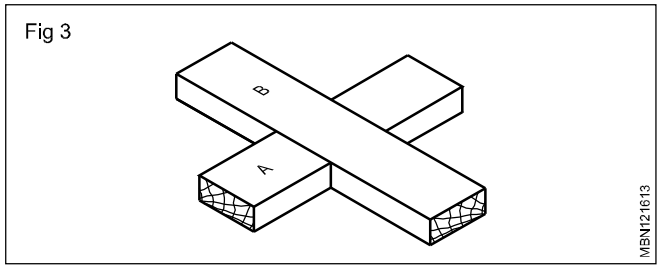
Fig 2



Cross half-lap joint

It is used where the members cross each other and the faces of the pieces are required to be flush as in diagonal stays of tables and chairs, and frames of cheap panelled doors. (Fig 3)

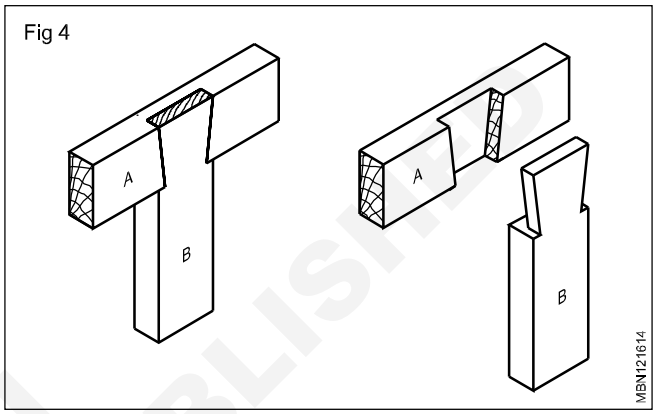
Fig 3



The dovetailed half lap joint

It is used for connecting the ends of cross rails in frame like construction where an outside strain occurs. This joint can be separated in only one direction. (Fig 4)

Fig 4

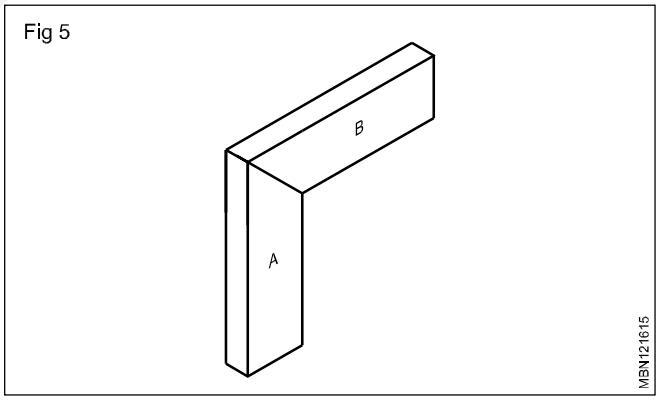


Mitre half lap joint

The mitre- half lap joint is used to hide end grains of woods in picture frames, mouldings rafter and drip caps etc. (Fig 5)

There are some heavy duty half lap joints which will resist pulling stresses in one direction. Straight bevel half laps are used for lengthening wall plates, joints and rafters.

Fig 5



Housing joints

Objectives: At the end of this lesson you shall be able to
- **state the meaning of housing joint**
- **identify its purpose and uses**
- **state the types of housing joints.**

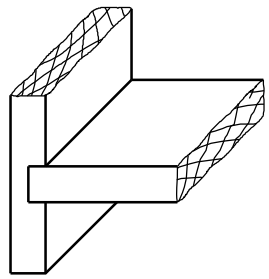
The housing joint consists of sinking the one end or edge of one member into a groove or trench in the face of another member. It is mainly used in fixing shelves or divisions in book-cases, cabinets, treads of step ladders, treads of stairs etc.,

Types of housing joints

Full housing joints (Fig 1)

The whole end or edge is fitted into an enough trench and the joint is visible on both sides of edges. (Fig 1)

Fig 1



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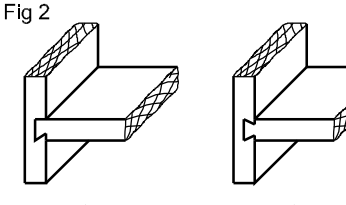
Dovetailed housing joint (Fig 2)

Wherever a stronger joint is required it is used. The end of the shelf is dovetailed on one or both sides and fitted into dovetailed trench. The depth of the trench is about 1/3rd thickness of the plank. (Fig 2b)

Fig 2



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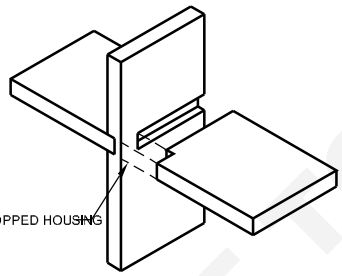
Stopped housing joint (Fig 3)

For improved appearance, this is used in preference to through housing. The end of the trench is stopped back from the front edge. The end of the shelf notched to suit so that in the assembled joint the trench is not seen.

Fig 3



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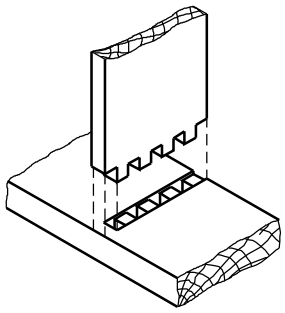
Care case pinned joint (Fig 4)

This joint is generally used in car case construction for fixing partitions, where all the member are of solid plywood. The end of partition piece is divided into a number of short tenons which fits into suitable mortises in the top and bottom pieces. Tenons may pass through the bottom to be wedged, making the joint stronger. The mortised pieces is slightly trenched to improve fitting.

Fig 4

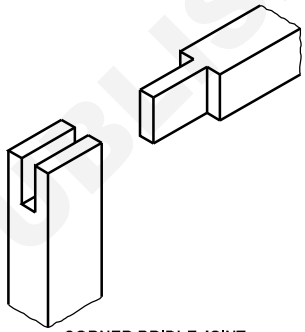


CARCASE PINNED JOINT

MBN121634

Corner bridle joint (Fig 5): Some times it is called the open mortise and tenon joint. It is used as a substitute the haunched mortise and tenon at the corners of frames.

Fig 5



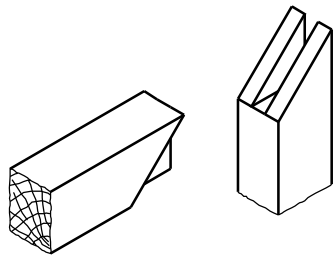
CORNER BRIDLE JOINT

MBN121635

Mitre corner bridle joint (Fig 6)

One or both sides of the socket may be mitered as required. It is used where a stronger joint than the mitred halving joint is required on either plain or moulded timber as on mirror frames etc.

Fig 6



MITRED BRIDLE JOINT

MBN121636

Formwork or shuttering

Objectives: At the end of this lesson you shall be able to
- **definition of formwork**
- **state requirements of formwork**
- **explain removable of formwork**
- **describe centering for various building components.**

Introduction

Temporary boarding or shuttering or sheeting created to hold concrete work for some days to allow the hardening and strengthening, of concrete is know as formwork (casing or shuttering).

Moduls: The term moulds is sometimes used to indicate formwork of relatively small units such as litels, cornices.

Centering: For circular work such as arch, dome, etc.

The term centering is generally used.

Materials: Materials used for formwork such as wooden, plywood, steel, combined wooden- steel etc.

Requirement of formwork

1 It should be sufficiently strong to take the dead and live loads during construction.

2 It should be as water tight as possible.

3 It should be easily removable without damage to it.

4 Formwork gives a smooth level surface concreting.

Removal of formwork (Stripping)

The operation of removing the formwork is commonly known as stripping.

Stripping time

Formworks may be struck after expiry of following periods:

1 Walls, columns and vertical sides of beams - 24 to 48 hours as may be decided by the enginner-in-charge.

2 Slab soffits (props left under) - 3 days.

3 Beam soffits (props left under) - 7 days.

4 Removal of props to slabs:

  i Spanning up to 4.5 m-7days.

  ii Spanning over 4.5 m - 14 days

5 Removal of props to beams and arches:

  i Spanning up to 6 m -14 days

  ii Spanning over 6 m - 21 days

Centering for square and cicular columns (Fig 1)

Shuttering for a column is probably the simplest.

It consists of the followign main components:

1 Sheeting all round the column periphery,

2 Side yokes and end yokes,

3 Wedges and

4 Bolts with washers.

5 The side yokes and end yokes consist of two numbers each, and are suitably spaced along the height of the column.

6 The two-side yokes are comparatively of heavier section, and are connected together by two long bolts of 16 mm dia. Four wedges, one at each corner, are inserted between the bolts and the end yokes.

7 The sheathing is nailed to the yokes shuttering for octagonal and round columns.

Centring for beam and slab (Fig 2)

1 The formwork for beam and slab floor.

2 The slab is continuous over a number of beams.

3 The slab is supported of 2.5 cm thick sheeting laid parallel to the main beams.

4 The sheathing is supported on wooden battens which are laid between may be propped at middle of the span through joints.

5 The side forms of the beam consist of 3 cm thick sheathing.

6 The bottom sheathing of the beam from may be 5 to 7 cm thick.

7 The ends of the battens are supported on the ledger which is fixed to the cleats throughout the length.

8 Cleats 10 cm X 2 cm to 3 cm are fixed to the side forms at the same spacing as that of battens, so that battens may be fixed to them.

9 The beam form is supported on a head tree.

10 The shore or post is connected to head tree through cleats.

11 At the bottom of shore, two, wedges of hard wood are provided over a sole piece.

Centering for concrete wall

1 Fix from for walls.

2 The boarding may be 4 to 5 cm thick for walls up to 3 to 4 m high.

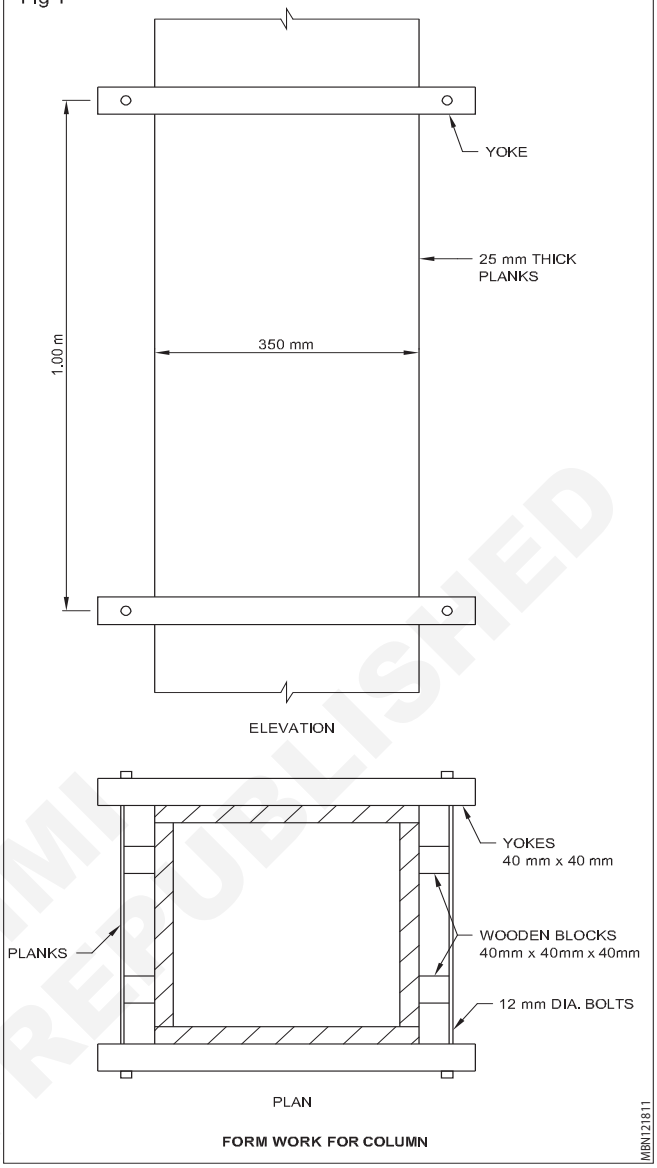
3 The boards are fixed to 5 cm x 10 cm posts, spaced at about 0.8 m apart, known as studs or soldiers,

4 Horizontal waling of size 7.5 cm x 10 cm are fixed to the posts at suitable interval.

5 The whole assembly is then strutted using 7.5 cm x 10 cm struts.

6 The two shutters are kept apart equal to the thickness of the wall, by providing a 5 cm high concrete kicker at the bottom and by 2.5 cm x 5 cm spacers nailed to the posts.

Fig 1



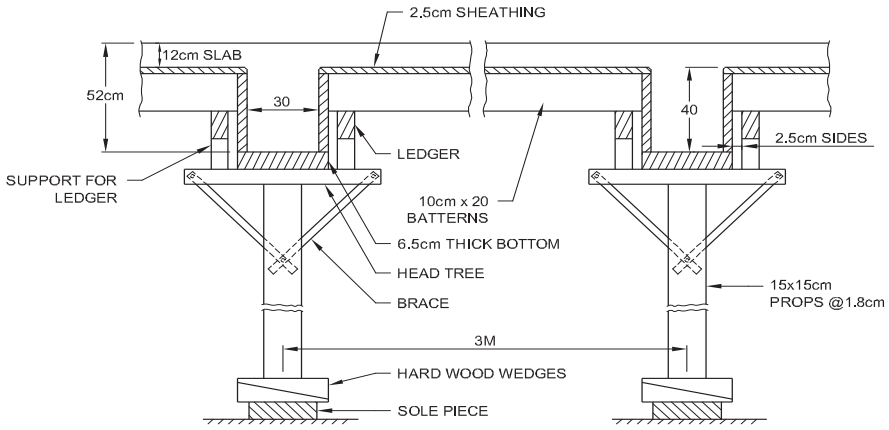
FORM WORK FOR COLUMN

Form work for walls

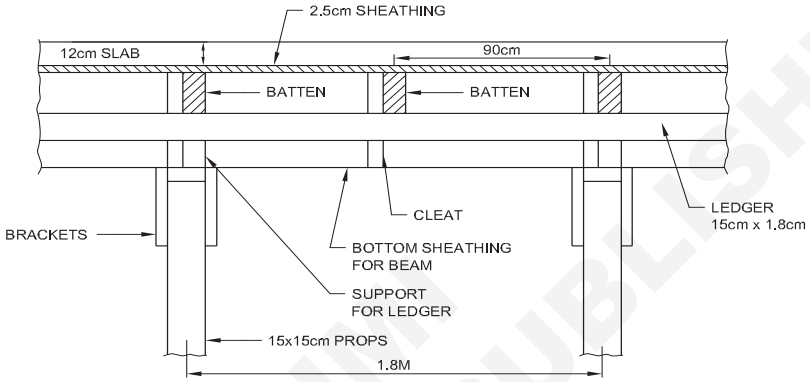
Objective: At the end of this lesson you shall be able to
- **describe the points to be considered formwork for walls.**

- The ties are to maintain the distance between the sheet. (Fig 1)
- The space are used and they removed as the concrete reaches required level.
- Wire ties and bolts are provided to keep the position of sheet.
- The following points to be considered in case of form work for walls are as follows.
- The braces are provided at the horizontal distance of about 2m. and they are supported by stakes.
- If the wall is high the form work is to be supported on either side by guy wires instead of timber braces.
- The reinforcement is properly placed in position before laying the concrete.
- The formwork should be cleaned before laying the concrete.

Fig 2



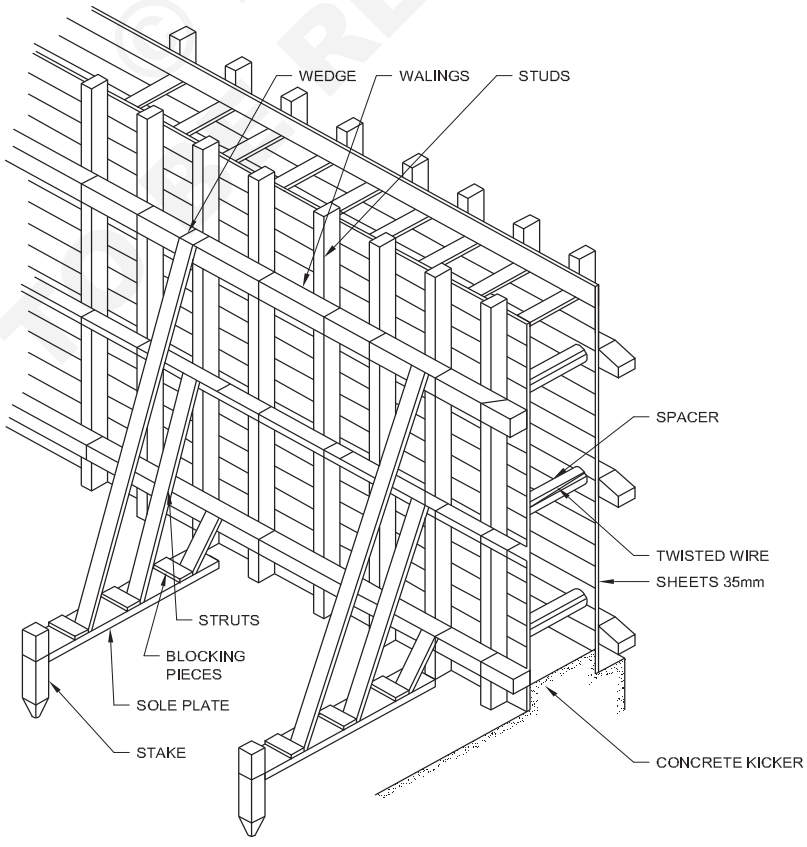
(a) SECTION ACROSS BEAMS



(b) SECTION ALONG BEAMS

MBN121812

Fig 1



FIXED FORM FOR WALL

MBN121821

Technical terms used in brick masonry

Objective: At the end of this lesson you shall be able to
- **define and explain the different technical terms used in brick masonry, necessity of bonding BRICK.**

Masonry is the art of construction in brick or stone

- From the very early ages of civilization new know the art of construction though the method were crude.
- But the advancement of age the technique of construction have appreciably developed.

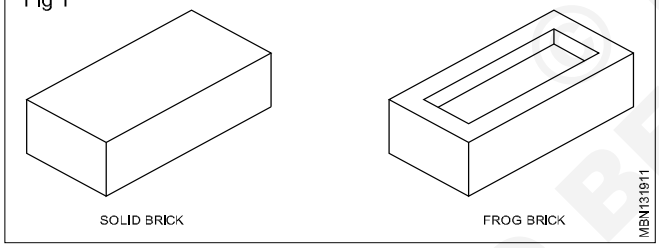
Masonry broadly divided into two parts

- Stone masonry
- Brick masonry
- Stone masonry is that in which stone is used as a construction material
- Brick masonry is that in which brick is used as a construction material.
- Technical terms used in Brick masonry

Brick

- Brick is the artificially manufactured It is in rectangular shape and size is 230 mm x 110mm x 70mm as shown in (Fig 1) (in ISI 200x100x100mm)

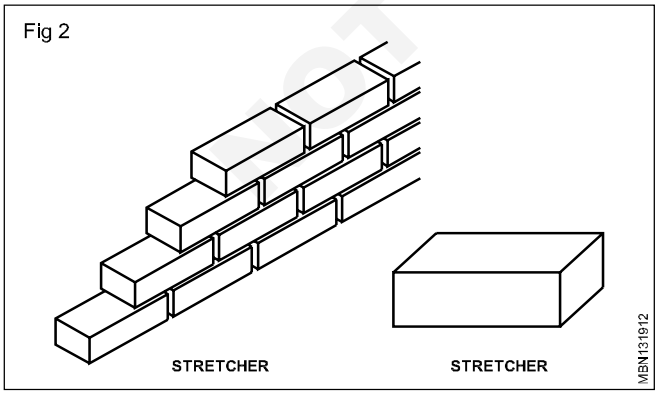
Fig 1



Stretcher

These are the bricks or stones laid long in a wall as shown in (Fig 2)

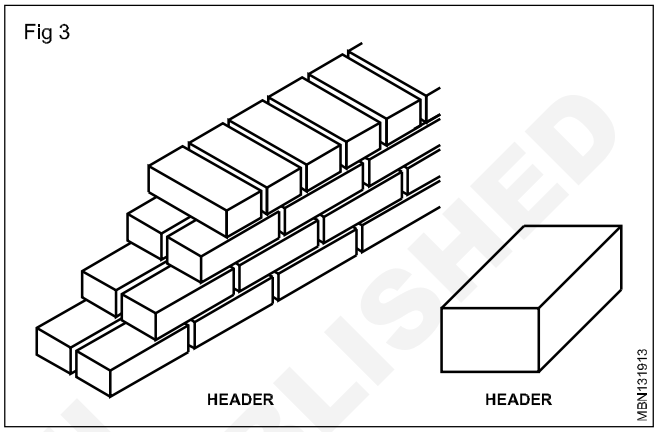
Fig 2



Header

These are bricks or stone blocks laid breadth wise or thier headers length of the wall as shown in (Fig 3)

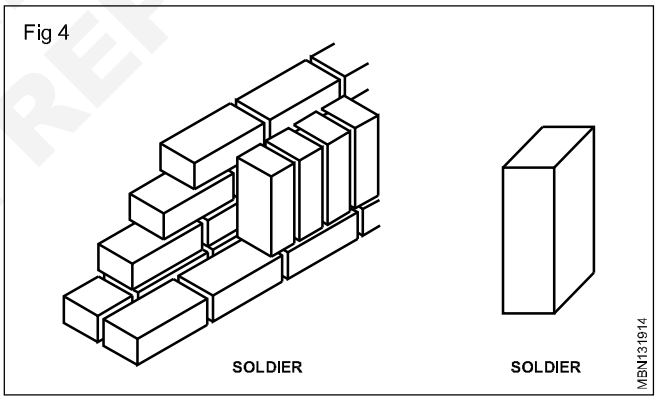
Fig 3



Soldier

These are bricks, laid stretcher face in vertical position as shown in (Fig 4)

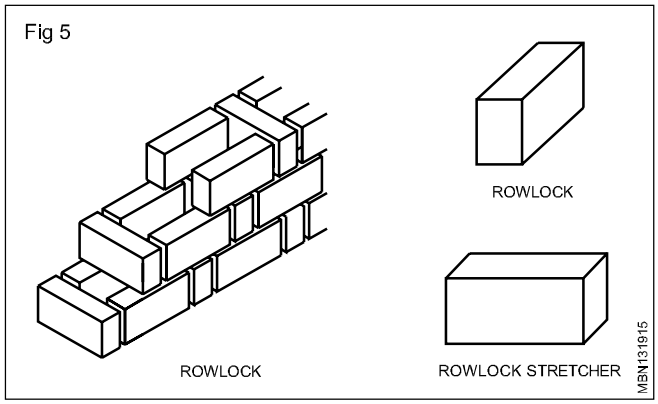
Fig 4



Row lock

These are bricks which are laid on its edge as shown in figure. This is also called Brick-on-edge as shown in (Fig 5)

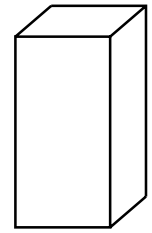
Fig 5



Sailor

These are bricks which are laid vertical position with bed of the brick is placed in elevation shown in (Fig 6).

Fig 6



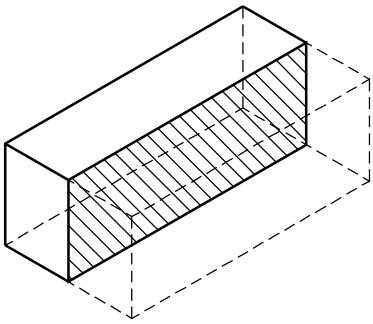
SAILOR

MBN131916

Queen closer

These are half bricks cut length wise. It is used along the length of a quoin for staggering joints of alternate course see (Fig 7).

Fig 7

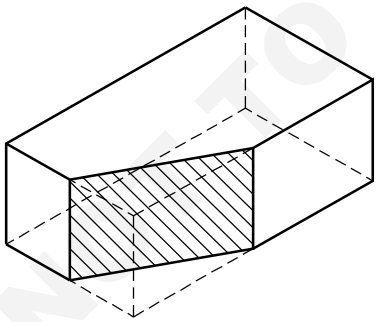


MBN131917

King closer

It is a brick which is cut in such a manner that the width of one of its ends is half a full brick. It is formed by cutting a triangular portion of one of the corner of a brick between the centre of one end of the centre of the other end as shown in (Fig 8).

Fig 8



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Quoin (or) Quoin header

It is the brick or block of stone used at the corner of two walls. This bricks or block of stone will look as header from one side and stretcher from the other side as shown in (Fig 9).

Bats

These are bricks which are cut length wise into two half bats, which are known as half brick as shown in (Fig 10).

Fig 9

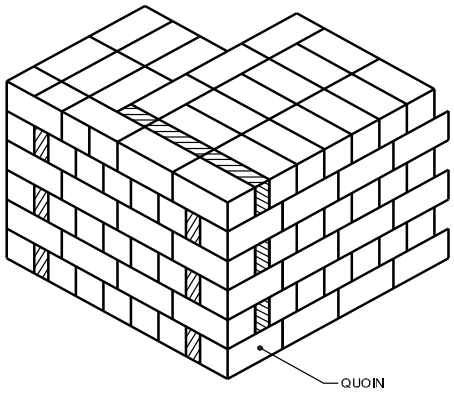

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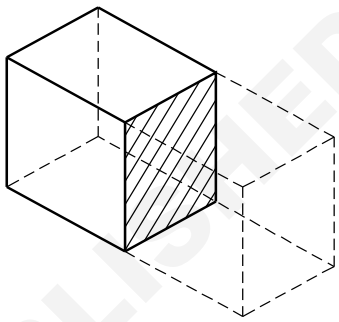
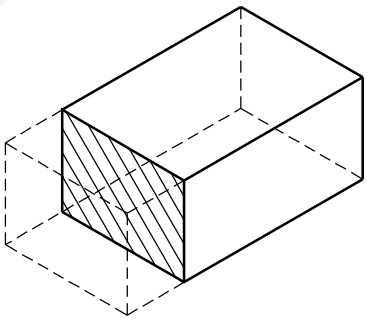
Fig 10



MBN13191A

If the full brick is cut into 3/4 then it is called as 3/4th bat as shown in (Fig 11).

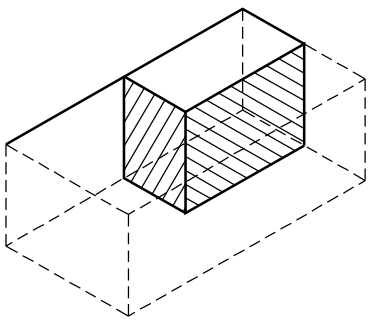
Fig 11



MBN13191B

If the full brick is cut length wise into two half portion is queen closer, and again cut into two half is known as 1/4 brick. as shown in (Fig 12).

Fig 12

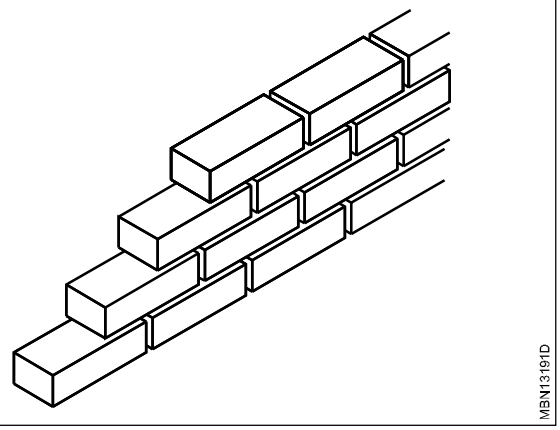


MBN13191C

Course:

A horizontal layer of Bricks or stones laid in mortar or without mortar in a systematic way is called as course. see (Fig 13).

Fig 13

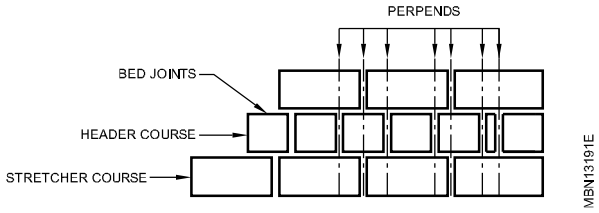


Bed joints

These are horizontal joints of a brick or stone masonry.

Perpends These are imaginary vertical lines, containing the vertical joints of masonry (Fig 14).

Fig 14



Jambs

These are vertical sides of a door or window openings on the backside These may be squared or splayed and are provided with recess to receive the door or window frame.

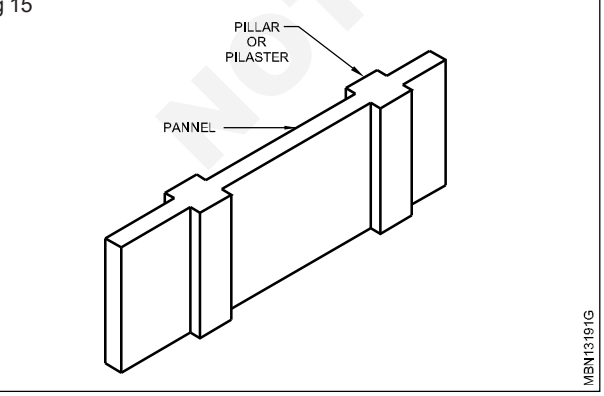
Reveal

These are exposed vertical surface of walls on the outside of an opening of a door or window. The function of a reveal is to protect the frame and to keep privacy of the room.

Panel and Pilaster wall

These are boundary walls consisting of pillars at regular intervals and thin partition walls. The function of a panel and pilaster wall is to increase the transverse strength of the long boundary wall. (Fig 15)

Fig 15



Necessity of bonding bricks

According to their uniform size and shape the bricks are arranged various pattern.

Bonding is essential to eliminate continuous vertical joints both in the body as well as in the face of the wall to give the strength to masonry.

A wall having continuous vertical joints does not act as a homogeneous mass to distribute the superimpose load.

Back

The wall surface which is not exposed to weather is called (inner surface) back or backing.

Face

The exterior wall surface which is exposed to weather is called face or facing.

Hearting

The portion between the inner and outer portion of wall.

Side

This is the surface formed by boundary of bricks or stones in a direction transverse to the face and bed.

Joint

It is the junction of two or more bricks or stones in a course then it is termed as bed joint. The joints which are perpendicular to bed joint. The joints are known as vertical joints or joints.

Bond

The method of arranging bricks in a masonry so that the individual / each brick or stone tied together. Bonding is may important to eliminate continuous vertical joints in both in body as well as on the face of wall.

Spalls

These are the chips of stones used for filling the cavity between two surfaces of walls.

Quoins

These are the stones / bricks used in corners of a wall.

Frog

It is an indentation or cavity or depression on top face of a brick made to forming a key for the mortar.

Cornice

It is a ornamental projecting course near the top of building or at the junction of wall and ceiling.

Blocking course

A top most course of stone masonry provided immediately above the cornice to prevent the tendency of the cornice to our turn.

Pier

It is an intermediate vertical support in stone or brick masonry and if it projecting beyond to support the ends of beam or truss or roof slap and then it is called pilaster.

Corbel

The extension of one or more course of stone or brick from the face of wall to act as a support for wall plate.

Parapet

It short or low wall along the edge of a roof to protect the users.

Weathering

The upper surface of stones used for sill, cornice and coping is dressed in a sloping way so that the water may flow off easily this is termed as the weathering.

Throating

A groove is provided on the underside of sill, cornice and coping so that the rainwater can be discharged clear of the wall surface, this is known as the throating.

Toothing

The termination of a wall in such a fashion that each alternate course at the end projects is known as the toothing and it is adopted to provide adequate bond when the wall is continued horizontally at a later stage.

Thicknessing

When an old wall is to be thickened reassess of 20 x 20 x 10 cm should be cut in the old wall, at one for every square metre. The new work should then be built in cement mortar against the old and block bonded to it at every recess. The surface of the old work should be cleaned brushed and wetted before the new work is added. This is also called block bonding.

Racking back

The termination of a wall in a stepped fashion is known as the racking back.

Method of cutting bricks by using of bolster and hammer

Objective: At the end of this lesson you shall be able to
• method of cutting bricks by using of bolster and hammer.

- Set one brick face up on an off cut of timber or fibre board.
- Mark the face of the brick for cutting. Using the width another brick as a guide.
- Hold the blade of the bolster on the face of the brick and vertical to it.
- Strick the bolster with a firm hard blow with the lumb hammer.
- Use the bolster and Lump hammer to trim any excess remaining on the half brick.
- Mark the line of cut for the closer on each header face an the brick to be cut.
- Stand the brick an one header face on a fibre board pad and Place the bolster along the cutting line.
- Strike a medium blow with a lump hammer, turn the brick to the other header face and repeat the cut with are medium blow.
- Continue alternating between each header face until the brick is cut.

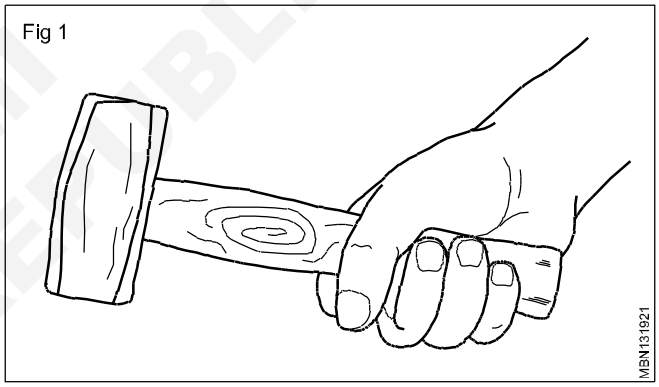
Caution

- Keep away fingers from the chisel head.
- Care should be taken while blow with hammer. Other wise may spoil the fingers. (Fig 1)

Lump hammer

- 1 kg hammer used in conjunction with a bolster for cutting. (Fig 1)

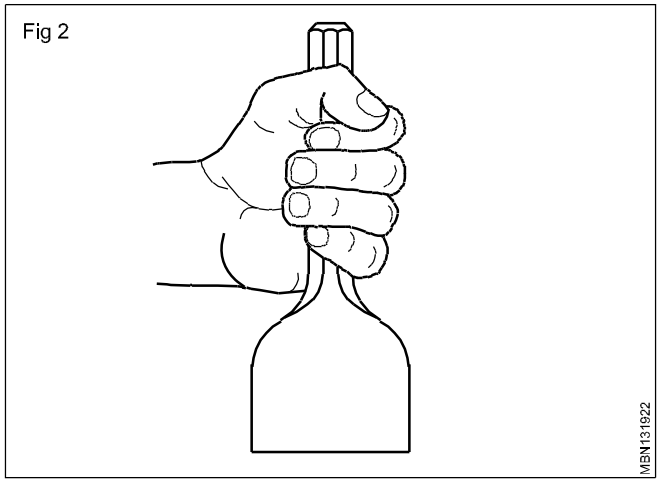
Fig 1



Bolster (Fig 2)

- 100 mm wide chisel, when cutting or trimming the bricks The brick should rest on a fibre of soft wood Pad to reduce unnecessary fractures. For final cutting the bolster should be given a sharp heavy blow with lump hammer or club hammer.

Fig 2



Types of bonds

Objectives: At the end of this lesson you shall be able to
- **state header & stretcher bond construction**
- **state english & flemish bond.**

Bricks can be arranged in different fashions and patterns.

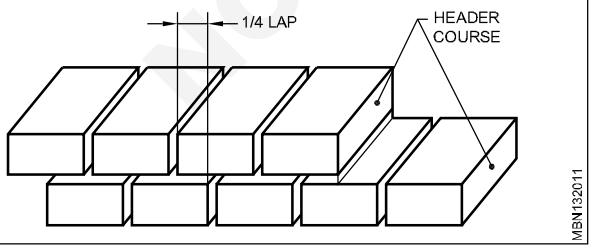
The following arrangements are mostly used for different types of work and for different situations.

- Header Bond
- Stretcher Bond
- English Bond
- Flemish bond
  - a Single Flemish bond
  - b Double Flemish bond
- Raking bond
  - a Herring bone bond
  - b Diagonal bond
- Garden wall Bond
  - a English garden wall Bond
  - b Flemish garden wall Bond.
- Dutch Bond
- Facing Bond
- English cross Bond
- Monk Bond and so on

Header bond

- This is simple type of bond consists of headers in every courses.
- All the bricks are laid cross wise with 5cm lap in each course.
- The bond is used in foundation footings, curved walls, in corbels and overhanging courses as shown in (Fig 1).

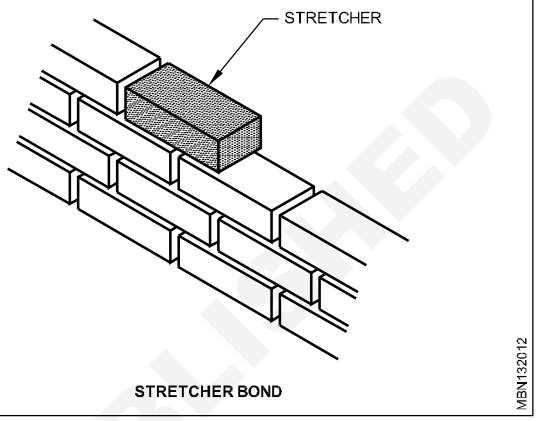
Fig 1



Stretcher Bond

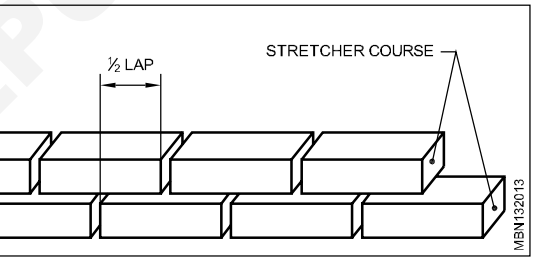
- This type of bond consists of bricks laid length wise or as stretchers with a overlap of 10cm in each course.
- When the thickness wall is 20cm or more, the transverse strength of the wall reduces.
- It is only recommended for walls having a thickness of only half brick 10cm s shown in (Fig 2).

Fig 2



- All the bricks are laid lengthwise half Brick lap as shown in (Fig 3).

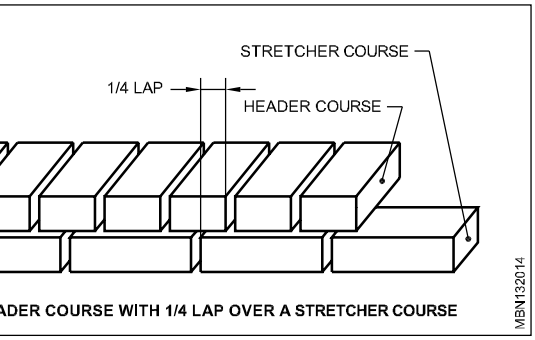
Fig 3



English Bond

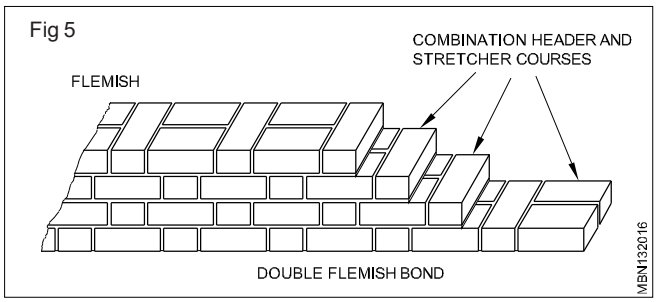
- This is most common and popular bond and is chiefly used for walls varying thickness ranging 20cm and above.
- It consists of equal balancing of header and stretchers in the wall.
- Headers and stretchers are arranged in alternate courses as shown in (Fig 4).
- English bond commences from the quote and along the length of the quoin, Queen closer is placed as shown in (Fig 4).

Fig 4

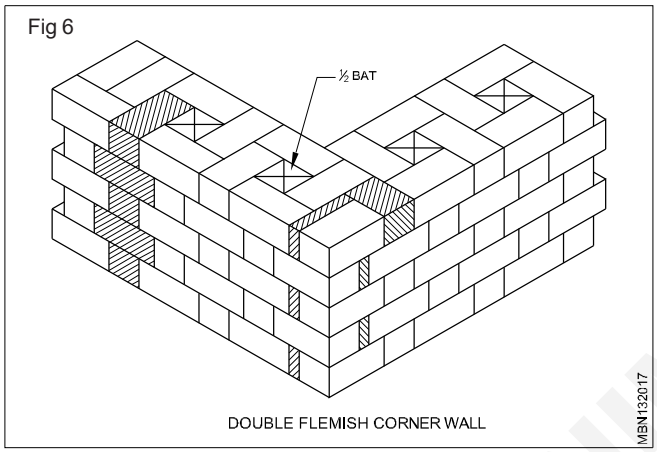


Flemish Bond

- In this arrangement of bonding each course headers an stretchers are alternately placed.(Fig 5)



- Every header is centrally supported over at stretcher below it as shown in (Fig 6)



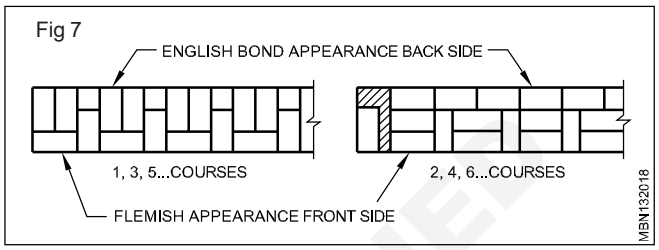
- Large number of half bats are used in Flemish bond.
- Short continuous vertical joints are formed which are unavoidable
- Skilled labour is required for the construction of this bond for having a neater face appearance

The flemish bond is divided into two groups:

- Single flemish bond
- Double flemish bond

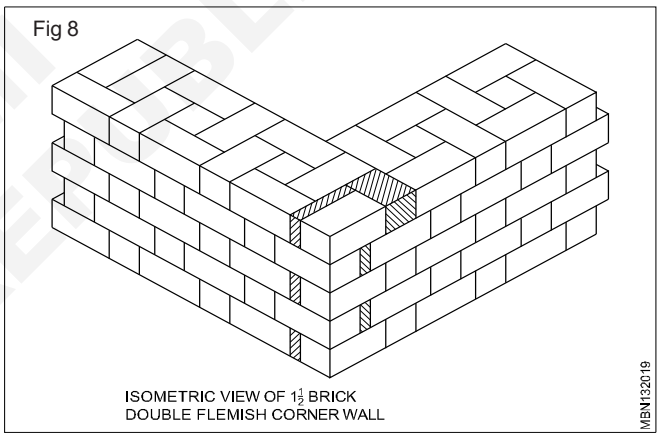
Single Flemish bond

- The single Flemish bond the face elevation is made in Flemish and back elevation in English bond.
- A single Flemish bond is the combination of an English bond and Flemish bond.
- The appearance of a flemish bond and strength of an english bond is combined together as shown in (Fig 7).



Double Flemish bond (Fig 8)

- In double Flemish headers and stretchers are alternately placed in each course in the front as well as on the back.



Cross wall and T.L junction

Objectives: At the end of this lesson you shall be able to
- **state the cross wall of english and flemish bond**
- **describe 'T' junction of english and flemish bond**
- **state adust and acute junction**
- **describe 'L' cross wall of english and flemish bond.**

Cross Junction

- When two walls meet at right angles and cross each other a cross junction is formed. In the cross junction queen closer is not used. as shown in

  Plans showing the bonding arrangements of alternate courses of $1^{1/2}$ brick wall cross with one brick wall in english bond shown in (Fig 1).

- Plan showing the bonding the bonding arrangements of alternate course of 2 brickwall cross with 2 brick wall in english bond shown in (Fig 2).

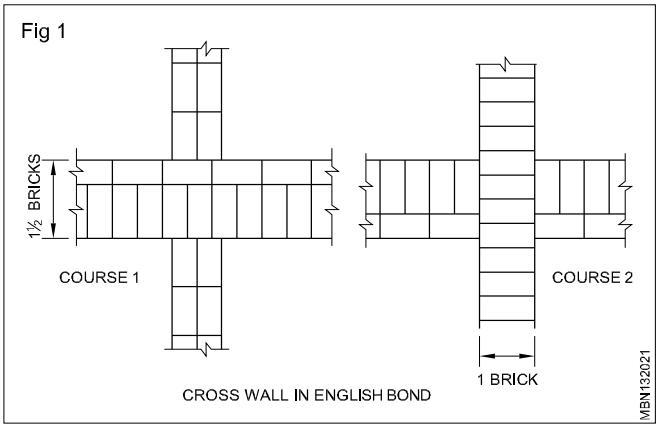
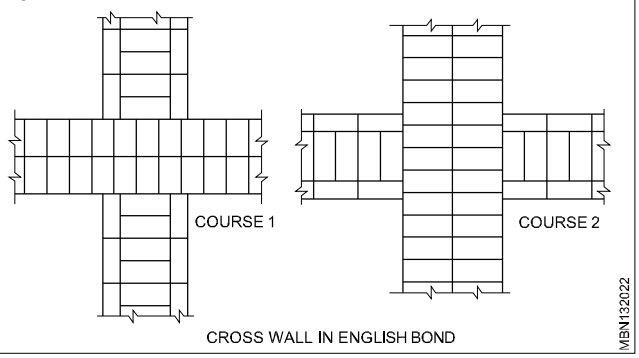


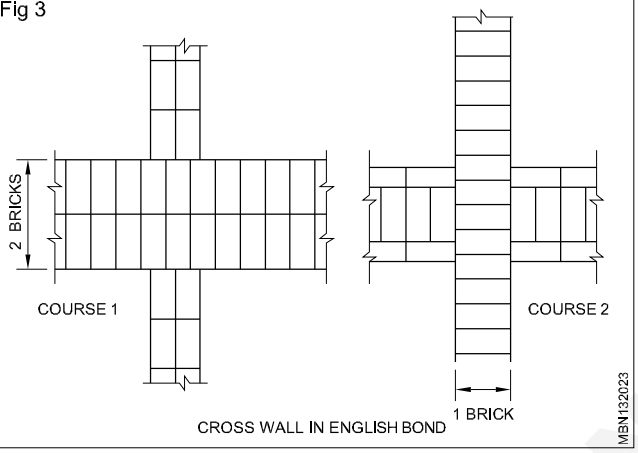
Fig 2



CROSS WALL IN ENGLISH BOND

- Plans showing the bonding arrangements of alternate courses of a 2 brick wall cross a 1 Brick wall in English bond a shown in (Fig 3).

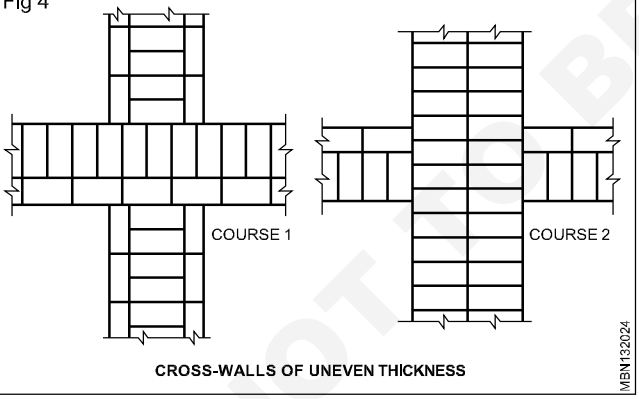
Fig 3



CROSS WALL IN ENGLISH BOND

- Plans showing the bonding arrangements of alternate courses of a 2 Brick wall cross a 1½ Brick wall in English bond as shown in (Fig 4).

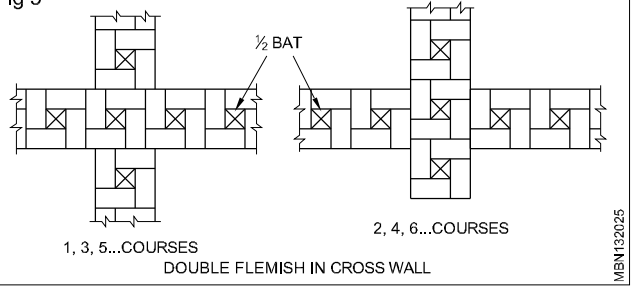
Fig 4



CROSS-WALLS OF UNEVEN THICKNESS

- 1½ brick main wall and cross wall meet each other as as shown in Fig 5 in double flemish bond.

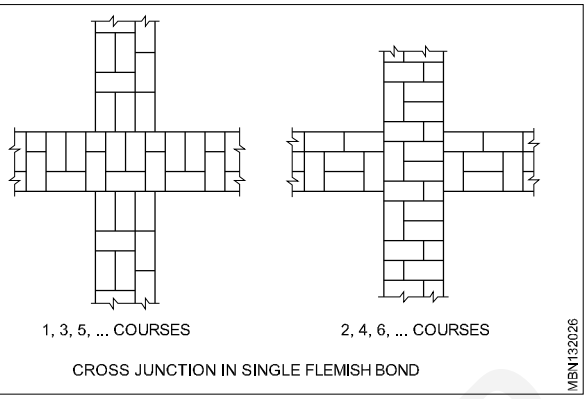
Fig 5



DOUBLE FLEMISH IN CROSS WALL

- Cross Junction
- 1½ Brick main wall and cross wall meet each other as shown in (Fig 6) single Flemish bond.

Fig 6

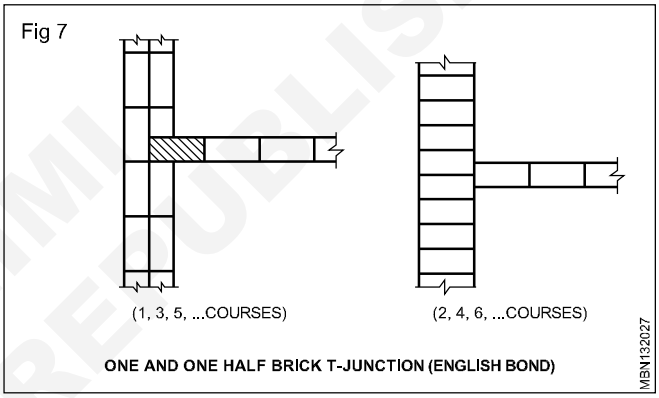


CROSS JUNCTION IN SINGLE FLEMISH BOND

"T" Junction

- Here the two walls meet at right angle but not at the corner. (or) when a main wall meets a cross wall at 'T' Junction is formed. as shown in (Fig 7).

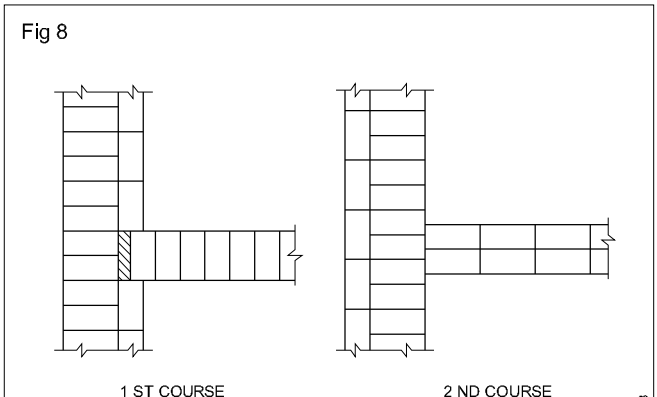
Fig 7



ONE AND ONE HALF BRICK T-JUNCTION (ENGLISH BOND)

- One brick main wall and half brick wall meet at right angle 'T' junction as shown in (Fig 7).
- The following figures will illustrate the arrangement of bricks in walls and columns in English Bond bricks.
- 1½ Brick main wall and 1 Brick wall meet at right angle 'T' Junction as shown in (Fig 8).

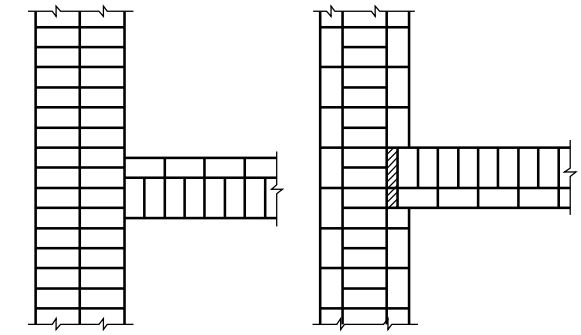
Fig 8



T-JUNCTION ENGLISH BOND

- 2 Brick main wall meet with 1½ Brick wall at right angle each other and formed 'T' Junction as shown in (Fig 9).

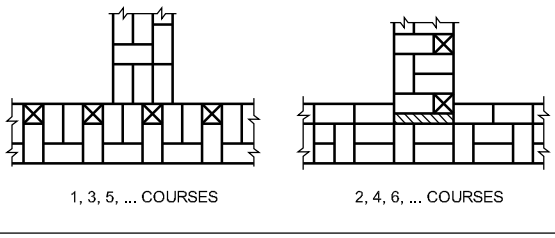
Fig 9



"T" junction

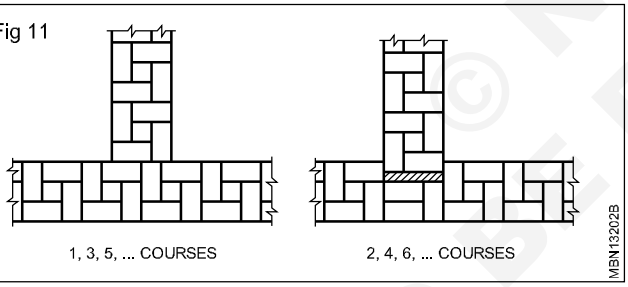
- 1½ Brick wall "T" - Junction in single flemish bond as shown in (Fig 10).

Fig 10



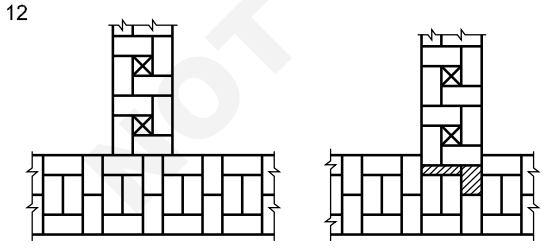
- 1½ Brick wall "T" Junction in double Flemish bond as shown in (Fig 11).

Fig 11



- 2 Brick main wall meet with 11/2 Brick cross wall at right angle 'T' junction in double Flemish bond as shown in (Fig 12).

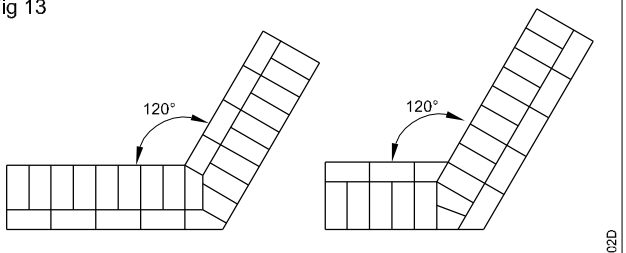
Fig 12



Obtuse Junction

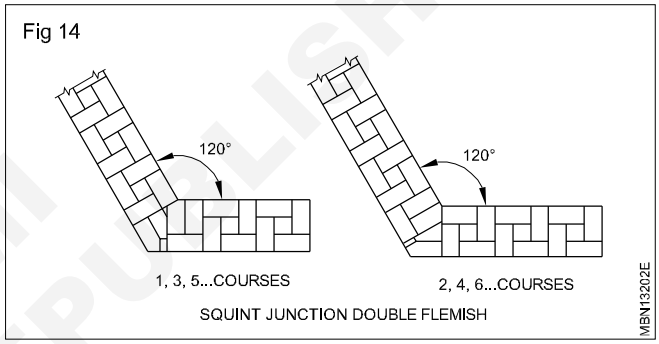
- Where as the obtuse junctions are those where the walls meet at an angle which is more than 90°.
- Two main wall 11/2 Brick thick meet each other at an angle 120° (Obtuse) as shown in (Fig 13).

Fig 13



- The principle of construction the same as for outer walls but the aim should be to obtain the maximum lap with the minimum of cutting If the walls are to be plastered necessary but the principle of correct bonding should be observed and continuous vertical joints should be avoided.
- 1½ Brick thick two main walls meet each other at angle more than 90° is known as Abtuse angle as shown in (Fig 14).

Fig 14



Acute junction

- Acute junction are those where the walls meet each other at angle less than 90° as shown in (Figs 15&16).
- 1½ Brick thick, Two walls meet each other at an angle less than 90° and (Figs 15&16) shows two walls meet each other at 45° angle and 75° angle.

Fig 15

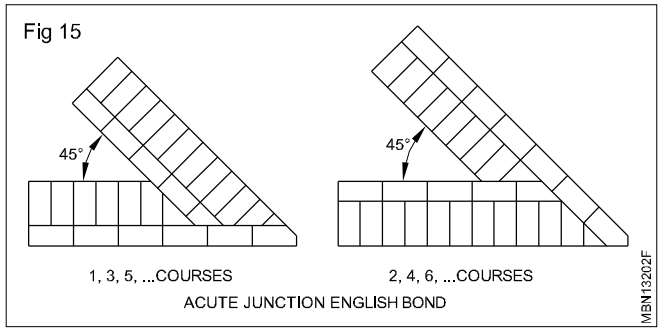
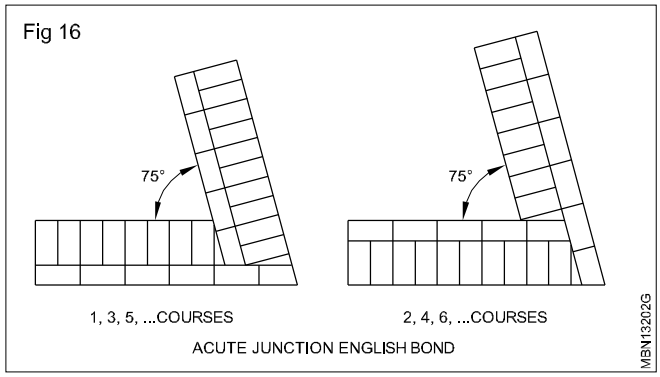
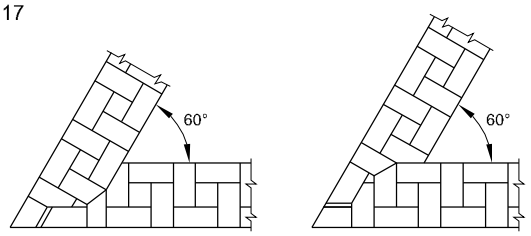


Fig 16



- 1½ Brick thick two walls meet each other at angle 60° is known as shown in (Fig 17).

Fig 17

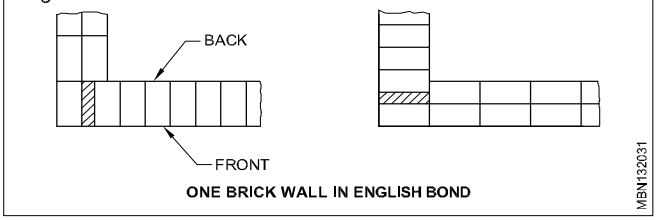


Corner wall bond

Objectives: At the end of this lesson you shall be able to
- **state the corner wall of english bond**
- **state the corner wall of double flemish bond.**

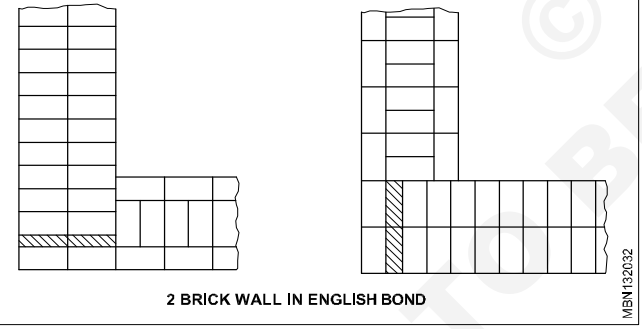
- If the wall is one brick, two brick and so on there will be headers on the face and headers on back of the wall in the same course as shown in (Fig 1).

Fig 1



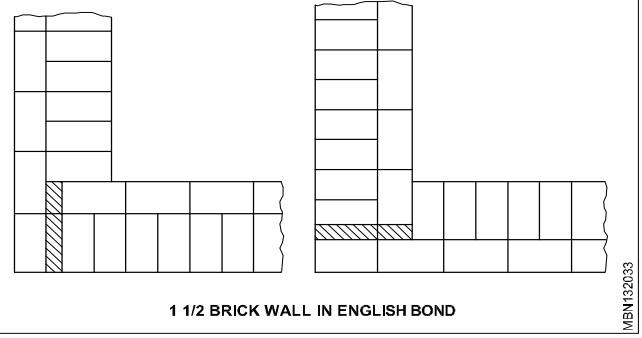
- Similarly stretchers on the face and stretchers on the back of the wall in the same course as shown in (Fig 2).

Fig 2



- On the other hand if in the thickness of wall one and a half brick (1½ Brick) and two and a half brick and so on there will be stretchers on the face and headers on the back refer drawing No.3 and viceversa in the same course also in 2½ Brick wall as shown in (Fig 3).

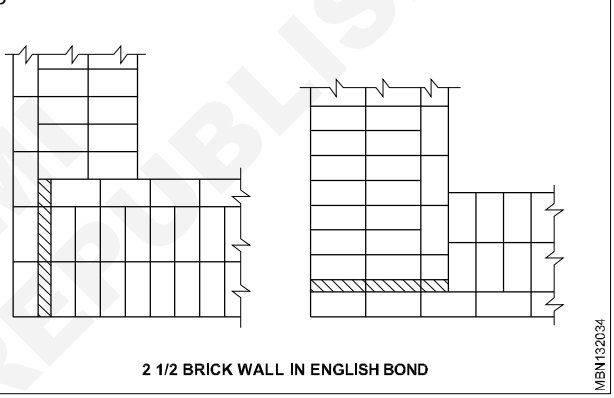
Fig 3



Corner Junction

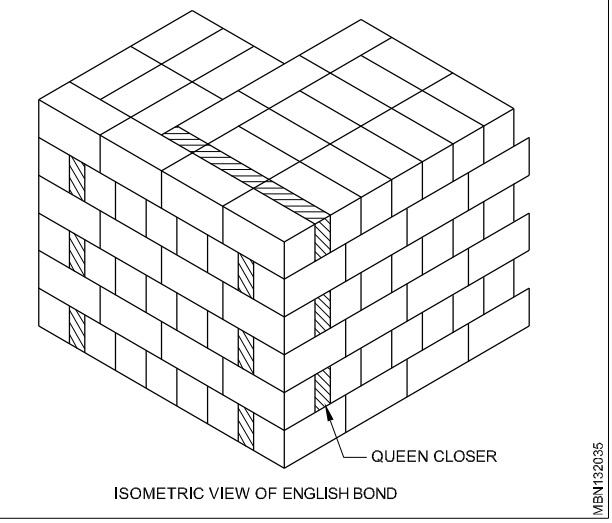
- Here the two walls meet each other in right angles in corner. (Fig 4)

Fig 4



- In one course the quoin is placed in one direction while in the other course it is place at right angles to its previous position in the previous course as shown in (Fig 5)

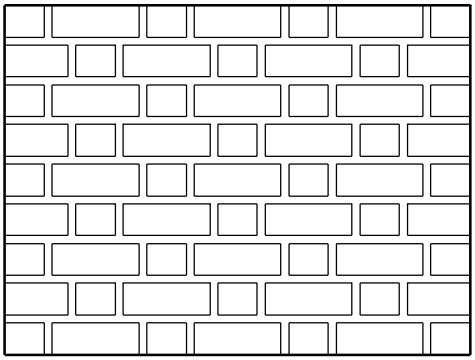
Fig 5



Corner wall

- One Brick wall showing the same elevation front and back of the wall is called double Flemish wall as shown in (Figs 6&7).

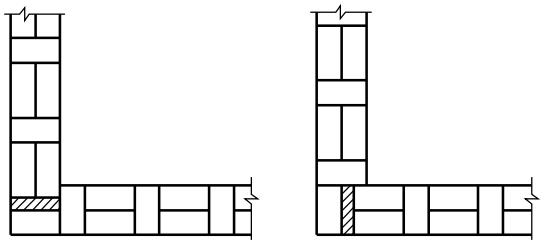
Fig 6



FLEMISH BOND

MBN132036

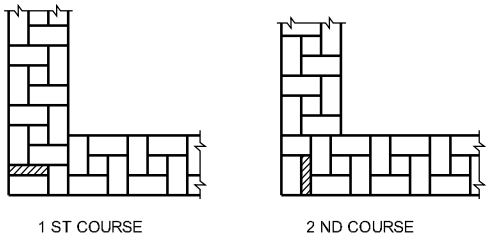
Fig 7



MBN132037

- 1½ Brick wall corner in double Flemish bond as shown in (Fig 8).

Fig 8



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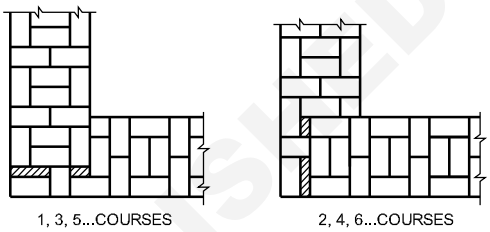
- 2 Brick wall corner in double flemish bond as shown in (Fig 9).

Fig 9



MBN132039

Types of bonds II

Objective: At the end of this lesson you shall be able to
- **state types of bond construction.**

Garden wall

a English garden wall

1 One header course is provide to two or three stretcher course.

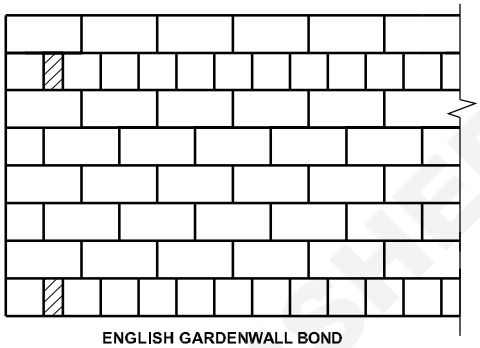
2 Quoin headers are placed in alternate bond course and queen closer is placed next to the quoin header in header course to develop lap.

3 The wall is one brick wall and the bond height is 2 m (Fig 1).

4 It may be constructed in English or Flemish bond.

Uses:-The bond is used for Garden walls and compound wall.

Fig 1



ENGLISH GARDENWALL BOND

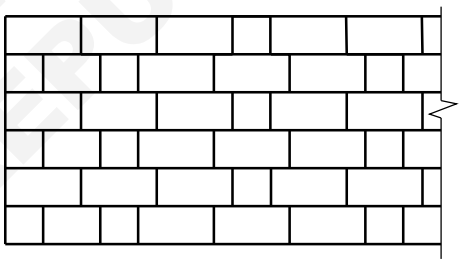
MBN132111

b Flemish garden wall bond

1 Each course contain one header to three or five stretcher.

2 A ¾ th bat is placed next to the quoin header. (Fig 2)

Fig 2



FLEMISH GARDENWALL BOND

MBN132112

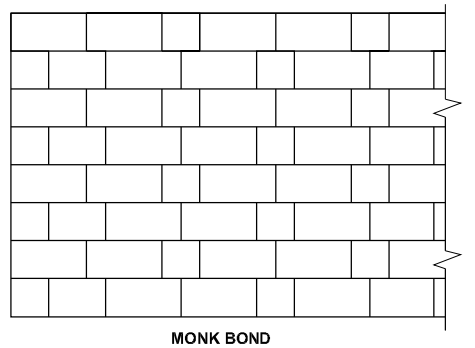
c Monk bond

1 A header is placed centrally over each middle stretcher.

2 Each course contain one header to two stretchers

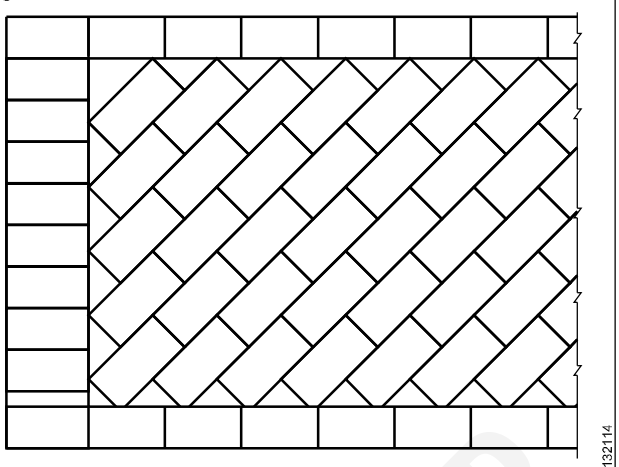
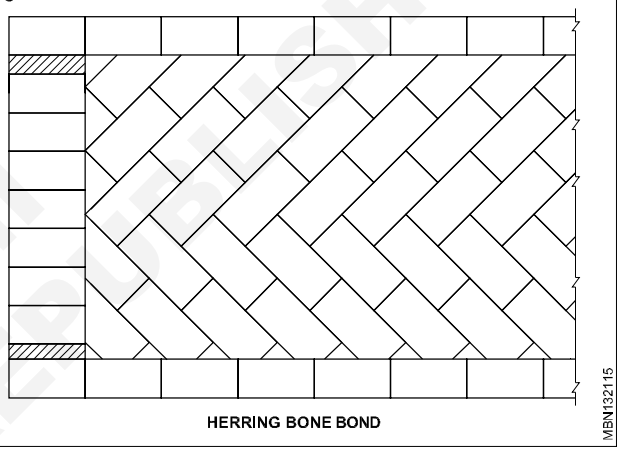
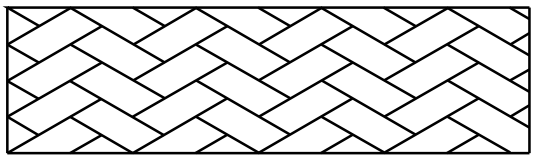
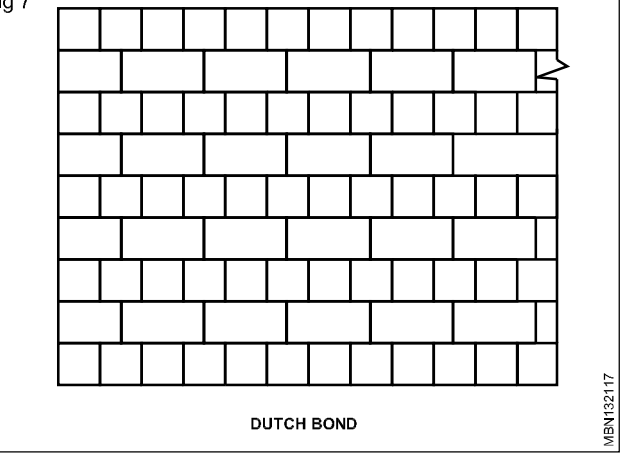
3 The header rest on the joint be tween two headers. (Fig 3)

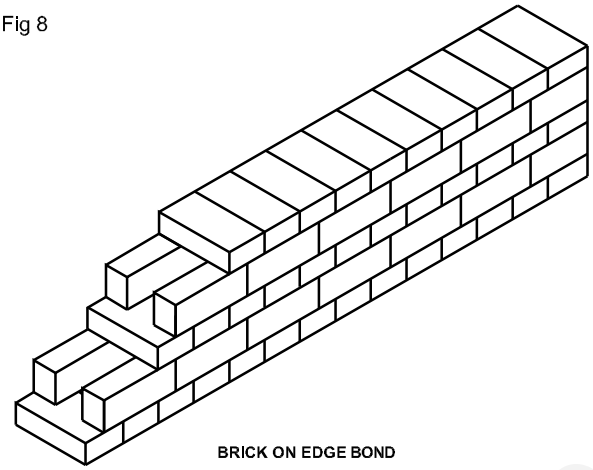
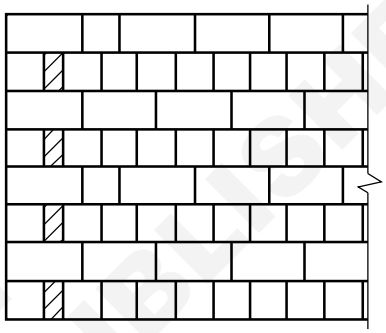
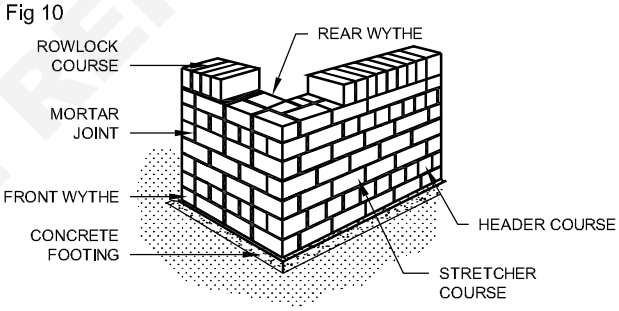
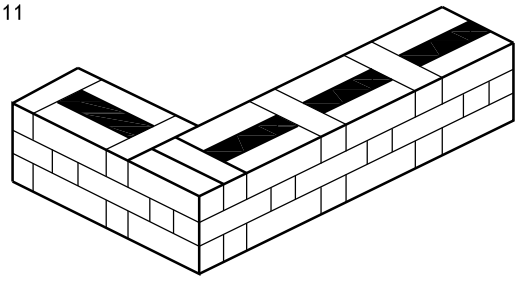
Fig 3



MONK BOND

MBN132113

6 Raking bond	1 Courses are inclined 2 Inclination should be in opposite direction in alternate courses.	Fig 4
a Diagonal bond	Bricks are laid diagonally, useful for 2-4 brick thick. (Fig 4)	
b Herring bone	Brick are laid at 45° from the centre in both the direction, Useful for ornamental finish. (Fig 5)	Fig 5
		
c zig-zag bond	Bricks are laid in zig-zag fashion and used for flooring. (Fig 6)	Fig 6
		
Dutch bond	1 Alternate courses of headers and stretchers. (Fig 7) 2 The quoin of stretcher course is ¾ bat. 3 A header is introduced next to the ¾ bat in every alternate stretcher course. Uses: Corner of wall can be strengthened.	Fig 7
		

Brick on edge bond	1 Bricks are laid as headers and stretchers in alternate courses.(Fig 8) 2 Headers are laid on bed and stretchers are laid on edge. 3 Continuous cavity is formed. Uses:- Used for garden wall, compound wall, partition wall.	Fig 8  BRICK ON EDGE BOND MBN132118
English cross bond	1 Alternate courses are of headers and stretchers. (Fig 9) 2 The queen closers are placed next to the quoin header. 3 A header is introduced next to the quoin stretcher. Uses:- This bond adds the beauty of wall.	Fig 9  ENGLISH CROSS BOND MBN132119
Facing bond	1 A header course is placed after several stretcher course. (Fig 10) Uses:- Used when facing and backing brick are varying size.	Fig 10  MBN132211A
Rat trap bond	1 Locally made bricks having thickness less than 10cm are used. (Fig 11) 2 All the bricks are laid on edge. 3 Alternate headers and stretchers are used in same course. 4 A cavity is formed inside the course. 5 It is strong, sound and heat proof.	Fig 11  RAT TRAP BOND MBN132118

Building materials - Sand

Objectives: At the end of this lesson you shall be able to
• state types of sand
• state classification of sand
• describe bulking of sand.

Types of sand

The sand particles consists of small grains of silica. (Sio2) It is formed by the decomposition of sand stone due to various effects of weather.

According to the natural sources from which the sand is obtained It is the following three types.

- Pit sand
- River sand
- Sea sand.

Pit Sand

- This sand is found as deposits in soil and it is obtained by forming pits into soils.
- It is excavated from a depth of about 1m to 2m from ground level.
- The pit sand consists of sharp angular grains.
- It is free from salt and other organic matters.
- It proves to be excellent materials for mortar or concrete work.

River sand

- This sand is obtained from banks or beds of rivers.
- The river sand consists of fine rounded grains.
- The colour of river sand is almost white.
- The river sand is usually available in clean condition.
- It is usually used for all works in Civil Engineering construction.

Sea sand

- This sand is obtained from sea shores.
- It is also consists of fine rounded grains.
- The colour of sea sand is light brown.
- The sand contains salts.
- Hence, it is not generally used in construction purposes.
- It mainly used for filling basements works.

Qualities of good sand

- Sand should be clean, sharp angular hard and durable.
- Sand should be free from clay, mica and soft flaky pieces.
- Mostly River sand and pit sand used for all construction works.
- All sand must be well washed and cleaned before use.
- Generally 4 to 6 percent of clay and silt are permitted in sand.
- well graded sand should be used for cement work as it adds to the density of the mortars and concrete.

Classification of sand

According to the size of the grains, the sand is classified as:

- Fine sand
- Coarse sand
- gravelly sand

Fine sand

- The sand passing through a screen with clear openings of I - 5875 mm is known as the fine sand.
- It is mainly used for pointing and plastering works.

Coarse sand

- The sand passing through a screen with clear openings of 3.175mm is known as the coarse sand.
- It is generally used for masonry work.

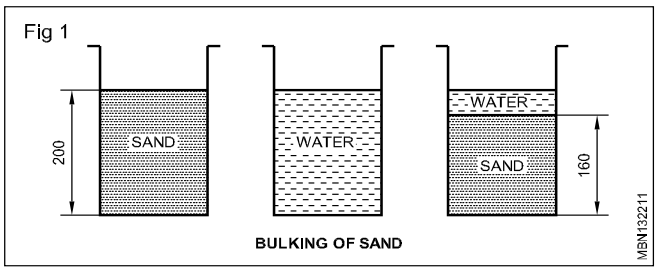
Gravelly sand

- The sand passing through a screen with clear openings of 7.62 mm is known as the gravelly sand.
- It is generally used for concrete work.

Object of mixing sand in mortar is

- The prevent excessive shrinkage and cracking of mortars in setting, especially in the case of the fat limes which shrink very much while drying cement also shrink to some extent.
- To improve the setting power of fat limes.
- To improve the strength of a mortar as sand has greater crushing strength.
- To increase the bulk and reduce the cost, especially in the case of cement mortar.

Bulking of sand (Fig 1)



- A very simple test may be carried out to decide the percentage of Bulking of sand.
- The following procedure is adopted.
- A glass container is taken and it is filled two -third with the sample of sand which is to be tested.
- Measure the height of sand filled, say it is 200 mm.
- The sand is removed out from the container, there is no less of sand during this transaction.
- The container is filled with water.
- Sand is then slowly dropped in the container and it is thoroughly stirred by means of a rod.
- The height of sand is measured say it is 160 mm.

$$\text{Bulking of sand} = \frac{(200 - 160)}{160} = \frac{40}{160} = \frac{1}{4} \text{ (or) } 25\%$$

Bulking of sand is 25%.

Mortar

Objectives: At the end of this lesson you shall be able to
- **define mortar**
- **describe ingredients of mortar**
- **state the functions of mortar**
- **explain properties of good mortar**
- **list out the uses of mortar.**
- **state the types of mortar**
- **state preparation of mortar**
- **list out the tests for mortar**
- **select the mortars for different engineering works.**

Introduction

For construction of buildings, nowadays, we mostly use cement mortar and cement plasters. A large amount of cement is consumed for these works. The total consumption is about 3 bags per square metre of plinth area in residential buildings and about 4 bags per square metre of plinth area in office buildings of this a major part is used for making mortar and plasters.

Definition

A paste formed by the addition of water to a mixture composed of an aggregate such as sand and a matrix or binding material like lime or cement is called mortar.

Ingredients of mortar:

1 Binding or cementing materials…..such as cement or lime.

2 Fine aggregates……such as sand, surkhi, ashes, cinder, etc.

3 Water……should be free from oils, acids, alkalies and other inorganic impurities.

Functions of mortar

- It's binds together stones or bricks properly.
- In any concrete, it holds coarse aggregates together.
- In stone masonry and brick masonry, it fills up empty joints; a thin liquid mortar used for such purposes is termed as grout.
- It provides a durable / weather resisting layer between different course of masonry in the structure.
- It forms a homogeneous mass of the structure so that it may resist all the loads coming over it and transfer the same uniformly to its foundation.
- It does pointing or plastering to the structure.

Properties of a good mortar

- It should be capable of developing good adhesion with the building units.
- It should be easily workable.
- It should be cheap.
- It should be durable.
- It should be capable of resisting penetration of rain water.
- It should be capable of developing the design stresses.
- It should be durable and should not affect the durability of other materials.
- The joints formed by mortar should not develop cracks and they should be able to maintain their appearance for quite a long period.

Uses of mortar

1 To bind the building units such as bricks, stones, etc. into a solid mass.

2 To carry out pointing and plaster work on exposed surfaces of masonry.

3 It is employed for moulding purposes.

4 It is used to form joints of pipes.

5 It is used to improve general appearance of structure.

6 It is used to hide open joints of a masonry work.

7 It is used as a matrix in concrete.

Preparation of mortar(Fig 1)

It may prepare by Hand mixing or Machine mixing. When a small quantity of mortar required, hand mixing method is adopted. When large quantity of mortar is required continuously at a fast rate, it is prepared by mixing of the ingredients in mechanical mixtures.

In order to test the quality of mortar, the following tests are usually conducted:

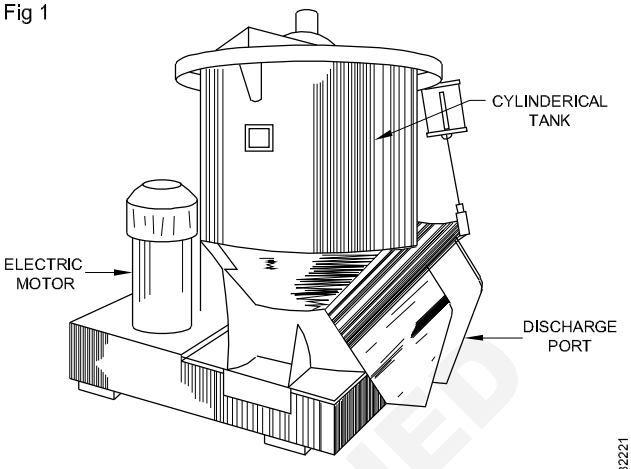
1 Adhesiveness to building units test.

2 Crushing strength test.

3 Tensile strength test.

4 Setting time test.

Fig 1



TURBULENT MORTAR MIXER

SELECTION OF MORTARS FOR DIFFERENT ENGINEERING WORKS

S. No.	Nature of Work	Mortar - Type and Composition
1	Thick joints in stone masonry	Hydraulic time sand mortar (1:2:3)
2	Stone masonry in foundations and superstructure of ordinary buildings.	1:2 fat lime surkhi mortar or 1 part lime, 1 part surkhi and 1 part sand.
3	Brickwork in arches, plastering inside of walls. mortar (1:2) or lime, surkhi and sand. (1:1:1) mortar.	1:5 to 1:6 cement mortar, or lime surkhi
4	Reinforced brickwork.	1:3 cement mortar.
5	Mass concrete in foundations, paving tiles, cavity walls, plastering of ceiling and external plastering work etc., where good finish is required.	1:4 cement sand mortar or 1:2 to 3 hydraulic lime mortar.
6	Massive work below ground level especially in water logged areas.	1:3 cement sand mortar or 1:3 lime (eminently hydraulic) sand mortar.
7	Massive works, dams, retaining walls, damp proofing, flooring, etc. where very high finish is required.	1:3 cement sand mortar.
8	Pointing work 1:1 to 1:2 cement sand mortar.	
9	General R.C.C. works such as slabs, beams and columns cement concrete flooring etc	1:2 cement sand mortar.
10	Damp proof course and cement concrete roads.	1:2 cement sand mortar.
11	R.C.C tanks and other retaining structures etc.	1:1½ cement sand mortar.
12	Highly stressed numbers of structure.	1:1 cement sand mortar.
13	Laying fire-bricks.	Fire- resisting, mortar consisting of 1 part of luminous cement to 2 parts of finely crushed of fire-bricks.

Types of cement

Objectives: At the end of this lesson you shall be able to
- **types of cement and their is codes grade mm**
- **state the admixture**
- **describe the cement test**
- **describe the uses of cement.**

TYPES OF CEMENT

Cement is specified by its grade (compressive strength of 1:3 cement mortars as cubes of 50 cm² areas (7.06 cm) in 28 days for defining strength) thus, Grade-33 cement (C-33) means cement with standard mortar cube strength of 33 N/ mm² in 28 days. Only the grade of the cement is marked on the bags of 50 kg.,

The following are the IS specifications:

1 Ordinary Portland cement (OPC) in 3 grades,
   a Grade 33 - IS: 269-1989 designated as C-33,
   b Grade 43 - IS: 269-1989 designated as C-43,
   c Grade 53 - IS: 269-1989 designated as C-53
2 Portland pozzolana cement (PPC) (a mixture of OPC and Pozzolana)
   a IS: 1489 (Part-I)-1991 (fly ash -based)
   b IS: 1489 (Part-II)-1991 (calcined clay-based)
3 Sulphate-resisting cement-IS: 12330-1988
4 Portland slag cement-IS:455-1989 (PSC)
5 Low- heat cement-IS: 12600-1989
6 Rapid-hardening cement-IS:8041-1990
7 Concrete sleeper-grade cement-IS: T40-1985
8 Coloured cement-white cement-IS: 8042-1989
9. Oil well cement-IS: 8229-1986
10 Hydrophobic cement-IS: 8043-1991
11 Masonry cement-IS: 3466-1988
12 High-alumina cement-IS: 6452-1989
13 Super-sulphated cement-IS: 6909-1990
14 Expansive cement
15 Quick setting cement

CEMENT WATER PROOFERS

The water proofers are required for all water retaining structures especially for:

i Swimming pools
ii Basements
iii Hospitals
iv Refrigeration rooms
v Cold storages
vi Water supply and sewage works
vii Exterior plaster
viii Bath rooms and kitchens
ix Reservoir

These water proofers render mortar or concrete water tight either by filling the pores physically or reacting chemically. The water proofer may be in powder, paste or liquid form. The amount to be added must be in accordance with the instructions of the manufactures; generally the following proportions are used:

- 2 to 5 %.....when in powder form
- 1 part paste and 10 parts water…when in paste form
- 1 litre liquid and 15 litres water….when in liquid form

ADMIXTURES

These are the Materials which are added in cement mortar or concrete to improve upon their quality. The admixtures serve the following purposes:

1 Improve the workability.
2 Retard setting action of the mortar and concrete.
3 Increase the bond strength between reinforcement and concrete.
4 Improve the water proofing properties of the cement mortar or concrete.
5 Reduce shrinkage during setting of mortar or concrete.
6 Reduce bleeding and segregating effect of concrete.

TESTS FOR CEMENT

The properties of concrete or mortar largely depend upon the quality of cement used. The quality of cement can be tested in the laboratory by the following tests based on Indian Standard Specification (IS: 269-1958):

1 Fineness: To know the fineness of grinding.

2 Compressive strength: Cement cubes are prepared and tested after 3,7 and 28 days of curing.

3 Consistency: To know the quantity of water to be added for testing the cement for setting time, soundness and compressive strength. Vicat apparatus is used for this test.

4 Setting times: To know the initial and final setting times. Vicat apparatus is used for this purpose.

5 Soundness: To find out the presence of free lime. Le chatelier apparatus is used for this purpose.

Field tests may be carried out to ascertain roughly the quality of cement:

1 Colour-Greenish grey.

2 Presence of lumps,-Pressed between the thumb and fore finger it should be powdered.

3 Rubbing-When rubbed between the fingers it should feel smooth.

4 When a hand full of cement thrown into a bucket of water it floats.

5 One should feel cold when a hand is insert in to a bag of cement.

Grades of cement

The bureau of Indian Standards has classified in three different grades

i 33 grade

ii 43 grade

iii 53 grade

The grade number indicates the compressive strength of cement sand mortar in N/mm^2 at 28 days.

Properties of cement

- Provides strength to masonry
- Stiffens or hardens early
- Possesses good plasticity
- An excellent building material
- Easily workable
- Good moisture resistant

S.No.	Types	Features	Uses
1	Ordinary portland cement	General concrete structures	Medium rate of strength developed less resistance to chemical attack
2	Acid resistant cement	Acid resistant heat resistant coating of installation of chemical industry	It cannot resist the action of water well
3	Rapid hardening portland cement	Rapid strength is developed	Curing period short, burnt at high temperature
4	Blast furnace cement	Mass concrete structure	Initial setting time not less than 30 minutes, final setting time 10 Hrs
5	Expanding cement	Construction of water retaining structures repairing the damaged concrete structures	-
6	Coloured cement	Finishing of floors, external surface artificial marble, stair tread	By adding 5 to 15% of suitable colouring pigment before the cement is finally ground.
7	High alumina cement	For works in chemical plant and furnaces	It is completely resistant to the action of surface
8	Hydrophobic cement	Frost resistant and water resistant	Initial stage the gain in strength is less
9	Modified portland cement	Heavy construction of heavy abutment, large piers, retaining wall etc	Less heat of hydration
10	Extra rapid hardening	Suitable for cold weathering concrete cement	Qty of calcium chloride should not exceed 3 percentage
11	Sulphate resisting portland cement	Used at places where sulphate action is severe.	-

Lime

Objectives: At the end of this lesson you shall be able to
- **define lime**
- **classify lime**
- **state properties of lime**
- **describe uses of lime**
- **compare fat and hydraulic lime**
- **explain tests for lime**
- **list out the precautions in handling lime.**

Introduction

Lime is produced from calcium carbonates in the form of limestone, seashells, coral, kankar, etc. quicklime is not a stable product. If it left exposed to air, it absorbs carbon dioxide from air and revert back to carbonate. Hence, quick lime should be slaked to calcium hydroxide (Hydrated or slaked lime) as early as possible to make the material stable.

Definition

A powder obtained by heating limestone, is called lime.

1 Carbide lime is a by-product of manufacturing of acetylene. It can be used for mortar for plaster work, but generally it is not recommended for whitewashing unless procured fresh in the form of a paste before it dries up or is treated properly.

2 Lime containing more than 30 percentage impurities like clay is called poor limes.

Classification:

IS: 712-1973, classifies lime as follows:

Class a: eminently hydraulic lime, which can be used for structural works, such as arches, domes, etc.

Class b: semi-hydraulic lime which can be used for constructing masonry.

Class c: fat lime that can be used for finishing coat in plastering, white washing, etc. or used for masonry mortar with addition of pozzolanic material.

Class d: magnesium or dolomite lime is used for finishing coat in plastering and whitewashing.

Class e: Kankar lime produced by burning lime nodules (found in soils like black cotton soils contain silica) is hydraulic. It can be used for masonry mortar.

Class f: Siliceous dolomite lime is used generally for undercoat and finishing coat of plaster.

Properties of lime

1 Easily workable.

2 Possesses good plasticity.

3 Stiffens early.

4 Provides strength to the masonry.

5 Offers good resistance to moisture.

6 An excellent cement and adheres to the masonry units perfectly.

7 Lime masonry proves durable due to low shrinkage in drying.

Uses of lime:

1 It is used as a matrix for concrete.

2 It is used as a binding material in mortars for stoneware and also in bedding and joining brickwork of low strength.

3 It is used for plastering walls, ceilings, etc.

4 It is employed for white washing and as a base coat for distempers.

5 It is used for knotting of timber work before painting.

6 It is used for production of artificial stone, lime - sand bricks, foam-silicate products, etc.

7 When mixed with Portland cement, the lime-cement mortar attains such valuable properties, that it replaces the costly cement plaster and serves as a plasticizer.

8 It is used as a flux in the manufacture of steel.

9 Eminently hydraulic lime can be used for masonry work below ground level.

10 It is used in the manufacture of paints.

11 It is used for stabilizing the soils.

12 It is employed for creating good sanitary conditions in foul, damp and filthy places.

Comparison between fan lime and hydraulic limes:

S.No.	Item	Fat Lime	Hydraulic lime
1	Composition	It is obtained from comparatively pure carbonate of lime containing only 5% of clayey impurities.	It is obtained from lime stones containing to the extent of about 5 to 30 % and some amount of ferrous oxide.
2	Slaking action	It slakes vigorously. Its volume is increased to about 2 to 2 ½ time the volume of quick lime. The slaking is accompanied by sound and heat.	It slakes slowly. Its volume a slightly increased. The slaking is not accompanied by sound or heat.
3	Setting action	It sets slowly in presence of air. It absorbs carbon dioxide from atmosphere and forms atmosphere and forms calcium carbonate.	It sets under water. It combines with water and forms crystals of hydrated tri-calcium silicate.
4	Hydraulicity	It does not possess hydraulic property.	It possesses hydraulic property.
5	Colour	It is perfectly white in colour.	Its colour is not so white as fat lime.
6	Strength	It is not very strong. Hence, it cannot be used where strength is required.	It is strong and can therefore be adopted where strength is required.
7	Uses	It is used for plastering, white washing, etc. and for preparing mortar with sand or surkhi.	It is used for preparing mortar for thick walls, damp places, etc. extreme care is required to prepare mortar of this lime for plaster work.

Tests for lime: It can be classifies into two types- laboratory test and field test.

Laboratory tests for building lime: Indian standards specify ten laboratory tests for lime in IS: 6932-1973 'Methods of test for building lime'.

Field tests for building lime: IS: 6924-1974, gives a number of field tests for building lime, as follows:

1 **Visual examination:** class C lime should be pure white in colour.

2 **Hydrochloric acid test:** The purpose of this test is to assess the classification and calcium-carbonate content of lime.

3 **Ball test:** the purpose of this test is to assess the classification.

4 **Impurity test:** the purpose of this test is to assess the quality of lime.

5 **Plasticity test:** the purpose of this test is to assess the plasticity of lime.

6 **Workability test:** the purpose of this test is to assess the workability of lime.

Precautions in handling lime:

1 **Contact with water:** The quick lime should not be allowed to come in contact with water before slaking.

2 **Facilities for workers:** Goggles for eyes and respirators for nose and throat protection, rubber gloves, gum boots, skin protecting cream or oil and there should be provision of adequate quantity of water.

3 **Fire hazard:** All suitable measures should be taken to avoid chances of any fire hazard.

Foundation

objectives: At the end of this lesson you shall be able to
- **define foundation**
- **state types of foundation**
- **explain purpose of foundation**
- **explain various loads on foundation**
- **describe causes of failure of foundation and its remedies.**

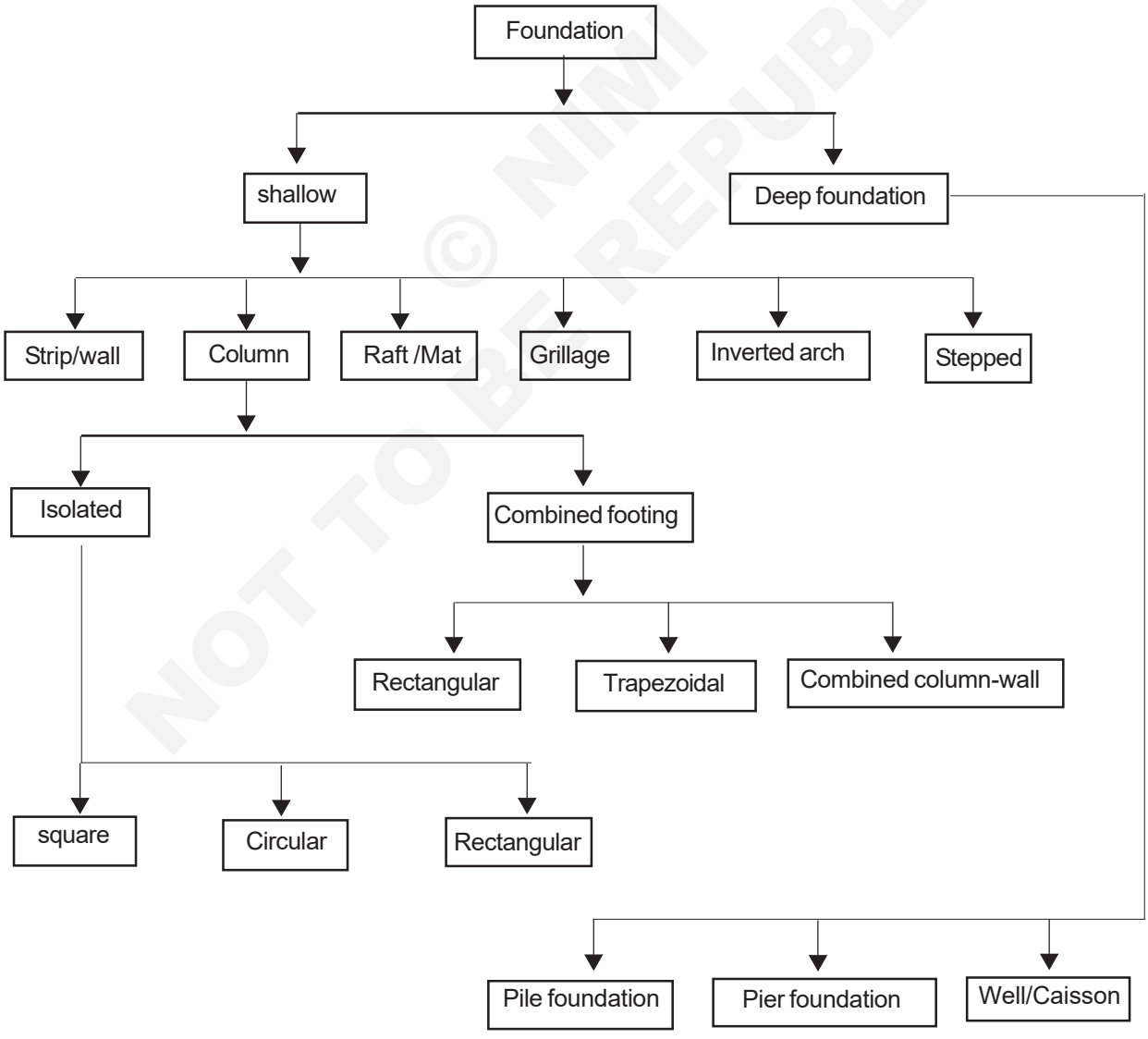
Introduction

Every structure consists of two parts, namely foundation and super structure. Foundation is the lowest part of a structure which transmits the weight of the structure, together with the effect of live loads and pressure, to the material on which the structure rests in such a manner that the underlying material is not stressed beyond its safe bearing capacity.

Definition

The lowest artificially prepared part of the structure, usually located below the ground level, which transmit the load of the superstructure to the ground is known as substructure or foundation.

Types of foundations



Types of loads

1 Dead load 2 Live load 3 Wind load 4 Snow load

Causes of failure of foundations and its remedies

Causes	Remedies
1 Unequal settlement of the subsoil	Foundation should rest on rigid strata. Design of foundations should be appropriate to the nature of subsoil.
2 Unequal settlement of the masonry	Using mortar of proper strength. Masonry work should be raised evenly. Proper Curing.
3 Withdrawal of moisture from the subsoil	Provide drive piles up to the hard rock.
4 Lateral pressure on the superstructure	Provide sufficient wide base.
5 Horizontal movement of the earth	Construct retaining walls to prevent the escape of earth.
6 Transpiration of trees and shrubs	Foundations should be sufficiently deep. Trees should not be planted near the building.
7 Atmospheric action	Provide suitable underground drains. Providing gentle ground slope away from the wall.

1 Dead Load

This is the load of the material used for the various components of a building such as wall, floor, etc., All permanent loads are this included in that load, sometime a dead load of 10kg/m^2 of the floor area is allowed for construction of a partition wall.

2 Live load

This is the movable load on the floor and hence it is variable. It is also sometime know as super imposed load. It includes load of person standing on a floor, weight of material temporarily stored on a floor. Live load is known superimposed or simply super load. Foundations shall be designed to carry 60% of the assumed live load in addition to the dead load, wind load and snow load.

3 Wind load

Incase of tall building the effect of wind should be consider. The exposed sides and roofs of such building are subject to wind pressure and it affect is it reduce the pressure on the foundation on the wind ward side and to increase the pressure on the foundation on the Lee ward side. The wind pressure will depend on the velocity the of the ground.

4 Snow load

The snow loads are acted in snow region and hills where snow falls.

Shallow foundation

objectives: At the end of this lesson you shall be able to,
- **define shallow foundation**
- **explain various types of shallow foundation**
- **describe setting out of building on ground.**

Introduction

It is possible to construct foundation of a building at a reasonable shallow depth, the foundations are termed as the shallow foundations.

Definition

The depth of foundation is equal or less than its width, is known as shallow foundation.

Setting out of building on ground

1 Clear the site.

2 Prepare a plan of setting out on paper.

3 Centre lines of walls to be marked on plan.

4 This is to be marked on ground.

5 Mark the centre lines of walls by stretching a string between wooden pegs.

6 Cross walls set by 3,4,5 method.

7 Corners of building are laid and sides checked by measuring diagonals.

8 Entire width of foundation marked

9 For big projects reference pillars of brick may be constructed.

Shallow foundation

Foundation having its depth less than or equal is its width are known as shallow foundation. Since such foundation are constructed by open excavation.

Hence those foundation having its depth even greater than its width but are constructed by way of open excavation are also come under shallow foundation.

Design of shallow foundation

Following data are required before design of a foundation

a The total load to be transmitted by the wall or pier to the foundation bed.

b The results of trial pit and the corresponding bearing capacity of each strata of soil.

The design of foundation required the three terms,

a Width of foundation.

b Depth of foundation below ground level.

c Depth of concrete block below the masonry roofing.

Width of foundation

The width of foundation should be sufficient enough to bear the super imposed load per unit length on the foundation bed. The width of foundation is obtained by

i Dividing the total load per unit length on foundation bed by safe bearing capacity of the soil.

Thus, width of foundation = $\frac{w}{p}$

Where, w = total load in tone/metre

p = safe bearing capacity of soil in tonne/m^2

ii width of foundation = 2 (T+J)

Where,

T = thickness of wall above the plinth level.

J = the projection of concrete block on the either side of the lowermost masonry footing. which should be atleast 10cm-15cm.

Depth of foundation below ground level

This is generally determined by the rankine's formula. Which gives the maximum depth.

Depth of foundation below the ground level,

$$d = \frac{p}{w}\left[\frac{1-\sin\theta}{1-\sin\theta}\right]^2$$

Where p = total load on soil in kg/m^2

w = wt. of soil in kg/m^3

θ = Angle of repose of the soil.

In order that all the shallow foundation should be taken to a minimum depth of 80 cm below the natural ground level. Unless hard soil is available within 80 cm.

Angle of repose

Angle of repose is the angle 30° to 45° the loose soil will make with the horizontal, if allowed to remain free in loose condition. The angle of repose of the soil varies with the type of earth.

Depth of concrete block

The depth of concrete block below the masonry footing is calculated by using the formula.

$$d = \sqrt{\frac{3PJ^2}{m}}$$

Where, P = the load on soil in kg/m^2

J = The projection of concrete on either side of the lower most masonry footing which should be at least 10-15cm.

m = modulus of rupture of concrete in kg/m.

The depth of concrete block below the masonry footing is also determined by the formula

$$d = \frac{5}{6}T$$

Where T = thickness of wall above the plinth level.

TYPES OF SHALLOW FOUNDATION

A Spread footing

The total load of the structure is transmitted to the base of the structure is spread out to a large area by spread footing.

a Strip footing

Spread footing for a wall is known as strip footing.

b Pad footing

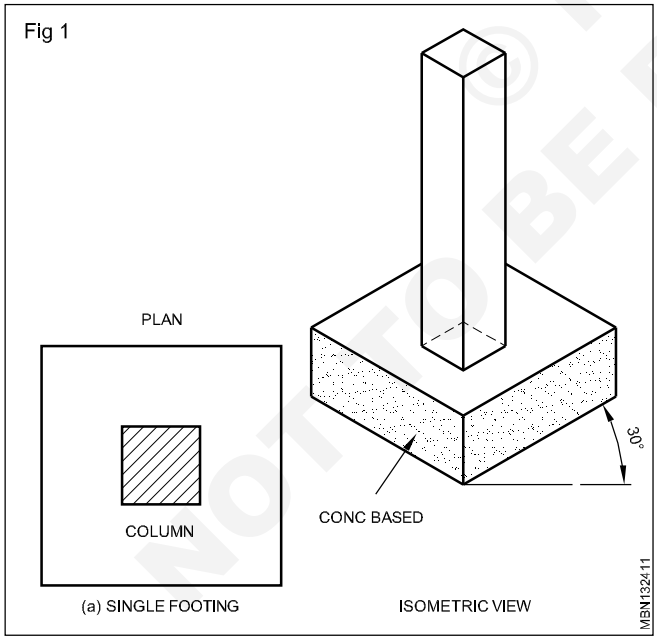
The spread footing for a single column is known as pad footing or isolated footing.

The spread footing may be of the following types

i Single footing

(Fig 1) shows the single footing for a column in which the loaded area (bxb) of the column has been spread to the size (BxB) through a single spread.

Fig 1



ii Stepped footing

The (Fig 2) shows the stepped footing for a heavily loaded column which require greater spread. The base of the column is made of concrete.

iii Sloped footing

(Fig 3) shows the sloped footing made in concrete base of non uniform thickness. Greater thickness at its bottom, smaller thickness at the top.

Fig 2

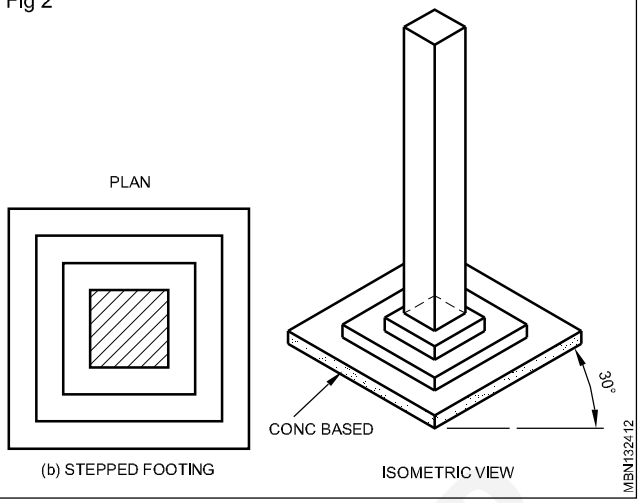
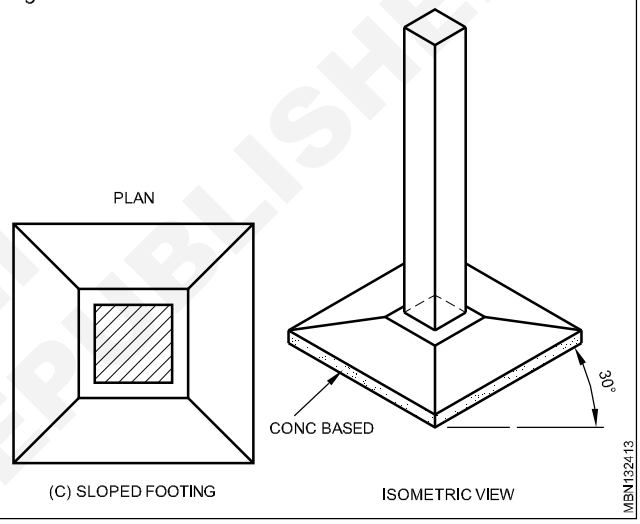


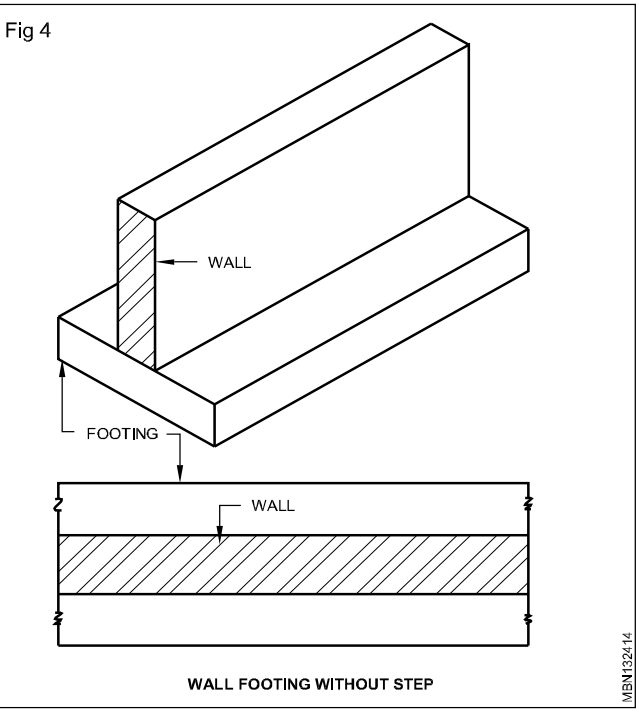
Fig 3



iv Wall footing without step

(Fig 4) shows the stepped footing for a wall consisting of concrete base without step.

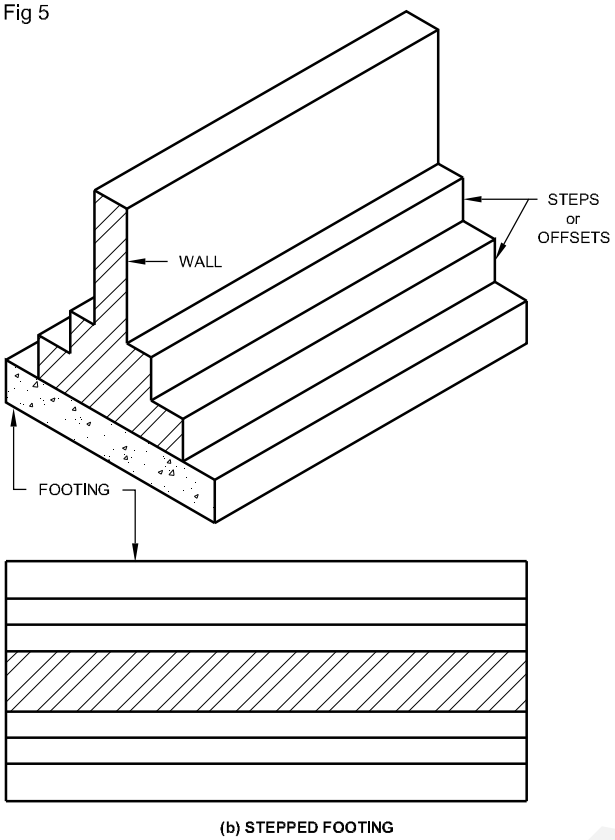
Fig 4



v Stepped footing for a wall

(Fig 5) shows the masonry wall have stepped footing with a concrete base.

Fig 5



(b) STEPPED FOOTING

SPREAD FOOTINGS FOR WALLS

vi Grillage foundation

A grillage foundation is a special type of isolated footing. Generally provided for heavily loaded steel stanchions or column, specially in those location where bearing capacity of soil is poor. The depth of foundation is limited from 1-1.5m. The load of the column or stanchion is distributed or spread to a very large area by means of layers of tiers of joist, each tier being placed at right angle to the next tier.

Grillage foundation are of two types:-

Steel grillage foundation

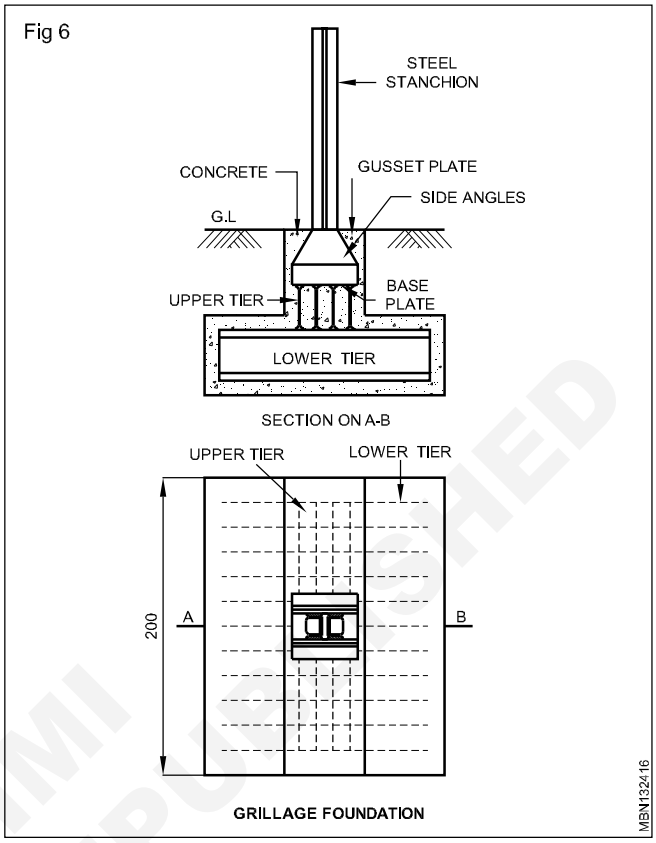
Timber grillage foundation.

Steel grillage foundation

Steel grillage foundation is constructed of steel beams, structurally known as rolled steel joist (RSJ) provided in two or more tiers. In case of double tier grillage (which is commonly provided) the top tier of grillage beams is laid at right angle to the Bottom tier. The joists or beams of each tier are held in position by 20mm diameter pipe separators (tie rod 20mm diameter) as shown in (Fig 6).

The grillage beams are embedded in concrete. Generally, the minimum clearance of 8cm is kept between the grillage beams. So that the concrete can be easily poured ,properly compacted. However the distance between the flanges should not exceed 30cm or 1½ times the flange width. So that the filled concrete acts monolithically with the beams. It should prevent their corrosion. A minimum concrete cover of 10cm is kept on the outerside of the external beams as well as upper flanges of top tier.

Fig 6

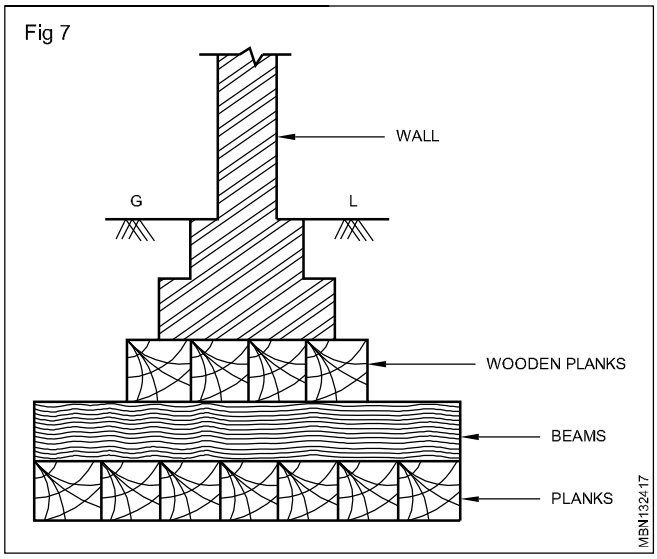


GRILLAGE FOUNDATION

Timber grillage foundation (Fig 7)

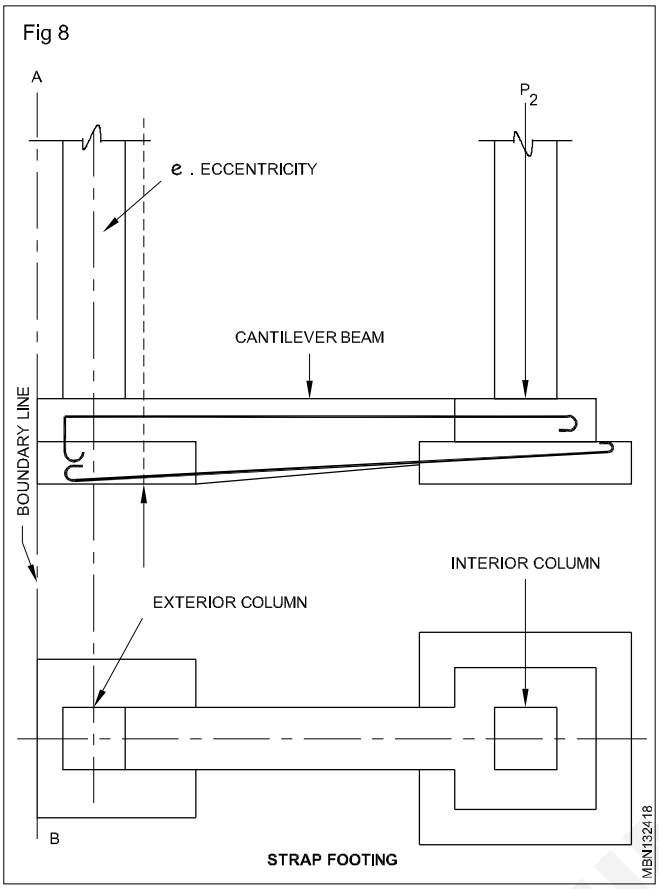
Temporary grillage foundation in the form of timber beams may be provided to timber columns, posts or walls etc. They can be design for supporting light building. In water logged areas. The loading on the soil is limited is 5.5 tone/ m. The grillage takes the form of a platform of wooden planks arranged in 2 layers at rectangle to each other. The two layers of planks are separated by rectangular section of timber placed at centre to centre distance of about 3.5cm-40cm.

Fig 7



B Strap footing or cantilever footing (Fig 8)

Fig 8



STRAP FOOTING

A strap footing comprises of two or more footings of individual columns, connected by a beam called a strap. When a column is near or right next to a property limit, its foundation cannot extended beyond the property line, and if the distance between this columns and the adjoining column is large, in that case strap footing may be provided. The strap beam connecting the spread footings of the two columns do not remain in contact with soil and does not transfer any pressure to the soil. The function of strap beam is to transfer the load of heavily loaded outer column to the inner column. In doing so the strap beam is subjected to bending moment and shear force and it should be suitably designed to withstand these.

iii Combined footing

RECTANGULAR FOOTING (Fig 9)

A spread footing which supports two columns is termed has combined footing. If the footing supports more than two columns it is known as continuous footing.

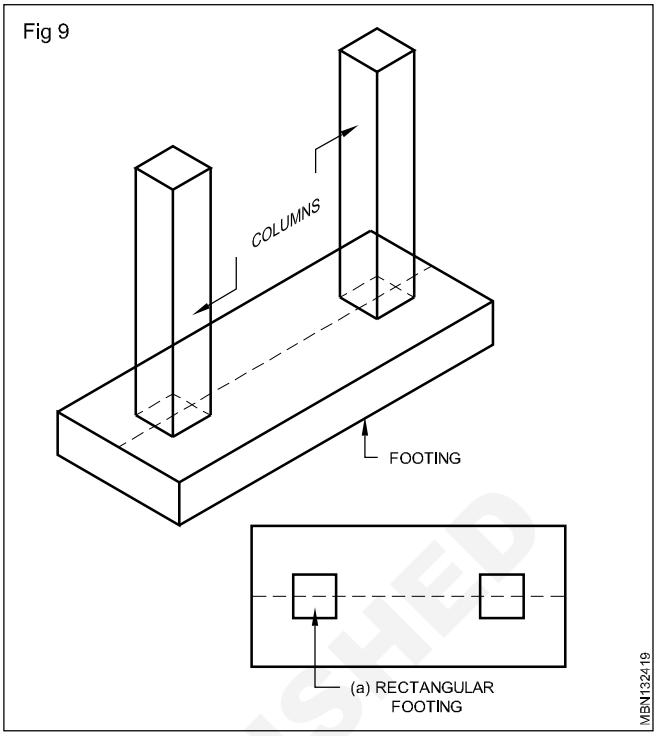
A combined footing is provided under the following circumstances

1 When the columns are very near to each other so that their footings overlap.

2 When the bearing capacity of soil is less requiring more area under individual footing.

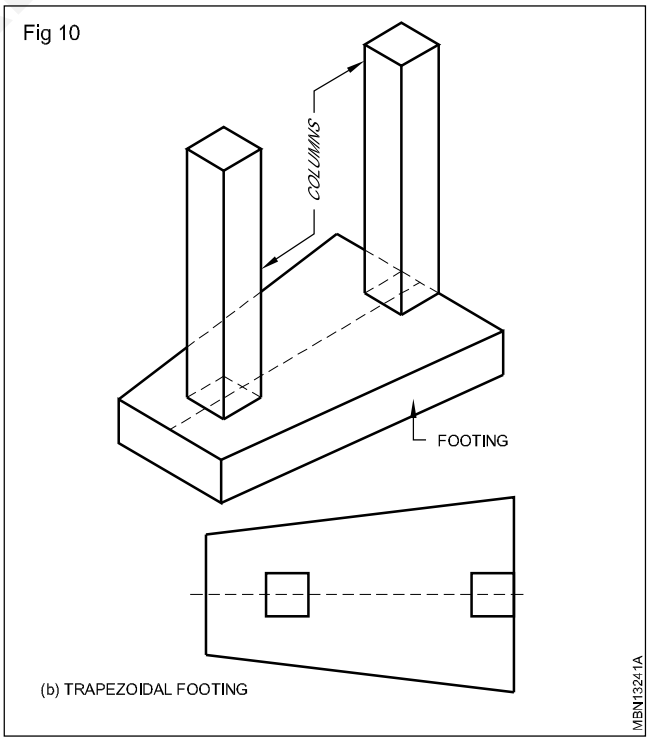
3 When the end column is near a property line so that its footing spread in that direction.

Fig 9



A combined footing may be rectangular or trapezoidal in plan. The aim is to get uniform pressure distribution under the footing. For this the centre of gravity of the footing area should coincide with centre of gravity of the combined load of two columns. If the outer column, near the properly line carries heavier load, provision of trapezoidal column becomes essential to bring the e.g of the footing in line with the e.g of the two column loads. In other cases rectangular footing may be preferred.(Fig 10)

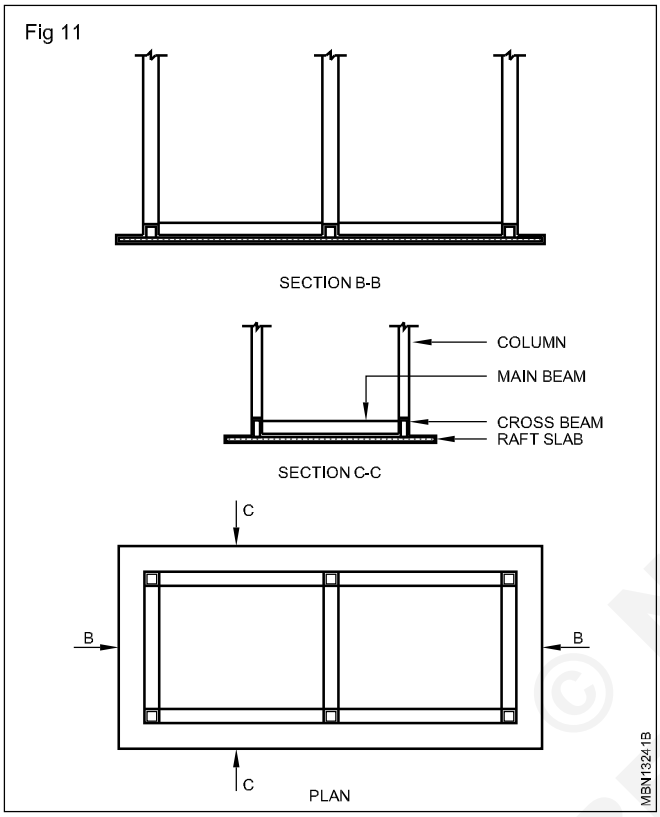
Fig 10



iv Mat or raft foundation

Generally a raft or mat foundation is used when the bearing capacity of soil is very poor and when it is required to distribute heavy concentrated load over a large area. The raft foundation is useful where there is a possibility of unequal settlement to occur. The raft foundation consist of thick R.C.C slab covering whole area in the form of a mat. If the required area of footing exceeds half the total area of the structures, raft foundation is used. Raft foundation is also used for increasing the area of foundation to neutralize the hydrostatic uplifts. (Fig 11)

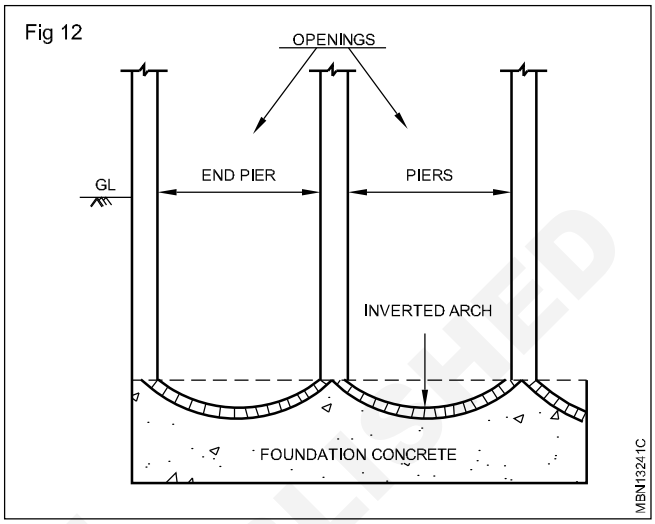
Fig 11



v Inverted arch foundation

The foundation which consist of inverted arches between the pier are known as inverted arch foundation. The rise of the arch is about 1/5th -1/10th of the span. The load transmitted to the soil through inverted arch. These are suitable for the construction of bridges, reservoirs, tanks etc. Now a days this type of foundation is rarely used in India. (Fig 12)

Fig 12



Deep foundation

objectives: At the end of this lesson, you shall be able to,

- **define deep foundation**
- **state classification of deep foundation**
- **explain pile foundation**
- **identifies various types of piles**
- **describe pier foundation**
- **explain well foundation (caisson).**

Introduction

This construction is adopted when the loose soil extends to a great depth. The load of the structure is transmitted by the piles to hard stratum below or it is resisted by the friction developed on the sides of piles.

Definition

The depth of foundation is greater than its width is called deep foundation.

Classification of deep Foundation

- Pile foundation
- Pier Foundation
- Well Foundation (Caissons)

A Pile Foundation (Fig 1)

Pile is a long vertical load transferring member which may be of timber, steel or concrete.

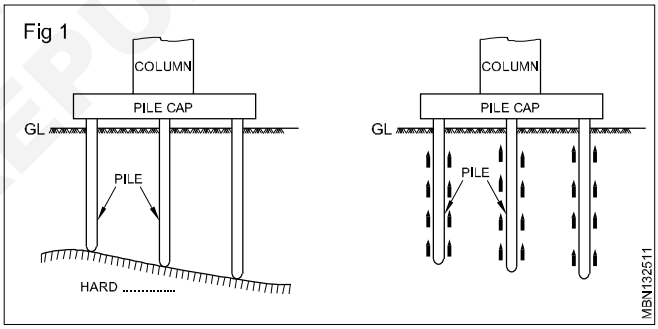
1 The loads are taken to a low level by means of columns in the soil.

2 It may be adopted where no firm bearing strata exists at reasonable depth and the loading is uneven.

3 The pumping of subsoil water is too costly for keeping the foundation trench in dry condition.

4 This foundation is to be adopted for the structures in the area where canals ,deep drainage lines, etc. are to be constructed.

Fig 1



Pile

Following are the situation in which a pile foundation is preferred:-

a When the load coming from the structure is very high and concentrated.

b When the other type of foundation cannot be provided due to heavy cost and site difficulties.

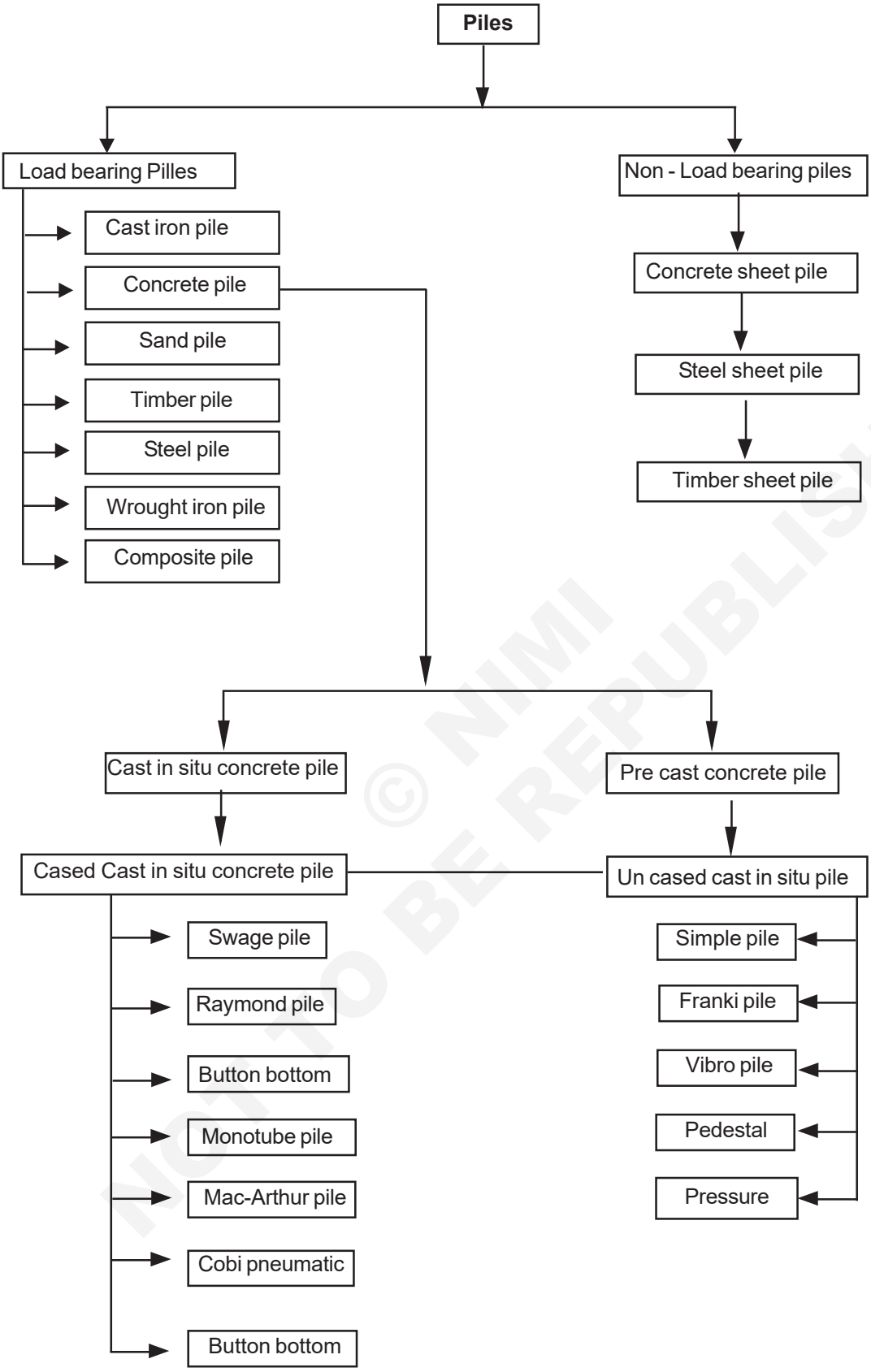
c When the water table is very near to the ground level and may defect the other type of foundation.

d When due to heavy inflow seepage, it is not possible to execute the trenches and keep them dry.

e Where there are chances of construction of irrigation canal in the near by area, which causes seepage of water in the foundation.

f When hard bearing strata is at a greater depth.

Types of pile



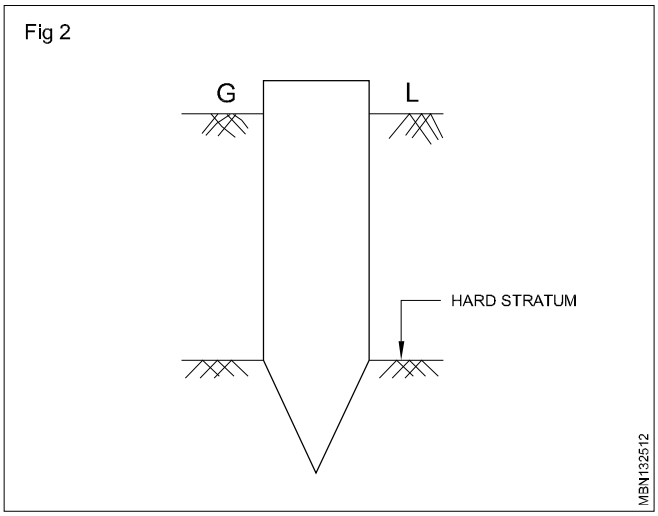
Classification of piles

a Classification according to foundation:-

1 End bearing piles (Fig 2)

Piles whose lower end rest on hard rock (hard stratum) is known as end bearing piles. These piles are used to transfer heavy load through water or soft soil to a suitable hard stratum.

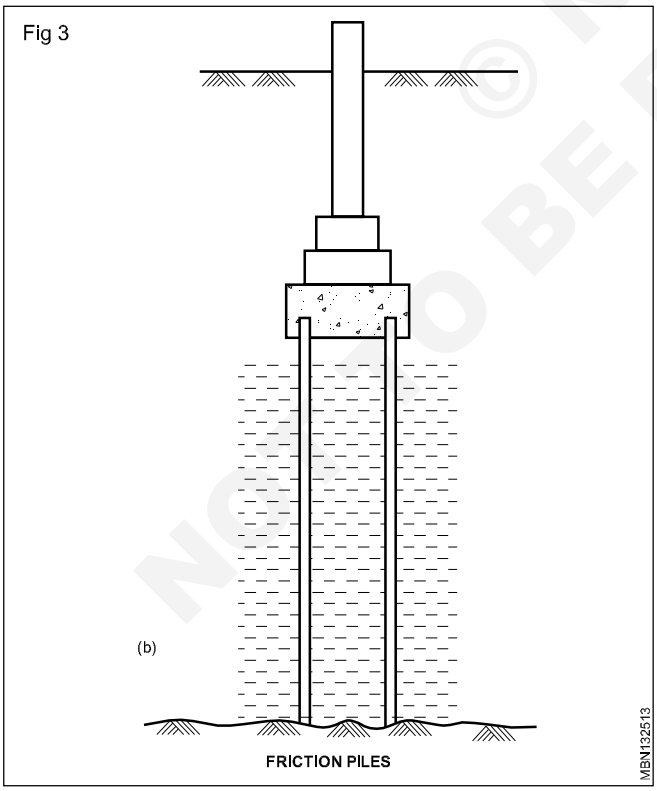
Fig 2



2 Friction piles (Fig 3)

The piles which support the structure load due to friction between the piles and surrounding soil are known as friction piles. Such piles are generally use in granular soil when the depth of hard strata is very great.

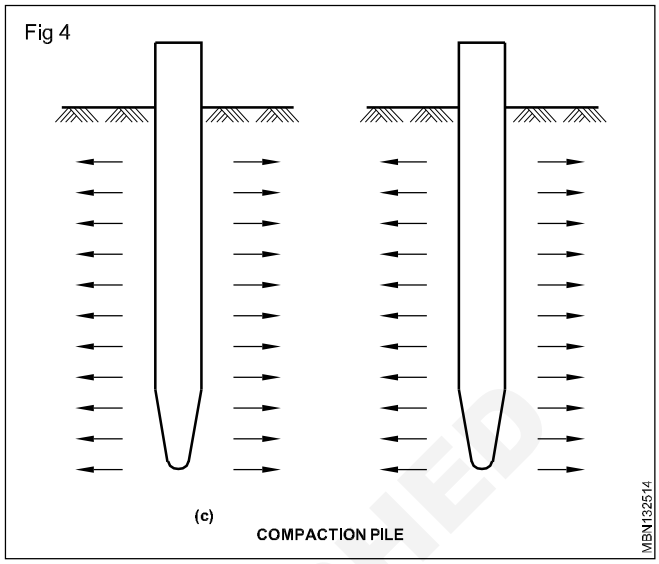
Fig 3



3 Compaction piles (Fig 4)

Compaction piles are used to compact loose granular soil thus increasing their bearing capacity. The compaction piles themselves do not carry any load. Hence they may be made of weaker materials like timber, bamboo sticks etc. Sometimes they may be made of sand only. The pile tube driven to compact the soil, is gradually taken out and sand is filled in its place thus forming a sand pile.

Fig 4



4 Tension or uplift pile

The tension piles anchor down the structures subjected to uplifts due to hydrostatic pressure or due to overturning moment.

5 Anchor piles

These piles provide anchorage against the horizontal pull from sheet piling or other pulling force.

6 Sheet piles

The piles are differ from bearing pile and friction pile. In that they are rarely used to furnish vertical supports, but are used to retain the soil that is, liable to escape laterally when subjected to pressure or to enclose the area required for some foundation. And protect it from the action of running water or leakage.

7 Fender piles and dolphins

These piles are used to protect the concrete deck or other water front structures against impact from ship or other floating objects.

8 Batter piles

These piles are driven at an inclination to resist large horizontal or inclined forces.

b Classification according to materials used:

1 Concrete piles

2 Timber piles

3 Steel piles

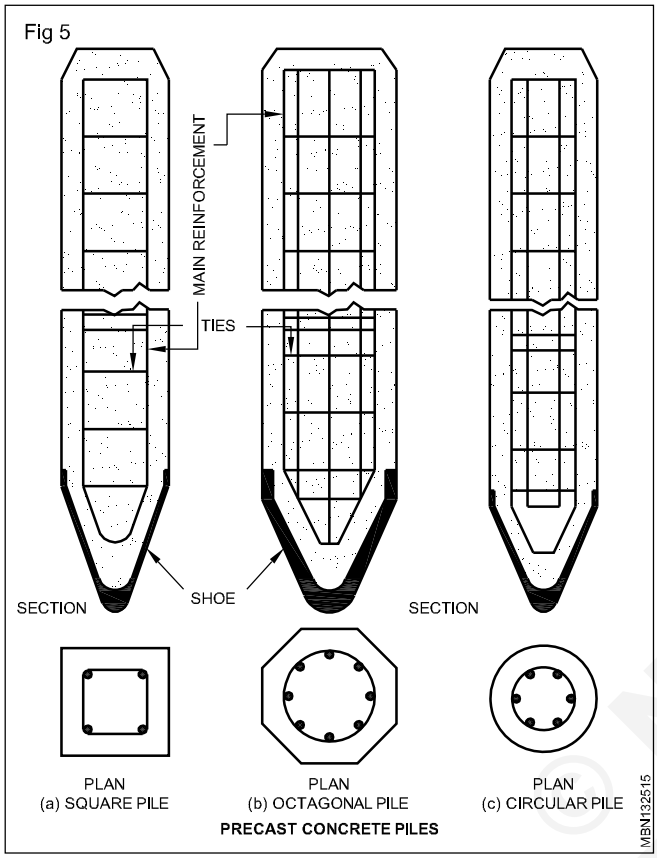
4 Composite piles

1 Cement concrete piles (Fig 5)

Cement concrete possess excellent compressive strength. R.C.C piles are becoming more popular and they are fast replacing piles of other material. R.C.C piles are divided into two groups.

i Pre-cast concrete piles (Fig 5)

Pre-cast concrete piles are those which are manufactured in a factory or at a place away from the construction site and then driven into the ground at the place required. They may be square and octagonal piles are cast in horizontal form. The round piles are cast in vertical forms. The size of the piles may be 30cm-50cm and the length may be much as 18m or more.



The reinforcement may consist of longitudinal steel bars of 20-40 mm in diameter 4-8 No's with lateral ties of 5-10mm wires spaced at 10cm-30cm c/c from bottom to middle respectively. A concrete cover of atleast 50mm is provided as shown in figure. At the toe of the piles a steel shoe is generally provided. The steel shoe protect the toe and helps the pile in penetrating into the ground during the driving. Pre-casting piles are useful in carrying fairly heavy loads through soft materials to thinner strata.

Advantages of pre-cast concrete piles

a The position of reinforcement in pile is not disturbed from its original position.

b These piles can be driven under water. Concrete in the cast-in-site piles may not be set under water.

c It is possible to have a proper control over the composition and design of these piles as they are manufactured in a workshop.

d Any defect of casting such as hollows etc can be found out and repaired before driving the pile.

e Any number of piles can be manufactured at a convenient place and this may prove to be economical.

f These piles process high resistance to biological and chemical action of the ground.

g These piles, when driven are ready to take up the load. There is no wastage of time.

Disadvantages of pre-cast concrete piles

a These piles are heavy in weight and it is therefore difficult to transport, to handle and to drive them.

b Extra reinforcement is provided to resist the stresses during handling and driving operation. This fact makes the pile costly.

c If sufficient care is not taken, piles may break during transport or driving.

d The size and length of pile will depend on the available transport facilities.

ii Cast-in-situ concrete pile

In this type of concrete piles a bore hole is dug into the ground by inserting a casing. This bore is then filled with concrete after placing reinforcement, if any. The casing may be kept in position or it may be withdrawn. The former piles are known as cased-cast-in-situ concrete piles and the later is known as uncased-cast-in-situ concrete piles.

Advantages of cast-in-situ concrete piles

a Light weight shells are used in cast-in-situ concrete piles and these shells are easy to handle and to drive in the ground.

b No extra reinforcement is necessary to resist stresses developing during handling or driving operation only.

c There is no wastage of materials as the piles of required length is constructed.

d The pile are sound in construction as they are not driven into the ground by a hammer.

Disadvantages

a It is difficult to maintain the reinforcement in correct position during construction of piles.

b These pile cannot be constructed under water.

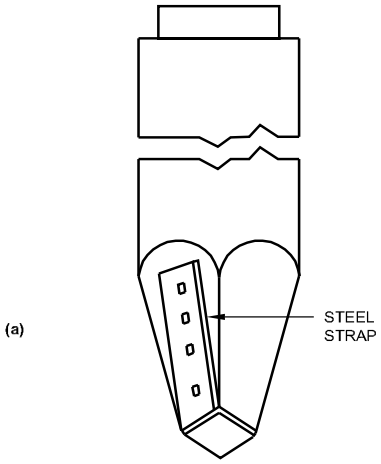
c The dry ground may absorb, moisture from the wet concrete. The piles are then weakened.

2 Timber piles (Fig 6)

The timber pile may be rectangular, circular, square. The size of timber varies from 30cm to 50cm. The length of the timber pile does not exceed 20times its top width otherwise it may fail by buckling. At the bottom a cast-iron shoe is provided and at the top, a steel plate is fixed. The timber pile should be properly treated so as to make them durable.

A timber pile is made of trunk of a tree. The wood to be used for timber pile should be free from knots. flaws and shakes and other defects. The common Indian timber which are used are babool, chir, jarul, poon, Sal, teak.

Fig 6



TIMBER PILES

Advantages of timber piles

a Where timber is available easily these piles prove to be economical in cost.

b These piles can be handled easily with little risk or danger of break.

c The length of the timber pile can be adjusted either by cutting or lengthening without must extra cost.

d Skilled supervision is not required in the construction of timber lile.

e These piles can be removed easily if necessary.

f These pile donot required heavy equipment for driving them into the ground.

Disadvantages

a These piles cannot be take heavy loads and are unsuitable for used as end bearing piles.

b A joint in the lengthened timber pile is a source of weakness.

c It becomes very difficult to drive these piles in the hard formation.

d Timber piles are generally used for temporary work.

3 Steel piles

Steel piles are used as load bearing piles in the different form.

i H-beam piles

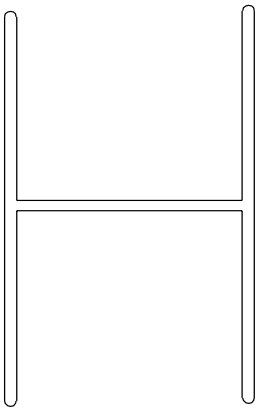
ii Box-piles

iii Tube-piles

i H-beam piles

Fig 7 shows the plan of an H-beam steel piles. These piles are usually of wide flange section and they are most common variety of steel piles in general use. They are found very much suitable especially for trusted type structure in which the pile extent above ground level and work also as column for the structure. The driving of H-piles is very simple and energy from a piles hammer is effectively transmitted to the lower portion of the pile.

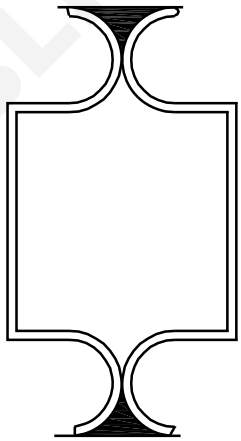
Fig 7



ii Box pile

Fig 8 shows the plan of box pile. Various type of patented box piles are available, the figure shows "Larssen-Box pile". A box is driven either with closed bottom or with open bottom. These piles are used when it is not possible to drive H-beam piles upto the hard strata.

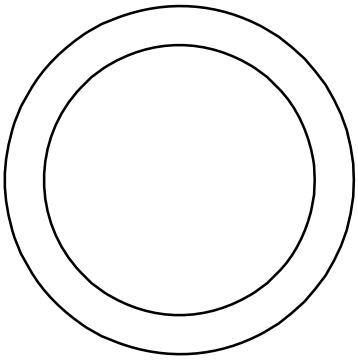
Fig 8



iii Tube piles

Fig 9 shows the plan of tube pile. In this type of steel piles, tubes or pipes of steel are driven into the ground. The pile may be driven either with open end or with closed end. Concrete is filled in side the tube piles. Because of circular cross section these piles are easily to handle and easy to drive.

Fig 9



Advantages of steel piles

a These piles withstand easily the stresses due to driving.

b These piles can be easily to lengthened by welding without any delay in driving operation.

c The extra length of these piles can be cut off easily.

d The bearing capacity of these pile is comparatively high. The allowable compressive stress on steel is taken as about 6-8 kg/mm^2

e These piles can be handled roughly without any serious damage.

Disadvantages

Corrosion is the only drawback of steel pile.

4 Composite piles

Composite piles are those which are made of two portion of two different materials driven one above the other. Two common type of composite piles are :

a Timber and concrete pile

In the timber and concrete composite pile, timber portion is use below the permanent or lowest water level, while concrete piles, usually cast-in-sites is formed above it. Due to this combination the advantages of both types are combined. Also the total cost of the pile is reduced.

b Steel and concrete composite pile

This type of composite pile is used where the required length of pile is greater than that available for the cast-in-situ type pile. The pile consist of steel pile attached to the lower end of concrete pile. This type of composite pile is used where satisfactory penetration of the pile into the rock is required for heavy loads.

Foundation for black cotton soil

Black cotton soil is a loose type of soil, and it considerably swells and shrinks by variation in moisture content. The variation in the volume of the soil is to the extend of 20%-30% of the original volume. During rainy season moisture penetrates into the soil the particles separate out, resulting in increase in the volume.

This increase in volume is known as swelling. During summer season, moisture moves out of the soil and consequently the soil shrinks, shrinkage cracks are formed on the ground surface. These shrinkage cracks are formed on the ground surface. These shrinkage cracks sometimes also known as tension cracks may 10-15cm wide,1/2-2m deep. Hence extreme care should be taken when foundation are to rest on this soil.

Following are the precautions to be taken in designing footings on black cotton soil:-

a For important structure the raft foundation should be adopted.

b The black cotton soil should be completely removed if possible and convenient.

c The black cotton soil should not be allowed to come in direct contact with the foundation masonry.

d The construction work should be carried out in dry season.

e The depth of foundation should extend beyond the depth of crack in black cotton soil.

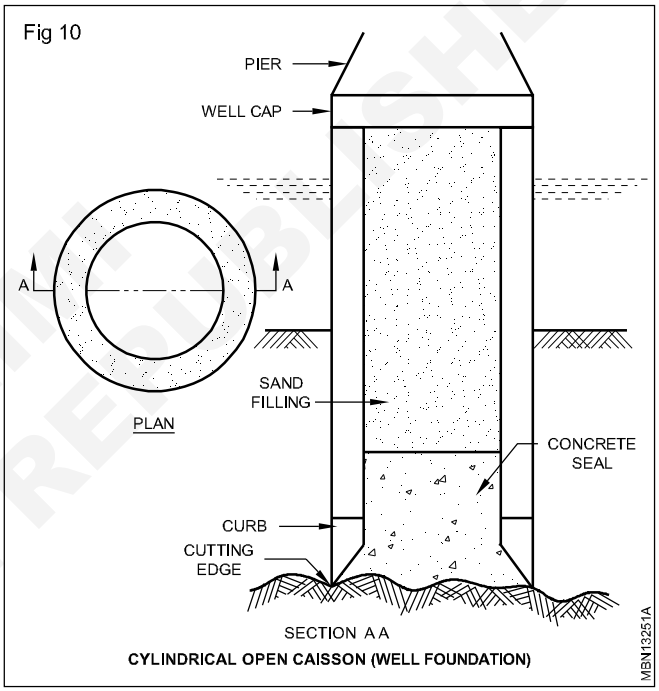
Pile cap and pile shoe

When the column or any other load carrying structural component is supported on more than one pile, the pile should be connected through a rigid pile cap, to distribute the load to individual pile, pile cap maintain the proper alignment of the pile. It is advisable to ensure that a pile projects atleast by about 10cm in the pile cap.

Pile shoes are provided at the tips to facilitate the process of driving through hard strata. Pile shoes are made from cast iron, steel or wrought iron. In case of steel piles it is necessary.

B Well foundation (caissons) (Fig 10)

Fig 10



CYLINDRICAL OPEN CAISSON (WELL FOUNDATION)

Well foundation is the convenient of securing a trust worthy foundation in deep sand or soft soil. It is also useful in moderate depth of water when foundation is to be taken in soft sandy soil, well are generally made of concrete or masonry. In masonry well vertical holding down bolt and iron plate or loop iron are provided to secure good bond.

In order to prevent cracks during sinking operation. At the bottom of the well curb made of concrete, a steel or cast iron, cutting edge is attached. The position of well to be sank is first correctly marked on the ground and the curb is placed upon it. On the curb masonry ring is built to a height of about 1.2m and allowed to drying.

Type of foundation in black cotton soil

Foundation in black cotton soil may be of the following types.

1 Strip or pad foundation

2 Pier foundation

3 Under-reamed pile foundation

1 Strip or pad foundation

For medium loads strip foundation (for walls) and pad foundation (columns) may be provided. These are two method of strip or pad foundation.

1st method

This method of constructing foundation on black cotton soil is adopted when the depth of black cotton soil is more and there are not chances for surface water to penetrate through the soil for more than 1m - 1.5m.

The procedure is as follows

a The foundations trenches are excavated to a depth given by the equation.

d = maximum depth of crack + 30cm

b The width of the trenches is kept such that the allowable bearing capacity of the soil does not exceed 15 tone/ m^2.

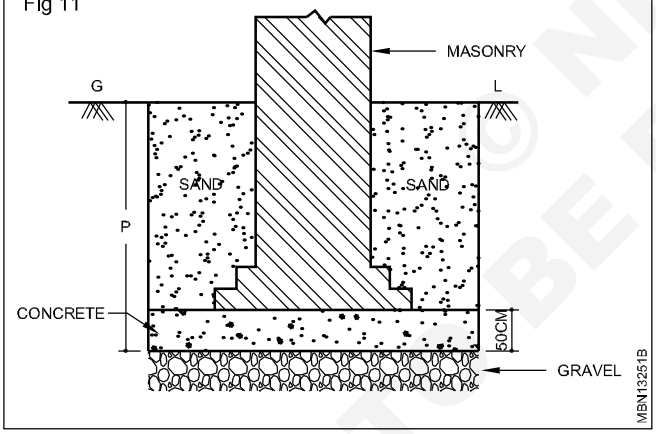
c Gravel is spread for the face width of the trench and well rammed.

d A layer of concrete of 50cm depth is laid on the gravel.

e The masonry work is started on the top of the foundation soil and it is carried out upto the plinth level.

f The side of the trenches are filled with sand as shown in (Fig 11).

Fig 11



2nd method

This method of constructing foundation on black cotton soil is adopted at places where there is heavy rain-fall and there are chances for surface water to reach a greater depth in the soil.

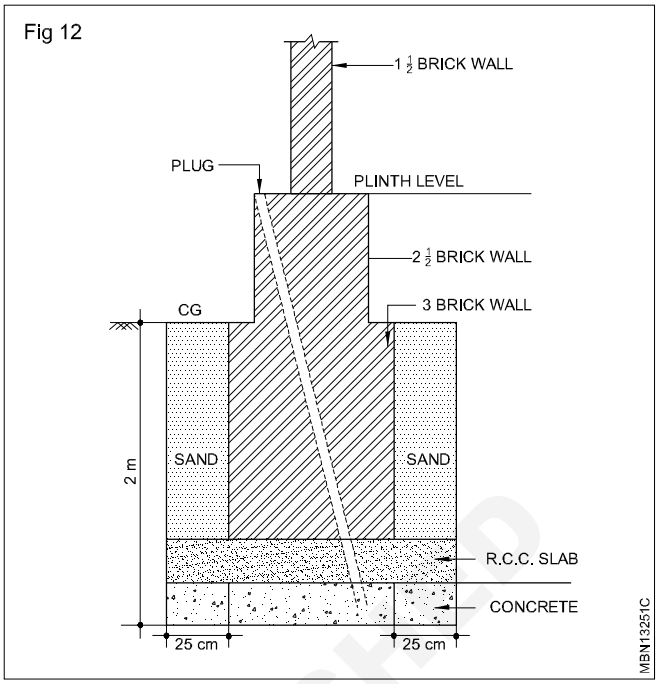
The procedure as follows

a The foundation trenches are excavated to a depth of 2m.

b The side portion of the trenches are filled with concrete having a section of 25cm x 25m as shown in (Fig 12) and the hollow space equal to 1st layer of masonry is filled with sand.

c 12cm - 15cm thick R.C.C slab covering the face width of the trench is laid.

Fig 12



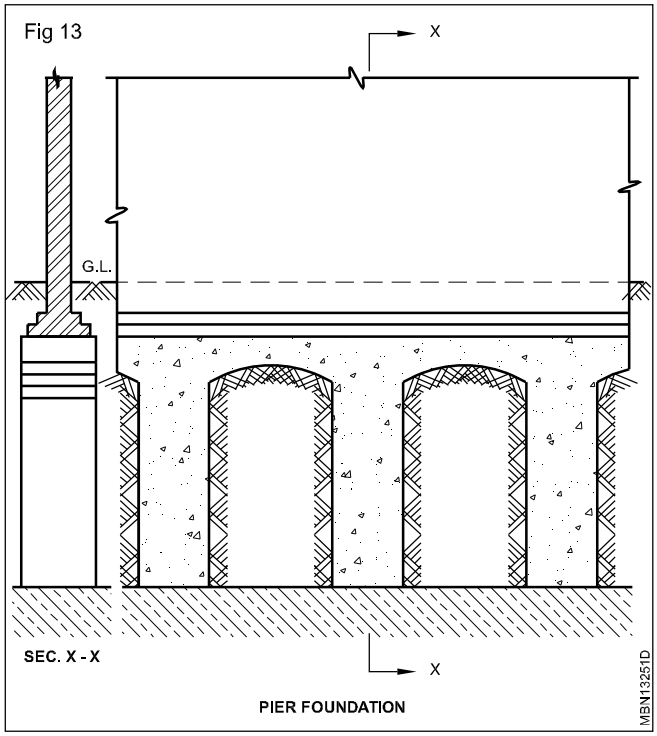
d The masonry work is started on the top of R.C.C slab and it is carried upto the plinth level.

e 80mm diameter pipes spread at 1.5cm centre to centre are placed through the masonry and R.C.C slab, as shown in figure. The pipes are brought upto plinth level and filled with sand. A plug is provided at the plinth level. These piles are inspected periodically if required.

2 Pier foundation (Fig 13)

When a heavy loaded building is situated in a sandy soil, black cotton soil or soft soil, over lying hard bed at reasonable depth pier foundation are sometimes used to transfer the load the building to the hard bed below. This method consist in sinking vertical shaft upto hard bed and filling them with concrete.

Fig 13

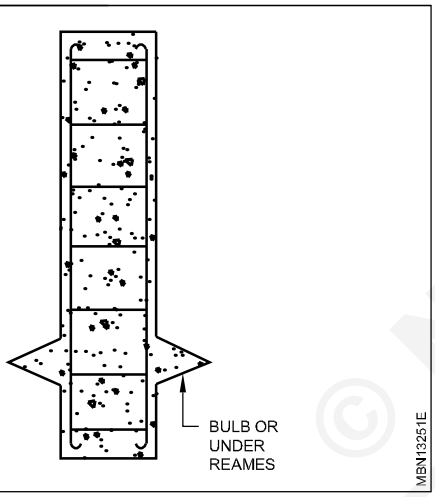


The diameter of the shaft and the centre to centre spacing depend upon the loading condition, the nature of soil and depth at which hard bed is situated. The diameter or horizontal dimension should be less than 1/12th its height. To prevent the side earth from falling in the side, the shaft is sometimes lined with timber. The timber lining is removed during the filling up the shaft with concrete. The shaft are connected to each other by an arch or reinforced cement concrete or steel grillage cap.

3 Under reamed pile foundation

These piles are developed for serving as foundation for black cotton soil. An under reamed pile is a bored concrete pile having one or more bulbs in its lower portion. The bulbs or under-reams are formed by under reaming tools. The foundation will be anchored to the ground, and it would not move with the movement of the soil. The diameter of a under-reamed pile is about 3m - 8m. The spacing of pile may vary from 2m - 4m. The safe load for an under reamed pile varies from 20 to 40 tone (Fig 14).

Fig 14

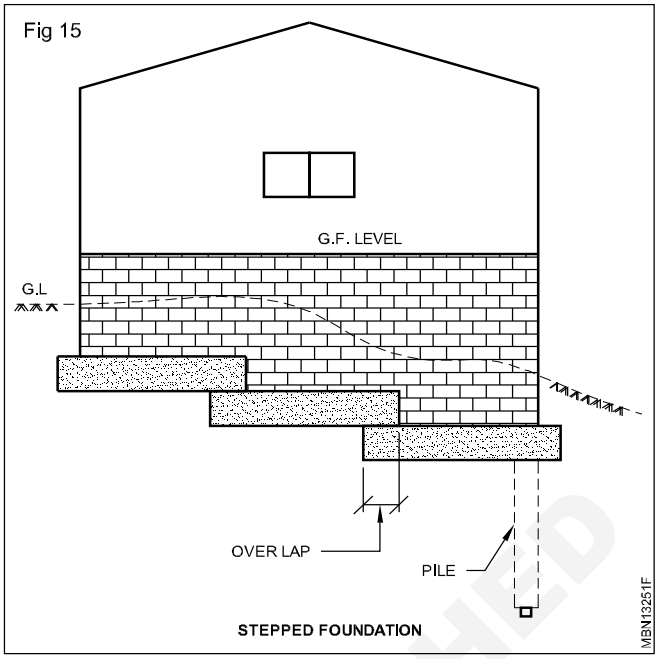


The load carrying capacity of under reamed pile can be increased by adopting pile of large diameter or by extending the length of pile, or by making more bulb at the base. A single under-reamed pile has only one bulb at the bottom. When the no.of bulbs at the base (2 or more) it is known as multi under-reamed piles. The vertical distance of bulbs varies from 1.25 to 1.50 times the diameter of the bulb. The under-reamed pile is selected by the consideration of pile length, stem diameter, bulb diameter, a no of bulbs. In black cotton soil the bulb of under-reamed piles, not only increase the load bearing capacity, but also provide anchorage against uplifts.

Foundation on slopping ground or stepped foundation (Fig 15)

1 When the ground is sloping it becomes an-economical to provides foundation at same level along the length of the wall, in such cases stepped or benching foundation may be provided. The foundation trench is excavated in the form of steps, if possible all the steps should be of equal depth and length. Overlap between two layer of foundation concrete should be atleast equal to the depth of foundation concrete. A minimum depth of 1m for soil and 60cm for rock should be provided between sloping surface and the lower edge of the footing.

Fig 15



STEPPED FOUNDATION

COFFER DAM AND CAISSON

Coffer dam

It is defined as a temporary structure which is constructed so as to remove water and soil from an area and make it possible to carry out the construction work under reasonably dry condition.

Following are the uses of coffer dam

1 To facilitate the pile driving operation

2 To place grillage and raft foundation.

3 To construct foundation for pier and abutment of bridge, dams etc.

4 To provide working platform for the foundation of buildings when water is met with.

5 To provide space for carrying out the foundation work without disturbing or damaging the adjoining structure such as building, pipe line etc.

Caisson

It is defined as a structure which is sunk through ground or water to exclude the water and semifluid material during the process of excavation of foundation and which subsequently becomes an integral part of the sub-structure.

Following are the use of the caisson

1 To reach the hard bearing stratum for transferring the load coming on supports for bridge pier

2 To serve as an impervious core wall of earth dams. when place adjacent to it.

3 To provide on access to a deep shaft or tunnel.

4 To provide an encloser below water level for installing machinery, pump etc.

The main difference between coffer dam and caisson is that the coffer dam is a temporary structure, while caisson forms the part of the permanent work.

Method of settingout of foundation trench

Setting out or ground tracing is the process of laying down the excavation lines and centre lines etc on the ground.

The process for setting out of foundation trenches as follows:

1 From the site plan of the building one line which can be easily established on the ground is selected.

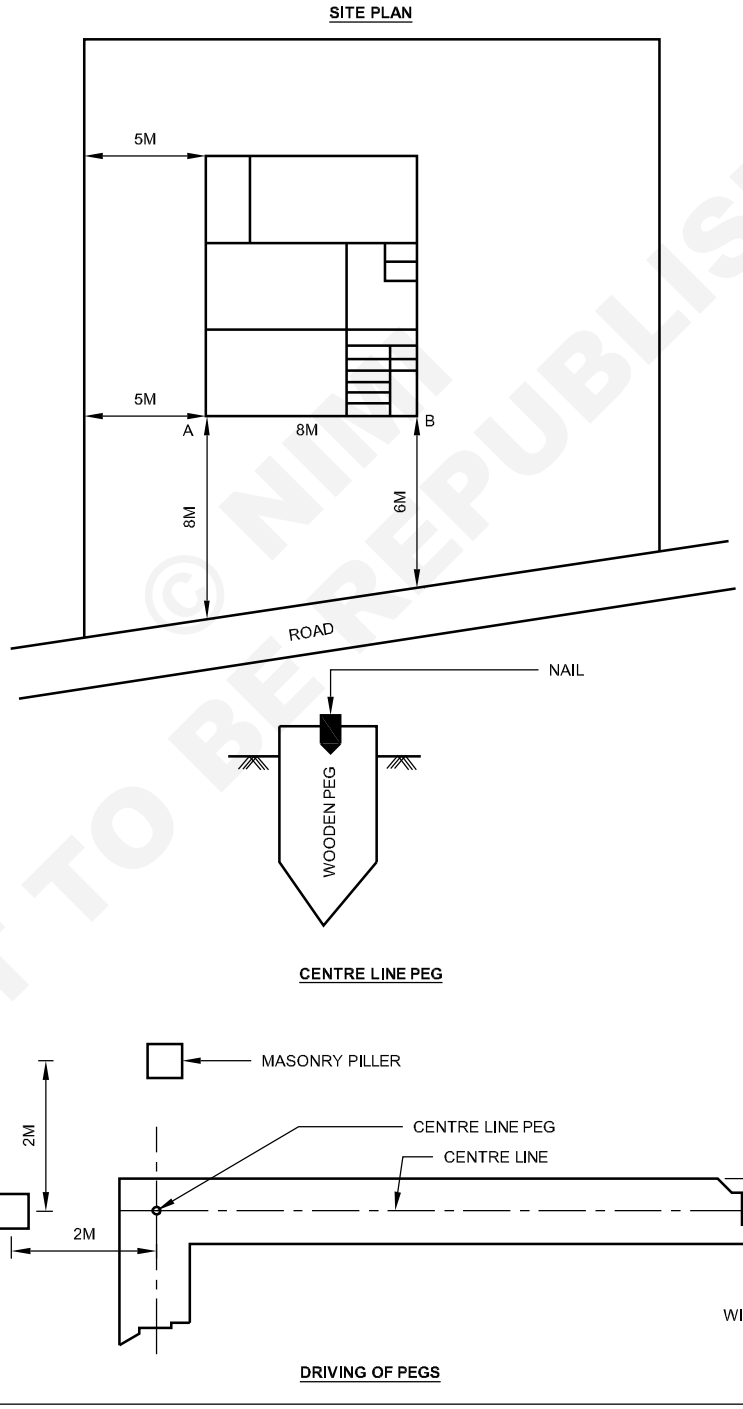
For example as per fig16 the point 'A' can be easily located on the ground and its co-ordinates are completely defined. With the help of point 'A' line 'AB' can be demarcated on the ground.

Thus line 'AB' will be the base line and from this base line the entired building can be traced out on the ground. It should be noted that the point 'A' and 'B' are on the centre line of the wall and hence it is essential to prepare the centre line plan of the building before starting this work.

2 Centre line wooden pegs are driven on the ground and they project about 25mm above the ground level. Nails are provided on the top of the pegs as shown in figure.

3 Two other pegs are driven at equal distance on either side of the centre line peg such that the distance between them becomes equal to the width of the foundation trench as shown in (Fig 16).

Fig 16



4 With the help of these pegs the foundation plan can be completely traced on the ground. For this purpose strings are tied to respective pegs and lines are marked along these strings with the help of pick-axe or wing powder.

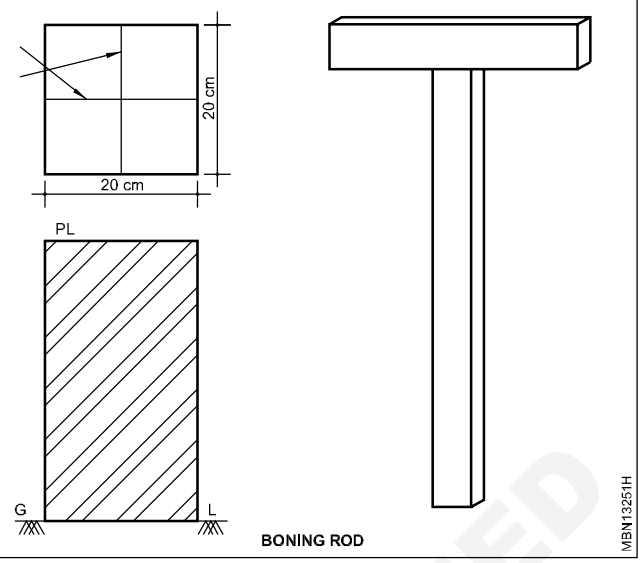
5 Along the centre line pegs brick pillars of size 20cm x 20cm are constructed about 2m away from centre. In some level upto plinth level height. The top surface of the pillar is plastered and grooves showing centre lines are provided as shown in (Fig 17).

6 The masonry pillar should be preserved till the foundation work is completed.

7 The depth of excavation can be started.

8 The depth of excavation is check by fixing a strings along the grooves on the opposite pillars and holding boning rod. The length of the boning rod should be equal to the depth of foundation trenches.

Fig 17

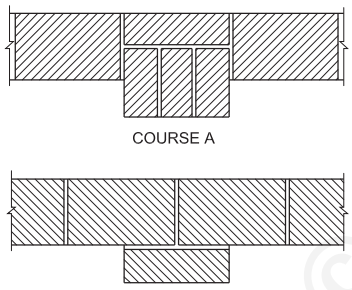


Attached pier and copings

Objectives: At the end of this lesson you shall be able to
- **state attached pier**
- **state brick copings**
- **state attached pier.**

- Pilasters or attached piers are a kind of support pillar or pier column that are built into a masonry wall for extra strength
- They project out from the wall to give additional bearing area
- Pilaster or attached piers are designed to receive loading directly from above, as from the end of a steel support beam.
- The brick is laid in an interlocking pattern so it is completely bonded into the wall. Note how the brick are laid so they are bonded into the wall as shown in (Fig 1)

Fig 1



- The first two courses are repeated over in sequence to the top of the wall as shown in (Fig 1).
- The brick pilaster layouts for a 1/2 brick x one brick projection as shown in (Fig 2 to 4). And the method of laying bricks also differs see (Fig 2 to 4).

Fig 2

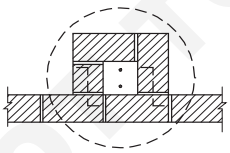


Fig 3

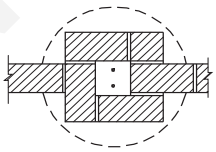
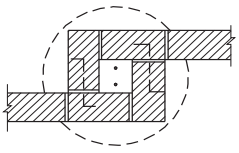
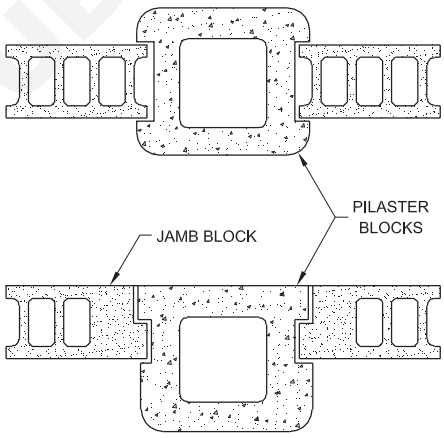


Fig 4



- Sometimes hollow portions made in the middle reinforcement which can give additional strength.
- These are laid out to interlock, with and be an integrated part of the bearing wall. Two courses are shown for each of the pilasters.
- Reinforced pilasters are made by using vertical reinforcing bars.
- Bricks are laid around the steel reinforcement then grout is poured in the space with the reinforcement.
- Attached pier or pilaster made from solid brick masonry and concrete pilaster block. Their purpose is to provide support for a wall It is usually found at intervals in long wall sections as shown in (Fig 5).

Fig 5

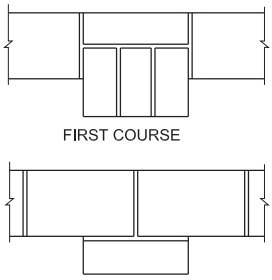


- A pilaster being constructed from 1/2 Brick one bricks, 11/2 brick depends on the strength.
- The 150 x 200mm in blocks are alternated each course of the pilaster with first course and part of the second course in place .It can be seen in Fig 8. how alternating positions of concrete blocks the pilaster is tied into the wall. (Fig 6).

Brick copings: (Fig 7)

- Copings are provided as coverings to garden walls, parapets etc. to threw off the water.
- Copings are provided in various shape.
- Copings are formed by specially moulded bricks. such as bull nosed, chamfered, half round, saddle-backed.
- Copings are formed stone or tile with brick on edge at top.

Fig 6



½ x 1 BRICK IN PROJECTION

SOLID MASONRY PILASTERS

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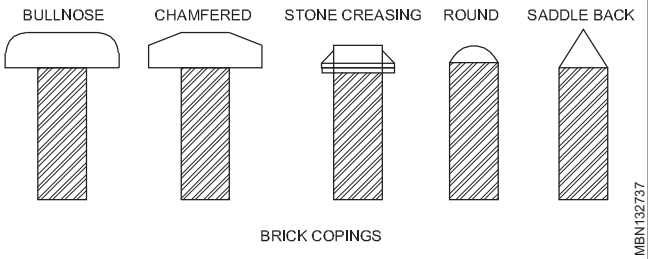
Fig 7



BRICK COPINGS

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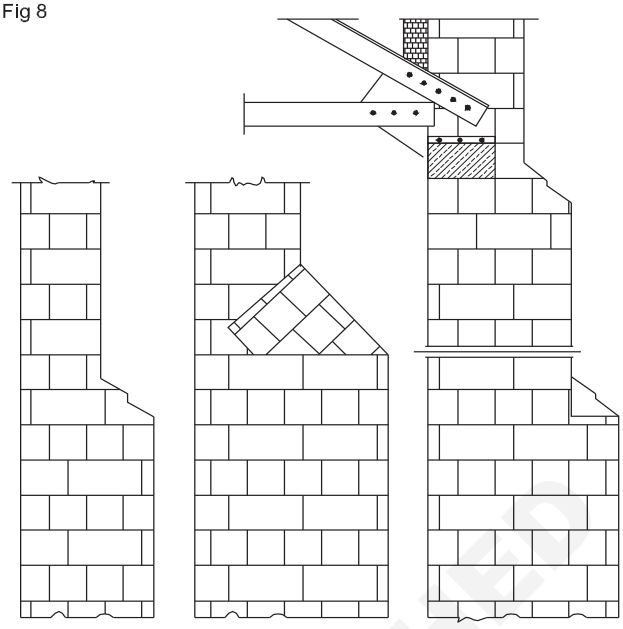
- Mortar joints should be rich cement mortar.

Buttresses:

- Buttresses are sloping pipers in the form of projections.
- Buttresses work as lateral supports of the wall.
- Buttresses with a splayed coping is provided two courses of splayed bricks (Fig 8).
- Buttresses with a tumbled in coping is provided with bricks laid on slope (Fig 8).

Fig 8



TYPES OF BUTTRESSES

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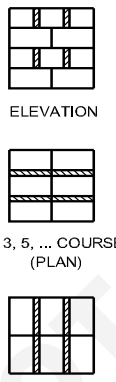
- Buttresses are constructed simultaneously with the main wall.

Detached Pillar (Brick)

- 2 Brick x 2 Brick square brick column shows the arrangement of bond shown in the (Fig 9).
- 21/2 x 21/2 brick square column as shown in (Fig 10).

Fig 9



TWO BRICK PIER IN ENGLISH BOND

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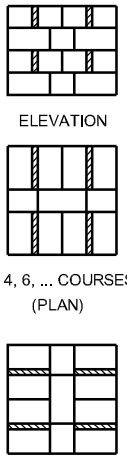
Fig 10



2 ½ BRICK PIER IN ENGLISH BOND

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Reinforced masonry

Objectives : At the end of this lesson you shall be able to,

- **explain reinforced masonry**
- **describe the features of reinforced masonry walls & columns**
- **explain reinforced masonry lintel & slabs**
- **prepare freehand sketches of reinforced masonry for walls & columns.**

Introduction

Brickwork strengthened by expanded metal, steel-wire mesh, hoop iron, or thin rods embedded in the bed joints.

Reinforced masonry is also essentially a wall material. Of course, beams and slabs have been built in reinforced masonry, but with the exception of deep wall beams, it is

hard to justify them in comparison with reinforced concrete ones. Reinforced masonry does not require shuttering and expensive element of concrete. The real advantage of reinforced masonry lies in walls subject to bending perpendicular to the wall plane. It combines flexibility of form with good finish and frequently a large cost saving compared with reinforced concrete. Reinforced masonry is thus a cheap, durable, fireproof, easy to construct and in most cases it results in the increase of floor space due to adoption of brickwork of lesser thickness. The reinforced masonry has been used with advantage under the following circumstances.

1 Retaining walls up to 6 m height can be constructed using various types of brick walls and filled hollow blocks, with a drained granular fill.

2 Reinforced masonry can be used for cantilevering vertically in boundary walls or tall sheds where the walls cannot be restrained at the top.

3 It can also be used in horizontally spanning cladding where it is not possible to prove stability in wind due to arching.

Reinforced masonry walls (Fig 1)

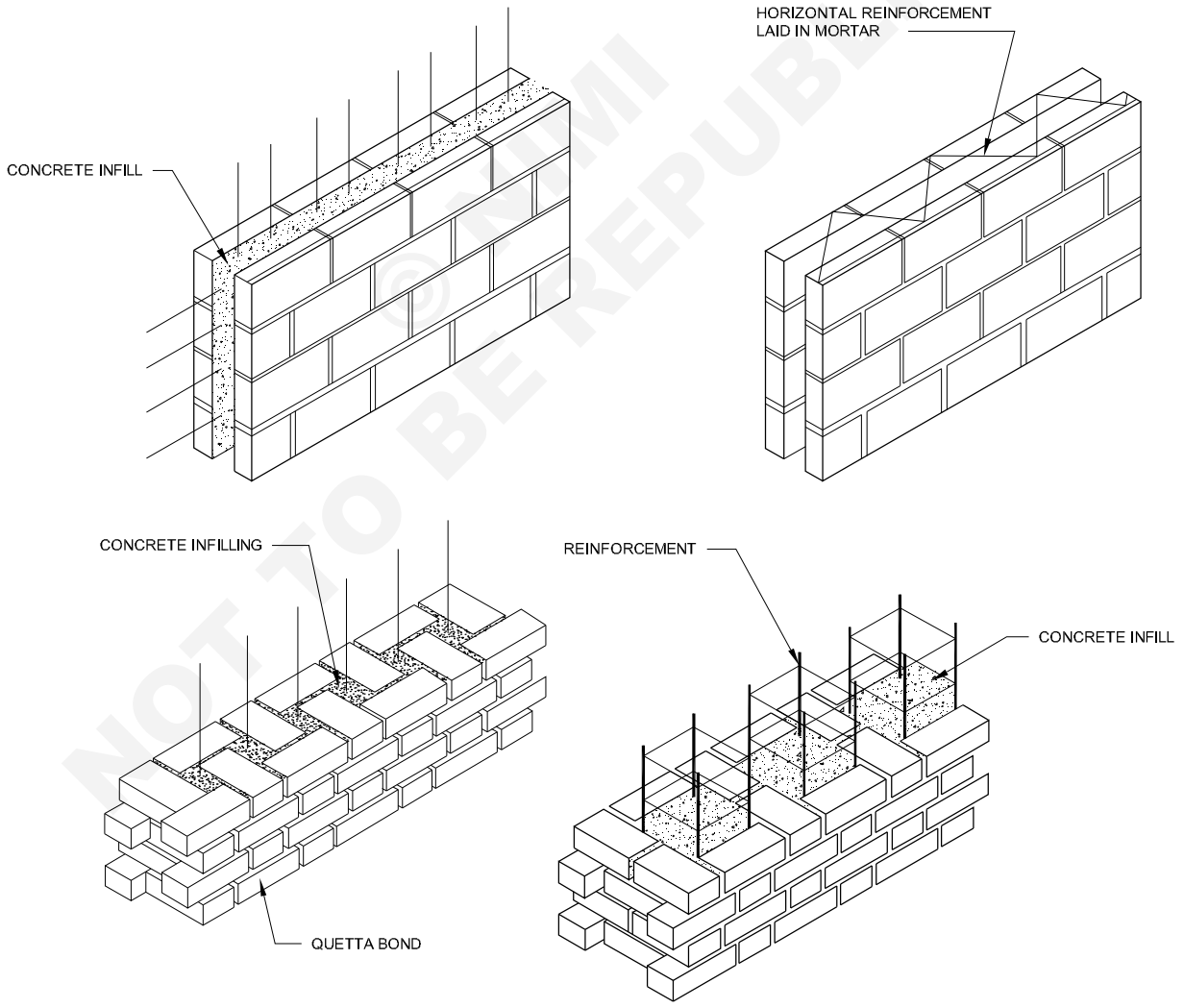
Iron bars or expanded metal mesh is generally provided at every third or fourth course. Before starting the next course the steel fabric is spread flat on the cement mortar and pressed evenly.

Flat bars of section about 25mm x 2mm may be used as hoop iron reinforcement for walls. They are hooked at corners and junctions and usually dipped in tar and sanded immediately so as to increase their resistance against rusting. Generally, one strip is provided for every thickness of half brick. Reinforcement in vertical directions may be provided by using special bricks or blocks. Mild steel bars (6 mm diameter) can also be used as longitudinal reinforcement in walls.

Masonry units used in reinforced masonry (Fig 1)

The properties of masonry units used for reinforced masonry work should comply with the requirements of relevant European standards (EN 771-1-6). Masonry units are classified into the following types: solid, perforated unit, hollow unit, cellular unit, horizontally perforated unit.

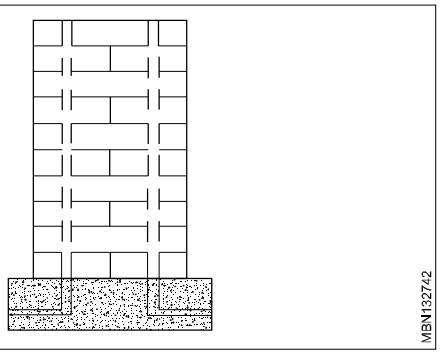
Fig 1



REINFORCED MASONARY WALLS

Masonry reinforced columns (Fig 2)

Fig 2

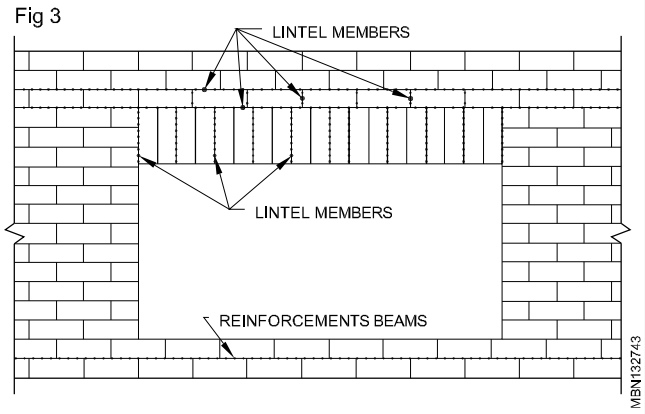


The reinforced columns are provided with steel palates of about 6 mm thickness at every fourth course. Vertically reinforcement bars are placed between special type of bocks used for the columns. The steel bars are fixed in the foundation concrete block.

Reinforced masonry lintels (Fig 3)

In case of brick lintels reinforcement in the form of 6 to12 mm diameter bars is provided longitudinally in between in between the vertical joints. Vertical stirrups of 6 mm diameter are provided at every third vertical joint to take up the vertical shear.

Fig 3



Reinforced masonry slab

For the construction of masonry slab, the centering in the form of a platform of wooden planks supported on beams is erected at the required level. The centering is covered with well-beaten earth and fine sand is sprinkled over it. Reinforcement is placed in positions and the bricks are laid in one or two courses. Reinforcement should be properly embedded in mortar. Joints should be properly filled with mortar. The slab is kept wet for a period of two to four weeks for proper curing. After 28 days the centering is removed and top and bottom surfaces of slab are suitable finished.

Centering of arches

Objective: At the end of this lesson you shall be able to
- **describe the centering for arches.**

Centering for arches:

1 A temporary structure (Centering) is required to support brick, stone or concrete arches during their construction.

2 The upper surface of the centering corresponds to the shape of intrados of the arch.

3 The centering for arches consists of two parallel boards having their upper edges shaped to the required curvature.

4 The boards are connected through their curved length by mans of narrow wooden strip which are know as the laggings. These laggings are used to support the brick or stones.

5 The centering is supported by props at each end.

6 The boards are prepared from two ribs whose thickness varies from 25 mm to 40 mm and whose width varies from 200 mm to 300 mm.

7 The struts and braces are provided to strengthen the ribs to prevent them from spreading.

8 The ties are generally 25 mm to 50 mm thick and 200 mm to 250 mm wide.

9 The bearers support the ribs and pair of folding wedges is provided at the top each drop to tighten or to loosen the centering.

Figure shows an arch centering for a span of 3.50 mm and of width equal to 1 1/2 brick thickness. (Fig 1)

Following points should be noted in connection with the arch centering

1 The length of laggings and the distance between the boards depend on the width of an arch. For rough and axed arches, the laggings are provided 20mm apart. But for gauged work, they are closely spaced.

2 The laggings should be kept 10 mm to 12 mm back from the face of arch work so that they will not form an obstruction to the linen and plumb rule observed by the masons during construction.

3 A thick wooden plank can be used as centering for arch of thickness one - half brick. The plank is shaped to the curvature of the arch and it is supported on the props. (Fig 2) shows the elevation, section and isometric view of centering with turning piece. The thick wooden plank with horizontal bottom and the upper surface shaped to the under side of the soffit is known as the center of turning piece. Its width is normally 100 mm and it is supported on vertical timber posts known as the props. The wooden wedges are provided to tighten or loosen the centering.

Fig 1

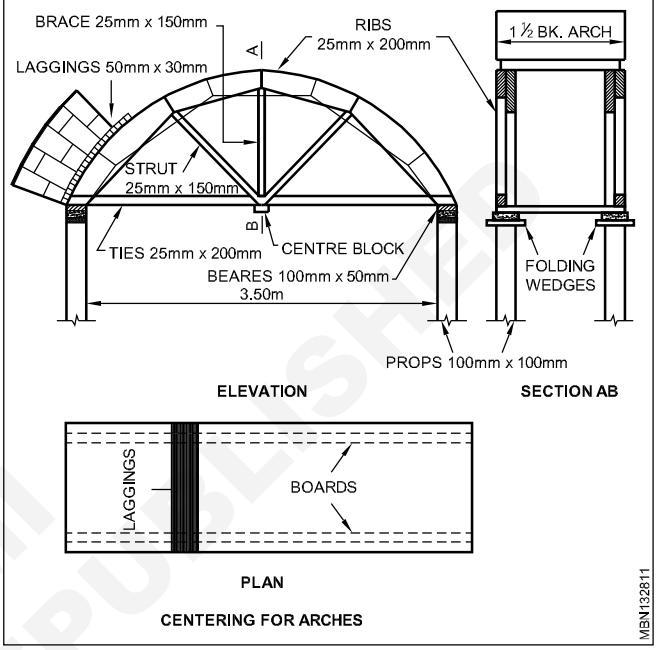
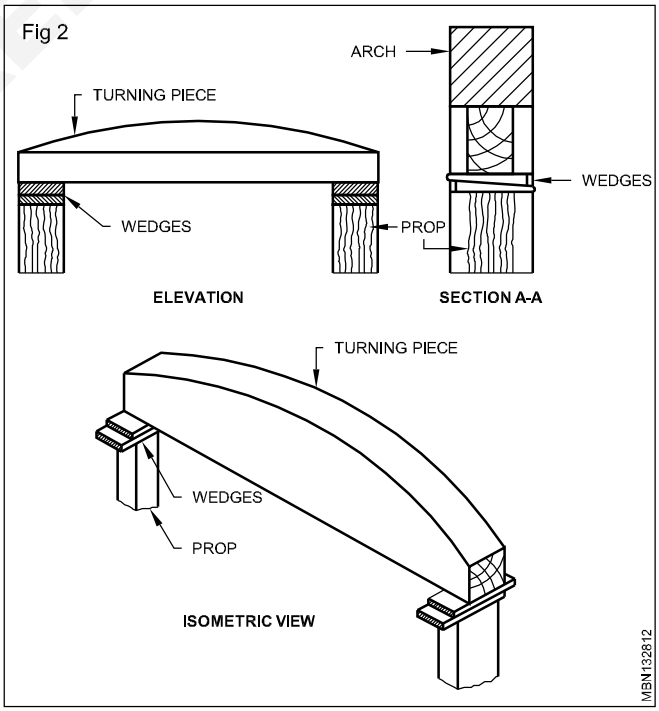


Fig 2



4 For small spans, the single ribs may be provided on side and laggings, bearers and folding wedges may be provided as usual.

5 The centering for arch should be removed after the arch has developed sufficient strength. For small spans, the removal of centering is done by slightly loosening the folding wedges. But when the span exceeds 7 m

or so, a method known as the sand box method, is adopted to avoid shocks. A box is filled with sand and a hole is provided at the bottom of box. The hole is plugged to retain sand. the bottom of prop rests on a plate which is provided at the top surface of sand when it is desired to lower the centering, The plug is taken out and the sand is allowed to come out of the box. The prop is thus lowered gradually.

6 The construction of centering for an arch depends on the span of arch, rise or arch, form of arch curve and the materials of which arch is constructed.

Qualities of good brick

The good bricks which are to be used and for construction of important engineering structure should posses the following qualities.

Colour: Uniform copper red colour.

Shape: Rectangular 19 x 9 x 9 cm as standard.

Soundness: Sound proof clear ringing sound when struck with each other.

Absorption: It should not absorb more than 20% for first class brick and 22% for second class brick when soaked in cold water for 24 hours.

Toughness: It should not break when dropped from an height of one meter.

Crushing strength: Minimum crushing strength 3.5 N/ mm^2

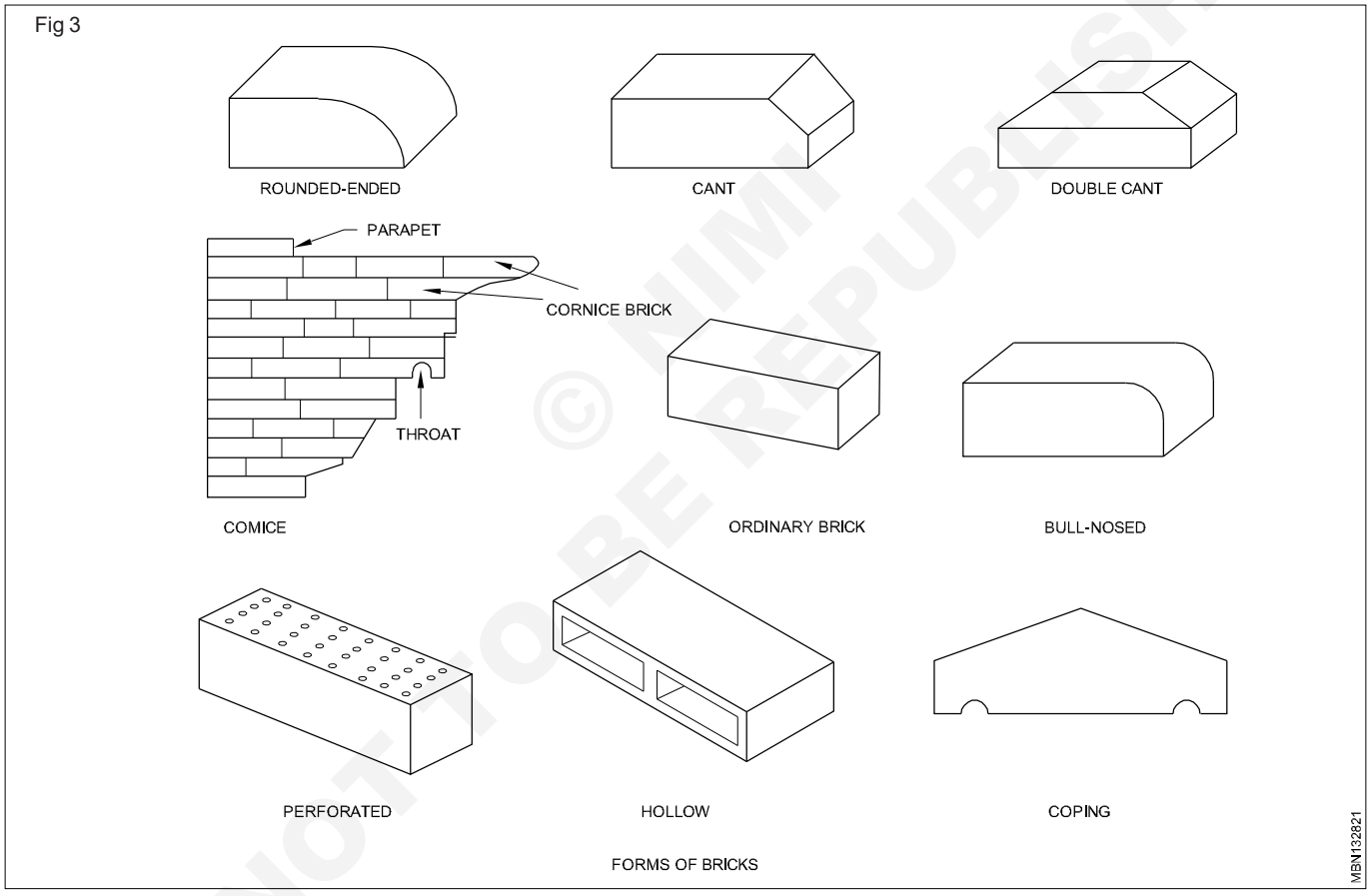
Specific gravity = 2 to 2.6.

Hardness: When the bricks is scratch by finger nail it should not show sign.

Structure: It should not have any holes and lumps.

Forms of Bricks (Fig 3)

Fig 3



Door frame

Objectives: At the end of this lesson you shall be able to
- **state the constructional details of door and door shutters**
- **state the technical terms used in door and door shutter construction**
- **state the types and uses of door shutters.**

- The door frame is an assembly of horizontal piece (head of Jambs) and the vertical piece (post) forming an enclosure to which the door shutters are fixed.
- Wooden door frames looks better than the other materials and they can be polished or painted.
- The thickness of the wooden frame varies depending upon the size of the door opening.
- The same thickness and width of wood be used for the head and the post.
- The frame is rebated on its outer edge to receive the door shutters.
- The width of the rebating varies from 12 mm to 15 mm while the depth is kept equal to the thickness of the door shutters.

Door shutter

Recommended dimensions for doors

No.	Designation	Size of opening (mm)	Size of door frame (mm)
1	8 DS 20	800 x 2000	790 x 1990
2	8 DS 21	800 x 2100	790 x 2090
3	9 DS 20	900 x 2000	890 x 1990
4	9 DS 21	900 x 2100	890 x 2090
5	10 DS 20	1000 x 2000	990 x 1990
6	10 DT 21	1000 x 2100	990 x 2090
7	12 DT 20	1200 x 2000	1190 x 1990
8	12 DT 21	1200 x 2100	1190 x 2090

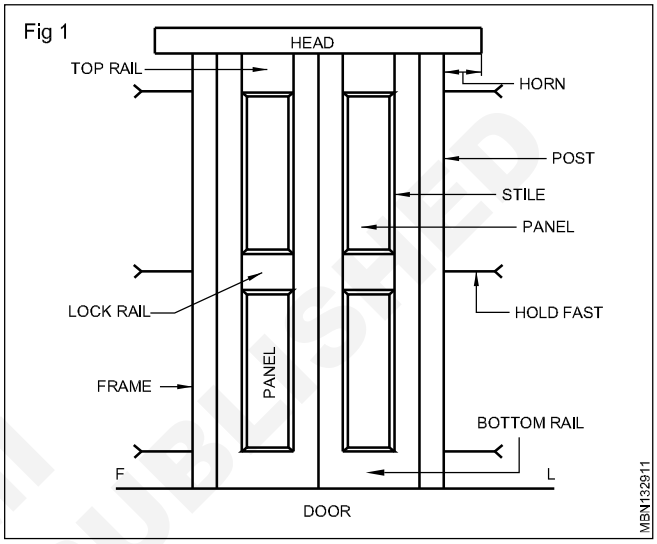
- A door may be defined as an openable barrier secured in an opening left in a wall for the purpose of providing access to the users of the structure.
- A door consist of two main parts called the frame and the shutter.
- The door shutter is held in position by the door frame which in turn is fixed in the opening of the wall by means of hold-fasts etc.
- A door should have the proper dimensions to allow the movements of the largest object likely to use the door and the tallest person likely to use the door.

The common width and height relation are...

Height = Width + 1.2 meter

Width = 0.4 to 0.6 of height

Technical terms used in door and the shutter. (Fig 1)



The definition of technical terms used in connection with doors and windows are as follows.

Frame

A frame consists of horizontal and vertical members forming as an enclosure to which the shutters are fixed.

Stile

The out side vertical members of the shutter of a door or window.

Head

The top or upper most horizontal part of a frame is called the head.

Sill

The lower most or bottom horizontal of window frame is called the sill (generally sills are not provided in door frame).

Top rail

This is the top most horizontal member of the shutter and is called the top rail.

Lock rail

The middle horizontal member of the shutter in doors where the locking arrangements are used.

Bottom rail

The lower most or bottom horizontal member of the shutter.

Intermediate or cross rail

These are the additional horizontal rails fixed between the top and bottom rails of the shutter.

A rail fixed between the top rail and lock rail is called Frieze rail.

Shutter

The openable part of the door or window. This is the entire assembly of styles, panels and rails.

Panel

The area of shutter enclosed between the adjacent rails.

Mullion

The vertical member of a frame which is employed to sub divide a door or window opening vertically.

Sash

This is a special type of frame to carry glass. A sash consist of two vertical styles and a top and bottom rails. This can be divided vertically or horizontally by providing the bars. These bars are called sash bar or glazing bar.

Transom

This is horizontal member which is employed to sub divide a window opening horizontally.

Louver

This is a piece of timber which is fixed in an inclined position with in a frame.

Jamb

The vertical wall face of an opening which supports the frame of the door and window is known as jamb.

Hold fast

This is generally in the form of a mild steel flat bar of section 30 mm x 6 mm and of length 200 mm. Hold fast are used to keep the door frame and window frame in position.

Rebate

The recess made in the door frame to receive the door shutter is called rebate.

Reveal

The external jamb of a door or window opening at right angles to the wall face is called the reveal.

Putty

This is a mixture of linseed oil and white chalk. It is used for fixing glass panels.

Types of door

- Ledged door
- Ledged and braced door
- Ledged and framed door
- Ledged, framed and braced door
- Framed and panelled door
- Glazed or sash door
- Louvered door
- Flush door

Ledged door (Fig 2)

This is the simplest type of the door and it is used for narrow opening where the strength and appearance are not important.

The door consists of vertical pieces called battens.

The battens are usually tongued and grooved and are joined together by using horizontal support pieces.

The horizontal support pieces are called the “LEDGES”.

The common batten sizes are 100 mm to 150 mm wide and 20 mm to 30 mm in thickness.

The ledges are 100 mm to 200 mm wide and 25 mm to 30 mm thickness.

Three ledges are generally used as top, middle and bottom on battens.

The door is hung on ‘T’ hinge which are fixed on ledges using by suitable wood screws.

Ledged and braced door (Fig 3)

These doors differ from ledged door except that the diagonal or inclined member called “Braces” are provided to give more strength

These doors can be used where the wide-opening are required.

The braces are generally 10 cm to 15 cm wide and 2.5 cm to 3 cm thickness.

The braces are usually housed in the ledges.

It is important that the braces must slope upwards from the hanging side, as they have to work in compression and not in tension.

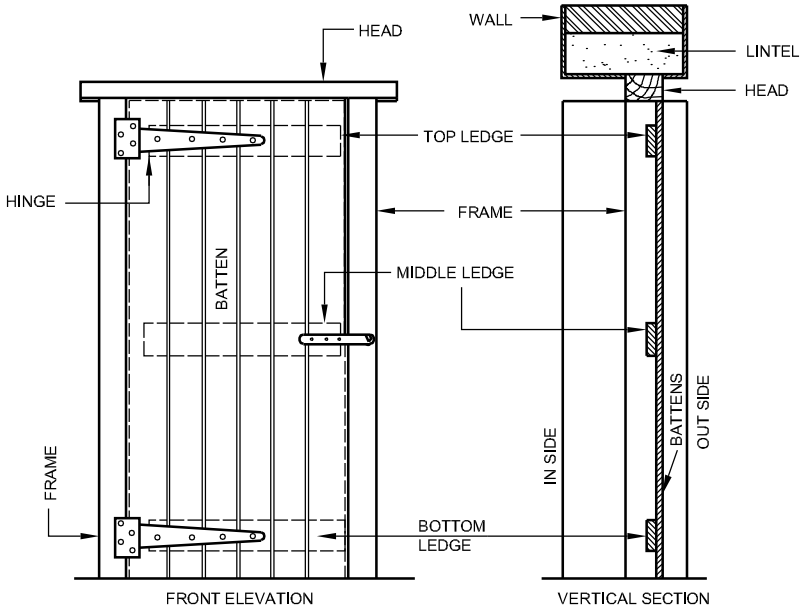
Ledged and framed door (Fig 4)

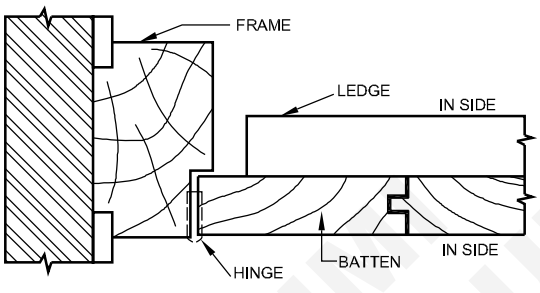
These doors are modified and differ from the ledged door.

A frame work for the shutter is provided in the form of vertical pieces called “STYLES” to make the door stronger and good in appearance.

- The stiles are generally 10 cm wide and 4 cm thick.
- The battens and three ledges are provided as usual.

Fig 2





LEDGED DOOR

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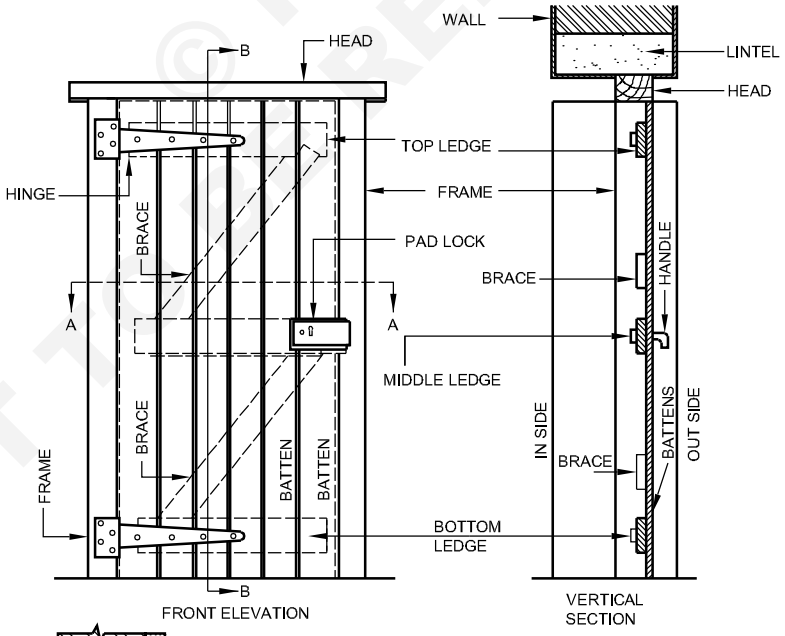
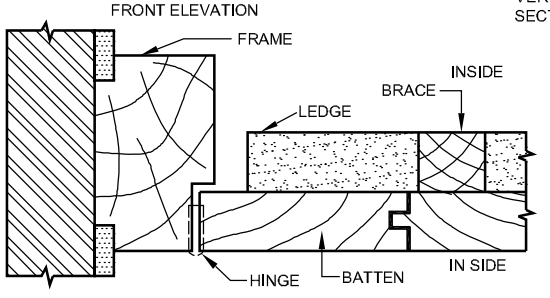
Fig 3





LEDGED AND BRACED DOOR

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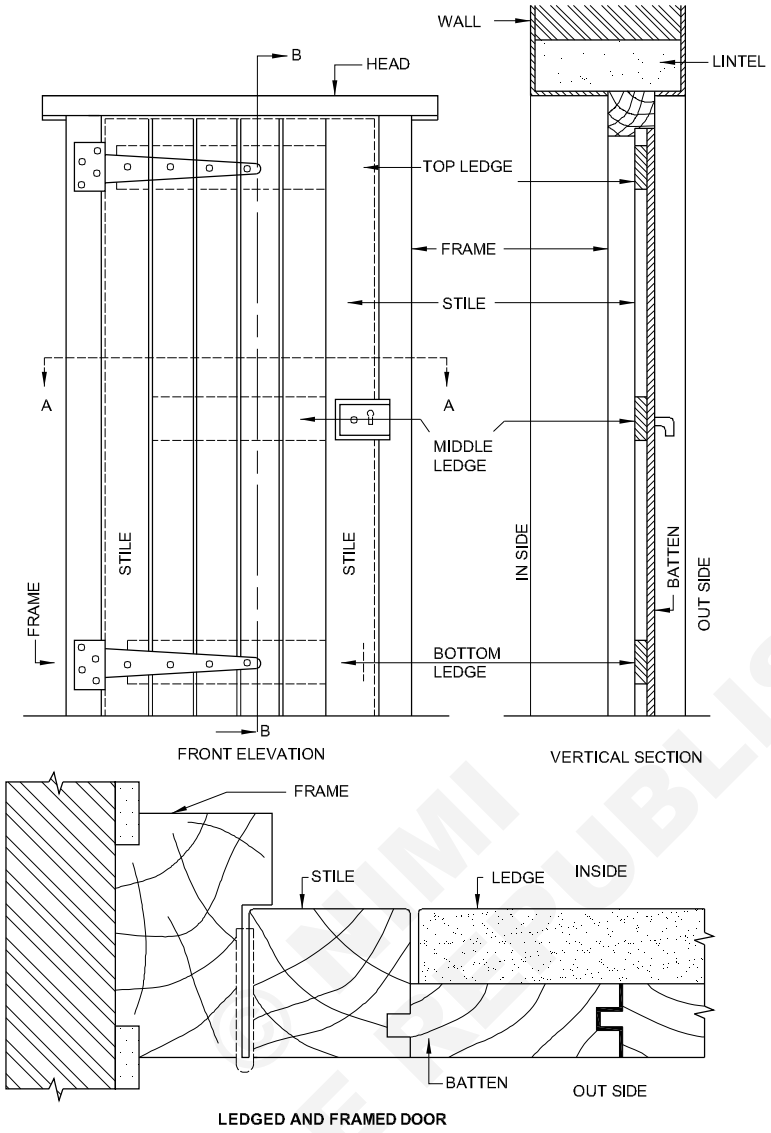
Fig 4



- The thickness of styles are equal to the thickness of ledges and the thickness of battens.

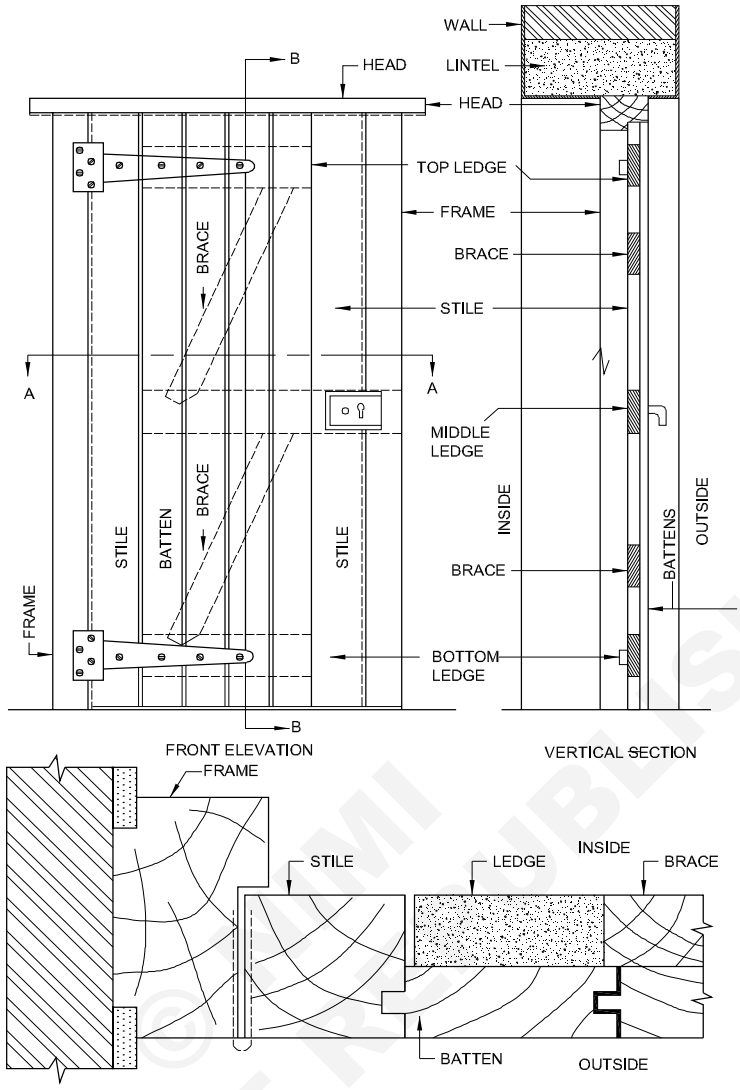
Ledged, braced and framed door (Fig 5)

- These doors differ from the above three doors.
- An additional braces provide diagonally between the ledges to increase more strength, good appearance and more durability of the door.
- These doors consist of two styles, three ledges and two braces.
- The battens are joined together used by tongued and grooved and 'V' joints.
- The braces are normally housed into the ledges at about 3.5 cm to 4.5 cm from the styles of the door.

Framed and panelled door (Fig 6 & 7)

- This is the common type of door used in all kinds of buildings.
- This door consists of a frame work with vertical members called "STYLES" and the horizontal members called "RAILS".
- The styles and rails are grooved along their inner edges of the frame work to receive the panels.
- This type of doors strong, gives a good appearance and reduces the tendency of shrinkage.
- The panels are made from wood, plywood and glass etc.
- A door can have one panel to multi panel as required.
- In the vertical sub division of panels, the vertical pieces are called "MULLIONS.

Fig 5



LEDGED-BRACED AND FRAMED DOOR

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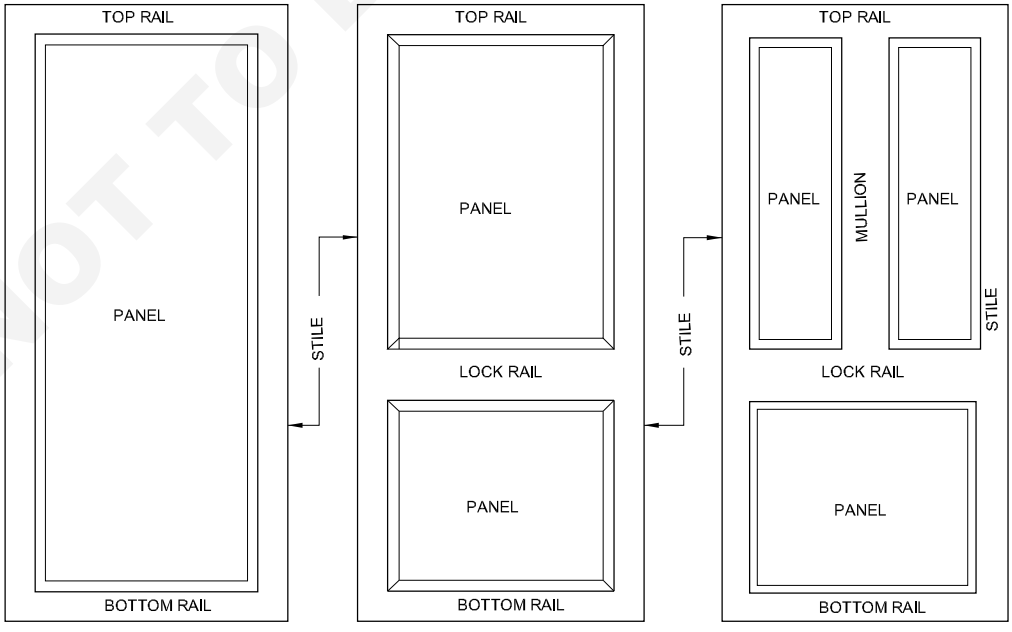
Fig 6



SINGAL PANEL DOOR | DOOR WITH TWO PANELS | DOOR WITH THREE PANELS

FRAMED AND PANELLED DOOR

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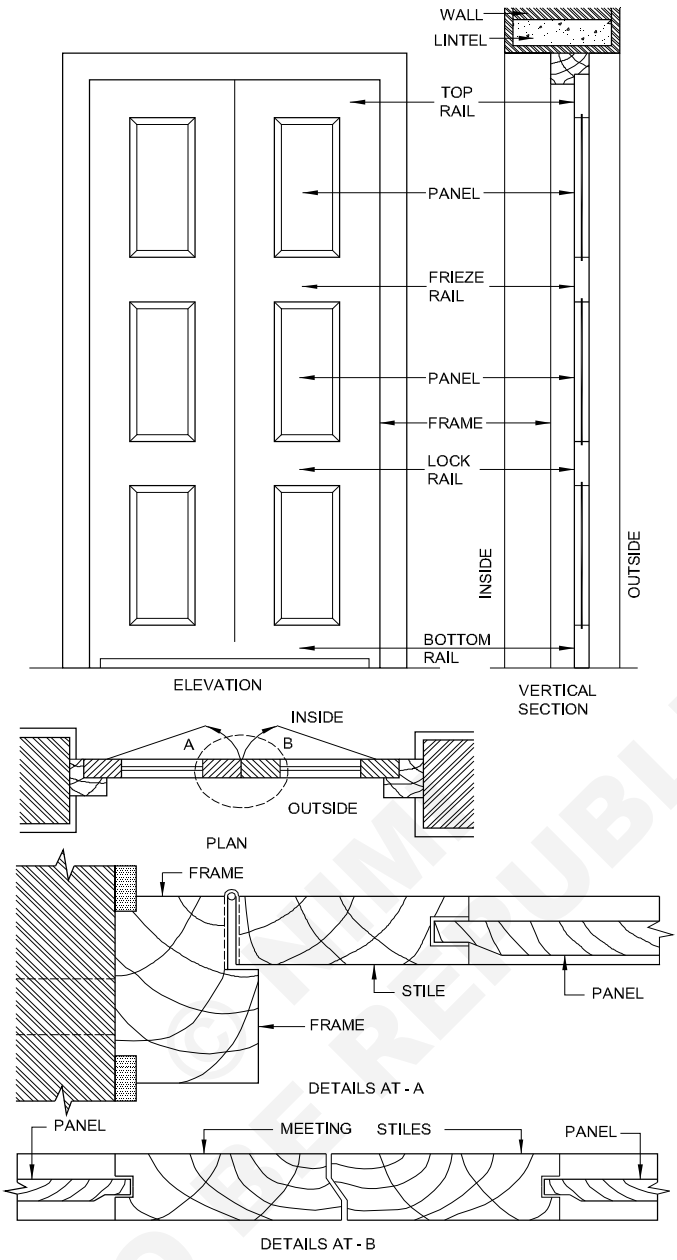
Fig 7



DOUBLE-LEAFED DOOR WITH SIX PANELS

MBN132917

Windows and ventilators

Objectives : At the end of this lesson, you shall be able to,

- **enumerate factors for selection of size, location & no of windows in a room**
- **describe Indian standard recommendations of windows**
- **explain different types of windows and ventilators.**

Introduction

Windows: Windows are necessary for ventilation and lighting. These are usually glazed with clear or opaque glasses. As already stated, not less than 10 to 15 percent of the floor area of a room is given to windows opening to the outside. The smaller the floor area, the larger will be the percentage.

Ventilators

Ventilators are windows of small heights and they are fixed at the top of door or window. The ventilators are provided with glass panels and steel grill is fixed in the ventilator for the purpose of safety.

Windows

The selection of size, shape, location and no. of windows in a room depends upon the following factors.

1 Size of the room

2 Location of the room

3 Utility of the room

4 Direction of the wall

5 Direction of the wind

6 Climatic conditions such as humidity, temperature, etc.

7 Requirement of exterior view.

8 Architectural treatment to the exterior of the building.

Based on these factors the following thumb rules are in use.

1 Breath of window = 1/8 [Width of room + Height or room].

2 The total areas of window opening normally varies from 10-12% of the floor areas of the room depending upon the climatic conditions.

3 The areas of window opening should be at least 1 sq.m for every 30-40 cubic metre of the room volume.

4 In public buildings, the minimum area of window should be 20% of floor areas.

5 For sufficient natural light, the area of glazed panels should at least be 8-10% of the floor area.

Indian standard recommends that the size of window frame. Should be derived after allowing a margin of 5 mm all round an opening for convenience of fixing. The width and height of an opening is indicated by a number. of modules, where each module is of 100 mm. A designation 6ws12 indicates a window opening with single shutter having width equal to 6 modules.

It, 6 X 100 = 600 mm

And height equal to 12 modules

It, 12 X 100 = 1200 mm.

Indian standard recommendations for size of opening, size of frame and size of window shutters are given below.

Sl. No	Designation	Size of opening	Size of window frame	Size of window shutters
1	6 WS 12	600 x 1200	590 x 1190	560 x 1100
2	10 WT 12	1000 x 1200	990 x 1190	460 x 1100
3	12 WT 12	1200 x 1200	1190 x 1190	560 x 1100
4	6 WS 13	600 x 1300	590 x 1290	560 x 1200
5	10 WT 13	1000 x 1300	990 x 1290	460 x 1200
6	12 WT 13	1200 x1300	1190 x 1290	560 x 1200

Types of windows

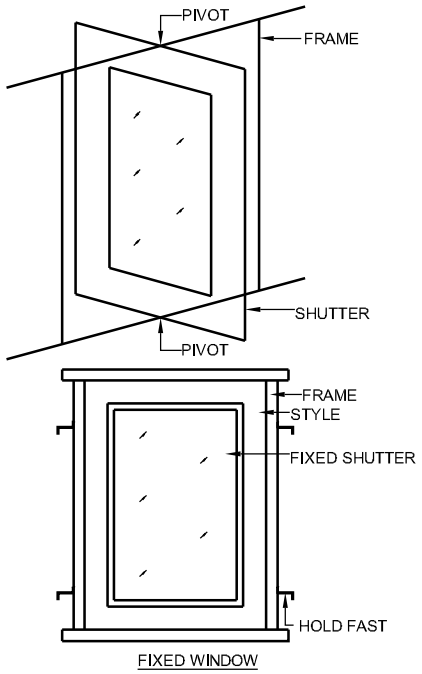
The common varieties of windows used in building construction are as follows:-

1 Fixed window
2 Pivoted window
3 Double hung window
4 Casement window
5 Sliding window
6 Sash window
7 Louvered window
8 Metal window
9 Bay window
10 Clerestory window
11 Dormer window
12 Corner window
13 Gable window
14 Lantern window
15 Sky lights
16 Ventilators
17 Combined windows and ventilators

Fixed Window: These windows are provided for the only purpose of admitting light and providing vision in the room. This window may consist of a window frame to which shutters are fixed. No rebate are provided to the window frame. The shutters are fully glazed.

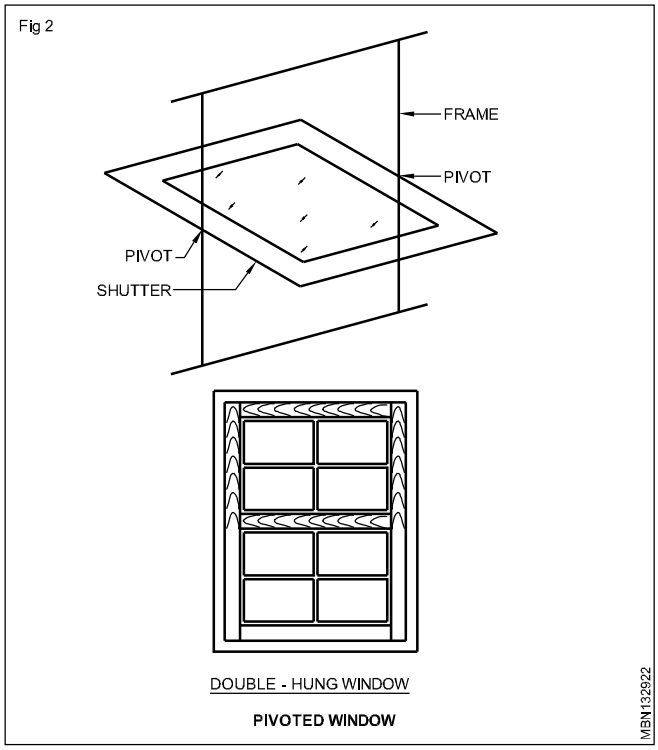
Pivoted windows: In this type of window the shutter is capable of rotating about a pivot fixed to window frame. The window frame has no rebate. The shutter can rotate horizontally or vertically depending upon the position of pivot. (Fig 1)

Fig 1

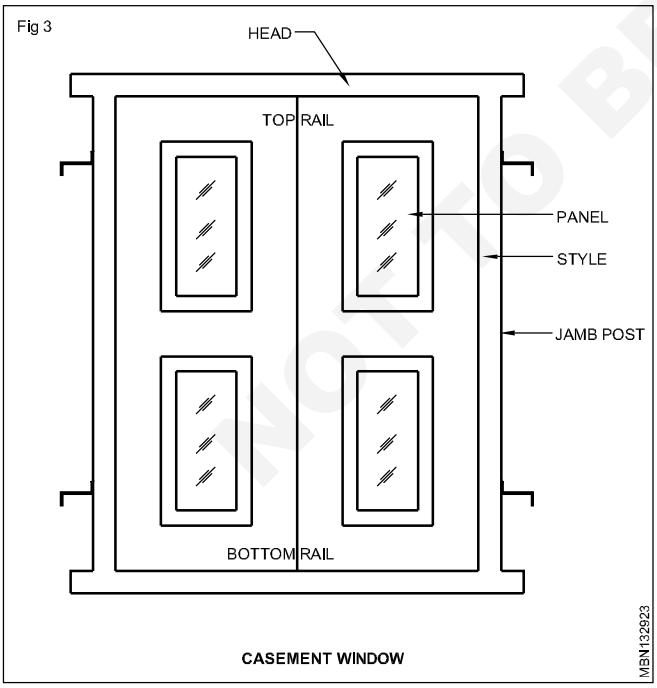


Double - hung window: This type of window consist of a pair of shutters arranged one above the other which can slide vertically within the grooves provided in the frame. A pair of metal weights connected by chain passing over pulleys, is provided for each shutter. By this arrangement the window can be opened at top or bottom to the desired

extent by pulling the metal weight suitably. Thus in this type of window, it is possible to have controlled ventilation. In addition, the shutter can also be cleaned easily. (Fig 2)



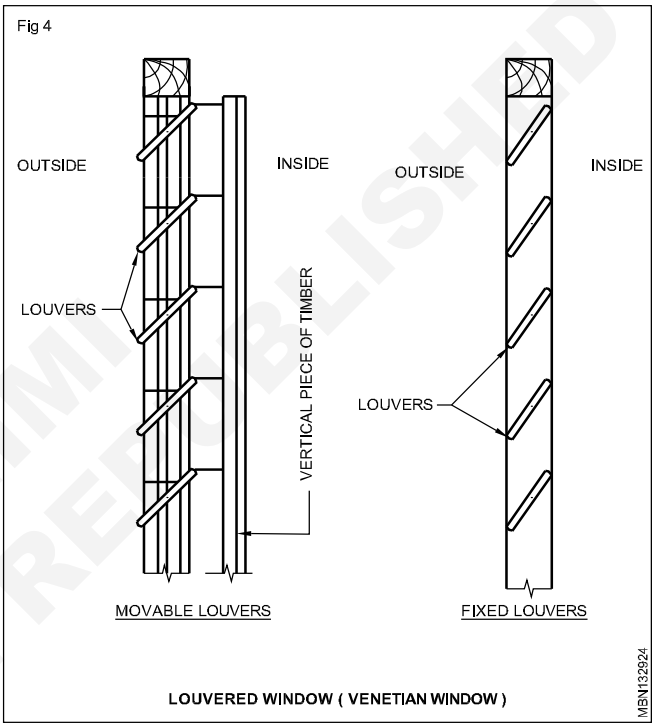
Casement window: Window where shutters open like doors are called casement windows. The window has a frame which is rebated to receiving the shutters. The shutters consist of style, top rail, bottom rail and intermediate rail, thus dividing it into panels. The panel may be glazed or unglazed or partially glazed and partially unglazed. In case of windows with doubles shutters, the outer shutter may have wire- gauged panels. (Fig 3)



Sliding window: In this type of window the shutters move on roller bearing and can slide either horizontally or vertically similar to sliding door.

Sash or glazed window: In this case the window shutter consists of two vertical styles, top and bottom rails. The panel space of window shutter between the style and rail is suitably divided by sash bars into panels of small size for fixing glass panels. The glass panels are secured in position either by putty or by fillets, known as glazing beads.

Louvered window (Venetian window): In this type of windows the lowers are provided as in the case of louvered doors. They allow free passage of air when close and at the same time they maintain sufficient privacy. The shutter consists of top rail, bottom rail and two styles; which are grooved to receive the louvers. The economical angle of inclination of the louvers is 45° and they are generally fixed in position. (Fig 4)



Metal window: These are now a day's widely used especially in public buildings. Windows are made of metals like mild steel, galvanised mild steel, aluminium, bronze, stainless steel etc. Bronze, aluminium and stainless steel are considered to be the best as they posses high degree of elegance, finishing, durability and are dust - proof as well. Mild steel being cheapest of the above metals, steel window works out to be the most economical. Hence steel windows are extensively used in all types of buildings.

Steel window can be fixed direct in the masonry opening in the wall or it may be fitted in a wooden frame fixed in a window opening in the wall. It should be ensured that no load of the wall etc, is transferred to the window frame. For this, it is usual practice to keep the size of the window opening slightly more than that of window frame. Also the frame may be fixed in the opening after the masonry work is complete.

Method of fixing metal windows (Steel windows):

The prepared opening in which steel window frame is to be fixed is cleaned and exact position of the window frame is marked by drawing lines.

The distance of fixing holes on the frame are measured and these positions are marked on the chalk line drawn in the opening.

Holes are cut in brick masonry of size 5 m^2 and 5-10cm deep to accommodate hold fast or legs. In case of stone masonry or R.C.C work where it is difficult to cut holes for legs, wooden plugs are embedded at appropriate places during the construction itself. The window frame is then fixed to these plugs with the help of galvanized iron or wood screws.

The frame is placed in the opening and position is adjusted in correct alignment by striking wooden wedges in correct position. Since there is a little gap between the opening and window frame temporary wooden wedges can be easily driven after adjusting the window in correct alignment the legs are screwed light in the frame.

Legs are grouted into the holes with cement mortar. After grout has set, wooden wedges are removed and space between the opening and frame is filled with cement mortar.

Following precaution are to be taken in metal windows:

The members of the frame and sash should be properly welded at corners.

Precaution should be taken to prevent the corrosion of metal windows.

Glasses panels should be properly fixed.

The metal frame should be embedded in cement or bituminous mastic to prevent the entry of moisture on rain water.

It is advisable to check and slightly adjust the movement of shutter before erecting the window in the opening.

The handles to the window should be fixed before doing the glazing work.

Scaffolding members or any other support should not be tied down the metal windows. Otherwise the window will be damaged.

The masonry opening to receive the metal window should be prepared in proper level and plumb.

Following are the advantages of steel windows over wooden windows:

The steel windows are factory made products and hence they possess greater precision as compared to the wooden windows.

The steel windows are not subjected to contraction and expansion due to whether effects as in the case of wooden windows.

The steel windows exhibit elegant appearance.

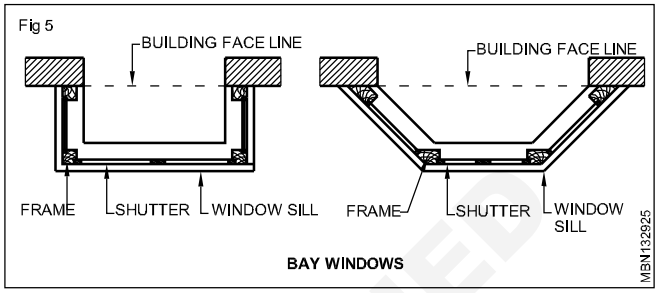
The members of steel windows are narrow and hence the steel windows admit more light and ventilation for the same area as compared to the wooden windows.

Steel windows are easy to maintain when compared to wooden windows.

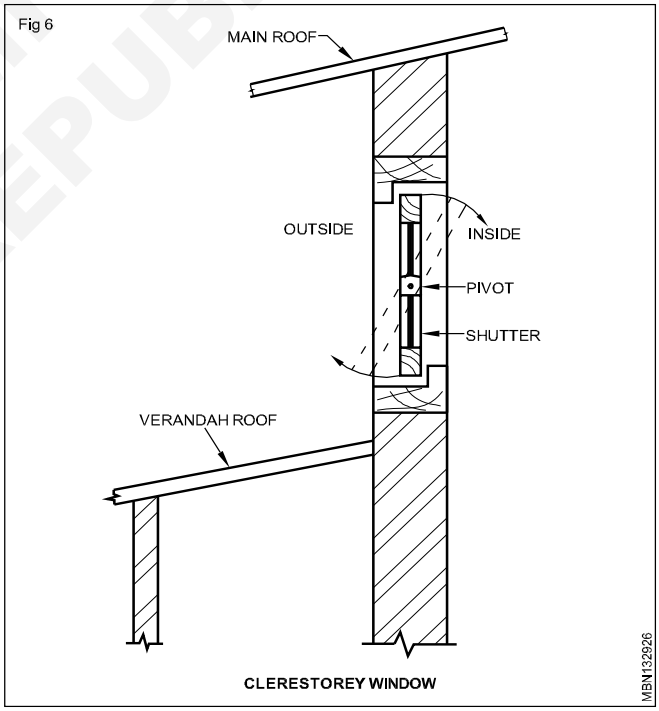
The steel windows are highly termite proof and fire proof.

Steel windows are more durable and stronger as compared to wooden windows.

Bay windows: Bay windows project outside the external walls of a room. This projection may be triangular, circular, rectangular or polygonal in plan. Such a window is provided to get an increased area of opening for admitting more light and air. They also provide extra space in the room, and improve the overall appearance of the building. (Fig 5)



Clere - storey window: These windows are provided near the top of main roof. The pivoted windows are used for this purpose. The clere -storey windows provide ventila tion to the inside of the room where the front is blocked by the veranda and improve the appearance of the building. (Fig 6)



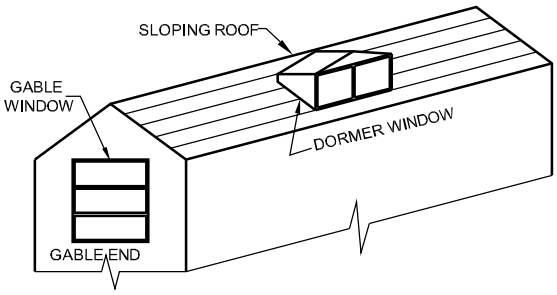
Dormer window: A dormer window is a vertical window built in the sloping side of the pitched roof. This window is provided to achieve proper ventilation and lighting of the enclosed spaces below the roof. Dormer window also serves as an architectural feature of the building. (Fig 7)

Gable window: The windows provided in the gable end of a pitched roof are known as a gable windows.(Fig 7)

Corner window: These windows are provided at the corner of the room and thus they have two faces and two directions. Due to this there is entry of light and air from two directions and in many cases the elevation of the building is also improved. However special lintel will have

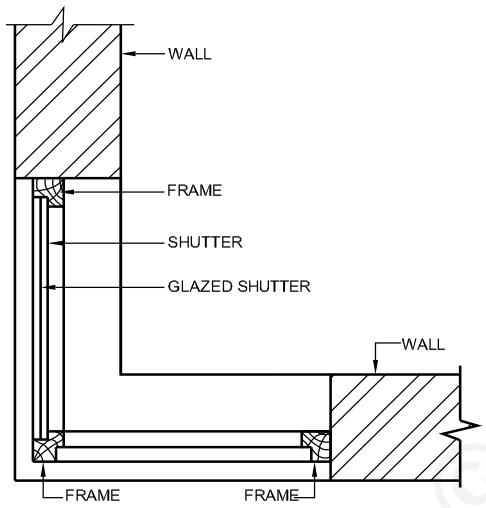
to be casted at the corner and jamb posts of the window at the corner will have to be made of heavy section. (Fig 8)

Fig 7



DORMER WINDOW

Fig 8

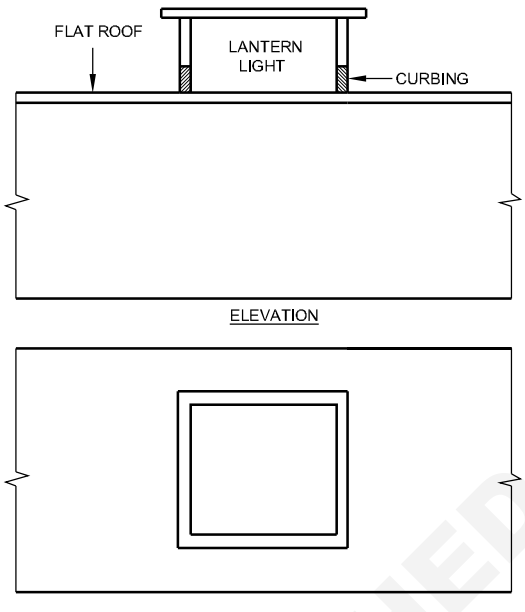


CORNER WINDOW

Lantern window: These are the windows which are fixed on flat roofs to provide light to the inner portion of the building where light coming from the windows in the external wall is in sufficient. They may be square or rectangular or curved. Glass panels are generally fixed; but if ventilation is required in addition to light, then pivot window may be provided. (Fig 9)

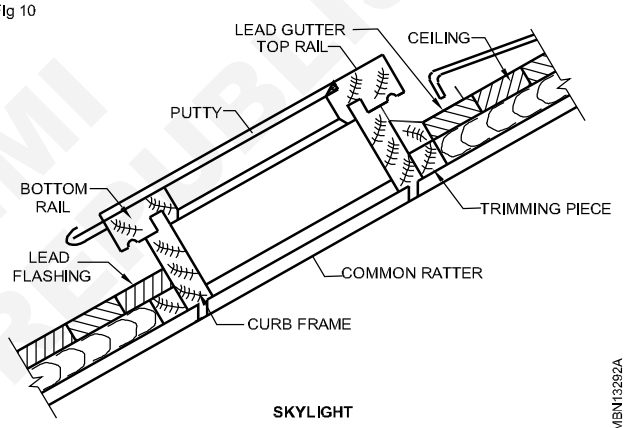
Sky light: A sky light is provided on a sloping roof to admit light. The window project above the sloping surface and is parallel to the sloping roof surface. The sky light is provided with a view to permit the room below to be fully lighted with natural light. The opening for sky light is made by cutting the common rafters. (Fig 10)

Fig 9



LANTERN WINDOW

Fig 10



SKYLIGHT

Ventilators: Ventilators are small windows fixed at a greater height than the window, generally about 30-50 cm below the roof level. The ventilator has a frame and a shutter generally glazed and horizontally pivoted. The top edge of the shutter open inside and the bottom edge open outside so that rain water is excluded.

Ventilators combined with window or door: Ventilators may be provided in continuation of a door or a window at its top. Such a ventilator is known as Fan-light. The construction of a fan light is similar to sash window. Such a ventilator is usually hinged at top and can open out. Alternatively, the ventilator shutter can be hinged at the bottom.

Lintels

Objectives: At the end of this lesson you shall be able to,
- **define lintel**
- **explain bearing of lintel**
- **list out the materials used lintel**
- **classify the lintel according to material of construction.**

Introduction

A lintel can be a load bearing building component placed over an opening. The function of lintel is just the same as that of an arch or a beam. However the lintels are easy and simple in construction. Lintels are made from various materials. The lintels of RCC are widely used to span the openings for doors, windows etc. in a structure.

Definition

A Lintel is a structural horizontal member which is placed across an opening to support the portion of the structure above it.

Bearing of lintel

Bearing of lintel means the distance up to which it is inserted in the supporting wall. Bearing should be the minimum of the following three considerations.

1 100 mm or

2 The height of lintel or

3 1/10th to 1/12th span.

Materials for lintels

The common materials used in the construction of the lintel are as follows.

1 Wood or timber

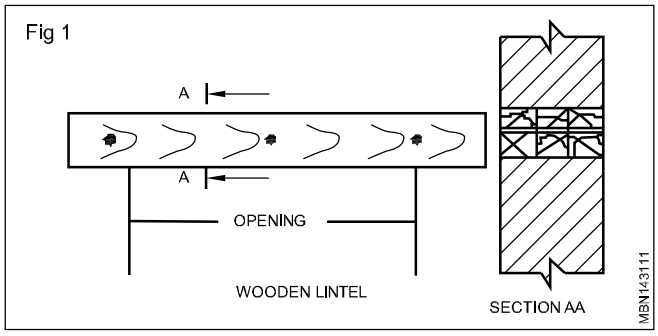
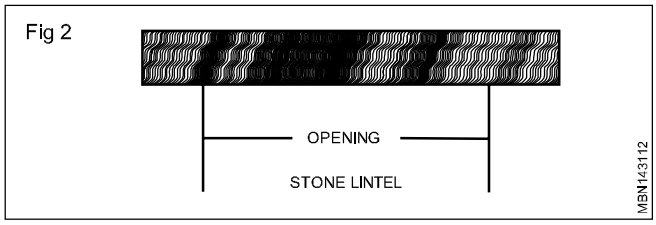
2 Stone

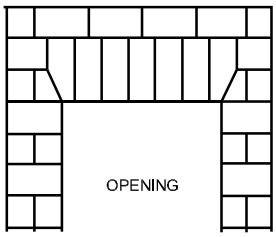
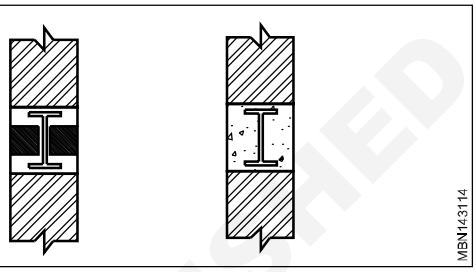
3 Brick

4 Steel

5 Reinforced cement concrete

Classification of lintels according to the material used

Name	Features	Figure
1 Wood or timber lintel.	A single piece of timber or built up sections of wood can be used as a lintel. • A bearing of about 15 cm to 20 cm should be provided. • The width of lintel should be equal to the opening • The depth of lintel should be about 1/12th or 8 cm which ever is greater.	Fig 1 
2 Stone lintel	These lintels consists of slabs of stones which it placed across the openings. **Disadvantages of stone lintels** • Stone posses low tensile resistance. • It is difficult to obtain a good stone of required depth.	Fig 2 

3 Brick lintels	Brick lintels consist of bricks which are generally placed on edge. • Bricks should be well burnt, copper coloured • Free from cracks and with sharp and square edges. • This lintel have a depth equal to some multiple of brick courses. • Suitable up to a span of one metre and for greater spans reinforcement or steel angle may be provided.	Fig 3  MBN143113
4 Steel lintels	• Steel lintels consist of steel angles or rolled steel joists. Steel angles are used for small spans and light loading. • Rolled steel joists are used for large spans and heavy loading. • Tube separator-may be provided to keep the joists in position. • R.S.J - The joists are embedded in concrete to protect steel from corrosion and fire.	Fig 4  MBN143114

Bar bending

Objectives : At the end of this lesson you shall be able to,
- **state the types of reinforcement bar**
- **state the different types grade of cement**
- **describe the characteristics reinforcement.**

Reinforcement

Reinforcement shall be any of the following

- Mild steel and medium tensile steel bars conforming to IS: 432.
- Hot rolled deformed bars conforming to IS: 1139.
- Cold twisted bars conforming to IS: 1786.
- Hard - drawn steel wire fabric conforming to IS: 1566.
- Rolled steel made from structural steel conforming to IS: 226.
- All reinforcement shall be free from mill scales, loose rust and coats of paints, oil, mud or other coatings, which destroy or reduce bond.

Grades of concrete

The concrete shall be in grades M5, M7.5, M10, M15, M20,M25,M30,M35 and M40. In the designation of concrete grade, letter M refers to the mix and the number to the specified characteristic compressive strength of 15 cm cube after 28 days, expressed in N/mm^2. Grades of concrete lower than M15 shall not be used in R.C.C.

Table 1: Nominal Proportion for different Grades

Grade	Proportion			Quantity of water in litres per 50 kg of cement
	Cement	Fine aggregate	Coarse aggregate	
M5	1	5	10	60
M7.5	1	4	8	45
M10	1	3	6	34
M15	1	2	4	32
M20	1	1.5	3	30
M25	1	1	2	28

Grade of cement

For engineering purposes, there are many types of cement but in general, 'ordinary portland cement' (OPC) which is available in three grades should be used for house construction.

33 grade ordinary portland cement

This ordinary 'portland' cement is used widely in the country. It is more suitable cement for masonry and general concrete works where the members are not taken to very high stresses. It is not suitable where 'sulphate' is in the soil or in the ground water.

43 Grade ordinary portland cement

43 grades of cement are used where high early strength in 1 to 28 days range is required. These days the 'structural engineers' propose this cements mainly for RCC works where each structural member takes high tensile stress.

53 grade ordinary portland cement

53 grades of cement are used where high early strength in 1 to 28 days range is required. These days 'structural engineers' propose these cements mainly for RCC works where a member takes high tensile stress.

Caution in the use of 53 grade cement in construction:

The strength of 53 grade cement does not increase much after 28th day because of early gain while 33 grade cement continues to gain strength after 28th day.

In addition, due to faster hydration process, the concrete releases heat of hydration at much faster rate initially and release of heat is the highest in case of 53 grades. The heat of hydration being higher, the chances of micro - cracking of concrete is much greater. Thus during initial setting period of concrete, the higher heat of hydration can lead to the damage of micro - cracking within the concrete which may not be visible at surface.

This cracking is different from shrinkage or cracks which occur due to faster dryness of concrete in windy conditions. The situation can be worse when we tend to increase the quantity of the cement in concrete with a belief that such increments are better for both strength and durability of concrete.

Reinforcement: The material which can be used as reinforcement in R.C.C. work should have the following characteristics:

1 It should be able to develop perfect bond with concrete.

2 Its co - efficient of thermal expansion should be nearly same as that of concrete.

3 It should have high tensile strength.

4 Concrete should not produce any harmful effect on the embedded material.

5 It should be easy to cut, bend, bind or weld.

6 It should be easily available.

It is seen that steel meets all the above requirements and as such it is the only material which is used on large scale in R.C.C works.

The various types of steel that are commonly used for making different forms of reinforcement are mild steel, medium tensile steel, high tensile steel and hard drawn steel. These differ from each other in their chemical composition and other properties like, ultimate tensile strength, yield points etc.

The various forms in which steel is used as reinforcement in R.C.C work are: round bars, deformed bars, twisted bars, square bars and flats. Sometimes expanded metal fabric or fabric made by welding or weaving steel wire in the form of oblong or square mesh are also used as reinforcement in slabs, shells and concrete roads. For works of large dimensions like massive foundations, etc., sections like rolled steel beams, channels or angle iron are also used as reinforcement.

Mild and medium tensile steel bars of round section are most commonly used in R.C.C work. The diameter of round bars (in mm.) used in normal building work are:

6,8,10,12,16,18,20,22,25,28,32,36 and 40

Bars of greater diameter, i.e., 45 mm. and 50 mm., are only used in exceptionally heavy foundations, large girders, or counterforts etc.

With the introduction of deformed bars and twisted bars, the use of plain round bars is gradually declining. Deformed bars or high yield strength deformed bars (HYSD) are furnished with lugs, ribs or other form of surface deformations for the purpose of increasing their bond strength with concrete. (Fig 1)

Fig 1

DEFORMED BAR

MBN143121

It is seen that the process of twisting a plain or a deformed bar results in the following improvements in its properties:

- Considerable increase in yield stress.
- Increase in tensile strength.
- Increase in bond strength.

Twisted plain or deformed bars not only have high yield stress but also have bond strength which is 40% more than that of plain round bars. On account of increased bond strength such bars do not need end hooks, and require reduced length for overlaps etc. thereby effecting reduction in the cost of reinforcement and labour.

Characteristic strength of steel reinforcement

The term characteristic strength of steel reinforcement means that value of the strength of steel below which not more than 5% of the test results are expected to fall. The characteristic strength of different type of steel reinforcement or (f_y) is taken as the value of the minimum yield stress (or 0.2% proof stress) for the type or grade of steel used in the manufacture of the reinforcement. The value of (f_y) or the characteristic strength for three commonly used type of reinforcing bars are given in Table 2.

Reinforcement shall be any of the following:

a Mild steel and medium tensile steel bars conforming to IS: 432.

b Hot rolled deformed bars conforming to IS: 1139.

c Cold twisted bars conforming to IS:1786.

d Hard - drawn steel wire fabric conforming to IS: 1566.

e Rolled steel made from structural steel conforming to IS: 226.

f All reinforcement shall be free from mill scales, loose rust and coats of paints, oil, mud or other coatings, which destroy or reduce bond.

Table 2: Characteristic strength of steel reinforcement

Sl.No.	Types of reinforcement	Yield stress or 0.2% proof stress	Characteristic strength (F_y)	Permissible tensile strength σ_{st}
1	Mild steel bars conforming to grade 1 of IS:432 (Part 1) or deformed m.s. bars conforming to IS: 1139.	250 N/mm^2 (average)	250 N/mm^2	140 N/mm^2 (for bars upto 20 mm ϕ) 130 N/mm^2 (for bars over 20 mm ϕ)
2	High yield strength deformed bars (HYSD bars) conforming to IS: 1109 or grade Fe 415 of IS: 1786.	415 N/mm^2	415 N/mm^2	230 N/mm^2
3	High yield strength deformed bars conforming to grade Fe 500 of IS:1786.	500 N/mm^2	500 N/mm^2	275 N/mm^2

Types of reinforcement steel (Figs 2-16)

In R.C.C works steel reinforcement may be used in the form of plain round bars deformed bars, twisted bars, and square bars or flats. According to chemical composition and other properties like yield point, ultimate strength etc. steel is divided into.

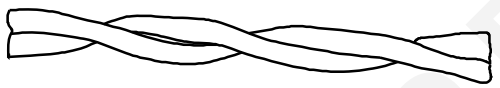
1 Mild steel (Fe 250)

Grade -I (IS:432)
Grade -II (IS:432)

2 Medium tensile steel (IS:432)

3 High yield strength deformed bars (Fe 415) (IS: 1139).

Fig 2



TWIN TWISTED BARS

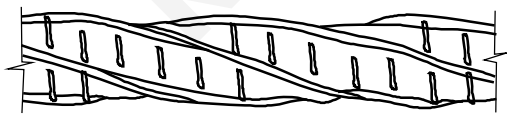
MBN143122

Fig 3

RIBBED TORSTEEL

MBN143123

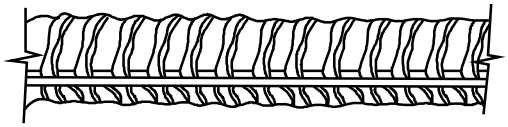
Fig 4



GRIP BAR

MBN143124

Fig 5



TRSTRONG BAR 1 & 2

MBN143125

Fig 6

TISCON 42 , 12 MM , 2 RIBS

MBN143126

Fig 7

TISCON 42 , 12 MM , 4 RIBS

MBN143127

Fig 8

TISCON 42 , 20 MM , 4 RIBS

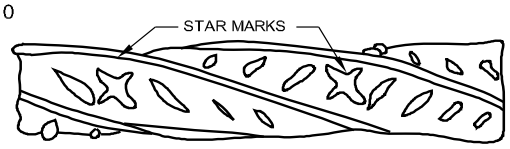
MBN143128

Fig 9

TISCON 50 , 12 MM , 2 RIBS

MBN143129

Fig 10



TISCON 50 , 20 MM , 4 RIBS

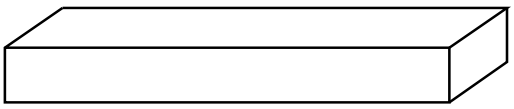
MBN143124A

Fig 11

CIRCULAR BAR

MBN143128

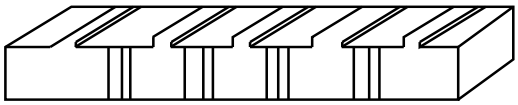
Fig 12



SQUARE BAR

MBN14312C

Fig 13



SQUARE BAR WITH INDENTATIONS

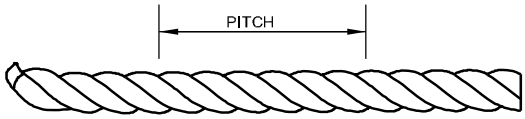
MBN14312D

Fig 14

TWISTED BAR

MBN14312E

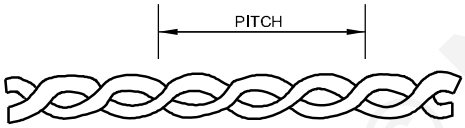
Fig 15



SINGLE - SQUARE TWISTED BAR

MBN14312F

Fig 16



TWIN TWISTED BAR

TWISTED BARS

MBN14312G

Twisted bars are nothing but mild steel bars whose quality has been improved by various processes of cold working and have improved its yield stress is about 50% more than that for ordinary mild steel bars. The ribs, legs and deformations on their surface increase the bond strength.

Reinforced materials

1 Deformed bars: There are bars whose surface is roughened to increase the resistance to slipping between the bar and the concrete. These have same types of corrugation or projections on their surface which check the slipping. (Fig 1)

2 Twisted bars: The quality of steel bars can be improved by the use of various processes or working. One of these methods is if twisting of bars. Twisting of bars may be singly or doubly is shown in figure. During the double as twin twisting the length of combined bar will be shortened. The effects of twisting are as follows"

i A considerable increase in the yield strength of bar.

ii A slight increase in ultimate tensile stress.

iii Considerable decrease in the ultimate elongation.

Do the yield stress is increased by 50% or more and thus the working stresses are also increased proportionality and it results by 33% or so. The steel used as reinforcement shall conform with IS:456.

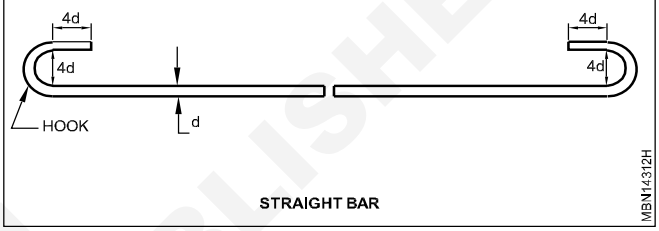
I.S. Codes

Indian standard codes have been prepared to be used for the construction of various structures. On such code IS: 456 which deals with construction of reinforced cement concrete structures. Various specification to be adopted for steel and concrete are laid down in the code for guidance. While designing the R.C.C structures these codes are followed.

Bending of bars

In case round bars are used as reinforcement in concrete, hooks at the ends are provided. Provision of hooks, bends and laps etc. are shown in figures. (Figs 17-20)

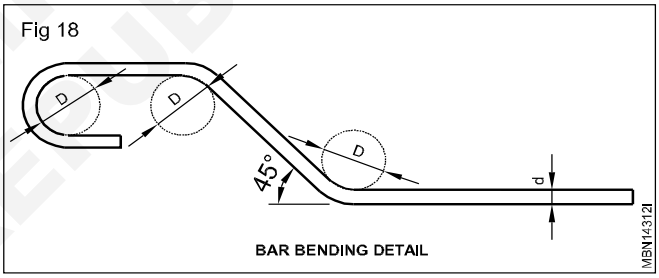
Fig 17



STRAIGHT BAR

MBN14312H

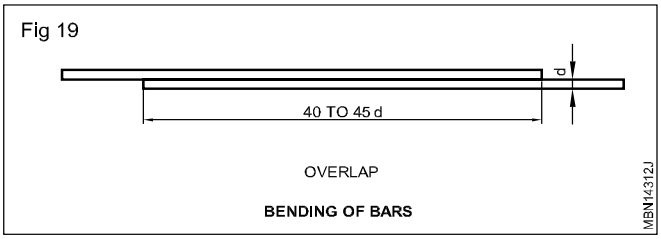
Fig 18



BAR BENDING DETAIL

MBN14312I

Fig 19

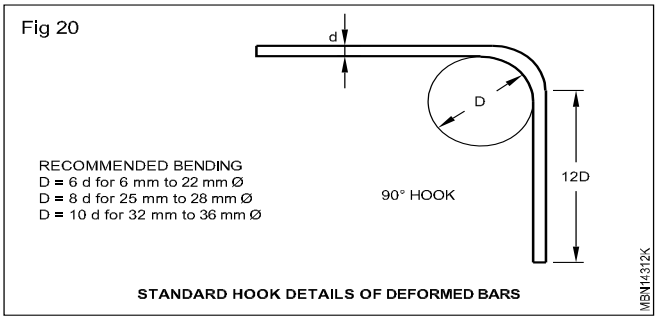


OVERLAP

BENDING OF BARS

MBN14312J

Fig 20



STANDARD HOOK DETAILS OF DEFORMED BARS

MBN14312K

Cover in reinforcement

The reinforcement in shape of bars is embedded in concrete so that it is fully covered. Minimum cover required for various structures as per IS: 456 - 1962 is as given below:

Clear cover at the ends of bars = Not less than twice the dia of bars but minimum 25 mm.

Clear cover of slabs = 15 mm or dia of bar whichever is more.

Clear cover of beams = 25 mm or dia of bar whichever is more.

Clear cover for columns = 40 mm or dia of longitudinal bar whichever is more.

Clear cover for foundation slabs and beams = 50 mm.

When surfaces of concrete members are exposed to the action of harmful chemicals, acids, vapours, sulphurous smoke etc. the cover thickness may be increased.

e Examples denoting reinforcement: These form the most important symbols used against each type of reinforcement indicated in a drawing.

16 @ 150

(16 mm DIA PLAIN BARS SPACED AT

150mm CENTRE TO CENTRE)

20@ 250

(20mm DIA DEFORMED BARS SPACED AT

250mm C.C)

Method of construction of precast lintel

Objective: At the end of this lesson you shall be able to,
- **state the method of construction of precast lintel.**

Precast Lintel

- Precast lintel are suitable for small span up to 2 m.
- They are cast in wooden moulds.
- Wooden moulds are prepared as per lintel requirement.
- Reinforcements are made ready before mould.
- The reinforcements are kept in mould in position with around cover distance.
- Then the concrete is poured in the mould.
- Compaction is carried out all the ways while concreating.
- After completion of concreting.
- Curing is carried out from next day for 14 days.
- Later the casted lintel is placed on wall where ever it is required with proper bearing on (20cm) either side.

Method of construction form work lintel

Objectives: At the end of this lesson you shall be able to,
- **explain the form work construction**
- **state the members name used in from work.**

Reinforced cement concrete (R.C.C) Lintels:

Method of construction:

R.C.C Lintels consists of steel reinforcement embedded in cement concrete.

Cement concrete is a material which is very strong in compression but comparatively very weak in tension.

To overcome this weakness, steel reinforcement is provided to take up in tensile stresses.

R.C.C Lintels are stronger and more durable.

These are fine proof and economical, these can be used for very large opening

R.C.C Lintels are usually constructed with 1:2:4 cement concrete reinforced with steel bars.

For smaller spans precast R.C.C lintels can also be used.

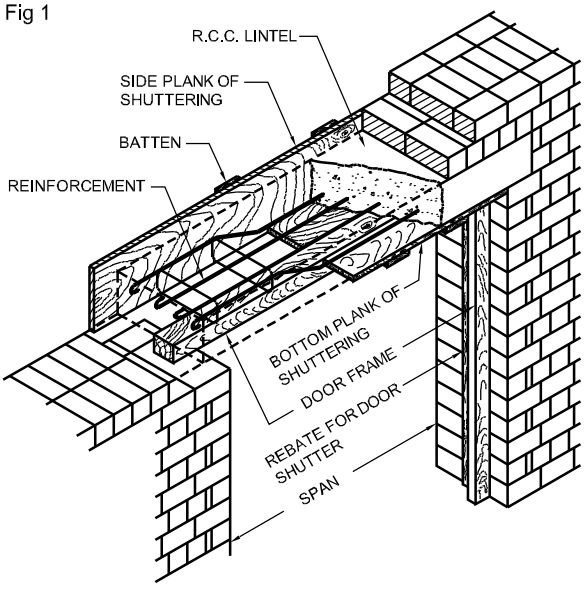
The precast Lintels are manufactured and cured in factories or sites before they are used.

The precast lintels are economical in construction as then no form work is required and the same mould can be used again and again.

Construction

As shows in (Fig 1).
- Bottom plank width equal to wall thick the length equal to the opening is nailed with the two end support.
- Then it is fixed between the opening.
- Then the bottom plank is nailed on either side with in lengthwise another two planks to support concrete.
- The high of plank in minimum height of lintel the side thickness plank nailed also with walls.
- Then the reinforcement is placed in between the mould.
- After placing the reinforcement the side planks top ends and centre are linked & nailed with bottoms.
- Now the mould is ready for concreting.

Fig 1



ISOMETRIC-VIEW OF R.C.C. LINTEL SHOWING VARIOUS DETAILS

Arches

Objectives: At the end of this lesson you shall be able to,
- **define arch**
- **state the technical terms regarding the arch**
- **identify the components of arch**
- **classify the arches.**

Introduction

It is a geometrical shaped structure placed over an opening to transfer the load coming over it. It generally consist of small wedge shaped units which are joined together with mortar.

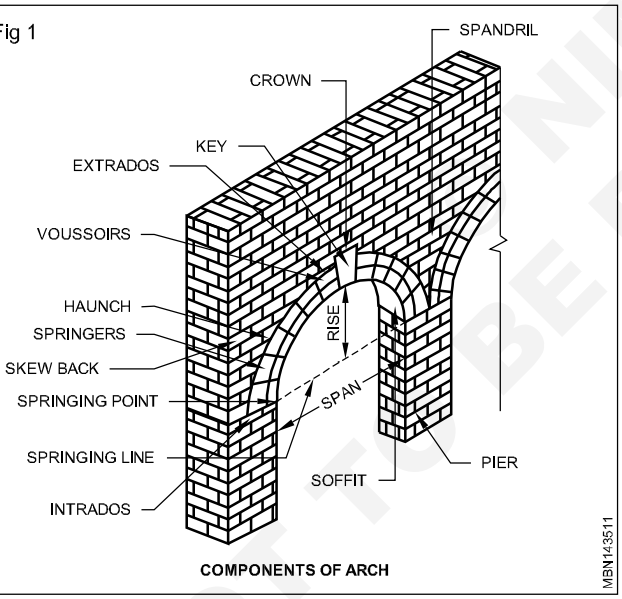
Arches made of steel and R.C.C is built in single units without the use of wedge shaped units and they are used for bridge construction.

Definition

An arch is a structure which is constructed to span across an opening.

Components of arch (Fig 1)

Fig 1



COMPONENTS OF ARCH

Intrados : Inner curve of an arch.

Soffit : Inner surface of an arch.

Extrados : Outer curve of an arch

Voussoirs : Wedge shaped units of masonry

Crown : Highest part of extrados

Key : Wedge shaped unit fixed at the highest point of arch.

Spandril : Curved triangular space formed between extrados and the horizontal line through the crown.

Skew back : Inclined splayed surface on the abutment which is Prepared to receive the arch.

Springing point : Points from which the curve of the arch springs.

Springing line : It is an imaginary line joining the springing points.

Springers : The lowest voussoir immediately adjacent to the skewback.

Abutment : End support of an arch

Pier : An intermediate support of an arch

Arcade : Row of arches.

Haunch : Lower half of the arch.

Span : Clear horizontal distance between supports

Rise : Clear vertical distance between highest point on the intrados and the springing line.

Depth : Perpendicular distance between the intrados and extrados.

Thickness : Horizontal distance measured perpendicular to the front and back faces.

Classification of arches

Arches

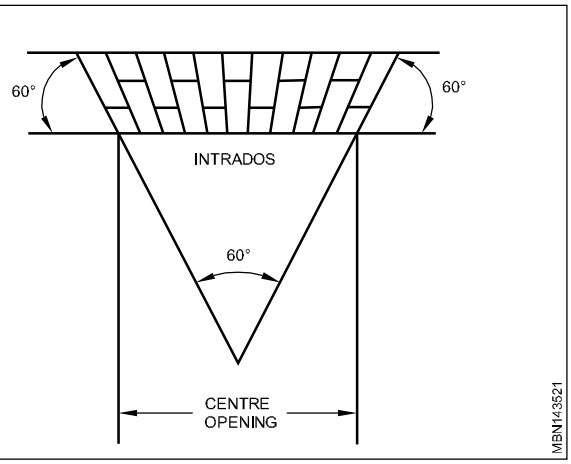
According to shape	According to number of centers	According to materials used	According to workmanship
1 Flat arch	1 One centered arch	1 Brick arch	1 Rough arch
2 Segmental arch	2 Two centered arch	2 Stone arch	2 Rough cut
3 Semi-circular arch	3 Three centered arch	3 Concrete arch	3 Gauged arch
4 Bull's eye arch	4 Four centered arch	4 Purpose made	
5 Semi elliptical arch	5 Five centered arches		
6 Inverted arch			
7 Pointed arch			
8 Relieving arch			
9 Horse-shoe arch			
10 Stilted arch			
11 Venetian arch			
12 Florentine arch			
13 Ogee arch			
14 Tudor arch			
15 Drop arch.			

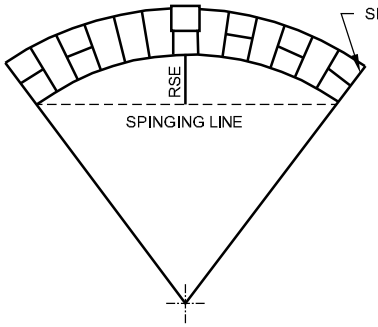
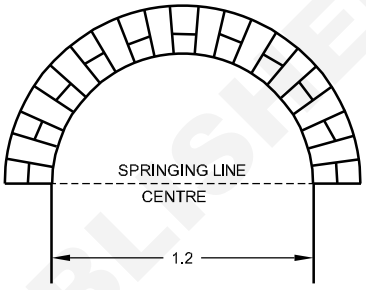
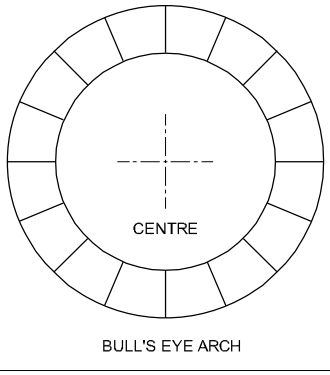
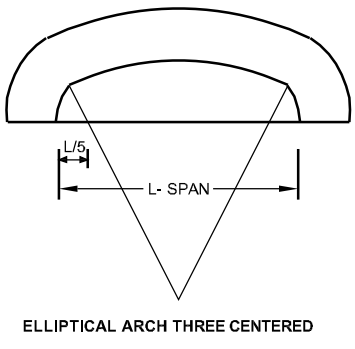
Arches according to shape

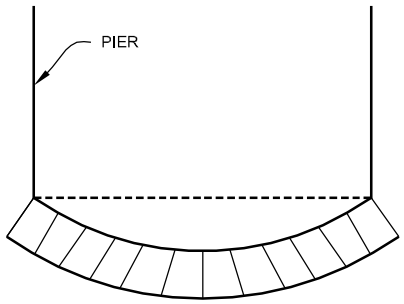
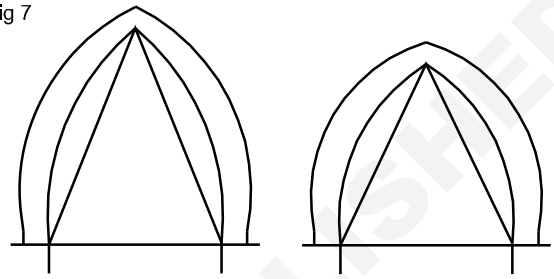
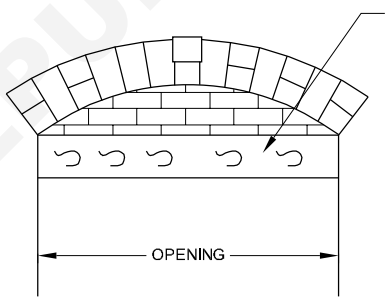
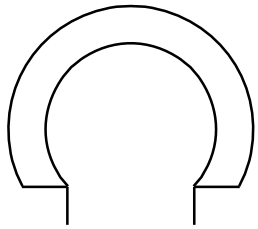
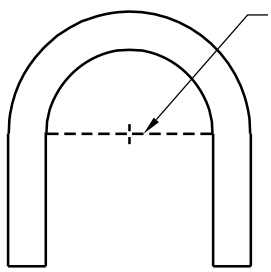
Objectives : At the end of this lesson you shall be able to,
- **classify arches according to shape**
- **state the technical terms regarding the arch**
- **classify the arches.**

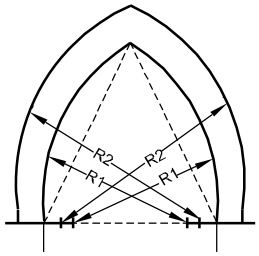
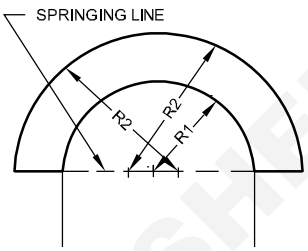
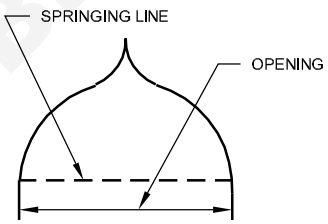
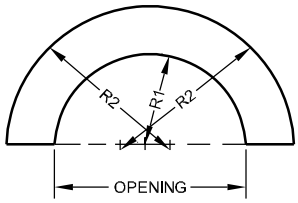
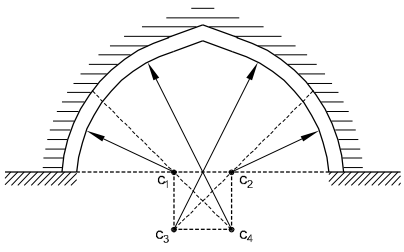
According to shape, the arches are classified as follows.

Classification of arches according to shapes

Name of arch	Features	Figure
1 Flat arch	• Shape flat and skewback forms 60 degree with horizontal. • Depth equal to course of masonry. • Slight rise of about 10mm to 15 mm per metre length of masonry opening. • Max.span upto 1.5m • Used for light loading.	Fig 1 

Name of arch	Features	Figure
2 Segmental arch	• Centre of arch is below spring line. • Thrust transferred to the abutment in an inclined direction.	Fig 2 
3 Semicircular arch	• Centre of arch lies on the springing line. • Skewback is horizontal. • Thrust transferred to the abutment in vertical direction.	Fig 3 
4 Bull's eye arch	• One centre only. • Used for circular windows	Fig 4 
5 Semi-elliptical arch	• More than one centre arch (Three or five)	Fig 5 

Name of arch	Features	Figure
6 Inverted arch	• Constructed between piers to increase the bearing power of soil. • Rise is 1/5 to 1/10 of span. • Built in ½ brick rings.	Fig 6  INVERTED ARCH MBN143526
7 Pointed arch	• Two curves meeting at the apex of a triangle. Two types are - Equilateral arch and - Lancet or isosceles arch.	Fig 7  LANCET OR ISOSCELES ARCH EQUILATERAL ARCH MBN143527
8 Relieving arch	• Constructed over a wooden joist or flat arch. • It relieves the joist or flat arch from carrying load.	Fig 8  RELIEVING ARCH MBN143528
9 Horse shoe arch	• Adopted from architectural considerations. • Shape include more than a semicircle.	Fig 9  HORSE - SHOE ARCH MBN143529
10 Stilted arch	• Semi circular portion attached at the top of two vertical portions. • Springing line passes through the top of vertical portions.	Fig 10  STILLED ARCH MBN143528A

Name of arch	Features	Figure
11 Venetian arch	• Depth at crown is more than that at the springing line. • Have four centres.	Fig 11  VENETIAN ARCH MBN14352B
12 Florentine arch	• Similar to venetian arch except that the intrados has a Semi circular shape.	Fig 12  FLORENTINE ARCH MBN14352C
13 Ogee arch	• Consist of three centres and with reverse (Ogee) curve.	Fig 13  OGEE ARCH MBN14352D
14 Drop arch	• Consist of two centres	Fig 14  DROP ARCH MBN14352E
15 Tudor arch	• Consist of four centres. • This is a pointed arch of four centres.	Fig 15  TUDOR ARCH MBN14352F

Arches according to number of centres

Objectives : At the end of this lesson you shall be able to,
- **classify arches according to number of centers**
- **sketch the various arches with number of centers**
- **state the features of arches according to the number of centers.**

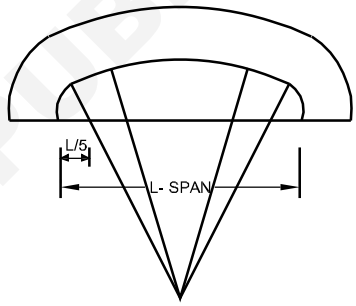
According to number of centers ,the arches are classified as follows

Classification of arches according to number of centres

Name of arch	Description	Example
1 One- centered arch	This type of arches have only one centre	Flat, Segmental, Circular, Horse shoe, Stilted, Etc.
2 Two- centered arch	This type of arches have two centers	Pointed arches ie, Equilateral pointed and isosceles pointed arch (Lancet and Drop).
3 Three-centered arch	This type of arches has three centers	Three centered semi-elliptical arch, Florentine arch, Ogee arch.
4 Four-centered arch	This type of arches has four centers	Venetian, Tudor.
5 Five-centered	This type of arches has five centers	Five centered semi elliptical arch.

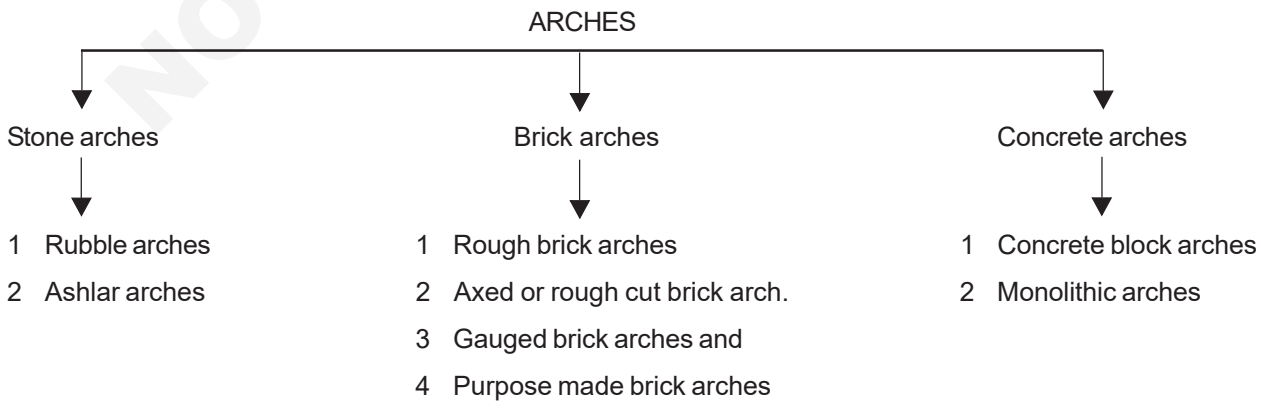
We can make more types of arches with more number of centers. (Fig 1)

Fig 1



Arches according to material of construction & workmanship

Objectives : At the end of this lesson you shall be able to
- **classify arches according to material of construction & workmanship**
- **state the features of arches according to material of construction**
- **state the features of arches according to workmanship.**



Classification of arches according to materials of construction

NAME	TYPE OF MATERIALS	DESCRIPTION
Stone arch	1 In ashlar masonry 2 In rubble masonry	• Constructed from wedge shaped units. • Stones should be laid with their natural bedding plane. • Weak and used for inferior work. • Span limited to 1m or so.
Brick arch	1 With ordinary bricks 2 With purpose made brick 3 With soft brick	• Joints are made wedge shaped. • Not suitable for exposed brick work. • Good quality arch work. • Soft bricks are cut, sawn and rubbed to desired shape.
Concrete arch	1 With precast concrete blocks 2 Monolithic concrete	• Similar to stone arches in ashlar masonry. • Constructed from cast in -situ concrete and are suitable for long spans.

Classification of arch according to workmanship

Name	Description
1 Rough arch	• Using ordinary uncut bricks. • Bricks are rectangular shape and mortar joints are wider at extrados than at the intrados. • Rough arch is used where appearance is secondary importance, the arch surface is plastered.
2 Axed or rough cut arch	• The bricks used are wedge shaped by means of an axe. • The thickness of mortar joints varies 3mm to 6mm.
3 Gauged arch	• The bricks used are wedge shaped by means of a wire saw, the bricks are cut finely. • The mortar joints are 1.5mm to .75mm

Method of constructing centering of an arch

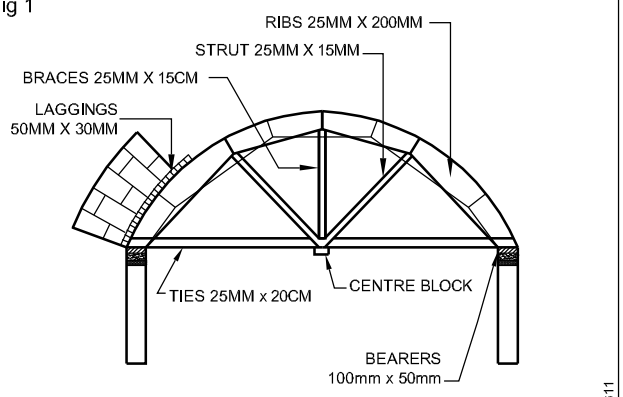
Objectives : At the end of this lesson you shall be able to,
- **define centering of arches**
- **identify the components of a timber centering**
- **state the features of centering**
- **explain removal of centering**
- **preparation of voussoirs**
- **trammel and template use.**

Definition : It is the temporary structure which supports arch during construction or till it attains strength.

Centering of arch (Figs 1 & 2)

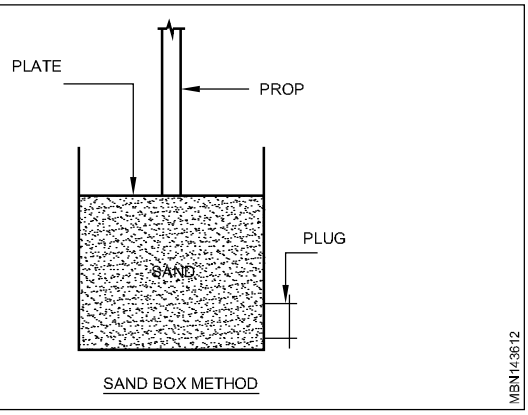
- Timber centering is commonly used because it is simple to erect, dismantle & reuse.
- Narrow wooden strips known as 'LAGGING' supports the brick or stone of arch.
- Two parallel boards called ‘RIBS’ having their upper edge shaped to the curvature of arch to support Laggings.
- The struts & braces strengthen the rib.
- A horizontal ties provided at lower end of rib to prevent from spreading.
- The bearer support the rib.
- The whole centering is supported by props.
- A pair of folding wedges used to tighten or loosen the centering.
- The whole centering parts except props can be replaced.

Fig 1



CENTERING OF AN ARCH

Fig 2



SAND BOX METHOD

Removal centering

- The centering can be removed after attaining sufficient strength for arch.
- For small spans the removal is done by slightly loosening the wedges.
- Spans exceeding 7m or so , bottom of the prop secured in sand box which is filled with sand having a plug.
- To lower the centering remove the plug and the prop lowered gradually.

Setting out of arch

1 **Preparation of Voussoirs:** (Semi circular arch) after fixing the frame work to support the arch work check the mark of the voussoirs position at bottom and top. It is already marked in ground level it self by properly dividing the semicircular arch bottom & top uniformly. As per the measurement it may done by a template make a wooden mould for voussoirs. The voussoirs must have mortar. Joint provisions just may be like forges in bricks (or) a cavity in joining sides. Now prepare the voussoris by mould by dasing the clay in the mould finish the top surafce & genlly remove the mould make it dry until fit for burning. (Before mould oil the inner surface of the mould).

Trammel and template use:

Trammel & template may be a signle piece

The template should have a mark a voussoirs bottom & top position of an arch by moving trammel for each voussoirs position. We can place the voussoirs in connect position at the same time the trammel is acting a template, so that it guides the inner arch and out arch positions of each voussoirs.

Pointing

Objectives: At the end of this lesson you shall be able to,
- **state pointing**
- **describe the types of pointing.**

Pointing: Pointing is the art of finishing the mortar joint of the walls, with either cement mortar or lime mortar in order it protect the joint from atmospheric influences and also to improve the appearance of the structure.

Types of pointing

There are many types of pointing. The selection of a particular type of pointing depends upon the type of bricks used and the appearance required.

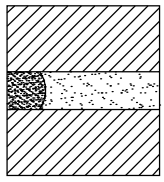
1 Flush or flat pointing (Fig 1)

This is the simplest type of pointing. The appearance is not satisfactory. This pointing is very durable. This pointing does not afford a loading place for dust. Flush joint are filled up with mortar with the face of the wall and the edge are neatly trimmed with a trowel and straight edge.

2 Struck pointing (Fig 2)

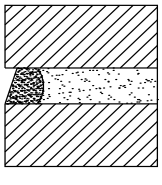
In struck pointing, the upper sides mortar joint are kept about 12 mm inside face masonry and bottom flush with exterior face of masonry. Struck pointing is also known as ruled pointing.

Fig 1



FLUSH OR FLAT POINTING

Fig 2

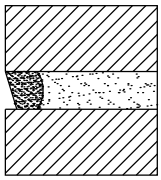


STRUCK POINTING

3 Overhead struck pointing (Fig 3)

Overhead struck pointing is similar the struck pointing but the lower side of the mortar joints are kept about 12 mm inside face of masonry of the upper flash with face of masonry.

Fig 3



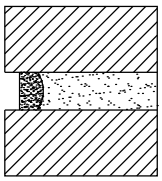
OVER HEAD STRUCK POINTING

MBN143713

In this type of pointing water collecting on the ledges and pass through the mortar and cause dampness on the inside.

4 Recessed pointing (Fig 4)

Fig 4



RECESSED POINTING

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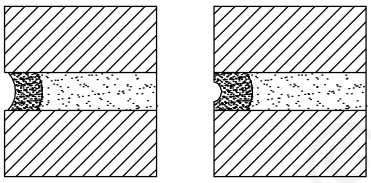
The face of the pointing is pressed behind the place of the wall with suitable tool and is left vertical.

5 Keyed or grooved pointing (Fig 5)

Fig 5



KEYED OR GROOVED POINTING

MBN143715

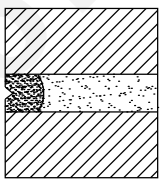
The joints are first filled up flush to the face of the wall.

The bent end of a small steel is called pointer or nails is pressed and rubbed in the middle of the joints until a uniform.

Semi-circular notch is formed. This pointing is used for superior work.

6 VEE-Pointing (Fig 6)

Fig 6



VEE POINTING

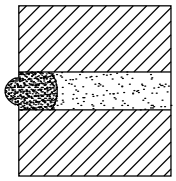
MBN143716

Vee-pointing is shown in fig-6 and is made as described for the keyed or grooved pointing and with a still jointer having its lower edge suitably shaped.

7 Beaded pointing (Fig 7)

Beaded pointing is formed in conjunction with pointing rule by a steel having concave edge this pointing has a good appearance but it is liable to be damaged.

Fig 7



BEADED POINTING

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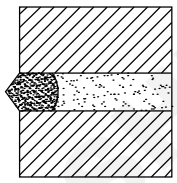
8 Weather pointing (Fig 8)

Fig 8



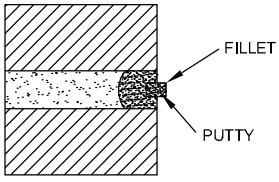
WHEATHER POINTING

MBN143718

Each pointing joint is finished with a V-shaped raised bond of mortar as shown in (Fig 8).

9 Tuck pointing (Fig 9)

Fig 9



TUCK POINTING

MBN143719

In tuck pointing the mortar joints are raked out brushed and wall watered.

6 mm wide by 3mm deep groove is immediately and carefully formed along the entire of each joint and the groove is filled or trucked in.

The lime putty is given a maximum projection is 3mm.

Both top and bottom edge are neatly trimmed off by means of french man.

Note:

Frenchman: It is a discorded table knife, the blade of which is out to a point which is bent above 10mm at right angle to the blade this is used for tuck pointing only.

Cavity wall

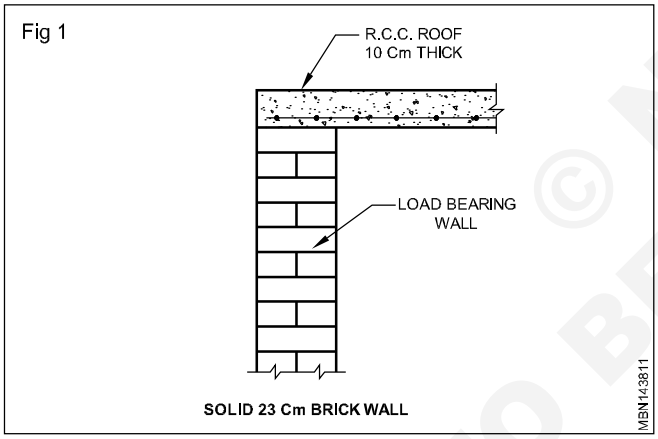
Objectives : At the end of this lesson you shall be able to,
- **state the construction of cavity wall**
- **describe the provisions of weep hole and ties**
- **describe load bearing and non-load bearing wall**
- **describe cavity wall.**

In brick masonry walls are mainly divided into two types

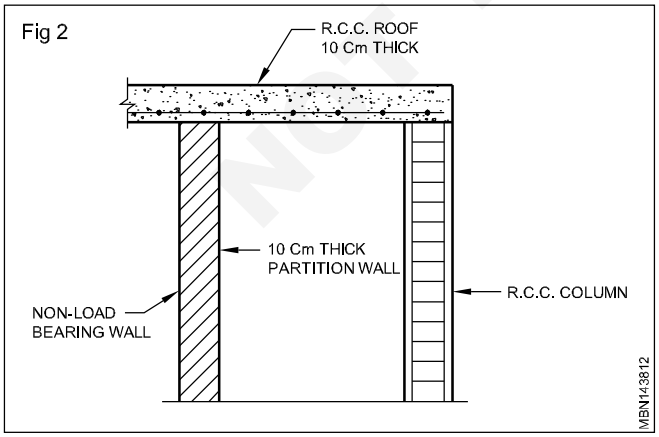
- Load bearing walls
- Non load bearing walls

Load bearing walls (Fig 1)

- Load bearing walls are those walls which are directly subjected to the action of load of the structure.
- The beams, trusses, or any other heavy fittings are always made to rest on these load bearing walls.
- A continuous foundation is provided for all load bearing walls.
- These walls support the load of the entire structure including their own load.

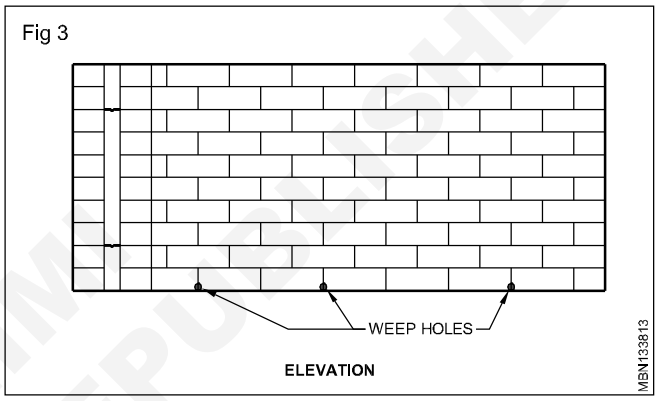


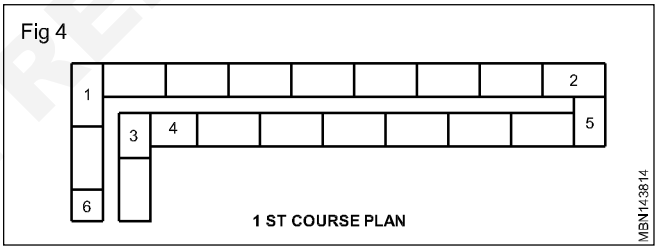
Non load bearing walls (Fig 2)

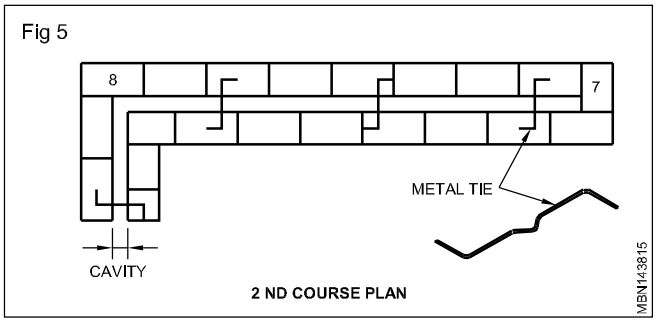


- The Non-load bearing walls are those which are not subjected to the action of load of the structure directly.
- The non load bearing walls are called partition walls, curtain walls, screen, dwarf or filler walls.
- The walls are primilarly intended for screening and partitioning with a view to enclosing a space for privacy
- To carry no super imposed load and are only strong enough to support their own load or weight.

Cavity walls (Fig 3,4 & 5)



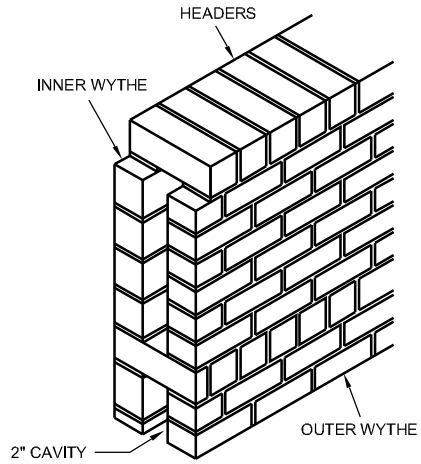




- Cavity walls or hollow walls, as they are sometimes called, are a modern method of construction.
- Cavity walls consists of two leaves outer leaf, and inner leaf.
- Cavity wall separated by a through cavity or hollow in between two leaves are constructed together by metal ties or tie bricks.
- The outer leaf of cavity wall is generally 10cm thick.
- The inner leaf is sufficiently thick and strong to carry supper imposed loads and safely.

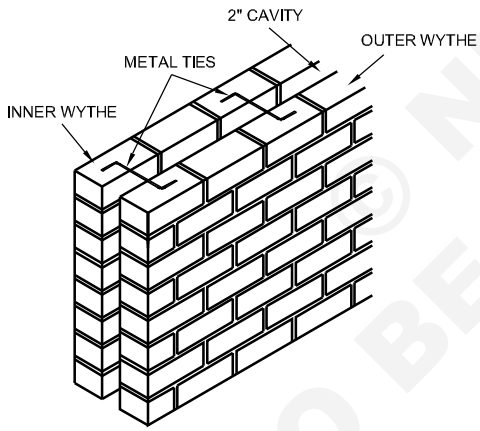
- The width of cavity varies from 5cm to 8cm.
- The cavity should be uniform and continuous.
- The outer and inner leaf should be properly connected by metal ties at regular intervals as shown in (Fig 5).
- The outer leaf (wythe) and inner leaf (wythe) of cavity wall bonded with brick headers as shown in (Fig 6).

Fig 6



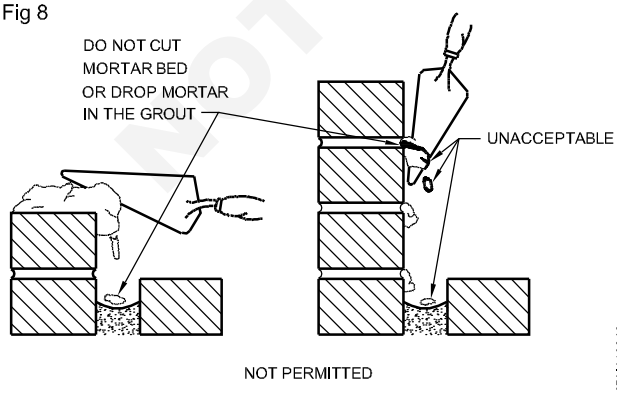
- The two leaves of cavity wall outer leaf and inner leaf bonded with metal ties as shown in (Fig 7)

Fig 7



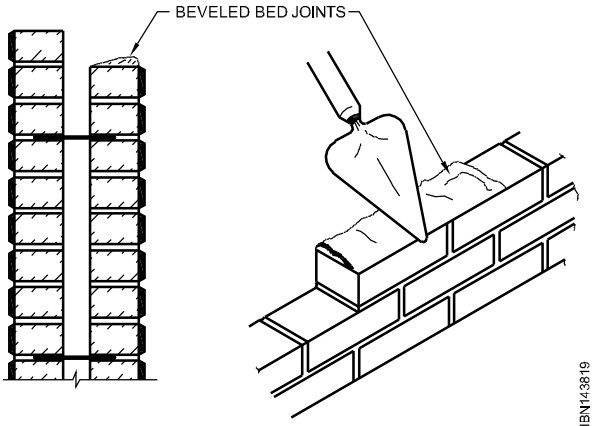
- Do not lay or cut mortar so it falls inside the cavity wall as shown in (Fig 8)

Fig 8



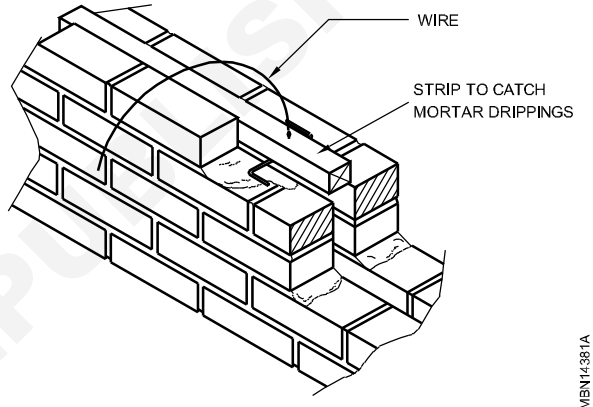
- It is good practice to lay mortar so it is beveled and does not fall inside the wall cavity as shown in (Fig 9)

Fig 9



- use wood strip to catch mortar dropping while constructing the cavity wall as shown in (Fig 10)

Fig 10



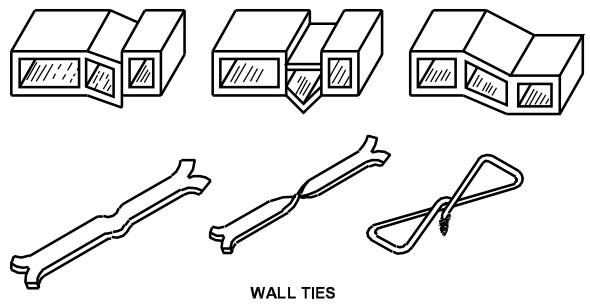
Metal ties (or) wall ties

Metal ties or wall ties are used to bond the two leaves together.

Spacing of 50cm to 75cm center horizontally and 30cm to 40cm on center vertically is commonly used.

The various types of wall ties are shown in (Fig 11).

Fig 11



Weep Holes

- Weep holes are required at the base of the cavity wall just above the flashing.
- This allows any moisture that penetrates or condenses in the wall to flow outside.

- Weep holes are commonly located every 50cm to 75cm on center in the course immediately above the flashing. as shown in (Figs 12&13).

Fig 12

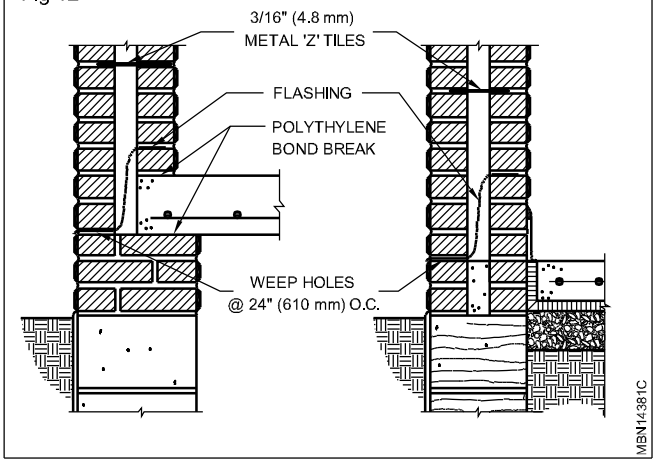
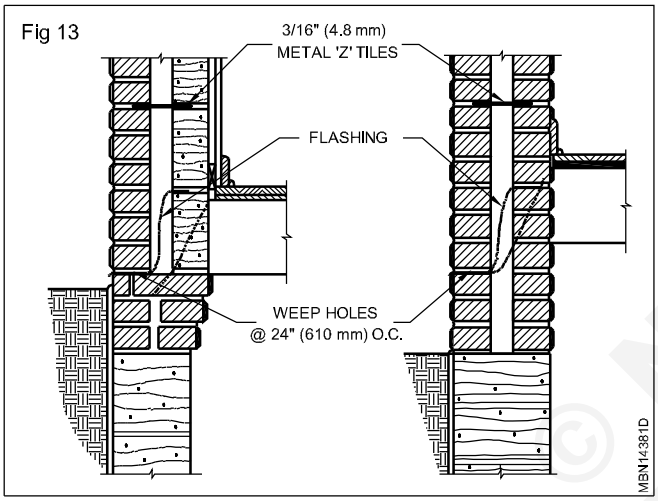


Fig 13



Cavity wall insulation

When insulation used in the cavity wall standard flashing and weep holes placement is still required Insulation can be divided into two ways.

- Loose insulation
- Rigid insulation
- Loose insulation is poured into the cavity Rigid insulation is attached to the back of the cavity on the backing leaf.
- There should be a 25mm air space between the rigid insulation and the back of the facing leaf.
- The flashing at the base should run behind the rigid insulation and into a bed course of the backing leaf. as shown in (Fig 14).

Grouting

- Only few cm of grout are poured at any one time.
- Steel reinforcement rod or dowels are already set in the concrete support base as shown in (Fig 14).
- A brick wall is laid one side of outer wall as shown in (Fig 15).

Fig 14

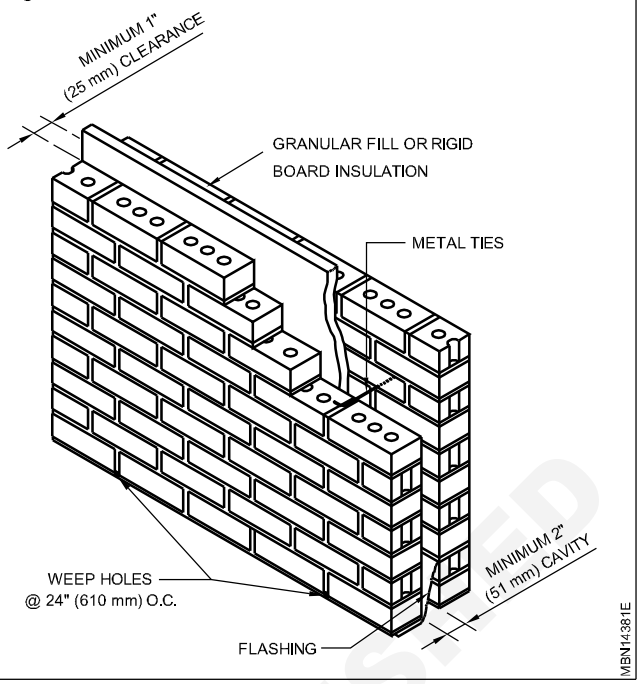
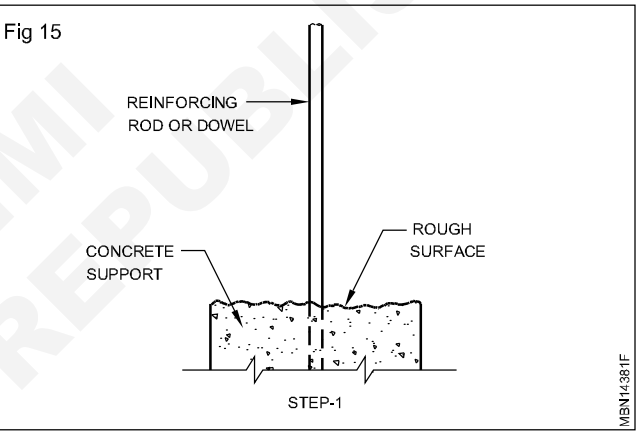
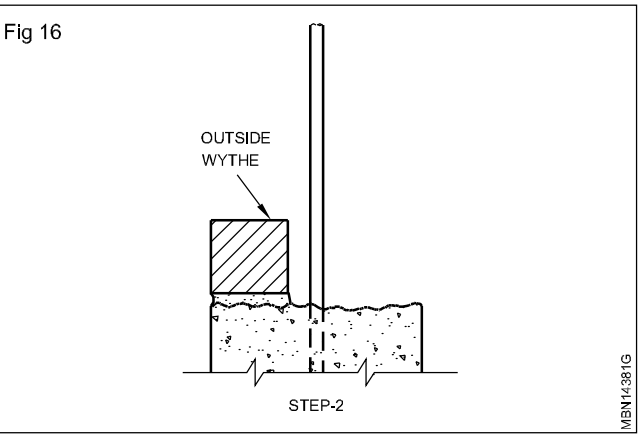


Fig 15



- The two leaves of cavity wall is laid as shown in (Fig 16).

Fig 16



- First cement grout pour in cavity as shown in (Fig 17).
- Outer leaf may laid about 40cm height than inside leaf as shown in (Fig 18).
- Second grout is poured after raising sufficient height of cavity wall as shown in (Fig 19).

Fig 17

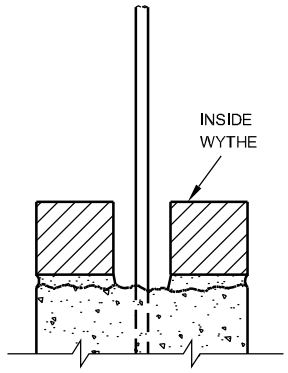


Fig 18

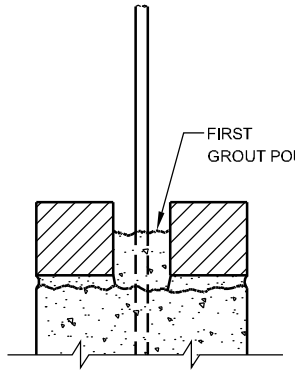
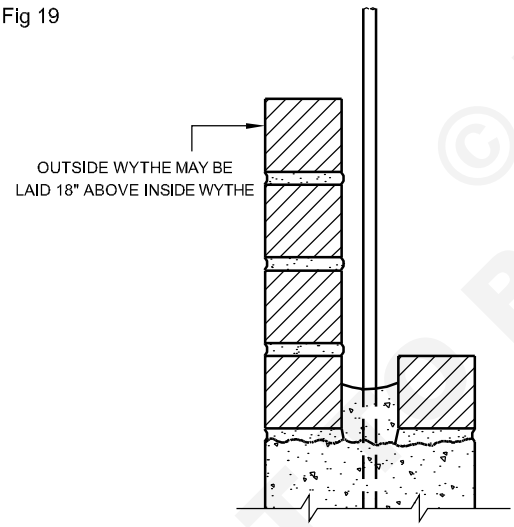


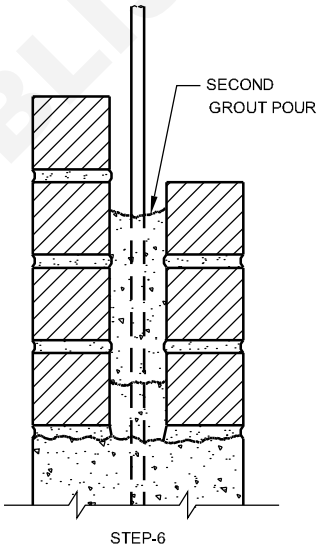
Fig 19



Construction of cavity walls (Fig 20)

- The two leaves of a cavity wall are constructed separately.
- Cavity walls connected together by metal ties or wall ties at a horizontal distance of 1m and vertical distance of 0.5m leaving clear cavity between them.
- Outer cavity wall leaf is normally 10cm thick, and the inner leaf is 10cm to 23cm thick.
- As for as possible there should be no intimate contact between the two leaves of the cavity except with ties.
- The damp proof course should be laid separately for the two leaves.
- The cavity should be properly ventilated and drained by providing weep holes at bottom.
- metal ties should be rust proof and preferably should be galvanished.
- The cavity should start from the bottom just below the ground level and should extend up to the parapet.

Fig 20



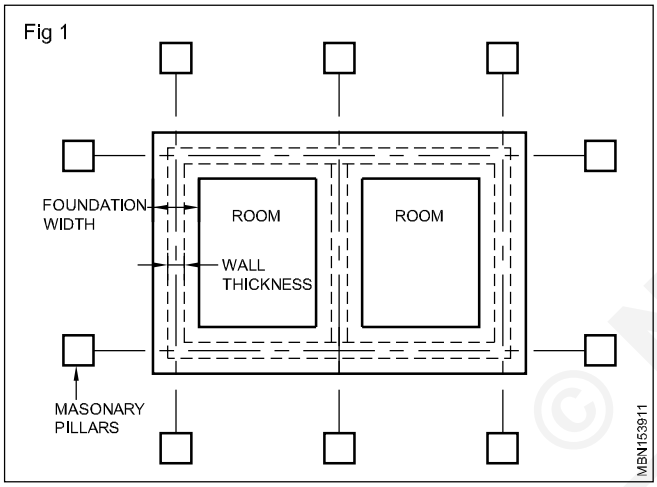
Setting out of building foundation

Objectives: At the end of this lesson you shall be able to
- **describe setting out of building foundation**
- **describe temporary site bench mark.**

Setting out of building foundation

- Setting out or layout of foundation means to layout the details of the foundation trenches to be excavated.
- In other words we can say that layout is nothing but transferring the details from the paper to the ground.
- The first essential before the layout of foundation is to prepare a foundation plan to a convenient scale showing all centre lines and all measurements as shown in (Fig 1).

Fig 1



- To start with centre line of the longest wall passing through that corner which has been located with help of a fixed point or object is marked on the ground.
- Stretch a string or Thread between two wooden pegs.
- Take measurements accurately as per the drawing for first line, because all other lines will be located with respect of this line.
- After setting this line, other lines are similarly located by using centre lines as shown in (Fig 2).
- Steel tape is used for measuring the distances.
- For setting out perpendicular lines a right angled triangle is formed by measuring the lengths in 3,4,5 method as shown in (Fig 3).

Fig 3

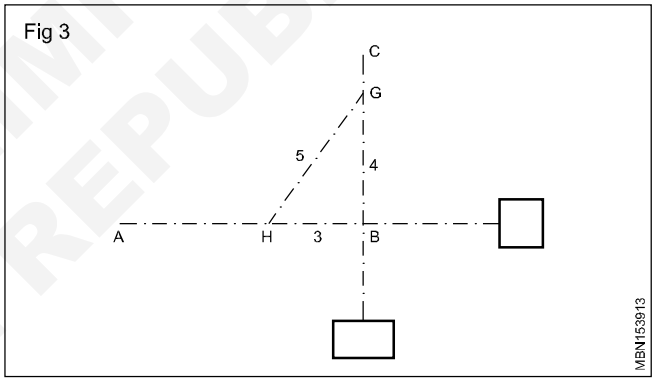
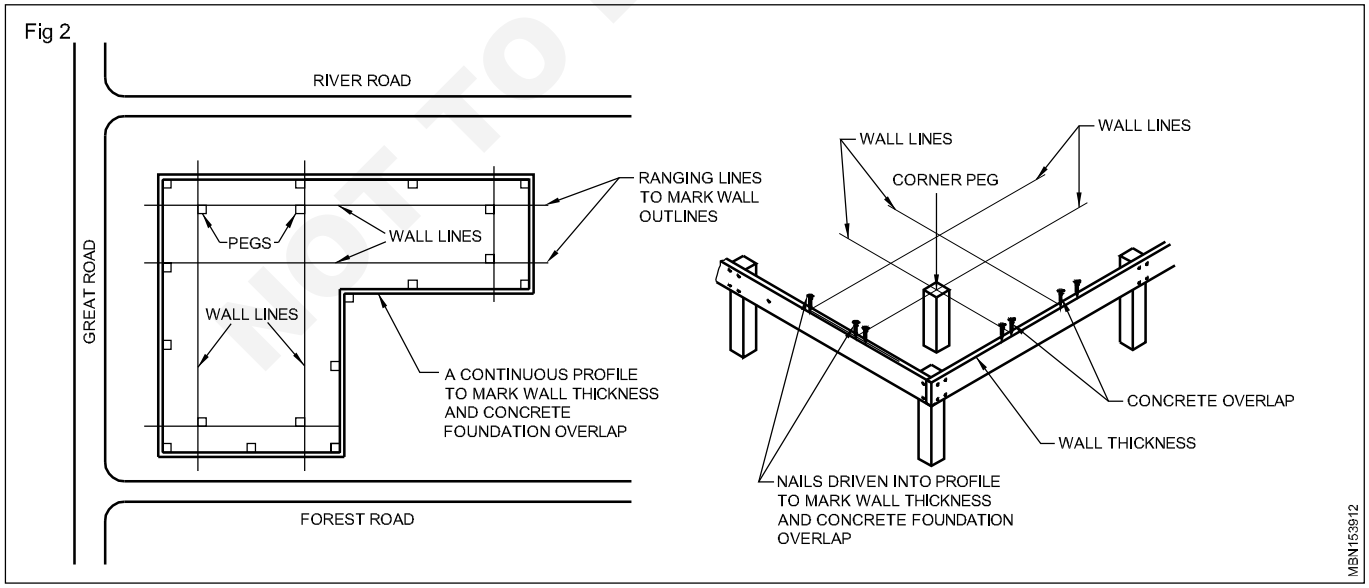


Fig 2



Setting of perpendicular lines for layout out of plan

List of tools required for setting out

Levelling Instrument

100mm diameter ball pieces 500 to 600mm long.

35mm long nail.

Hammer

Right angle (or) Builder's square

steel tape 30 meter long.

Steel tape 3 meter long.

Pencil

Thin cotton Thread (Line dori)

Materials required for setting out

Bricks

Cement

Lime powder

Screened sand

Paint (if necessary)

Preliminary works

- The following preliminary works will have to be executed before the actual work of setting out is taken up.
- Site should be cleared of all grass, bushes, trees etc.
- Spot levels of ground should be recorded
- A permanent bench mark is to be constructed in the vicinity.

Baseline and centre lines

- While setting out most important factor is to establish a base line.
- This is done as per the site plan requirements and offsets are taken from the existing road or existing building.

Caution

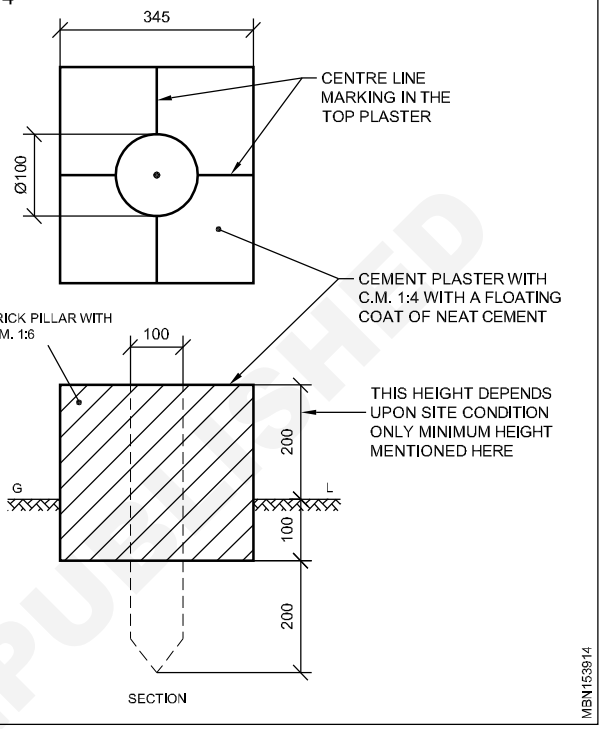
The setting out of a structure is taken up in a systematic manner. The mistakes that may crop up in the initial stages and which are very difficult to rectify at latter stages.

On important works a theodolite should be used.

Details of brick pillars

- At the end of each centre line masonry pillars of 20 x 20cm size having a height equal to the height plinth are constructed.
- The height of all brick pillars as far as possible should be kept at a same height.
- The top of the pillars are plastered with cement mortar 1:4 finished with floating coat of neat cement.
- The position of centre lines are marked on the top of a plastered surface of the brick pillars or imprinted for future guidance as shown in (Fig 4)

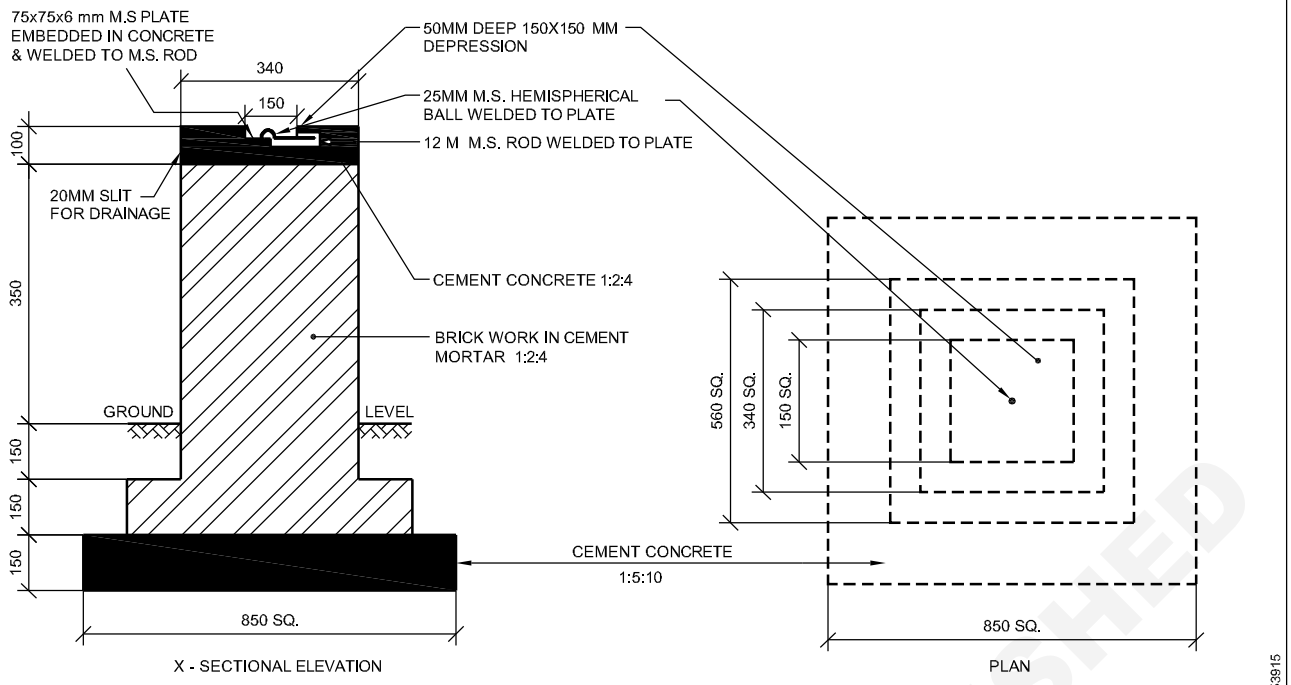
Fig 4



Temporary site bench mark (Fig 5)

- Before starting the actual setting out of the building, it is essential to establish a level on the site, to which references pertaining to levels, of elements of work, may be made in the course of executing the work.
- In planned cities and towns ordinary Bench mark are established and points marked along streets in permanent position or cut into the plinth of walls and gate posts or other reasonably permanent fixtures whenever possible ordinary Bench marks should be used.
- In connection with establishing the levels of land and surface water drains floors etc.
- If the bench march is far from the proposed site a levelling instrument can be used to transfer the datum level to site.

Fig 5



THE DESIGN FOR TEMPORARY SITE BENCH MARK

Plastering tools & plastering

Objectives: At the end of this lesson you shall be able to
- **state plastering tools / mason tools**
- **define plastering**
- **state types of plastering and explain each plastering.**

Block laying and concreting tools consists of tools normally used by the brick layer plus a few additional tools which have been developed to meet the specific demand of the work involved.

The Block layer and concrete is often also a plasterer, a tiler and drain layer.

we shall discuss some of the most important tools under the headings that follow.

Laying tools

Wall straightening tools

Cutting and Trimming tools

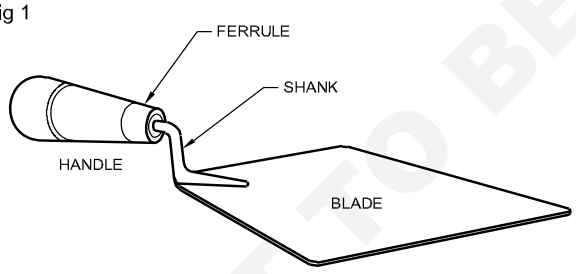
Finishing tools.

Laying tools

Block Trowel (Fig 1)

This is a tool which every block layer and concreter must possess used for picking up mortar from the mortar board, spreading it on the wall for bed joints, forming cross joints on blocks, cutting of excess mortar and consolidating cross joints. It is also used for tapping down laid blocks and for rough cutting of blocks.

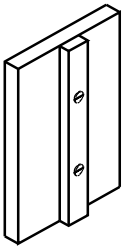
Fig 1



BLOCKLAYING TROWEL

Jointing Board (Fig 2)

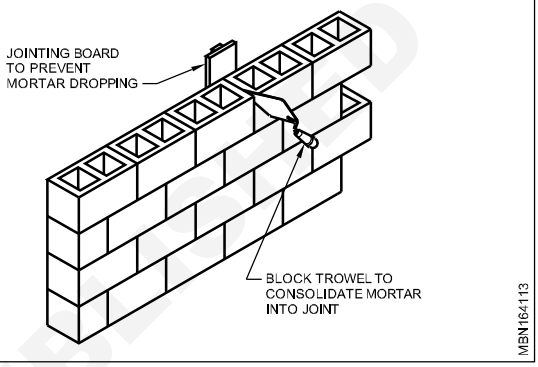
Fig 2



JOINTING BOARD

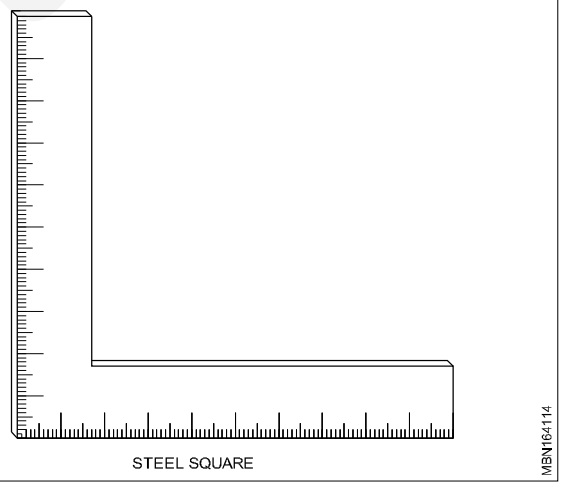
The jointing board can be made quite easily from either a 25mm thick piece of wood or a 19mm thick piece of plywood. It measures 300mm long by 75mm side. with a 25mm gripping piece screwed to the back. Its use as a tool is to facilitate the filling of cross joints to prevent mortar dropping (Fig 3).

Fig 3



Steel square (Fig 4)

Fig 4



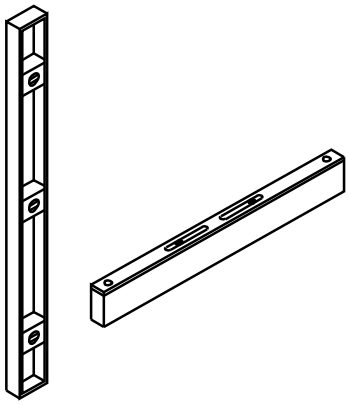
This tool is used in checking whether or not the angle formed by two walls meeting one another is 90^0. It is marked in millimeters and measures 600mm by 450mm.

Wall straightening tools

Spirit level (Fig 5)

The spirit level or plumb level as it is sometimes called is a very useful tool in the Brick layer or Block layer's toolkit. It may be made of wood or metal with straight edges. It is fitted with 3 spirit tubes for levelling and plumbing These spirit tubes are fitted one at each end with single tubes used for checking the plumb of the wall. and other two tubes fitted at the centre for checking levels, The most common type is 1 metre long.

Fig 5



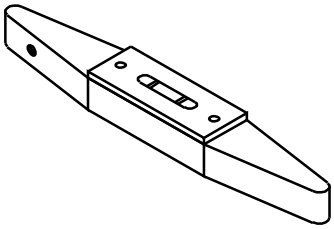
SPIRIT LEVELS

MBN164115

Boat level Spirit level (Fig 6)

This level performs the same functions as the spirit level or plumb level. But is used mainly at small openings Boat levels measure from 225 mm to 300mm

Fig 6



BOAT LEVEL

MBN164116

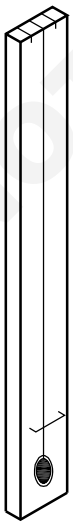
Plumb rule

This is a straight edge with a cut line running down the centre from the top to with in about 150mm from the bottom edge where a hole is made slightly larger than the plumb bob.

The plumb bob is an egg shaped angle piece of steel or lead held in position by a plumbline.

This tool ensures a very accurate vertical check as shown in (Fig 7).

Fig 7



PLUMB RULE

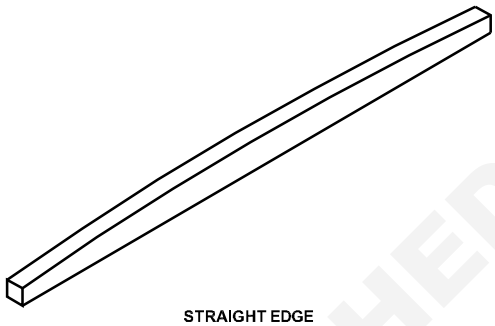
MBN164117

Straight edge (Fig 8)

This is a piece of timber or Aluminium hollow piece of a length to suit its purpose, a convenient length for the brick layer or Block layer being 2 metres. It is bevelled at both ends to reduce the overall weight in the case timber.

The straight edge is used to check the flatness of a newly laid piece of wall and ensure that all blocks or bricks are laid to the same level in each course.

Fig 8



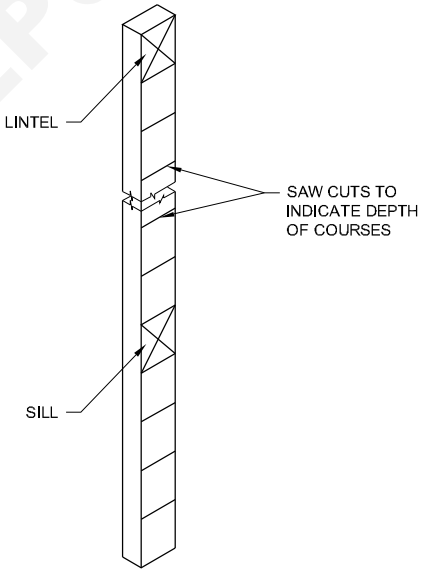
STRAIGHT EDGE

MBN164118

Gauge Rod or Rule (Fig 9)

The Gauge rule should be sufficiently long. It has the depth of Block courses or Brick courses including mortar joints thickness marked on it. In addition to the courses of Bricks or Blocks, various important levels such as sill level, springing level are marked on it.

Fig 9



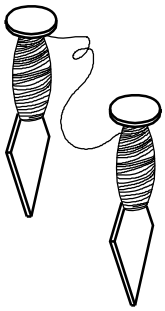
GAUGE RULE

MBN164119

Line and Pins (Fig 10)

The line is usually made of hemp or nylen. It is wound round the spear like steel pins. To use this tool, the pins are each pushed into a joint at each end or Quion of the wall to hold the line tight. Each course is then laid using the line as a guide. The blocks or bricks being laid to leave just a strip of daylight between their edges and the lines so that they do not actually touch it.

Fig 10



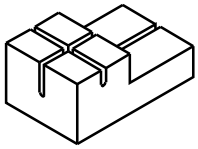
LINE AND PINS

MBN16411A

CORNER BLOCKS

Where glazed work is involved and the joints are so tight that pins cannot be inserted into them, corner blocks are used instead of pins to hold the line tent. as shown in (Fig 11).

Fig 11



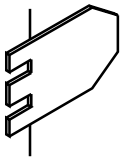
ENLARGED VIEW OF CORNER BLOCK

MBN16411B

Tingle plate

This is a small metal plate with three fingers at one end used to take up the sag of the line. A common size is 100mm long as shown in (Fig 12).

Fig 12



TINGLE PLATE

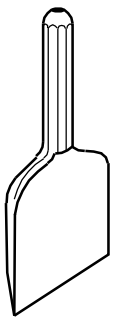
MBN16411C

CUTTING AND TRIMMING TOOLS

Bolster (Fig 13)

The bolster is used for the clean cutting of Blocks and concrete components. It has a blade whose cutting edges ranges from 75mm to 125mm wide with a slight convex curve. It is hardened for cutting. The stock or striking end is left unhardened to prevent pieces of metal braking and flying off when struck with hammer.

Fig 13



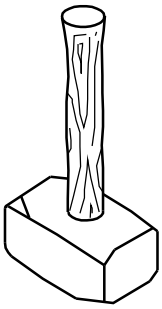
BOLSTER

MBN16411D

Club Hammer (Fig 14&15)

The club Hammer is made in two ranges those with the steel head weighing 1.135Kg and those with 1.81kg head. It is fixed to a handle about 225mm long. This tool is used together with the bolster for cutting purposes.

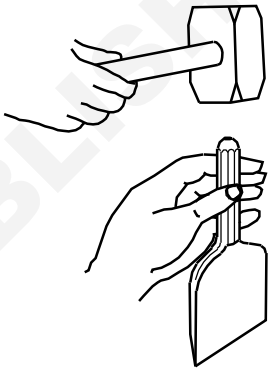
Fig 14



CLUB HAMMER

MBN16411E

Fig 15



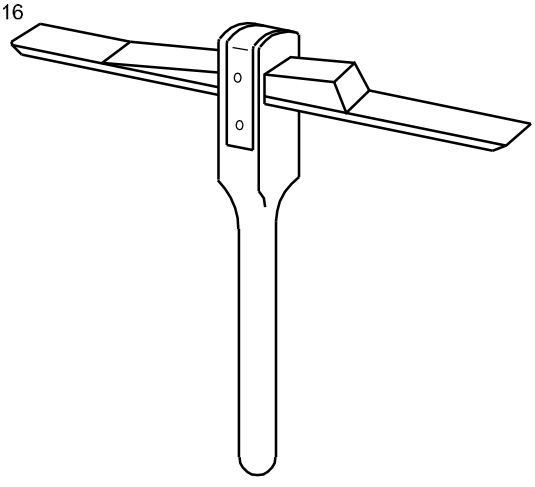
CUTTING WITH BOLSTER AND HAMMER

MBN16411F

Scutch

The sketch consists of a stock wedge and reversible blade. It is used for trimming a block when cut. as shown in the (Fig 16)

Fig 16



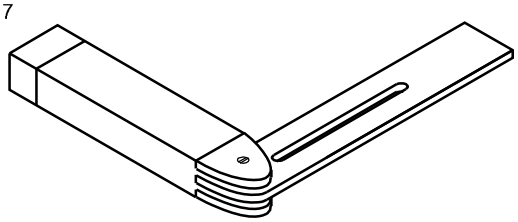
SCUTCH

MBN16411G

Square and bevel (Fig 17)

The square and bevel are used for marking splayed cuttings.

Fig 17



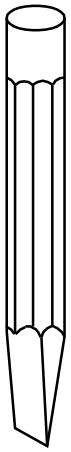
SQUARE AND BEVEL

MBN16411H

Cold chisel (Fig 18)

The cold chisel is made in varying lengths and thickness from 6.25mm x 400mm to 25mm x 450mm They are made of steel with the cutting edge and the stock treated in a similar manner to those of a bolster.

Fig 18



COLD CHISEL

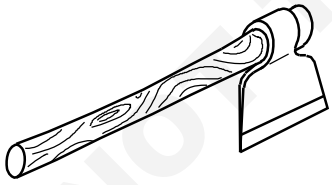
MBN16411I

Block Axe (Fig 19)

The block axe is very popular among block layers. It is used for cutting blocks into required dimensions and for cleaning the cut edges in much same way as a scutch is used.

Hollow blocks are difficult to cut with the success using a bolster and Hammer, because of the thickness of the ribs bounding the holes.

Fig 19



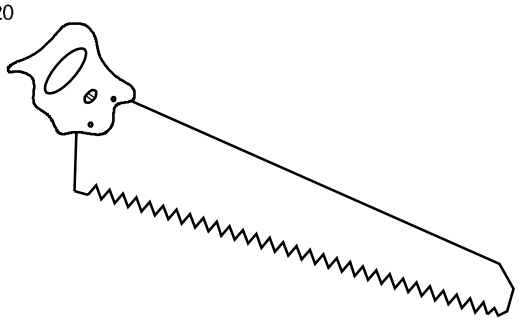
BLOCK AXE

MBN16411J

Mason's hand saw (Fig 20)

The hand saw with 12mm teeth is used for cutting soft stones and sandcrete blocks. The saw is similar in all respects to the carpenter's hand saw except that the mason's hand saw is set with chisel shaped teeth of the necessary clearance for the saw cut. When cutting a block with saw, the block is first soaked with water and kept wet throughout cutting operation. The water acts as a lubricant to minimise friction between the saw and the block.

Fig 20



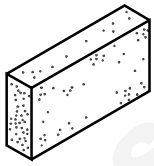
MASON'S JAW

MBN16411K

Carborundam stone (Fig 21)

A carborundam stone is used for rubbing down the cut edges of blocks.

Fig 21



CARBORUNDUM STONE

MBN16411L

Finishing Tools

Pointing Trowel (Fig 22)

This is smaller in shape and lighter than the laying Trowel.

It is used for filling in the joints of a Brick or Block wall during the pointing operation.

Fig 22

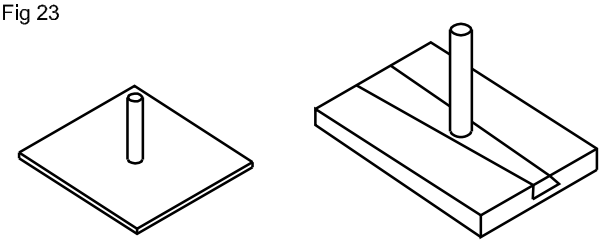
POINTING TROWEL

MBN16411M

Hawk (Fig 23)

The Hawk is a hand board made from wood, steel or aluminium and is used to carry mortar while pointing or plastering.

Fig 23



STEEL HAWK

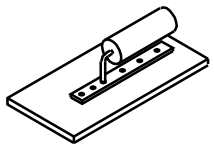
WOODEN HAWK

MBN16411N

Plastering Trowel (Fig 24)

Made of steel with a rectangular face of about 275mm by 125mm The plastering Trowel is used for laying mortar on the wall surface and when final coat is applied it is used as finishing tool to give a very smooth surface to the walls.

Fig 24



PLASTERING TROWEL

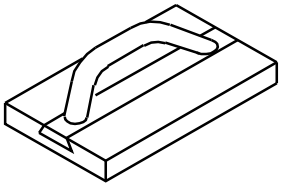
MBN16411O

Wooden float (Fig 25)

The cross grained wooden float, as the name implies, has grains running across the sole.

It is used for scouring of excess mortar on the surface of the wall finishing coats and making angles square and clean.

Fig 25



WOODEN FLOAT

MBN16411P

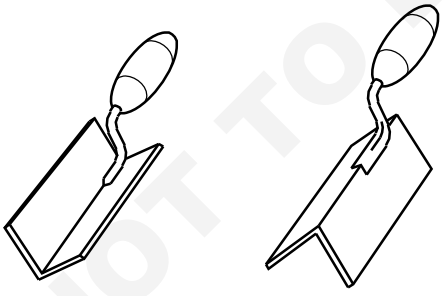
Angle tool (Fig 26)

These are made with either wooden or steel plate bent into angle of 900. It is used for finishing angles in neat and square form.

A Internal angle Tool

B External angle Tool

Fig 26



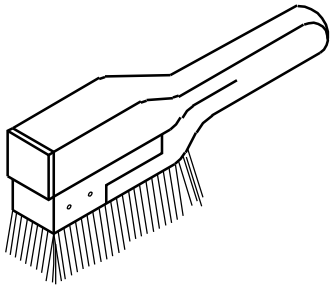
INTERNAL ANGLE TOOL EXTERNAL ANGLE TOOL

MBN16411Q

Wire brush (Fig 27)

Used for multi purposes such as cleaning the joints of Brick work or block work, before pointing operations removing dirt from plastered surfaces before a painting operation and cleaning tiled work etc. (Fig 28)

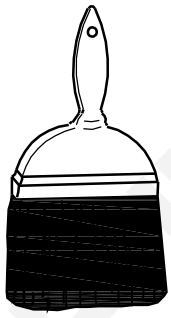
Fig 27



WIRE BRUSH

MBN16411R

Fig 28



MBN16411S

Joint cluster

The job of pointing in brick work and jointing block wall is much improved by finally using a joint cluster.

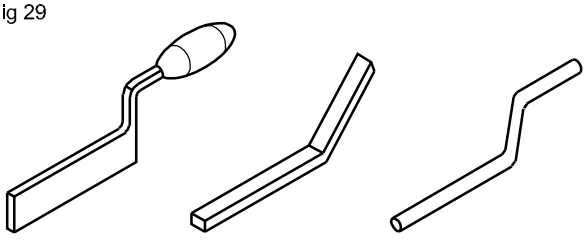
It is used to remove the excess mortar pieces from the finished work.

It is a convenient tool to use in wetting the joints before and as the work proceeds.

Jointing tools

These are popularly called jointers. They are of three main shapes as shown in the (Fig 29).

Fig 29



JOINTERS

MBN16411T

Materials for plastering / finishing

Objectives: At the end of this lesson you shall be able to
- **describe the purpose of plastering**
- **describe the definition of plastering and finishing**
- **state the uses of materials.**

Purpose of plastering

- Masonry structures after their construction require interior and exterior finishings. This finishings is known as plastering.
- Plastering is the covering of walls so as to improve their (Walls) appearance and to hide their irregularities of construction and also to provide a base for white and colour washing, painting, distempering etc.
- The following are the generalised advantages of plastering.
- Plastering provides a true, smooth and finished surface which improve the appearance of the structure.
- Plastering protects the structure from the atmospheric action such as sun, wind, rains, frost etc.
- Plastering helps in hiding the irregularities of workmanship.
- Plastering covers the unsound and porous material of the construction.
- Plastering provides a base for other finishings such as white and colour washing, distempering, painting etc.
- Plaster material is a fine paste either made of cement and sand or lime and sand or surki, and sometimes cement, lime and sand.
- When cement forms the binding material the plaster is called cement plaster.

Definitions

- The term plastering shall cover all type of rough or fair finished plastering, rendering, floating, and setting coat or finishing coat screed etc in mud lime, cement lime, cement mortar.
- "Dubbing out" shall mean filling in hollows in the surface of wall and roughly levelling up irregular or out of plumb surfaces prior to rendering.
- "Rendering or Rendering coat" shall mean the plaster coat to bring the rendering coat to a true and even surface before the setting or finishing coat is applied.
- "setting or Finishing coat" shall mean final coat in a two or three coat plaster work.
- "Thickness of plaster" shall mean the minimum thickness at any point on a surface. This does not include thickness of dubbing out.
- The term "even and fair" as referred to finishing of the plaster surface shall mean a surface finishing with a wooden float.
- The term "even and smooth" as referred to finishing of the plastered surface shall mean a surface levelled with wooden float and subsequently smoothed with a steel trowel .

Materials

- Cement
- Cement shall be ordinary port land cement or portland blast furnace cement or portland pozzolona cement as specified.

Lime

- Lime shall be semi hydraulic lime class B or fat lime class c.

Sand

- Sand shall consist of natural sand, except where crushed stone sand or crushed gravel sand or a combination of any of these are indicated. The sand shall be hard and durable, clean and free from adherent coating and organic matters and shall not contain any appreciable amount of clay balls. Sand shall be obtained from approved sources.

Water

- Water used for mixing and curing shall be clean, free from deleterious matter and sea water or blackish water shall not be used. Water fit for drinking is normally suitable.

Scaffolding

- For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided.
- The supports shall be sound and strong ,tied together with horizontal pieces over which scaffolding planks shall be fixed.
- In the case of inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose.
- only one header for each pole shall be left out.
- The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering. Where possible independent scaffolding shall be used.

Preparation of mortar and surface of walls

Objectives: At the end of this lesson you shall be able to
- **state the preparation of cement and lime mortar**
- **state method of application of mortar on wall surface**
- **describe curing and precaution of the surface of plastering.**

Preparation of cement mortar

- Mixing shall be done preferably in a mechanical mixer.
- If done by hand mixing operation shall be carried out on a clean water tight platform.
- cement and sand shall be mixed dry in the required proportion to obtain a uniform colour.
- The required quantity of water shall be added.
- In the case of mechanical mixing, the mortar shall be mixed for atleast 3 minutes after addition water.
- Cement mortar shall be freshly mixed for immediate use.
- **Preparation of Lime mortar**
- Lime and sand in the specified proportion shall be mixed with or without the addition of water on a dry water proof platform or in mixer.
- The mix shall be fed into a mortar mill with required addition of water.
- The mortar shall be raked continuously during grinding. Particularly in the angular edges of the mortar mill.
- Water may be added during grinding as required to bring the mix to the working consistency.

Preparation of surface

- The joints shall be raked out properly.
- Dust and loose mortar shall be brushed out.
- If any efflorescence shall be removed by brushing and scrapping.
- The surface shall be then throughly washed with water cleaned and kept wet before plastering is commenced.
- **Application of plaster**
- Ceiling plaster shall be completed before commencement of wall plaster.
- Plastering shall be started from the top and worked down towards the floor.
- All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down.
- To ensure even thickness and a true surface plaster about 15cm x 15cm shall be first applied, horizontally and vertically at not more than 2 metre intervals, over the entire surface to serve as gauges.
- The surfaces of these gauged area or level dots shall be truely in the plane of the finished plaster surface.
- The mortar shall then be laid on the wall between the gauges or level dots with the trowel.
- The mortar shall be applied in a uniform surface slightly more than the specified thickness.
- This shall be beaten with thin strips wooden about one metre long to ensure through filling of the joints.
- Then brought to a true surface by working a wooden straight edge reaching across the gauges, with small upward and side ways movement at a time.
- Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required.
- Excessive troweling or over working the float shall be avoided.
- All corners arises, angles and junctions shall be truely vertical or horizontal as the case may be and shall be carefully finished.
- Rounding or chamfering corners, arises, provision of grooves at junctions etc. Where required shall be done with proper templates or batterns to the required sizes.
- When suspending work at the end of the day, the plaster shall be left cut clean to line both horizontally and vertically.
- The plastering the edge of the old work shall be scrapped, cleaned and wetted with rich mortar before plaster is applied to the adjacent areas, to enable to properly joined together.
- Plastering work shall be closed at the end of the day.
- No portion of the surface shall be left out initially to be patched up later on.

Finish

- The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required.
- The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5m long and with plumb bobs.
- All horizontal lines and surface shall be tested with a level and all jambs and corners with a plumb bob as work proceeds.

Thickness

- The thickness of plaster specified shall be measured exclusive of the thickness of key ie grooves or open joints in brick work.
- The average thickness of plaster shall not less than the specified thickness (12mm).

- The minimum thickness over any portion of the surface shall not be less than specified thickness by more than 3mm.
- The average thickness should be regulated at the time of plastering by keeping suitable thickness of the gauges or level dots.
- Extra thickness required in dubbing behind rounding or corners at junctions of wall or in plastering of masonry cornices etc will be ignored.

Curing

- Curing shall be started 24hours after finishing the plaster.
- The plaster shall be kept wet for a period of seven days.
- During this period it shall be suitably protected from all damages.

Precautions

- Any cracks which appear in the surface and all portions which sound hollow when tapped or are found to be soft or defective shall be cutout in rectangular shape and redone the plastering.
- When ceiling plastering is done it shall be finished to chamfered edge, at an angle at its junction with a tool when plaster is being done.
- Similarly, when the wall plaster is being done it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6mm.
- To prevent the surface cracks appearing between junctions of column/beam and walls 150mm wide chicken wire mesh should be fixed with 'U' nails 150mm centre to centre before plastering the junctions.

Measurements

- Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal.
- The measurement of wall plaster shall be taken between the walls or partitions for the length and from the top of the floor, or skirting to the ceiling for the height.

Types of plastering

Objectives: At the end of this lesson you shall be able to
- **state the types of finishes**
- **state materials used for finishes.**

Plastering with lime mortar

- The mortar shall be of proportion as specified in the work and shall be prepared as per the specification on lime mortar.
- The plaster shall be laid on with somewhat more than the required thickness and levelled with wooden float or wooden rule.
- The finished thickness shall be sufficient to cover by minimum 12mm the surface of wall in brick masonry and by 20mm all the projections in the case of Random rubble masonry.
- The plaster shall be well press into the joints and surface rubbed smooth with a wooden straight edge or plaster Trowel sprinkling as much water as is necessary.
- During the process of rubbing an addition of lime and water of the consistency of thick cream is to be applied to give a smooth and even surface.
- The completed plaster shall be allowed to rest for 24hours and then sprinkled with water at short intervals and kept damp for atleast seven days.

Plastering with cement mortar

- Mortar shall conform to specification on "Cement mortar".
- It must be freshly mixed for immediate use and in such quantities as to permit the whole batch being used in the work before the mortar has commenced to set.
- The plaster shall be laid on with somewhat more than the required thickness and levelled with a wooden rule or straight edge.
- The finished thickness shall be sufficient to cover by 10mm the surface of the wall in brick masonry and by 6mm all the projections in the case of rubble stone masonry.
- The plaster shall be well pressed into the joints and surface rubbed smooth with a floating coat about 3mm of pure portland cement.
- The finishing coat must be applied while the base coat is still fresh.

Special type of plasters

- Apart from the plain plaster which is used on the walls in ordinary cases.
- There are certain other plasters which have got a specific use.
- Rough coat plaster
- Pebble dash plaster
- Stucco plaster

Rough coat plaster

- This type of plastered surface is prepared by throwing coarse aggregate and cement mixed together over the wet plastered surface.
- The rough cast mixture shall consists of sand or gravel or crushed stones of uniform colour as specified.
- It shall be ensured that the base surface which is to receive rough cast mixture is in plastic state.
- The mixture shall be wetted and shall be dashed on the plaster base in plastic state by hand scoop so that the mix get well pitched into the plaster base.
- The mix shall again be dashed over the vacant spaces if any so that the surface represents a homogeneous surface of sand mixed with gravel. Rough cast surface is water proof. durable and resistant to cracking.

Pebble dash plaster

- The rough finish of rendering coat of cement and sand mortar 1:3 shall be laid on to a thickness of not less than 10mm and shall be lightly pressed over to straighten it.
- The aggregate used for dashing or crushed stones or pebbles of suitable size generally from 10mm to 20mm shall be well washed, drained, and thrown wet on the rendering coat while it is still plastic, rough covering material being partially embedded in the surface.
- To ensure satisfactory bond between the dashing and the mortar the aggregate may be lightly tapped into the mortar with wooden float or the trowel.
- After completion of finishing coat the plaster shall be kept wet for atleast seven days and shall be protected during that period from extremes of temperature and weather.
- Therefore proper curing shall be done.

Stucco plaster

- Stucco plaster finished surface resembles very much marble finishes.
- Stucco plaster can be used for external as well as internal surfaces.
- Stucco plaster is applied in three coats and total thickness of the plaster should not be more than 25mm.
- The first coat is called stretch coat second as brown coat and third as finishing coat.
- Stucco plaster consists of lime plaster in which finely ground white marble is mixed.
- If hydraulic lime is used the plaster can be applied on the exterior surfaces also.

Materials requirement for 12mm thick cement mortar

Ratio	Sand	Cement	Formula = $10m^2$
1:2	$0.14m^3$	0.14/2 x 1440	100.80 Kg
1:3	$0.14m^3$	0.14/3 x 1440	67.20 Kg
1:4	$0.14m^3$	0.14/4 x 1440	50.40 Kg
1:5	$0.14m^3$	0.14/5 x 1440	40.32 Kg
1:6	$0.14m^3$	0.14/6 x 1440	33.60 Kg

Materials requirement for 20mm thick cement mortar

Ratio	Sand	Cement	Formula = $10m^2$
1:2	$0.22m^3$	0.22/2 x 1440	158.40 Kg
1:3	$0.22m^3$	0.22/3 x 1440	105.60 Kg
1:4	$0.22m^3$	0.22/4 x 1440	79.20 Kg
1:5	$0.22m^3$	0.22/5 x 1440	63.36 Kg
1:6	$0.22m^3$	0.22/6 x 1440	52.80 Kg

Mixing of concrete by hand and machine

Objectives: At the end of this lesson you shall be able to
- **state fine and coarse aggregate**
- **describe bulking of sand and water cement ratio**
- **describe the method of hand and machine mixing of concrete.**

Fine aggregate

- Aggregate which can pass through I.S sieve no 480 is known as fine aggregate.
- The maximum size of its particles is 4.75 mm.
- This aggregate should not contain more than 8% fine particles in it which may pass through IS sieve no 15.
- Natural coarse sand obtained from river - beds, Pits, lake-beds which is free from clay, silt, salts and other organic matters is mostly used in cement concrete.

Coarse aggregate

- Aggregate which cannot pass through IS sieve no. 480 has been classified as coarse aggregate.
- The maximum size of coarse aggregate mainly depends on the type of structure and nature of work.
- For all types of building works 20 to 25 mm maximum size is used.
- For mass concrete works such as dam even 200 mm size aggregate may be used.

Bulking of sand

If dry is brought in contact with moisture or water, thin film of water is formed around the sand particles and increases the volume of sand. This is called bulking of sand.

Water

- Clear sparkling water fit for drinking is also fit for concrete works.
- Water should have the following qualities.
- It should be free from ashes, soil and dissolve iron.
- It should be free from fats and oils.
- IT should be free from acids or alkalies or organic and inorganic impurities.
- Water is very important ingredient of cement concrete.
- It acts as lubricant for the fine aggregate and coarse aggregate.
- It acts chemically with the cement of particular concrete is

$$\text{Water cement Ratio} = \frac{\text{Weight of mixing water}}{\text{Weight of cement used}}$$

The increase in water cement ratio the strength of concrete reduces. Therefore as far as possible it should be kept as low as possible.

Mixing

All concrete should be mixed thoroughly until it is uniform in appearance and all ingredients are uniformly distributed.

- Mixing will be done either.
- Hand mixing.
- Machine mixing.

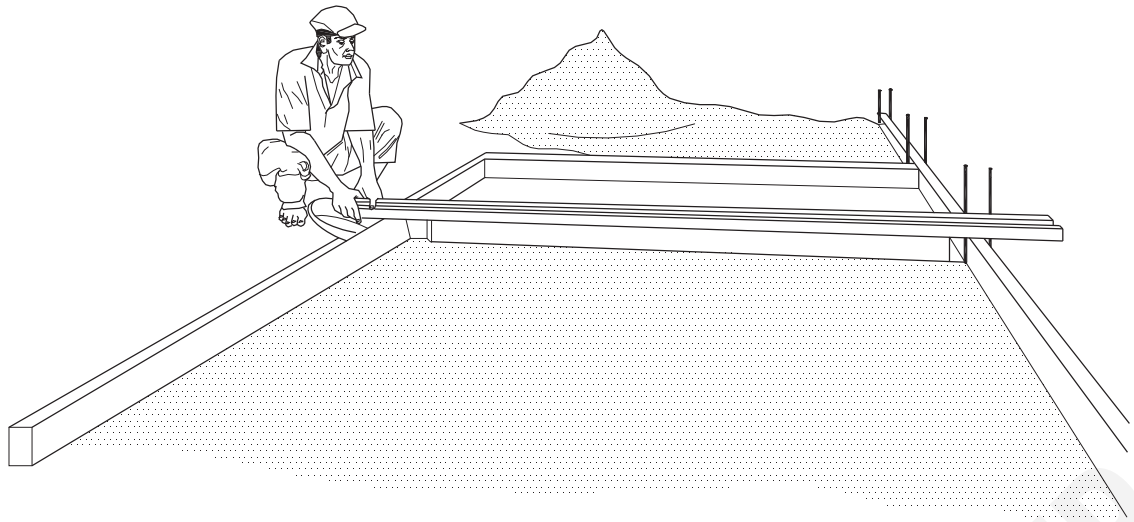
Hand mixing

- Hand mixing of concrete is done on hard platform.
- This method is mainly employed at such places where the quantities of concrete to be mixed in small.
- Cement and sand are first mixed together in dry condition.
- The coarse aggregate is spread on the platform in uniform thickness varying from 20 to 30 cm.
- The mixed cement and sand are spreaded in a uniform thick layer over the stack of coarse aggregate.
- These are mixed together first in dry state.
- Then measured quantity of water is sprinkled over it and the mass is continuously mixed till uniform workable concrete is obtained.

Machine mixing

- Machine employed for mixing concrete are known as “Concrete mixers”.
- These mixers may be of continuous mixing type or batch mixing type. For big projects where large quantity of concrete is required continuous mixing type mixers are used.
- The ingredients of concrete may be fed in the mixture by means of continuous moving conveyor belts or by other suitable methods.
- For small works of building mostly tilting drum type mixtures are used.
- While mixing concrete with mixtures first the coarse aggregates are fed in the mixture, then sand and then cement.
- After dry mixing the measured quantity of water is poured in the mixture and the concrete is mixed for 2 to 3 minutes to obtain the desired workable concrete.
- Before placing concrete in position care should be taken that proper mould is prepared alround where the concrete is to be laid as shown in the (Fig 1)
- All the faces of moulds coming in contact with concrete properly coat with crude oil. So that it may not absorb water from concrete and it is difficulty while removing batterns.

Fig 1



CEMENT CONCRETE IS USING A TEMPLATE TO CHECK THE SUBGRADE FOR SMOOTHNESS AND PROPER HEIGHT

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Placing of concrete

- Placing of concrete is most important, as the concrete must be placed in position, properly compacted within 30 minutes after adding water in as after this time the initial setting of cement will start.
- While mixing concrete it is most important that only the required quantity of concrete which can be used within 30 minutes, after adding water in it should be used.

Joints in Concrete

- During the construction of R.C.C or P.C.C structures it is impossible to do concreting work continuously.
- When concrete work is stopped at one time and continue after same time concrete joint occur.
- For making the concrete at such joints strong enough certain care is taken while concreting at these joints are classified as

Expansion and contraction joints

Construction joints

- A construction joint the wood key may be made from beveled 2 to 5 cm strip and is used for slab 10 to 15 cm thick as shown in the (Fig 2)
- The expansion joints material may be flush in areas where no safety hazard from tripping exists as shown in 2 to 4 figures.

Fig 2

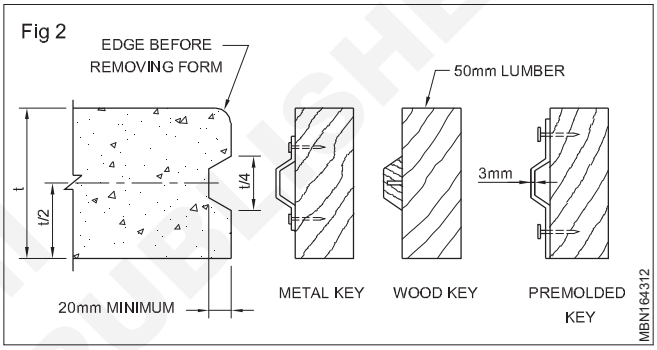

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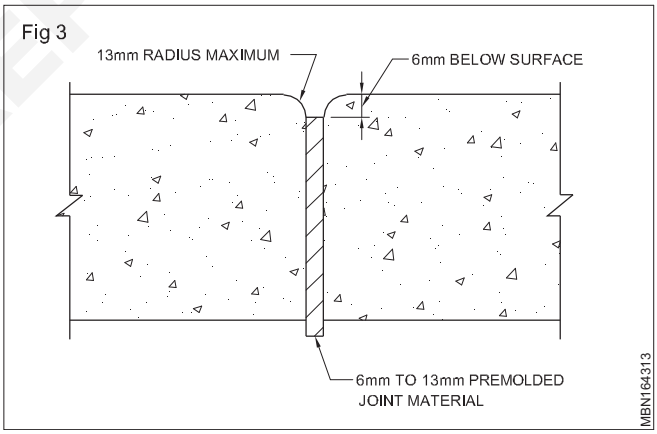
Fig 3



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Curing of concrete

Objectives: At the end of this lesson you shall be able to
- **state importance of curing**
- **state types of curing and its method**
- **state the period of curing.**

Importance of curing

- This is a very important operation if the concrete is to attain its optimum strength.
- Curing means keeping newly laid concrete under uniform conditions of temperature and moisture during the hydration of cement compounds.
- Curing makes concrete stronger, more durable, denser and more resistant to abrasion.
- If the concrete is allowed to dry out too quickly. the surface will be weak, and more likely to dust off, crakes may develop.

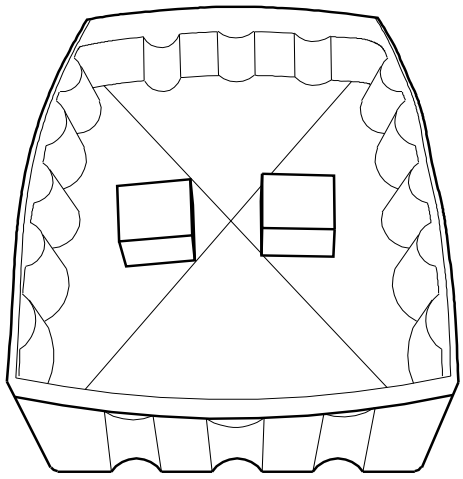
Methods of curing

- water curing
- Membrance curing or curing compounds.
- Sand layer
- Water spray.

Water curing

- This is the best method of curing than any other methods water curing can be done.
- The precast concrete items are normally immersed in curing tanks for the required duration.
- These precast concrete items are kept in water for minimum 7 days to 14 days as shown in (Fig 1).

Fig 1



IMMERSION CURING

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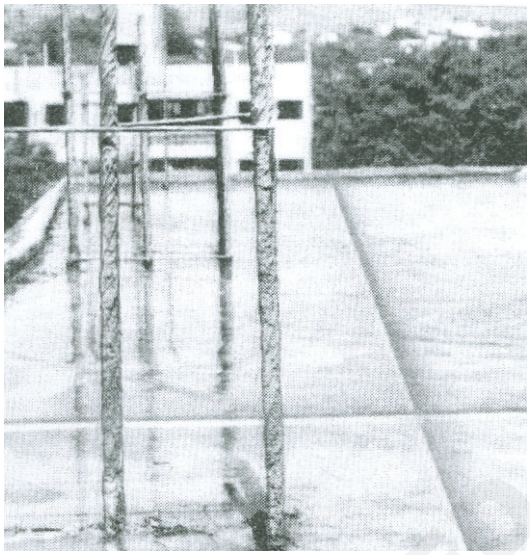
- After placing concrete for floor slab, roof slab
- By mixing lean mortar make small pieces of rectangular square by using lean cement mortar. water is stored in this small ponds.
- Simply speaking, floor slabs and road slabs etc. are covered under water by making small ponds of water as shown in (Fig 2).
- Where there is ample supply of water a hose pipe could be used to spray the concrete with water, keeping it moist for days.
- Vertical retaining walls, concrete columns are cured by spraying water. In some cases, wet coverings such as wet gunny bags are wrapped to vertical surface for keeping concrete wet as shown in (Fig 3).

Curing compounds

- The places where there is acute shortage of water, it is not possible to cure the concrete with ample quantity of water.

Fig 2



PONDING CURING OF A NEWLY LAID CONCRETE

MBN164322

Fig 3

WATER SPRAY

MBN164323

- In such places curing compounds are used.
- The curing compounds marketed under various names which offer specialised ways of keeping moisture inside the concrete until normal setting is achieved.
- They are usually applied 15 to 30 minutes after finishing the concrete.
- They are widely used in road works.

Period of curing

- The period during which concrete must be cured as specified.
- Generally, the curing time is the period for which is the concrete must remain covered or the time before the concrete will have all supports removed.
- Generally curing will takes place normally 14 days to 21days.

Floor (Ground)

Objectives : At the end of this lesson, you shall be able to
- **define flooring materials & Factors affecting the choice of flooring material**
- **explain the types and components of floors.**

Introduction

In order to sub-divide the portion between the plinth level or basement level and roof level, solid constructions are carried out. These constructions are known as floors and exposed top surface of floors are termed as floorings. Ground floors or basement floors, which directly rest on the ground, do not require the provision of a floor. But they are provided with suitable type of flooring.In addition to that measures should be taken to prevent the entry at dampers and for giving thermal insulation.

Definition

It is a horizontal element of a building structure, which divide the building into different levels, for the purpose of creating more accommodation within a restricted space, one above the other and provide support for the occupants, furniture and equipment of a building.

Purpose

The purpose of floor is to creating more accommodation within a restricted space, one above the other and provide support for the occupants, furniture and equipment of a building.

Flooring Materials

For giving pleasing appearance to the upper surface of the floor, various materials are used. The common materials used as flooring are.

1 Mud
2 Muram
3 Bricks
4 Flag stones
5 Concrete
6 Terrazzo
7 Mosaic
8 Tiles
9 Marble
10 Granolithic finish
11 Wood or timber
12 Asphalt
13 Rubber
14 Linoleum
15 Cork

Factors affecting the selection of flooring materials

1 Appearance: The material should give pleasing appearance and if should produce the colour effect with the use of building.

2 Cleanliness: It should be such that it can be cleaned easily and effectively and has resistance against oil, grease, etc.

3 Comfort: It should possess good thermal insulation to give comfort for the residents.

4 Cost: Cost should be reasonable.

5 Damp resistance: The material should offer sufficient resistance against dampness.

6 Durability: Resistance to wear, tear, and chemical action.

7 Fire resistant

8 Easy to give maintenance

9 Noiseless while using the floor.

10 Non slippery surface but smooth enough to clean easily.

Components of floor

Floor is composed of two essential components

1 Sub floor - base course or floor base.

2 Floor covering, or simply flooring.

Sub floor: It provides proper support to floor covering and the superimposed loads are carried by it.

Floor covering: It provides a smooth, clean, impervious and durable surface.

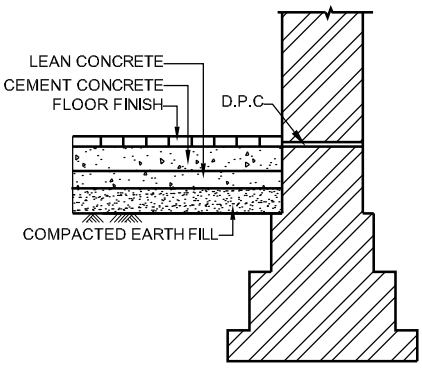
Type of floor

The floor is mainly divided in to two:

1 Ground floor 2 Upper floor

Ground floor (basement floor) (Fig 1)

Fig 1



The floors resting directly on the ground surface are known as ground floors. They do not require provision of a floor. The major problems of a ground floor are damp exclusion and thermal insulation. For this purpose it is usually provided a bedding concrete of 1:4:8.

Materials used for ground floor

Mud floors

1 Such flooring is cheap, hard and fairly impervious.

2 Easy to construct and easy to maintain.

3 It has good thermal insulation property.

4 Over a well- prepared ground, a 25 cm thick selected moist earth (mostly impervious) is spread and is then rammed well to get a compacted thickness of 15 cm.

5 In order to prevent cracks due to drying, small quantity of chopped straw is mixed in the moist earth, before ramming.

6 Sometimes, cow- dung is mixed with earth and a thin layer of this mix is spread over the compacted layer.

7 Sometimes, a thin paint of cement - cow - dung (1:2 to 1:3) is applied.

Muram floors

1 Muram is a form of disintegrated rock with binding material.

2 To construct such a floor, a 15 cm thick layer of muram is laid over prepared subgrade.

3 Over it, a 2.5 cm thick layer of powdered muram (Fine muram) is spread and water is sprinkled over it.

4 The surface is then rammed well.

5 After ramming, the surface is saturated with a 6 mm thin film of water.

6 The surface is well - trampled under the feet of workmen till the cream of muram rises to the top.

7 The surface is levelled and then kept in that state for a day, and then rammed again with wooden rammers.

8 This surface is then smeared or rubbed with thin paste of cow dung and rammed again for two days, during morning hours.

9 Finally, a coating of mud, cowdung mix is applied over the surface.

Brick floors (Fig 2)

1 These floors are used in cheap type of construction such as stores, godowns, Warehouses etc.

2 The brick to be used should be of uniform shape and colour and good quality.

3 It consists of layer of brick (Flat or on edge) laid over 10 to 15 cm thick P.C.C of 1:8:16.

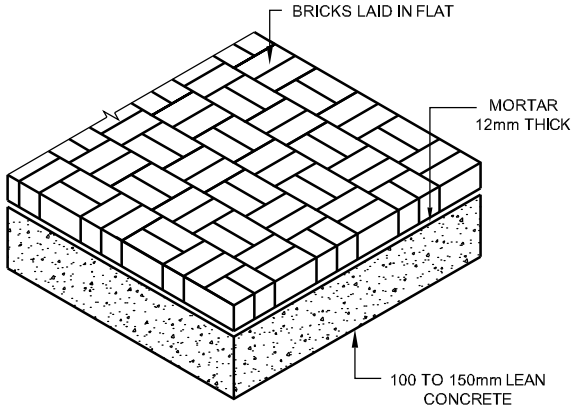
Flag stone floor (Fig 3)

1 Flagstone is any laminated sand stone available in 2 cm to 4 cm thickness.

2 The stone slabs are laid on concrete base.

3 The sub soil is properly compacted, over which 10 to 15 cm thick lime concrete or lean cement concrete is laid.

Fig 2



BRICK FLOOR

4 The flagstones (Stone slabs) are then laid over 20 to 25 mm thick layer of bed mortar.

5 In laying the slabs, work is started from two diagonally opposite corners and brought up from both sides.

6 A string is stretched between two corner slabs first to correct level.

1 Other slabs are then so laid that their tops touch the string.

2 If any particular slab falls lower than the string level, it is re-laid by putting fresh layer of stiff mortar.

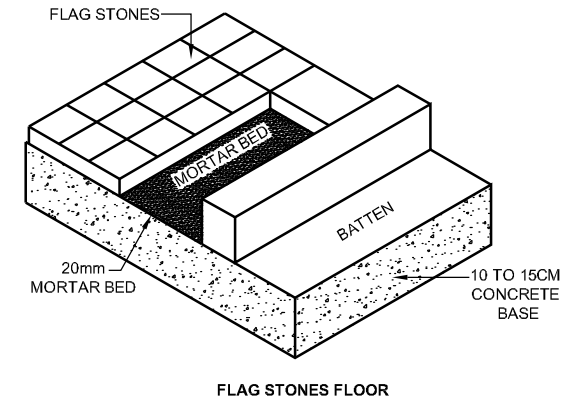
3 When the stone slabs are properly set, mortar in the joints is raked out to a depth of about 15 to 20 mm and then flush pointed with 1:3 cement mortars.

4 Proper slope is given to the surface for drainage.

5 The work is properly cured.

Cement concrete floor (Fig 4)

Fig 3



FLAG STONES FLOOR

1 This is commonly used for residential, commercial and even industrial buildings.

2 It is moderately cheap, quite durable and easy to construct.

3 The floor consists of two components (1) base concrete, and (2) topping or wearing surface.

4 The base course may be 7.5 to 10 cm thick, either in lean cement concrete (1:3:6 to 1:5:10) or lime concrete containing 40% mortar of 1:2 lime - sand (or 1 lime: 1 Surkhi: 1sand) and 60% coarse aggregate of 40mm nominal size.

5 The base course is laid over well compacted soil, and levelled to rough surface.

6 It is properly cured.

7 When the base concrete has hardened, its surface is brushed with stiff broom and cleaned thoroughly.

8 It is wetted the previous night of laying topping and excess water is drained.

9 The topping is then laid in square or rectangular panels, by use of either glass or plain asbestos strips or by use of wooden battens set on mortar bed.

10 The topping consists of 1:2:4 cement concrete laid to the desired thickness (usually 4 cm) in one single operation in the panel.

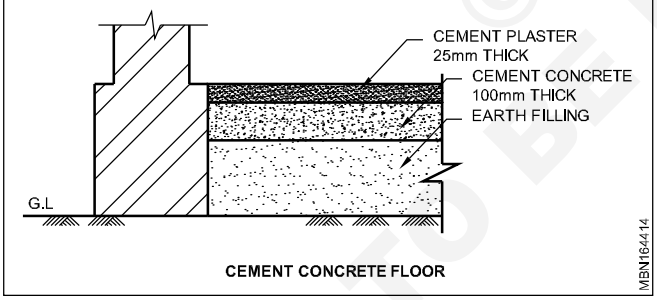
11 Topping concrete is spread evenly with the help of a straight edge, and its surface is thoroughly tamped and floated with wooden floats till the cream of concrete comes at the top.

12 Steel trowel is used for smoothening and finishing the top surface.

13 The prepared surface is protected from sunlight, rain, and other damages for 12 to 20 hours.

14 The surface is then properly cured for a period of 7 to 14 days.

Fig 4



CEMENT CONCRETE FLOOR

Terrazzo floors

1 In this floor, marble chips of various shades are used as aggregate.

2 The proportion of terrazzo mix is generally 1:2 to 1:3 i.e., one part of cement to two to three parts of marble chips by volume.

3 Prepare base concrete surface of 75cm thick.

4 Over this cement mortar 1:3 of 34 mm thick is laid, and zigzag line are marked on it. Surface is cured for effect.

5 The cement and marble chips are thoroughly mixed wet and laid for a thickness 20 mm

6 The first coat of polishing is done by a coarse carborandom stone , second coat is done by finely grained carborandom stone.

7 Wax is applied as a final coat of polishing to get glossy surface.

8 This floor in generally used for residential buildings, bath rooms, Clock rooms, etc.

Mosaic floor (Fig 5)

1 Mosaic flooring is made of small pieces of broken tiles of china glazed or of cement, or of marble, arranged in different pattern.

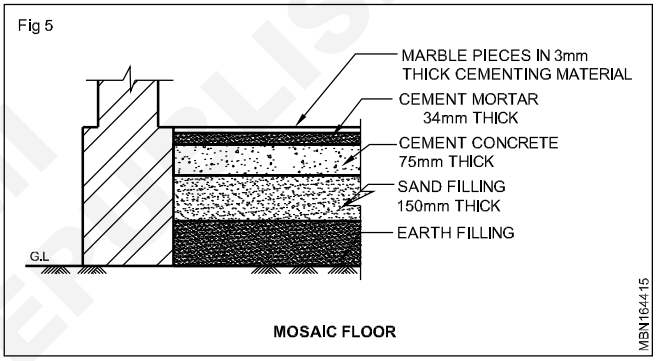
1 These pieces are cut to desired shapes and sizes.

2 A concrete base is prepared as in the case of concrete flooring, and over it 5 to 8 cm thick lime - surkhi mortar is spread and levelled.

3 On this, a 3 mm thick cementing material, in the form of paste comprising two parts of slaked lime, one part of powdered marble and one part of puzzolana material, is spread and is left dry for about 4 hours.

4 Small pieces of broken tiles or marble pieces of different colours are arranged in definite patterns and hammered into the cementing layer.

Fig 5



MOSAIC FLOOR

5 The surface is gently rolled by a stone roller.

6 Sprinkle water over the surface.

7 Surface is allowed to dry for 1 day, and is, thereafter, rubbed with a pumice stone.

8 The surface is polished smooth

9 The floor is allowed to dry for two weeks before use.

1 Tiled floors

2 Firstly, levelled hard bed or 15 cm thick P.C.C is prepared.

3 Over this bed, a thin layer of cement mortar 1:1 is laid.

4 Then pre cast tiles of cement concrete or pottery are laid over it carefully, filling the joints with mortar, which are generally paper thick.

5 Extra cement is wiped off and joints cleaned with saw dust. After curing the surface is rubbed and polished.

Marble

1 It is a superior type of flooring, used in residential buildings, hospitals, sanatoriums, temples etc., where extra cleanliness is an essential requirement.

2 Marble slab may be laid in different sizes, usually in rectangular or square shapes.

3 The base concrete is prepared in the same manner as that for concrete flooring.

4 Over the base concrete, 20 mm thick bedding mortar of either 1:4 cement: sand mix or (lime putty):1 (surkhi):1 (coarse sand) mix is spread under the area of each individual slab.

5 The marble slab is then lifted up, and fresh mortar is added to the hollows of the bedding mortar.

6 The mortar is allowed to harden slightly, cement slurry is spread over it, the edges of already laid slabs are smeared with cement slurry paste, and then the marble slab is placed in position.

7 It is gently pushed with wooden mallet so that cement pastes oozes out. This is cleaned with cloth.

8 The paved area is properly cured for about a week.

Granolithic floors

1 It is a finished coat, which is provided over a concrete surface.

2 The concrete mix used is 1:1:2 or 1:1:3. And aggregate used may be basalt, lime stone or quartz silt.

3 The granolithic layer of concrete is laid before the base concrete is set to get a monolithic construction.

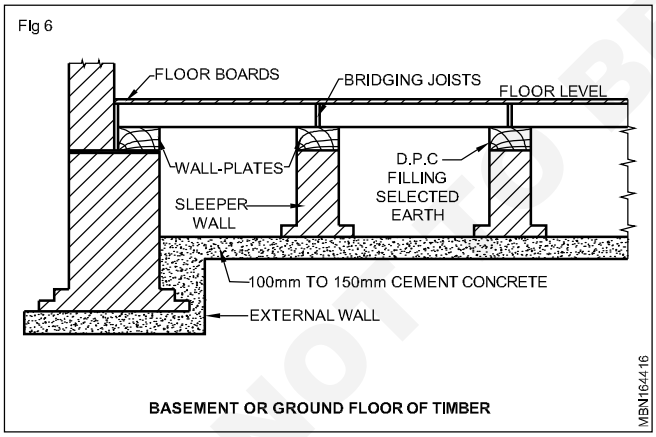
4 The minimum thickness of finishing should be 12 mm.

Wooden floors (Fig 6)

1 In hilly areas where the wood is available in a large quantity and on the other hand, the climate is damp, wooden floors are used.

2 These are also used in dancing halls, auditoriums, etc.

3 The timber to be used for flooring should be of the best quality, well- seasoned and free from cracks, knots, flaws and other defects.



BASEMENT OR GROUND FLOOR OF TIMBER

Asphalt floor

1 The asphalt flooring can be carried out in a variety of colours and in different forms.

2 The asphalt tiles, which are produced from natural asphalt, bitumen, asbestos fiber and mineral pigments are available in different sizes and in a variety of colours.

3 The asphalt terrazzo is formed by the combination of black or coloured asphalt with marble chips.

4 This terrazzo is laid hot and the surface is made smooth by a trowel.

5 The asphalt flooring is water-proof (no space),vermin - proof, dustless and joint less.

6 It is used for surface subjected to heavy wear as in case of dairies, breweries, hospitals, shops, restaurants, loading platforms, swimming pools, terrace, etc.

Rubber floor

1 It consists of sheets or tiles of rubber, in a variety of patterns and colours.

2 The sheet or tile is manufactured by mixing pure rubber with fillers such as cotton fibre, granulated cork or asbestos fibre.

3 The sheets or tiles are fixed to concrete base or wood by means of appropriate adhesive.

4 Rubber flooring is resilient and noise proof.

5 However, they are costly.

6 They are used only in office or public building.

Linoleum floor

1 It is a covering which is available in rolls, and which is spread directly on concrete or wooden flooring.

2 Linoleum sheet is manufactured by mixing oxidized linseed oil in gum, resins, pigments, wood flour, cork dust and other filler materials.

3 The sheets are either plain or printed, and are available in 2 to 6 mm thickness, and 2 to 4m width.

4 Linoleum tiles are also available, which can be fixed (or glued) to concrete base or wood floor, in different patterns.

5 Linoleum sheet is either spread as such, or also may be glued to the base by inserting a layer of saturated felt.

6 Linoleum coverings are attractive, resilient, durable and cheap, and can be cleaned very easily.

7 However, it is subjected to rotting when kept wet or moist for some time.

8 It cannot, therefore, be used for bath room, kitchens etc.

Cork floor

1 This type of flooring is perfectly noiseless, and is used in libraries, theatres, art galleries, broadcasting stations, etc.

2 Cork, which is the outer bark of cork oak tree, is available in the form of cork carpet and cork tiles.

3 It is fixed to concrete base by inserting a layer of saturated felt.

4 Cork Carpet is manufactured by heating granules of cork with linseed oil and compressing it by rolling on canvass.

5 Cork tiles are manufactured from high grade cork or shearing compressed in module to a thickness of 12mm and baked subsequently.

Glass floor (Fig 7)

1 This is a special purpose flooring, used in circumstances where it is desired to transmit light from upper floor to lower floor, and specially to admit light at the basement from the upper floor.

2 Structural glass is available in the form of tiles or slabs, in thickness varying from 12 to 30 mm.

3 These are fixed in closely spaced frames so that glass and the frame can sustain anticipated loads.

4 Glass flooring is very costly, and is not commonly used.

Plastic or PVC floor

1 It is made of plastic material, called Poly Vinyl Chloride (P.V.C), fabricated in the form of tiles of different sizes and different colour shades.

2 These tiles are now widely used in all residential as well as non-residential buildings.

3 The tiles are laid on concrete base.

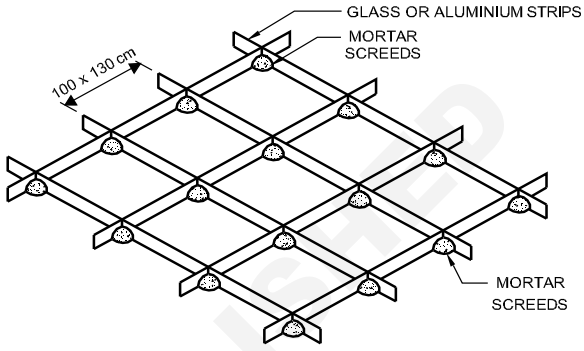
4 Adhesive of specified make is applied on the base as well as on the back of P.V.C tile with the help of a notched trowel.

5 The tile is laid when the adhesive has set sufficiently (say within 30 minutes of its application); it is gently pressed with the help of a 5 kg weight wooden roller and the oozing out adhesive is wiped off.

6 The floor is washed with warm soap water before use. P.V.C tile flooring is resilient, smooth, good looking and can be easily cleaned.

7 However, it is costly and slippery, and can be damaged very easily when in contact with burning objects.

Fig 7



METHOD OF FIXING GLASS STRIPS FOR CONCRETE FLOOR

MBN164417

Building rules and byelaws

Objectives : At the end of this lesson, you shall be able to
- **describe the different types of building**
- **define the term related to bye-laws**
- **explain requirements of building as per NBC**
- **explain requirement of building as per local byelaws.**

Introduction

Building is a structure that is built with three parts, foundation, superstructure and roof. Building means any structure whatever be the purpose and whatever materials used for construction includes foundation plinth, walls, floors, chimney, plumbing and building services, verandas, balconies etc.

Types of building

Occupancy classification

All buildings can be classified in one of the following groups:

Group A : Residential

Group B : Educational

Group C : Institutional

Group D : Assembly

Group E : Business

Group F : Mercantile (Includes both retail and wholesale stores)

Group G : Industrial (Includes low, moderate and high fire hazard)

Group H : Storage

Group I : Hazardous

A Brief description of the various classes of buildings is as follows:

Group A: Residential Buildings

These include any building in which sleeping accommodation is provided for normal residential purposes, with or without cooking or dining or both facilities, except any building classified under Group C.

a Subdivision A-1. Lodging or rooming houses. These include any building or group of buildings under the

same management, in which separate sleeping accommodation for a total of not more than 40 persons (beds) on transient or permanent basis, with or without dining facilities, but without cooking facilities for individuals, is provided. This includes inns, clubs, motels and guest houses.

A lodging or rooming house shall be classified as a dwelling in subdivision A-2 if no room in any of its private dwelling units is rented to more than three persons.

b Subdivision A-2. One-or two - family private dwellings. These include any private dwelling which is occupied by members of one or two families and has a total sleeping accommodation for not more than 20 persons.

If rooms in a private dwelling are rented to outsiders, these shall be for accommodating not more than three persons per room.

If sleeping accommodation for more than 20 persons is provided in any one residential building, it shall be classified as a building in subdivision A-1, A-3 or A-4 as the case may be.

c Subdivision A-3. Dormitories. These include any building in which group sleeping accommodation is provided, with or without dining facilities, for persons who are not members of the same family, in one room or a series of closely associated rooms under joint occupancy and single management, For example, school and college dormitories, student's hostels and military barracks.

d Subdivision A-4. Apartment houses (flats). These include any building or structure in which living quarters are provided for three or more families, living independently of each other and with independent cooking facilities, for example, apartment houses, mansions and stalls.

e Subdivision A-5. Hotels. These include any building or group of buildings under single management, in which sleeping accommodation is provided with or without dining facilities, for hotels classified up to 4 star category.

f Subdivision A-6. Hotels (Starred). These include the hotels duly approved by the concerned authorities as Five Star and above Hotels.

Group B: Educational Buildings

These include any building used for school, college other training institutions for day-care purposes involving assembly for instruction, education or recreation for not less than 20 students.

a Subdivision B-1. (Schools upto Senior Secondary Level). This includes any building or group of buildings under single management for students not less than 20 in number.

b Subdivision B-2. (All others/training institutions). This includes any building or group of buildings under single management used for students not less than 100 in number.

Group C: Institutional Buildings

This includes any building or part thereof, which is used for purposes, such as medical or other treatment or care of persons suffering from physical or mental illness, disease or infirmity; care of infants, convalescents or aged persons and for penal or correctional detention in which the liberty of the inmates is restricted. Institutional buildings ordinarily provide sleeping accommodation for the occupants.

a Subdivision C-1. (Hospitals and sanatoria). This subdivision includes any building or a group of buildings under single management, which is used for housing persons suffering from physical limitation because of health or age, for example, hospitals, infirmaries, sanatoria and nursing homes.

b Subdivision C-2. (Custodial institutions). This subdivision includes any building or a group of buildings under single management, which is used for custody and care of persons, such as children, convalescents and the aged, for example, homes for the aged and infirm, convalescent homes and orphanages.

c Subdivision C-3. (Penal and metal institutions).This subdivision includes any building or a group of buildings under single managements, which is used for housing persons under restraint, or who are detained for penal or corrective purpose, in which the liberty of the inmates is restricted, for example, jails, prisons, mental hospitals, mental sanatoria and reformatories.

Group D: Assembly Building

These include any building or part of a building, Where groups of people congregate or gather for amusement, recreation, social, religious, patriotic, civil, travel and similar purposes, for example, theatres, motion picture houses, assembly halls, auditoria, exhibition halls, museums, skating rinks, gymnasiums, restaurants, places of worship, dance halls, club rooms, passenger stations and terminals of air, surface and marine public transportation services, recreation piers and stadia, etc.

a Subdivision D-1. This subdivision includes any building primarily meant by theatrical or operatic performances and exhibitions and which has a raised stage, proscenium curtain, fixed or portable scenery or scenery loft, lights, motion picture booth, Mechanical appliances or other theatrical accessories and equipment and which is provided with fixed seats for over 1000 persons.

b Subdivision D-2. This subdivision includes any building primarily meant for use as described for subdivision D-1, but with fixed seats up to 1000 persons.

c Subdivision D-3. This subdivision includes any building, its lobbies, rooms and other spaces connected thereto, primarily intended for assembly of people, but which has no theatrical stage or theatrical and/or cinematographic accessories and has accommodation for 300 persons or more. For example, dance halls, night clubs, halls for incidental picture shows, dramatic, theatrical or educational presentation, lectures or other similar purposes, having no theatrical stage except a raised platform and used without permanent seating arrangement; art galleries, exhibition halls, community

halls, marriage halls, places of worship, museums, lecture halls, passenger terminals; and Heritage and Archaeological Monuments.

d Subdivision D-4: This subdivision includes any building, primarily intended for use as described in subdivision D-3, but with accommodation for less than 300 persons with no permanent seating arrangement.

e Subdivision D-5: This subdivision includes any building or structure permanent or temporary meant for assembly of people not covered by subdivisions D-1 to D-4,for example, grandstands, stadia amusement park structures, reviewing stands and circus tents.

f Subdivision D-6: This includes any building for assembly of people provided with multiple services/facilities like shopping, cinema theatres and restaurants, for example, multiplexes.

g Subdivision D-7: Any building or structure permanent or temporary meant for assembly of people not covered by D-1 to D-6. For example, underground or elevated railways.

Group E: Business Buildings

These include any building or part of a building which is used for transaction or business more than covered by (Group F) for keeping of accounts and records and similar purposes, professional establishments, service facilities, etc. City halls, town halls, court houses and libraries classified in this group so far as the principal function of these is transaction of people business and keeping of books and record.

Business Building are further subdivided as follows:

a Subdivision E-1. Offices, banks, professional establishments, like offices of architecture engineers, doctors, lawyers and police stations.

b Subdivision E-2. Laboratories, research establishments, libraries and test houses.

c Subdivision E-3. Computer installations.

d Subdivision E-4. Telephone exchanges.

e Subdivision E-5. Broadcasting stations and T.V. Stations.

Group F: Mercantile Buildings

These include any building or part of a building, which is used as shops, stores, market, for display and sale of merchandise, either wholesale or retail.

Mercantile buildings shall be further sub classified as follows:

a Subdivision F-1: Shops, stores, departmental stores, markets with area up to 500 m^2.

b Subdivision F-2: Shops, centres, departmental stores, markets with are more than 500 m^2 .

c Subdivision F-3: Underground shopping centres.

Storage and service facilities incidental to the sale of merchandise and located in the same building shall be included under this group.

Group G: Industrial Buildings

These include any building or part of a building or structure, in which products or materials of all kinds and properties are fabricated, assembled, manufactured or processed. For example, assembly plants, laboratories, dry cleaning plants, power plants, pumping stations, smoke houses, laundries, gas plants, refineries, dairies and saw - mills, etc.

The hazard of occupancy shall be the relative danger of the start and spread of fire, the danger of smoke or gases generated the danger of explosion or other occurrence potentially endangering the lives and safety of the occupants of the buildings.

a Subdivision G-1. (Buildings used for low hazard industries): This subdivision includes any building in which the contents are of such low combustibility and the industrial processes or operations conducted therein are of such a nature that there are no possibilities for any self- propagating fire to occur and the only consequent danger to life and property may arise from panic, fumes or smoke, or fire from some external source.

b Subdivision G-2. (Buildings used for moderate hazard industries): This subdivision includes any building in which the contents or industrial processes of operations conducted therein are liable to give rise to a fire which will burn with moderate rapidity and give off a considerable volume of smoke, but from which neither toxic fumes nor explosions are to be feared in the event of a fire.

c Subdivision G-3. (Buildings used for high hazard industries): This subdivision includes any building in which the contents or industrial processes or operations conducted therein are liable to give rise to a fire which will burn with extreme rapidly or from which poisonous fumes or explosions are to be feared in the event or a fire.

Group H: Storage Buildings

These include any building or part of a building used primarily for the storage or sheltering (including servicing, Processing or repairs incidental to storage) of goods, wares or merchandise (except those that involve highly combustible or explosive products or materials) vehicles or animals. For example, warehouses, cold storages, freight depots, transit sheds, storehouses, truck and marine terminals, garages, hangars (other than aircraft repair hangars), grain elevators, barns and stables.

Storage properties are characterized by the presence of relatively small number of persons in preposition to the area. Any new use which increases the number of occupants to a figure of the new use. For example, hangars used for assembly purposes, warehouses used for office purposes, garage buildings used for manufacturing.

Group 1: Hazardous Buildings

These include any building or part of a building which is used for the storage, handling, manufacture of processing of highly combustible or explosive materials or products which are liable to burn with extreme rapidity and /or which

may produce poisonous fumes or explosions; for storage, handling, manufacturing or processing which involve highly corrosive, toxic or noxious alkalies, acids or other liquids or chemicals producing flame, fumes and explosive, poisonous, irritant or corrosive gases; and for storage, handling or processing of any material producing explosive mixtures of dust which result in the division of matter into fine particles subject to spontaneous ignition. Examples of buildings of this class are those buildings which are used for:

a Storage, under pressure of more than 0.1 N/mm^2 and in quantities exceeding 70 m^3 ,of acetylene, hydrogen, illuminating and natural gases, ammonia, chlorine, phosgene, sulphur dioxide, carbon dioxide, methyl oxide and all gases subject to explosion, fume or toxic hazard, cryogenic gases, etc.;

b Storage and handling of hazardous and highly flammable liquids, liquefiable gases like LPG, rocket propellants, etc;

c Storage and handling of hazardous and highly flammable of explosive materials, (Other than liquids);

d Manufacture of artificial flowers, synthetic leather, ammunition, explosives and fireworks.

Introduction to Building Bye-Laws

For a planned development of towns and cities, planning authorities of the area lay down certain norms for construction of buildings which are known as "BUILDING BYE - LAWS"

For provisions and requirement for safe and stable design, methods of construction and sufficiency of materials in structures and regulations for maintenance of equipments, use and occupancy of all structures and premises, these rules may be helpful.

Terminology related to bye - laws

Abut: A building is said to be abut on the street, when the outer face of any of its (external) walls is on the street boundary.

Alley: Alley means a secondary public thoroughfare which affords a mean of access to the abutting properly.

Alteration: A change from one occupancy to another or a structural change such as an addition to the area or height or removal of the part of the building or any change to the structure.

Balcony: Balcony shall mean a cantilevered horizontal projection from the wall of building without any vertical support and having a balustrade or railing not exceeding one metre in height and intended for human use.

Barsati: It means a habitable space on the roof of the building with/without toilet facilities.

Basement/cellar: It means the lower storey of the building below or partly below the ground level

Building line: Building line is also known as set back or front building line. It is a line parallel to the plot boundaries beyond which no construction work is permitted. The distance is taken from the centre line of the road and building line.

Type of road	Building Line
Village road	9.0 m.
Other district road	9.0 m.
Major district road	15.0 m.
National & state highway	30.0 m.

Cabin: A non residential enclosure constructed of non load bearing partitions.

Canopy: Cantilever Projection known as canopy of size limit 4.5 m long and 2.4m width will not be considered as covered area.

Carpet area: Carpet area means usable floor area excluding staircase, lift and walls.

Carpet area = total floor area - circulation area

Carpet area of an office building is 60% to 70% of plinth area

Carpet area of residential building is 50% to 65 % of plinth area

For framed multi storied building the area occupied by wall is 5% to 10% of plinth area.

For ordinary building without frame the area occupied by walls may be 10% to 15% of plinth area.

Circulation area: It is floor area of veranda, passage, corridor, balconies, entrance hall, staircase etc, which are used for movement of persons using the building. It may be divided into two parts.

a **Horizontal circulation area** - Horizontal circulation area is area of veranda, passages, corridor, porch, etc which are required for horizontal movement of the users, it may be 10% - 15% of plinth area of building.

b **Vertical circulation area -** It is the area or space occupied by stair cases, lift and the entrance hall adjacent to them which are required for vertical movement of the users, it may be 4% - 5% of plinth area.

Cooking alcove: A cooking space having direct access from main room without any intermediate.

Court yard: Court yard shall mean an area open to sky within the boundary of a plot, which is enclosed of partially enclosed by building. Parapet or railing may be provided all around the court yard. It provided access to light air and rain water inside the building. It may be at ground floor level.

Covered area: Covered area means ground area coved by the building at the ground level.

The maximum covered area of the building of different classes shall be governed by the following:

Table - Covered area

Area of plot	Maximum permissible covered area
1 Less than 200 sqm (or 240 sq.yd)	60% of the site area on the ground and first floor and nothing on the second floor except a " barsati" not exceeding 25% of the ground floor.
2 200sqm. To 500 sqm. (or 240 sq.yd. to 600 sq.yd)	50% of the site area or 150 sqm (180 sq.yd.) whichever is more.
3 501 sqm. To 1000 sqm. (or 601 sq.yd.to 1200 sq.yd.)	40% of the site area or 250 sqm. (or 300 sq.yd.) whichever is more.
4 More than 1000 sqm.(1200 sq.yd)	33 1/2 % of the site area or 400 sqm.(480 sq.yd) whichever is more.

1 In a bazaar or market area the covered area shall not exceed 75% of the area of the site. Provided that sufficient off street parking facilities for loading and unloading of vehicles are available.

2 In an industrial area, the covered area shall not exceed 60% of the site area.

3 In residential area, the covered area shall be as given in table.

4 In the case of building of mixed class, the covered area shall be determined by the rules pertaining to the particular class for which the particular floor is used or intended to be used.

Cross wall: An internal wall built into an external wall.

Damp proof course: Damp proof course means a course consisting of some appropriate water proofing material provided to prevent penetration of dampness.

Dead load: Dead load means the weight of all permanent stationary construction, becoming a part of structure.

Drainage: Drainage means the removal of any liquid by a system constructed for the purpose.

Detached building: A building whose roofs and walls are independent of any other building with open spaces on all sides as specified.

Development of land: Development of land means any material change on the use of land intended for sale or construction of any structure.

Development plan: Development plan means a general planning scheme for the local area as a whole or any detailed planning scheme for any specified area.

Floor area: Floor area means the built up area of a building at any floor level. To get floor area, the area of wall shall be deducted from the plinth area. It includes all room veranda, corridor, entrance hall,dining hall, dinning, store, bath, latrine, etc.

Floor area = Plinth area- area occupied by walls

Floor area ratio: It means the quotient obtained by dividing the floor area of all floors by the area of the plot and multiplied by hundred.

$$F.A.R.= \frac{\text{Total floor area of all floors}}{\text{Total plot area}} \times 100$$

Assume :- Total plot area = 100 sqm.

Total floor area at ground floor = 60.00 sqm.

Floor area at first floor = 60.00 sqm.

Floor area at second floor = 30.00 sqm.

Total floor area = 150.00 sqm.

(Ground floor + first floor + second floor)

$$F.S.I = \frac{150}{100} \times 100 = 150$$

Floor space index: It is the ratio of built up area allowed to the plot area available.

$$F.S.I = \frac{\text{Built up area allowed}}{\text{Plot area available}}$$

Built up area = floor area at ground level + 20% of floor area for walls = 60 sqm + 12 sqm = 72 sqm.

$$F.S.I.= \frac{72}{100} = 0.72$$

Footing: The offset portions of a foundation to provide a greater bearing area.

Foundation: "Foundation" means the part of a structure which is below the lower most floor and which provides support for the super- structure and transmits the loads to the ground below .

Frontage: It means side or part of a side of a plot which abuts on a street.

Front yard: Means an open space extending laterally along the front side (entrance side) of a building and formatting part of the plot.

Gallery: Means an intermediate floor or platform projecting from a wall or an auditorium or a hall providing extra floor area, additional seating accommodation, etc.

Garage: A building or outhouse used for the storage of vehicles.

Ground floor: The storey of a building to which there is an entrance from the outside of the adjacent ground or street.

Habitable room: It means a room having windows and doors of size not less than one tenth of the floor area of the room and bath room.

Head room: Head room means the clear vertical distance measured from the finished floor surface to the finished ceiling surface.

Height of building: Height of building means vertical distance measured in the case of flat roofs from the average level of the ground around and contiguous to the building to the terrace of the last livable floor of the building.

Height of the room: It means the vertical distance between the floor and the lowest point on the ceiling.

Jhamp: A downward, vertical or sloping projection hanging below any horizontal projection like balcony, canopy, verandas, passage etc, to provide protection from direct sun and rain.

Jhot: A strip of land permanently left open for drainage purposes not to be used as an access way and is not a street or to be included as a part of setbacks.

Katra or chawl: A Building so constructed as to be suitable for letting in separate tenements each consisting of a single room, or two rooms, but not more than two rooms, and with common sanitary arrangements.

Key plan: It is a plan to a scale of not less than one in 10,000 (1:10,000) It shall be submitted along with the application for a development/building permit It gives the boundary location of the site w.r.t. neighbourhood.

Ledge: A shelf like projection supported in any manner what so ever, except by means of vertical support, within a room itself but not having, projection wider than 0.75m.

Lift well: It means the unobstructed enclosure provided for the vertical movement of the lift car(s) and any counterweight (s) including the lift pit and the space for top clearance.

Live load: It means all loads except dead load that may be imposed on structure.

Loft: A residual space in a pitched roof or any similar residual space, above normal floor level, which may be constructed for storage purpose.

Mezzanine floor: An intermediate floor in any story over-hanging and overlooking a floor beneath.

Open space around building: The national building code of our country has recommended following open space around building of varying heights.

Parking space: Means an area enclosed or un closed, sufficient in size to park vehicles, together with a driveway connecting the parking space with a street or alley.

Partly wall: Shall mean a common wall partly constructed on the plot of land and partly on an adjoining plot and serving both structurally.

Parapet: Means a wall not more than 1.2m in height built along the edge of a room or a floor.

Open space: Means an area forming integral part of the plot left open to the sky.

Pathway: An approach constructed with materials, such as bricks, Murrum, concrete, stone, asphalt or the like.

Pilaster: A pier forming part of a wall partially projecting there and bonded thereto.

	Description of building	Front space (width in m.)	Side space (width in m.)	Back space (width in m.)	Remarks
1	Building having height less than 10.0m	3.0 In no case less than 1.8	3.0	3.0 In no case less than 1.8	Minimum building line 7.5m.
2	Building having height more than 10.0m and less than 30.0m	3.0+A	3.0+A	3.0+A	The value of A is 1m for every 3m beyond 10m height of building.
3	Building having height more than 25.0m and less than 30.0m	10.0	10.0	10.0	
4	Building having height more than 30.0m.	10.0+B	10.0+B	10.0+B	The value of B is 1m for every 5m beyond 30m height of building.

Plinth: The portion of a structure between the surface of the surrounding ground and the surface of the floor first above the ground.

Plinth area: Plinth area means the area of the building at plinth level, it is the built up covered area measured at the floor level of basement or any storey. This is calculated by taking external dimension of the building at floor level excluding plinth offset.

Plinth height: Shall mean the height of the ground floor above the street level of the centre of the adjoin street.

Plinth level: Plinth level shall mean the level of the ground floor of a building.

Depth of plot: Depth of plot means the mean horizontal distance between the front and rear plot boundaries.

Porch: A covered surface supported on pillars or otherwise for the purpose of pedestrian or vehicles to approach a building.

Rain water pipe: A pipe or drain situated wholly above the ground and used for carrying water directly from roof surface of elevated court yard or other open surface.

Road: Road means any highway, street, lane, pathway, alley., stairway, passageway, carriage way, footway, or bridge, whether a through fare or not, over which the public have a right of passage or access uninterruptedly, for a specified period.

Road line: The line defining the side limits of a road.

Row housing : A row of houses with only front, rear and interior open spaces.

Sanctioned plan : It means the set of drawing and statements submitted under these rules in connection with a building and duly approved and sanctioned by the authority.

Semi detached building : A building detached on three sides with open space.

Sewage drain : A drain used or constructed to be used for conveying solid or liquid waste matter, excremental or otherwise to a sewer.

Site : Site means a parcel (piece) of land enclosed by definite boundaries.

Site double frontage : A site having a frontage on two streets other than corner plot.

Site plan : The site plan shall be drawn to a scale of not less than 1:400 provided that when circumstances are such as to make a smaller scale necessary or sufficient, the plan may with the constant of the authority be drawn to a scale of 1:800. It shall be fully dimensioned and shall show-:

1 The boundaries of the plot and of any continuous land belonging to the owner thereof including the revenue survey particulars in full.

2 The position of the site in relation to the neighbouring street (s) and its main access.

3 The name of such street(s), if any.

4 All existing structure standing on, over or under the plot.

5 All existing streets of foot paths within the plot.

6 The layout of street or foot paths within, adjoining or terminating at the site, existing or proposed to be widened or newly aligned.

7 The proposed plot subdivision, if any, and the area and uses of each subdivision thereof

8 The access to each plot sub division, if any.

9 The layout of any service road or foot paths and public parking space proposed or existing, if any.

10 The area and location of any land within the plot that is not proposed to be developed or redeveloped.

11 The area and location of any land that is proposed to be reclaimed.

12 North direction is relation to the site.

Stair covered : Stair covered means cabin like structure with a covering roof over a staircase and its landing built to enclose only the stairs for the purpose of providing protection from weather/and not used for human habitation.

Sunshade: It means a sloppy or horizontal structural overhang usually provided over opening an external walls to provide protection from sun and rain.

Stall : Stall means any temporary structure other than a hut used solely for the display and side sale of goods.

Storage : A space where goods of any kind or nature are stored.

Storey : Storey means any portion of a building included between the surface of any floor and the surface of the floor next above it, or if there be no floor above it, then the space between any floor and the ceiling next above it.

Street line : Street line means the line defining the side limits of a street.

Street level : Street level means the level at the centre line of the street.

Verandah : Veranda means a covered area with at least one side open to the outside with the exception of a parapet, trellis, jolly or grill work on the open side.

Vertical exit: A vertical exit is a means of exit used for ascension or descension between two or more levels including stairways, smoke- proof towers, ramps, and fire escapes.

Yard : An open space at ground level between a building and the adjoining boundary lines of the plot un occupied and unobstructed except by encroachments or structures specifically permitted by these by laws on the same plot with a building.

Yard front : Yard front means an open space extending laterally along the front side (main entrance side) of a building and forming part of the plot.

Yard rear : Yard rear means the utility open space extending laterally along the rear side of the plot and forming part of the plot.

Yard side: Yard side means an open space extending laterally between any side of a building of the plot facing that side other than front and rear/utility yard and forming part of the plot.

Building plan : The plan, elevation and sections of buildings accompanying the application shall be accurately drawn to a scale of not less than 1:100.

1 Include floor plan of all floors together with the covered area, accessory buildings and basement floor. It indicates clearly size of rooms, position of stair cases, ramps and lift well.

2 Show the use or occupancy of all parts of the building.

3 Show the exact position of services like water closet, sink, bath etc.

4 Include sectional drawing, showing clearly the size of footings, thickness of basement, wall construction, size and spacing of framing members, etc.

5 Show street elevations.

6 Include terrace plan indicating the drainage, and slope of the roof.

7 Specify total floor area of building.

Service plan : Service plan shall be drawn to the same scale as the building plan. It shall include plans and sections of private water supply and sewage disposal systems.

General site & Building requirements

1 No land development/redevelopment shall be made and / or no building shall be constructed on any plot, on any part of which there is deposited before, excrete or other offensive matter.

2 No land development /redevelopment shall be made and /or no building shall be constructed on a plot which comprises or includes pit, quarry, and other similar excavation.

3 No development/redevelopment shall be made and /or no building shall be erected on a plot liable to flood or on a slope forming an angle of more than 45° with horizontal, or on soil un suitable for percolation, or in sandy beds.

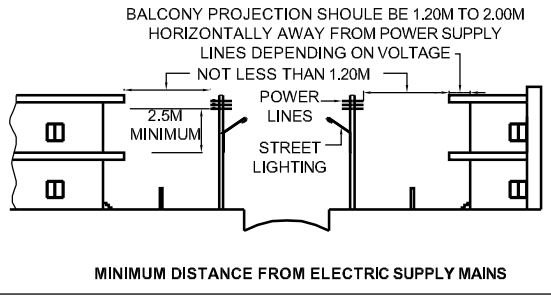
4 Any land development/redevelopment or building construction or reconstruction in any area modified by the government of India. As a regulation zone under the environment (protection)act. 1986 (29 of 1986).

Distance from power supply mains

The distance between any accessible part of the building and the electric supply mains should be between 1.2 m. to 2.0 m horizontally and 2.50 m to 3.70 m. vertically depending upon the voltage of power supply lines. This is necessary to avoid mishaps like electrocution of children playing in the balcony adjacent to the electric supply mains. House wife or servants drying wet clothes on the open terraces, loss of property and lives due to fall of supply mains of building etc. (Fig 1)

For voltage lines beyond 33 kv add 0.3 m to the above horizontal and vertical distance for every additional 33 kv and part thereof.

Fig 1



MINIMUM DISTANCE FROM ELECTRIC SUPPLY MAINS

Voltage of electric lines	Minimum distances	
	Vertical	Horizontal
1. Low medium	2.5m	1.2m
2. High voltage lines	3.7m	1.2m
Up to 11000 v(11kv)	3.7m.	2.0 m.
11000-33000 v(11kv-33kv)	3.7m.+ o.s.m for for every addl 33000 volt	2.0 m.+ 0.3 m for every addl 33000 volt
Above 33000 v(33kv)		

Minimum distance between central line of a street and building

The minimum distance between the central line of street an building other than compound wall or fence or outdoor display structure shall be 5.0 m and that between plot boundary abutting the street and building shall be 3.0 m.

Prohibition for construction abutting public roads

No person shall construct any building other than compound wall within 3.0 m from plot boundary abutting national highway, state highway or other road provided that open ramps or bridges or step with or without parapet or railing permitted as access from the street to the building within that 3.0 m and cornice or roof with protection had not exceeding 75.0cm shall be permitted with in that 3.0m.

Area and height limitations:- The limitations of area and height of different occupancy classes are achieved by specifying the Floor Area Ratio (FAR)

Sl.No	Building use of occupancy	Maximum permissible coverage percentage of plot area	Maximum permisible F.A.R.
1	Residential	50	1.5
2	Special residential	50	1.5
3	Educational (medical)	30	1.2
4	Institutional(medical)	25	1.0
5	Assembly	40	0.7
6	Governmental or semi public business	30	1.5

Sl.No	Building use of occupancy	Maximum permissible coverage percentage of plot area	Maximum permisible F.A.R.
7	Mercantile(commercial)	60	2.0
8	Industrial	40	1.2
9	Storage	70	2.0
10	Hazardous	25	0.7

ACCESS:-1) The clear width of access to a building from the street shall be the following:

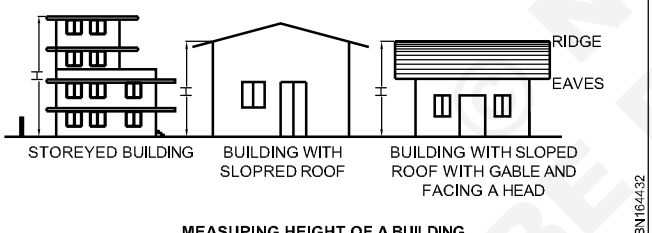
Building	Individual occupancy	Multiple occupancy
Single storey building	1.2 m	3.6 m
Two storey building	2.0 m	5.0 m

Height of building (Fig 2)

a The maximum height of the building shall not exceed 1.5 times width of the street abutting the plot plus 1.5 times the width of the yard.

b If the building abuts two or more streets of different width,then the building shall be deemed to face upon the street that has greeter width and the height of the building shall be regulated by the width of that street.

Fig 2



MEASURING HEIGHT OF A BUILDING

Occupancy : All buildings whether existing or proposed shall be classified as : GROUP A1: Residential [Normal residential purpose] GROUPA2:- Special residential [Lodging or rooming, hotels exceeding 150 sq. m floor area]

GROUP B : Educational

GROUP C : Medical/Hospital

GROUP D : Assembly

GROUP E : Office/ Business [Governmental or semi public business]

GROUP F : Mercantile

GROUP G1 : Industrial

GROUP G2 : Small Industrial

GROUP H : Storage

GROUP I : Hazardous

Parts of building

Foundation: Minimum depth of 60cm.

Plinth :- Every plinth shall have a minimum height of

- 30 cm above the level of Abutting street.
- 45 cm above the surrounding ground.

Habitable room : The carpet area of habitable room shall not be less than 9.5 sq.m. and a width not less than 2.4m. The average height shall not be less than 2.75m from the surface of floor to the lowest point of the ceiling or false ceiling.

Kitchen : The carpet area of a kitchen or any other room used as kitchen shall not be less than 5.0 sq m and its width shall not be less than 1.8m. The average height of kitchen measured from floor to the ceiling shall not be less than 2.75m IP there is a separate store area of kitchen reduced to 4.5m^2.

Bath room and latrines: The area of a bath room shall not be less than 1.8 sq m. with either side not less than 1.2m. The carpet area of latrine shall not be less than 1.1 sq.m. with one side not less than 0.9m. provided that the area of combined bathroom latrine shall not be less than 2.8 sqm with one side not less than 1.2m.

Height of bathroom and for latrine measured from floor to the ceiling shall not be less than 2.1 m.

Mezzanine floor : The floor area of mezzanine floor shall not exceed area of the main floor or room accommodating the mezzanine floor. The head room measured from the surface of the floor to any point underside of the mezzanine floor shall not be less than 2.2m.

Roof : The rise of Mangalore tile roof shall neither be more than half the span nor be less than one third the span.

Corrugated galvanized iron sheet, asbestos cement sheet roof : Rise shall be less than one fifth of the span.

Trussed roof : The rise of trussed roof shall not be less than either 1/5 th of the span or 11-20 degree whichever is greater.

Floors: Every kitchen, bathroom / latrine shall be provided with impermeable floor with a suitable slope towards the drain.

Stair case:- In any building exceeding four storeys (including basement or sunken floor) every floor area above and below plinth shall have at least two staircases, one of which may be external stairway.

1 The minimum width of stair shall not be less than 0.75m. for single family residential occupancy and 1.20m. for buildings of other occupancies. (As per NBC 1.00M for dwelling and .75m for row house).

2 Width of tread without nosing shall not be less than 25 centimetre for internal stair in the case of residential buildings and 30cm in the case of other buildings.

3 Height of riser shall not exceed 19 cm. In case of residential buildings & 15cm, in case of other buildings.

4 Height of hand rail shall not be less than 80 cm.

Industrial Occupancies: **Open space** : All building with built up area exceeding 75 square meter or the power used exceeds 30 H.P and/or the number of workers exceed 20 shall have open space not less than those prescribed below.

Open space	Value
Front yard	7.50 Mt.
Side yard on either side	3.00 Mt.
Rear Yard	7.50 Mt

Size of work room : All work rooms in buildings under this occupancy shall be provided with in a carpet area, not less than 3.4 sqm.

Height of work room : The minimum height of work room shall depend up on the type of industry. The height of any work rooms shall not be less than 2.6m, measured from the floor level to the lowest point in the ceiling.

Height of other ancillary rooms : Height of office laboratory, entrance hall, canteen, cloak room, etc. shall not be less than 3.0m.

In the case of store room and toilet, the height shall not be less than 2.4m.

Disposal of trade wastes and effluents: (1) In a case of a factory where the internal drainage system is proposed to be connect to the public sewerage system, prior approval of the arrangements shall be obtained from the pollution board and water and drainage authority.

(2) The industrial sewage effluents if proposed to be discharged in to nearby water bodies such as river, lakes, canals or sea, the dilution of such waste shall be such that the water bodies, area not polluted.

Rat - Proofing of building : Every building or part thereof designed or intended for the handling or storage of foodstuffs shall conform to the requirements specified below.

(1) Every such building unless supported on posts shall have continuous foundation from at least 60 cm. below ground level to at least 15 cm above ground level.

(2) All opening is such foundation or floors, windows and drains and all junctions between foundation and walls of the building shall be effectively rat-proofed. They are securely covered with rat-proof screening or grillage.

Sanitation requirement : Sanitation facilities shall be provided as stipulated below:

a One water closet for the first 50 males or part thereof and two water closets for the first 50 females.

b One urinal for every 100 males.

c Drinking water foundation shall be provided at the rate of one for every 100 persons or part thereof.

d Washing facilities shall be provided at the rate of one for 50 persons or part thereof.

Hazardous occupancy

Open space: There shall be minimum open space of 10 m all round for the hazardous occupancy.

Petrol filling station: The location of petrol filling stations and its layout shall be approved by the authority in consultation.

Traffic terminal stations: The location of traffic terminal stations like municipal bus stand, inter-stand, bus, terminals railway station and air ports shall be decided by the authority of consultation.

Sanitation requirements: The sanitation requirements for bus or train station and airports shall be as stated in table, below. Two non service type latrine one each for males and females and one non service type urinal for males.

1 Wash basin : At the following rates:-

a Domestic airports: minimum of 2 each for males and females.

b International airport : 10 for 200 persons

2 Shower stall : With wash basin

a 4 stall each in the females and males toilets in the transit/departure lounge.

b 4 stall each in the females and males toilets in the main concourse.

Tele communication towers

1 The base of the tower or poles shall have minimum 3 meters distance from the plot boundary abutting the road whether it is proposed on land or over a building, even if the building is having less than 3 meters distance.

2 Distance from other boundaries of the plot to the base of the telecommunication tower or pole structure or accessory rooms shall be minimum 1.20 meters.

Assessary rooms

1 The cabin may be made with any material but the area of such cabin shall not exceed 15 sq.m.

2 Installation of electricity generator may be allowed if the generator is covered with insulated sound- proof cabin.

Protective wall

1 Every tower erected on the ground and through which electric power is transmitted or passed shall be provided with protective wall or grill at a distance of one mater from any point of the base.

2 The wall or grill shall have a minimum of 1.20m, height and shall be kept under lock and key, if provided with door.

Warning light and specifications

1 Every telecommunication tower shall have one light (ANL) each at 40 meters and 70 metres height from the ground level.

2 Every telecommunication tower shall be painted with international orange and international white colours alternatively starting with international orange at the top.

Educational Institutional (Medical) Government or Semi Public Business Occupancies:

In the case of educational institutional (medical) Government or semi public business occupancies, provision of Rule 14 to 31 shall apply, subject to the modifications specified below.

1 Plot Requirements: All plot sub Division and building and layout shall be approved by the chief town planner.

2 Usage of plot: The usage of plots proposed for development/redevelopment or for construction of any building shall be governed by provisions contained in the detailed town planning scheme prepared for the locality.

3 Open space: All buildings with floor area exceeding 75sq.mt, shall have open space not less than those prescribed below:

Open space	Value
Front Yard	7.50 Mt.
Side yard on either side	8.00 Mt.
Rear yard	7.50 Mt.

4 Habitable Rooms: the carpet area of any habitable room shall not be less than 9.50 m^2 with width not less than 3 meters.

5 Kitchen, store, record room, laundry etc.: The width of kitchen, store, record room, and laundry etc, shall not be less than 2.4 meters. The head room shall not be less than 2.4 meters at any point from the floor.

6 Corridor, veranda, and passage way: The clear width of any corridor, veranda, and passage way shall not be less than 1.5 meters.

7 Circulation area: Horizontal circulation shall not be less than 12% of the floor area. The area occupied by vertical circulation space such as lift, ramp and stair cases shall not be less than 4% of the floor area.

8 Assembly occupancies : In the case of assembly occupancies open spaces shall be as given below:

Extent of built up area	Nature of open space	Dimension
1 Built up area exceeding 100 sq.m but below 400 sq.m	Front yard side yard (each) Rear yard	7.5m 3.0m 3.0m
2 Built up area exceeding 400sq.m but below 800 sq.m	Front yard side yard(each) Rear yard	10.5m 4.5m 3.0m
3 Built up area exceeding 800 sq.m	Front yard side yard(each)	12.0m 6.0m

Requirements of assembly spaces

a Any room in a building under assembly occupancy shall have clear height of not less than 4m for the assembly area. Provided that the clear head room beneath or above the mezzanine or balcony shall not be less than 3 m.

Provided also that the head room shall not be less than 2.4 m in air conditioned rooms, the height of store room, toilets and cellar rooms shall not be less than 2.4 m

b Balconies or galleries or mezzanines shall be restricted to 25% of the total accommodation of assembly hall area and the maximum slope of the balcony or gallery or mezzanine shall not exceed 35°.

Ventilation: The standard of ventilation shall be 28 m^3 fresh air per seat per hour.

Fire Protection

a Every such building shall be constructed of the fire resistant material throughout.

b Every place of assembly with a capacity of up to 600 persons shall have minimum of two separate exits as remote from each other as practicable.

Provided that where the capacity ranges from 601 to 1001 persons, such place of assembly shall have minimum of two separate exits as remote from each other as practicable, with each exit of not less than 2 unit width.

Provided further that where the capacity range over 1001 person, such place of assembly shall have minimum of four separate exits as remote from each other as practicable.

c When more than one auditorium or assembly hall is housed in the same building the exit requirements and fire escape provisions for each of the 2 units shall be mutually exclusive but shall be complimentary.

Mercantile (Commercial) occupancies

Size of a shop : Every shop unit shall have a carpet area not less than 15 m^2 with a width not less than 3 meter. Provided that in case of stalls in markets the carpet area

of such stall shall not be less than 5.0 m^2 with a width not less than 2.0 meter.

1 **Side yard:** Every building of two or more stories in area zoned for commercial purpose in the development plan for the town or city or detailed town planning scheme for the locality and abutting on public street not less than 7 m width, may not provide any side yard.

Provided that in case any window/ventilator or such other opening envisaged on any side of the building, the building shall have a clear side space of 1.5 m on that side.

2 **Rear yard:** The rear yard shall not be less than 1.5 meter.

3 **Covered path ways**: All stalls in public market shall be provided with a covered access passage of not less than 1.8 m width.

4 **Fish and meat stalls**: Fish and meat stalls in a public market shall invariably be provided with flies proof enclosure. The access passage in these stalls shall have minimum width of 2 meter.

5 **Sanitation Requirements**: Sanitation facilities to be provided for occupants in the group shall be as stipulated in table below.

Sanitation requirements for shops/commercial buildings

Sl. No	Fitments	For personal
1	Water Closet	One for every 25 persons or part thereof exceeding 15 (including employees and customers). For female 1 per every 15 persons of or part thereof exceeding 10.
2	Drinking water	One for every 100 persons with a minimum of one for each floor.
3	Wash basin	One for every 100 persons or part thereof.
4	Urinals	Nil up to 6 persons 1 for 7-20 persons 2 for 21-45 persons 3 for 46-70 persons 4 for 71-100 persons For 101-200 persons @ of 3% For over 200 persons @ 2.5%
5	Cleaner's sink	One for floor minimum preferably in or adjacent to toilets.

Building in small plot : Building under residential or commercial occupancy can be constructed in small plot not exceeding 125sqm of area.

i **No of floors to be limited** - The number of floors allowed shall be three

ii Conditions regarding set back

1 The minimum distance between the plot boundary abutting any street other than National highway, state highway, district road, and other roads and the building shall be 2m.

2 Any one side shall have minimum of 90 cm and other side shall have minimum of 60cm.

3 The rear side shall have an average of 1m set back with minimum 0.50m.

Row buildings

The number of dwelling units in a row building shall not exceed ten.

Plot area: The area of plot for one unit shall not exceed 85sq.mt.

Distance from street: The minimum distance between the plot boundary abutting any street other than NH,SH,DR,OR, shall be 1.5m

Maximum floors: The maximum number of floors permitted shall be 2 with a stair case room.

Wells: The site plan should show the position and dimension of well and all existing and proposed buildings and structures in the land within 7.5m radius from that well.

Set back

1 The set back from any street shall be as that required for a building

2 There shall be 1.5m set back from other boundaries

3 No leech pit, sock pit, refuse fit, earth closet or septic tank shall be allowed or made within a distance of 7.5m radius from any existing well and 1.2m distance from plot boundaries.

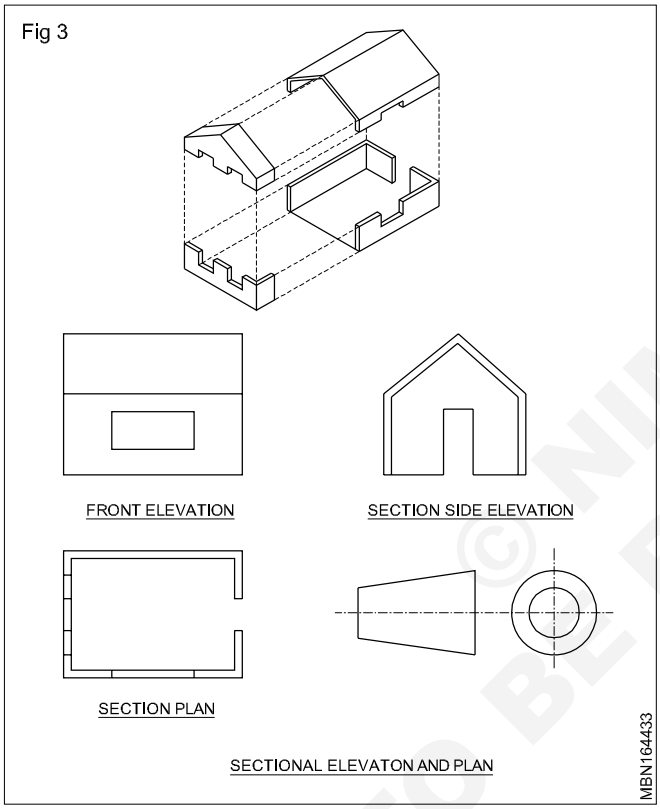
4 Well and surrounding:- The well shall be protected with brick wall with minimum 1m height.

Plans, Sections and Elevations of building

Three kinds of drawings are commonly used to illustrate buildings. They are plans, sections and elevations. All of these are drawn directly from measurements of the building, so they are more straightforward to do than perspective drawings. Always the buildings are drawn in first angle projections as shown.

Plan : A plan drawing shows what you would see if you sliced through the building horizontaily, lifted off the top part and looked down. The "cut" is usually made just above the level of the window sills. A separate plan is usually made for each storey of the buildings. Any solid part of the building which is cut through can be coloured in with shading or hatching. This is shown on the walls in the drawing. (Fig 3)

Fig 3



Section : A section drawing shows what you would see if you made a vertical cut through the buildings, took one half away, and looked into the other half. You can make as many section drawings as you need to explain the building, but one or two should be enough for most ordinary houses. To show where you have made your cuts, draw "section lines" on your plans with arrows on the ends to show which way the section is looking. Any solid parts which are cut (such as walls, floors or roofs) can be shaded or hatched.

Elevation : An elevation shows what you would see if you looked straight at the building from the outside. A detached house needs 4 elevation. A semi-detached houses has 3 elevations. A terraced house has 2 elevations. In individual rooms. You might want do this if you were working on a new interior design for your bedroom, for example.

Working Drawing : It is a set of drawings prepared and issued for the construction. It includes detailed plan, sectional elevations showing all the structural details, elevations and working specifications. (Figs 4&5)

Fig 4

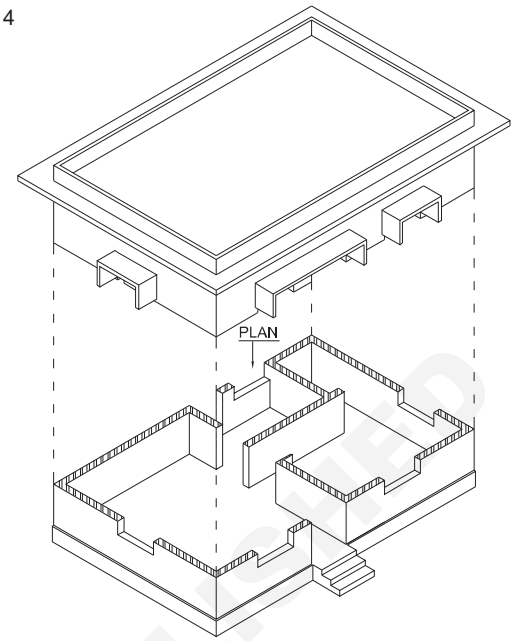
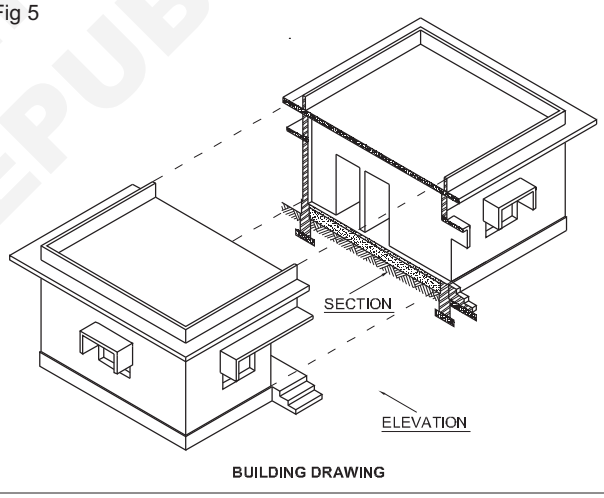


Fig 5



Site plan : The site plan sent with an application for permit shall be drawn to a scale of not less than 1 in 500 for a site up to one hectare and not less than 1 in 1000 for a site more than one hectare and shall show:

a. the boundaries of the site and of any contiguous land belonging to the owner thereof:

b the position of the site in relation to neighbouring street

c the name of the streets in which the building is proposed to be situated if any

d all existing buildings standing on over or under the site including service lines

e the position of the building and of all other buildings (if any) which the applicant intends to erect upon his contiguous land referred to in (a) in relation to.

i. The boundaries of the site and in case where the site has been partitioned, the boundaries of the

portion owned by the applicant and also of the portions owned by others

ii all adjacent street, buildings (with number of storeys and height) and premises within a distance of 12m of the site and of the contiguous land (if any) referred to in (a): and

iii if there is no street within a distance of 12m of the site the nearest existing street:

f the means of access from the street to the building and to all other buildings (if any) which the applicant intends to erect upon his contiguous land referred to in (a)

g space to be left about the building to secure a free circulation of air, admission of light and access for scavenging purposes

h the width of the street (if any) in front and of the street (if any) at the side or near the buildings

i the direction of north point relative to the plan of the buildings

j the direction of north point relative to the plan of the buildings

k any physical features, such as wells, drains, etc and

l such other particulars as may be prescribed by the Authority.

Sub Divisional / Layout Plan: In the case of development work, the notice shall be accompanied by the sub-division/ layout plan which shall be drawn on a scale of not less than 1:500 containing the following"

a scale used and north point

b the location of all proposed and existing roads with their existing/proposed/prescribed widths within the land

c Dimensions of plot along with buildings lines showing the setbacks with dimensions within each plot.

d The location of drains, sewers, public facilities and service and electrical lines etc.

e Table indicating size, area and use of all the plots in the sub-divisional /layout plan

f A statement indicating the total area of all the site, area utilized under roads, open spaces for parks, playgrounds, recreation spaces for parks, playgrounds recreation spaces and development plan reservations, schools, shopping and other public places alongwith their percentage with reference to the total area of the site propoed to be subdivided and

g In case of plots which are subdivided in built up area in addition to the above, the means of access to the sub-division from existing streets.

Building plan and details

The plan of the buildings and elevations and sections accompanying the notice shall be drawn to a scale of 1:100. The plans and details shall.

a include floor plans of all floors together with the covered area clearly indicating the size and spacings of all framing members and sizes of rooms and the position of staircases, ramps and liftwells

b show the use or occupancy of all parts of the buildings

c show exact location of essential services, for example, WC, sink, bath and the like

d include at least one elevations from the front showing height of buildings and rooms and also the height of parapet

e include at least one section through the staircase

f include the structural arrangements with appropriate sections showing type/arrangements of footings, foundations, basement walls, structural load bearings walls columns and beams, and shear walls and arrangements/spacing of framing memebrs, floor slabs and roof slabs with the material used for the same

g show all street elevations

h give dimensions of the projected portions beyond the permissible building line

i include terrace plan indicating the drainage and the slope of the roof and

j give indications of the north point relative to the plan.

The requirement of 1:100 is permitted to be flexible for specific details needed for further illustration and also for drawings for these in electronic form.

Building plan for multi-storeyed/special buildings

For all multi-storeyed buildings which are 15 m or more in height and for special buildings like educational, assembly institutional, industrial, storage and hazards and mixed occupancies with any of the aforesaid occupancies having covered area more than 500m^2, the building sanction shall be done in two stages.

Stage 1. First stage for planning clearance

The following additional information shall be furnished/ indicated in the building plan.

a Access fire appliances/ vehicles with details of vehicular turning circle and clear mortorable accessway around the building.

b Size (width) of main and alternative staircases along with balcony approach, corridor, ventilated lobby approach:

c location and details of lift enclosure

d location and size of fire lift

e smoke stop lobby/door, where provided

f refuse chutes, refuse, chamber, service duct, etc

g vehicular parking spaces

h refuse area, if any

i details of buildings services - Air-conditioning system with position of fire dampers, mechanical ventilation system, electrical services, boilers, gas pipes etc

j details of exits including provision of ramps, etc, for hospitals and special risks

k location of generator, transformer and switchgear room

l smoke exhauster system if any

m details of fire alarm system network

n location of centralized control, connecting all fire alarm systems, built-in-fire protection arrangements and public address system, etc

o location and dimension of static water storage tank and pump room along with fire service inlets for mobile pump and water storage tank

p location and details of fixed fire protection installations such as sprinklers, wet risers, hose-reels, trenchers, etc and

q location and details of first-aid fire fighting equipment/ installations.

Second stage for building permit clearance

After obtaining the sanction for planning (Stage 1) from the Authority a complete set of structural plans, sections, details and design calculation duly signed by engineer/ structural engineer (see Annex A) along with the complete set of details duly approved in stage 1 shall be submitted. The building plans/details shall be deemed sanctioned for the commencement of construction only after obtaining the permit for stage 2 from the authority.

Lighting and ventilation:

Aggregate area of opening for lighting and ventilation excluding doors shall not be less than

1/10 of the floor area for dry hot climates.

1/6 of the floor area for wet hot climates.

1/8 of the area for intermediate climates.

1/12 of the floor area for cold climates.

No portion of the room shall be assumed to be lighted if it is more than 7.5m from the opening. The windows shall open in to external air or to an open verandah of width not more than 3m. The openings in kitchen shall be increased by the 25% of the above value.

Introduction to fire protection Engineering

Fire engineering is the application of science and engineering principles to protect people, property, and their environments from the harmful and destructive effects of fire and smoke. It encompasses fire protection engineering which focuses on fire detection, suppression and mitigation and fire safety engineering which focuses on human behaviour and maintaining a tenable environment for evacuation from a fire. In the United States fire protection engineering is often used to include fire safety engineering.

The discipline of the engineering includes, but is not exclusive to:

Fire detection - fire alarm systems and brigade call systems

Active fire protection - fire suppression systems

Passive fire protection - fire and smoke barriers, space separation

Smoke control and management

Escape facilities - Emergency exits, Fire lifts etc.

Building design, layout, and space planning

Fire prevention programs

Fire dynamics and fire modelling

Human behaviour during fire events

Risk analysis, including economic factors

Wildfire management

Fire protection engineers identify risks and design safeguards that aid in preventing, controlling, and mitigating the effects of fires. Fire engineers assist architects, building owners and developers in evaluating buildings life safety and property protection goals. Fire engineers are also employed as fire investigators, including such very large-scale cases as the analysis of the collapse of the Word Trade Centers. NASA uses fire engineers in its space program to help improve safety. Fire engineers are also employed to provide 3rd party review for performance based fire engineering solutions submitted in support of local building regulation submitted in support of local building regulation applications.

Categories of Active Fire Protection

Fire Suppression

Fire can be controlled or extinguished, either manually (fire fighting) or automatically. Manual includes the use of a fire extinguisher or a Standpipe system. Automatic means can include a fire sprinkler system, a gaseous clean agent, or fire fighting foam system. Automatic suppression systems would usually be found in large commercial kitchens or other high -risk areas.

Sprinkler systems

Fire sprinkler systems are installed in all types of buildings, commercial and residential. They are usually located at ceiling level and are connected to a reliable water source, most commonly city water. A typical sprinkler system operates when heat at the site of a fire causes a glass component in the sprinkler head to fail, thereby releasing the water from the sprinkler head. This means that only the sprinkler head at the fire location operates - not all the sprinklers on a floor or in a building. Sprinkler systems help to reduce the growth of a fire, thereby increasing life safety and limiting structural damage.

Fire detection

Fire is detected either by locating the smoke, flame or heat, and an alarm is sounded to enable emergence

evacuation as well as to dispatch the local fire department. An introduction to fire detection and suppression can be found here. Where a detection system is activated, it can be programmed to carry out other actions. These include de-energising magnetic hold open devices on fire doors and opening servo- actuated vents in stairways.

Hypoxic air fire prevention

Fire can be prevented by hypoxic air. Hypoxic air fire prevention systems, also known as oxygen reduction systems are new automatic fire prevention systems that reduce permanently the oxygen concentration inside the protected volumes so that ignition or fire spreading cannot occur. Unlike traditional fire suppression systems that usually extinguish fire after it is detected, hypoxic air is able to prevent fires. At lower attitudes hypoxic air is safe to breathe for healthy individuals.

Construction and maintenance:

All AFP systems are required to be installed and maintained in accordance with strict guidelines in order to maintain compliance with the local building code and the fire code. AFP works alongside modern architectural designs and construction materials and fire safety education to prevent, retard, and suppress structural fires.

General fire safety requirements for buildings

In order that the fire hazards (i.e. personal hazard, internal hazard and exposure hazards) are minimised, IS: 1641-1960 recommends that the buildings shall conform to the following general requirements:

1 All buildings and particularly buildings having more than one storey shall be provided with liberally designed and safe fire-proof exits or escapes.

2 The exits shall be so placed that they are always immediately accessible and each is capable of taking all the persons on that floor as alternative escape routes may be rendered unusable and/or unsafe due to fire.

3 Escape routes shall be well- ventilated as persons using the escapes are likely to be overcome by smoke and / or fumes which may enter from the fire.

4 Fire - proof doors shall conform rigidly to the fire safety requirements.

5 Where fire-resisting doors are employed as cut - offs or fire breaks, they shall be maintained in good working order so that they may be readily opened to allow quick escape of persons trapped in that section of the building, and also, when necessary, prompt rescue work can be expeditiously carried out.

6 Electrical and/or mechanical lifts, while reliable under normal conditions may not always be relied on for escape purposes in the event of a fire, as the electrical supply to the building itself may be cut- off or otherwise interrupted, or those relying on mechanical drive may not have the driving power available.

7 Lift shafts and stairways invariably serve as flues or tunnels thus increasing the fire by increased drought and their design shall be such as to reduce or avoid this possibility and consequent spread of fire.

8 False ceiling, either for sound effects or air-conditioning or other similar purpose shall be so constructed as to prevent either total or early collapse in the event of fire so that persons underneath are not fatally trapped before they have the time to reach the exits; this shall apply to cinemas, and other public or private buildings where many people congregate.

9 To a lesser extent, the provisions of clause (8) above shall apply to single - storey buildings which may be used for residence or an equivalent occupancy. Whatever be the class or purpose of the building, the design and construction shall embody the fire retardant features for ceilings and/or roofs.

10 Floors. Floors are required to withstand the effects of fire for the full period stated for the particular grading. The design and construction of floors shall be of such a standard that shall obviate any replacement, partial or otherwise, because experience shows that certain types of construction stand up satisfactorily against collapse and suffer when may first be considered as negligible damage, but in practice later involves complete stripping down and either total or major replacement. This consideration shall also be applied to other elements of structure where necessary.

11 Roofs. Roof for the various fire-grades of the buildings shall be designed and constructed to withstand the effect of fire for the maximum period for the particular grading, and this requires concrete or equivalent construction. It is, however, important that maximum endurance is provided for as stated in para 9.

12 Basements. Where basements are necessary for a building and where such basements are used for storage, provision shall be made for the escape of any heat arising due to fire and for liberating and smoke which may be caused. It is essential that fire resistance of the basement shall conform to the highest order and all columns for supporting the upper structures shall have a grading not less than laid down in types 1 to 3.

13 Smoke extraction from basements. The following requirements shall be provided for smoke extraction:

a Unobstructed smoke extracts having direct communication with the open air shall be provided in or adjoining the external walls and in positions easily accessible for firemen in an emergency.

b The area of smoke extracts shall be distributed, as far as possible, around the perimeter to encourage flow of smoke and gases where it is impracticable to provide a few large extracts, for example, not less than 3 m^2 in area, a number of small extracts having the same gross area shall be provided.

c Converse to the smoke extracts shall, where practicable, be provided in the stall board and/or pavement lights at pavement level, and be constructed of light cast iron frame or other construction which may be readily broken by fire - men in emergency. The covers shall be suitably marked.

d Where they pass through fire resisting separations, smoke extracts shall in all cases be completely separated from other compartments in the building by enclosures of the appropriate grade of fire resistance. In other cases, steel metal ducts may be provided.

e Where these are sub - basements, the position of the smoke extracts from subbasements and basements shall be suitably indicated and distinguished on the external faces of the building.

Fire resistant construction

In a fire resistant construction, the design should be such that the components can withstand fire as an integral member of structure, for the desired period. We shall consider the construction of the following components:

1 Walls and columns.
2 Floors and roofs.
3 Wall openings.
4 Escape elements.
5 Strong room construction.

1 Walls and columns: The following points should be observed for making walls and columns fire-resistant:

i Masonry walls and columns should be made of thicker section so that these can resist fire for a longer time, and can also act as barrier against spread of fIre to the adjoining areas.

ii In the case of solid load-bearing walls, bricks should be preferred to stones.

iii If walls are to be made of stones, granite and lime stone should be avoided.

iv In the case of building with framed structure, R.C.C should be preferred to steel.

v If steel is used for the framed structure, the steel structural components should be properly enclosed or embedded into concrete, terracotta, brick, gypsum plaster board, or any other suitable material, as illustrated in (Figs 6 to 9)

vi If the frame work is of R.C.C., thicker cover should be used so that the members can resist fire for a longer time. It is recommended to use 40 to 50 mm cover for columns, 35 to 40 mm cover for beams and long span slabs and 25 mm for short span slabs.

vii Partition walls should be of fire-resistant materials such as R.C.C., reinforced brick work, hollow concrete blocks, burnt clay tiles, reinforced glass, and asbestos cement boards

viii Cavity wall construction has better fire resistance.

ix All walls, whether load bearing or non-load bearing, should be plastered with fire-resistive mortar.

2 Floors and roofs

The following points are note-worthy for fire-resistant floors and roofs:

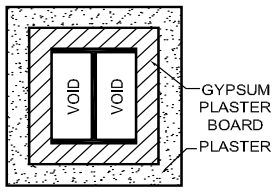
i For better fire resistance, slab roof is preferred to sloping or pitched roofs.

ii If it is essential to provide sloping roof, trusses should either be of R.C.C. or of protected rigid steel with fire proof covering.

iii For better fire resistance, the floor should be either of R.C.C. or of hollow tiled ribbed floor or of concrete jack arch floor with steel joists embedded in concrete.

iv If floor is made of timber, thicker joists at a greater spacing should be used, and fire stops or barriers should be provided at suitable interval.

Fig 6



PROTECTION OF STEEL COMPONENTS

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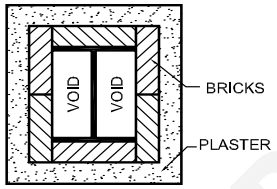
Fig 7



PROTECTION OF STEEL COMPONENTS

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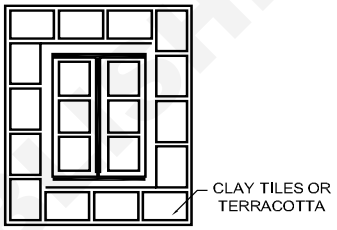
Fig 8



PROTECTION OF STEEL COMPONENTS

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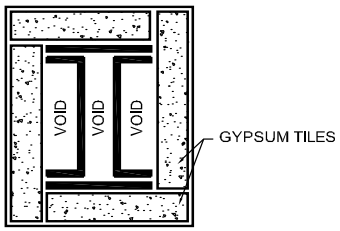
Fig 9



PROTECTION OF STEEL COMPONENTS

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v The flooring materials like concrete tiles, ceramic tiles, bricks etc. Are more suitable for fire resistance.

vi If cast iron, wrought iron, cork carpet, rubber tiles etc. Are to be used, these should be protected by a covering of insulating materials like ceramic tiles, plaster, terracotta, bricks etc.

vii Ceiling, directly suspended from floor joists should be of fire resistant materials like asbestos cement boards, fibre boards, metal lath with plaster etc.

3 Wall Openings

i From the point of view of fire spread, openings in the walls should be a bare minimum.

ii Openings serve means of escape. Hence these should be properly protected by suitable arrangements, in case of fire.

iii Doors and windows should be made of steel. Fire - resistant doors can be obtained by fixing steel plates to both the sides of the door.

iv Wire-glass panels are preferred for windows.

v Rolling shutter doors should be used for garages, godowns, shops etc.

vi In case of timber doors, minimum thickness of door leaf should be 4 cm. And that of door frame as 8 to 10 cm.

vii All escape doors should be such as to provide free circulation to the persons in passages, lobbies, corridors, stairs etc., and should be made of fire proofing material.

4 Escape Elements

i All escape elements, such as stair cases, corridors, lobbies, entrances etc. Should be constructed of fire - resistant materials.

ii These escape elements should be well separated from the rest of the building.

iii Doors to these escapes should be fire proof.

iv Staircases should be located next to the outer wall and should be accessible from any floor in the direction of flow towards the exits from the building.

v Fire proof doors to the emergency stair cases should be fixed in such a way as to make them close from inside only.

vi The lift shafts connecting various floors should be surrounded with the enclosure walls of fire-resisting materials.

vii Lift shafts should be vented from top to permit escape of smoke and hot gases.

viii An emergency ladder should be provided in the fire-resisting building. This ladder should be at least 90 cm wide, constructed of fire-resistant materials.

ix All escape routes over roofs should be protected with railings, balustrades or parapets not less than one metre in height.

5 Strong room construction

A strong room construction is found to be useful in case of safe deposit vaults in banks. Following are the important features of construction:

i The walls, floors and ceilings of a strong room are made of at least 30cm thick cement concrete. If thin R.C.C. walls are used, they should be have covering of bricks or terra-cotta and then suitably plastered with fire-resistant plaster.

ii Doors and windows are well anchored to concrete walls by large number of steel hold fasts longer in length.

iii Doors and windows should be fire-proof. It is preferable to have double fire-proof door.

iv Windows and ventilators should be covered by special grills made of 20 mm steel square bars. These grills should be well fixed to concrete walls by means of long steel hold fasts.

Fire alarms

Fire alarms are installed to give an alarm and to call for assistance in event of fire. The fire alarms give enough time to the occupants to reach to a safe place.

Fire alarms can be either manual or automatic

1 Manual alarms

These are of a hand-bell type or similar other sounding device, which can emit distinctive sound when struck. These are sounded by watchmen and the occupants are there by warned to have safe exit in shortest possible time. Manually operated alarms shall be provided near all main exits and in the natural path of escape from fire, at readily accessible points which are not likely to be obstructed.

2 Automatic alarms

These alarms start sounding automatically in the event of fire. It is used in large industrial buildings which may remain unoccupied during night. The automatic fire alarm sends alarm to the nearest control point. The system can also perform the function of sending message to the nearest fire brigade station.

Fire extinguishing equipments

Each building should have suitable fire extinguishing arrangements, depending upon the importance of the building and the associated fire hazards. Following are usual equipments required for fire extinction.

Manual fire extinguishing equipment

These devices are useful for extinguishing fire as soon as it starts. They are not so useful when once the fire has spread. Under this category comes the portable extinguishers of carbon - dioxide type or foam generation type etc. The discharge from a portable fire extinguisher lasts only for a short duration of 20 to 120 seconds. In some cases, especially in small buildings buckets of water, sand and asbestos blanket may be kept ready at all times to extinguish fire. These buckets are installed at convenient locations for taking care of fire of minor size.

Fire hydrants

These fire hydrants are provided on a ring main of 150 mm dia. In the ground around the building periphery. The ring main gets water from underground tank with pressure, so that available pressure at each hydrant is of the order of about 3.5 to 4 kg/cm^2.

Wet riser system

The system consists of providing 100 to 150 mm dia. Vertical G.I pipes (risers) at suitable locations in the building. A fire pump is used to feed water from underground tank to these pipes, to ensure a pressure of 3 kg/cm^2 at uppermost outlet.

Automatic Sprinkler system

This arrangement is adopted for important structures like textile mills, paper mills etc. The system consists of a net work of pipes 20 mm dia. Fixed to the ceiling of the room. These pipes are spaced at 3m centre to centre. Heat actuated sprinkler heads are fixed to these pipes at regular interval. The pipes get supply from a header. Each sprinkler head is provided with fusible plug. In the event of fire, the fusible plug in the sprinkler nearest to the wire melts due to rise of temperature, and water gushes out of the sprinkler head. The fire is thus brought under control in a short period.

Purpose of drainage

Objectives: At the end of this lesson you shall be able to
- **state purpose of drainage**
- **state conservancy system**
- **state water carriage system**
- **state the comparison between conservancy system and water carriage systems.**

Purpose of drainage

- When water is supplied to the building, provision should be made to remove the waste water.
- The pipes are used to remove waste water are called drainage pipes.
- While laying out to keep proper drainage slopes. Proper pipe capacities and proper sizes to prevent the abnormal air pressure in the drainage pipes.

There are two methods are employed for collection and disposal of refuse.

1 Conservancy systems

2 Water carriage system

1 Conservancy system

- In conservancy system, the different types of refuse are collected separately and carried and suitably disposed off.
- The garbage is collected from streets in pans or baskets.
- The garbage is conveyed by cart or truck to suitable place.
- The garbage is separated into two such as flammable and inflammable matter.
- Flammable is burnt into incinerators.
- Inflammable is buried into low laying areas for the reclamation of soil.
- The night soil is collected in pans from lavatories and the sewage is carried by labour in carts, trucks etc.,
- The night soil then buried into the ground and is converted into manure.
- The storm water and sullage are collected and conveyed separately by closed or open channels.
- The storm water and sullage are discharged in natural rivers or streams.

2 Water carriage system

- Water carriage system, water is used as medium to convey the sewage.
- The quantity of water to be mixed with solid matter is quite sufficient and the dilution ratio of solid matter with water.
- The sewage is conveyed in suitably designed and maintained services.

Comparison between conservancy system and water carriage system

S.No	Conservancy system	Water carriage system
1	Not compact design of structure	Compact design of structure
2	It is laid above ground. It is non - hygienic	It is laid below the ground. It is hygienic
3	It require small quantity of water. (30 to 40 litres per capita per day)	It require large quantity of water (100 to 120 litres per capita per day)
4	If has been used in rural areas	It has been used in an urban area
5	More labours are required	Few labours are required
6	There is presence of segregation	There is absence of segregation
7	Initial cost is low but maintenance cost is high	Initial cost is high but maintenance cost is low
8	Does not require skilled persons.	It require skilled persons for laying and maintenance
9	The city becomes dirty and bad smelling	The city appears neat and clean
10	Underground sources of water may be polluted due to soaking of liquid wastes from the latrines.	Practically no risk of pollution of underground sources of water closed sewers an carried above the water pipes.

Patterns of refuse collection

Objectives: At the end of this lesson you shall be able to
- **state the patterns of refuse collection**
- **state the name of fire pattern of refuse collection**
- **state fan pattern and interceptor pattern**
- **state perpendicular pattern**
- **state radial pattern and zonal pattern.**

Patterns of refuse collection

- The liquid waste to be collected depending upon the area to be drained, topographical and hydraulic features of the area, location of the treatment works, sewerage system adopted for the locality.

There are five patterns of collection system is adopted.

1 Fan pattern

2 Interceptor pattern

3 Perpendicular pattern

4 Radial pattern

5 Zonal pattern

1 Fan pattern

- The treatment plant is located at a certain point.
- All the sewage flow is directed towards this point.
- Like a fan, network of converging main sewers are laid in this pattern.
- In fan pattern only one unit of treatment plant will be required.

2 Interceptor pattern

- The sewers are intercepted by large size sewers . Which are laid along the water course.
- The sewage is carried to the treatment plant.
- The sewage is disposed off either with or without treatment.
- If the storm water is more, storm regulated provided at suitable point.

3 Perpendicular pattern

- The main trunk sewers are laid perpendicular to the natural water courses.
- The storm water disposed off directly without only treatment.
- This pattern can be used for separate or partially separate system.
- This pattern will be impracticable for combined system because it will required a treatment unit at every point of out let.

4 Radial pattern

- The sewers are laid radially outwards from the centre of the city.
- The radial pattern where facilities of sewage disposed by land treatment are available.

5 Zonal pattern

- The city is divided into suitable zones.
- A separate interceptor is provided for each zone.
- This pattern is suitable for sloping hills and also economic.

Systems of sewerage

1 Separate system of sewerage.

2 Combined system of sewerage.

3 Partially combined or partially separate system of sewerage.

1 Separate system of sewerage

In this system, two sets of sewers are laid. One sewer is meant for carrying sewage. While the other for carrying storm water.

Merits of separate system

i Sewer sizes are small.

ii Sewage load on treatment units is small.

iii River or stream waters are not polluted.

iv Without any treatment, rainwater or storm water can be discharged into streams or rivers.

v When sewage has to be pumped. This system proves to be economical.

Demerits

i It is costly, because it requires two set of sewers.

ii Sewers being small, it is difficult to clean them.

iii Sewers are likely to choke frequently.

iv Storm water sewers are used only during rains. Therefore during non - rainfall season they may become the dumping places for garbage and may get choked up.

2 Combined system of sewerage

In this system, only one set of sewer is laid to carry both sewage and storm water.

Merits of combined system

i Rain water keeps sewage fresh making it easier and more economical for treatment.

ii Dilution itself is a method of treatment.

iii Automatic flushing is provided by water.

iv Because of the bigger size of the sewer, cleaning is easier.

v This is a simple method of collection and house plumbing is economical.

vi Maintenance cost is reasonable.

vii Only one set of sewers is required in this system.

Demerits of combined system

i The bigger size of sewer would involve larger excavation.

ii The D.W.F. being a small amount of the total flow, the larger size of the sewer would often result in causing silting up due to low velocity.

iii Cost of pumping and treatment is more, since large quantity of sewage is to be handled.

iv Over flowing under worst conditions may endanger public health.

v Load on treatment units increases.

vi Storm water is unnecessarily polluted.

3 Partially combined or partially separate system of sewerage

In this system also, only one set of sewer is laid. During small rain falls, the rain water is collected and conveyed along with sanitary sewage. If the amount of storm water exceeds certain limit, it is collected and conveyed in open drains. While sewage continues to flow through sewers.

Merits of partially combined system

i It simplifies the drainage of the house.

ii It provides reasonable sizes of sewers.

iii It is economical.

iv The rain water avoids silting in sewers.

v It has the advantages of both separate and combined systems.

Demerits of partially combined system

i Low velocity during dry period.

ii Storm - overflows may be found necessary.

iii Load on pumping and treatment unit is increased due to the admission of storm water.

iv Storm water is polluted unnecessarily.

Types of roofs

Objectives: At the end of this lesson you shall be able to
- **state the roof**
- **state the technical terms regarding roof**
- **state the five types of single roof**
- **state about double roof.**

Roof

A roof is termed as the uppermost part of a building which is constructed as a framework to give protection against weathering actions such as rain, heat, snow, wind etc

A roof consists of structural elements and roof coverings.

Requirements of a good roof: The following aspects should be fulfilled while designing a good roof.

A roof should have

- Durability against the weathering agents such as rain, heat, snow, wind etc.
- Structural stability and should be capable of withstanding the loads likely to act over it.
- Facility to discharge the rainwater very quickly
- Insulation against heat and sound.
- Damp - proofing arrangements to prevent the entry of dampness

Classification of roofs

Following are the three classifications of roof according to their shape.

Pitched or sloping roof

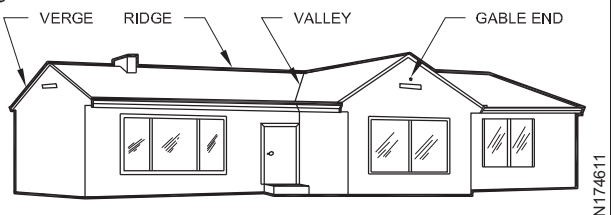
Flat or terraced roof.

Curved roof.

Climatic conditions, shape of building, availability of materials and importance of the building are the four aspects which govern the selection of the type roof for a building. The salient features of pitched roof are explained in this lesson.

Pitched or sloping roof: A sloping roof is called as pitch roof. As the pitched roofs have sloping top surfaces, they are useful at places where the rainfall or snowfall is very heavy. (Fig 1)

Fig 1

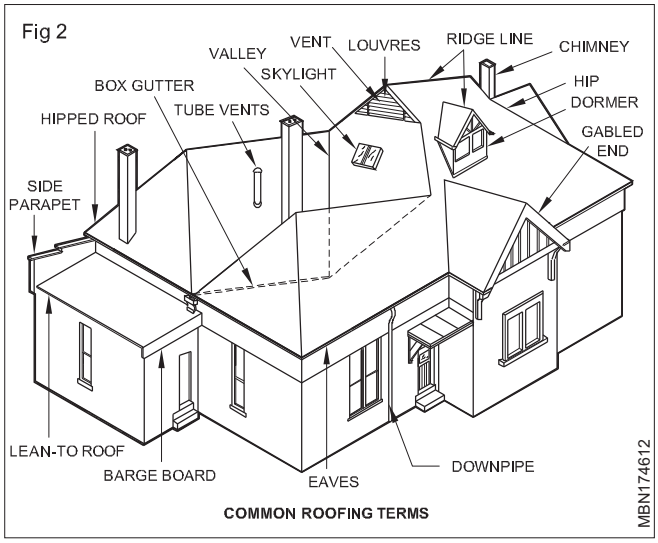


Technical terms: Following are the technical terms used in connection with the pitched roofs (Fig 2).

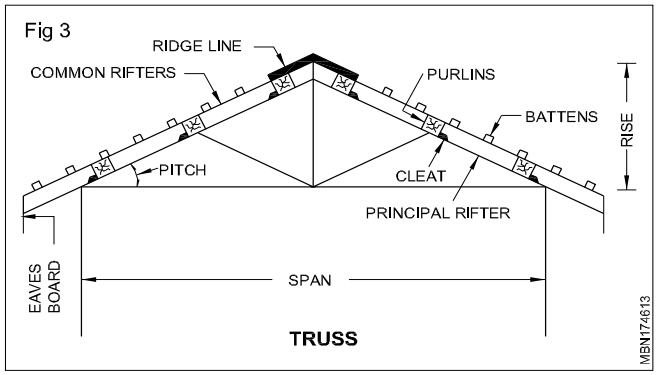
Span : The horizontal distance between internal faces of supports or walls is called span. It is also known as clear span.

Effective span

It is the horizontal distance between centre to centre of walls or supports.



Rise : This is the vertical height measured from the lowest to the highest points of a pitched roof. (Fig 3)



Pitch: The inclination of sides of a roof to the horizontal plane is called as pitch (Fig 3) It can be expressed either in degrees or in ratio of rise to span.

The pitch of a roof depends upon the climatic conditions and the materials used for roof covering.

Pitch of roof for various covering materials

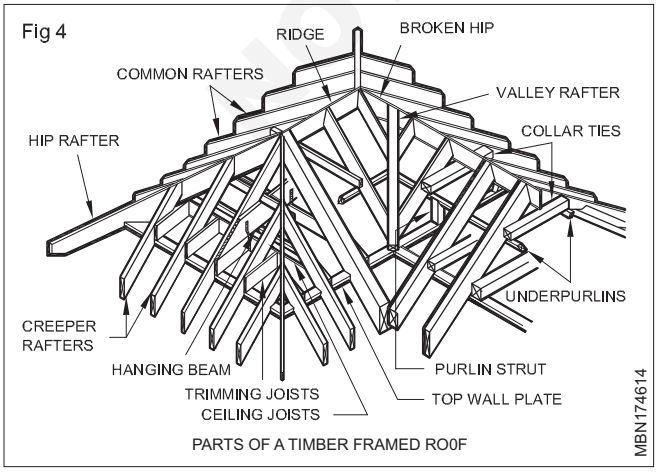
Roof covering material	Angle with Horizontal	Ratio of rise to span
Mangalore pattern tiles	$33^0 40'$	1:3
Country tiles	$45^0 00'$	1:2
Pan tiles	$33^0 40'$	1:3
Thatch tiles	$45^0 00'$	1:2
Slates	$26^0 33'$	1:4
Asphalt felt , corrugated	$11^0 18'$	1:10
Asbestos and iron sheets		
Stone slabs	$33^0 40'$	1:3
Zinc, asphalt and copper	$0^0 45'$	1:160
Asphalt concrete or mud terrace	$2^0 00'$	1:30

Gable or Gable end:

It is the triangular upper portion of a wall at the end of a pitched roof. (Fig 1 & 2)

Ridge line: The apex line of a sloping or pitched roof is known as ridge line. (Fig 1&2)

Ridge: A wooden member provided at the ridge line of sloping roof (Fig 4) is called as ridge or ridge piece or ridge board.



Eaves: The lower edges of a pitched roof are known as Eaves (Fig 2) They are resting upon or projecting beyond the supporting walls.

Eaves board: A thin board of wood which is provided at the eaves to cover the ends of rafters. (Fig 3) is known as eaves board. The usual size of an eaves board is 25mm thick and 125 to 200 mm width.

Truss: A frame work (usually triangular in shape) steel members designed to support the roof covering or ceiling over rooms is known as truss in Fig 3.

Rafters: Rafters are timber members or pieces which extend from the eaves to the ridge. The various types of rafters are given below.

i Common rafters:

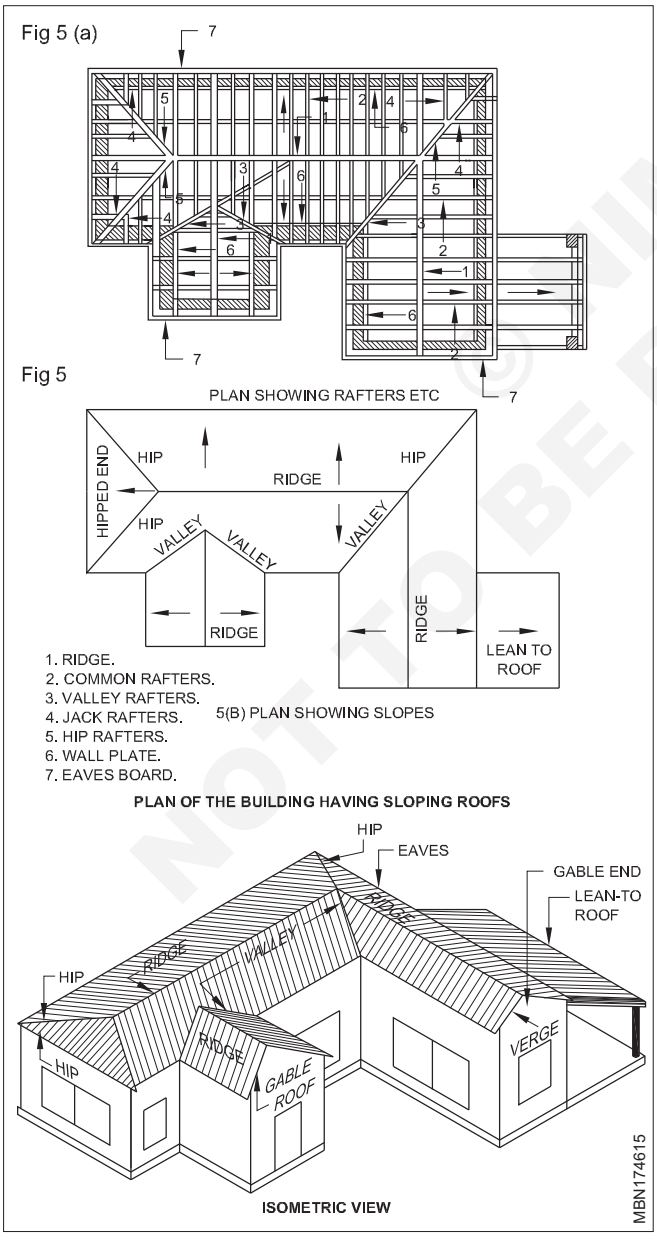
The intermediate rafters which give support to battens and boarding to support of covering are known as common rafters (Fig 4 & 5)

The common rafters are fixed with ridge piece and wall plate (see Fig 4). Usually common rafters are provided at a span of 300 to 450mm centre to centre. Following are the normal size of common rafters for different spans.

No.	Unsupported length of rafters	Size of rafters (Depth x Breadth)
1	1.75m	75 x 50mm
2	2.00m	90 x 50 mm
3	2.50 m	100 x 50 mm
4	2.75 m	110 x 50 mm
5	3.00 m	125 x 50 mm

Minimum size of common rafters spaced at 300 to 450mm c/c

ii Hip rafters: The rafters which are provided at the junction of two roof slopes are known as hip rafters (Fig 4 & 5a)



iii Jack rafters: Any rafter which is shorter than a common rafter is known as Jack rafter. (Fig 5a)

iv Principal rafters: The inclined members of a truss are known as principal rafters. (Fig 3)

Purlins: These are the wooden pieces which are used to carry the common rafters by placing them horizontally on principal rafters when the span is large (Fig 3). They are generally supported by walls and roof trusses.

The usual sizes of purlins are tabulated below.

Size of timber Purlins for Various Spans.

Purlins exceeding 5 metres in length are not economical. Hence, in the absence of crosswalls, or partitions, trusses are provided to limit the unsupported length of purlins to 5 metres.

Battens: These are the thin strips of wood (Fig 3) Which are fixed on the rafters to support the roof covering. The roof covering such as slates, tiles etc. are laid directly over the battens.

The battens are generally 12 to 25mm thick and 25 to 50mm wide

Barge board: The wooden planks or boards which are fixed on the gable end of a roof are known as barge boards. They connect the ends of ridge, purlins and wall plates at gable end. (Fig 2)

Cleats : The small blocks of wood which are fixed on the trusses to keep the purlins in their position are known as cleats (Fig 3)

Dragon beam: The diagonal piece of timber which is laid across the corner of a wall to support the lower end of a hip rafter is known as dragon beam. It is also known as dragon beam. It is also known as a dragon tie or angle tie.

Hip: The external angle formed at the intersection of two roof slopes is known as hip (Fig 5)

Valley: The internal angle formed at the intersection of two roof trusses is known as valley (Fig 5)

Template: It is the bedding block placed at the end of a truss. A template may be made up of wood or stone or R.C.C A template resist the truss and spread the load in a larger area of wall.

The shape of a template is a square or rectangular and the thickness varies from 100 to 150mm.

Verge: Verge is the edge of a roof running between the eaves and ridge (Fig 1)

Wall plates: These are the long wooden members which are securd on top of a wall to support the common rafters (Fig 5). The wall plates connect the walls with the roof.

Span in meters	Maximum 1.75m	Inclined 22.5m	Distance in apart 2.75m
1.75	112 x 75 mm	125 x 75 mm	150 x 75mm
2.50	150 x 75 mm	175 x 75 mm	175 x 100mm
3.00	175 x 75 mm	175 x 100 mm	200 x 100mm
3.50	175 x 150 mm	200 x 100 mm	225 x 125mm
4.25	225 x 125 mm	250 x 112 mm	275 x 100mm
5.00	275 x 100 mm	275 x 125 mm	275 x 150 mm

The normal size of wall plate is 100 x 80mm

Post plates and pole plates: These are continous timber pieces which are fixed on the tops of post to support the common rafters. The post plates are usually 150x 75mm These are similar to wall plates. but, smaller in cross section.

Boarding or Sarking: This consists of boards which are nailed to the upper edges of common rafters and to which the roofing materials are secured. Generally the thickness of boards is 25mm.

Bressummer : It is a timber beam which is fixed on top of two timber posts at the ends without any intermediate support. The bressumer is similar to post plates but, the cross section will be larger than that of post plates.

Classification of pitched roof: Pitched roofs are classified into the following three main classes.

- Single roof
- Double roof or purlin roof
- Triple membred (or) Trussed (or) Framed roof

The features of single roof and double roof are explained in this lesson.

Single roof : In single roof, the common rafters are provided in each slope without any intermediate supports. The common rafters are secured with ridge piece and wall plates. The various forms of single roof are

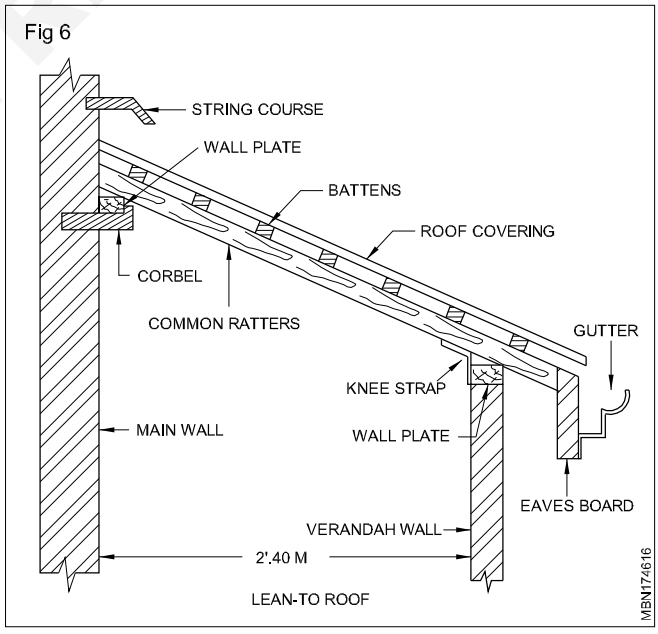
- Lean to roof
- Couple roof
- Couple - close roof
- Collar beam roof
- Collar and scissors roof

The salient features of above types are briefly described below

Lean to roof (Fig 6)

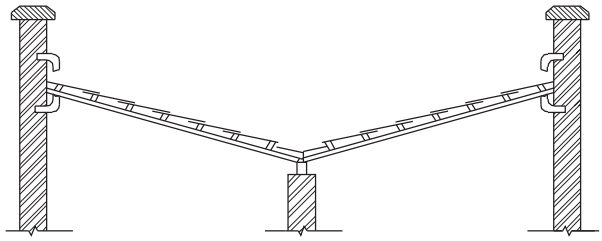
- This is the simplest form of pitched roof which is also known as pent roof' or 'Aisle roof' or 'Shed' or verandah roof.
- This is formed with one slope only.
- One wall (mainwall) is carried at higher than the other one (Verandah wall) to give necessary slope to the roof.
- The rafters are secured suitably on wall plates and eaves board as shown in Fig 6.
- Sometimes, the common rafters are made to enter the main wall about 15cm deep.
- Battens and roof covering are provided over the common rafters.
- The lean to roof is limited to 2.4m span and this type of roofing is used for out-houses attached to main buildings, verandahs etc.

Fig 6



- The lean to roof may also be constructed as 'Double lean to roof' as shown in (Fig 7).
- In this type two lean to roof slope towards each other, constituting a V shape over which a gutter is formed as detailed in (Fig 8).

Fig 7



DOUBLE LEAN TO ROOF OR PENT OR V ROOF

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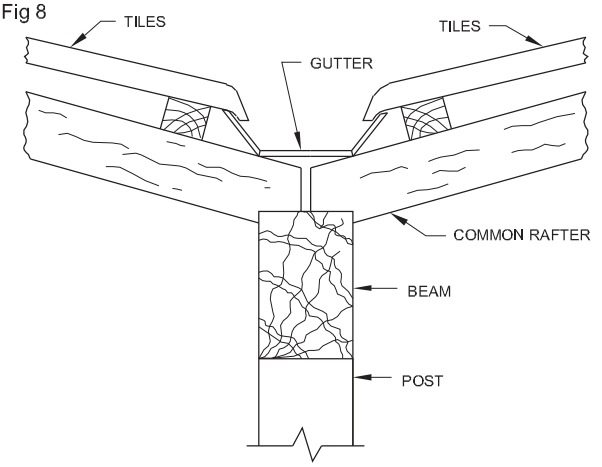
Fig 8



DETAILS OF PENT OR V ROOF

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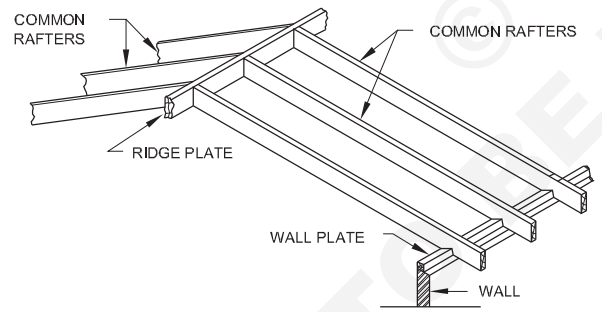
Couple roof: In this type each pair of common rafters runs in opposite directions from ridge piece to wall plates as shown in (Fig 9).

Fig 9



DETAILS OF FIXING COMMON RAFTERS

MBN174619

- The common rafter are secured at both ends. One end being on the ridge piece and the other end on the wall plate. Eaves board, rainwater gutters, battens and roof coverings are provided as shown in (Fig 10).
- This is not a good form of pitched roof as it has a tendency to spread at the feet and thrust on walls.
- Therefore this type of roof is limited to a span of 3.60m

Couple close roof:

- This type of roof is similar to couple roof except that the bottom of common rafters are connected with a tie-beam as shown in (Fig 11).

Fig 10

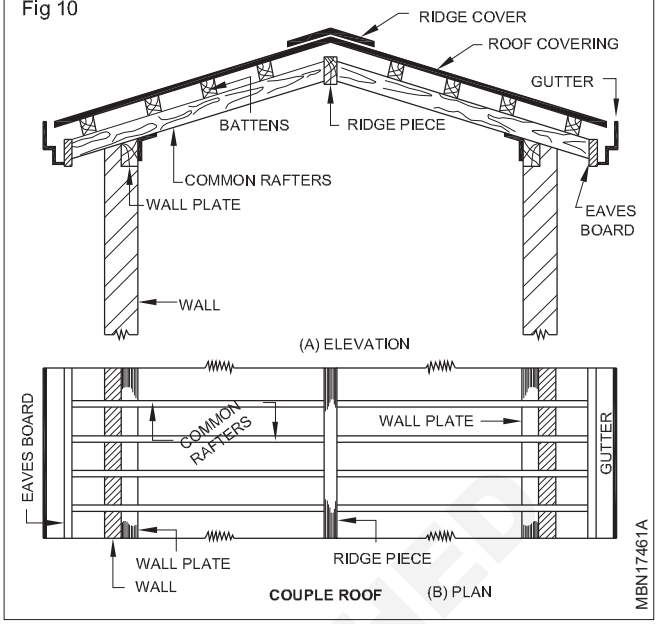


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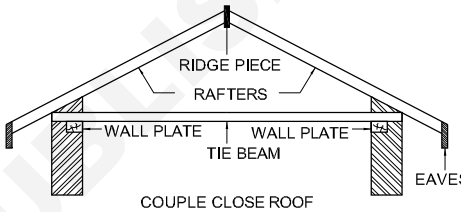
Fig 11



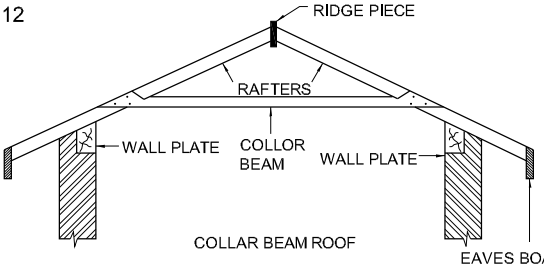
MBN17461B

- The tie beam prevent the tendency rafters to spreadout and thus avoid the danger of overturning of walls.
- Sometimes a ceiling is formed between the tie beams. In such cases the tie-beams are called as ceiling joists (Fig 4)
- This type of roof is suitable upto a span of 4.20m.
- For increased spans or greater loads, a central rod knowns a 'King rod' is used to connect the ridge piece with tie-beam This arrangement prevent the sagging of couple close roof.

Collar beam roof:

- This is similar to couple close roof except that the tie-beam is placed at a higher level as shown in the (Fig 12).

Fig 12



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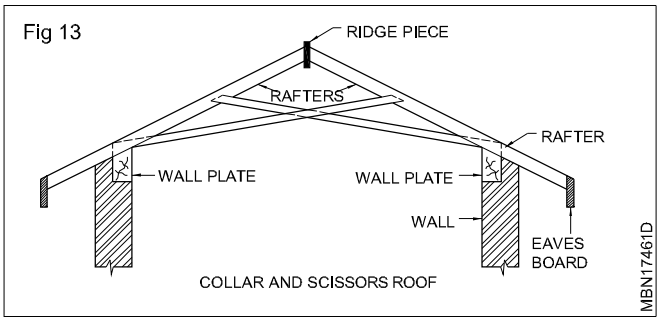
- The tie at higher level is known as 'Collar' or 'Collar beam'
- Usually the collar beam is placed between one-third to one - half the vertical height from the wall to the ridge.
- Collar beam roof can be adopted upto a span of 4.80m

Collar and scissors roof:

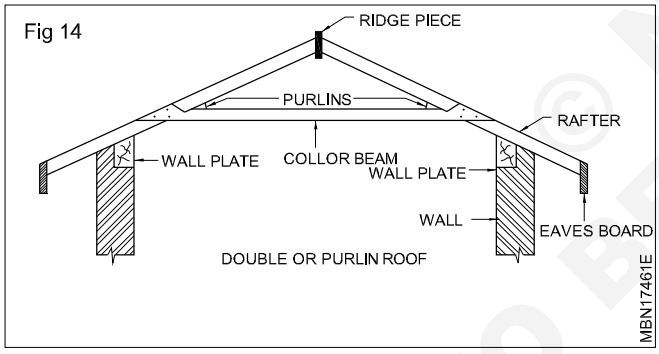
- This type of roof is similar to collar beam roof except that two collars are used in the shape of scissors which are crossing each other as shown in (Fig 13).



- Collar and scissors roof can be adopted upto a span of 5.00m

Double roof (or) Purlin roof:

- Additional members known as purlin are introduced in this type of roof to support the common rafters at intermediate points as shown in (Fig 14).



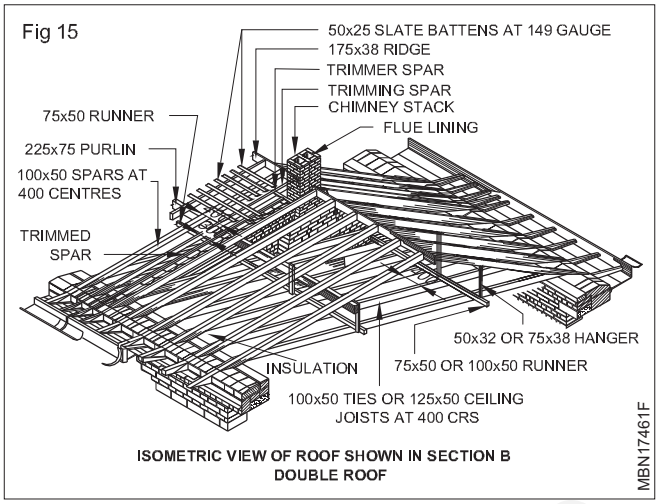
- Usually purlins are required when the span exceeds 5.00m. But inorder to reduce the size of common rafters, purlins may be introduced from 2.40m span onwards. Hence, the single roof, shown in (Fig 11 to 14) may be altered to double or purlin roof.
- Inthis type of roof, each common rafter is supported at three points.
- at the top of wall plate
- at the ridge piece and
- at the centre by a purlin.

This type of roof is stronger than single roofs

(Fig 15) shows pictorial view of a Double roof.

Roof covering for pitched roof.

The following factors are considered before the selection of roof covering for a pitched roof.



Climatic condition

Type of building

Construction cost and maintenance cost.

Durability

Availability of materials and labour.

Roof framework

Resistance to heat and fire

Locality condition

The commonly used roof coverings are briefly explained below,

Thatch

- It is the cheapest and very light roof covering. But, it is liable to decay due to absorbtion of moisture.
- It is unstable against winds.
- If thatch is used as roof covering the pitch is kept at 45° to drain off the rain water quickly.
- The thatch is laid on a bed of matting over battens.
- It is widely used in rural areas.

Ordinary half round country tiles

- Usually these tiles are laid in two layers and known as double -tiled roof.
- An overlap of at least 80mm should be provided when these tiles are used.
- These tiles are easily breakable and hence frequent replacement is required.
- These are used for low-cost building.

Shingles

- The wood shingles (wooden boards) are obtained from well seasoned timber.
- The length of shingles varying from 300 to 380mm and widths varying from 60 to 250mm.
- These are laid similar to tiles or slates.
- It is widely used in hilly areas where it is easily and cheaply available.

King post truss

Objectives: At the end of this lesson you shall be able to

- **state what is trussed roof**
- **state kingpost truss**
- **state queen post truss**
- **state combination of king and queen post truss**
- **state steel truss.**

State trussed roof

When the span exceeds 5m and when there are no inside support walls (or) pillar or column. To support purlins, framed structure known as truss. It is provided at suitable interval.

The Trusses limiting 3m for wooden trusses.

The steel trusses are limited upto 14m span.

The Roof consist of rafter, purlin, struts, post steel stirrups and Ridge and cleat etc.

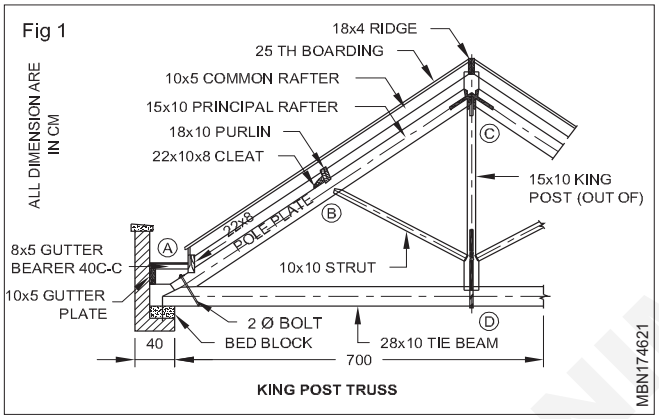
The various types of trusses in uses are,

King post truss

A king post truss the central post known as king post.

It forms a support for the tie beam is horizontal member, the inclined members known as struts. It is preventing the principal rafters from bending in the middle. The king post truss shown in (Fig 1,2,3,4&5).

Fig 1



KING POST TRUSS

Fig 2

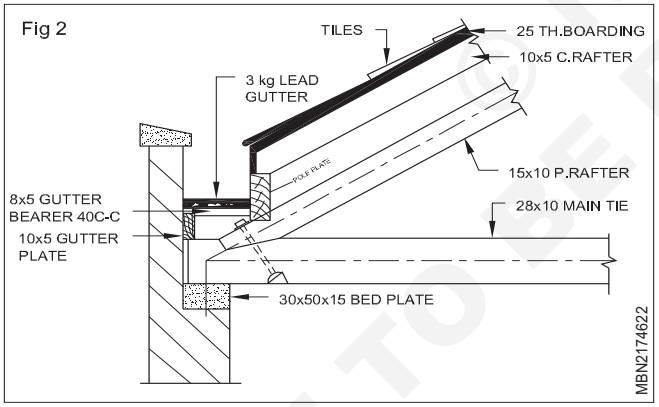


Fig 3

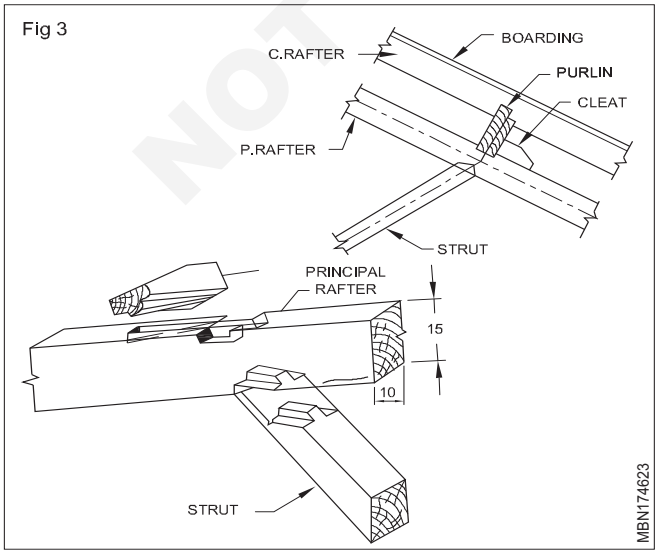


Fig 4

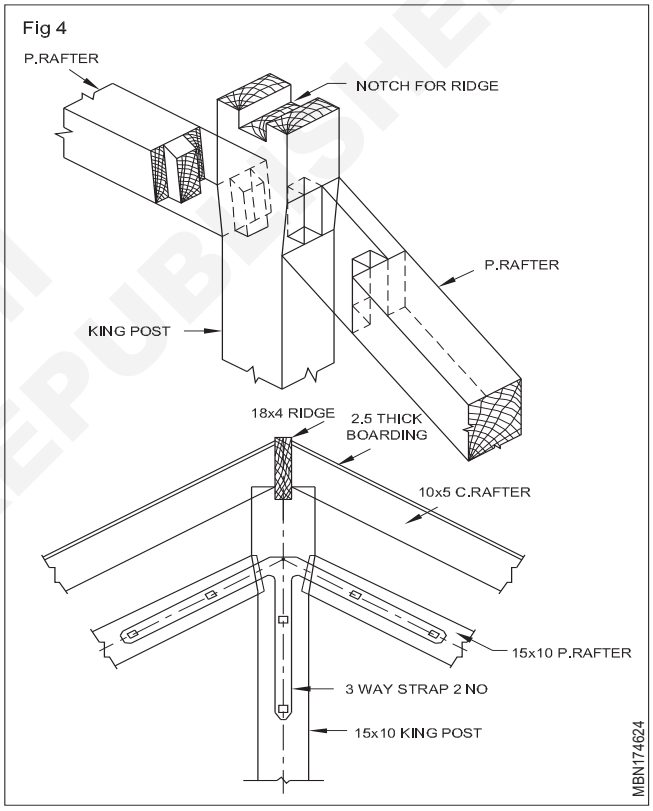
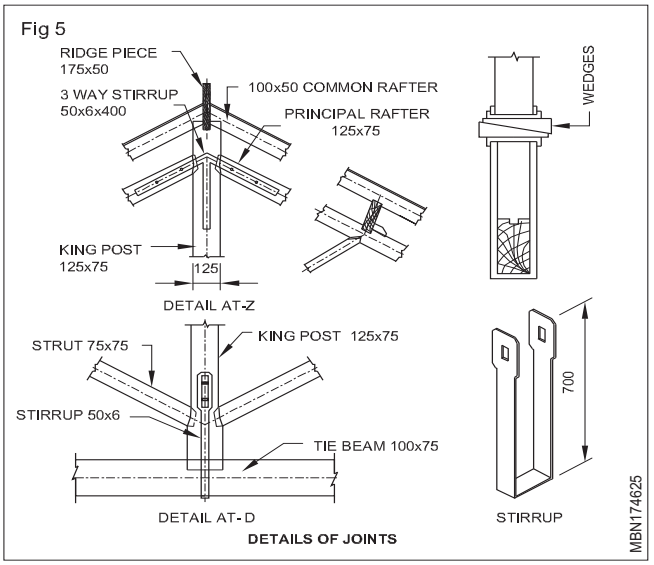


Fig 5

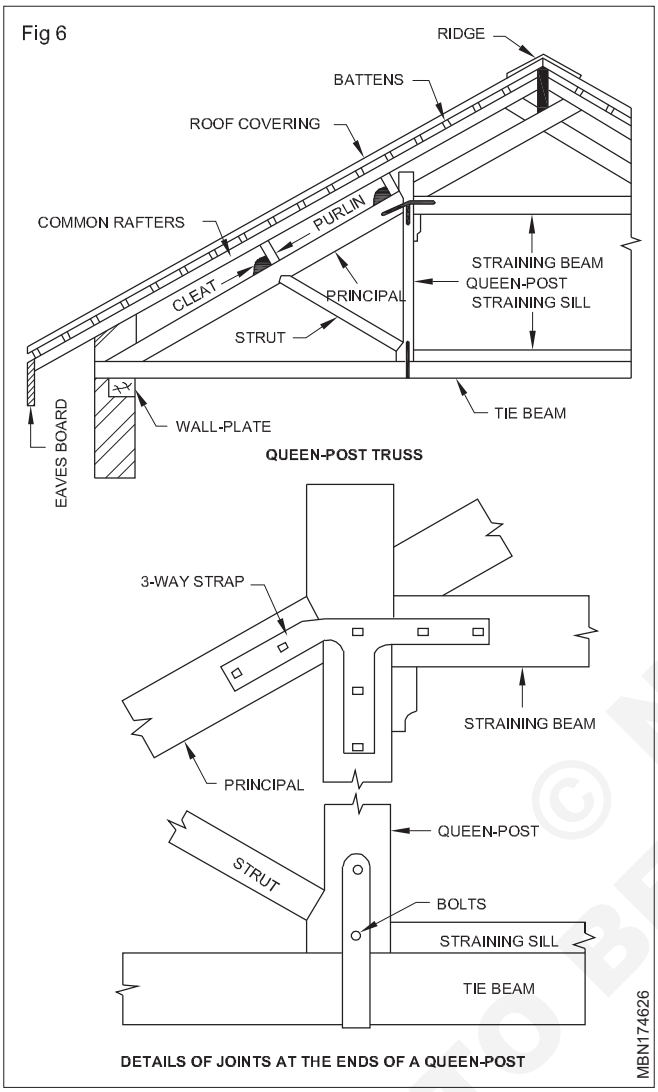


DETAILS OF JOINTS

Queen post truss

This truss is differ from a king post truss, it have two vertical post known as the Queen posts. The upper ends of the queen post are kept in position by a horizontal member known as straining beam. The purlin are supported on the queen posts.

Queen post roof is shown in (Fig 6)



Combination of king and queen trusses

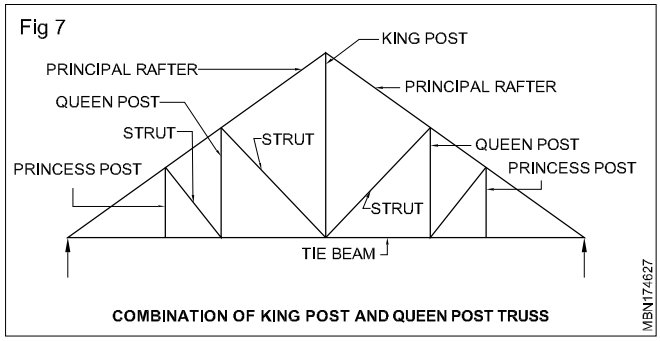
Combination of the king and queen post truss can be made to increase the suitable span upto 18 metres.

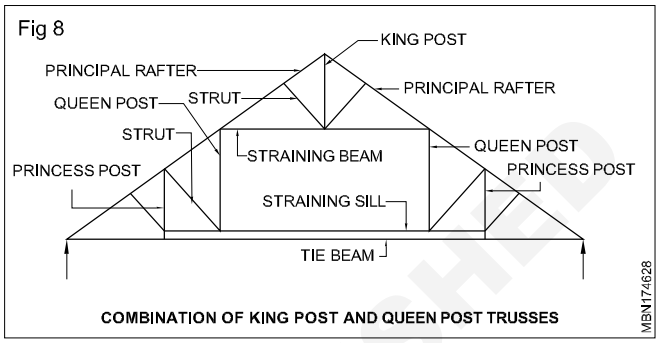
Purpose of the Queen post truss is strengthen one more upright member Known as princess post on either side (Fig 7&8).

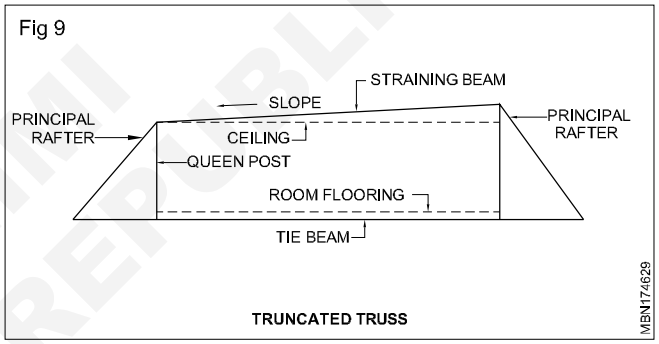
Truncated truss is a two storey truss with upper portion is consisting of king post and the lower portion is of Queen post truss Except the top is finished flat with a gentle slope to one side (Fig 9) shows a Truncated truss.

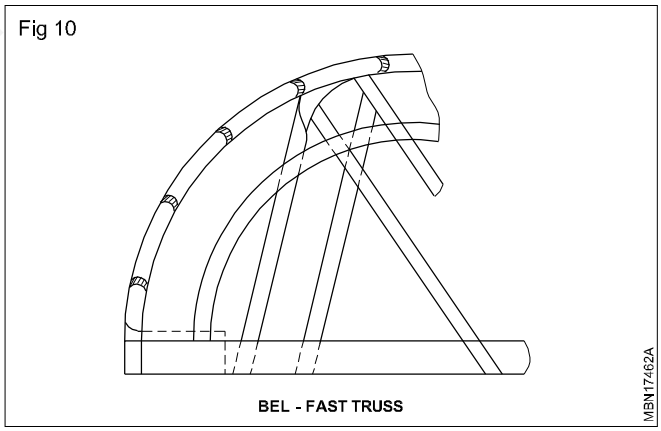
Belfast truss

This truss is form a bow shapped. It consist of thin section of steel (or) timber. The top of chord curved This truss can be used for long span of about 30 metres. This roof covered light roofing. This roof is called laticed roof truss or low string truss shown in (Fig 10).









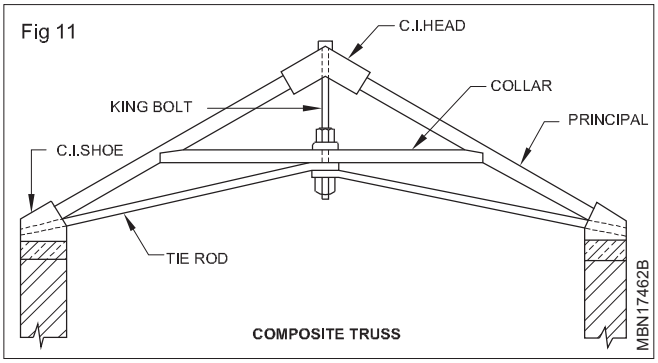
Steel trusses

The steel trusses consists of angles riveted or welded together through plates known as the Gusset plates. A steel can resist both the stresses, compression and tension. The arrangement of various sizes available in mild steel sections in local market it is depend on the span, loading and wind pressure the spans are greater than 12 metres.

Composite trusses

These trusses composed of wooden member and steel. The steel is used for resist tensile stresses. A (Fig 11) shown in a typical composite truss. this is light in weight and economical When were special fitting required at the junction to connect the steel and timber This joints in composite truss are such that cast or forged fitting is used.

Fig 11



Roof covering components

Objectives: At the end of this lesson you shall be able to

- **state roof covering**
- **state galvanized corrugated iron sheet**
- **state corrugated asbestos cement sheet**
- **state half round country tiles and mangalore tiles**
- **state flat pan tile**
- **state sloteand allahabad tiles.**

Pitched roof covering

- Pitched roof covering gives a protective surface to the roof structure.
- The function of roof covering materials to prevent heat and moisture into the building.
- The selection of roof covering materials depends upon its availability, initial cost, maintenance cost, local condition, type of roof structure, appearance and durability.

Galvanized corrugated iron sheet

- 22 gauge sheets are used as roof covering materials in workshop buildings.
- The purpose of corrugation is to give additional strength to thin sheet and drain out rain water.

Size (L x B)	No. of Corrugation
1.80 x 0.90	10
2.20 x 0.90	10
2.50 x 0.90	10
2.80 x 0.90	10
3.20 x 0.90	10
3.60 x 0.90	10
1.80 x 0.75	8
2.20 x 0.75	8
2.50 x 0.75	8
2.80 x 0.75	8
3.20 x 0.75	8
3.60 x 0.75	8

- The pitch of corrugation is 85 mm
- Depth of corrugation is 18 mm.
- Thickness of sheet is 0.8 mm.

Method of fixing

- End lap not less than 15 cm. (Fig 1)
- Side lap varying from 1 ½ to 2 corrugation. (Fig 2)
- The sheets fastened above eaves by 25 x 6 mm flat iron as a tie.
- Sheets are fixed to the portions by means of 8 mm dia iron hook bolt.

Fig 1

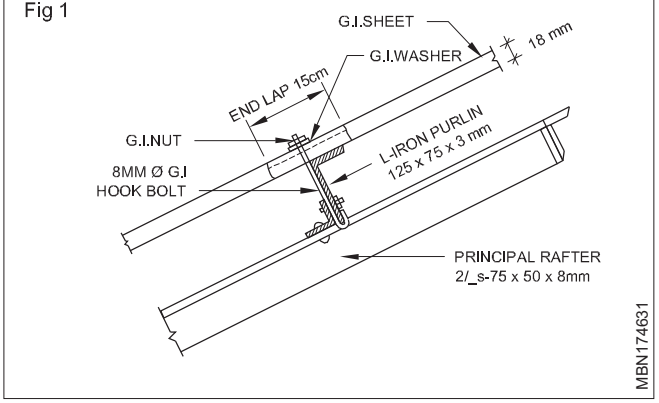
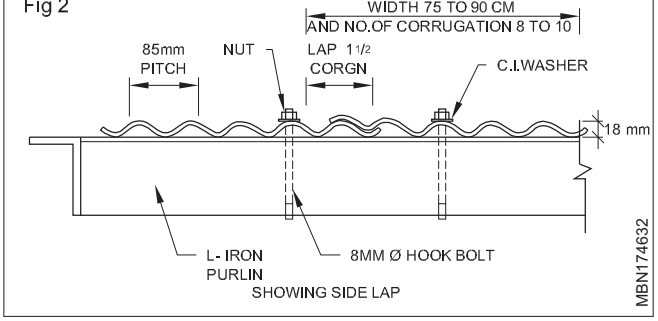


Fig 2

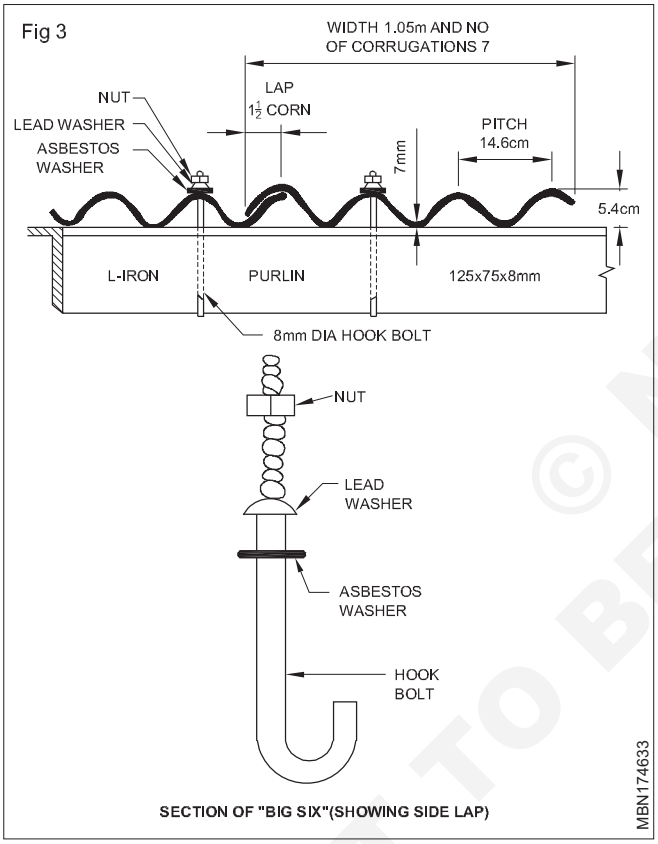


Corrugated asbestos cement sheet

- Corrugated asbestos cement sheets are laid similar to galvanized corrugated sheets.
- There are two types.

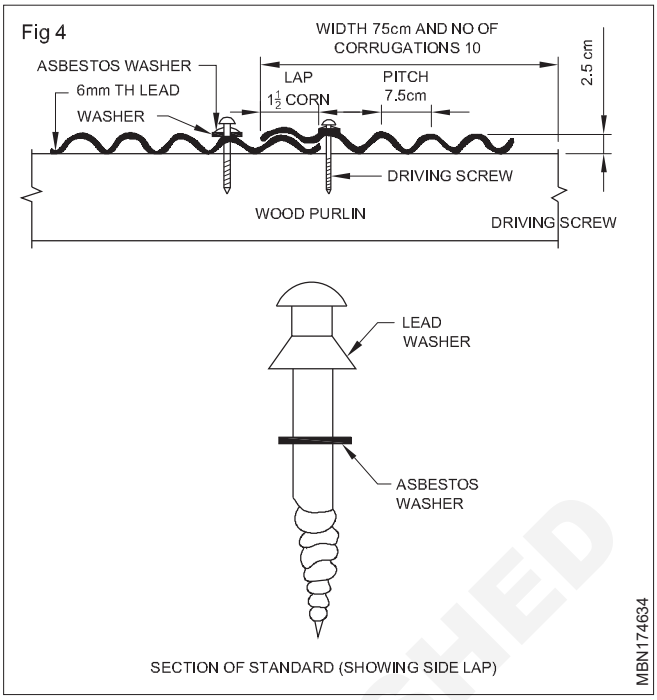
i Big six (Fig 3)

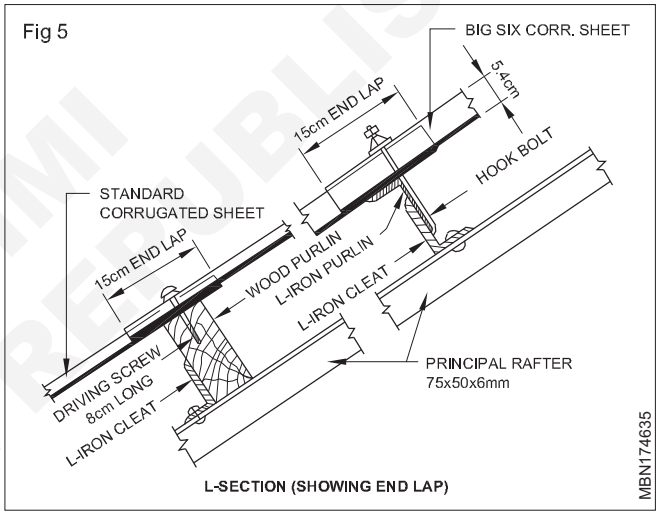
- Width of sheet 1.05 m
- Length of sheet 2 to 3 m
- Side lap 1½ corrugation
- End lap 15 cm
- Thickness of sheet 7 mm
- Depth of sheet = 5.4 cm
- Pitch 14.6 cm
- No. of corrugation 7



ii Standard (Fig 4&5)

- Width of sheet 0.76 m
- Length of sheet 2 to 3 m
- Thickness of sheet 6 mm
- Side lap 1 ½ corrugation
- End lap 15 cm
- Depth of sheet 2.5 cm
- Pitch 7.3 cm
- No. of corrugation 10

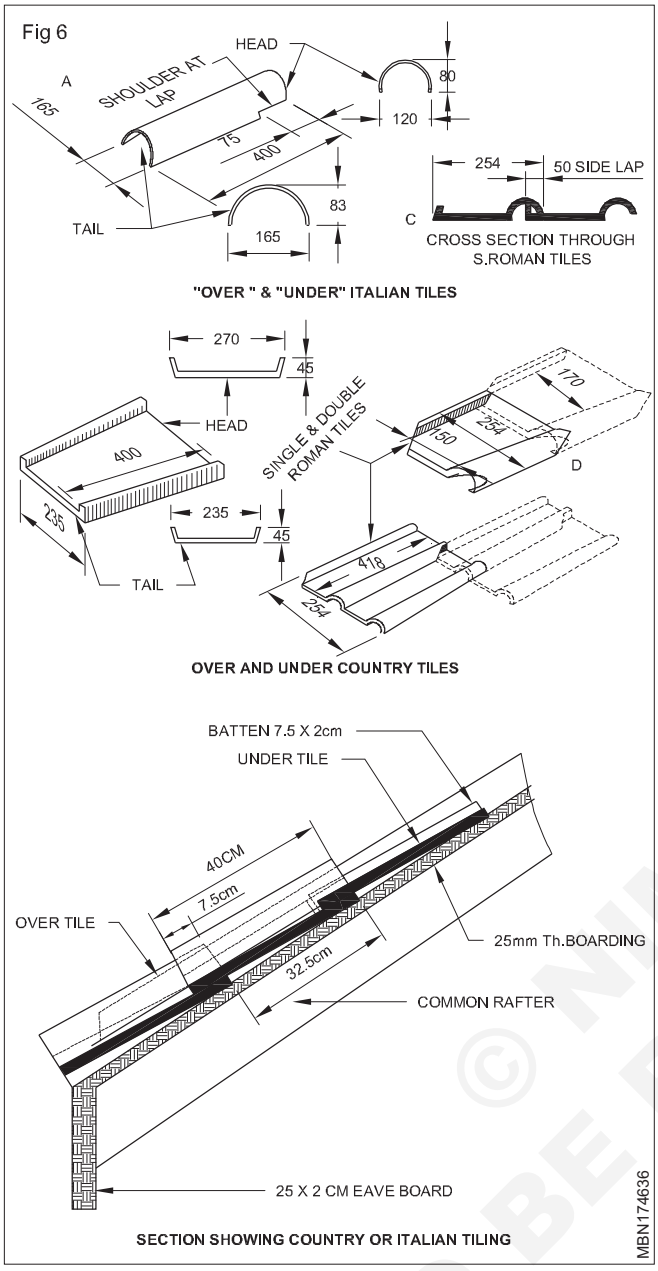


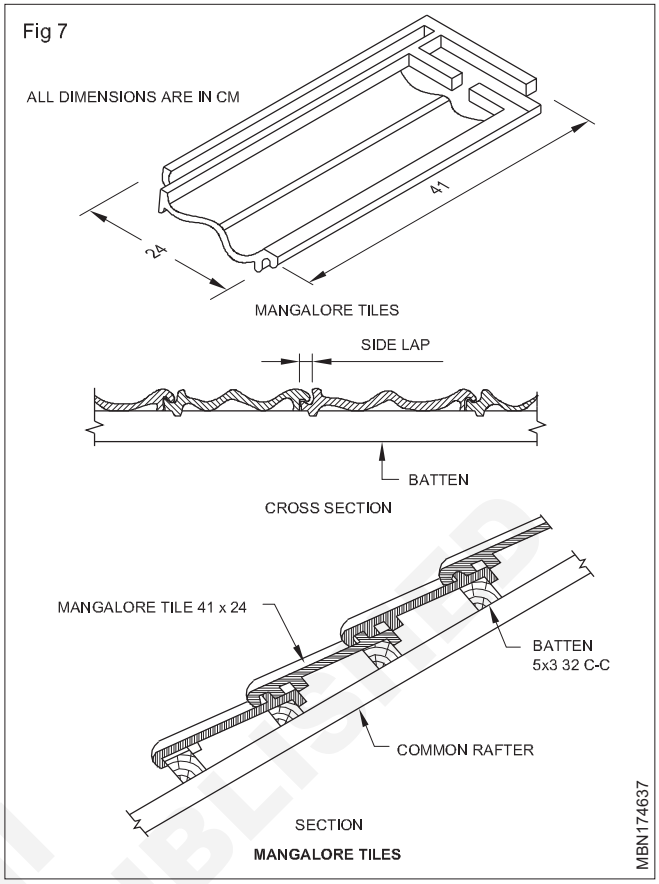


Tiles (Fig 6)

i Half round country tiles (or) Italian tiling

- The length of flat tiles 40 cm
- Width at tail 25 cm
- Width at head 30 cm
- Half round tile 40 cm length
- Flat tiles are laid on batten
- The side joints of every two adjacent flat tile should be covered by over tiles .
- The tiles are laid in rows from bottom to top of the roof.
- Same times they are laid in two layers one over the other. This roof is called "double tiled roof".





Mangalore tiles (Fig 7)

- Mangalore tiles are flat pattern tiles with suitable key projections.
- The size of tiles 41 cm x 24 cm. and covers 32 cm x 21 cm.
- 16 Mangalore tiles are required to cover 1 sq.m.
- The batten (5 cm x 3 cm) are fixed 32 cm c/c.
- Special tiles are used for ridges, hips and valleys.

Flat pan tiles (Fig 8)

- The size of flat pan tiles 33 cm to 36 cm long and 23 cm to 25 cm wide.
- Head lap 8 cm.
- Side lap 5 cm.
- Flat pan tiles an laid on battens 4 cm x 2 cm at an interval of 28 cm c/c.
- The common rafter (10 cm x 5 cm) is placed 15 cm c/c.
- Pan tiles having a hole near the head it can be secured with batten by means of nails.

SLATE

- The size of slate stone vary from 25.60 x 12.35 cm.
- The pitch of slope 22° to 33° according to the size of slate.
- The thickness of slate 1.6 mm to 4.80 mm.
- The lap should not be less than 10 cm.
- Copper nail or non - rusting nails are used to fix to slate.
- The minimum size of batten 4 cm x 4 cm.
- The size of common rafter 10 cm x 5 cm at 60 cm c/c.

Allahabad tiles (Fig 9)

- Single tiling consists of flat tiles and adjacent sides are covered by semi - cylindrical tiles.
- Double tiling consists of a layer of flat tiles laid on the battens.
- The side joints of every two flat tiles covered by semi - hexagonal tiles.

Fig 8

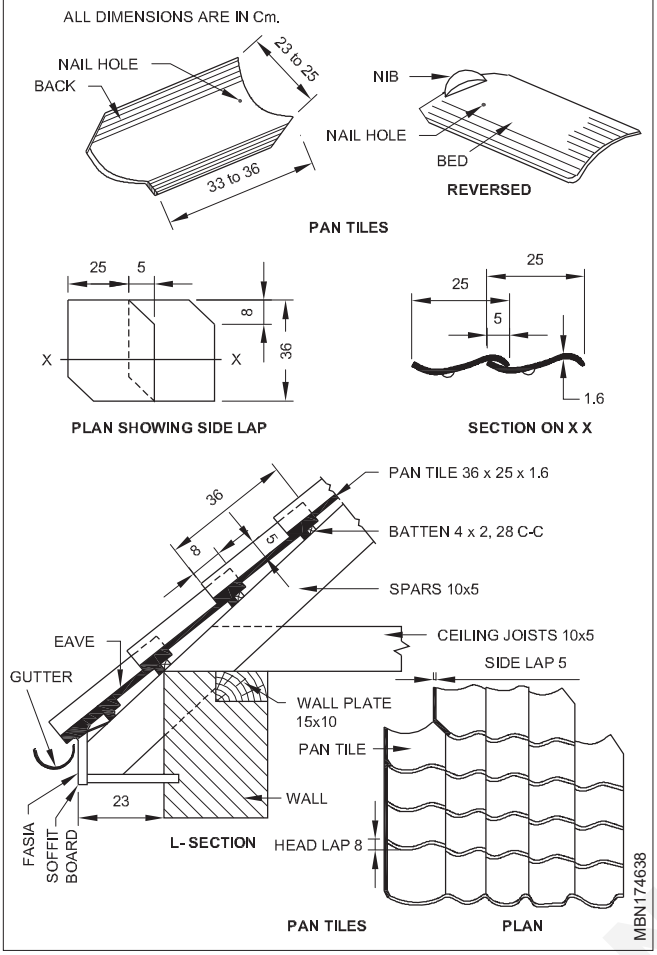
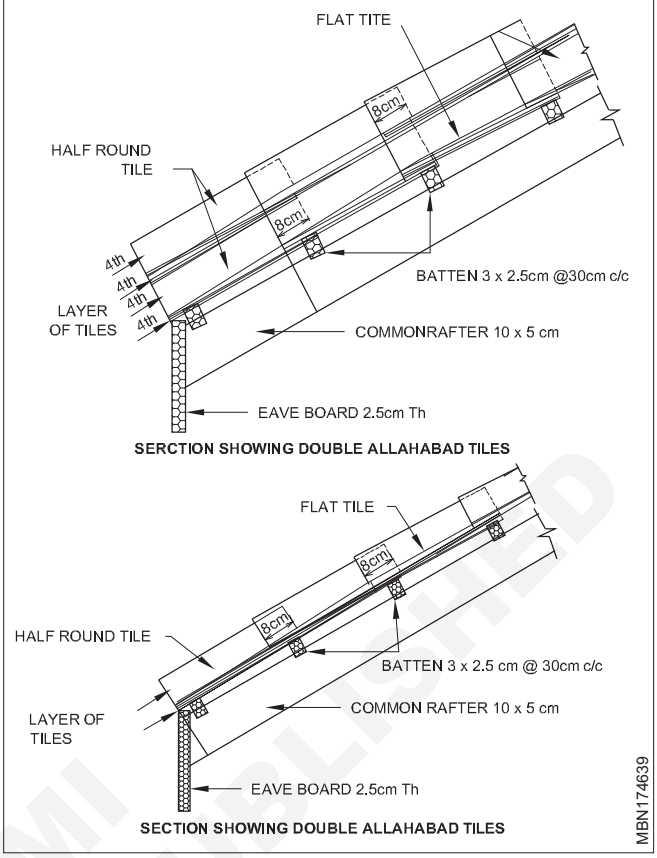


Fig 9



House drainage system

Objective: At the end of this lesson you shall be able to
- **explain various system of plumbing drainage.**

Systems of sanitary plumbing: Following are the four principle systems adopted in plumbing of drainage work in a building:

- Two pipe system
- One pipe
- Single stack system
- Partially ventilated single stack system.

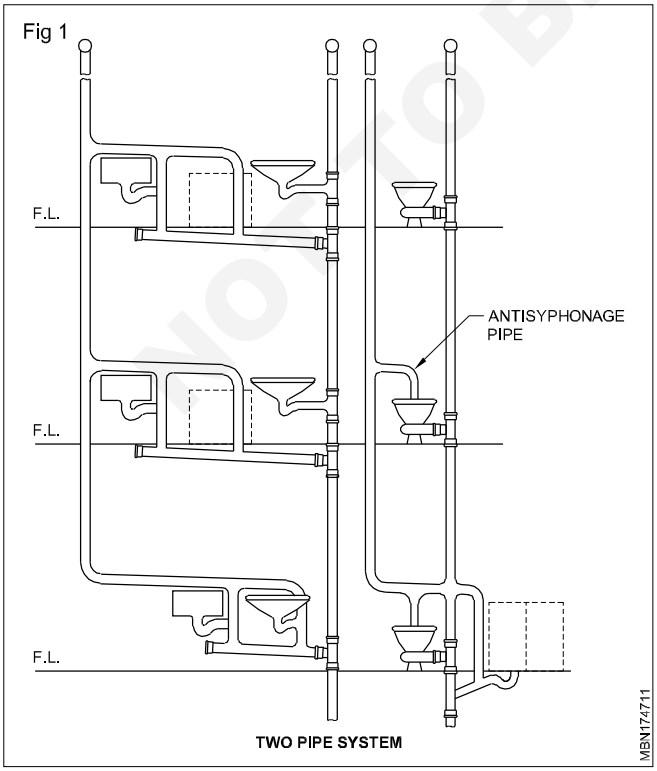
This systems are discussed below:

Two pipes system: This is the best and the most improved type of system of plumbing. In this system, two sets of vertical pipes are laid, i.e., one for draining night soil and the other for draining sullage. The pipes of the second set carrying sullage from baths pipes, etc., are called sullage pipes or waste pipes.

The soil fixtures, such as latrines and urinals are all connected through branch pipes (laterals) to the vertical soil pipe; whereas, the sludge fixtures such as baths, sinks, wash basins, etc. are all connected through branch pipes to the vertical waste pipe. The soil pipe as well as the waste pipe are separately ventilated by providing separate vent pipes or antisiphonage pipes . This arrangement, thus requires four pipes.(Fig 1)

This system, thus involves a large number of pipes, and is thus quite costly. In small houses, moreover, it becomes difficult to accommodate such a large number of pipes.

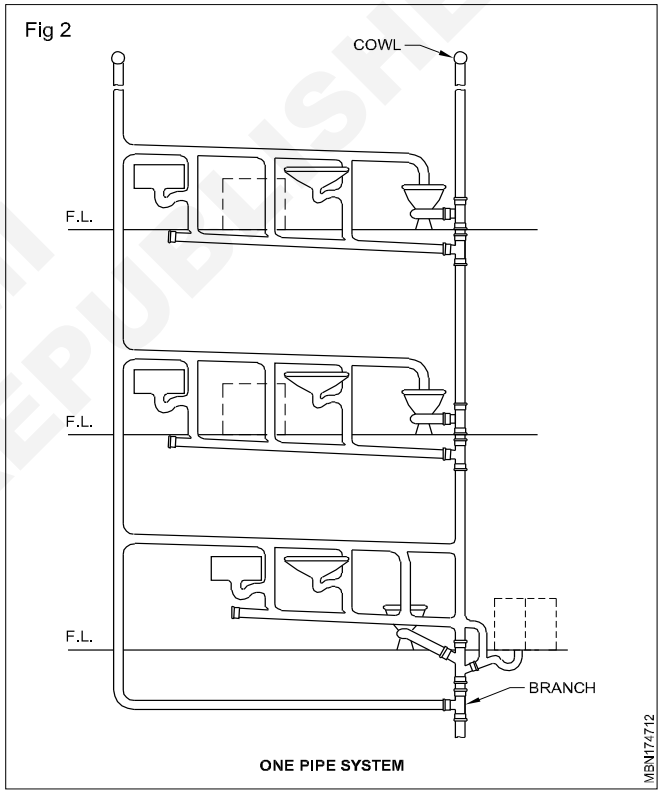
Fig 1



TWO PIPE SYSTEM

One pipe system: In this system, instead of using two separate pipe (for carrying sullage and night soil, as is done in the above described two pipe system) only one main vertical pipe is provided, which collects the night soil as well as the sullage water from their respective fixturesthrough branch pipes. The main pipe is ventilated in itself by providing cowl at its top, and in addition to this, a separate vent pipe, however, is also provided as shown in (Fig 2). This system, thus, has two pipes, instead of four pipes of the two pipe system.

Fig 2

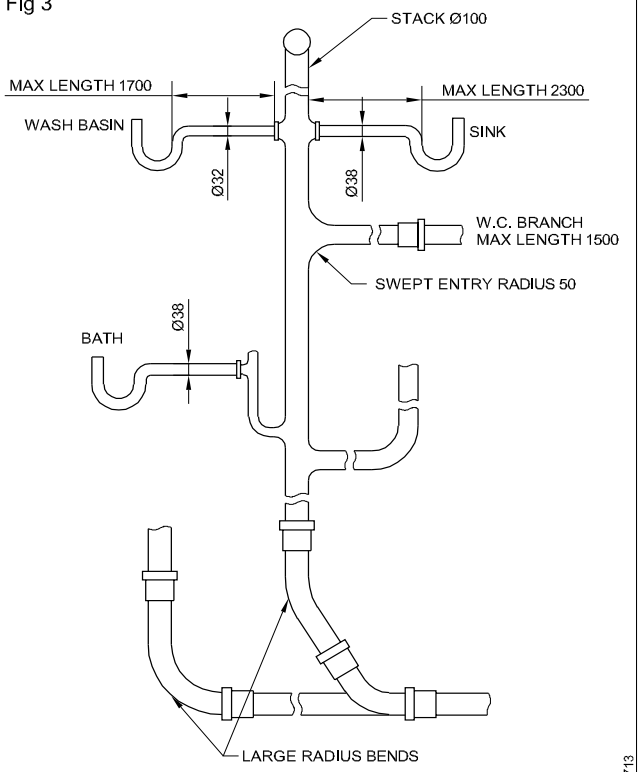


ONE PIPE SYSTEM

Single stack system: This system is a single pipe system without providing any separate ventilation pipe. Hence, it uses only one pipe, which carries the sewage as well as the sullage and is not provided with any separate vent pipe, except that it itself is extended upto about 2m higher than the roof level and provided with a cowl, for removal of foul gases as shown in (Fig 3 & 4).

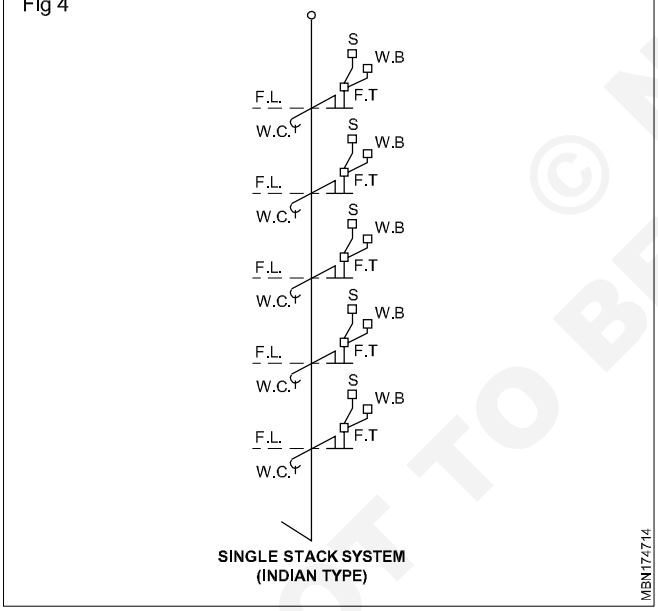
Partially ventilated single stack or single pipe system: This is an improved form of single stack system in the sense that in this system, the traps of the water closets are separately ventilated by a separate vent pipe called relief vent pipe. This system, thus, uses two pipes as in a single pipe system, but the cost of branches (laterals) is considerably reduced compared to single pipe system, because the sullage fixtures are not connected to the vent pipe. This arrangement is shown in (Fig 4). Besides these systems, other combinations and permutations are also possible and may be adopted by some people.

Fig 3



SINGLE STACK SYSTEM (WESTERN TYPE)

Fig 4



SINGLE STACK SYSTEM (INDIAN TYPE)

Choice of a Particular System of Plumbing: As pointed out earlier, the two pipe system is the best system for efficient conveyance of sanitary house wastes with minimum use of traps and is therefore, largely favoured, particularly for large and multistoried buildings. This system, however, requires a large number of pipes and their connections and is hence costly. Moreover, it is also difficult to find suitable place for accommodation so many pipes in small houses and buildings. In that case, one pipe system is more economical and easy to accommodate, but requires sufficient safe guard, to make the drainage effective in the form of proper ventilation, adequate water seals and proper connections between the sanitary fixtures and the soil pipe. In multistoried buildings, moreover, use of one pipe system, generally makes it imperative to place the lavatory blocks of various floors one above the other.

Sewerage Plans of Buildings and Designs of Sewer Pipes

Quantity of Flow: The flow in the drainage pipes of a house sewerage system is irregular in nature and is not continuous. The quantity is also small. The average rate of flow is usually based on a water supply of 135 litres per capita per day for average Indian conditions. The maximum flow may be taken as three times this average.

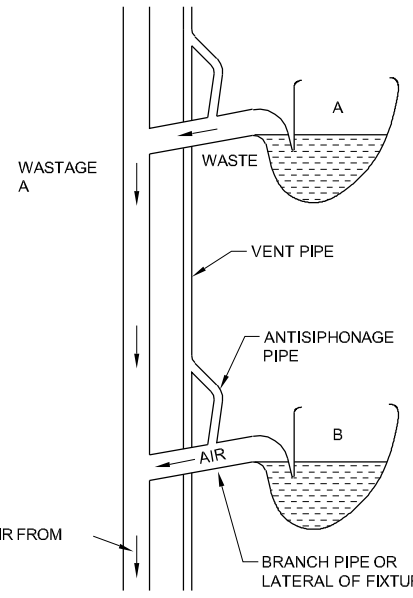
Waste pipes: Every pipe for carrying water or overflow water from every bath, wash basin or sink to a drain shall be of 32 to 50mm diameter. Waste stacks shall have a minimum dia of 75mm.

Ventilating pipes

- The building drain ventilating pipe should be not less than 75mm in diameter when, however, it is used as main soil pipe or main waste pipe (MSP or MWP). The upper portion, which does not carry discharges, should not be of lesser diameter than the remaining portion.
- The diameter of the main ventilating pipe should not be less than 50mm.
- A branch ventilating pipe on a waste pipe in both one and two pipe systems should be of not less than two-thirds, the diameters of the branch waste ventilated pipe subject to a minimum of 25mm.
- A branch ventilating pipe on a soil pipe should be not less than 32m in diameter.

Anti Siphonage pipes: Water seals of traps in multi-storied buildings or houses may sometimes get broken due to siphonic action, as explained below: (Fig 5).

Fig 5



INDUCED SIPHONAGE AND ANTI-SIPHONAGE PIPE

When waste water is suddenly discharged from a sanitary fixture on the upper floor, it moves down rapidly through the soil (or the waste) pipe; and in its movement, it may suck some air from the lateral pipe connecting the soil pipe

with the fixture at the lower floor. This sucked air causes siphonic action, resulting in the flow of water from the trap of the fixture to the soil pipe and thus, breaking its water seal.

To overcome this difficulty, a separate pipe of smaller diameter is attached to the traps, which connects the trap with the vent pipe. This pipe is known as anti siphonage pipe and it supplies air to the short branch pipe of the lower fixture, at the time of suction; otherwise also, it acts as a vent pipe connection of the lower fixture. This pipe. thus will normally serve as a vent pipe, and as an anti-siphonage pipe in case suction takes place, as explained above. Hence, some people get confused when anti siphonage pipes or vent pipes are sometimes described separately and sometimes written as one and the same thing.

PVC pipe fitting

Objectives: At the end of this lesson you shall be able to
- **explain the requirement of soil waste and rain water pipes**
- **identify correctly the names of different PVC pipe fittings used for soil waste and ventilating pipes**
- **explain the fuction of PVC fittings.**

Unplasticized polyvinyl chloride (UPVC) pipe: There are two types of pipes as detailed under.

Type A: for use in ventilation pipe work and rain water application.

Type B: for use in soil and waste discharge system. these pipes should confirm IS13592. The material from which the pipes are produced consists of Polyvinyl Chloride, additives and stabilizer.

Pipes are available in length of 2,3,4 & 6M either plain or with sliding/grooved sockets. A tolerance of +10mm on specified lengths are permitted. The pipes are designated by its outside diameter. The mean outside ϕ, outside ϕ at any point wall thickness for Type A and B are at Table1, rubber lubricant evenly on the chamfered spigot and sealing ring **** socket with a light twist upto the marking on pipe.

Fittings used should confirm to IS14735 and rubber ring to IS5382. The pipes and fittings are provided with square groove and special shaped rubber rings. The single socketted pipes cover with plain end duly chaufed at the end. When required lengths are cut from pipe the plain end to be chamfed. The plain end of all fittings are chamfered at the end. The pipes should be supported on the walls with PVC pipe clip and it should be fixed below the socket of pipe or fitting (not on the socket).Maximum spacing of clips shall be as under.

Ring seal joints: After cleaning the spigot end and inside of socket the sealing ring is placed evenly in the socket. After chamfering the pipe end to an angle of 15^0 with a rough file, measure the depths of socket. After allowing a gap of 10mm mark the distance on spigot end of pipe. Apply the

Table 1

Size of pipe mm	Support distance in meter	
	Vertical	Horizontal
40	1.2	0.5
50	1.2	0.7
75	1.8	0.9
110	1.8	0.9
160	1.8	1.0

Layout of house drainage

Objectives: At the end of this lesson you shall be able to
- **state the house drainage**
- **state what are the points shuld be considered while preparing house drainage.**

House drainage layout

- Before starting the building construction work it is very essential to prepare the drainage plan. (Fig 1)
- While preparing the layout of house drainage the following points should be kept in mind.
- The drain should be laid in slope due to self cleaning velocity is developed.
- The slope for different diameter pipes are 1 in 40 for 10 cm diameter. 1 in 60 for 15 cm diameter. 1 in 90 for 25 diameter.
- The drainage system should be ventilated.
- Vent pipe should be provided at higher level from the building.
- Before the pipe future safety should be considered.
- Further expansion should be considered while laying drain pipe.
- Soil pipe should be connected directly to drain.
- Discharge from both, sink and rain water should be connected through gully by waste pipe.
- Laying of drain pipe considered for future expansion.
- It the sewage is very small of flushing tank may be provided.

Fig 1

F.T.=FLOOR TRAP

G=GULLY TRAP

S.P.=SOIL PIPE

V.P.=VENT PIPE

V.S.=VENTILATING SHAFT

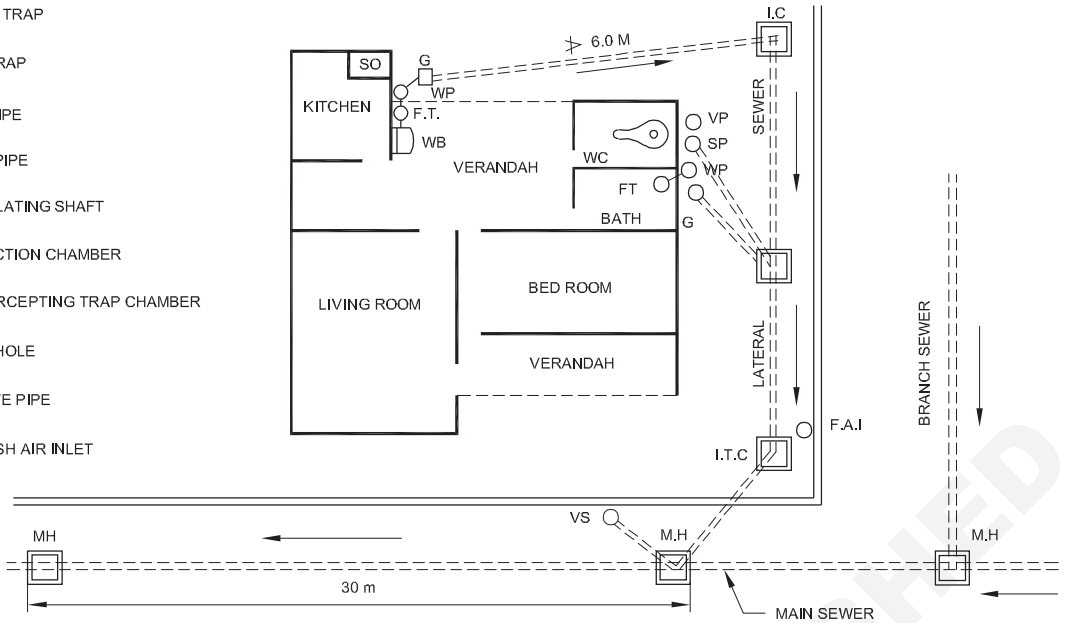
I.C.= INSPECTION CHAMBER

I.T.C.= INTERCEPTING TRAP CHAMBER

M.H.= MAN HOLE

W.P.= WASTE PIPE

F.A.I = FRESH AIR INLET



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LAYOUT OF HOUSE DRAINAGE

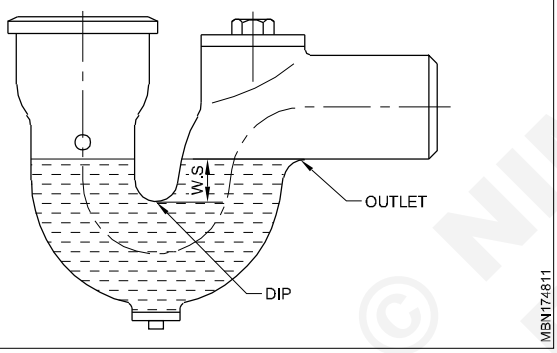
Traps in house drainage

Objective: At the end of this lesson you shall be able to
- **explain the traps used in house drainage.**

Functions and types of traps being used in Sanitary plumbing systems

Definition: Traps may be defined as fittings, placed at the ends of the soil pipes or the sullage pipes (waste pipes) to prevent the passage of foul gases from the pipes to the outside. This is possible because traps does enclose or maintain water seal between the pipe and the outside. This water depth does not allow gases to escape to the outside of the pipe. The efficiency and effectiveness of a trap will depend upon the depth of the water seal. Greater is this depth, more effective the trap will be. This water seal generally varies from 25mm to 75mm, 50mm being quiet common in most of the traps. (Fig 1).

Fig 1



Qualities: A good trap should posses the following qualities:

- It should provide sufficient water seal (50mm - or so) with large surface area. The seal of a trap is the water between the outlet and the dip.
- Its interior should be smooth so as not to obstruct flow and the trap should thus be self cleaning.
- It should be provided with an access door for cleaning and
- It should be made of some non absorbent material.

Types: Depending upon their shapes, the traps may be of three types i.e P-trap, Q-trap and S-trap.

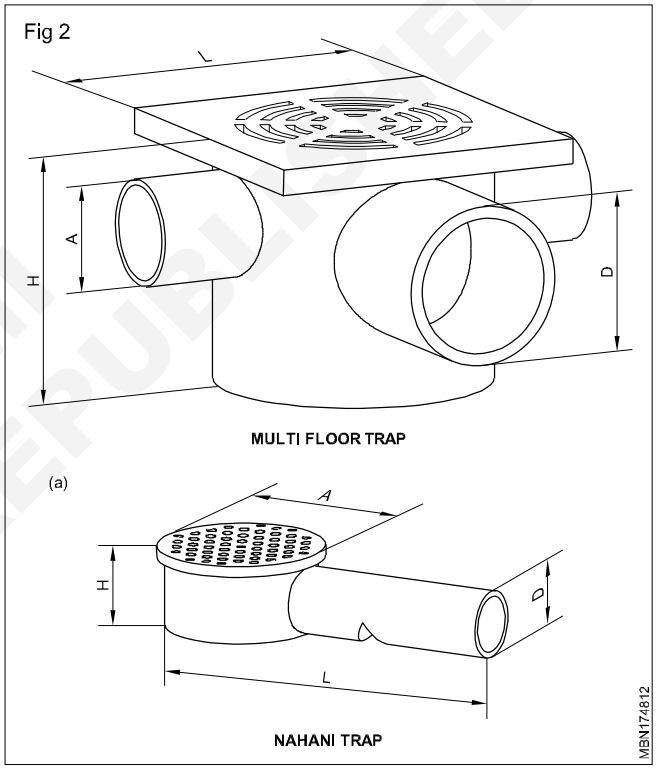
A trap essentially consists of a U tube, which retains water, acting as a seal, between the foul gases (inside the pipe) and the outside atmosphere. They are largely used for baths, sinks and lavatories. In all such needs, they are made with enlarged mouth, so that the waste pipe may be thoroughly flushed out.

Depending upon their use, the traps may again be of three types i.e Floor trap, Gully trap and Intercepting trap.

These three different types of traps are briefly described below:

Floor traps: These traps are generally uses to admit waste water (sullage) from the floors of rooms, kitchens, baths, etc. into the said room drain (sullage pipe). These are invariably provided with cast iron or galvanized or stainless steel gratings (Jallis) at the top, so as to prevent the entry of solid and larger sticky matter, into the drain pipe, to avoid frequent blockade. A commonly used patented name of such a trap is Nahani trap.(Fig 2a).

Fig 2



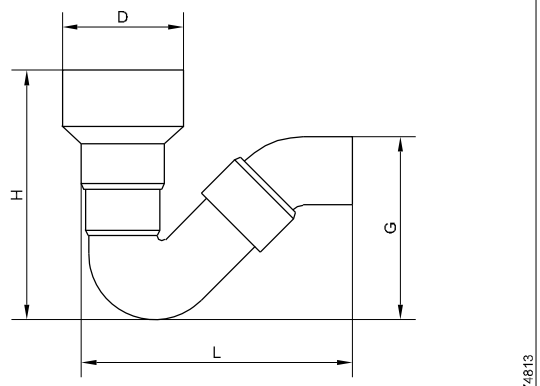
Gully traps: A gully trap or a gully is often provided at the junction of a room or a roof drain and the other drain coming from bath, kitchen etc. The foul sullage from baths, will enter through the side inlet (called back inlet) and the un foul room washings or rain water from roof or courtyard will enter from the top.

Gully traps may either have a S-trap or a P-trap. The water seal is usually 50mm to 75mm deep. The top of the trap is covered by a C.I grating to exclude the entry of coarser materials to avoid blockade. (Fig 3).

Intercepting traps: (Fig 4) An intercepting trap is often provided at the junction of a house sewer and a municipal sewer, so as to prevent the entry of the foul gases of the municipal sewer, into the house drainage system. This trap at such a junction is often provided in a small man-hole constructed just near the house, either outside in the street or in a corner inside the house boundary. This trap is provided near its top with an access gate or a plug,

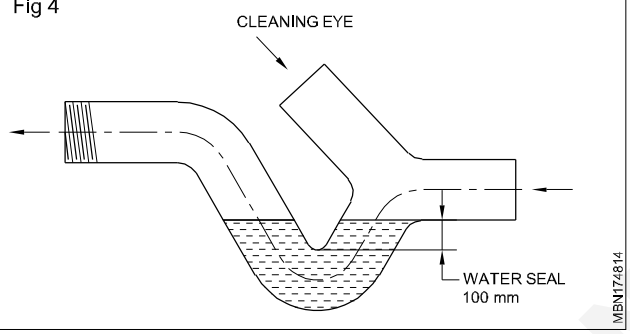
called cleaning eye for removing silted matter from inside the trap incase of blockade. It has a high depth of water seal, say about 100mm. It is interesting to note the merits and demerits of an interceptor, which are given below.

Fig 3



GULLY TRAP

Fig 4



Merits of interceptors

Foul gases of public sewer cannot pass through the interceptor, and hence prevented from entering the house drainage system. If the interceptor is not provided these gases will enter the vent pipes of the house drainage system, and spread around in the surrounding atmosphere causing serious air pollution.

Harmful pathogenic bacteria contained in the public sewers are thus prevented from entering the house drains, due to the presence of the interceptor.

Properly designed and constructed interceptors can quickly remove the foul matter of the house drains into the public sewer.

Demerits of interceptors

If the discharge from house drains is small, the solid heavy matter may be retained in the trap and may start decomposing, producing foul gases. The basic purpose of interceptors of preventing foul gases, will then no longer be served.

If the lid or the plug is not fitted properly, or is broken, foul gases from public sewer will do enter the house drain.

Cleaning through the inspection arm of the trap is not easy.

Interceptor itself forms an obstruction to the normal flow of sewege.

Omission of interceptors from house drains is found not to present too serious a difficulty or a problem.

Presence of interceptors installed by house owners, is found to seriously affect the ventilation of public sewers, as in such cases, the foul gases of public sewers will find an outlet only through the ventilating columns, which are provided at the head of every branch sewer and at other key points in the city sewerage system. Hence, if interceptors are allowed, then public sewers will need greater ventilation arrangement, and hence involving more expenditure, consequently leading to greater taxes on the public.

In view of the difficulty, the city municipality itself decides whether to allow the house owners to install or not to install interceptors.

Traps which are fittings or parts of appliances that retain water so as to prevent the passage of foul air into the building should be properly sited. A trap may be formed as an integral trap with the appliance during manufacture or may be a separate fitting called an attached trap which may be connected to the waste outlet of the appliance.

Traps should always be of a self-cleansing pattern. A trap which is not an integral part of an appliance, should be directly attached to its outlet and the pipe bore should be uniform throughout and have a smooth surface.

Traps for use in domectic waste installations and all other traps should be conveniently accessible and provided with cleaning eyes or other means of cleaning.

Fixing of sanitary appliances

Objective: At the end of this lesson you shall be able to

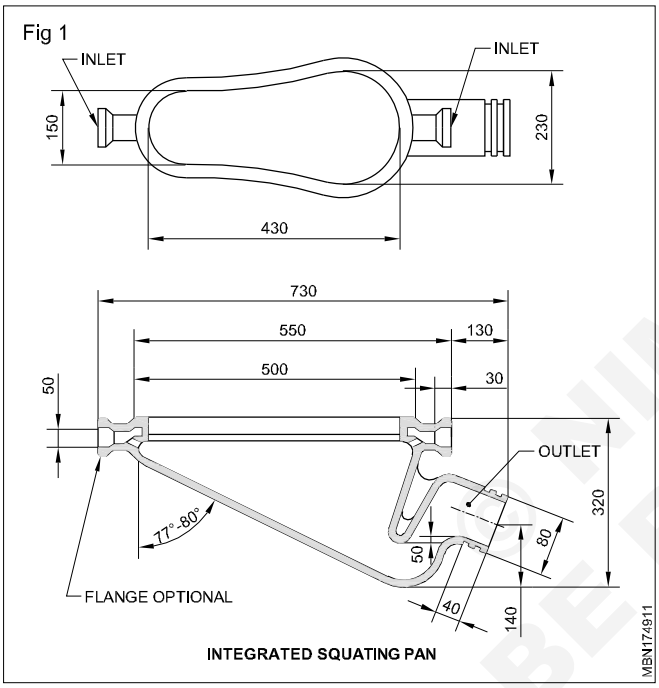
- **state the specification of various sanitary appliances i.e water closets, foot rests, flushing cistern, wash basin, towel rail, mirror, pillar tap, sink, drain board, urinals, bath tubs, taps.**

Water closet

Indian type: Indian type (squating pan) are of white vitreous china conforming to IS2556 part for general requirements and as per IS codes indicated for different pattern.

- Long pattern IS 2556 Part III.(Fig 1).

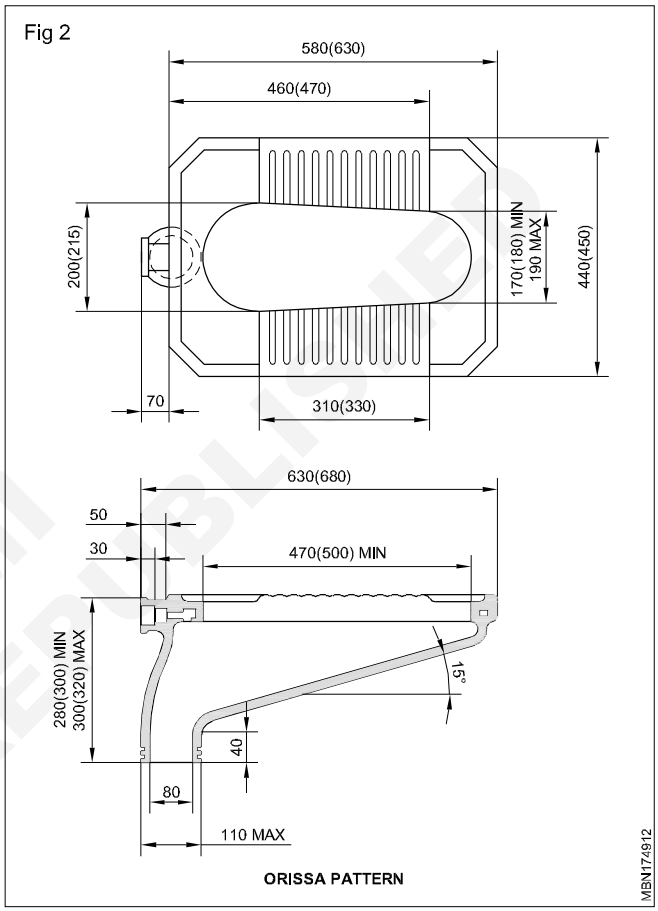
Fig 1



INTEGRATED SQUATING PAN

- Orissa pattern IS2556 Part III.(Fig 2).
- Integral pattern IS2556 Part XIV (with inbuilt trap).

Fig 2



ORISSA PATTERN

Each pan is having an integral flushing rim. It has a inlet for connecting the flush pipes either at rear or front or on both places. Weep holes are available in the rim. Bottom of pan is slopping towards outlet to ensure easy and quick cleaning. The exterior surface of the outlet below the flange is having grooves on unglazed surface for proper jointing with P or S trap.

The following tolerances are allowed on the specified dimensions.

Long pattern, Orissa pan and integrated squatting pan.

- on dimensions 50mm and over ±4%.
- on dimension less than 50mm ±2mm.
- on all angles ±3°.

The top surface of long pattern pan shall not at any point vary from its designed plane by more than 6mm in case of 580mm pan, 10mm in case of 630mm pan and 10mm in case of Orissa pan. It is fixed 250mm away from wall behind sunken floor and wall to be waterproof.

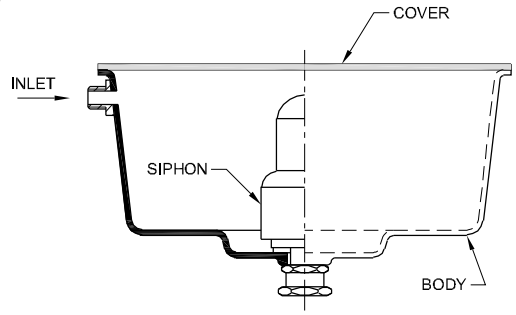
European water closet (Wash down type): These water closets are of white vitreous China conforming to IS2556 Part I and II. There are many patterns available in the market i.e. ordinary, one piece construction including flush tank etc. Each closet is having two or more holes of minimum of 6.5mm for fixing to floor. It has integral flushing rim with a weep hole and inlet for connecting to flush tanks. P or S traps are integral with a water seal of 50mm. Inside surface of closet and trap are uniform and smooth. This enables for an efficient flushing, Serrated part of outlet is not glazed. It help to have tight jointing. Dimensions tolerance for different pattern shall be as per IS. It is fixed 340mm away from wall behind.

Before fixing inlet and outlet, proposed closet and flushing cistern are to be purchased to find out the locations of inlet and outlet.

Foot rests: Footrests are of vitreous China conforming to IS2556 part X. Foot rests are rectangular.

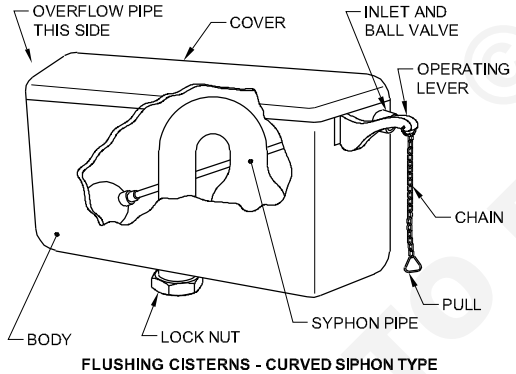
Flushing cistern: (Fig 3,4&5) There are three types of flushing cistern based on operations i.e. automatic and manually operated. It is also classified based on level of fixing i.e high level and low level. It is also classified based on the system of syphoage i.e. bell type, plunger type. High level cistern is for operating at a minimum height of 125cm while low level for a maximum height of 30cm between the top of pan and under side of the cistern. Cast iron, vitreous china, pressed steel, plastic and fibre glass cisterns are available. The thickness of the body including cover for cast iron is 5mm while for vitreous china it is 6mm. Body of pressed steel cistern is of seamless or welded construction outlet syphon is securely connected to the cistern by means of lock nut. Cistern should be mosquito proof i.e. there should not be any clearance anywhere which would permit a 1.6mm wire to pass through when in fixed position.

Fig 3



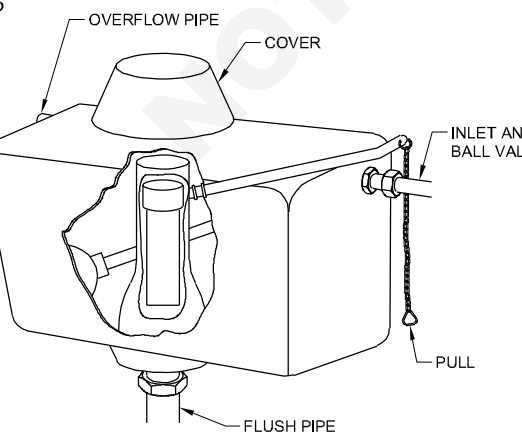
FLUSHING CISTERN - AUTOMATIC TYPE

Fig 4



FLUSHING CISTERNS - CURVED SIPHON TYPE

Fig 5

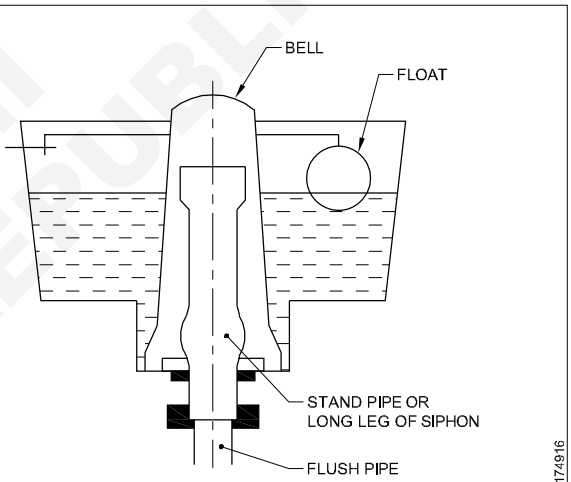


FLUSHING CISTERN - BELL TYPE

The cistern is generally supported on two cast iron brackets embedded in cement concrete 1:2:4 block 100x75x150mm. In case of low level cistern it has two holes in backside above the overflow level for screwing into the wall. The cistern outlet of 32mm and 38mm for high level and low level respectively are provided. Ball valve of screwed type 15mm dia. and confirm to IS1703 are provided. In case of high level cistern GI chain capable to sustain a suddenly applied pull of 10kg or a dead load of 50kg are provided to flush. In case of low level flush cistern a handle of CP brass etc are fixed. Cast iron cisterns are painted with two coat of black bitumonise paint on the inside and two or more coats of paint on the inside and two or more coats of paint on the outside. In case of high level cistern the flush pipe of 125cm long and 32 ±1mmf and incase of low level cistern 30cm long and 38 ±1mmf are used. G.I over flow pipe of 20mm dia and mosquito proof brass cover having 1.25mm dia perforations are to be provided to discharge to floor of toilet.

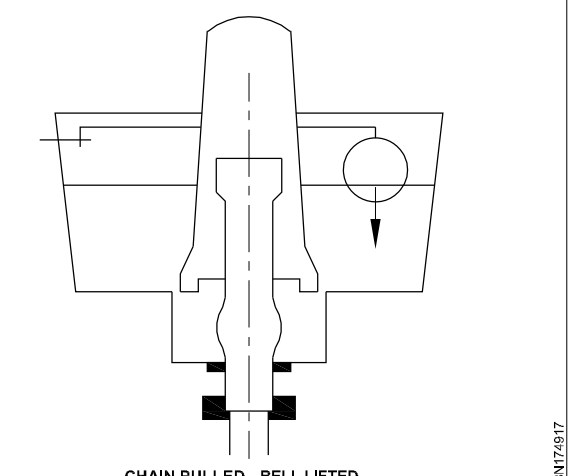
Functioning: In case of bell type flush cistern, the bell is kept over the outlet pipe. The inlet end of outlet pipe is slightly above to fill water level. Functioning illustrated in the sketch.(Fig 6 to 10).

Fig 6



NEUTRAL POSITION

Fig 7



CHAIN PULLED - BELL LIFTED

Fig 8

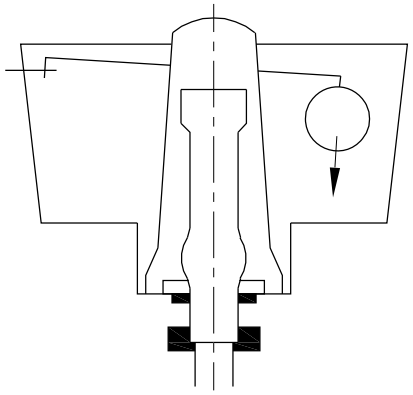


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Fig 9

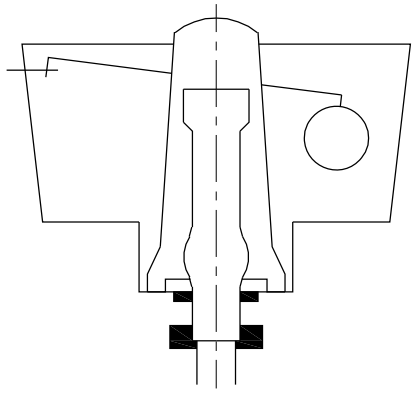

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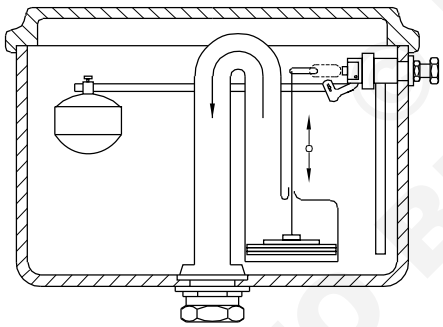
Fig 10



MBN17491A

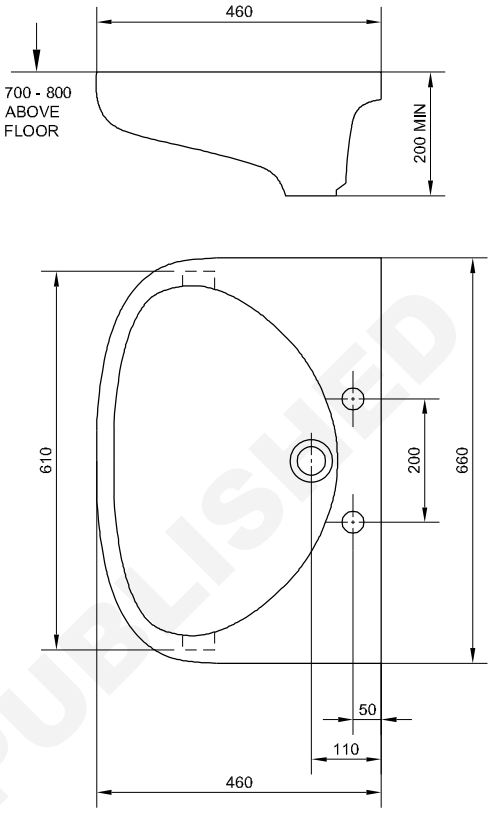
Chain released - bell falls down - water level inside the bell rises till water enters the siphonic pipe - water flowing down the pipe creates suction and causes more tank water to enter bell and pipe - siphonic action starts - float valve starts opening.

Flushing goes on until the water level in the tank is lowered to the base of the bell when air is admitted and breaks the siphonic action - float valve remains open till tank is filled again.

Toilet paper holder: CP brass, vitreous china paper holders are available. It is fixed in position by means of CP brass screw and wooden plugs embedded in wall. Bottom of toilet paper holder is to be at 450mm from floor.

Wash basin: Wash basin are made of white vitreous china conforming to IS 2558 part I and IV. Generally there are two types i.e flat back and angle back. These are one piece constructors with a provision of inbuilt overflow. There is rim on all sides except side in contact with wall. There are provision for tap holes of different dimensions i.e 28mm square 30mm round or 25mm round etc. It has a circular waste hole. It has stud slots to receive stud brackets. Each basin is having an integral soap holder recess and a overflow slot.(Fig 11 to 15).

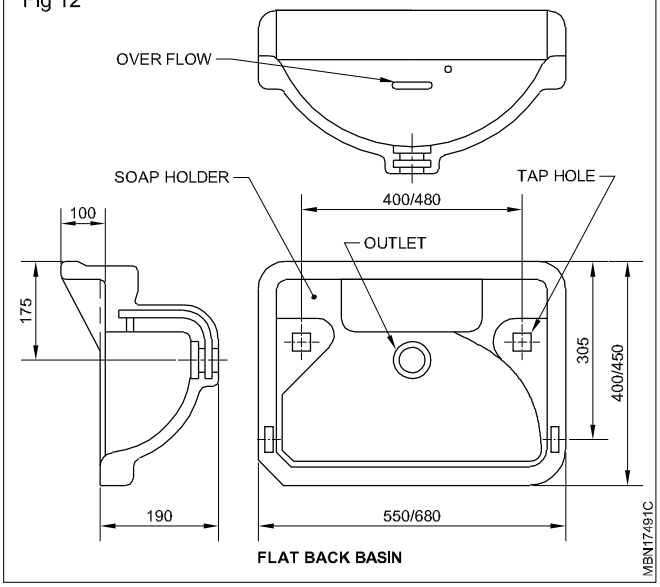
Fig 11



SURGEON'S BASIN

MBN17491B

Fig 12



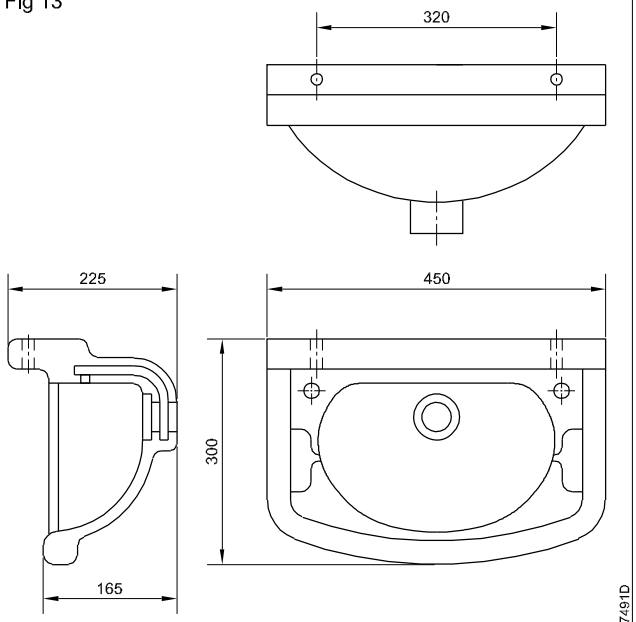
FLAT BACK BASIN

MBN17491C

Oval shape or round shape wash basins are fixed on RCC platform with stone topping either fully sink in stone top or top flush with stone.

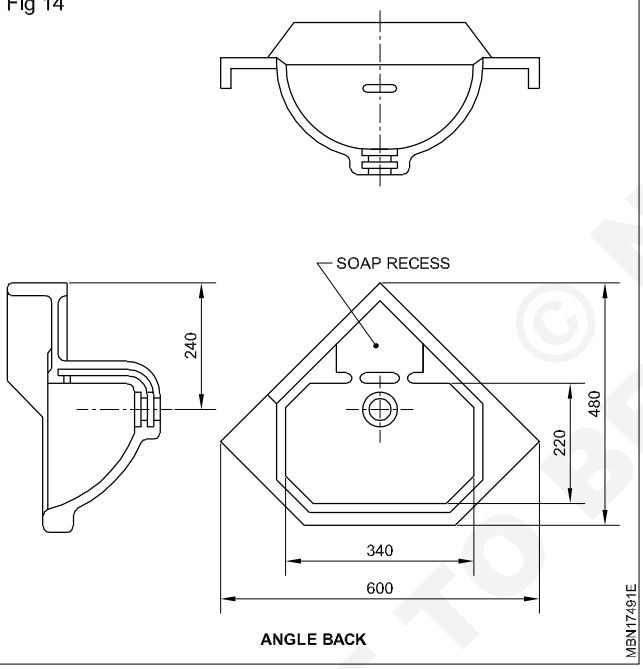
Pedestal for wash basin can also be fitted. The fixing height from the floor to top of the rim of basin is generally 75 to 80cm. In case it is meant for children it can be at lower level also.

Fig 13



FLAT BACK TYPE WITH ONE TAP

Fig 14



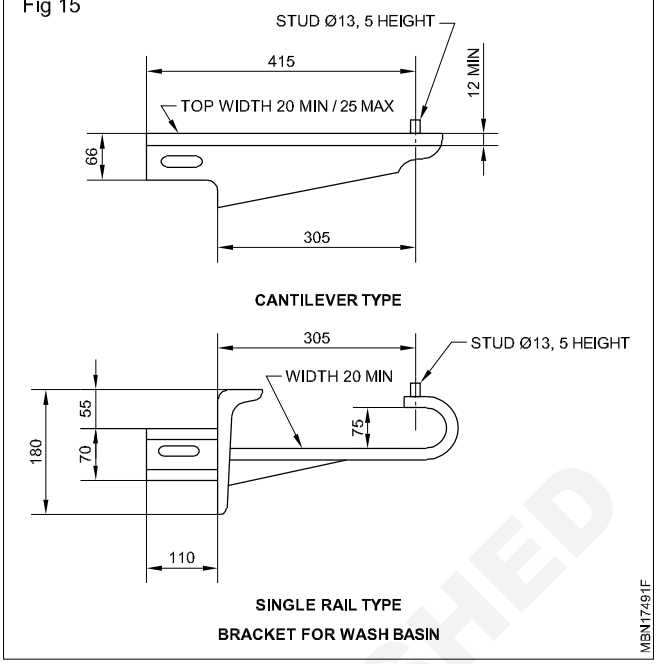
ANGLE BACK

The following tolerance can be allowed on dimension specified on.

- diameter 75mm and over ±4%
- diameter less than 75mm ±2mm
- diameter of waste hole ±3mm

If it is fixed in a row it can be at 900mm centre to centre. 1st and last basin shall be 450mm from side wall.

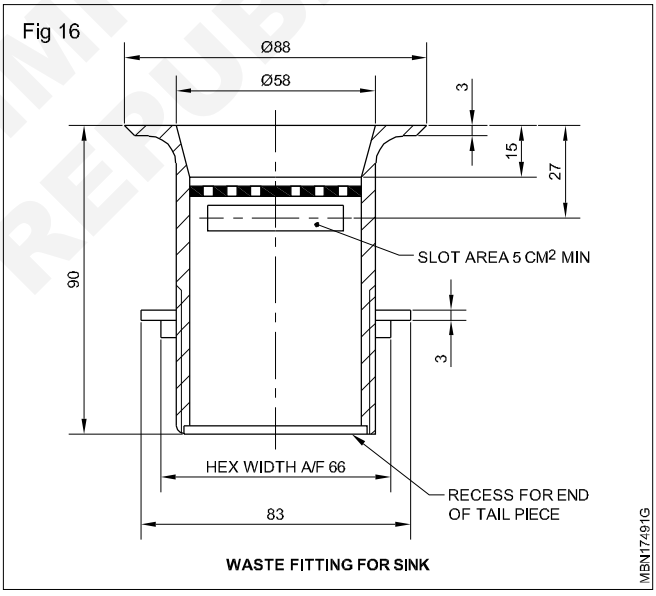
Fig 15



BRACKET FOR WASH BASIN

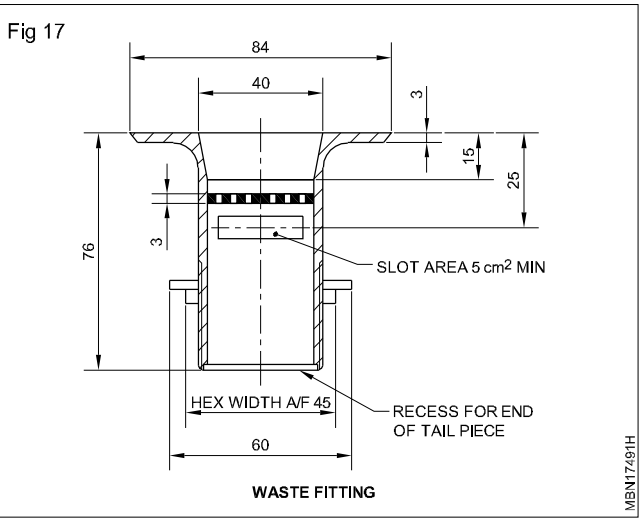
Waste fittings: (Fig 16&17) Waste fittings of nickel chrominum plated brass are generally used. PVC waste fittings are also available. Waste fitting for wash basin is of nominal size 32mm while for sink it is 50mm.

Fig 16



WASTE FITTING FOR SINK

Fig 17



WASTE FITTING

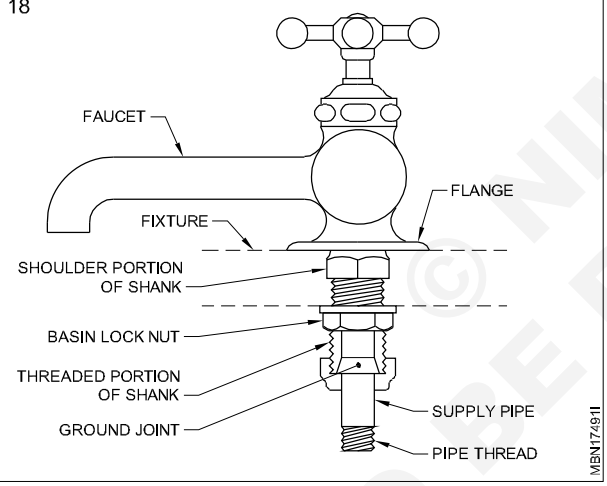
Towel rail: Different types of towel rails are available like CP brass, aluminium, acralic etc. There are to be fixed with CP brass screws using ravel plug embedded in wall. It is fixed at 1100mm from floor level.

Shelf: Glass shelves (60 x 12cm and 5.5 cm thick) with CP bracket, PVC shelves are available. These shall be fixed with CP brass screws to ravel plugs embedded in the wall. It is fixed at 300mm above wash basin top level.

Mirror: General size of mirror is 60 x 45 with 5.5 mm thickness. Backing of mirror to be chosen from environmentally friendly material other than asbestos cement sheet and it shall be of non water absorbent materials. Edges of mirror is to be sealed to prevent entry of water/vapour. Mirror tops are fixed at a height of 1700-1750 from floor level.

Pillar taps: (Fig 18) It is generally of chromium plated brass. Pillar taps of other materials are also available in market. The size is designated by the nominal bore of pipe outlet to which the tap is to be fitted. The weight of CP brass pillar tap of 15mm and 20mm are 650gm and 1175 gm respectively. Pillar tap should withstand an internally applied hydraulic pressure of 20 kg/sq.cm.

Fig 18



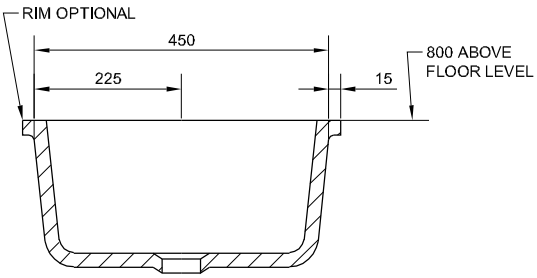
Sinks: (Fig 19&20) Laboratory sinks are of white vitreous china and shall conforming to IS2556 (PV). Kitchen sink are of white glazed fire clay and shall confirm to IS771 (PII). The sink has overflow Weir - It has waste holes. It is supported with C1 brackets conforming to IS775. Stainless steel sinks for kitchen are manufactured as per Is13983.

Drainboard: (Fig 21) Drain boards of stainless steel (ISI3983) stone, wooden are available . It is to be fixed near sink with a slight stop towards sink.

Urinals: The following types of urinals are generally used.

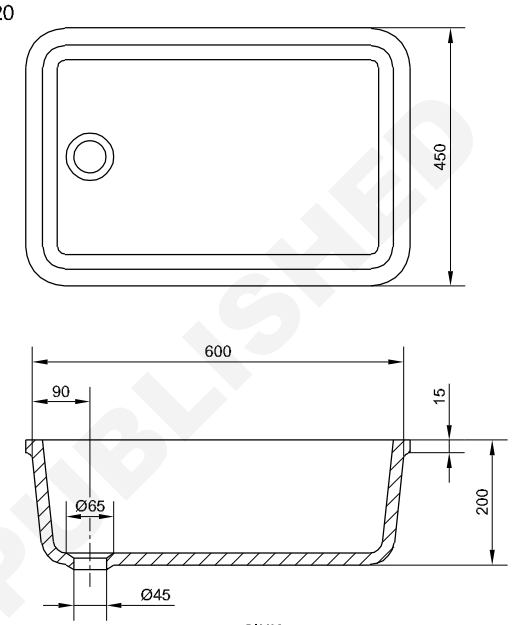
- Flat back
- Corner type
- Stall
- Half stall
- Squalting plate
- Sensor type
- Water less urinal

Fig 19



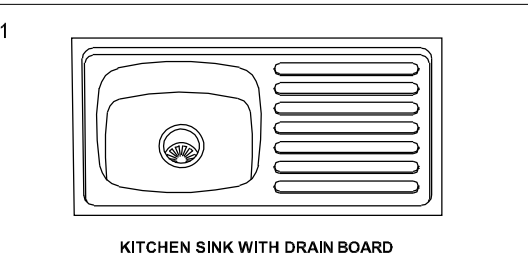
SINK

Fig 20



SINK

Fig 21



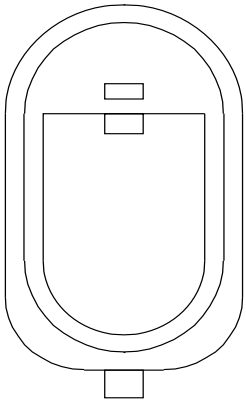
KITCHEN SINK WITH DRAIN BOARD

Sensor type urinals: (Fig 22) Manufactured from white vitreous china clay. These urinals are fitted with sensors so that automatic flush tank will work only when it is used. Thus there is lot of saving in water and at the same time immediately after use it is flushed automatically size 61 x 39 x 38 cms.

Water less urinals: (Fig 23) Aqua free white vitreous china clay. This can be put into use without water connections - size available is 60 x 30 x 31.5cm. it is costly.

Flat back/corner urinal: (Fig 24&25) These are manufactured from white vitreous china conforming to IS2556 (PVI). The urinals are one piece construction. These have two fixing holes of a minimum 6.5mm each side. It has an integral flushing rim inlet to connect flush pipe and outlet to connect an outlet pipe. Inside surface of urinals are uniformly smooth. The bottom of pan has sufficient slope in the front towards the outlet.

Fig 22



SENSO URINAL

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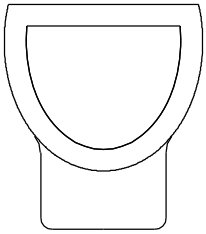
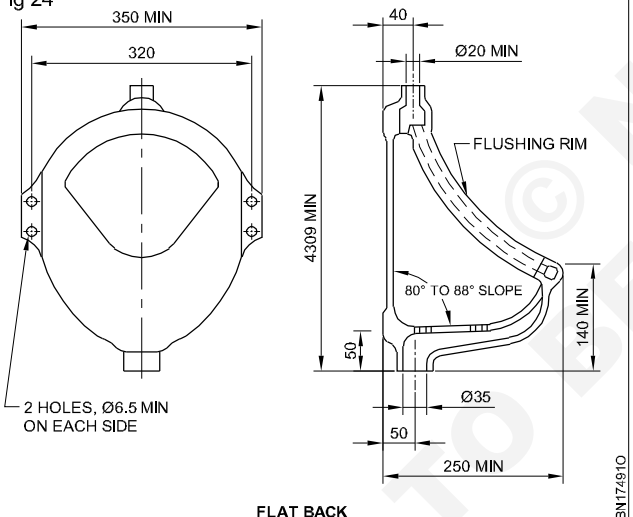
Fig 23



WATERLESS URINAL

MBN17491N

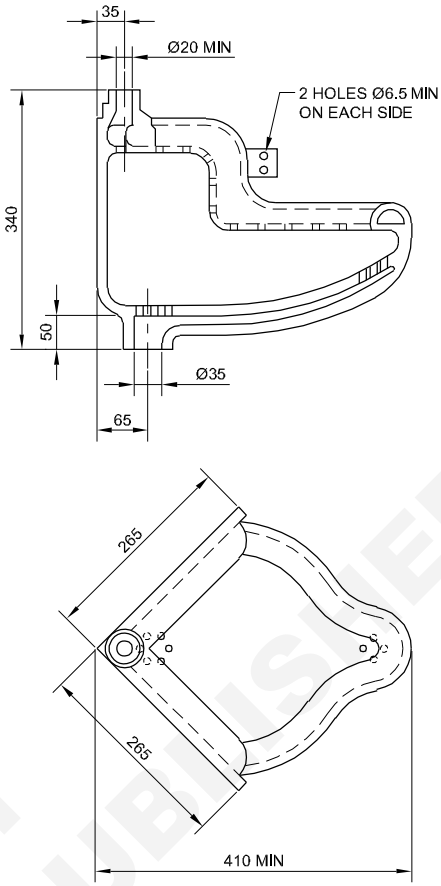
Fig 24



FLAT BACK

MBN17491O

Fig 25



ANGLE BACK

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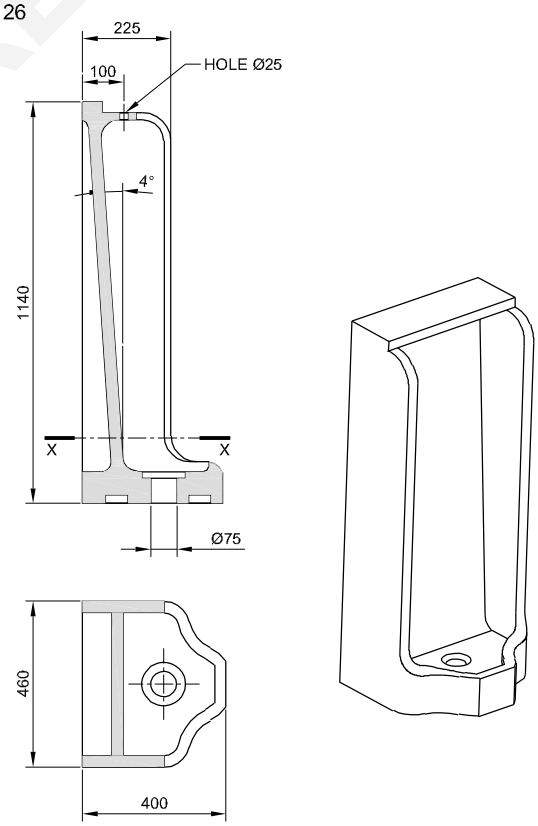
Fig 26



URINAL-STALL

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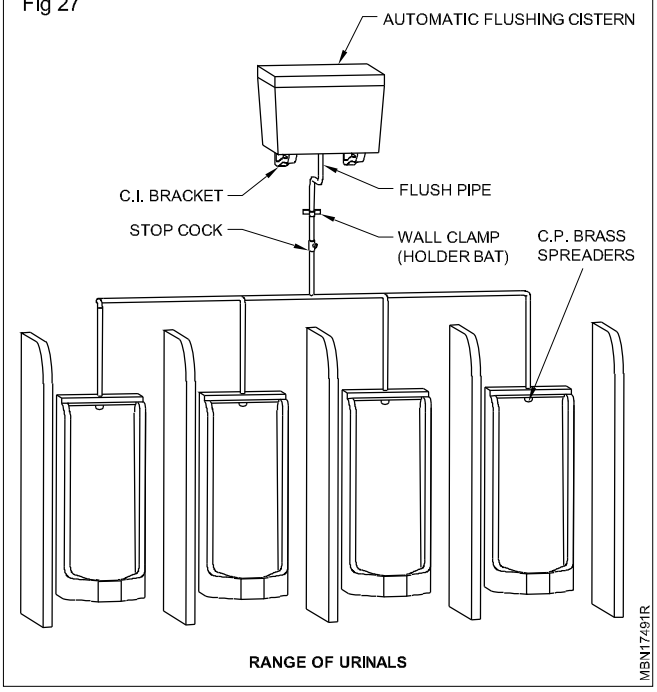
The following tolerance are allowed on the dimensions.

- on dimension 50mm and over ±4%.
- on dimension less than 50mm ±2mm.
- on all angle ±3°.

Automatic cistern for flushing are fixed at a height of 1900 mm from floor to bottom. If urinals are fixed in a row it shall be at 690mm centre to centre.

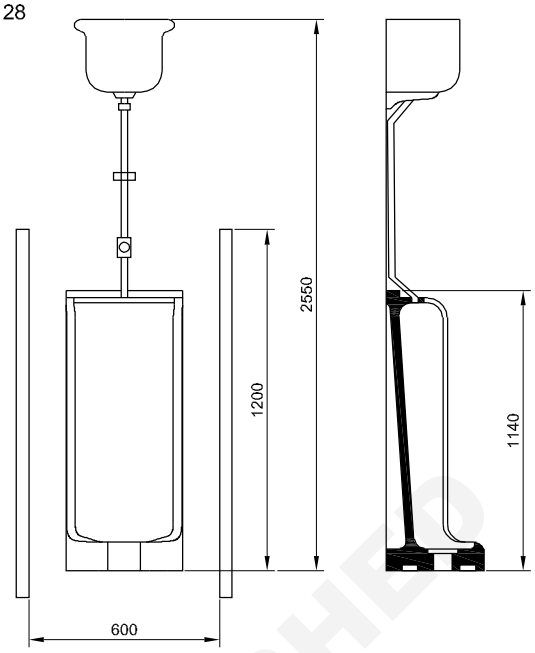
Stall urinal: (Fig 26&27) The stall urinal and its screen are of white glazed fire clay and confirm to IS771 (Part 3 sec 2). It is 1140mm high 460mm wide with 400mm overall depth at the base. Screen are of size 1200mm 15cm wide (overall) and projects 50cm after embedding in the wall. Inside surface of stall and screen are regular and smooth - water spreaders as per IS2556 (PVI se 6) is to be provided.

Fig 27



RANGE OF URINALS

Fig 28



INSTALLATION OF URINAL

Half stall urinal: These are to be manufactured as per IS2556 (PVI Sec 2). They are one piece construction with or without integral flushing box rim - water spreader shall to be provided if integral flushing rim is not provided.

Squalt inplate urinal: These plates are of white vitreous china conforming IS2556 PI and Part VI sec 3. These are having internal flushing rim with front or side inlet. These are of one piece construction - urinals are having integral longitudinal flushing pipe which can be connected to flush pipe. A 100mm white glazed vitreous china channel with stop and outlet piece infront is also a part of this.

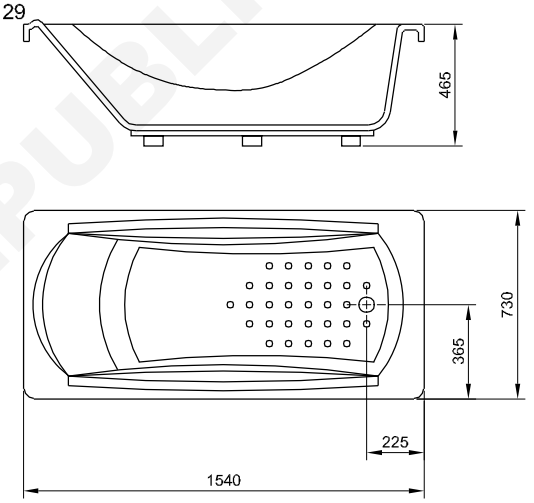
Bath tubs: Bath tubs are manufactured from enamelled sheet steel, Gel coated glass fibre reinforced polyster resin, a crystal sheets etc. It is available in market of various sizes and shapes.

Bath tubes are one piece construction with opening for waste outlet and floor. Slopping towards the outlet. An overflow is normally provided on the side near waste outlet. Bath tubes are provided with supporting structure integrated or with height adjustable type.

A few of the pattern available in market are shown in the sketch. (Fig 28 - 30).

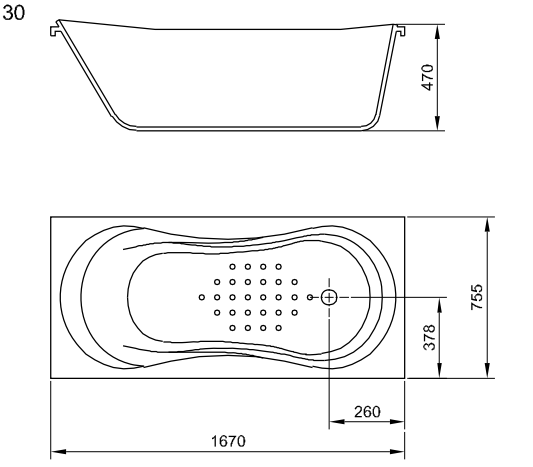
Whirlpool, Airpool, turbo pool, type bathing facilities are also available. shower enclosures, shower tray of different sizes, materials, designs are available. These are to be fitted as per manufacturer specifications.

Fig 29



BATH TUB

Fig 30



Construction of surface drain

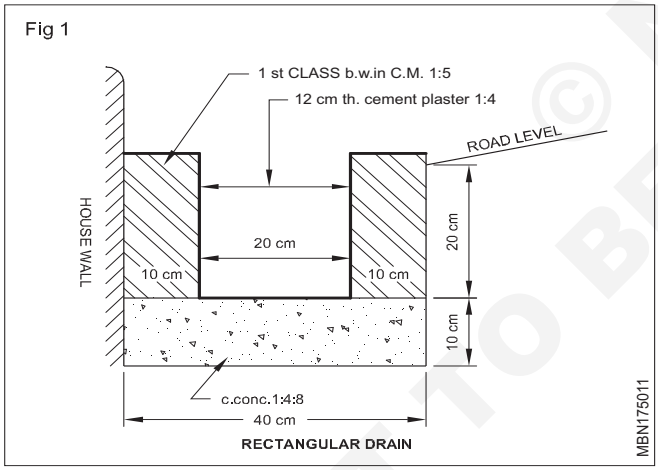
Objectives: At the end of this lesson you shall be able to
- **state about surface drain**
- **state about rectangular drain**
- **state about semicircular drain**
- **state about 'V' shaped drain**
- **state about 'U' shaped drain.**

Surface drain

- Where the sewer system is not possible, the surface drain may be used.
- In small town sewerage system is not possible due to financial difficulty and inadequate of water supply for flushing, a system of surface drains may be provided.
- Surface drains are constructed on one side or both side of streets.
- Surface drain carry discharge from bath rooms, kitchens, washing places etc., as well as rain water from roofs, open area, and court yard.
- Surface drain do not carry discharge from w.c and urinals etc.,
- Surface drain are constructed in different shape and sizes.

1 Rectangular drains (Fig 1)

Fig 1



- Rectangular drain discharge is small and good velocity is not developed.
- Some deposit take place in the drains.
- Rectangular drains are suitable for large discharge.

2 Semi circular drains (Fig 2)

- Semi circular drains are suitable for large discharge
- The construction of semi circular drain quite easy due to this fact they are commonly used.

3 V-Shaped drains (Fig 3)

- V- shaped drains are suitable for kind of discharge.
- V- shaped drains are commonly used.
- V- shaped drains construction is difficult and costly.

Fig 2

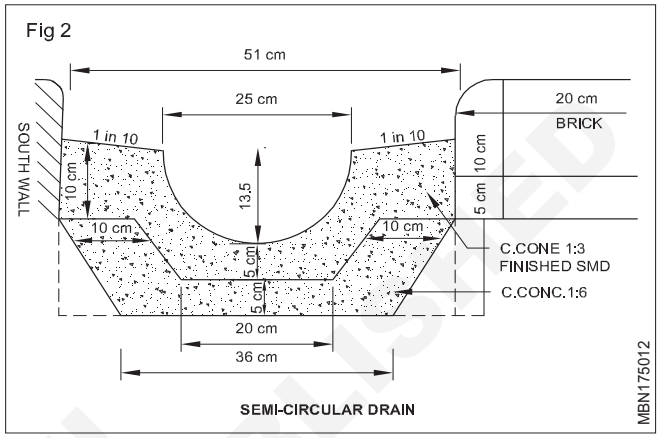
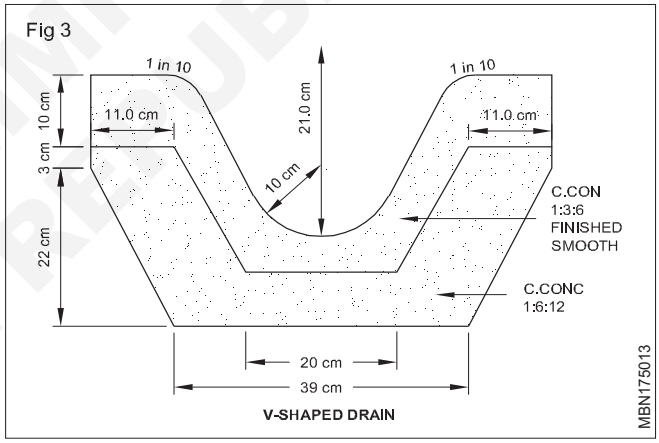


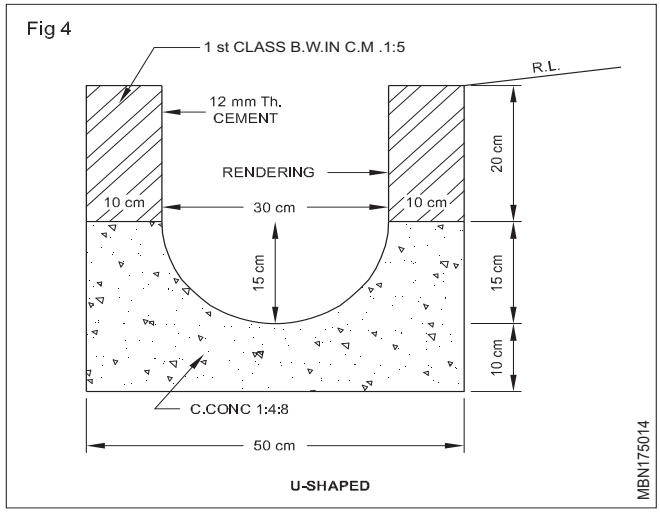
Fig 3



4 U- shaped drains (Fig 4)

- U-shaped drain is the combination of rectangular and semi-circular drains.
- This drain suitable for both small and large discharge.

Fig 4



Different types of pipes and fittings used by plumber

Objectives: At the end of this lesson you shall be able to
- **describe pipes, gravity and pressure conduits**
- **describe pipe materials, asbestos cement pipes, cast iron pipes**
- **describe cement concrete pipes, copper pipes, galvanised iron pipes**
- **describe lead pipe, plastic pipe, steel pipe, wrought iron pipe**
- **importance of water tightness.**

Pipes

The water can be conveyed either through gravity conduits or through pressure conduits.

Gravity conduits

Gravity conduits are in the form of open channels.

Water is conveyed under atmospheric pressure.

Pressure conduits

The pressure conduits are in the form of pipes.

Water is conveyed under pressure.

Size of pipe

The size of pipe depends upon discharge of water through pipe and permissible velocity of flow of pipe.

- Stress due to change of direction.
- Stress due to internal water pressure.
- Stress due to soil above the pipe.
- Stress due to water hammer.
- Stress due to yielding of soil below pipes.
- Due to temperature stresses.

Various materials of pipes

1 Asbestos pipe

These pipes are made from a mixture of asbestos fibres and cement.

Asbestos cement pipes are used to convey water under low pressure.

But their use is restricted.

1. **The pipes are brittle**
2. **The pipes are not durable**
3. **The pipes cannot be laid in exposed places.**
4. **The pipes can be used only for very low pressure.**

2 Cast iron

Cast iron pipes are made from pig iron.

The pipes are given suitable treatment for protecting against corrosion.

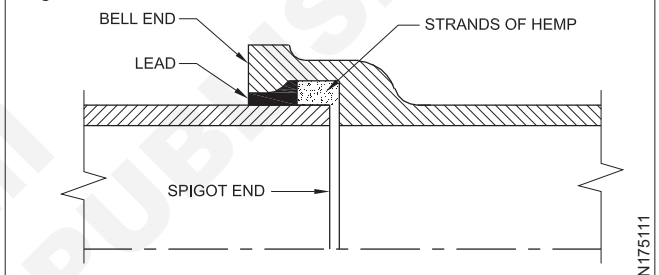
Cast iron pipes are used for conveyance of water.

The size of cast iron pipes available upto diameter about 120 cm or more.

Class A cast iron pipes can with stand a pressure of 60 m head, those of class B, 120 m of head; those of class c, 180 m of head ; and those of class D 240 m of head.

Bell and spigot joint (Fig 1)

Fig 1



BELL AND SPIGOT JOINT

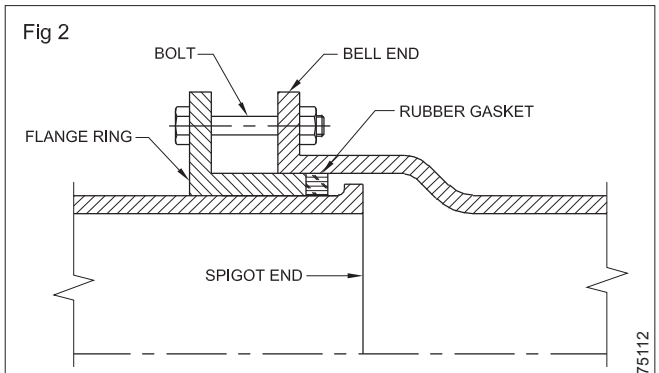
The spigot end is inverted into larger diameter bell end.

The hemp is used to maintain the alignment of pipes.

Molten lead is poured to finish up the joint.

Expansion joint (Fig 2)

Fig 2



EXPANSION JOINT

Expansion joints are used when the pipes are subjected to serve changes in temperature.

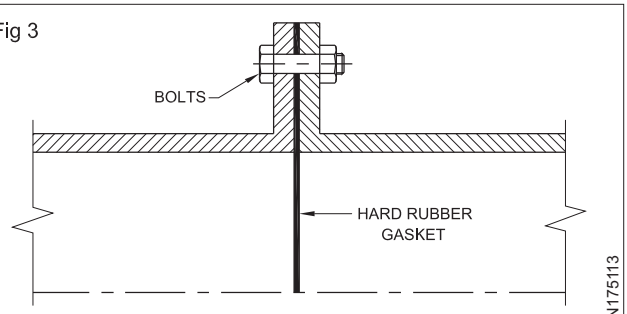
To make water tight joint, a rubber gasket is inserted between the spigot and bell ends.

The flanged ring is bolted to bell.

Flanged joint (Fig 3)

The end of pipe are provided with wide flanges which are bolted together.

Fig 3



FLANGED JOINT

A hand rubber gasket is inserted between the flanges to make the joint water tight.

Expansion joint is used for carrying water at high pressure.

Advantages of cast iron pipes

The pipes are easy to joint.

The pipes are not subject to corrosion.

The pipes are strong and durable.

The service connections can be made easily.

The life is about 100 years, under normal conditions.

Disadvantage of cast iron pipe

Breakages of these pipes are large.

The pipes are not used for pressure greater than 7kg per cm^2.

The pipes become heavier and uneconomical, specially when their size increases beyond 120 cm diameter.

3 Cement concrete pipe

These are three types.

1 Plain cement concrete pipe.

2 Reinforced cement concrete pipe

3 Prestressed cement concrete pipe

Plain cement concrete pipes

The plain cement concrete pipes are used for low heads upto about 15m.

The reinforced cement concrete pipes are used for heads upto 75m.

The prestressed cement concrete pipes are used for heads above 75m.

The hemp or jute rope is inserted between the pipes and collar to maintain the alignment of pipes.

The remaining space is then filled up by rich cement mortar. (Fig 4)

Advantage of cement concrete pipes

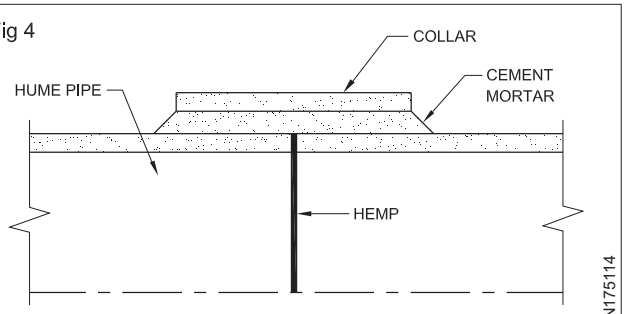
The inner surface can be made smooth.

Very low maintenance cost.

The pipes are durable.

The pipes can be cast at site, there is no need of transport, expense.

Fig 4



JOINT BETWEEN HUME PIPE

There is no danger of rusting.

Disadvantages of cement concrete pipes

The pipes are very heavy and difficult to transport.

The pipes are to crack during handling.

The repairs of these pipes are difficult.

4 Copper pipes

The copper pipes do not sag or bend due to hot water.

They are not liable to corrosion.

They can bent easily.

They are not used for distribution of water.

5 Glavanised iron pipe (G.I. pipe)

Galvanized iron pipe are used for service connection.

Size of G.I pipe 6 mm to 75 mm diameter.

These pipes light in weight, easy to handle, easy to join.

These pipes are easily affected by acidic or alkaline water.

The life of pipe is short about 7 to 10 years.

6 Lead Pipe

Lead pipes are not used for conveyance of water.

The lead pipes may cause lead poisoning.

The pipes are easily bend.

The acidic water react on lead pipes.

Lead pipes cannot be used to carry hot water.

7 Plastic pipes

The pipes are durable and they possess enough strength to resist impact, sunlight and atmospheric actions.

The pipes are flexible and possess low hydraulic resistance.

The pipes are free from corrosion.

The pipes are good electric insulators.

The pipes are light in weight.

The pipes are easy to bend, join and install them.

The pipes are less resistant to heat.

Some pipes may give taste to the water.

8 Steel pipes

Mild steel is used for the manufacture of steel pipes.

The joints of steel pipes are either riveted or welded.

Generally the pipes having diameter greater than 120 cm.

The inside and outside surface of steel pipes are galvanized.

Advantages of steel pipes

The pipes are available in long length and hence to reduce number of joints.

The pipes are durable and strong and resist high internal water pressure.

Easy to laid on curves.

The pipes are light in weight and easy to transport.

Disadvantages of steel pipes

Maintenance cost is high.

The pipes are likely to be rusted.

The pipes require more time for repairs during break down.

The steel pipes are likely to deform in shape under the combined actions of external and internal loads.

9 Wrought iron pipe

Wrought iron pipes are light in weight and easy to cut.

Wrought iron pipes are costly.

Wrought iron pipes are less durable when compared to cast iron pipes.

Generally not used in the conveyance of water.

Importance of water tightness

Pipes are used to carry water under pressure.

The distribution system should be water tight otherwise less of water due to leakage.

If leakage in water mains all such effluents will be sucked in the water pipe due to partial vaccum.

When the supply of water starts the consumers will be supplied with diluted sewage in lead of pure water.

Due to leakage the waste water is brought down to the maximum possible extent, it results in increased supply of water to the consumers and it helps in the reduction of cost treated water.

Septic tanks are constructed in water tight structure, otherwise the surrounding well water may be spoiled

Sewer appurtenances

Objectives: At the end of this lesson you shall be able to
- **explain the important sewer appurtenances**
- **drop/deep/shallow manhole**
- **explain various types of chambers in sewer line**
- **explain rainwater collection**
- **explain bio gas tank important construction and their functions.**

General

In order to make the construction process easy and to have efficient working and maintenances the sewer system requires various structures known as sewer appurtenances.

Following are the important sewer appurtenances,

1 Manholes

2 Drop manholes

3 Lamp holes

4 Catch basins

5 Clean - outs

6 Flushing tanks

7 Grease and oil traps

8 Inlets

9 Storm regulators and weirs

10 Inverted siphons

11 Junction chambers

12 Outlets

1 Manholes

They are openings in the sewer line for a man to enter through its.

Purpose

The purpose of manholes is to inspect, clean and for other maintenance operations in connection with sewers.

Location

Man holes are located:

1 at every change in gradient, direction alignment or diameter.

2 at junctions of sewers.

3 at street intersections and,

4 at intervals of 45 m to 90 m in straight reaches.

Component parts of manholes and their functions (Fig 1)

i Access shaft

It is the upper portion of a deep manhole. It provides an access to the working chamber below.

ii Bottom or invert

It is the bottom of the manhole. It is constructed of cement concrete or brick paving, over which the sewage flows.

iii Cover and frame

They are provided at the top of manholes. They provide an entry to the manhole whenever required. During other periods, these form the surface of the road. They prevent the accident of falling into the manholes.

iv Steps or ladder

They are provided to make the entry and exit of men easy. They are staggered two vertical runs, 200 mm apart horizontally and 300 mm vertically. They are also called rungs.

v Walls

They are constructed of brick work or stone work or cement concrete. They form the structure of the manhole. They support the components above, retain the soil from the sides and enclose the sewers.

vi Working chamber

It is the lower portion of a deep manhole. It provides a working space for a man to stand inside and to carryout cleaning and inspection of sewer lines. It may be circular or rectangular in plan.

2 Drop manholes (Fig 2)

Purpose

The purpose of drop manholes is to avoid unnecessary steep gradient of branch sewer and thus reducing the quantity of earth work. Also, they avoid the splashing of sewage on the man working and on the masonry work.

Location

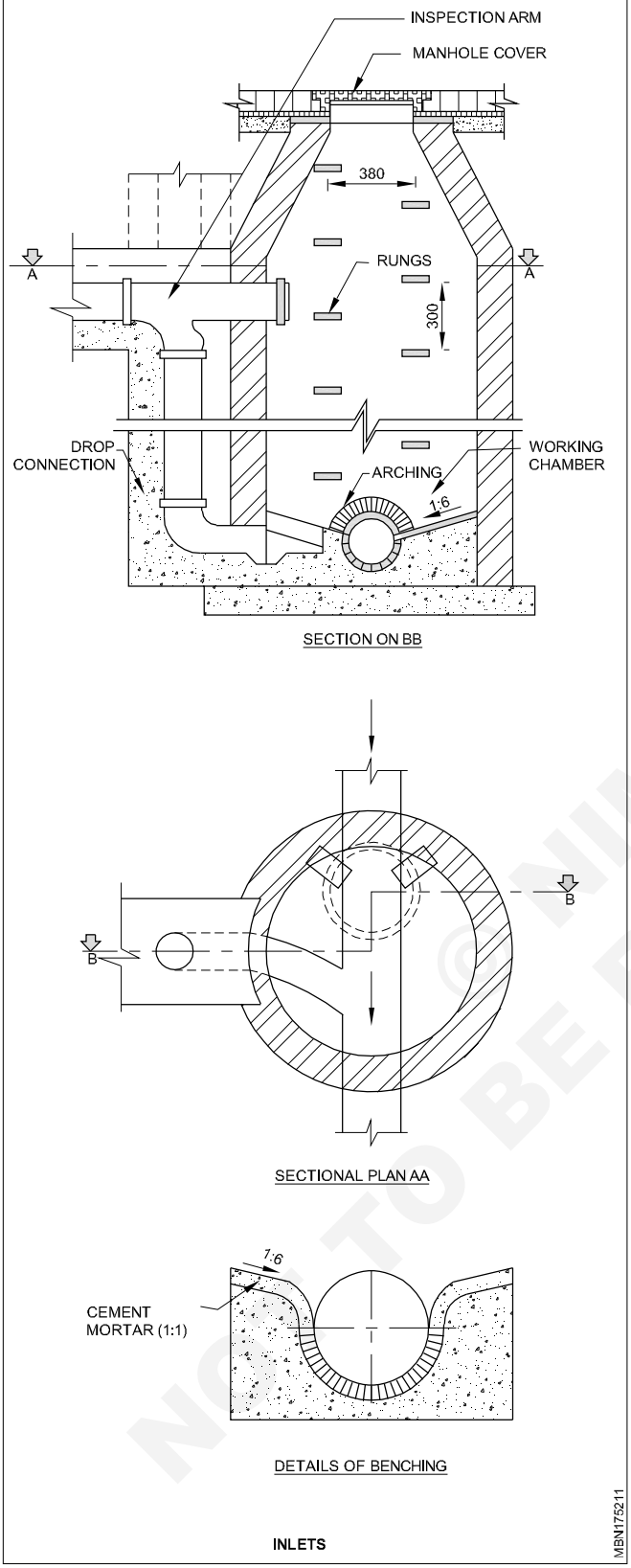
Drop manholes are located,

1 Where inlet and outlet pipe sewers have to be connected at different levels.

2 In places where it is desired to drop the level of invert of the incoming sewer.

The length of the pipe between the vertical shaft and the wall is called inspection arm. Opening the plug, it is used for inspecting and clearing of the vertical shaft, the vertical shaft is carried upto the ground level.

Fig 1



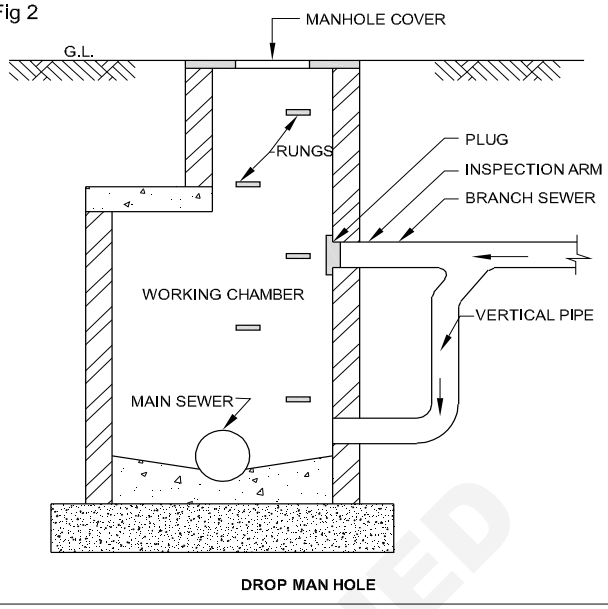
INLETS

Lamp holes (Fig 3)

Purpose

The lamphole is intended to detect the obstruction in the sewer. It is done by inserting a lamp in the lamphole and viewing it from the adjacent manholes. Also they incidentally serve as fresh - air inlets and for flushing.

Fig 2



DROP MAN HOLE

Location

Suitable locations for lamp holes are,

i In places where a bend is necessarily to be inserted.

ii In places where construction of manhole is difficult.

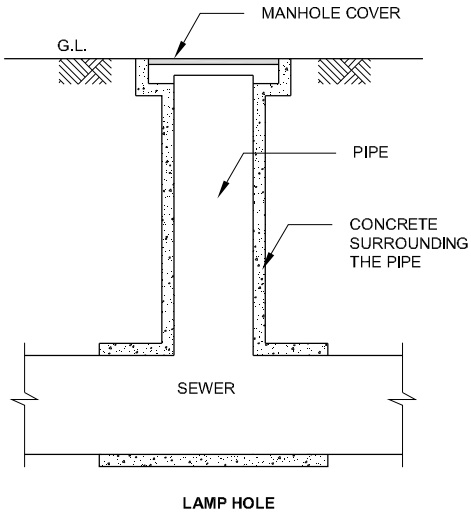
iii When straight length between manholes is considerably more and,

iv For flushing the sewer line in the absence of any other flushing devices.

The use of lampholes should be recommended only under special circumstances.

There use should be as far as possible avoided.

Fig 3



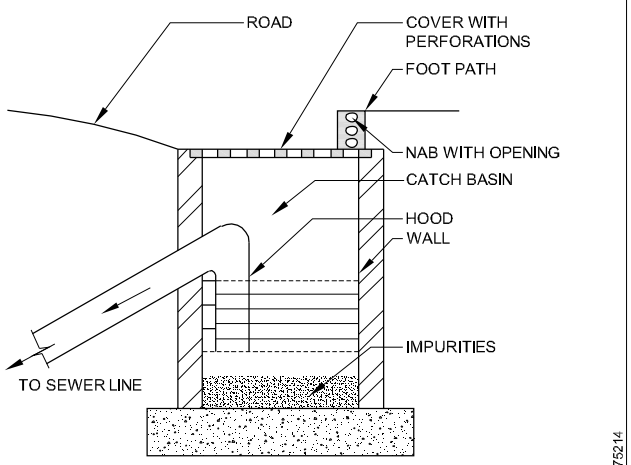
LAMP HOLE

4 Catch basins (Fig 4)

It is a structure constructed in the form of a chamber along the sewer line to admit clear rain water into the combined sewer. It also prevents the escape of sewer gases. It consists of a chamber constructed of walls. The silt, grit, etc, settles in the bottom and clear water alone flows into the sewer. At the top, a cover with perforations is fixed at the pavement, edge. A hood is provided which prevents the

escape of sewer gases into the basin. It provides a temporary storage for impurities in rain water. Hence, it is cleaned after each storm.

Fig 4



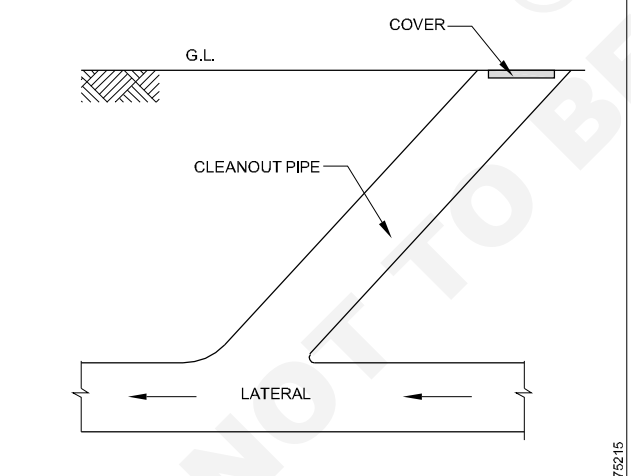
CATCH BASIN

5 Clean - outs (Fig 5)

It is a pipe, one end is connected to the underground sewer and the other end is brought upto ground level and is covered. It is generally provided at the upperends of lateral sewers in place of manholes.

For working, the cover is removed and water is forced through clean out pipe into lateral sewers to remove obstacles in the sewer line. Flexible rods may also be inserted through the cleanouts and moved back and forwarded to remove obstructions.

Fig 5



CLEAN OUTS

6 Flushing tanks

These are devices or arrangements used to store and then to throw water into the sewer to produce self cleansing velocity for flushing the sewer. Sometimes sewage is to be stored for a short period before allowed into the sewer line. Flushing tanks are used to store sewage temporarily and then discharge at intervals to flush the sewers. They are provided near the dead ends of sewers. Their capacity is about 10% of the cubical contents of the sewer line served by it.

The flushing tanks are of the following two types

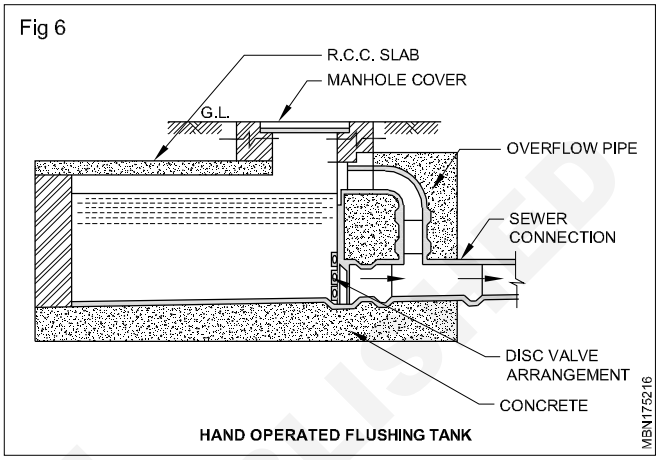
1 Hand operated flushing tanks

2 Automatic flushing tanks

Hand operated flushing tanks (Fig 6)

The flushing is done manually at intervals. Both the outlet and inlet ends of the manhole are closed. Then the manhole is filled with water completely. The lower end of the manhole is then opened and the water under pressure cleans of flushes the sewer line.

Fig 6

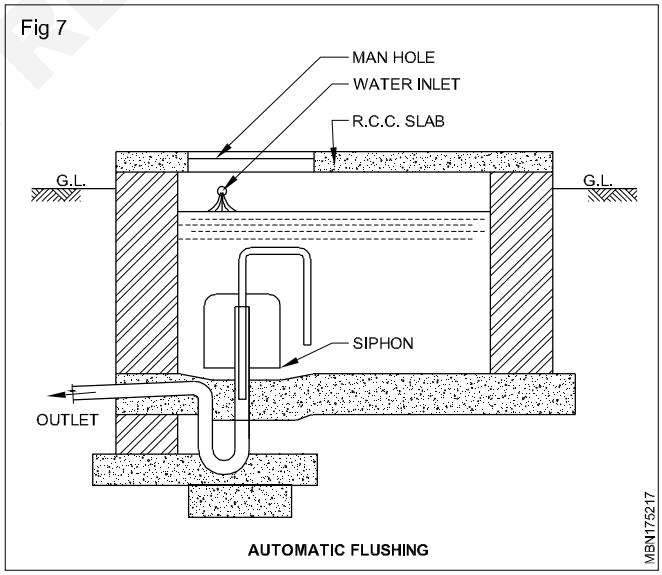


HAND OPERATED FLUSHING TANK

Automatic flushing tank (Fig 7)

The tank is like a manhole with a siphonic arrangement fixed at bottom. Water supply is regulated to flow at a constant rate through a connection made in the side wall. When the tank is full, the siphon goes into operation and quickly discharges the water into the sewer.

Fig 7



AUTOMATIC FLUSHING

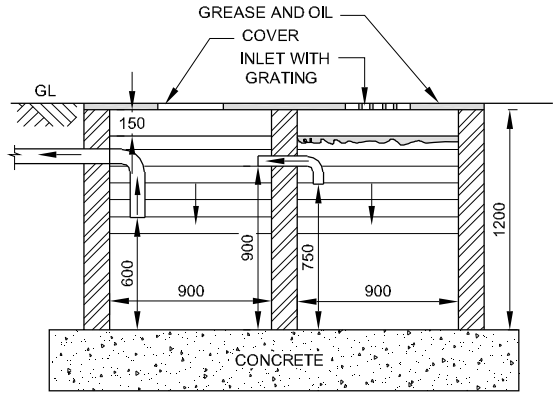
Working

The water rising above the level of the sniff hole entraps and compresses air in the bell. The compressed air of the bell presses down water in the U - shaped trap. When the water level at the level of sniff hole goes down to the bottom of U - shaped trap, the air of the bell bubbles out with violence. Also, water tickles out through the outer limb of the U - tube into the sewer. More water now rushes into the bell. When the water level is above the lip of the trap pipe in the bell siphonic action begins.

This action continues till water level in the tank falls below the level of the swift hole. Air again enters the bell and the siphonic action is stopped. Thus, the cycle is repeated.

7 Grease and oil traps (Fig 8)

Fig 8



GREASE AND OIL TRAPS

They are chambers on the sewer line to exclude grease and oil from sewage before it enters the sewer. These substances being light in weight, float on the surface of sewage. If the outlet draws sewage from lower level, grease and oil are excluded. Hence the outlet level is located near the bottom of chamber. Grease and oil traps are located near automobile workshops, grease and oil producing industries garages, etc.

If grease and oil enter the sewers, they stick to the sides of sewer and may cause explosions. Also the suspended impurities stick to the grease. Consequent the capacity of the sewer reduces.

8 Inlets

They are openings, through which storm water is admitted and conveyed to storm water sewer. They are located near the sides of the roads at 30 to 60 m centres. They are connected by pipes to the nearby manholes. They consist of concrete box with provision for admitting storm water.

They are of the following three types,

1 Gutter inlet

In this type of inlet, a horizontal grating is provided at the top (Fig 9a). This type of inlets are suitable for roads having steep slope. This inlet is also known as horizontal inlet.

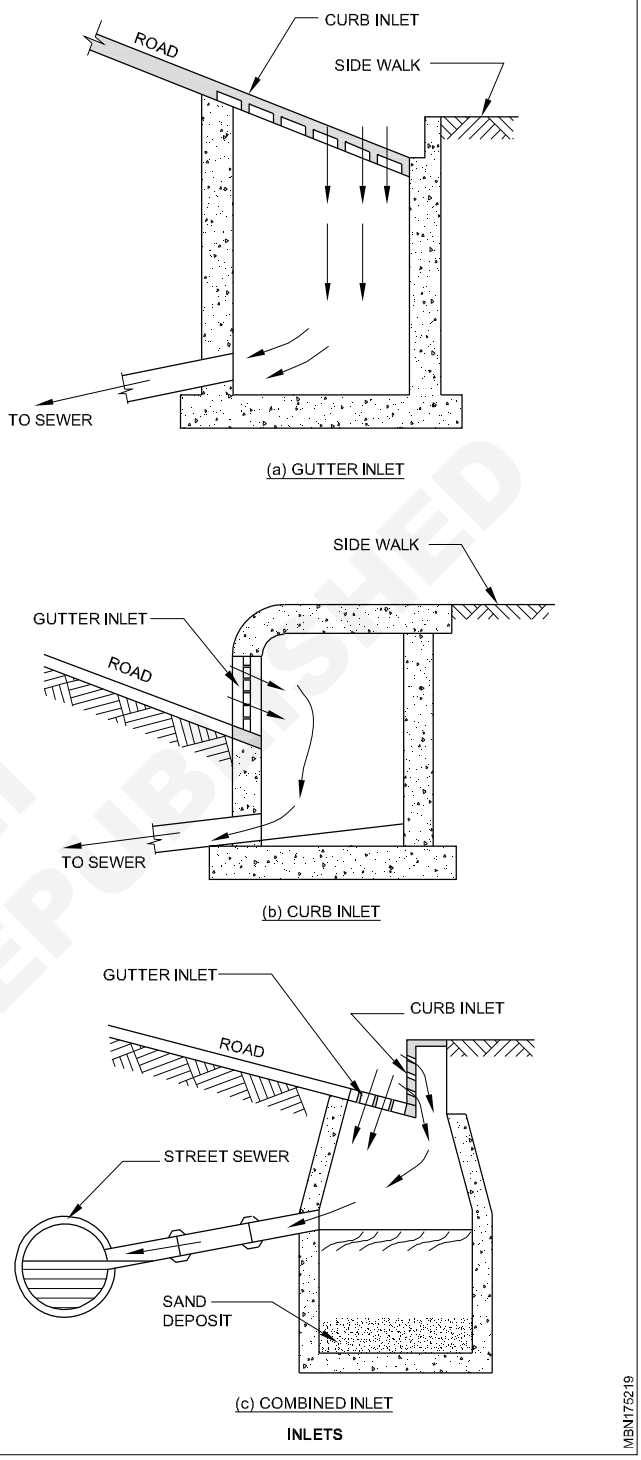
2 Curb inlet

In this type of inlet, a vertical grating is provided at curb (Fig 9b). It is also called vertical inlet.

3 Combined inlet

In this type of inlet, storm water can enter from both gutter and curb. (Fig 9c)

Fig 9



INLETS

9 Storm regulators and weirs

The structure used to divert a portion of the flow of sewage from a combined or storm sewer are called storm regulators. Storm regulators come into operation when the discharge exceeds a certain limit. The excess storm water is diverted to natural streams. Thus, they reduce the load on the pumping stations.

Following are the three types of storm regulators,

i Leaping weir

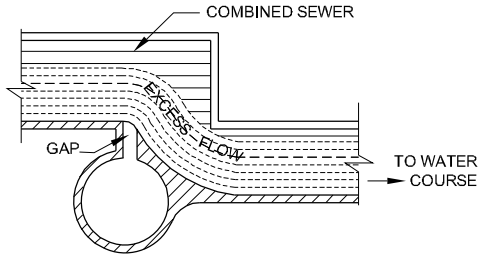
ii Overflow weir

iii Siphon spillway

i Leaping weir (Fig 10)

Leaping weir is one, in which the normal dry weather flow falls into the sanitary sewer through an opening provided in its crown. The excess quantity of storm or sewage leap or jump over the opening on to the water course. The leaping weir does not have any moving parts. A grating may be provided on the gap to prevent stones, debris, etc. from entering into the intercepting sewer.

Fig 10

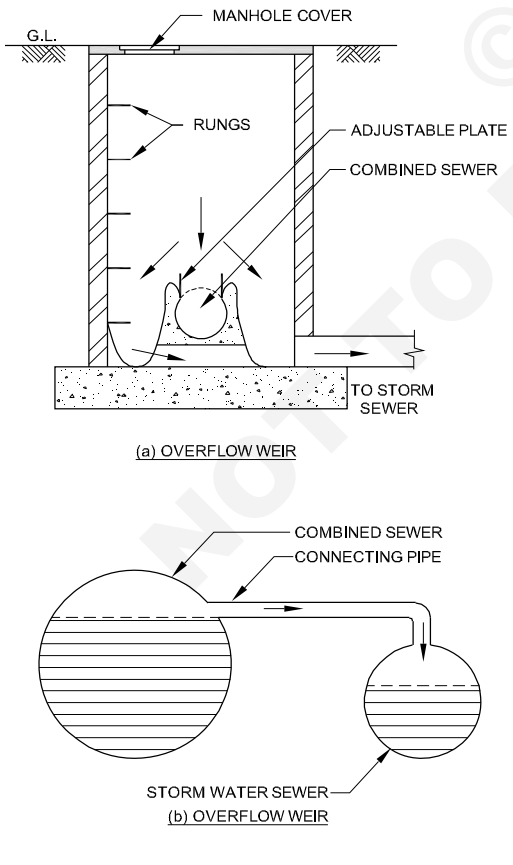


LEAPING WEIR

ii Overflow weir

Overflow weir is one, in which the extra quantity of sewage or storm water spills over the weir to pass off into another overflow sewer. The normal dry weather flow flows to the sewer outlet. Various types of overflow weirs are shown in (Fig 11a, b).

Fig 11

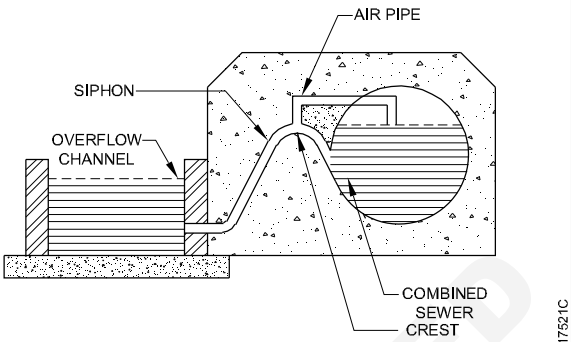


TYPES OF OVERFLOW WEIR

iii Siphon spillway (Fig 12)

It works on the principle of siphonic action and it works automatically. The rise of sewage is the combined sewer is thus controlled well. The overflow channel is connected to the combined sewer through the siphon. An air pipe is provided at the crest level of siphon.

Fig 12



SIPHON SPILLWAY

Working

The level of crest of siphon is kept at the level reached by the flow in combined sewer during the period of maximum dry weather flow.

When the level is combined sewer goes beyond the crest level of siphon, the mouth of air pipe is closed and the air contained in the siphon is suddenly carried away and develops siphonic action. Water commences to flow into the overflow channel until the water level falls below the mouth of connecting pipe.

10 Inverted siphons (Fig 13)

Inverted siphons are ordinary pipes running under pressure. They are constructed for conveying the sewage under streams, railways, rivers, and such other obstructions. They are also called "depressed sewers".

Two manholes are built one at each end of the inverted siphon. These two structures are connected by the siphon pipe or pipes. An overflow pipe is provided to divert the sewage flow, when the inverted siphon is choked.

While designing the siphon, the following points should be considered.

1 The construction of the siphon should be simple.

2 Changes of direction should be easy and gradual.

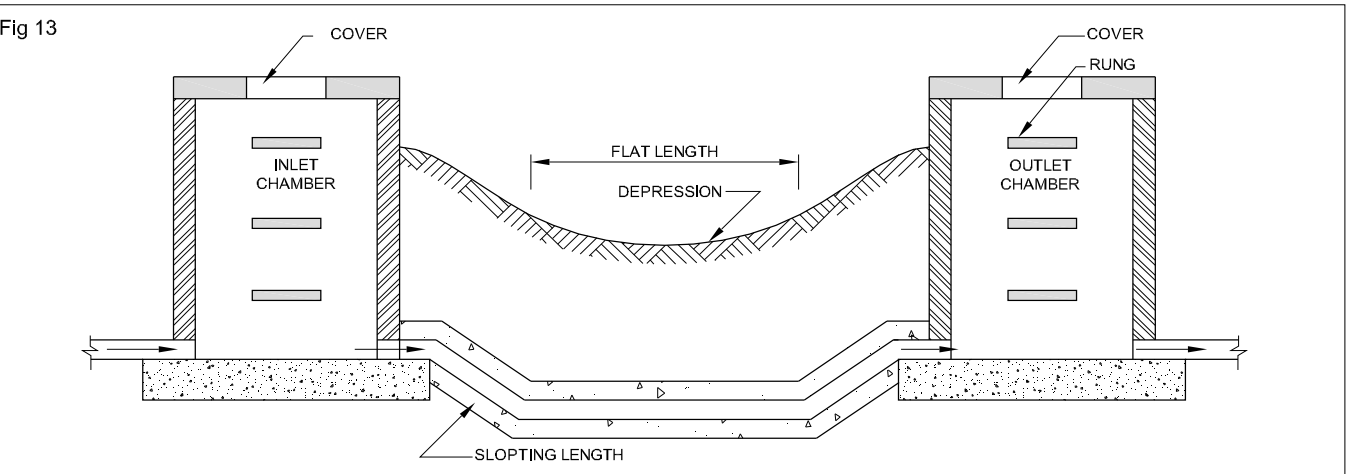
3 The velocity of average flow should be atleast. 1 metre per second so that there will be no deposition of solids.

4 Siphons should be built with two or three pipes of different sizes. (These should be arranged in such a way that they come into servicing and in proportion to the amount of flow.

5 The total length of the siphon is not the straight length from inlet to outlet, but includes the fall, bends and rise.

6 The siphon must be considered as a pipe running full under pressure. (For this, the maximum head available must be known).

Fig 13



INVERTED SIPHON

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7 Allowance should be made for losses of head due to bends and due to increased friction on account of roughness in the siphon caused by silting.

8 For the selection of the proper size of pipes for an inverted siphon, the minimum, average, and maximum flows in the sewer should be considered.

9 To avoid danger of silting, facilities should be provided for easy cleaning of the pipes. This can be achieved by.

- i providing screens and detritus pits above the siphon inlet.
- ii duplication of the pipe line for diversion of flows and
- iii laying the pipes in such a way that they could be drained to some lower point

10 overflow provision should be made to deal with the surcharge, in case the siphon is choked.

11 Junction chambers

They are chambers constructed to facilitate the junction of two or more sewers. They are large enough for a man to enter. They are provided where sewer intersect with horizontal angles between their axes to be less than 30°, so that ordinary type of junction is difficult to be constructed. They are classified based on the shape of the top surface.

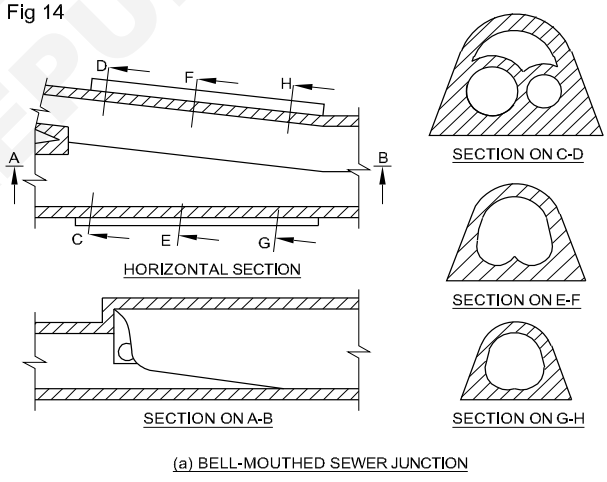
There are two types of junction chambers

i Bell - mouthed sewer junction. (Fig 14)

ii Flat - top sewer junction. (Fig 15)

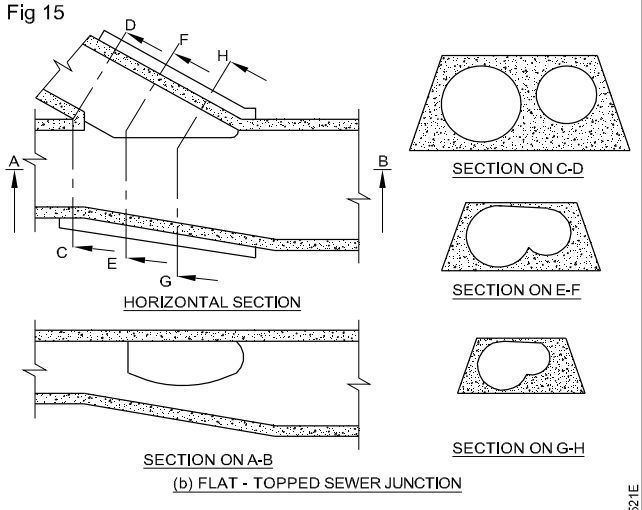
The former type is now obsolete because of the greater skill and cost involved. The latter type is commonly used.

Fig 14



(a) BELL-MOUTHED SEWER JUNCTION

Fig 15



(b) FLAT - TOPPED SEWER JUNCTION

JUNCTION CHAMBERS

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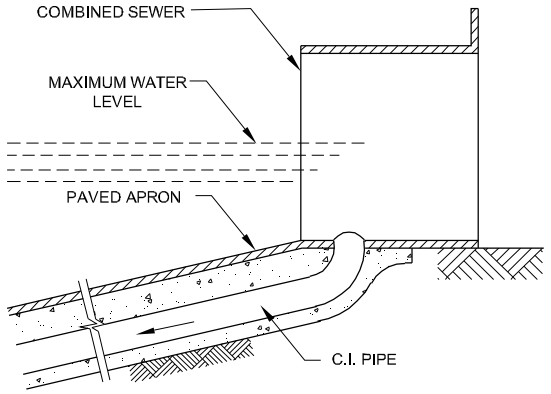
12 Outlets (Fig 16)

In a separate sewerage system, the storm water, discharges directly on the bank while the sewer outlet, which simply consists of cast iron pipe extending into the body of water from a manhole in the bank. In a combined system, it is considered more economical to separate out storm water overflow and discharge it into river bank or lake and the domestic sewage into the deep water.

Fig 16



OUTLETS

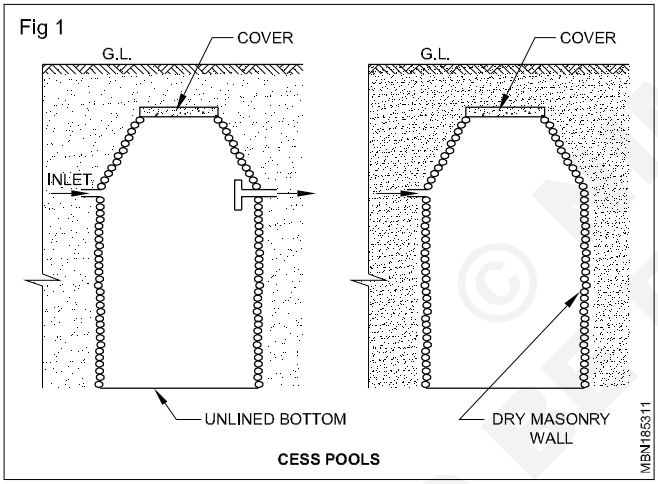
Septic tank

Objectives: At the end of this lesson you shall be able to
- **explain cess pool**
- **explain septic tank**
- **explain the principle of septic tank**
- **explain the disposal of septic tank effluent**
- **explain the construction details of septic tank**
- **design septic tank.**

Cess pools

The water - carried wastes of small habitations may be disposed off by means of cess pools. These are masonry pits, usually not less than 1.5 m in diameter and 1.8 to 3m deep. Inner surfaces are plastered and covered by an air - tight cover at top. When the pool is filled up, it is emptied and cleaned. The contents obtained are conveyed in carts for further disposal. This is a tedious job and it results in extra cost. At the time of collection, it creates lot of nuisance due to bad smell and spillage (Fig 1).

Fig 1



CESS POOLS

Cess pools should be located on leeward side and away at least by 15 to 20m from residential buildings and wells of drinking water. They should also be properly ventilated.

Septic tank - The septic tank is a water tight underground tank. Sewage is admitted in to it for treatment. It is suitable for disposing excreta and liquid wastes from individual dwellings, small groups of houses and institutions.

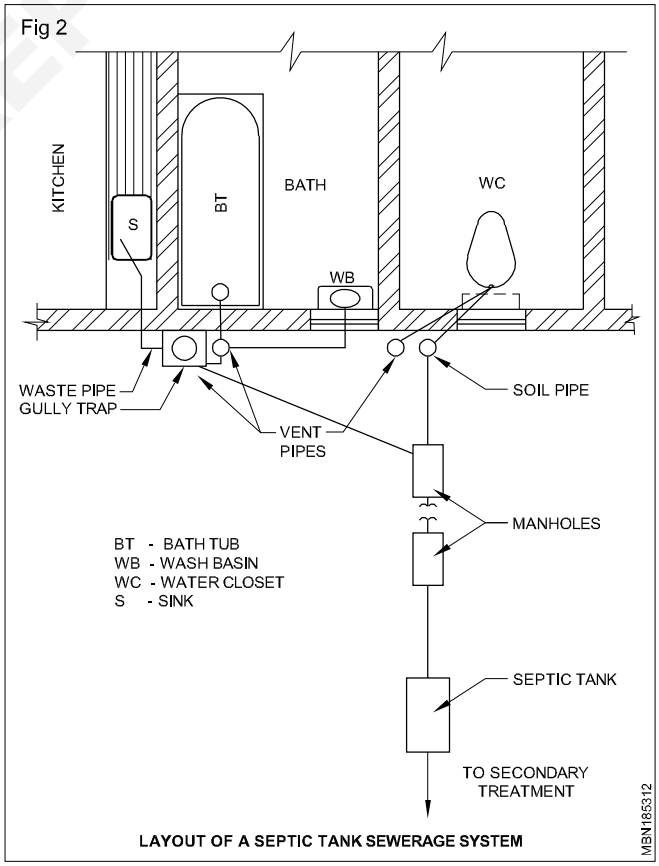
Principle and working of a septic tank

Septic tank is just like a horizontal continuous flow plain sedimentation tank. The sewage moves very slowly. The flow is continuous from the inlet to the outlet. During the detention period, the solids settle down in the tank as sludge. The lighter solids rise to the surface as scum. The baffle wall prevents the scum from leaving the tank with the effluent. The solids get attacked by anaerobic bacteria and fungi. They are broken down into simpler chemical compound. This is the first stage of purification called anaerobic digestion. It renders sludge stable and inoffensive. The digested sludge from the tank is periodically removed and disposed off in a suitable manner. A portion of the solids is converted into liquids and gases. The gases rise to the surface in the form of bubbles causing bad smell. Hence septic tanks are covered at top. They are provided with high vent shaft for the escape of gases.

The liquid which passes out of the outlet pipe is called the effluent. It is highly odours and rich in Biochemical Oxygen Demand (B.O.D). It has finely divided solid contents with numerous highly infectious pathogenic bacteria. For further treatment it is allowed to percolate into the subsoil through soak pit or dispersion trench. The aerobic bacteria in the upper layer of soil oxidize the organic matter into stable end products. This stage of purification is called aerobic oxidation.

Disposal of septic tank effluent (Fig 2)

Fig 2



LAYOUT OF A SEPTIC TANK SEWERAGE SYSTEM

The effluent from septic tank contains a large amount of harmful organic matter and its B.O.D is high. Therefore the effluent should be disposed off carefully to cause minimum nuisance to public health.

Septic tank effluent is more commonly disposed off on land by the following methods.

Disposal in absorption trenches

In this method the effluent is allowed to percolate into the subsoil by means of perforated or open jointed pipes laid in trenches. The trenches are about 1 m deep and 1 m wide excavated with slight gradient. The trenches are filled with gravel, well graded aggregate and ordinary soil. The effluent percolates into the surrounding media. The organic matter present in the effluent is oxidised by the bacteria present in the upper layers of the soil. The clearer water get dispersed into the surrounding soil.

Disposal into soak pit

Soak pit is a covered circular pit. The effluent is allowed into it and gets soaked or absorbed into the surrounding soil. The pit may be kept either empty or filled up with brick bats or stone aggregates. When empty, the pit is lined with brick, stone or concrete blocks with dry open joints. It is provided with at least 75 mm backing of coarse aggregate below the inlet level to support the lining. When filled, no lining is required except for the top masonry ring.

Construction details of septic tank

i Dimensions of septic tank

Width = 750 mm. minimum

Length = 2 to 4 times width.

Depth = 1000 to 1300 mm. minimum below water level + 300 to 450 freeboard.

Total maximum depth = 1800 + 450 = 2250 mm.

Capacity = 1 cubic metre minimum.

ii Suitable sizes of septic tanks for use of 5,10,15,20 and 50 persons. See fig 2 which gives a typical layout of a septic tank sewerage system.

iii Detention period of 24 to 48 hours is usually available in a septic tank. The rate of flow of effluent must be equal to the rate of flow of influent.

iv The floor is of cement concrete 1:2:4 and laid with a slope of 5 to 10% towards sludge outlet or sludge collecting sump; if provided. Tank is cleaned of sludge every 6 to 12 months.

v **Inlet pipe** An elbow or T - pipe if 100 mm. diameter of stone ware or asbestos is used. It is laid at the time of construction of walls of the tank. The T - pipe is submerged to a depth of 250 to 600 mm below the liquid level.

vi **Outlet pipe** An elbow or T- pipe of 100 mm. diameter submerged to a depth of 200 to 500 mm below the liquid level is provided.

vii **Baffle walls** For small tanks, R.C.C hanging type of scum baffle walls are provided. Baffle walls are provided near the inlet as well as outlet. The inlet baffle is generally placed at a distance of L/5 from the end wall, where L is the length of the tank. The baffle wall is generally extended 150 mm above scum level and 400 to 700 mm. below it. Its thickness may vary from 40 to 80 mm. Flag stone slabs can also be used. For large tanks baffle walls are made of 100 mm thick brick walls with honey combed bottom courses to allow the flow of sludge.

viii **Roofing slab** The top of the tank is covered with an R.C.C slab of 80 mm. thickness. For the purpose of inspection and desludging, access openings are provided. Incase of circular openings the clear opening is kept 500 mm. in diameter and if rectangular, the opening is kept 600 x 450 mm.

ix **Ventilating pipe** A cast iron or asbestos pipe of 50 to 100 mm. diameter is used as a ventilating pipe. It is extended upto 2 m. minimum above G.L. Top of the ventilating pipe is provided with a mosquito proof wire mesh or cowl.

x The effluent from the septic tank is disposed off by seepage pit or dispersion channels.

xi The septic tank is exclusively used for residential buildings or such living units where there are no other sewerage disposal arrangements.

Design of septic tank (Fig 3)

Design of septic tank consists or providing chamber for

1 Settling of incoming sewage.

2 Digestion of settled sewage.

3 Storage of digested sludge.

4 Storage of scum.

1 Space for settling

This is calculated for the average flow and detention period. Smaller tanks are designed on the basis of average flow and 24 hours detention period and larger tanks, 12 hours detention period. If latrines are connected to septic tank, average flow per capita per day may be taken as 45 litres. On the other hand, if all the waste water of the houses is to be treated in septic tank, the average flow should be taken depending on the water supply. The volume of setting also depends on the clear space available. The clear space is the space between the upper level of the sludge and lower level of scum. The vertical height of the clear space may vary from 0.23 m to 0.30 m. The clear space multiplied by the plan area of the tank gives the minimum tank volume for settling.

2 Space for digestion

Sludge digestion capacity varies from $0.028m^3$ & $0.056m^3$/ capita.

Space for digested sludge

The space for digested sludge produced per capita in different periods are shown in table.

Period of cleaning	Storage capacity
6 months	0.0283 m^3
1 year	0.0490 m^3
2 years	0.0708 m^3
3 years	0.0850 m^3

The space for storage digested sludge designed on the basis of cleaning and number of persons using the tank.

Space of scum For scum storage 0.01 m^3 per capita is required.

Example No1

Design a septic tank for 50 users (Fig 3).

Assuming the usage of water 135 litre per/capita/day

No.of users = 50

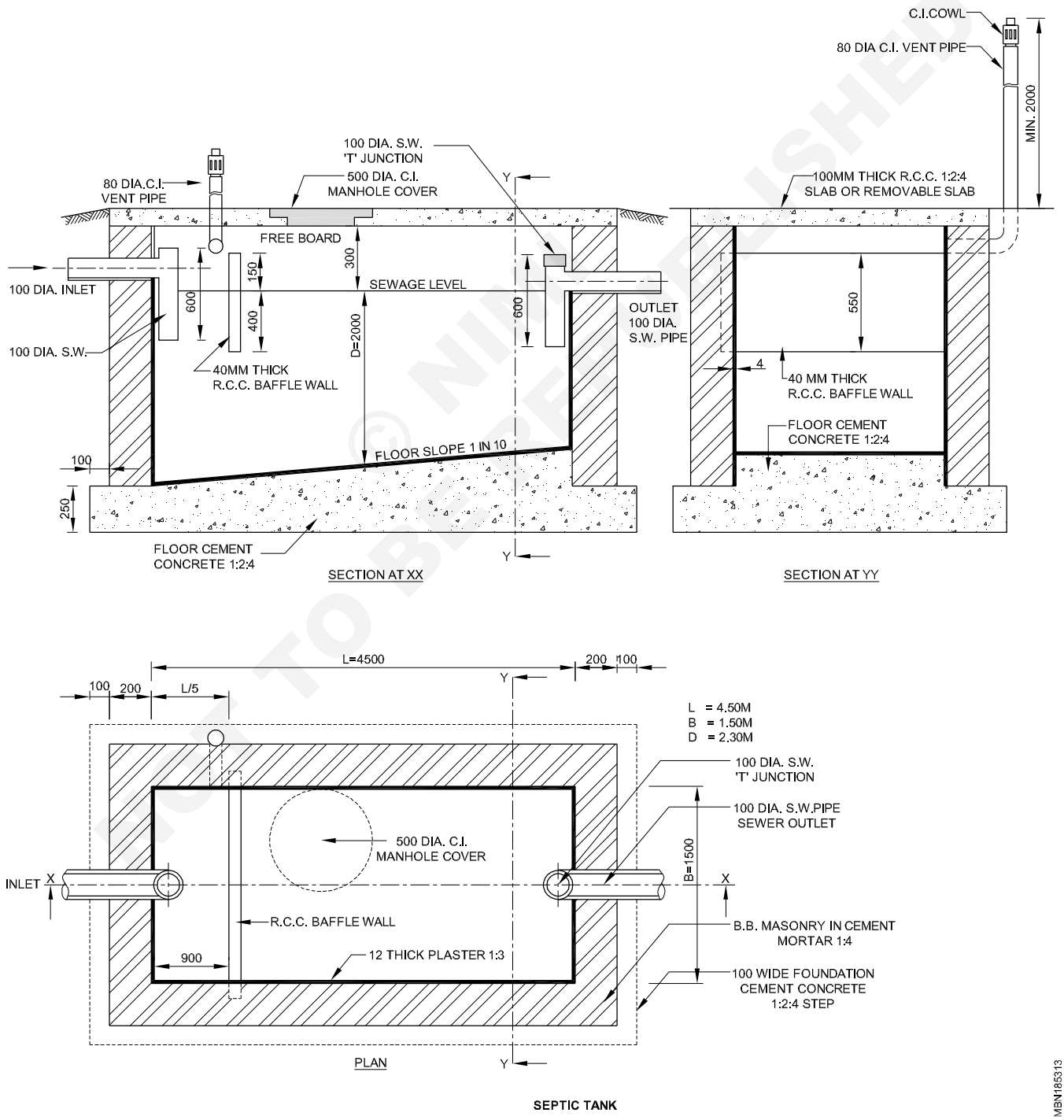
Total quantity of sewage = 135 x 50 = 6750.00 litres = 6.75 m^3

Assuming a detention period = 24 hours (normal range 12.00 - to - 24.00 hours)

$$\text{Tank capacity} = 6.75 \times \frac{24}{24} = 6.75 m^3$$

Assuming the tank is cleaning period = 2 years

Fig 3



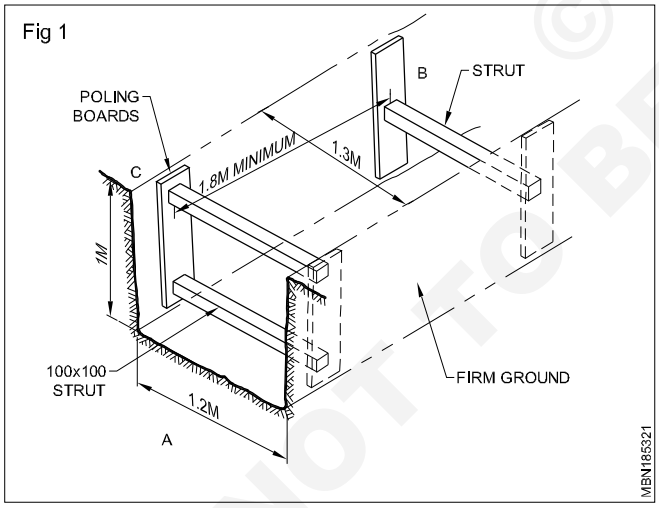
Shoring for deep trenches

Objectives: At the end of this lesson you shall be able to
- **state shoring**
- **state shoring if the soil stiff clay and moderately firm soil**
- **state shoring in soft soil**
- **state shoring in loose soil.**

Shoring

- Timbering of trenches knows as shoring
- Shoring is a temporary arrangements of boardings or poling boards.
- Walings and struts provided to give support to the sides of trench.
- In case of hard soil where the depth of excavation is moderate.
- In hard soil the side of trench require no support.
- In firm soil, if the depth of trench is small, shoring not necessary.
- In firm soil the depth of excavation is more to provide light support required.
- As a rule, all trenches in soil other than rock or hard compact soil more than 1.5 m deep, shoring should be provided.
- Size of poling boards 20 to 25 cm x 4 to 5 cm. Length of poling boards according to the depth of excavation.
- Struts are spaced minimum distance of 1.8 m along the length of trench (Fig 1)

Fig 1



- Some times, the site condition may require two struts between boards (Fig 2)

In stiff clay or moderately firm soil

- In this soil, the support to sides of trench can be given horizontal boarding or waling.
- The size of waling 20 to 25 cm x 5 to 7.5 cm is run continuous along the length of trench on both side.
- The pair of waling is strutted apart as shown in (Fig 3).

Fig 2

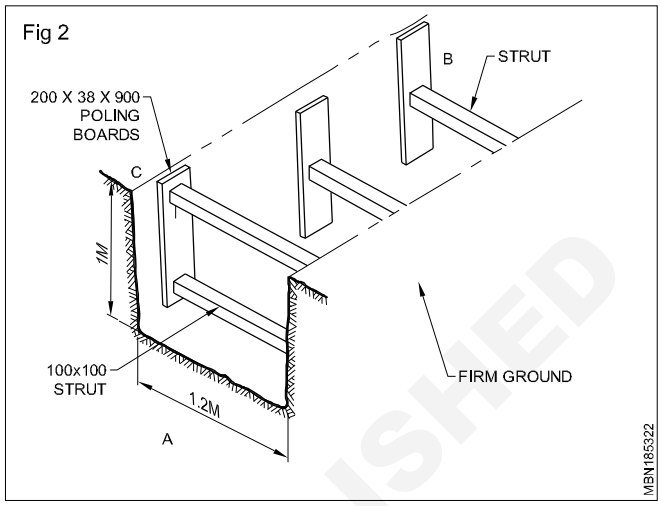
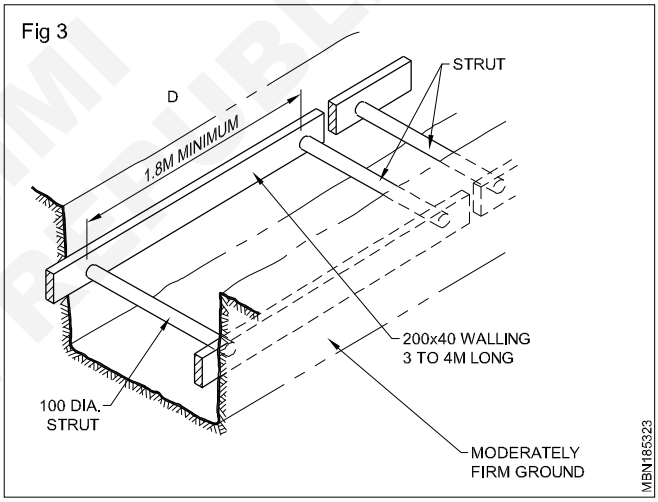


Fig 3



Soft soil

- In soft soil, the poling boards are placed closer, as 90 cm apart and one held by walings.
- The waling on either sides is strutted apart (Fig 4)

Loose soil

- In loose soil the poling boards are placed side by side vertically and supported by waling and struts at intervals (Fig 5)
- In case of natural soil is cannot stand un-supported even for a few centimeter.
- In this case vertical sheeting is necessary to be provided (Fig 6).
- In loose soil, for deep excavation, the trench is excavated in stepped form.
- The trench width is increased towards top.

Fig 4

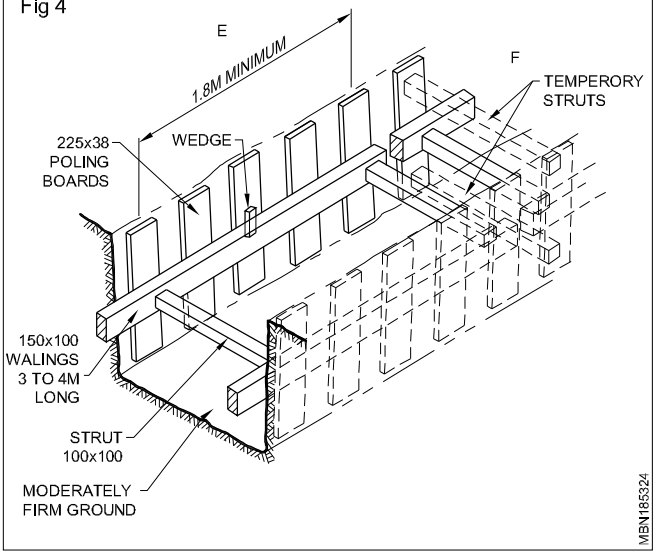
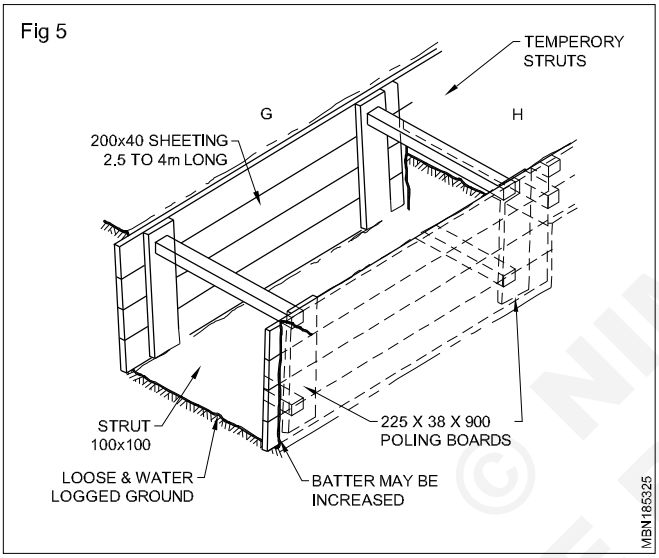


Fig 5



- The arrangement of sheeting, vertical props, struts and runners etc., (Fig 7)

Fig 6

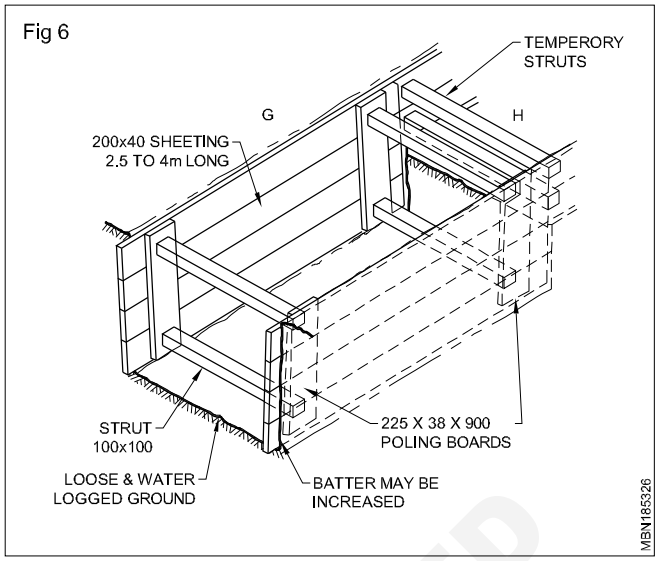
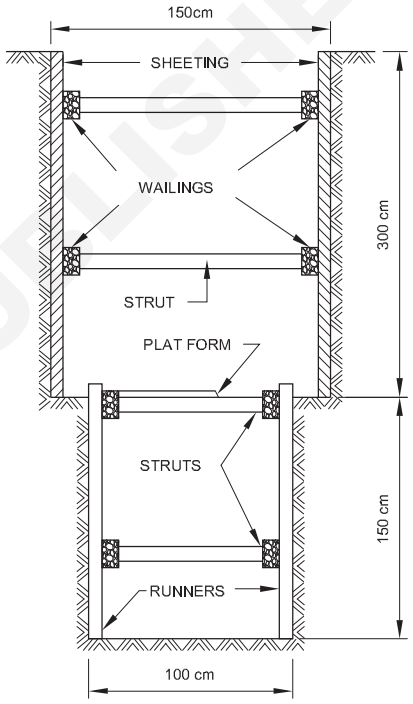


Fig 7



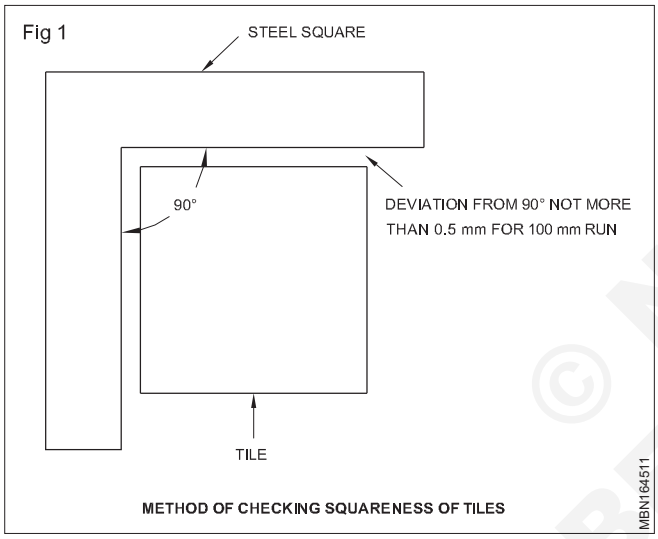
TIMBERING OF DEEP TRENCH IN LOOSE SOIL

Glazed tile flooring

Objectives: At the end of this lesson you shall be able to
- **explain quality of glazed tiles**
- **describe the dimensions and square /rectangular patterned tiles**
- **state the importance of wetting tiles/bricks before use.**

Glazed tile flooring

- The tiles shall be of approved make and shall generally conform to IS. 777.
- They shall be flat and true to shape and free from blisters crazing chips, welts, crawling or other imperfections detracting from their appearance.
- The tiles shall be square or rectangular of nominal size such as 150 x 150 mm, 100 x 100 mm, 100 x 200 mm or as directed as shown in (Fig 1).



- The thickness of tiles shall be 5mm, or 6mm as specified.
- The length of all four sides shall be measured correct to 0.1mm and average length, breath shall not vary more than ± 0.8mm from specified dimension.
- The variation of individual dimension from average value of length /breadth shall not exceed ± 0.5mm
- Where tiles of nominal sizes 150 x 150mm or 100 x 100mm are not available. tiles of nominal sizes 152 x 152mm or 108 x 108mm may be used.
- The actual size of the tiles supplied shall be 1mm less so that with 1mm joint, the tile when laid shall conform to the nominal size.
- The top surface the tiles shall be glazed and glaze shall be either glossy or matt.
- The underside of the tiles shall not have glaze on more than 5 percent of the area in order that the tiles may adhere properly to the base.
- The edge of the tiles shall be preferably free from glaze.

Coloured tiles

- Only glaze shall be coloured as specified. The size and specifications shall be the same as for the white glazed tiles.
- The size of these tiles shall be 152 x 152 x 6mm and or 108 x108 x6mm.
- Decorated and having coloured background.
- The size of the tiles shall be 152 x 152 x 6mm and or 108 x 108 x 6mm.

Preparation of surface and laying

- Base concrete or the R.C.C slab on which the tiles are to be laid. shall be cleaned, wetted and mopped.
- The bedding for the tile shall be with cement mortar 1:3 (1 cement : 3 coarse sand).
- The average thickness of the bedding shall be 10mm while the thickness under any portion of the tiles shall not be less than 5mm.
- Mortar shall be spread tamped and corrected to proper levels and allowed to harden sufficiently to off a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.
- Over this mortar bedding neat grey cement slurry shall be spreaded at the rate of 3.3kg of cement per square metre over such an area as wood accommodate about twenty tiles.
- Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another.
- Each tile gently being tapped with a wooden mallet till it is properly bedded and in level with adjoiinng tiles.
- The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.
- The surface of the the flooring during laying shall be frequently checked with a straight edge about 2m long so as to obtain true surface and slope.
- Where the full tiles can be fixed these shall be cut to the required size and their edge rubbed smooth to ensure straight and true joints.
- Tiles are fixed in the floor adjoining the wall shall enter not less than 10mm under the plaster skirting or dado.
- After tiles have been laid surplus cement slurry shall be cleaned off.
- Joints shall be cleaned off the grey cement slurry with coir brush or trowel to depth of 2 to 3mm & all dust and loose mortar removed.

- Joint shall be flush pointed with white cement added with pigments if required to match the colour of files.
- The floor shall be then kept for 7 days, after curing the surface shall be washed & cleaned.
- The finished floor shall not sound hollow when taped with wooden mallet.

Purpose of wetting bricks and tiles before use:

The bricks tiles should saturated with water so as to prefered absorption of moisture from mortar. This is effectively done by providing a tank at the site of work and by immersing the brciks or tiles for a period of at least 2 hours be fore actually placed in portion.

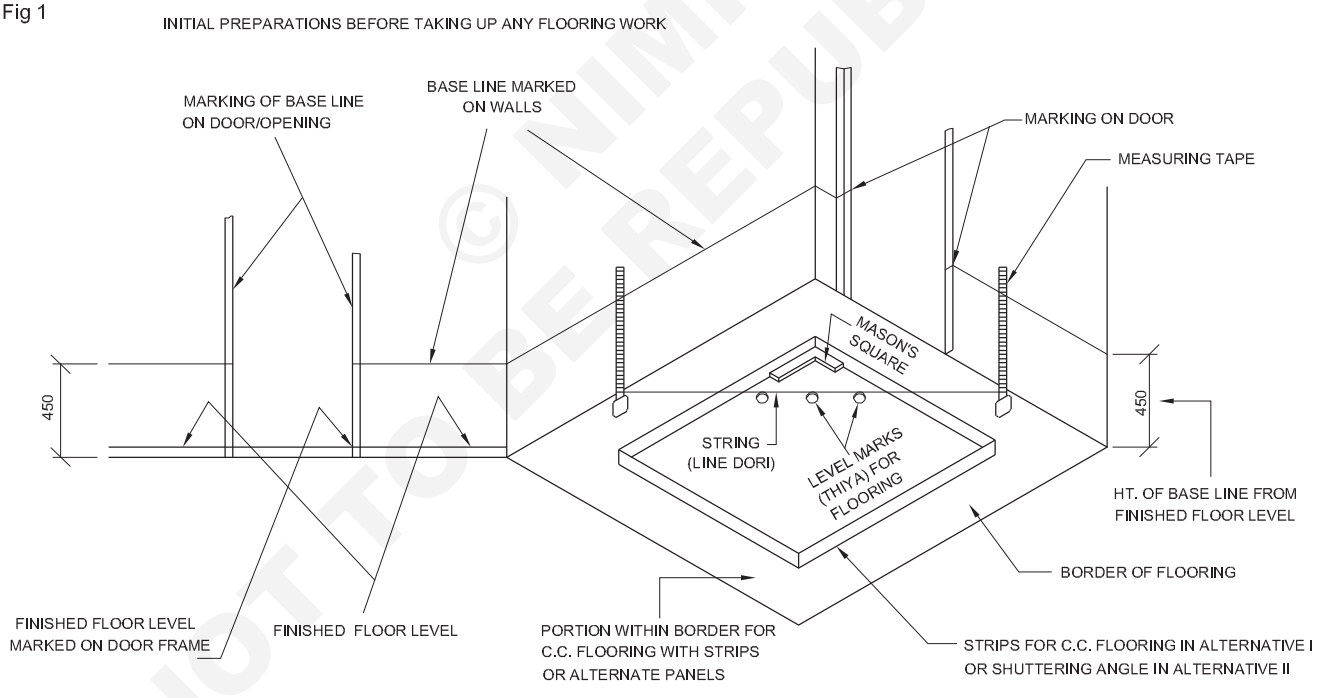
Preparation before takingup any flooring

Objectives: At the end of this lesson you shall be able to
- **check border line accurately for square/Rectangle**
- **prepare subgrade for flooring**
- **fix strips/angle iron for square and rectangle.**

Preliminary arrangements

- Before taking up any flooring work of any type of mason must be asked to make the initial arrangements so that the irreparable mistakes can be totally avoided.
- After the plastering work is completed and before taking up the work of flooring, transfer the finished floor level very accurately at the one of the door openings preferably on front door frame.
- Measure a height of 450mm to the above marking of finished floor level along the door frame upwards, and make a temporary mark on the door frame
- Carry this level on all the doors of the flat/Building and make the mark on the all doors.
- Again transfer this level on all the walls of the room and on conforming it any slope is to be provided with the floor. The level is transferred by measuring the required distance with a measuring tape from the base line.

Fig 1



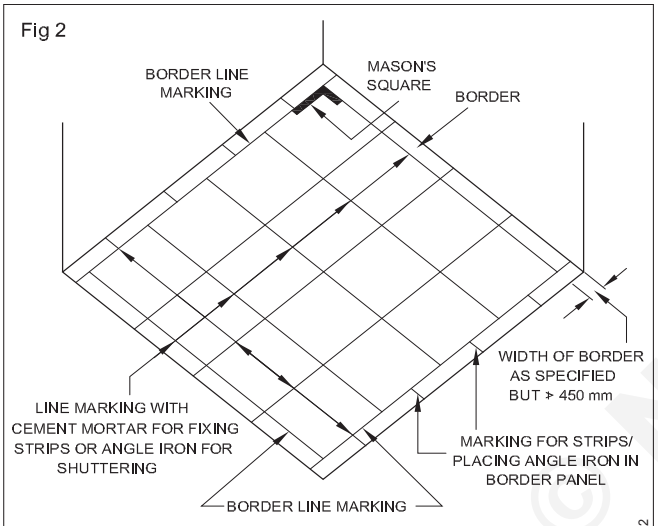
INITIAL PREPARATIONS BEFORE TAKING UP ANY FLOORING WORK (MARKING BASE LINE)

The level marks or level dots for top of lean concrete are made at regular intervals in the entire room to be covered with flooring. The lean concrete is then laid to the exact level of the markings or level dots. as shown in (Fig 1).There is a general tendency to complete work of lean concrete below the floor, even before the walls of the room are raised.This method looks to be convenient for the movement of labours and general work but this is not good practice. Because at the stage, laying lean concrete to the exact level may not be possible, and later when the accurate levels for laying flooring are taken. The surface of the lean concrete has to be chipped off or the rich mix of flooring concrete has to be used for filling the depressions.

- On completing the laying of lean concrete again measure the distance required till finished floor level from the base line and erect the level marking or level dots as before for the finished floor level.

- The short cut method generally adopted by masons to measure the thickness of floor.
- The surface of already laid lean concrete and make the level marking and proceed with flooring work should not be permitted. Another most important activity is fixing strips for joints of flooring in position to cast the flooring in position to the cast the flooring alternation or erecting the angle iron or flats in position to cast the flooring in alternate bays under alternative II as shown in (Fig 1).The strips for joints or the angle iron for shuttering must be fixed in perfect straight line and also in right angles when they form an angle
- For this purpose it is necessary to make the marking on the floor. If a border on all sides is prescribed then a border line with cement mortar shall be marked by measuring the required width of border from the face of the wall as shown in (Fig 2).

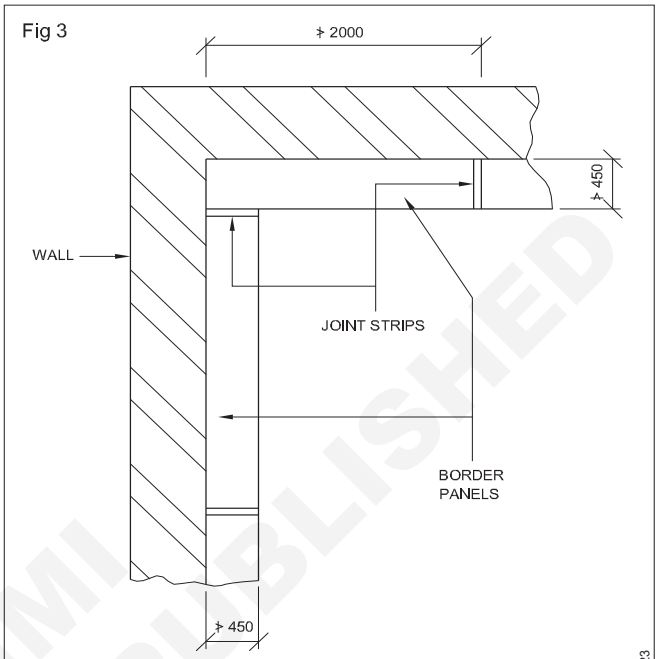
Fig 2



MARKING OF BORDER AND FLOOR PANELS WITH CEMENT MORTAR ON LEAN CONCRETE

- Complete the marking of border line on all four sides of the room and check the four angles of the square or Rectangle with help of mason's square
- If due to any mistake in the construction of walls if you are not getting all corners in perfect right angles make slight adjustment in the width of the border.
- So that the edges of square-rectangle formed should be in perfect right angle.
- On satisfactory completing the marking of the border line, the side panels should be marked with as shown in (Fig 3).

Fig 3



SHOWING MAXIMUM WIDTH OF BORDER PANEL PERMITTED AS PER SPECIFICATIONS

- Once the marking of square/rectangular is complete in whole room, the strips for joints or angle iron for the centering of the panels should be fixed along the marking adjusting, top surface of the strip-angle iron with string stretched across the level marks or Level dots.
- The strip/angle iron can be fixed to the desired level/ slope and the bays for concreting can be made ready.
- This method is followed very carefully.

Useful points on flooring work

Objectives: At the end of this lesson you shall be able to
- **define the important useful guidelines**
- **state the various floors and its uses in building.**

Useful points on flooring work

- Flooring should be done after plastering work on the walls are over.
- If building is multi storeyed, it is preferable to start flooring work from top storey so that movement of the persons on the newly cast flooring is minimized.
- Polishing of the floor wherever required should be done after completion of painting on the wall painting on the walls should be done after completion flooring (include grinding if any).
- Persons should be discouraged to walk on freshly laid floor since the marks left on such flooring become a permanent eyesore later.
- Glass strips design for flooring panels should be prepared in advance in order to have a uniform and pleasing flooring.
- Border panel of the flooring should be preferably cast along with the skirting.
- Flooring should be done after first marking Level dots with the help of water level and string to ensure proper level and slopes.
- Flooring should always be done over base of lean concrete (minimum 5cm thick) and should not be done directly over soling lean concrete serves the following purposes.

- It will give a level base to work upon and rich floor concrete would not be wasted.
- It will avoid hollow sounds over some points of the flooring wherever flooring is not in full contact with soling and sand below.
- Structural strength of flooring is increased for any point load which will be resisted now by the combined thickness of flooring and plain cement concrete (P.C.C) below.

Skirting is provided for the following purposes

- To finish the joints between flooring and plastering.
- To protect the bottom paint of the wall due to water mopping and other accidental hits.
- To protect the bottom part of plastering of wall from damage due to accidental hitting of furniture and other items.
- Stains over flooring formed due to any reason can be removed by using oxalic acid, Acetic acid or using vim powder, salt water, lemon water.
- Stains ceramic tiles and other china clay material can be removed either by vim powder or dilute HCL.
- Stones normally used for grinding of flooring are corborundum and pumic stones.
- Terrazzo flooring is relatively more resistant to acids and alkalines than cement concrete flooring.
- Hence in kitchen and toilets Terrazzo flooring is preferable to cement concrete flooring.

Location	Types of Floor
Bed Rooms	1 Cement concrete flooring with neat cement finish 2 Terrazzo tiles 3 Terrazzo - in - situ (Gray or white) 4 Kota stone 5 Marble crazy flooring.
Drawing cum Dining Room	1 White terrazzo in -situ flooring 2 Kota stone 3 Marble tiles
Office rooms (for general staff)	1 Cement concrete flooring with neat cement finish 2 Terrazzo flooring (Grey) 3 Terrazzo tiles
Library Computer rooms	**1 P.V.C flooring**
Toilet flooring and Kitchen Rooms	1 Ceramic tiles 2 Marble tiles or slabs 3 Terrazzo tiles 4 Cement concrete flooring with neat cement finish 5 Terrazzo in-situ flooring
Stair case Flooring	1 Kota stone 2 Slate stone 3 Terrazzo tiles 4 Cement concrete flooring with neat finish 5 Marble stone
Walkway Flooring	1 Agra stone 2 Plain concrete tiles (precast) 3 Chequered concrete tiles (Precast and coloured) 4 Sand stone slab (Dholpur stone) 5 Cement concrete flooring in panels (either granular finish with chequered design by putting jalli)
Lobby Reception main Lounge	**1 Ceramic tiles** 2 Terrazzo tiles 3 Kota stone 4 Granite stone

Location	Types of Floor
Wall cladding pillars cladding, Beam cladding in offices/Hotels in main circulation areas and reception areas Kitchen counter slab	1 Granite 2 Teak ply 3 Cudappah black stone 4 Marble slab 5 Granite 6 Cement concrete flooring with neat finish
Roof	1 Brick tiles 2 Cement concrete tiles 3 C.C flooring in panels 4 Terrazzo tiles 5 Agra red stone/Dholpur stone.

Laying of marble stone flooring

Objectives: At the end of this lesson you shall be able to
- **describe types and colour of marble stone**
- **explain laying methods of marble stone flooring.**

- Marble shall be hard, sound, dense and homogeneous in texture with crystaline texture as far as possible
- It shall generally be uniform in colour and free from stains , cracks decay and weathering.
- Marbles are metamorphic rocks capable of taking polish, formed from the limit recrystallization of lime stones or dolomitic.
- stones are distinguished from lime stones by even visibly crystalline nature and non flaggy stratification.
- Marble is a product of nature, hence it is difficult to guarantee uniformity of colour.
- Veining or other characteristics that may be represented in any sample submitted.
- A sample will indicate only average of colour, Veining and other general texture and specified finish
- Marble blocks, slabs and tiles shall be classified.
- White marbles.
- Coloured marbles such as blue, green, pink, brown, grey marble

Dressing of slabs

- Every stone shall be cut to the required size and shape
- Fine chisel dressed on all sides on full depth so that a straight edged laid along the side of the stone shall fully in contact with it.
- The top surface shall also be fine chisel dressed to remove all waviness.
- All angles and edges of the marbles slab shall be true, square, and free from chippings and the surface shall be true and plane.
- The thickness of the slab shall be 20,30 or 40mm as specified in the description of the item.

Laying

- Base concrete or the R.C.C slab on which the slabs are to be laid shall be cleaned , wetted and mopped.
- The bedding for the slab shall be with cement mortar 1:4 (one part cement and four parts coarse aggregate)
- The average thickness of the bedding mortar under the slab shall be 20mm and the thickness at any places under the slab shall be not less than 12mm.
- The slab shall be laid in the following manner.
- Mortar of the specified mix shall be spread under the area of each slab to the average thickness specified.
- The slab shall be washed clean before laying. It shall be laid on top. pressed, tapped with wooden mallet and brought to the level with the adjoining slabs.
- It shall be lifted and laid aside. The top surface of the mortar shall than be corrected by adding fresh mortar at hollows.
- The mortar is allowed to the harden a bit and cement slurry shall be spread over the same at the rate of 4.5kg of cement per sq.m
- The edges of slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the marble slabs.
- The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible.
- Subsequent slabs shall be laid in the same manner After each slab has been laid surplus cement on the surface of the slabs shall be cleaned off.
- The flooring shall be cured for minimum period of 7 days.

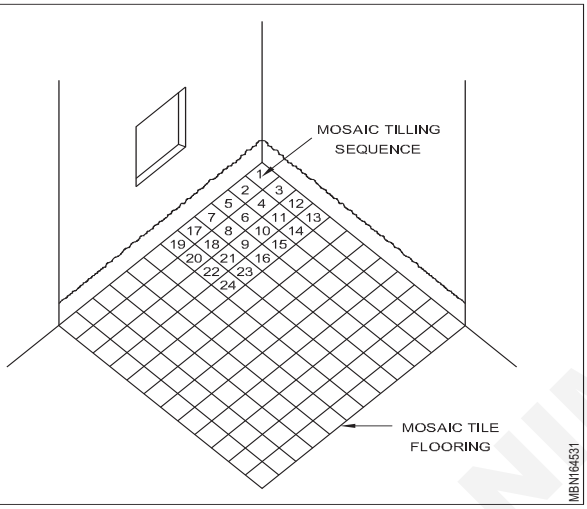
- The surface of the flooring as laid shall be true to levels and slopes as specified.
- Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of veins/streaks.
- The slabs which are fixed in the floor adjoining the wall shall enter not less than 12mm . Under the plaster skirting or dado
- The junction between wall plaster and floor shall be finished neatly and without waviness.

Types of flooring

Objectives: At the end of this lesson you shall be able to
- **state placing of mosaic tiles and terrazzo tiles**
- **state method of plastering**
- **state timber linoleum P.V.C, rubber floors.**

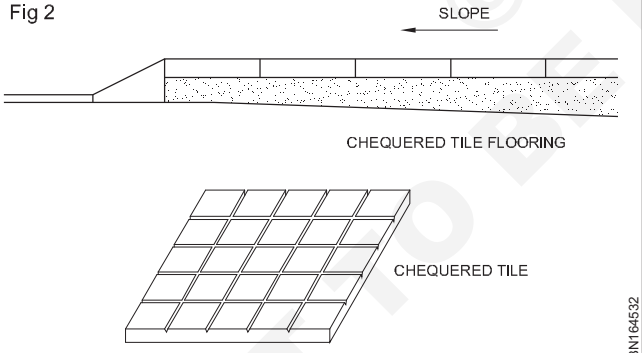
- Sequence for placing mosaic tiles or Terrazzo tiles and fixing of tiles as shown in (Fig 1).

Fig 1



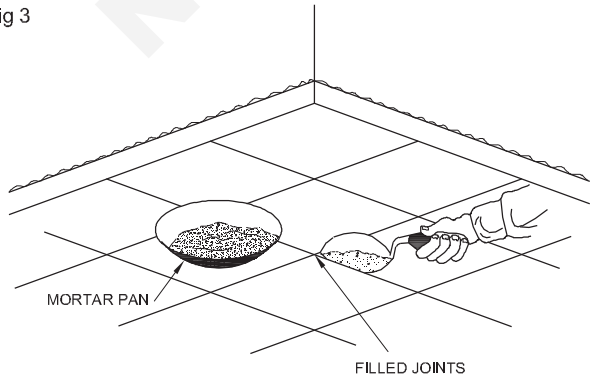
- Details of chequered tile fixing as shown in (Fig 2).

Fig 2



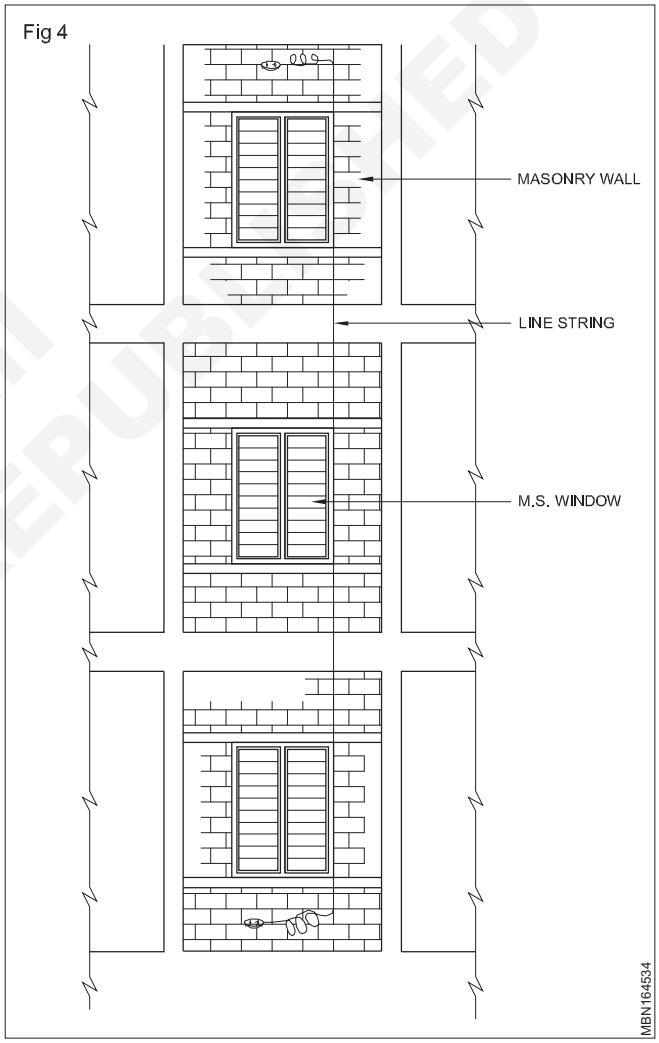
- Filling joints in the grey or white cement after laying tiles as shown in (Fig 3).

Fig 3



- Checking straight line alignment and plumb of window opening as shown in (Fig 4)

Fig 4



- Plaster cutting for skirting provision shown in the (Fig 5)
- Internal wall skirting details as shown in the (Fig 6)
- Fixing of skirting slices as shown in (Fig 7)
- Laying tiles in risers steps skirting and dado as shown in (Fig 7)
- Cement concrete pavement joint is filled with sealing compound as shown in (Fig 8)

Fig 5

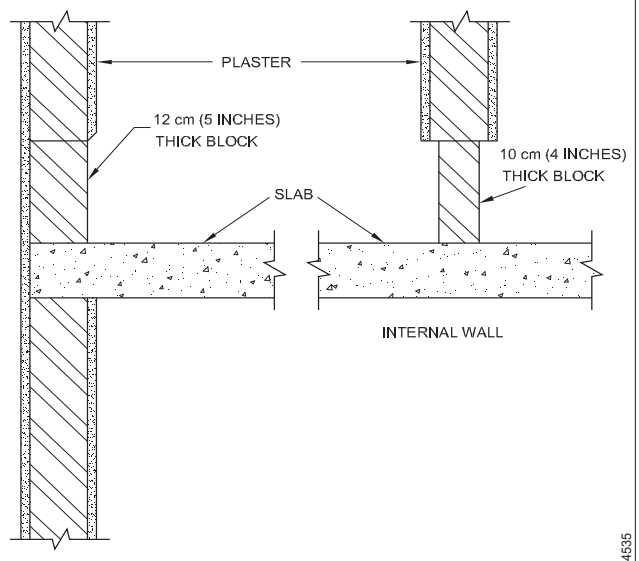


Fig 6

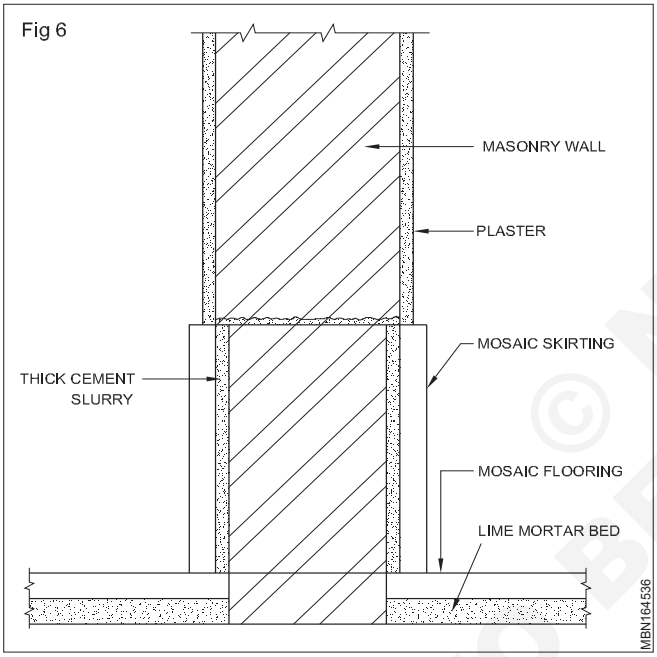


Fig 7

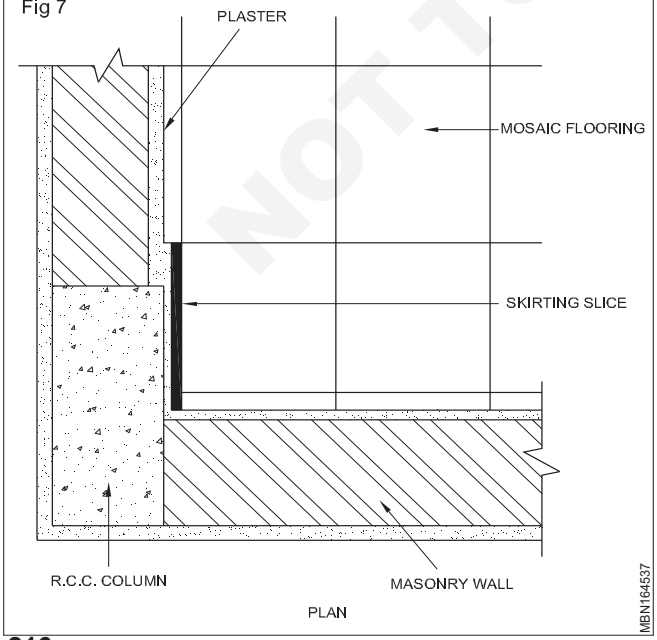
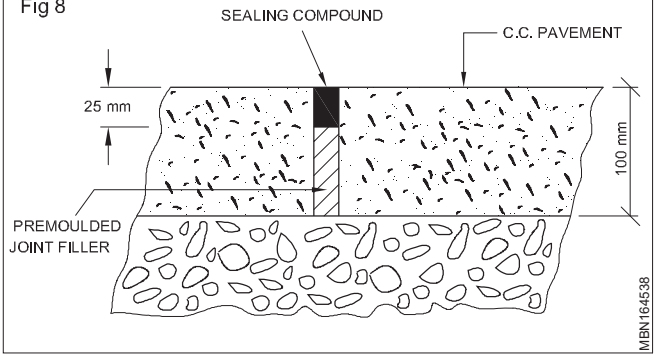
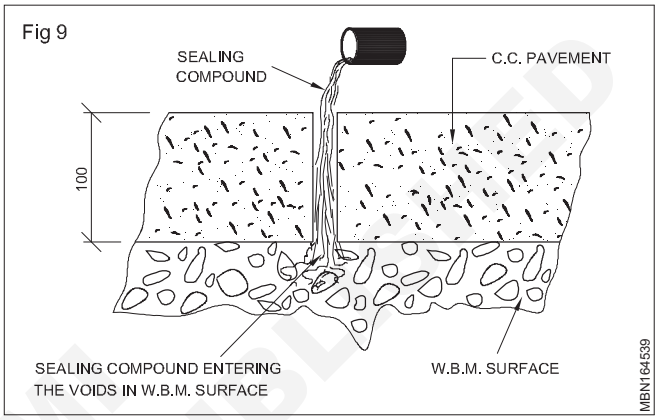


Fig 8



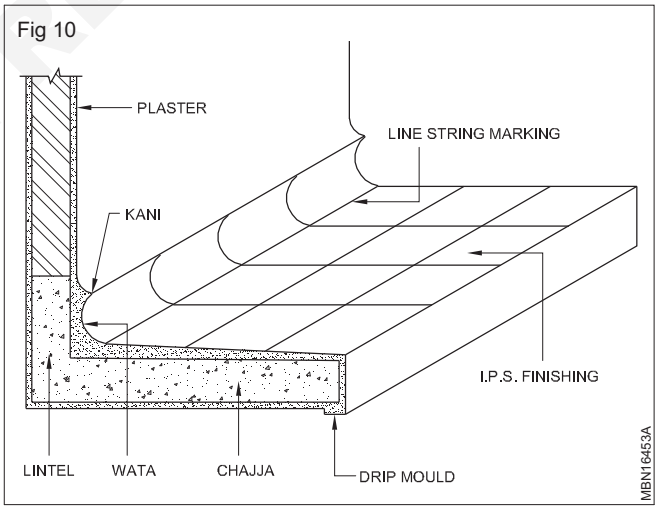
- Cement concrete pavement joint sealing compound poured entering the voids in base surface.(Fig 9)

Fig 9



- The projecting cantilever sunshade (chajja) finished with IPS. Finishing as shown in the (Fig 10)
- I.P.S smooth finish made on loft top with neat line string as shown in (Fig 10)

Fig 10



- Details of threshold fixing at door opening as shown in (Figs 11&12) (section and plan).
- Details of window sill with cuddappa stone sill with nosing fixing at bottom of window as shown in (Figs 13,14 & 15)

Elevation of window (Fig 15)

- Wooden template (farma) is prepared for skirting purpose to maintain uniform thickness and straight line.

Fig 11

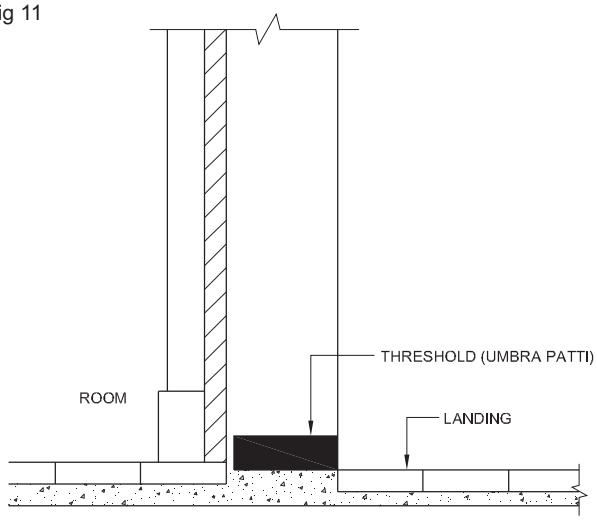


Fig 12

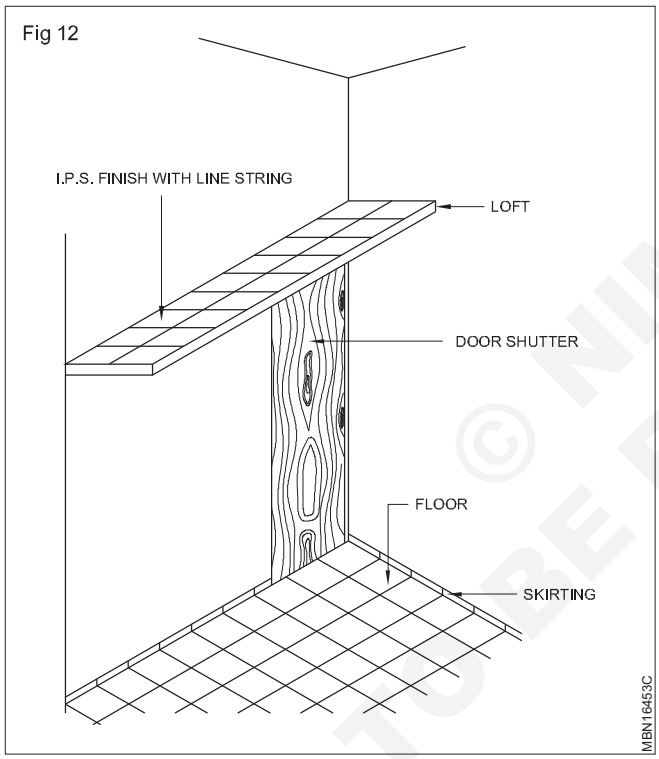


Fig 13

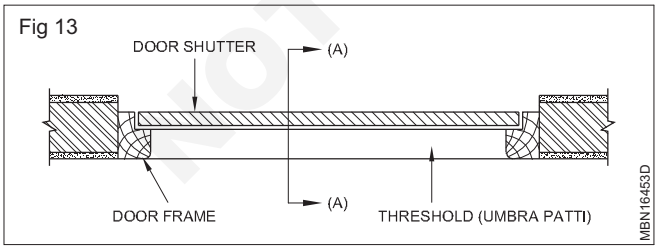


Fig 14

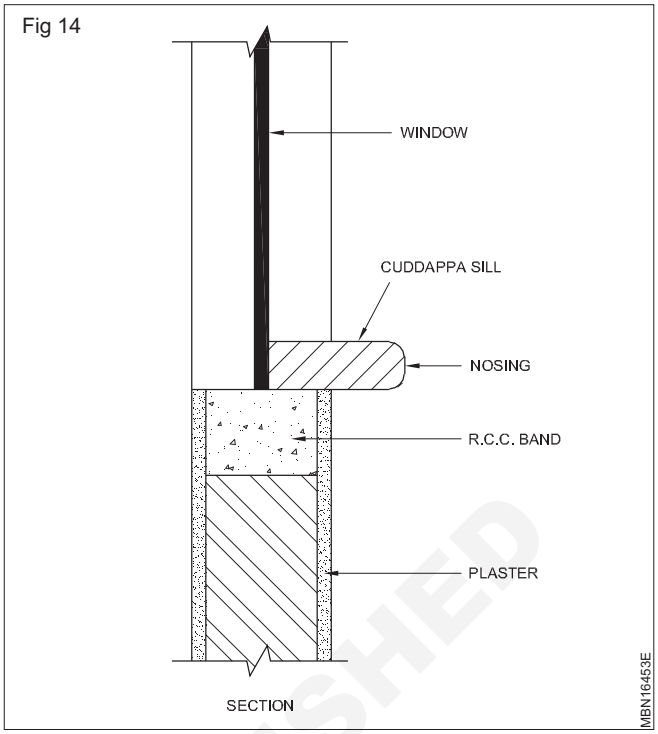
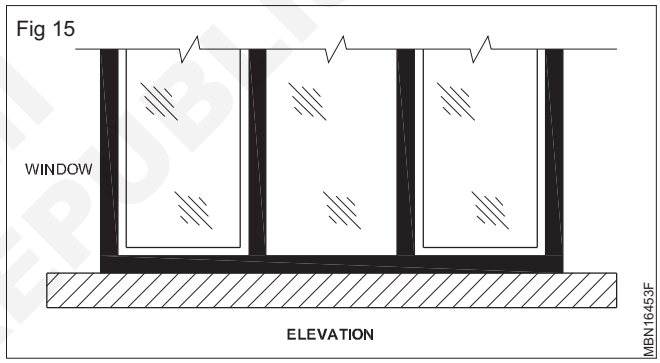
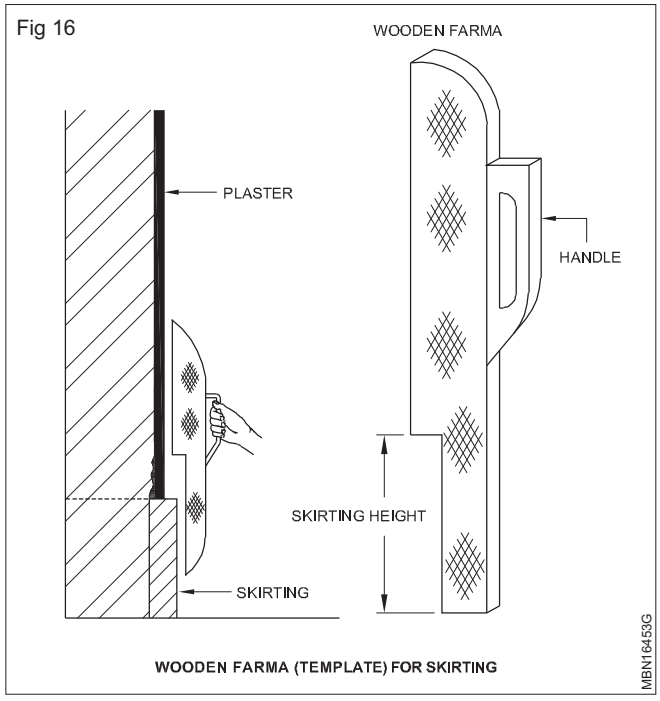


Fig 15



- Reference line marking on the plaster surface of masonry wall as shown in the (Fig 16).

Fig 16



- Skirting provision is made plaster surface masonry wall for about 20 cm height as shown in the (Fig 17 A & B).

Fig 17 (A)

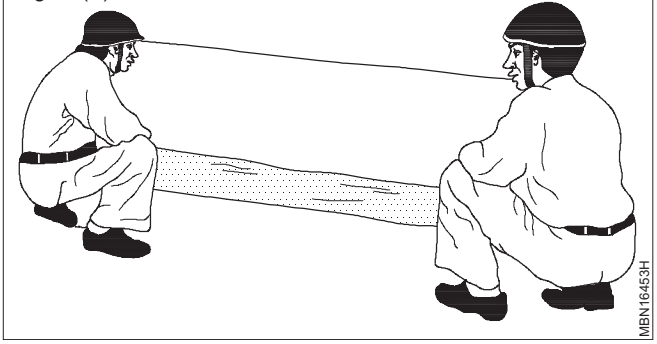
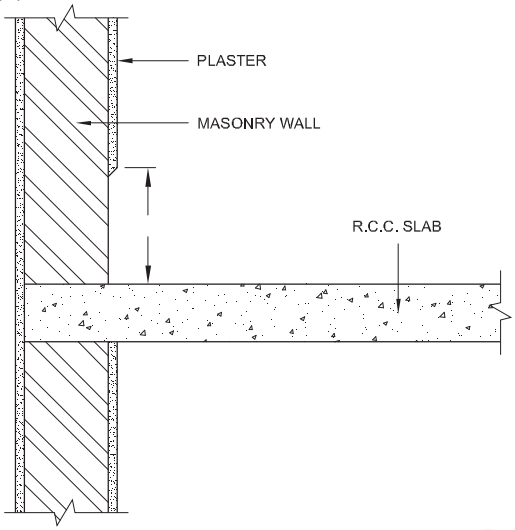


Fig 17 (B)



- Internal/external wall skirting details height of skirting, thickness cement paste and floor jointing etc., with tools used in skirting. As shown in (Figs 18 to 24).

Fig 18

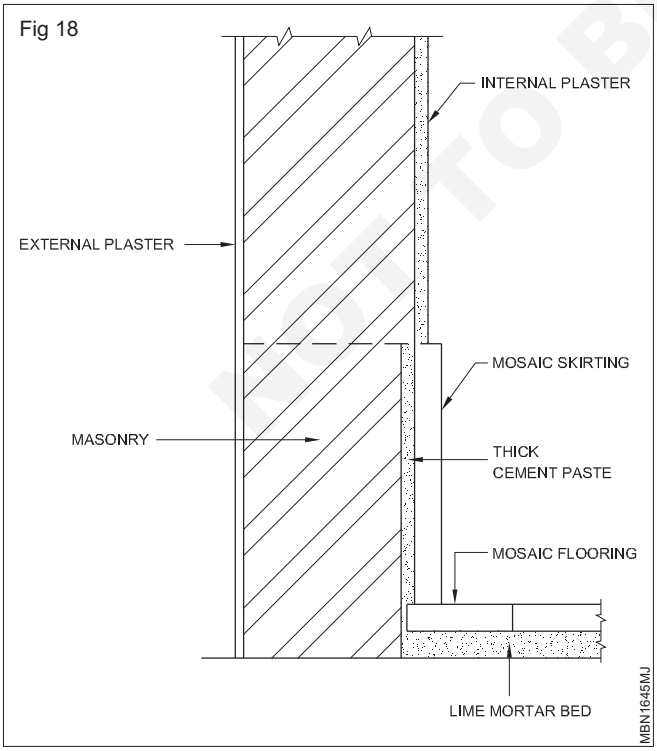
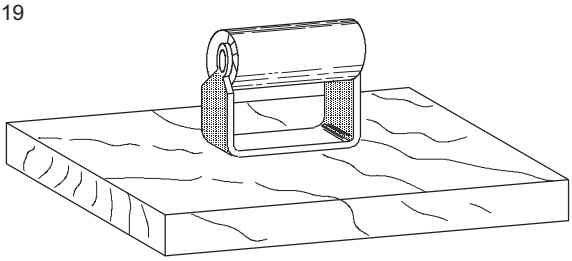
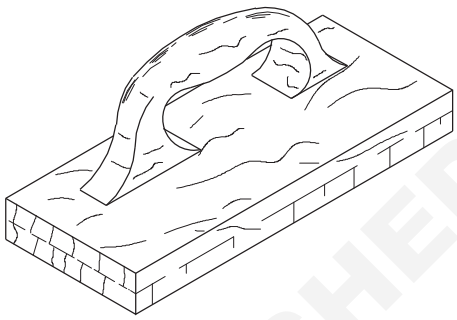


Fig 19



CORK CONSTRUCTION

Fig 20

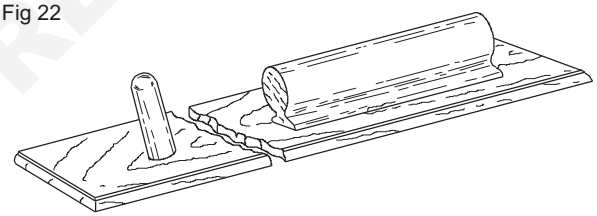


CORK-FACED FLOAT WITH HARD WOOD BACKING

Fig 21

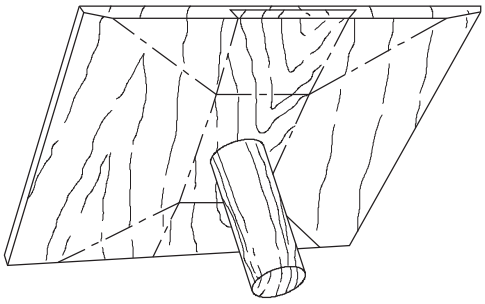
WOOD ANGLE

Fig 22



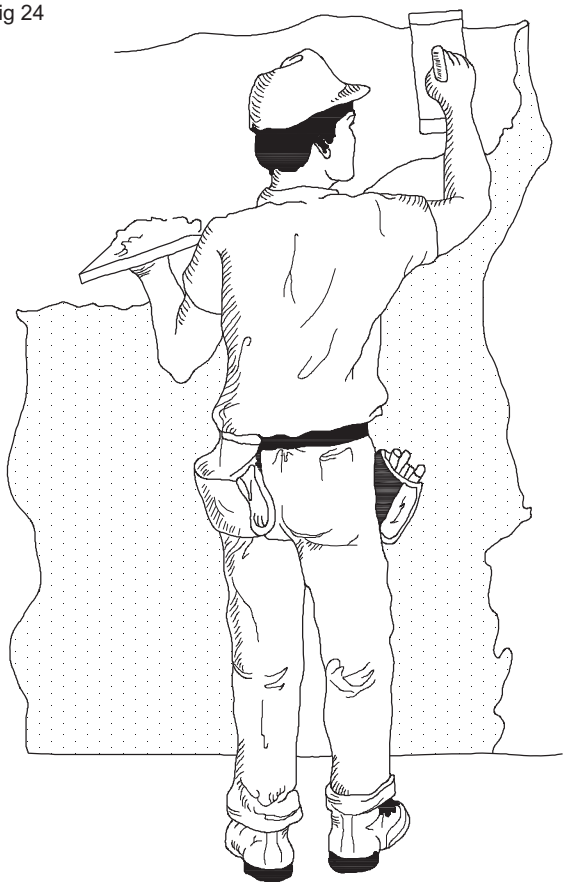
AN ORDINARY WOODEN DARBY USED TO
LEVEL LARGE AREAS OF PLASTER

Fig 23



WOOD HAWK USED TO CARRY THE PLASTER MATERIAL
TO THE WALL OR CEILING

Fig 24

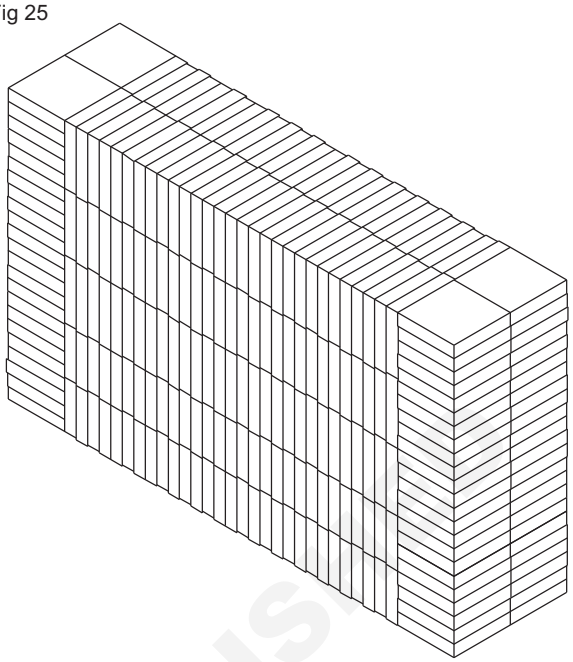


HOW PLASTER IS APPLIED TO THE WALL SHOWING THE USE OF THE HAWK AND THE TROWEL

MBN16453P

- Mosaic / Terrazzo tiles are stacked in a guard arrangement as shown in (Fig 25).

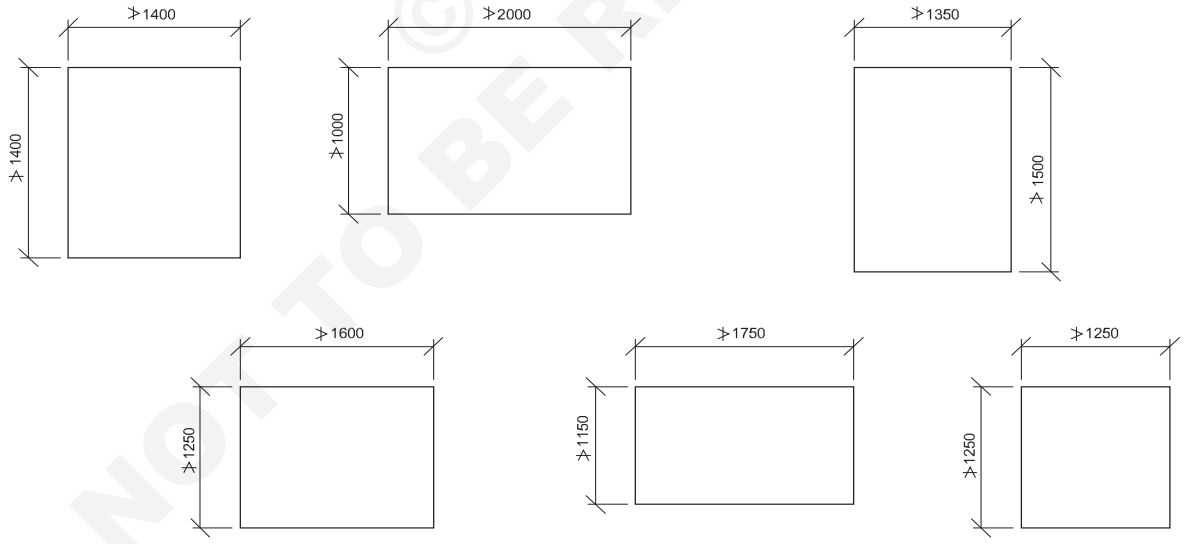
Fig 25



MBN16453Q

- Maximum size of panels with their dimensions square / Rectangular panels as shown in (Fig 26).

Fig 26

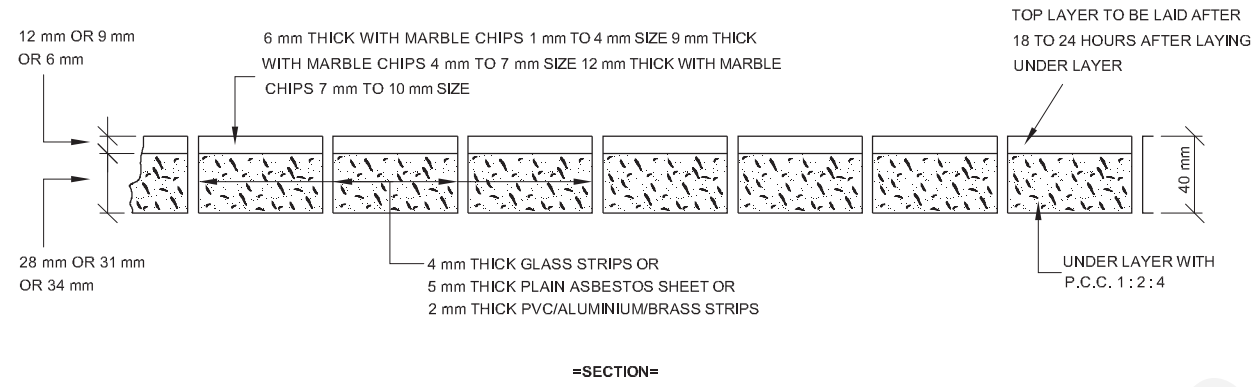


MAXIMUM SIZE OF PANELS PERMITTED FOR TERRAZZO FLOORING IN INSIDE SITUATIONS

MBN16453R

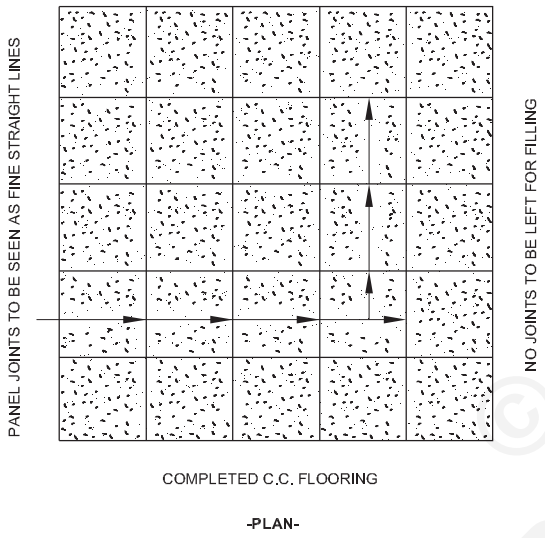
- Terrazzo marble chips flooring laid in situ with panel strips as shown in (Fig 27).

Fig 27



- Completed cement Concrete Flooring (Fig 28)

Fig 28



- Broken pieces of mosaic tile are laid with grey or white cement as a flooring is called as “Crazy Flooring”. (Figs 29&30)

Fig 29

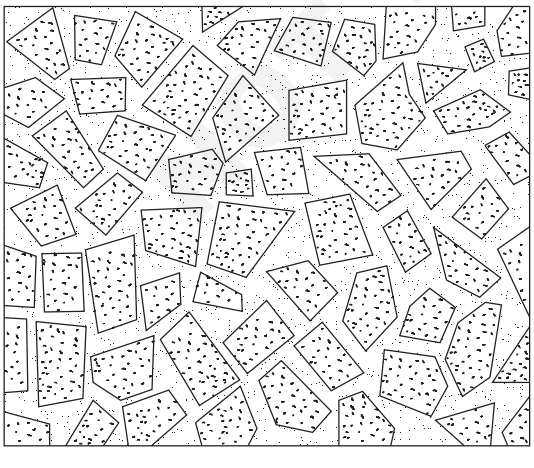
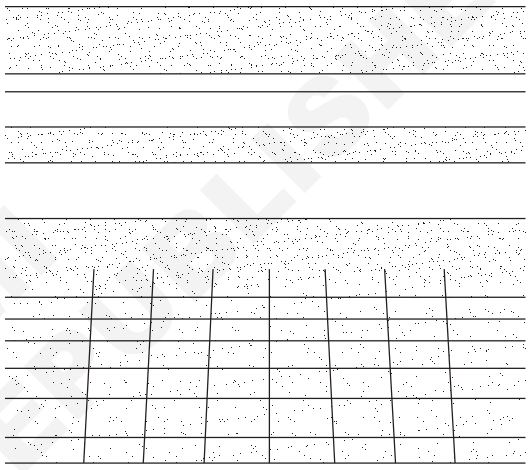
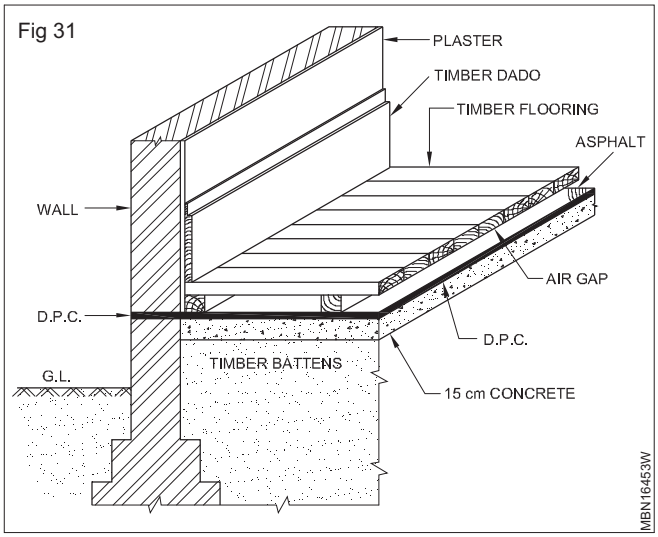


Fig 30



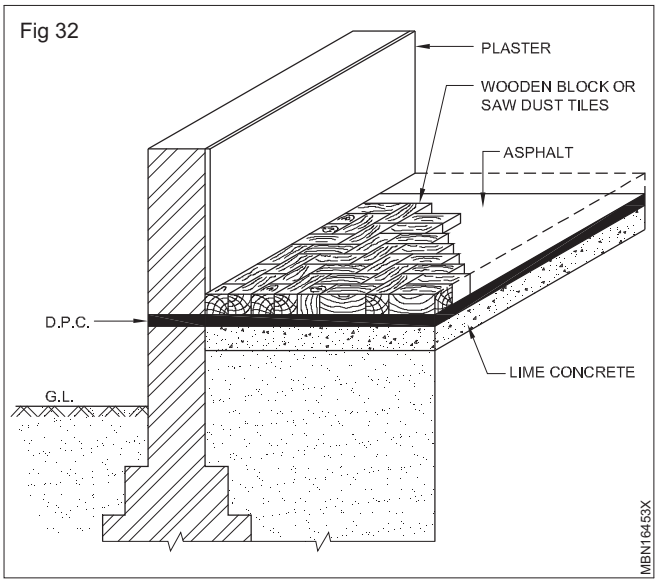
- Types of Flooring
- Timber Planks Flooring (Fig 31)

Fig 31



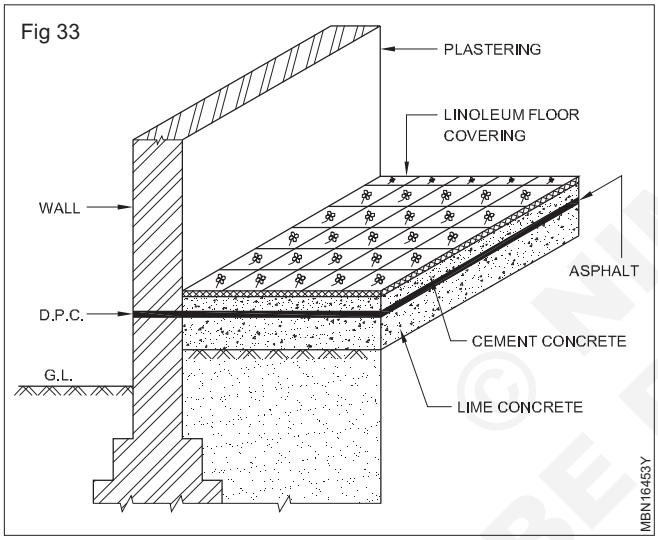
- Timber Pieces Flooring (Fig 32)

Fig 32



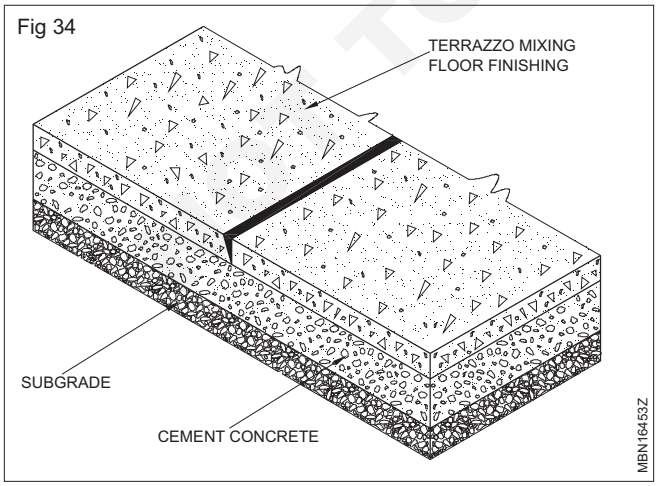
- Linoleum Flooring (Fig 33)

Fig 33



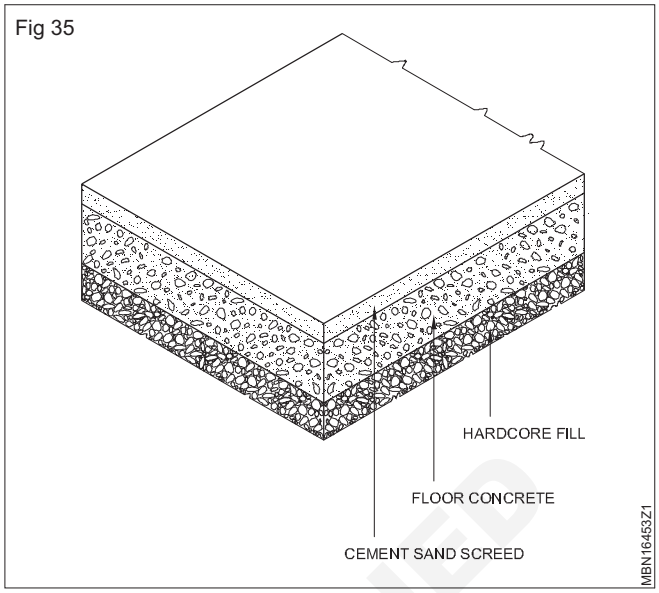
- Types of Floor Finishes
- Terrazzo floor finish (Fig 34)

Fig 34



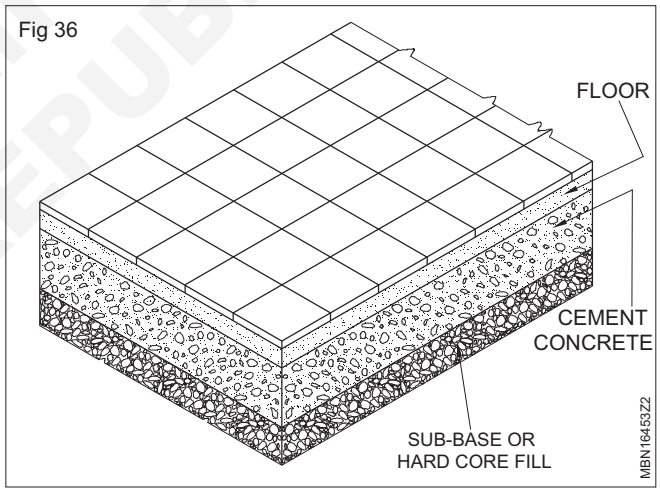
- Screed topping floor finish (Fig 35)

Fig 35



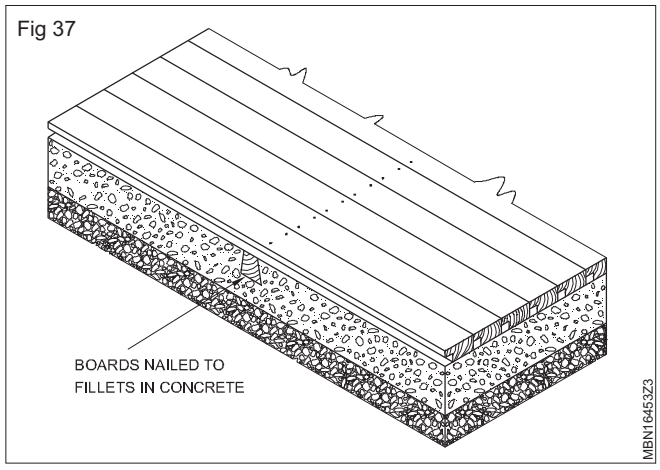
- P.V.C. Tiled floor finish
- Wood board finish flooring.(Fig 36)
- Lime concrete is laid as floor base over which mosaic tiles are laid with bedding cement mortar as shown in (Fig 36)

Fig 36



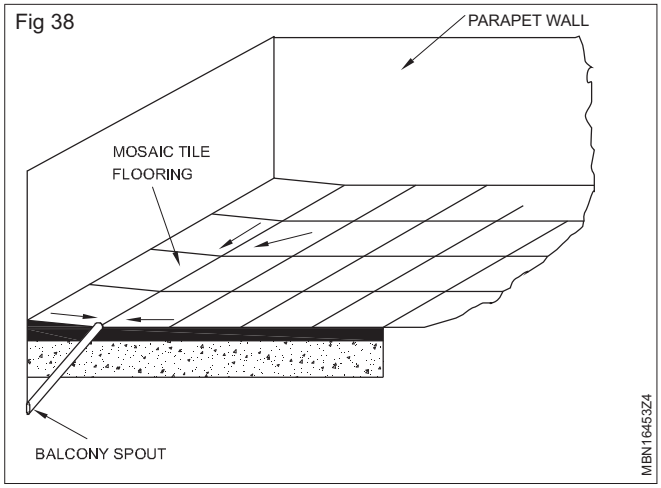
- Terrazzo flooring is laid with forming panels using glass strips with marble chips and cement.(Fig 37)

Fig 37



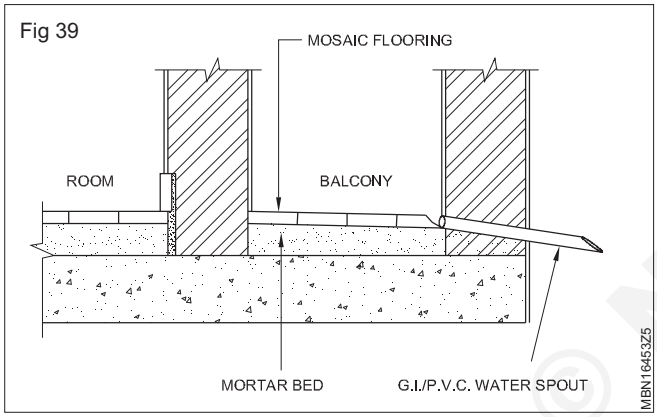
- Exposed balcony portion is laid with sloping floor is provided G.I / P.V.C water spout. As shown in (Fig 38)

Fig 38



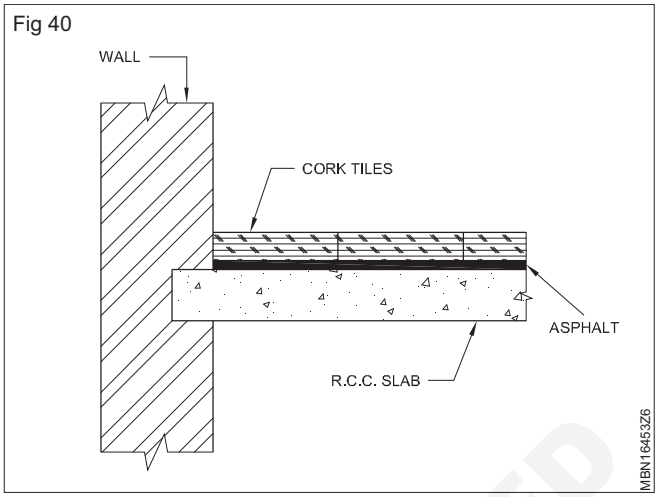
- In sectional elevation of balcony mosaic the flooring provided slope to easy discharge of water. GI / PVC water spout is provided. As shown in (Fig 39).

Fig 39



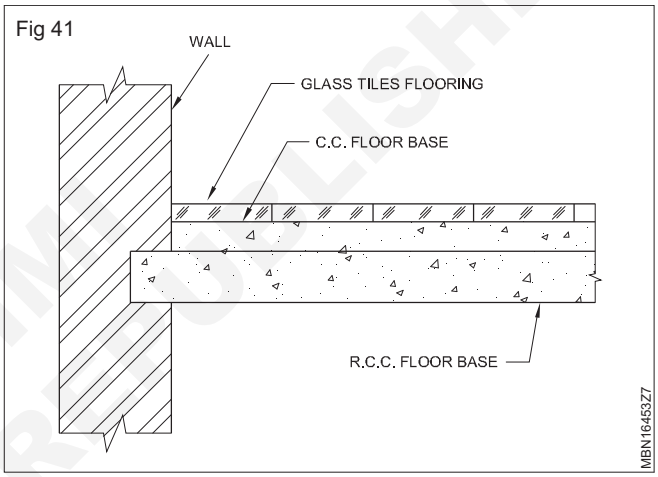
- Cork tiles flooring with adhesive of asphalt laid over R.C.C slab. (Fig 40)

Fig 40



- Glass tiles flooring laid over R.C.C floor base. (Fig 41)

Fig 41



Purpose made brick

Objectives: At the end of this lesson you shall be able to
- **state purpose made brick**
- **state circular wall.**

Purpose - made bricks

- In order to achieve certain purpose, these bricks are made.
- The splay bricks are made for jambs of doors and windows.
- The arch bricks made of wedge shape to keep the mortar joint of uniform thickness.
- The ornamental bricks are prepared for corbels, cornices etc
- Fire bricks are used lining materials for furnances chimneys.
- Fire bricks are usually white or yellowish white in colour

Circular wall:

- In circular or octagonal construction moulded bricks are used.

Laying a hollow concrete block walls and columns

Objectives: At the end of this lesson you shall be able to
- **describe the basic techniques for working with concrete blocks**
- **explain method of concrete block construction**
- **state hollow block column.**

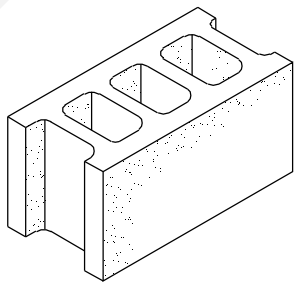
Basic Technic

- Concrete block is widely used in commercial and industrial construction.
- Concrete block is used for backing for other exteriors or finishes such as brick or tile.
- The most important aspect of the job is good planning and organisation.
- Good planning starts with the layout of the concrete block and mortar at your work station or place.
- Concrete block is placed in the same manner as other masonry units.
- The well planned concrete block structure will involve mainly stretcher and corner blocks.
- These concrete blocks are nominally 200 mm x 200 mm x 400 mm and actual size 190 mm x 190 mm x 390 mm.
- This allows for 10 mm mortar joint which is standard.
- Blocks of other sizes are sometimes used, but they also use a 10 mm thick mortar joint as shown in (Figs 1 & 2).
- These two concrete blocks are primary units used to construct most concrete masonry walls.
- Blocks of other sizes are sometimes used, but they also use a 10 mm thick mortar joint as shown in (Figs 1 & 2).

Method of concrete block construction

- The face edge of the wall or other building element is located on the footing.

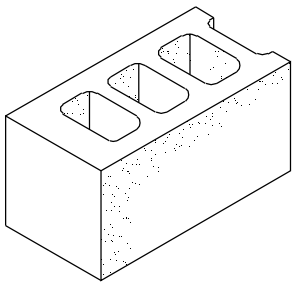
Fig 1



STRETCHER

MBN1106311

Fig 2

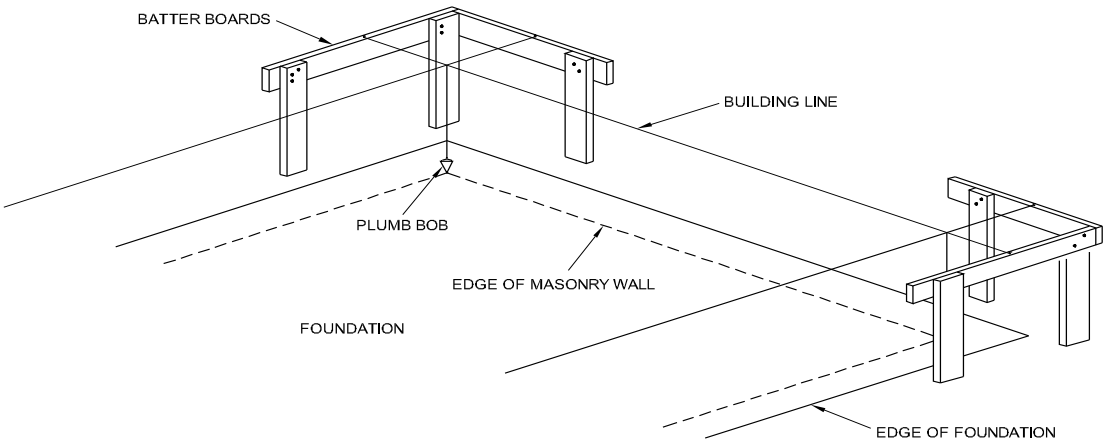


CORNER

MBN1106312

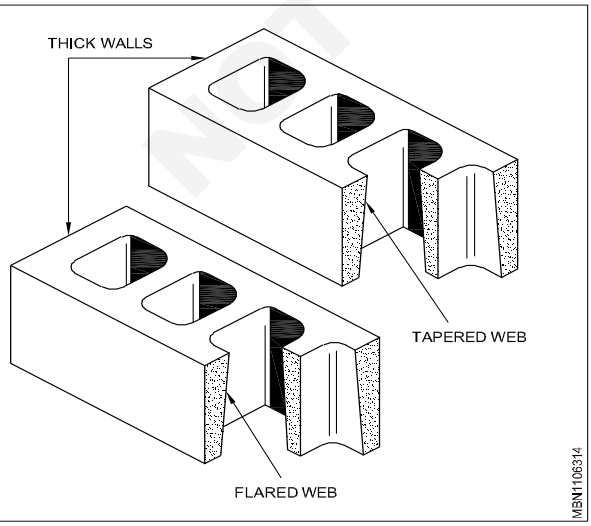
- The corners are located by dropping a plumb bob down from building lines as shown in (Fig 3).
- Corners of concrete block walls are located by dropping plumb bob down from building line as shown above in (Fig 3).
- Most concrete block wall are laid in a running bond with joints and centered.
- The mortar joints are laid with 10 mm thickness uniformly.

Fig 3



- Concrete blocks must be protected from moisture before use.
- If they are wet when placed they will shrink when dry and cause cracks.
- Blocks should be stacked on platforms and covered with plastic or tarpaulin to protect them from rain.
- Mortar for concrete block masonry should be mixed accordance with specification.
- Laying concrete block wall.
- Good block construction required advance planning is necessary for a strong wall with good appearance.
- The length of the blocks must be considered as they relate to check the building dimensions carefully before beginning the work.
- The outside wall line should be established.
- A check line may be used.
- Provide a straight line for the first course of block.
- The wall line should be checked for squareness and proper length.
- Block should always be laid in the wall with the wider web of the block facing up.
- The thicker or flared side of the block is always laid facing upward as shown in (Fig 4).

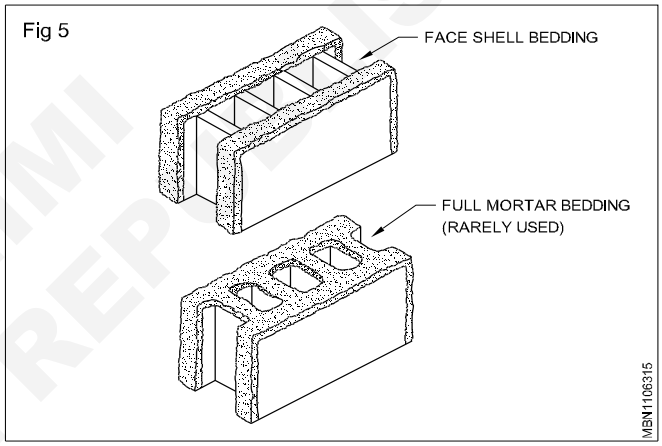
Fig 4



Applying head joint

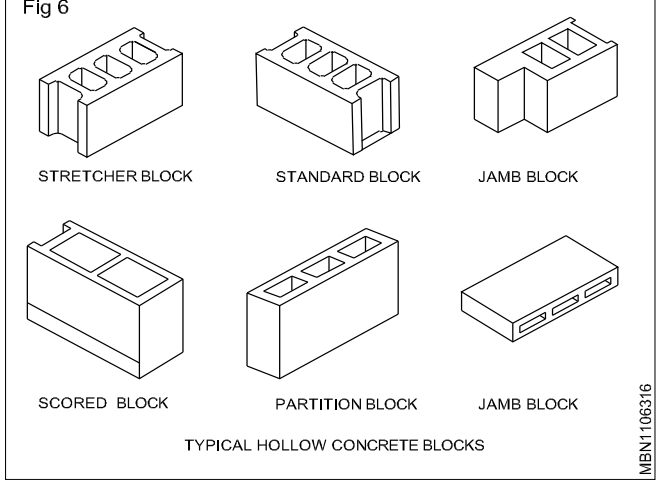
- Full head joints should be formed on both ears (end edges) of the block to be laid.
- With the trowel pick up enough mortar from the mortar board to form the head joints as shown in (Fig 5).

Fig 5



- Laying mortar on the block.
- Stand the block and its end in a vertical position and apply head joints on the both ears of the block.
- Lift the block firmly by grabbing the web at each end of the block and lay it on the mortar bed joint as shown in (Fig 6).

Fig 6



Hollow block column

- Hollow block columns can be either built separately or as integral units with the walls.
- Hollow block columns are used wherever large bearing surface are needed.
- The hollows with a blocks filled with concrete.

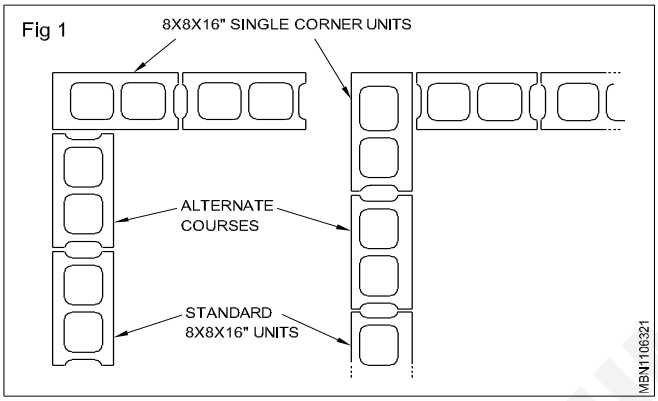
Laying out and build 'L' corner block wall

Objectives: At the end of this lesson you shall be able to
• describe setting out and mark dimensions
• build 90° angle L corner wall.

Setting out and mark Dimensions

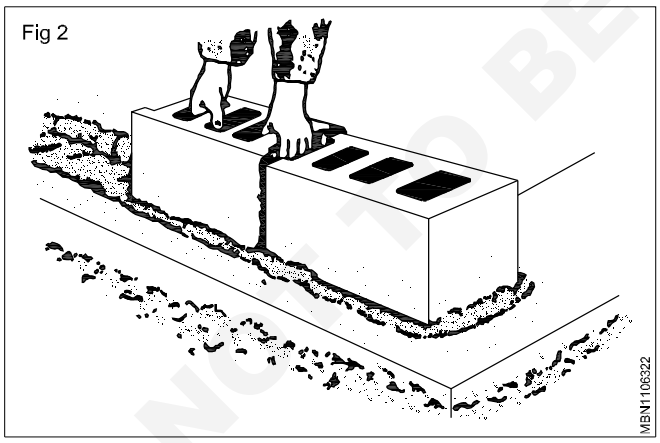
- Corners should be carefully built up with leads to serve as a guide for the courses.
- Running bond is used and corner block alternated from each side or leg of the lead as shown in (Fig 1).

Fig 1



- Corner block alternate from course to course.
- Provide a straight line for the first course of the block and the wall line should be checked for squareness and proper length before proceeding to the next step as shown in (Fig 2).

Fig 2



- String out the block for the block for the first course without mortar and allow 10mm thick for each mortar joint.

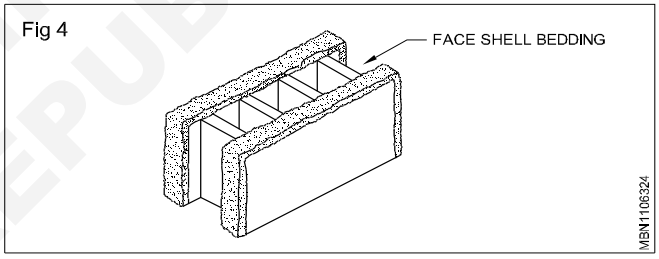
Build 90º angle L corner Wall

- A full mortar bed is spread and furrowed with Trowel provide plenty of mortar on which to set the block as shown in (Fig 3).
- Lay the corner block position it correctly, carefully and accurately.

Fig 3

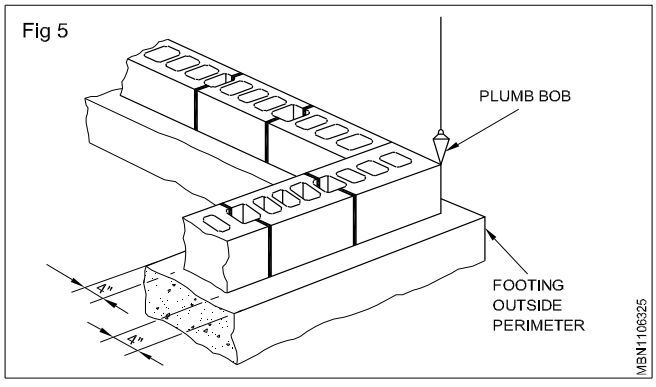
- Concrete blocks should be laid with the thicker edge of the face shell up to provide a wider mortar bed. as shown in (Fig 4).

Fig 4



- The first course of blocks laid with dry without mortar to guide lines marked as shown in (Fig 5) and also after laying with mortar corner of block wall should be plumbed for its perpends by using the plumb rule or plumb level.

Fig 5



- Lay several stretcher blocks along the wall line and buttered on the end of the face shells which speeds the operation.
- To place them, push them downward into the mortar bed and side ways against the previously laid one.
- After three or four blocks have been placed into position they may be aligned leveled and plumbed with mason's level or plumb level as shown in (Fig 6).

Fig 6

MBN1106326

- After the first course has been laid the corner lead is built up.
- This corner is very important since the remainder of the wall is dependent upon its accuracy.
- The lead corner is usually laid up four or five courses high above the center of the wall. Each course is checked for its alignment, level and plumb as it laid as shown in (Fig 7).

Fig 7

MBN1106327

- The face of the blocks should be in the same plane. Each block is stepped back half a block.
- The spacing may be checked by placing the level diagonally across the corners of the block as shown in (Fig 8).
- After the corner block have been constructed the blocks are laid between the corners A mason's line should be stretched from corner to corner at a proper height for each course as shown in (Fig 9).

Cutting block

- Even though concrete blocks are available in half length units as well as full length units.
- It is sometimes necessary to cut block to fit.

Fig 8

MBN1106328

Fig 9

MBN1106329

- Block may be cut with a brick hammer and blocking chisel.
- Another method is to use a masonry saw. When using the chisel hold the beveled edge towards you. The piece of block to be cut off should be facing away from you.
- Score the blocks on both sides to get cleaner break.
- If a neater, cleaner cut is desired a masonry saw should be used as shown in (Figs 10&11).
- Breaking block with chisel and hammer into half block in (Fig 10).
- A masonry saw being used to cut a concrete block in (Fig 11).
- If the concrete block wall is constructed to the required height all the horizontal as well as vertical joints should be neatly finished.
- The most effective joint is one that has been compacted or pressed into place.

Fig 10

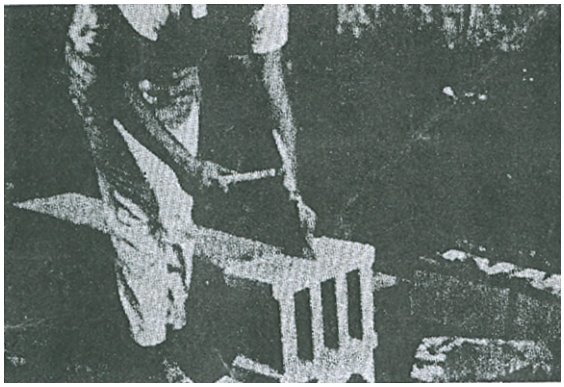


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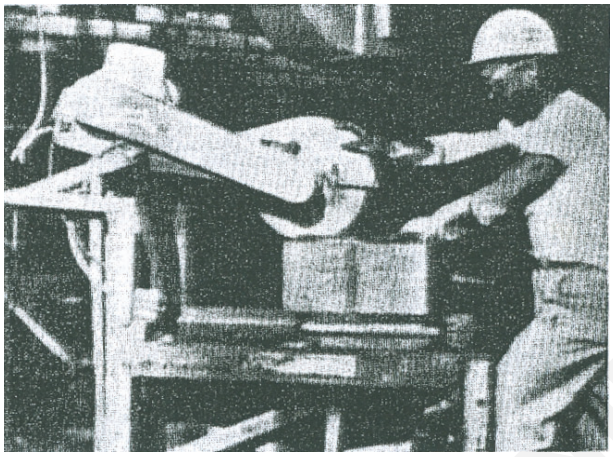
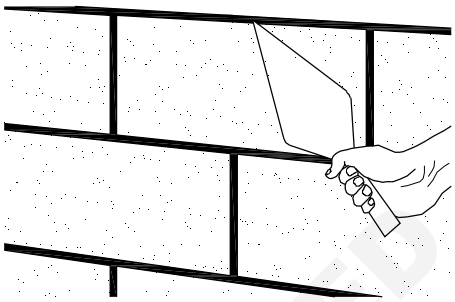
Fig 11



MBN110632B

- For this reason the concave or ‘V’ joint is best for exterior work as shown in (Fig 12).
- Joints may be tooled when the mortar has become thumb print hard. The tool should slightly larger than the width of the joint so that it will make contact along the edge of the blocks as shown in the (Fig 12).

Fig 12



MBN110632C

Partitions

Objectives: At the end of this lesson you shall be able to
- **state partitions**
- **state hollow blocks and clay block partition**
- **state concrete partition**
- **state metal lathe partition**
- **state concrete hollow block partition.**

Partitions

- Partitions are constructed as a thin, sound, insulated, wall enclosing the area for rooms with in a building.
- Partitions are may be constructed up to full floor height or upto 2.5m.
- Partitions are designed to carry their own weight only.

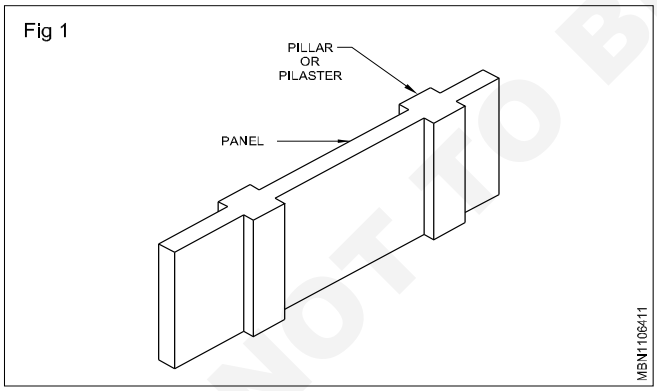
1 Hollow block and clay block partitions

- The section of hollow clay block 30 cm x 20 cm.
- The thickness varying form 5 cm to 15 cm.
- The blocks are provided with grooves on top and bottom.
- The side of the block making the joints rigid and make as a key to plaster.
- This partitions are fire and sound proof.

2 Concrete partitions

- Concrete partitions can be either precast or cast-in-situ.
- The thickness of precast concrete slab is 4 cm.
- Precast post are in 'I' shaped unit. (Fig 1)

Fig 1



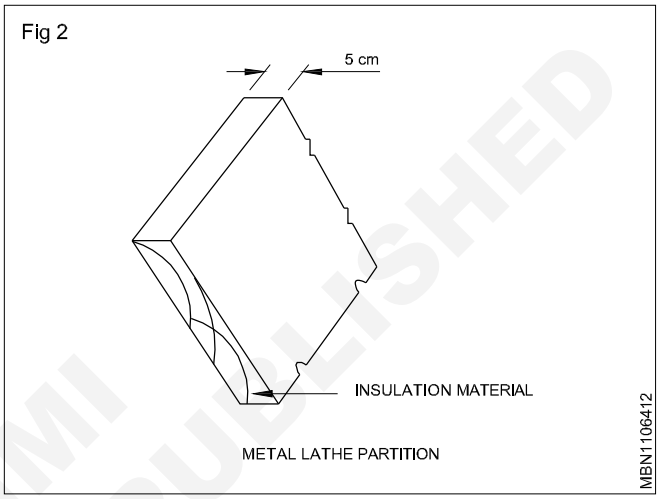
- The wall panels are two sizes,

  100 cm x 20 cm x 4 cm and

  80 cm x 20 cm x 4 cm
- The slab have a groove on the top edge and a tongue projection at the bottom edge.
- M 150 concrete are used and vibrated.
- The precast components are cured for 14 days with water and allowed to remain for 28 days before laying in construction.

3 Metal lathe partitions (Fig 2)

Fig 2



- Mild steel or bronze are used for metal partitions.
- Steel are fixed in to the panels forced by vertical posts of mild steel.
- Hollow spaces are filled insulate materials.
- Partitions can be forced cut of metal lathes supported and fixed with by 9 mm to 12 mm dia steel rod or steel channels.
- The thickness of partitions are about 5 cm after plastering.
- This partitions are light in weight, fire proof and strong.
- This partitions are used for office and industrial building.

4 Concrete hollow block partitions

- Due to light weight concrete hollow blocks are used load becoming walls as well as for partitions.
- Concrete blocks for walls are 5cm think.
- Concrete hollow blocks are prepared in modular dimensions such as,

  20 cm x 30 cm x 4 cm

  20 cm x 20 cm x 4 cm

  20 cm x 10 cm x 4 cm

R.C.C construction

Objectives: At the end of this lesson you shall be able to
- **define R.C.C**
- **state advantages of R.C.C**
- **list out materials used in R.C.C**
- **explain grade of cement**
- **explain reinforcement materials**
- **explain bending of bars**
- **state the testing of steel reinforcement.**

Introduction

Concrete may be defined as a building material obtained by mixing cement, aggregates and water in a suitable proportion which when allowed to cure, becomes hard like a stone. The proportion of ingredients varies with the nature of work for which the concrete is to be used. It can be readily moulded into durable structural items of various size and shapes. This mixed concrete is strong in compression but weak in tension.

Reinforced cement concrete (R.C.C) is the above said mixture of cement concrete with addition of reinforcement in it. The plain concrete is weak in tension, so steel reinforcement is added to make it strong both in compression and tension. The resulting product of cement, aggregates, water and steel reinforcement is called reinforced cement concrete.

Definition

Concrete is a brittle material and is strong in compression. It is weak in tension, so steel is used inside concrete for strengthening and reinforcing the tensile strength of concrete. The steel must have appropriate deformations to provide strong bonds and interlocking of both materials. When completely surrounded by the hardened concrete mass in forms an integral part of the two materials, known as “reinforced concrete”.

Reinforced concrete is a structural material widely used in many types of structures. It is competitive with steel if economically designed and executed.

Advantages of reinforced concrete

- Reinforced concrete also has greater compressive strength as compared to most other materials used for construction besides good in tension.
- It has better resistance to fire than steel and capable of resisting fire for a longer time.
- It has long service life with low maintenance cost.
- In some types of structures, such as dams, piers and footings, it is the most economical structural material.
- It can be cast to take the shape required, making it widely used in pre - cast structural components.
- It yields rigid members with minimum apparent deflection.
- Yield strength of steel is about 15 times the compressive strength of structural concrete and well over 100 times its tensile strength.
- By using steel, cross sectional dimensions of structural members can be reduced e.g in lower floor columns.
- Less skilled labour is required for erection of structures as compared to other materials such as structural steel.

Disadvantages of reinforced concrete

- It needs mixing, casting and curing, all of which affect the final strength of concrete.
- The cost of the forms used to cast concrete is relatively high.
- It has low compressive strength as compared to steel (the ratio is about 1:10 depending on material) which leads to large sections in columns/beams of multistory buildings cracks develop in concrete due to shrinkage and the application of live loads.

Materials used in R.C.C

1 Cement

Generally any of the following cements is used for R.C.C

a Ordinary or low heat portland cement conforming to IS: 269.

b Rapid hardening portland cements conforming to IS: 8041.

c Portland slag cement conforming to IS: 455.

d Portland pozzolona cement conforming to IS: 1489.

e High strength ordinary portland cement conforming to IS: 8112.

f Hydrophobic cements conforming to IS: 8043.

g High alumina cements conforming to IS: 6452.

h Super sulphated cement conforming to IS: 6909.

2 Fine aggregate

The aggregate which passes through IS sieve no.480 is called fine aggregate. The particle size of this aggregate does not exceed 4.75 mm. Fine particles passing though the sieve no. IS: 15 should not exceed 8%. Sand and sieved quarry dust are usually using as fine aggregate. It should be free from silt clay, salts and other organic matter and it should be conforming to IS: 383.

3 Coarse aggregate

The aggregate, which is retained over, sieve no. IS: 480 are called coarse aggregate. The size of this aggregate depends upon the type and nature of work. It should be free from clay and other organic matter. It should not have

glossy surface. It should not be soft, porous or flake. It should not absorb more than 5% of water by weight when immersed in 24 hours and in all aspects it should be conforming to IS: 383.

4 Water

Water used for making concrete should be free from dirt, organic impurities, sulphur contamination and chlorides which cause efflorescence. The clear water used for drinking purpose (IS: 14543) should be used. The pH value of water should be between 6 and 8. Mixing or using of concrete with seawater is not recommended because of presence of harmful salts in seawater.

Compaction of concrete

Objectives: At the end of this lesson you shall be able to
• state the various types of vibrators
• describe method of using vibrators and in compaction.

Various types of vibrators : Compaction of the concrete is the process adopted for removing the entrapped air from the concrete.

The entrapped air if not removed fully, the strength of concrete reduces considerably.

Compaction are adopted following methods:

- Rodding
- Ramming
- Tamping

These are hand compaction.

Compaction by vibration

- Needle vibration
- Formwork vibration
- Table vibrator
- Platform vibrator
- surface vibrator

Methods of using vibrators and in compaction

Hand compaction

Rodding

- Rodding is nothing but Racking the concrete with 2 metre long and 16mm diameter rod to pack to the concrete between the reinforcement and sharp corners and edges.
- This type of compaction may be adopted in case of small work as shown in (Fig 1)

Ramming

- Ramming is generally used in plain cement concrete for foundation concrete or column footings or in underground floor construction.
- Generally wooden rammers and steel rammers are used for ramming purpose as shown in (Fig 2)

Tamping

- Tamping consists of beating the Top surface of concrete by wooden cross beam of section 15cm x 10cm
- Tamping is generally done for thin structures like slabs.
- By tamping concrete compacts well and also levels the top surface as shown in (Fig 3)

Fig 1

RODDING

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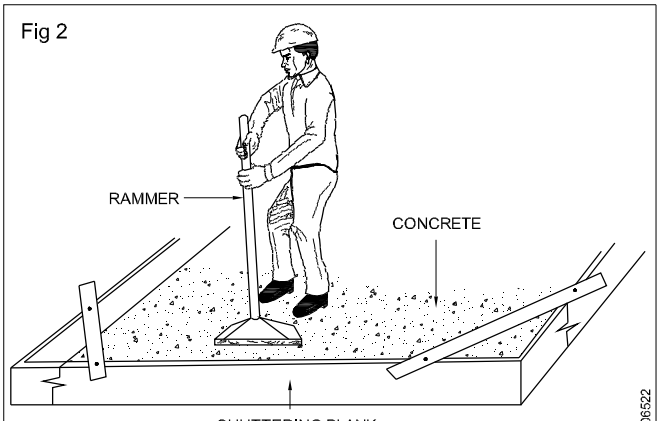
Fig 2



RAMMING

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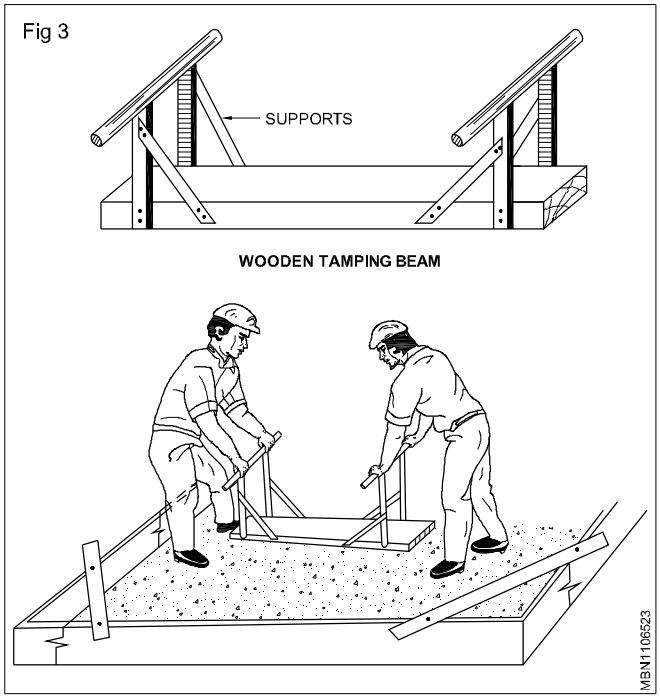
Compaction by vibration

- For the shift concrete handle vibrator does not give satisfactory results and to compact such concrete mechanically operated vibrating equipments must be used.

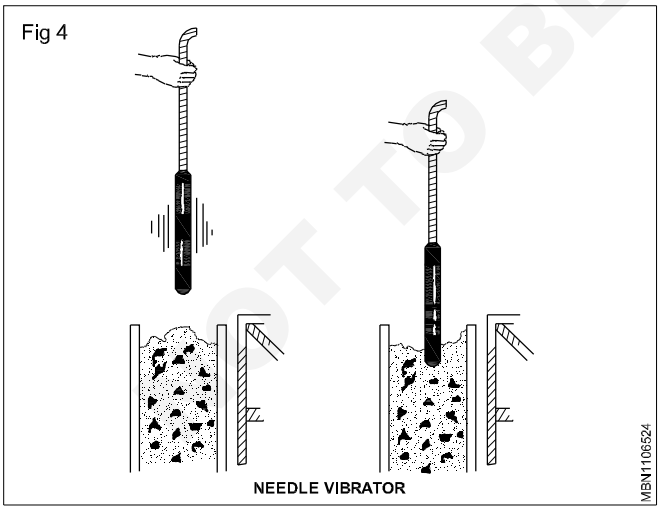
Fig 3



Needle Vibrator

- Needle vibrator is also called as internal vibrator.
- It consists of power unit a flexible shaft and a needle.
- Power unit may be electrically driven or operated by petrol engine or air compressor.
- The average frequency of vibration is between the 3500 to 5000 RPM
- The common needle diameter are 25mm and 40mm and its length varies from 25cm to 90cm
- It can be shifted from place to place very easily as shown in (Figs 4&5).

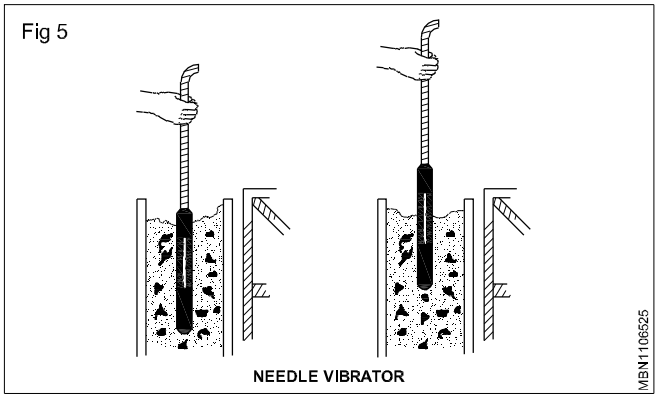
Fig 4



External Vibrator

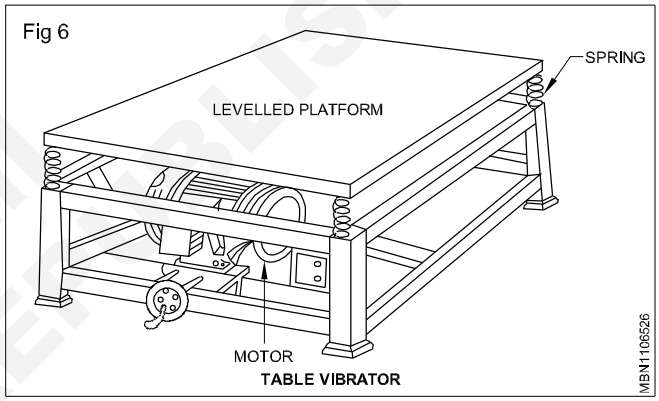
- Form work vibrator is also called as external vibrator.
- For columns, thin walls, and thin precast units this type of vibrators are used.
- The vibrator machine is clamped to the external wall surface of the framework and shuttering is then vibrated.

Fig 5



- Table vibrator is a special type of external vibrator which is used mostly in Laboratories in making small precise prefabricated R.C.C members.
- This is large type table vibrator.
- This is used in manufacture of large prefabricated concrete elements such as electric poles, railway sleepers etc. Table vibrator is shown in (Fig 6)

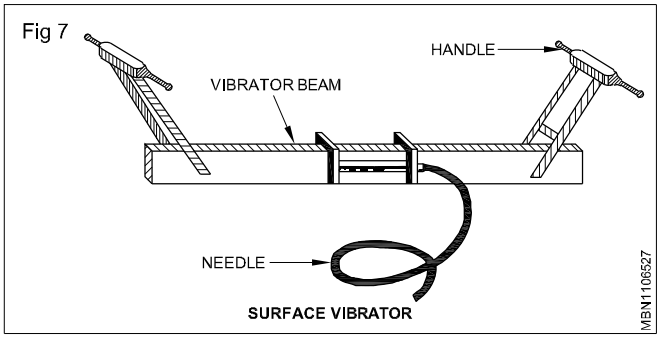
Fig 6



Surface Vibrator

- Screed board vibrators are also known and called as surface vibrator.
- A small vibrator placed on the screed board gives an effective method of compacting and levelling of their concrete members such as floor slabs, roof slabs, and road surface as shown in (Fig 7).

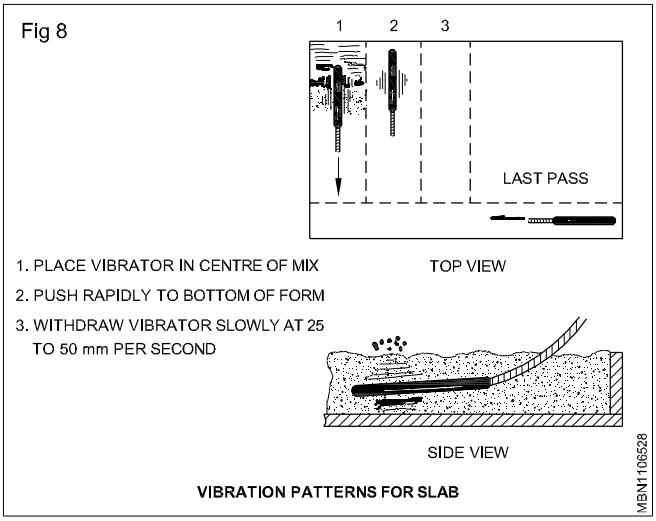
Fig 7



Precaution

- Do not stop the vibrator when needle in concrete. (Fig 8)
- Avoid over vibrating, otherwise formwork centering and shuttering may damages.

Fig 8



VIBRATION PATTERNS FOR SLAB

- Stop the vibrator if cement slurry flows out from shuttering.

R.C.C slab for roof and beams

Objectives: At the end of this lesson you shall be able to
- **describe form works shuttering for slab and beams**
- **describe reinforcement details of slab and beam**
- **describe curing of concrete.**

- Roof is a covering supported on the top of walls and pillars.
- R.C.C roof slabs protect the buildings from rains, sun and wind.
- R.C.C roof slabs also increase the transverse strength of walls
- Reinforced cement concrete slab work shall comprise the following.
- Form work (Centering and shuttering)
- Reinforcement
- Concreting (Cast - in - situ precast)

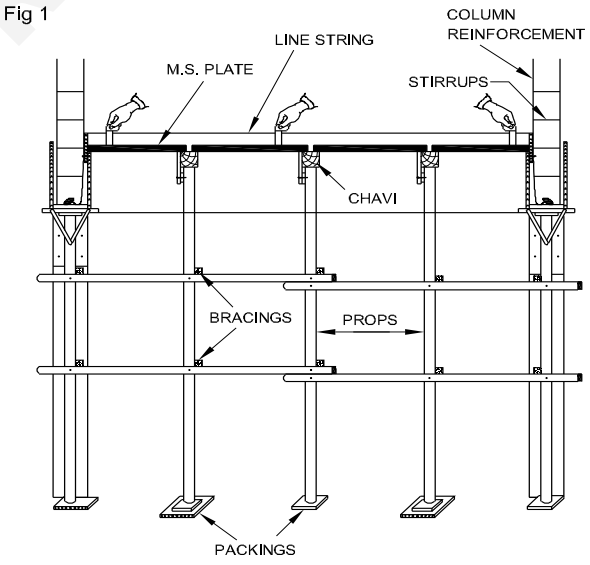
Formwork (centering and shuttering)

- Form work shall include all temporary or permanent forms or mould required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support.
- In general the form work shall be strong enough to withstand the dead and wind loads and forces caused by ramming and vibrations of concrete.

Reinforcement detail

- Reinforcement shall be clear and free from loose miscales which may be destroy, or reduce bond.
- It shall be stored in such a way as to avoid distortion, and to prevent deterioration and corrosion.
- Prior to assembly of reinforcement or no account any oily substance shall be used for removing the rust.
- Bars shall be bent correctly and accurately to the size and shape as shown in the detailed drawing.
- Preferably bars of full length shall be used.
- Necessary cutting and straightening and over lapping of bars also shall be done as per the drawing or as directed by engineer-in -charge.
- The overlapping bars shall be bound together at intervals by using binding wire.
- Form work centering and shuttering is completed the top level of form work must be checked for uniformity as shown in (Fig 1).

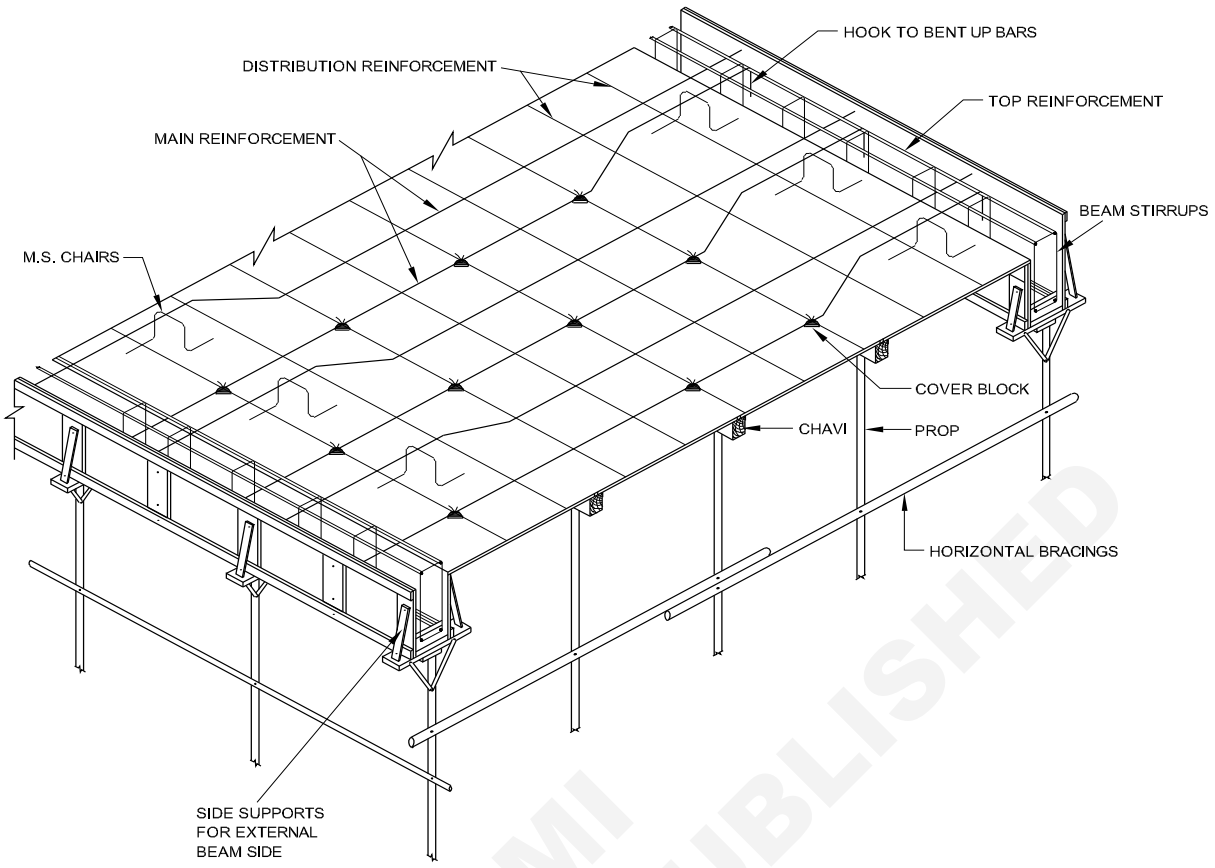
Fig 1



CHECKING OF SLAB LEVEL

- Reinforcement bars are placed on the top of the form work.
- Spacing of bars are done as per the R.C.C drawing ie main bars are placed 15cm centre to centre and the distributor bars 20cm centre to centre bentup bars or cranked bars are placed alternatively as shown in (Fig 2).

Fig 2



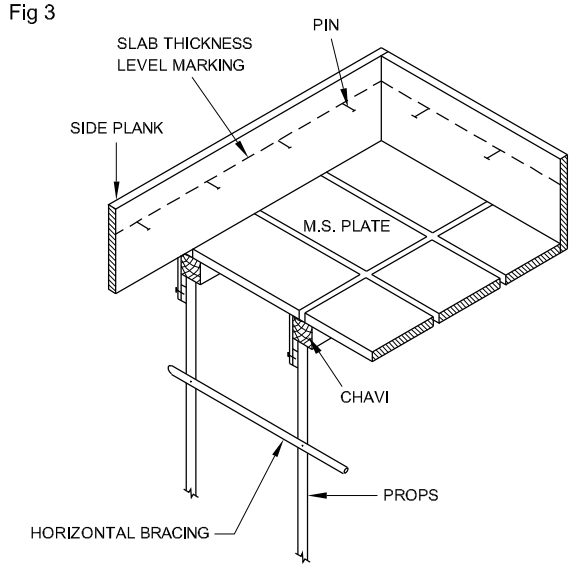
DETAILS OF REINFORCEMENT IN SLAB

- R.C.C slab roof is widely used in all type of construction buildings simple R.C.C slab can be used up to 4m. Span and for larger spans 'T' Beam slab is used when the ratio of the length and breadth is 2 or more, the slab is designed along the width as one way slab and the main reinforcement is placed along the width of the row.
- If the ratio of length and breadth of room is less than 2, the slab may be designed as two way slab and the main reinforcement is placed along the length and breadth both.
- For construction R.C.C slab firstoff shuttering is constructed and the top of the shuttering is plastered and made smooth. Proper slope is provided in the shuttering itself and camber is provided in the centre of shuttering so as to account for the sagging of the slab. (Fig 3)
- Over the prepared surface of shuttering reinforcement is placed the main reinforcement and the cross reinforcement are tied together in the m.s wires called binding wires.
- When the reinforcement get ready. it is embedded in cement concrete generally M-15 (1:2:4 mix).

Curing of Concrete

- The concrete is being properly compacted with the help of surface of vibrators or with a tamping rod.
- The slab is then allowed to dry for 36 hours and then it is subjected to curing.
- Curing is being done by making small bunds and filling the spaces with water.
- Curing for R.C.C slab and beam is done about for 10 to 12 days.
- The shuttering is generally removed after 21 days.

Fig 3



LEVEL MARKING PINS FOR SLAB THICKNESS

Reinforcement details and concrete mixes and ratios

Objectives: At the end of this lesson you shall be able to
- **state steel reinforcement and assembly reinform**
- **state bar bend, hook**
- **state cross sectional area of bar and weight**
- **state the prade of concrete**
- **state period of storage of cement.**

- Plain cement concrete is too strong in taking compression. but on the other hand it also too weak in taking tension.
- By taking tension by the concrete members, steel is used in it.
- The concreting which has steel in it for taking tension is known as “Reinforced cement concrete”

Reinforced cement concrete work shall comprise of the following.

- Form work (Centering and shuttering)
- Reinforcement
- Concreting cast -in situ
- Pre- cast

Materials

- The raw materials for concrete are water, cement, fine and coarse aggregate.

Steel reinforcement

- The steel used for reinforcement shall be.
- Mild steel and medium tensile bars conforming to IS 432 part - I.
- High strength deformed steel bars conforming to IS:1786.
- High drawn steel wire fabric conforming to IS 1566.
- Structural steel conforming to Grade A of IS: 2062.
- Thermo mechanically treated bars TMT bars. (high strength deformed steel bars)

Steel reinforcement shall be stored in such a way as to prevent distorting and corrosion. Care shall be taken to protect the reinforcement from exposure atmosphere during storage .

It may be achieved by Treating the surface of reinforcement with cement wash.

Assembly reinforcement : Bar shall be bent correctly and accurately to the size and shape as shown in the detailed drawing.

Preferably bars of full length shall be used.

The overlaping bars shall not touch each other and these shall be kept apart with concrete between them by 25mm. or 1¼ times the maximum size to the course aggregate whichever greater but where this not possible the overlapping bars shall be bound together at internals not exceeding twice the dia.

Bonds and Hooks forming End Anchored

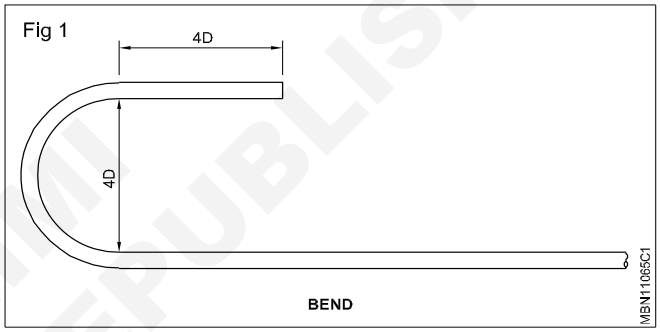
Reinforcement shall be bent fixed in accordance with procedure specified in IS 2502 code of practice for bending and fixing of bars for concrete reinforcement.

The details of bend and hooks

‘U’ type Hook

In case of mild steel plain bars standard ‘U’ type hook shall provided by bending ends of rod into semicircular hooks having clear diameter equal to four times of diameter of the bars, as shown in (Fig 1).

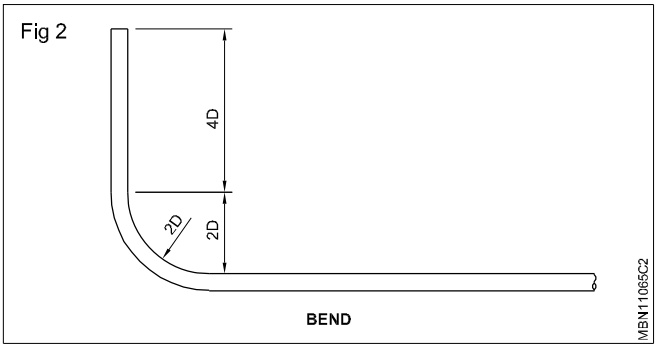
Fig 1



Bends

Bends forming anchorage to a mild steel plain bar shall be bent with an internal radius equal to two times the diameter of the bar with a minimum length beyond the bend equal to four times of the diameter of the bar.(Fig 2)

Fig 2



Anchoring bars in Tension

Deformed bars may be used without end anchorage provided development length requirement is satisfied. Hooks should normally be provided for plain bars in the tension development length of bars will be determined as per IS 456 - 2000.

Anchoring bars in compression

- The anchorage length of straight bar in compression shall be equal to the “development length” of bars in compression as specified in IS 456 - 2000.

- The projected length of hooks bends and straight lengths beyond bend, if provided for a bar in expression, shall be considered for development length.

Concrete mix "M" refers to the mix and specified compressive strength of 150mm size cube at 28 days expressed in N/mm^2

Converting concrete mix proportions by weight to mix proportions by volume for concrete and grades can be easily calculated by using the given tables above and it is more useful for calculation.

Cross sectional area and mass or steel bar

Nominal size mm	Cross sectional area Sqmm	Mass per meter Run KG
6mm	28.3	0.222
7mm	38.5	0.302
8mm	50.3	0.395
10mm	78.6	0.617
12mm	113.1	0.888
16mm	201.2	1.58
18mm	254.6	2.00
20mm	314.3	2.47
22mm	380.3	2.98
25mm	491.1	3.85
28mm	616.0	4.83
32mm	804.6	6.31
36mm	1018.3	7.99
40mm	1257.2	9.85
45mm	1591.1	12.50
50mm	1964.3	15.42

The volumetric mix proportions are to the grades of concrete as specified in the IS 456 . 1964

Concrete mix proportions.	Grades of Concrete
1:4:8	M - 7.5
1:3:6	M - 10
1:2:4	M - 15
1:11/2 :3	M - 20
1:1:2	M - 25

Proportion of total quantity of coarse and fine aggregate to 50kg of cement

No.	Grade of concrete	Total quantity of sum of the masses of fine and coarse aggregate per 50kg of cement
1	M- 5	800 kg
2	M - 7.5	625 kg
3	M - 10	480 kg
4	M - 15	330 kg
5	M - 20	250 kg

Grades of concrete

Group	Grade Designation	Compressive strength of 150mm cube at 28 days in N/mm²
	M - 5	5
Lean concrete	M - 7.5	7.5
	M - 10	10
Ordinary	M - 15	15
concrete	M - 20	20
Standard	M - 25	25
Concrete	M - 30	30
	M - 35	35
	M - 40	40
	M - 45	45
	M - 50	50
	M - 55	55
High	M - 60	60
Strength	M - 65	65
concrete	M - 70	70
	M - 75	75
	M - 80	80

Reduction of strength of cement with passage of time

No.	Storage period of cement	Strength of reduction
1	Fresh	Nil
2	3 months old	20%
3	6 months old	30%
4	12 months old	40%
5	24 months old	50%

Table showing mix proportions by weight under normal mix for different grades of concrete

No.	Grade of concrete	Maximum size of coarse aggregate	Nominal mix proportion by weight			Usage
			Cement Kg	Sand Kg	Coarse aggregate Kg	
1	M - 5	40mm	50	230	570	Lean concrete Levelling course
2	M - 7.5	40mm	50	180	445	------ do ---------
3	M - 10	40mm		140	340	Plain concrete
		20mm	50	160	320	-------- do -------
4	M - 15	40mm		95	235	Plain concrete
		20mm	50	110	220	--------- do ------
		10/12.5 mm		130	200	---------- do --------
5	M - 20	20mm	50	85	165	Reinforced concrete work.

Material for plastering / finishing

Objectives: At the end of this lesson you shall be able to
- **describe the purpose of plastering**
- **describe the definition of plastering and finishing**
- **state the uses of materials.**

Purpose of plastering

- Masonry structures after their construction require interior and exterior finishings. This finishings is known as plastering.
- Plastering is the covering of walls so as to improve their (Walls) appearance and to hide their irregularities of construction and also to provide a base for white and colour washing, painting, distempering etc.
- The following are the generalised advantages of plastering.
- Plastering provides a true, smooth and finished surface which improve the appearance of the structure.
- Plastering protects the structure from the atmospheric action such as sun, wind, rains, frost etc.
- Plastering helps in hiding the irregularities of workmanship.
- Plastering covers the unsound and porous material of the construction.
- Plastering provides a base for other finishings such as white and colour washing, distempering, painting etc.
- Plaster material is a fine paste either made of cement and sand or lime and sand or surki, and sometimes cement, lime and sand.
- When cement forms the binding material the plaster is called cement plaster.

Definitions

- The term plastering shall cover all type of rough or fair finished plastering rendering, floating, and setting coat or finishing coat screed etc in mud lime, cement lime, cement mortar.
- “Dubbing out” shall mean filling in hollows in the surface of wall and roughly levelling up irregular or out of plumb surfaces prior to rendering.
- “Rendering or Rendering coat” shall mean the plaster coat to bring the rendering coat to a true and even surface before the setting or finishing coat is applied.
- “setting or Finishing coat” shall mean final coat in a two or three coat plaster work.
- “Thickness of plaster” shall mean the minimum thickness at any point on a surface. This does not include thickness of dubbing out.
- The term “even and fair” s referred to finishing of the plaster surface shall mean a surface finishing with a wooden float.
- The term “even and smooth” as referred to finishing of the plastered surface shall mean a surface levelled with wooden float and subsequently smoothed with a steel trowel.

Materials

- Cement
- Cement shall be ordinary port land cement or portland blast furnace cement or portland pozzolona cement as specified.

Lime

- Lime shall be semi hydraulic lime class B or fat lime class c.

Sand

- Sand shall consist of natural sand, except where crushed stone stand or crushed gravel sand or a combination of any of these are indicated. The sand shall be hard and durable, clean and free from adherent coating and organic matters and shall not contain any appreciable amount of clay balls. Sand shall be obtained from approved sources.

Water

- Water used for mixing and curing shall be clean, free from deleterious matter and sea water or blackish water shall not be used. Water fit for drinking is normally suitable.

Scaffolding

- For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided.
- The supports shall be sound and strong ,tied together with horizontal pieces over which scaffolding planks shall be fixed.
- In the case of inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose.
- only one header for each pole shall be left out.
- The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering. Where possible independent scaffolding shall be used.

Preparation of mortar and surface of walls

Objectives: At the end of this lesson you shall be able to
- **state the preparation of element and line mortar**
- **state method of application of mortar on wall surface**
- **describe curing and precaution of the surface of plastering.**

Preparation of cement mortar

- Mixing shall be done preferably in a mechanical mixer.
- If done by hand mixing operation shall be carried out on a clean water tight platform.
- Cement and sand shall be mixed dry in the required proportion to obtain a uniform colour.
- The required quantity of water shall be added.
- In the case of mechanical mixing, the mortar shall be mixed for atleast 3 minutes after addition water.
- Cement mortar shall be freshly mixed for immediate use.

Preparation of Lime mortar

- Lime and sand in the specified proportion shall be mixed with or without the addition of water on a dry water proof platform or in mixer.
- The mix shall be fed into a mortar mill with required addition of water.
- The mortar shall be raked continuously during grinding. Particularly in the angular edges of the mortar mill.
- Water may be added during grinding as required to bring the mix to the working consistency.

Preparation of surface

- The joints shall be raked out properly.
- Dust and loose mortar shall be brushed out.
- If any efflorescence shall be removed by brushing and scrapping.
- The surface shall be then thoroughly washed with water cleaned and kept wet before plastering is commenced.

Application of plaster

- Ceiling plaster shall be completed before commencement of wall plaster.
- Plastering shall be started from the top and worked down towards the floor.
- All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down.
- To ensure even thickness and a true surface plaster about 15cm x 15cm shall be first applied, horizontally and vertically at not more than 2 metre intervals, over the entire 'surface to serve as gauges.
- The surfaces of these gauged area or level dots shall be truely in the plane of the finished plaster surface.
- The mortar shall then be laid on the wall between the gauges or level dots with the trowel.
- The mortar shall be applied in a uniform surface slightly more than the specified thickness.
- This shall be beaten with thin strips wooden about one metre long to ensure through filling of the joints.
- Then brought to-a true surface by working a wooden straight edge reaching across the gauges, with small upward and side ways movement at a time.
- Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required.
- Excessive troweling or over working the float shall be avoided.
- All comers arises, angles and junctions shall be truely vertical or horizontal as the case may be and shall be carefully finished
- Rounding or chamfering comers, arises, provision of grooves at junctions etc. Where required shall be done with proper templates or batterns to the required sizes.
- When suspending work at the end of the day, the plaster shall be left cut clean to line both horizontally and vertically.
- The plastering the edge of the old work shall be scrapped, cleaned and wetted with rich mortar before plaster is applied to the adjacent areas, to enable to properly joined together.
- Plastering work shall be closed at the end of the day.
- No portion of the surface shall be left out initially to be patched up later on.

Finish

- The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required
- The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5m long and with plumb bobs.
- All horizontal lines and surface shall be tested with a level and all jambs and corners with a plumb bob as work proceeds.

Thickness

- The thickness of plaster specified shall be measured exclusive of the thickness of key le grooves or open joints in brick work.
- The average thickness of plaster shall not less than the specified thickness (12mm).

- The minimum thickness over any portion of the surface shall not be less than specified thickness by more than 3mm
- The average thickness should be regulated at the time of plastering by keeping suitable thickness of the gauges or level dots.
- Extra thickness required in dubbing behind rounding or corners at junctions of wall or in plastering of masonry cornices etc will be ignored.

Curing

- Curing shall be started 24hours after finishing the plaster.
- The plaster shall be kept wet for a period of seven days.
- During this period it shall be suitably protected from all damages.

Precautions

- Any cracks which appear in the surface and all portions which sound hollow when tapped or are found to be soft or defective shall be cutout in rectangular shape and redone the plastering.
- When ceiling plastering is done it shall be finished to chamfered edge, at an angle at its junction with a tool when plaster is being done.
- Similarly, when the wall plaster is being done it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6mm.
- To prevent the surface cracks appearing between junctions of column/beam and walls 150mm wide chicken wire mesh should be fixed with 'U' nails 150mm centre to centre before plastering the junctions.

Measurements

- Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal.
- The measurement of wall plaster shall be taken between the walls or partitions for the length and from the top of the floor, or skirting to the ceiling for the height.

Types of plastering

Objectives: At the end of this lesson you shall be able to
- **state the types of finishes**
- **state materials used for finishes.**

Plastering with lime mortar

- The mortar shall be of proportion as specified in the work and shall be prepared as per the specification on lime mortar.
- The plaster shall be laid on with somewhat more than the required thickness and levelled with wooden float or wooden rule.
- The finished thickness shall be sufficient to cover by minimum 12mm the surface of wall in brick masonry and by 20mm all the projections in the case of Random rubble masonry.
- The plaster shall be well press into the joints and surface rubbed smooth with a wooden straight edge or plaster Trowel sprinkling as much water as is necessary.
- During the process of rubbing an addition of lime and water of the consistency of thick cream is to be applied to give a smooth and even surface.
- The completed plaster shall be allowed to rest for 24hours and then sprinkled with water at short intervals and kept damp for atleast seven days.

Plastering with cement mortar

- Mortar shall conform to specification on "Cement mortar".
- It must be freshly mixed for immediate use and in such quantities as to permit the whole batch being used in the work before the mortar has commenced to set.
- The plaster shall be laid on with somewhat more than the required thickness and levelled with a wooden rule or straight edge.
- The finished thickness shall be sufficient to cover by 10mm the surface of the wall in brick masonry and by 6mm all the projections in the case of rubble stone masonry.
- The plaster shall be well pressed into the joints and surface rubbed smooth with a floating coat about 3mm of pure portland cement.
- The finishing coat must be applied while the base coat is still fresh.

Special type of plasters

- Apart from the plain plaster which is used on the walls in ordinary cases.
- There are certain other plasters which have got a specific use.
- Rough coat plaster.
- Pebble dash plaster.
- Stucco plaster.

Rough coat plaster

- This type of plastered surface is prepared by throwing coarse aggregate and cement mixed together over the wet plastered surface.
- The rough cast mixture shall consists of sand or gravel or crushed stones of uniform colour from 2.5m to 12mm or as specified.
- It shall be ensured that the base surface which is to receive rough cast mixture is in plastic state
- The mixture shall be wetted and shall be dashed on the plaster base in plastic state by hand scoop so that the mix get well pitched into the plaster base.
- The mix shall again be dashed over the vacant spaces if any so that the surface represents a homogeneous surface of sand mixed with gravel. Rough cast surface is water proof. durable and resistant to cracking.

Pebble dash plaster

- The rough finish of rendering coat of cement and sand mortar 1:3 shall be laid on to a thickness of not less than 10mm and shall be lightly pressed over to straighten it.
- The aggregate used for dashing or crushed stones or pebbles of suitable size generally from 10mm to 20mm shall be well washed, drained, and thrown wet on the rendering coat while it is still plastic, rough covering material being partially embedded in the surface.
- To ensure satisfactory bond between the dashing and the mortar the aggregate may be lightly tapped into the mortar with wooden float or the trowel.
- After completion of finishing coat the plaster shall be kept wet for atleast seven days and shall be protected during that period from extremes of temperature and weather
- Therefore proper curing shall be done

Stucco plaster

- Stucco plaster finished surface resembles very much marble finishes
- Stucco plaster can be used for external as well as internal surfaces
- Stucco plaster is applied in three coats and total thickness of the plaster should not be more than 25mm
- The first coat is called stretch coat second as brown coat and third as finishing coat
- Stucco plaster consists of lime plaster in which finely ground white marble is mixed
- If hydraulic lime is used the plaster can be applied on the exterior surfaces also.

Materials requirement for 12mm thick cement mortar

Ratio	Sand	Cement	Formula = $10m^2$
1:2	$0.14m^3$	0.14/2 x 1440	100.80 Kg
1:3	$0.14m^3$	0.14/3 x 1440	67.20 Kg
1:4	$0.14m^3$	0.14/4 x 1440	50.40 Kg
1:5	$0.14m^3$	0.14/5 x 1440	40.32 Kg
1:6	$0.14m^3$	0.14/6 x 1440	33.60 Kg

Materials requirement for 20mm thick cement mortar

Ratio	Sand	Cement	Formula = $10m^2$
1:2	$0.22m^3$	0.22/2 x 1440	158.40 Kg
1:3	$0.22m^3$	0.22/3 x 1440	105.60 Kg
1:4	$0.22m^3$	0.22/4 x 1440	79.20 Kg
1:5	$0.22m^3$	0.22/5 x 1440	63.36 Kg
1:6	$0.22m^3$	0.22/6 x 1440	52.80 Kg

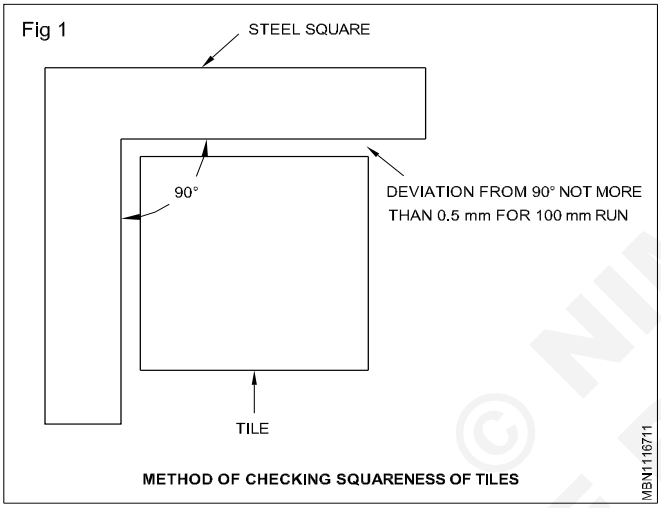
Glazed tile flooring

Objectives: At the end of this lesson you shall be able to
- **explain quality of glazed tiles**
- **describe the dimensions and square /rectangular pattened tiles.**

Glazed tile flooring

- The tiles shall be of approved make and shall generally conform to IS. 777.
- They shall be flat and true to shape and free from blisters, crazing chips, welts, crawling or other imperfections detracting from their appearance.
- The tiles shall be square or rectangular of nominal size such as 150 x 150 mm, 100 x 100 mm, 100 x 200 mm or as directed as shown in (Fig 1).

Fig 1



METHOD OF CHECKING SQUARENESS OF TILES

- The thickness of tiles shall be 5mm, or 6mm as specified.
- The length of all four sides shall be measured correct to 0.1mm and average length breath shall not vary more than ± 0.8mm from specified dimension.
- The variation of individual dimension from average value of length /breadth shall not exceed ± 0.5mm
- Where tiles of nominal sizes 150 x 150mm or 100 x 100mm are not available. tiles of nominal sizes 152 x 152mm or 108 x 108mm may be used.
- The actual size of the tiles supplied shall be 1mm less so that with 1mm joint, the tile when laid shall conform to the nominal size.
- The top surface the tiles shall be glazed and glaze shall be either glossy or matt.
- The underside of the tiles shall not have glaze on more than 5 percent of the area in order that the tiles may adhere properly to the base.
- The edge of the tiles shall be preferably free from glaze.

Coloured tiles:

- Only glaze shall be coloured as specified. The size and specifications shall be the same as for the white glazed tiles.
- The size of these tiles shall be 152 x 152 x 6mm and or 108 x108 x6mm
- Decorated and having coloured background.
- The size of the tiles shall be 152 x 152 x 6mm and or 108 x 108 x 6mm

Preparation of surface and laying

- Base concrete or the R.C.C slab on which the tiles are to be laid. shall be cleaned, wetted and mopped.
- The bedding for the tile shall be with cement mortar 1:3 (1 cement : 3 coarse sand).
- The average thickness of the bedding shall be 10mm while the thickness under any portion of the tiles shall not be less than 5mm.
- Mortar shall be spread tamped and corrected to proper levels and allowed to harden sufficiently to off a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squant on it.
- Over this mortar bedding neat grey cement slurry shall be spreaded at the rate of 3.3kg of cement per square metre over such an area as wood accommodate about twenty tiles.
- Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another.
- Each tile gently being tapped with a wooden mallet till it is properly bedded and in level with adjoining tiles.
- The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.
- The surface of the flooring during laying shall be frequently checked with a straight edge about 2m long so as to obtain true surface and slope.
- Where the full tiles can be fixed these shall be cut to the required size and their edge rubbed smooth to ensure straight and true joints.
- Tiles are fixed in the floor adjoining the wall shall enter not less than 10mm under the plaster skirting or dado.
- After tiles have been laid surplus cement slurry shall be cleaned off.
- Joints shall be cleaned off the grey cement slurry with coir brush or trowel to a depth of 2mm to 3mm and all dust and loose mortar removed.
- Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles.
- The floor shall then be kept for seven days. After curing the surface shall be washed, and finished clean.
- The finished floor shall not sound hollow when tapped with the wooden mallet.

Repair of cracks

Objectives: At the end of this lesson you shall be able to
- **state the repair of cracks**
- **state the repair the damaged plaster**
- **state the repair of damaged floor.**

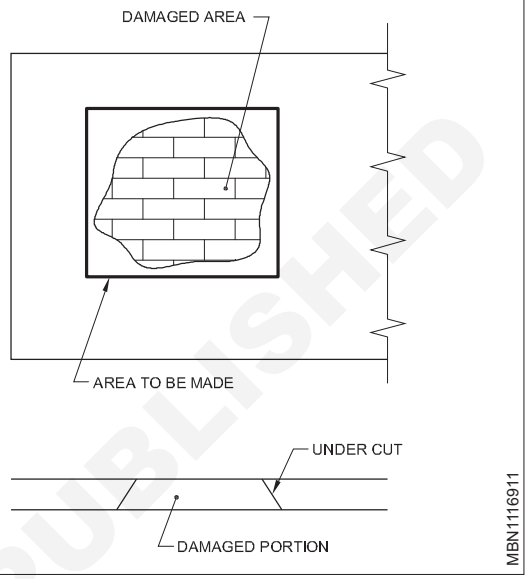
Cracks

- Stone masonry cracks may small or large.
- Small cracks should be cleaned with wire brush and filled thick paste of cement mix.
- Large cracks should be repaired only after the settlement causing the crack has stopped.
- Large cracks should be raked out to get a firm key for the mortar.
- An cement mortar 1:2 mix used.
- Aluminum may be added in mixture to make it tight fit.

Repair the damaged plaster: (Fig 1)

- Tap the surrounding area of damaged plaster.
- Remove the plaster surrounding.
- Damage area cut into square or rectangular.
- Masonry joints are rake out.
- In minimum 10mm thick in brick masonry and 20mm thick for stone masonry.
- Remove all loose materials.
- The area should be washed with water.
- The area will be wet till plastering is started.
- The area should be even and matching with old surrounding plaster.

Fig 1



Repair of damage floor

- Dismantle the floor as rectangle/square in size and without damaging the base.
- Remove all dismantled materials.
- Repair the edge and make smooth and vertical.
- Lay the floor.
- Finish neat at the same level of existing floor.

Construction and expansion joint - Method of filling

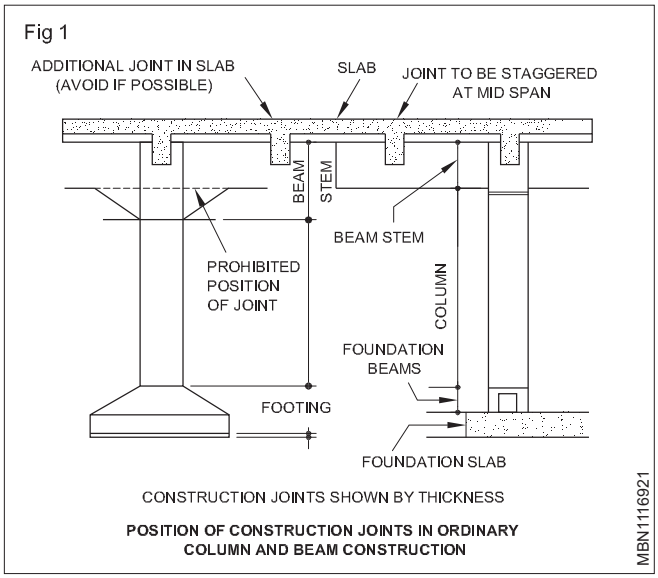
Objectives: At the end of this lesson you shall be able to
- **state construction joints**
- **state method of forming construction joints**
- **state permanent walls**
- **state expansions and contraction joints.**

Construction joints:

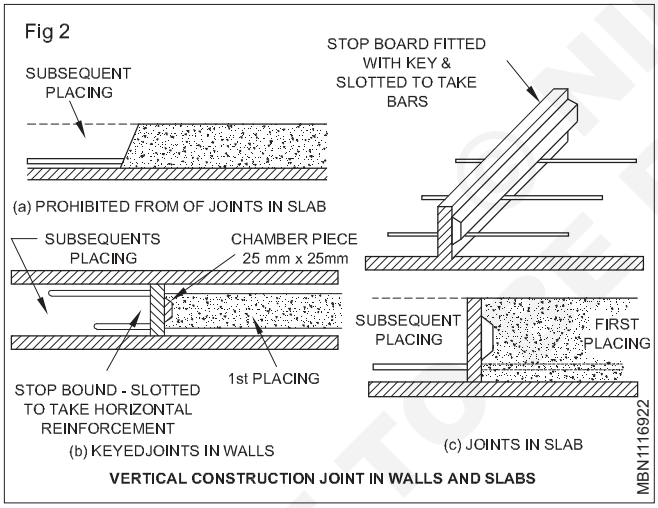
- The general rule should be observed during construction joints.
- Column should be filled to a level few centimetre below the junction of a beam.
- The joint of beam and slab should formed at the points of minimum shear.
- The position of joints in ordinary column and beam construction should be shown in (Fig 1).

Methods of forming construction joints

- The interval between the first placing and subsequent placing is short duration of two hours.
- Mortar grout should be appeared to first placing or old surface.
- When the concrete has partially hardened, the surface should be scrubbed and brushed.
- The old surface should be applied a grout of cement slurry (1:2).

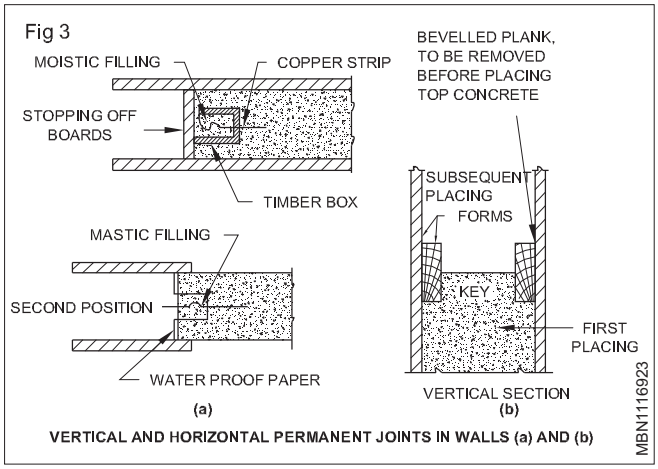


- Where to concrete has hardened, similar treatment to the above is given.
- An inclined profile joint should not be provided (Fig 2).
- This portions joined are very weak and flake off.
- For proper transmission of stresses across the joints, to extend the reinforcement of the old concrete into the concrete.
- Provision of the shear keys as shown in (Fig 2b&c).



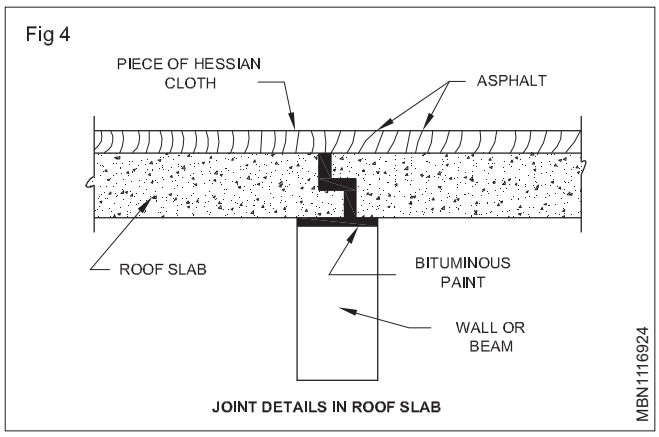
Permanent joints in walls:

- When concrete is proud in walls which are high and large and long to provide suitable joints.
- Walls are expected to be water- proof for vertical joints to provide a water stop as shown in (Fig 3a).
- For horizontal joints key are provided as shown in (Fig 3b).
- Expansion and contraction joints.



Cause of expansion and contraction joint

- Temperature change.
- Shrinkage (due to hydration of cement during setting action).
- Change moisture content.
- In building, horizontal and vertical joints in walls can be provided at off-sets, recesses, etc.
- This joint is made water proof and is located over a wall or beam.
- The bitumen joint is between the slab and the wall. Under it so as to ensure free movement.
- Fill the asphalt in the joints.
- Asphalt prevent the cracking over the joint.
- A place of hessian cloth is laid over the joint and covered with asphalt as shown in (Fig 4).
- Hessian piece reinforces the asphalt and keeps it separate the slap, by which its flexibility is increased.
- Different expansion and contraction joints elastic materials known as joint filler.
- Joint filler such as bitumen felt, rubberized cork, mental strip, fiber board etc and dowels, keys.



Marking and cutting tiles

Objectives: At the end of this lesson you shall be able to
- **cutting ceramic tiles**
- **cutting ceramic tiles with mechanical cutter or contractors tile cutter**
- **drilling holes in ceramic tiles.**

Cutting ceramic tiles with holes

- How to cut tiles to fit in to the gaps without breaking them.
- Guide lines on cutting tiles to fill the awk ward shapes that you always have left over when tiling.
- The first method for cutting straight lines in tiles is the hand cutter or tile scribe.
- Tipped with tungsten carbide, this tool will score the glaze on any tiles.

Note: If the glaze is not scored for the complete using of the cut, the tile will break.

Cutting ceramic tiles with mechanical cutter or contractor tile cutter

- A slightly easier way by using mechanical cutter.
- The tile is placed in the machine, the handle has a circular blade on the end is pushed on the tile along the line you need to cut.
- Then the clamp is wound down on to the tile which breaks it in the required place.
- It is a cheaper ones that you need to go over the tile with the cutter 2-3 tiles to make sure that you have completely scored the glaze so the unwanted section will break off easily.
- If possible get one with an adjustable guide as you are ensure that your tile stays straight while cutting it.
- Get a nice crisp line.

Electric tile cutter

- Electric tile cutter are widely available, easy to use and cheap.
- Make the job much neater.
- Most models will feature an adjustable guide.
- Specific size can be cut.
- Your tile is level with the guide at all times will ensure that your cut is straight and true.

Drilling holes in ceramic tiles

- First make a mark in the centre of the hole needs drilling using a hand held tile scribe.
- Put it in the place where you need the hole and twist it so it scores the glaze and are a power drill.
- The drill bit should be the smallest you have to start with.
- If require 6 or 7mm hole, start with 3 mm hole first then go up 5mm drill bit then 7mm.
- This makes the operation far less likely to break tiles.

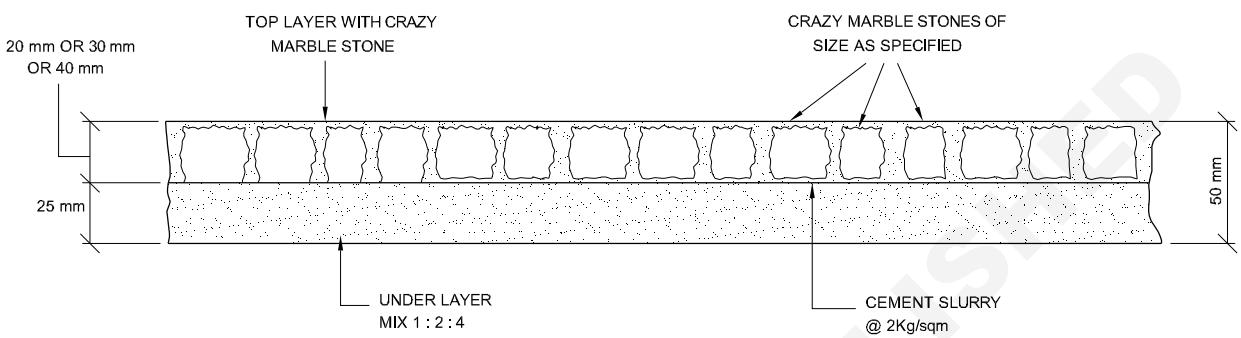
Note: Do not put force on drill just gentle position.

Crazy marble flooring

Objectives: At the end of this lesson you shall be able to
- **state and explain the materials used for crazy flooring**
- **describe the method of laying and construction of crazy flooring.**

- Crazy marble stone flooring shall be laid on cement or lime concrete base.(Fig 1)
- The base concrete shall be provided with slope required for the flooring in verandahs and court yards to drain off wasting and rain water.

Fig 1



CRAZY MARBLE FLOORING

- The surface of the base shall be roughened with steel wire brushes without disturbing the concrete
- The surface is welled and smeared with a floating cast of cement slurry at 2 kg of cement spread over an an area of one sq.m so as to get a good bond between base and flooring
- Before laying the flooring an R.C.C slabs, the laitance shall be removed.
- The surface of slab hacked and a coat of cement slurry at 2 kg of cement spread over an area of one sqm shall be applied so as to get a good bond between R.C.C slab and floor.

Under layer

- Under layer of crazy marble flooring shall be of cement concrete of thickness 25mm or as specified.
- The mix shall be normally be 1:2:4 (one cement : two coarse sand: four graded stone aggregate 12.5mm nominal size by volume.

Top layer

- The mix of crazy marble stone flooring shall consists of white cement with or without pigments marble powder, marble chips and marble stone pieces and water
- The marble stone shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains.
- It shall be uniform in colour and free from stains, cracks decay and weathering.
- Before starting the work check marble pieces as well as marble stones.
- The white cement and marble powder shall be mixed with proportion of three parts of cement and one part of marble powder by weight
- And the proportion of marble chips to binder the mix by volume shall be seven parts of marble chips to four parts of binder mix.
- The marble chips shall be hard, sound, dense and homogeneous in texture.
- It shall be uniform in colour and free from stains, cracks decay and weathering.

Laying

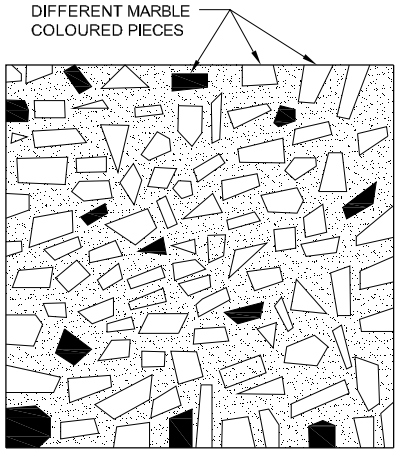
- A coat of cement slurry at the rate of 2kg of cement per sq shall be spread and then the marble stone pieces shall be set by hand in such a manner that the top surface of all set marble stones shall be true to the required level and slopes.
- After fixing the stone, the cement marble chips mixture shall be filled in between the gaps of laid marble stone pieces.
- The filled surface then shall be trowelled over, pressed and brought to the level of the laid marble stone pieces.

Curing and polishing

- Polishing shall be done by machine.
- About 36 hours after laying the top layer, the surface shall be watered and ground evenly with machine fitted with special rapid cutting grit blocks of corborundum stone. of coarse grade 60 number till the marble chips are evenly exposed and the floor is smooth.

- Finally the third grinding shall be done with machine fitted with fine grade grit blocks 320no. to get even and smooth surface without pin holes.
- The finished surface should show the marble chips evenly exposed. as shown in the (Fig 2).

Fig 2



CRAZY MARBLE FLOORING

MBN196142

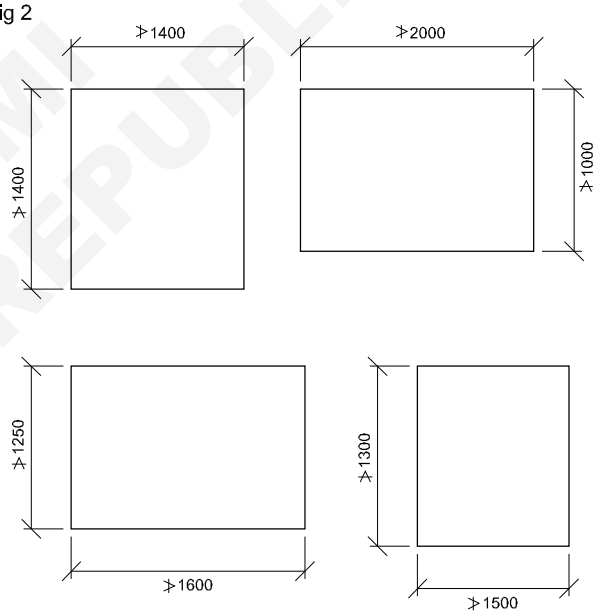
Laying of terrazzo floors

Objectives: At the end of this lesson you shall be able to
- **state methods providing panels and its dimensions**
- **explain forming of panel strips and materials used.**

This is another type of popular floor

- Commonly recommended for bath rooms, dining and drawing rooms offices, hospitals etc.
- Terrazzo is actually a concrete surface with special type of aggregate of marbles.
- This special concrete surface is laid over the ordinary surface of concrete
- This type of floor is very durable smooth, pretty in appearance, non absorbent can be easily cleaned and washed.
- This floor is very commonly known amongst the masses of as mossaic floor.
- The terrazzo is a finish laid over the cement concrete base.
- Making this floor the earth is filled in the plinth and then thoroughly compacted.
- Over the compacted earth, a layer of lime concrete in a thickness of 15cm is laid with the suitable slope, varying from 1 in 100 to 1 in 120.
- The lime concrete bed is thoroughly compacted with hand hammers.
- After the lime concrete bed is prepared, the whole surface is divided into squares or rectangles in a similar manner as in cement concrete as shown in (Fig 1)
- As per the specification the maximum size of panels permitted with its dimensions either squares or rectangles as shown in (Fig 2)
- On the edges of these squares or rectangles, aluminium or glass strips having a width of 35mm, and thickness of 2mm are placed with the help of mortar screeds.

Fig 2



MAXIMUM SIZE OF PANELS PERMITTED AS PER SPECIFICATIONS

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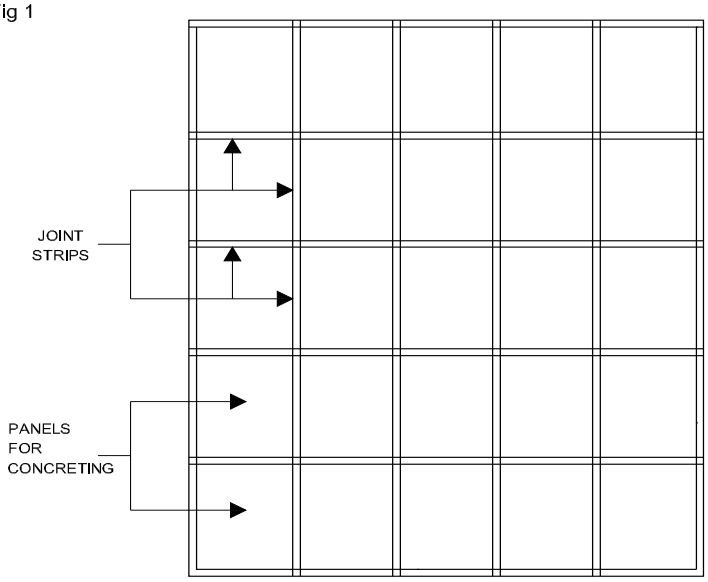
- Now when these bays or panels are ready ordinary cement concrete 1:2:4 is laid in the bays or panels in a thickness of 25mm.
- The method of laying the cement concrete will be the same as for ordinary cement concrete floor with the difference that the surface is made rough by brooming and is left for drying.
- After three or four days of laying cement concrete terrazzo finish is laid in a thickness of 10mm in the following manner.
- The terrazzo mix consists one part of ordinary cement and 3 parts of marble chips and half part of marble dust mixed with sufficient quantity of water so as to make a workable mix.

Fig 1



PLAN

CEMENT CONCRETE FLOORING WITH STRIPS

NOTES:-

(1) AFTER FIXING THE JOINT STRIPS CONCRETE FOR PANELS SHALL BE LAID IN ONE OPERATION TO ACHIEVE THE UNIFORMITY IN COLOUR.

(2) STRIPS OF BAYS SHALL NOT BE DISTURBED DURING CONCRETING.

(3) THICKNESS OF STRIPS TO BE PROVIDED:
GLASS : 4 mm
PLAIN ASBESTOS : 5 mm
ALUMINIUM : 2 mm
PVC OR BRASS : 2 mm

MBN196151

- This terrazzo mix is laid evenly over the prepared bed of cement concrete
- The top of the terrazzo finish should be in conformity with the top strips.
- The surface is now left for drying for atleast three days. During this period also the surface is kept wet by sprinkling water. Now the whole surface is ground with a carborundum stone either by hand or by grinding machine.
- The first cutting is done by 60 or 80 number of grinding stone. After the first cutting or grinding the surface is washed and then covered with neat cement paste.
- The cement to be used should be the same which was used for making the terrazzo mix.
- The purpose of applying cement paste is to fill up the pores so formed durng the process of cutting.
- The next day, second cutting is done with a 100 number corborundum stone, either by hand or grinding machine.
- After grinding the surface it is again coated with a neat thin cement paste or grout.
- On the third day final cutting is done with a 120 number grinding stone.
- The surface is then washed clean with either soap water or very dilute oxalic acid.
- Finally the floor is polished either with a wax polish or saw dust socked with kerosene oil etc.

Mossaic Floors

- Originally the floor was known as china mosaic floor.
- This floor is also laid over a hand bed of cement concrete
- For the construction this floor earth is filled in the plinth and properly compacted.
- Over it a layer of 10cm thick lime concrete is laid with a proper gradient and thoroughly compacted with hand rammers.
- The lime concrete surface is properly levelled.
- A layer of rich mortar 1:1 one part cement and one part white sand is evenly laid in a thickness of 1cm and broken tiles, pieces of crockery, or marble chips cut wedge shapes, laid with hand and set properly in desired pattern.
- Dry cement either ordinary or coloured in sprinkled and pressed in the joints.
- The process is continued for the whole floor, water is periodically sprinkled so that the cement is properly set.

  The joints of the tiles are then rubbed with a corborundum stone.

Terrazzo tile flooring

Objectives: At the end of this lesson you shall be able to
- **testing and checking tiles**
- **detailed description of subgrade**
- **method laying terrazzo tiles**
- **method of polishing flooring.**

Terrazzo tiles generally conform to I.S 1237.

Requirements and methods of testing of tiles should be done before laying of tiles.

Tolerance

- Tolerance on length and breath shall be plus or minus one millimetre and tolerance on thickness shall be plus 5mm.

The size of tiles should be as follows

No.	Length nominal	Breadth nominal	Thickness not less than
1	200mm	200mm	20mm
2	250mm	250mm	22mm
3	300mm	300mm	25mm

- The range of dimensions in any one delivery of tiles shall not exceed 1mm on length and breath 3mm on thickness.
- The tiles shall be manufactured in a factory under process subjected to hydraulic pressure of not less than 140 kg per square centimetre.
- The intial grinding is given with machine and grouting of the wearing layer before delivery to work site.
- The edges of wearing layer may be rounded.
- The proportion of cement to aggregate in the backing of tiles shall be not leaner than 1:3 by weight.
- Where colouring materials is used in the wearing layer 10 percent by weight of cement used in the mix.
- The finished thickness of upper layer shall not be less than 5mm for size of marble chips from the smallest upto 6mm and also.
- not less than 5mm for size of marble chips ranging from the smallest upto 12mm. and not less than 6mm for size of marble chips varying from the smallest upto 20mm.

Laying

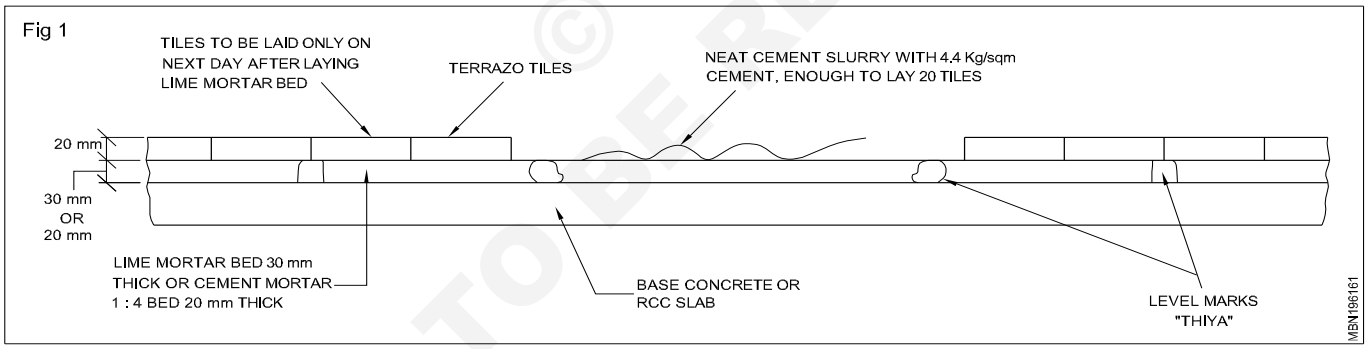
Base concrete or R.C.C slab on which the tiles are to be laid shall be cleaned, welled and mopped.

The bedding for the tiles shall be with lime mortar of any of the following specifications.

a	1:1:2	1 lime putty
		1 surkhi
		2 coarse sand
b	1:3	1 lime putty
		3 surkhi
c	1:3	1 lime putty
		3 coarse sand

- The ingredients shall be thoroughly mixed by volume in dry form
- Care should be taken to ensure that there are no hard lumps present
- Water shall be then added and the ingredients thoroughly mixed.
- Where lime putty of proper quality is not available cement, mortar 1:4 (one cement : 4coarse sand) bedding may also be used.
- The average thickness of bedding mortar shall be 30mm and thickness at any place shall not be less than 10mm as shown in (Fig 1).

Fig 1



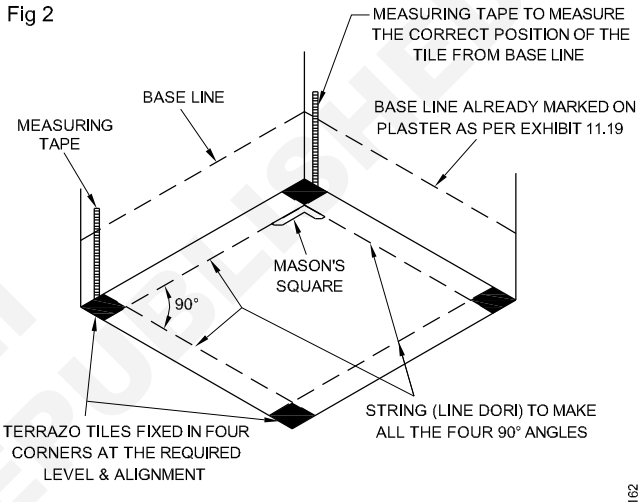
- Lime mortar bedding shall be prepared and spread, tamped and corrected to proper levels and allowed to harden for a day before the tiles are set.
- If the cement mortar is laid in bedding the terrazzo tile shall be immediately after laying mortar.
- over this bedding neat grey cement slurry is spreaded at the rate of 4.4kg of cement per sq metre. over such an area as would accommodate about twenty tiles.
- These shall be washed clean and shall be fixed in this grout one after another.
- Each tile being gently tapped with a wooden mallet till it properly bedded and in level with adjoining tiles
- The joints shall be kept as thin as possible not exceeding 1.5mm and in straight lines or to suit the required pattern.
- The surface of the Terrazzo flooring should be frequently checked with a straight edge atleast 2 metre long so as to obtain a true surface with the required slope.
- Where the full tiles or half tiles cannot be fixed, tiles shall be cut from full tiles to the required size and their edges rubbed smooth to ensure a straight and true joint.
- Tiles which are fixed in the floor adjoining the wall enter not less than 12mm under the plaster, skirting or dado.
- The junction between wall plaster and tile work, shall be finished neatly
- After the tiles have been laid surplus cement grout that may have come out of the joints shall be cleared off.

Curing, polishing and finishing

- The day after the tiles are laid all joints shall be cleaned of the grey cement grout with a wire brush, or trowel to a depth of 5mm
- All dust and loose mortar removed and cleaned.
- All the joints should be grouted with grey or white cement mixed with or without pigment to match the shape of the topping of the wearing layer of tiles.
- The same cement slurry is applied to the entire surface of the tiles in a thin coat with a view to protect the surface from damage and fill the pin holes that may exist on the surface.
- Then the floor shall be kept wet for a minimum of 7 days.
- The surface shall be thereafter be grounded evenly with machine fitted with coarse grade grit block no.60
- Water shall be used during grinding after grinding the surface shall be thoroughly washed to remove the grinding mud cleaned and mopped
- It is then covered with a thin coat of grey or white cement mixed with or without pigments to match the colour of the topping of the wearing surface in order to fill any pin holes that appear.
- The surface shall be again cured well
- The second grinding shall then be carried out the day after the second grinding.
- For small areas hand polishing may be used in lieu of machine polishing after laying the tiles.
- For hand polishing the following carborundum stones are used.
- 1st grinding - Coarse grade stone no 60
- 2nd grinding - Medium grade no 80
- Final grinding - fine grade no 120
- In all other respects, the process shall be similar as for machine polishing.
- After the final polish oxalic acid shall be dusted over the surface at the rate of 33 gram per sq metre sprinkled with water and rubbed hard with a pad or wooden rags.

‘ The following day the Terrazzo tiled floor wipped with a moist rag and dried with a soft cloth and finished clean.

Fig 2



METHOD OF SETTING THE TILE WORK IN FLOORING IN PROPER ALIGNMENT AND LEVEL

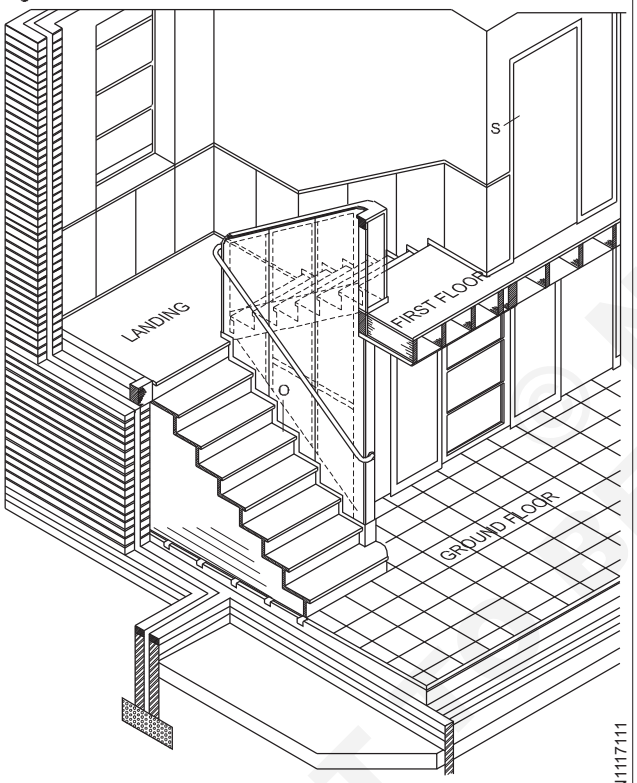
Types of stairs

Objectives: At the end of this lesson you shall be able to
- **state the stair**
- **state the components of stair and stair case**
- **state about straight stair, quarter turn, half turn, three quarter turn, bifurcated spiral and helical stairs**
- **state about ramp, lift and escalator.**

Stairs: The means of transportation of men and material (between the floors of a building are stair, ramp, elevator (Lift) and Escalator).

Stair: Stair is a series of steps suitably arranged to provide access between the floors. In other words, a stair is provided to afford the means of ascent and descent between the floors or landings. (Fig 1)

Fig 1



ISOMETRIC VIEW OF DOG LEGGED STAIR

Ramp: Ramp is a sloping surface which is adopted in place of a stair for easy connection between the floors. The usual slope of ramp varies from 1in 10 to 1 in 15.

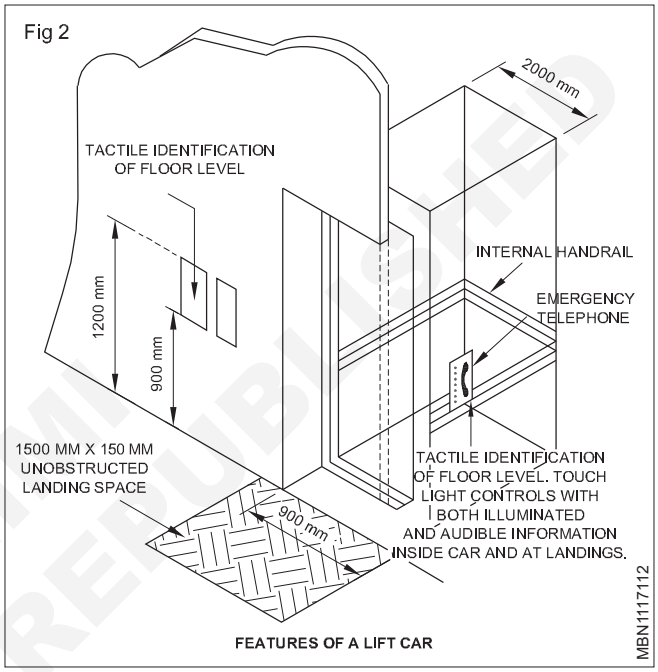
A ramp requires more space than stair.

Elevator (Lift): Elevator is an electrically operated platform which provides vertical movement between floors. (Fig 2) It is an additional facility in a building along with a stair or ramp. It is provided in apartments public buildings etc.

Escalators: These are known as moving stairs. Escalators are electrically operated and the flights are kept continuously in motion by a revolving drum. The pitch is kept at 30°. They are used in railway stations, airports etc.

Among the above, a stair is a simple construction which is commonly used in almost all the buildings.

Fig 2



FEATURES OF A LIFT CAR

Technical Terms

The technical terms used in connection with the stairs are as follows.

Stair case: The room or portion of building in which the stair is located is called as stair case.

Stair way: The space occupied by the stair is stair way.

Tread: The horizontal upper part of a step (Fig 3 to 5) is known as a tread.

Rise: This is the vertical distance between the treads of two successive steps. (Fig 3 to 5)

Riser: This is the vertical member of a step which provides support to the tread. (Fig 3 to 5)

Flight : An unbroken series of steps between the landings is known as flight. (Fig 3)

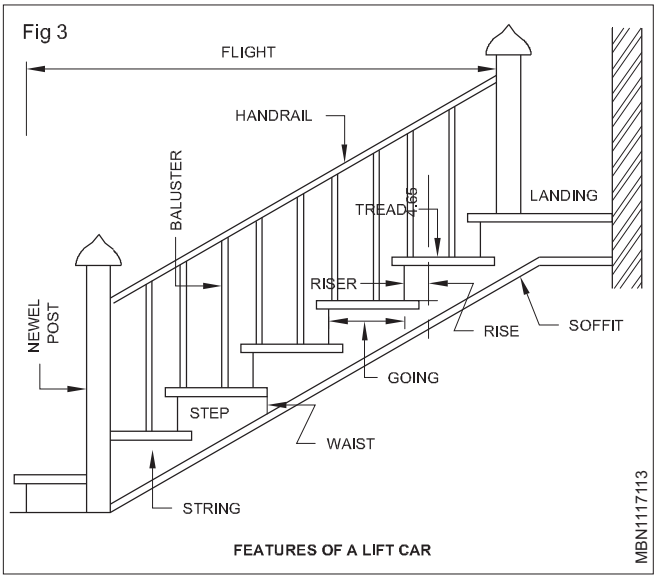
Going: The horizontal distance between the faces of two successive risers is called as going. (Fig 3 to 5)

Landing: The horizontal platform provided between two successive flights of a stair (Fig 3) is known as Landing. A landing may be used to change the direction of flight and it also gives an opportunity to take rest during the use of a stair.

String: The inclined member of a stair which supports the ends of steps (Fig 3) is called as string.

The string may be a cut or open string (Fig 6) and a closed or housed string. (Fig 7)

Fig 3



FEATURES OF A LIFT CAR

Fig 4

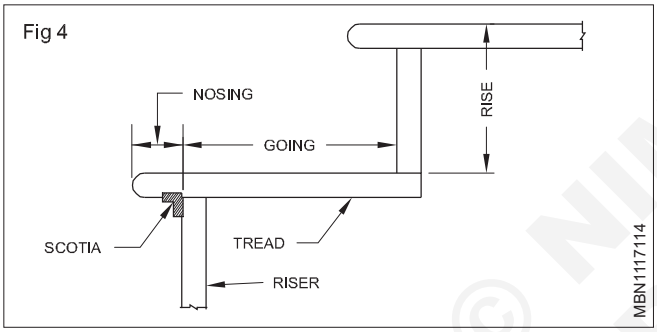
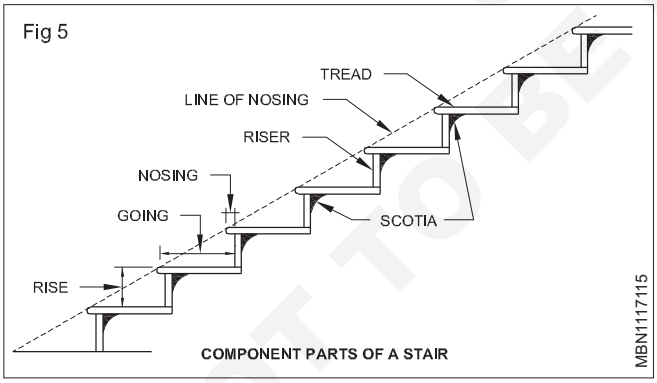
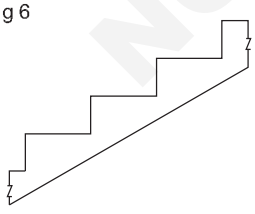


Fig 5



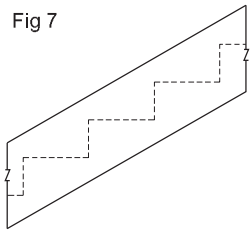
COMPONENT PARTS OF A STAIR

Fig 6



CUT OR OPEN STRING

Fig 7



CLOSED OR HOUSED STRING

Hand rail: The inclined rail over the string is called as hand rail. (Fig 3) Generally the hand rail is provided parallel to pitch of stair and at a height of 900mm.

Baluster: The vertical member which is provided between string and hand rail to support the hand rail (Fig 3) is known as baluster.

Balustrade: The entire framework of balusters and hand rail is known as Balustrade. This is also called a barrister.

Newel post: This is the vertical member which is fixed at the ends of flights to connect the ends of hand rails and strings. (Fig 3)

Nosing: The projecting part of the tread beyond the face of riser is nosing. (Fig 3 to 5)

Line of Nosing: It is an imaginary line parallel to the slope of stair and touching nosing of each tread. (Fig 5)

Pitch: The angle of inclination of the stair with the floor is termed as pitch (Fig 3) the angle which the line of nosing makes with horizontal will be equal to pitch.

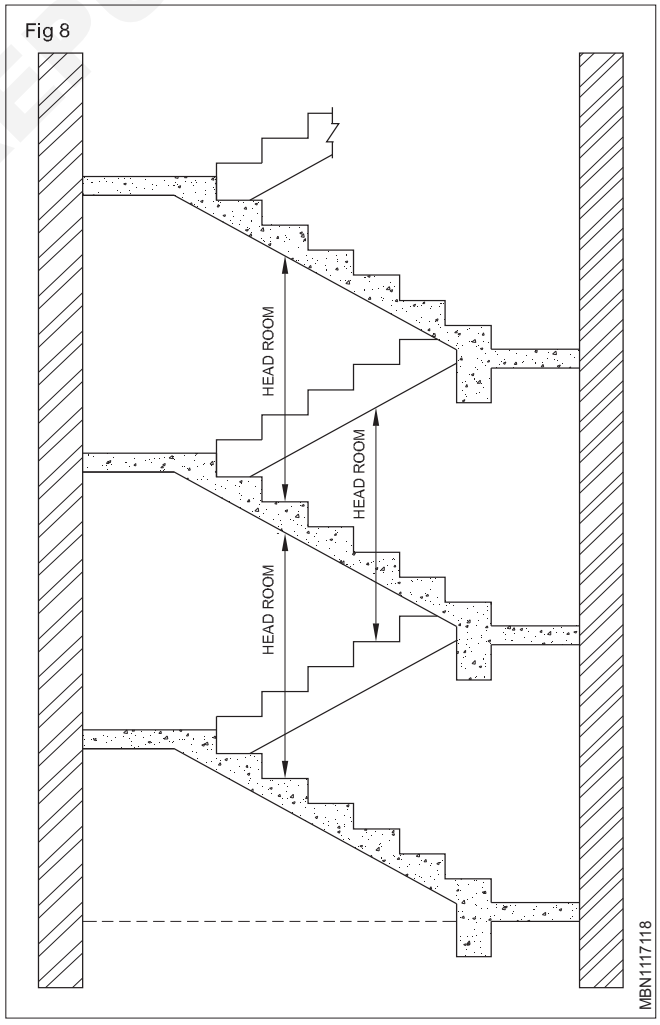
Scotia: It is an additional finish to the nosing (Fig 4). Scotia provides strength to the nosing and improves the appearance of step in elevation.

Soffit: Soffit is the under surface of a stair. (Fig 3)

Run: It is the total length of a stair in plan which includes the lengths of landings also.

Head room: The clear vertical distance between the nosing (or) treads of one flight and the soffit of flight or landing immediately above is known as head room. (Fig 8)

Fig 8



Waist: Waist is the thickness of inclined member which forms the flight. In case of an R.C.C stair, the thickness of structural slab is known as waist. (Fig 3)

Walking line: The approximate line of ascending or descending while using a stair is known as walking line. The walking line may be assumed approximately 450mm from the centre of hand rail.

Step

The combination of tread and riser is termed as step. The types of steps as follows.Bull nose step. (Fig 9a)

The end corner of this step forms a circular quadrant in plan. It is provided as first step in front of the newel post.

Commode Step: This step consists of curved riser and tread (Fig 9d). It is also provided as first step in front of the newel Dancing or balancing step (Fig 9e).The steps which do not radiate from a common centre is known as dancing or balancing step.

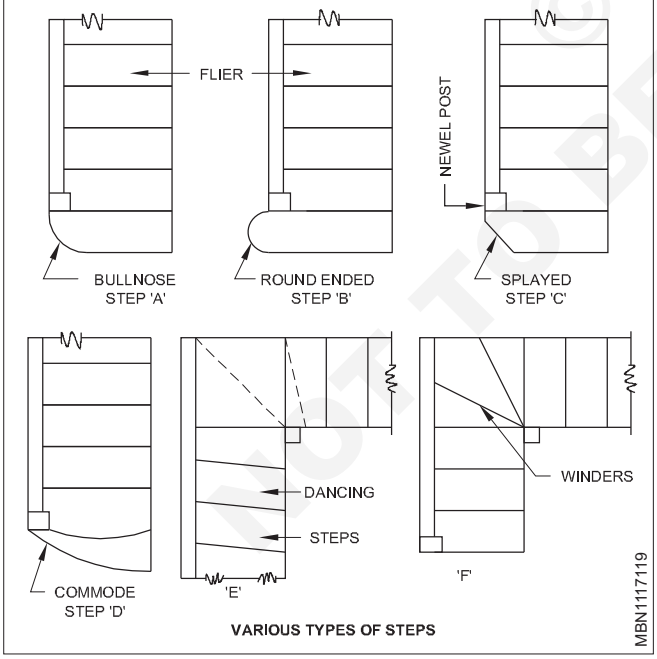
Flier: The ordinary step or rectangular shape in plan is called as Flier. (Fig 9a&9b)

Round ended step: The end of this step is semi circular in plan which is also provided as first step in front of newel post. (Fig 9b)

Splayed step: This step has one end or both ends splayed in plan. (Fig 9c)

Winder: Winders are the tapering steps which are used to change the direction of a flight. The winders are radiating from a common centre. (Fig 9f)

Fig 9



VARIOUS TYPES OF STEPS

Types of Stairs (Fig 10)

The stairs may be classified according to shape and materials used in the construction.

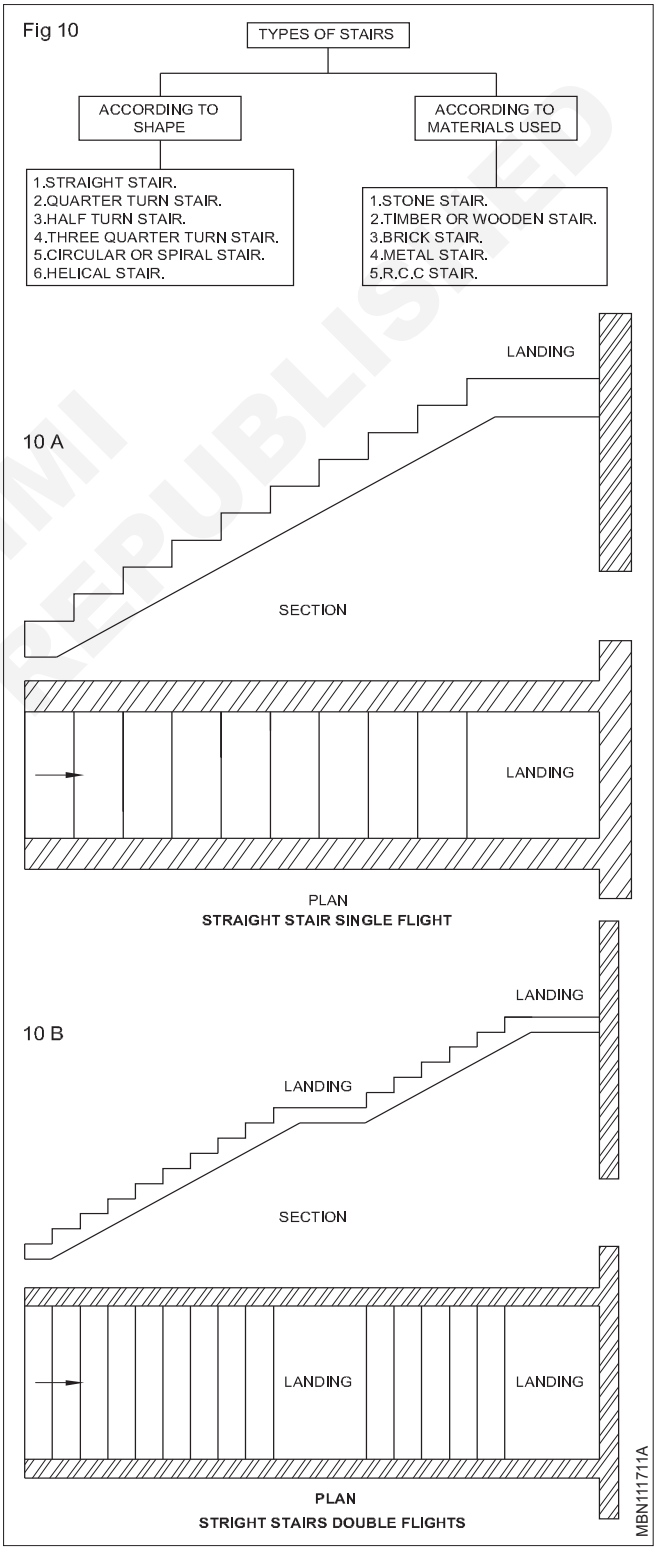
According to the shape of stairs, they are subclassified into,

- Straight stairs
- Quarter turn stairs
- Half turn stairs
- Three quarter turn stairs
- Spiral stairs and
- Helical stairs

The salient features of the above types of stairs are given below.

Straight stairs: In this type all steps are running in one direction only. There may be one (Fig 10a) or more (Fig 10b) flights.

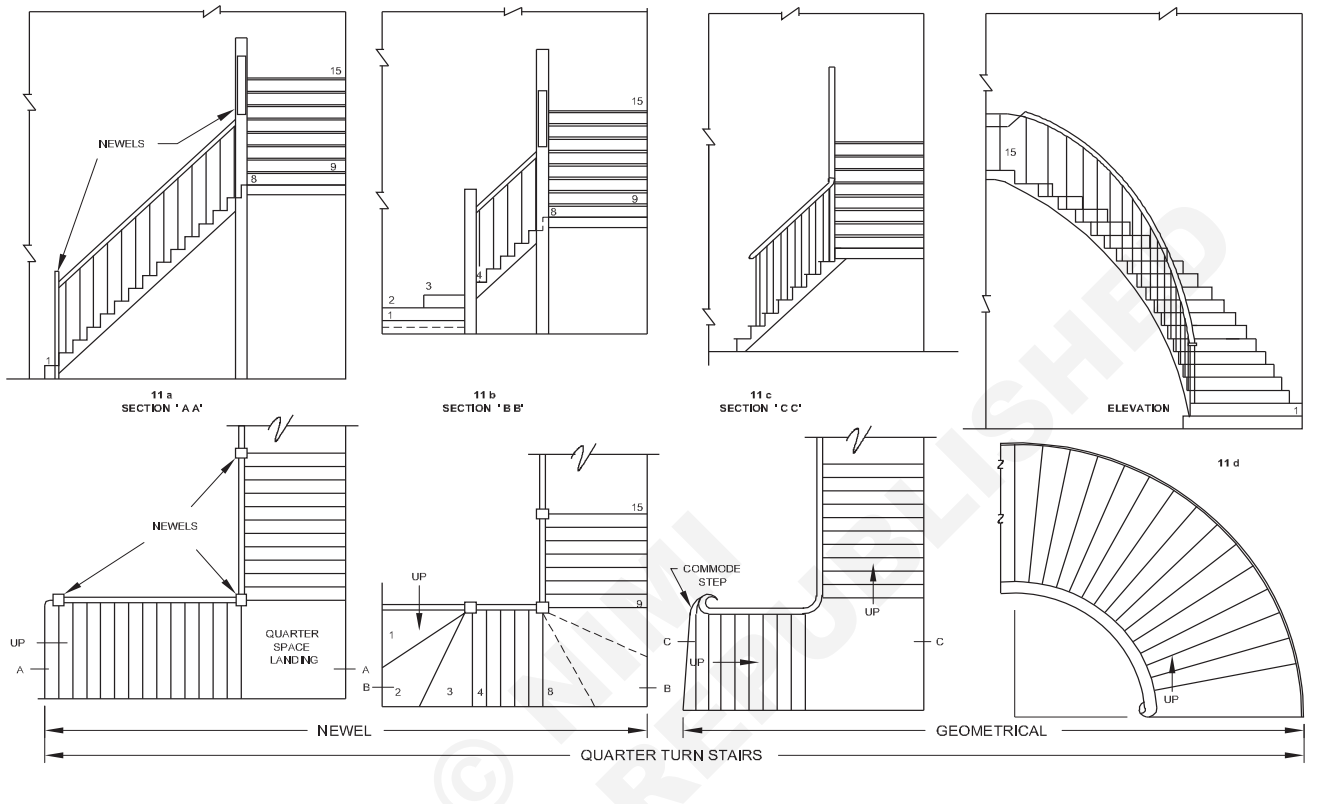
Fig 10



These stairs are provided when the available space is long but narrow in width.

Quarter turn stairs: The flights turn to one right angle (90°) in this type of stairs. A landing is provided in between the two flights (Fig 11a) Sometimes, in place of landing winders may be used to change the direction of flights (Fig 11b) Since, the newel post is used to support the balustrade, the above two types (Fig 11a & 11b) are known as quarter turn newel stairs.The quarter turn stair may also be constructed as geometric stairs without newel post (Fig 11c & 11d) Fig 11C shows a quarter turn geometrical stair without landing. The geometrical stairs improves the appearance in elevation.

Fig 11



If a quarter turn stair is branched into two flights from a landing (Fig 12) it is known as Bifurcated stair. Generally, it is used in the enterance hall of a public building.

The first flight of this stair is wider and it branches into two narrow flights at the landing. (one flight turns to the left and another to the right).

The (Fig 12) shows the left half as newel type and right half as geometrical type.

Half turn stair: A stair running through to right angles (180°) is termed as half turn stairs. Similar to quarter turn stair, a half turn stair may be newel type or geometrical type.

Dog legged stair (Fig 13a) and open wall stair (Fig 13b) are two forms of newel type.

The features of Dog legged stairs are (Fig 14)

- There is a well or opening between the flights in plan.
- The well may be utilized to fix a lift
- The width of stair = Twice the width of steps + width of well

The half turn geometrical stair may be formed with landing (Fig 13c) or without landing (Fig 13d).

Fig 12

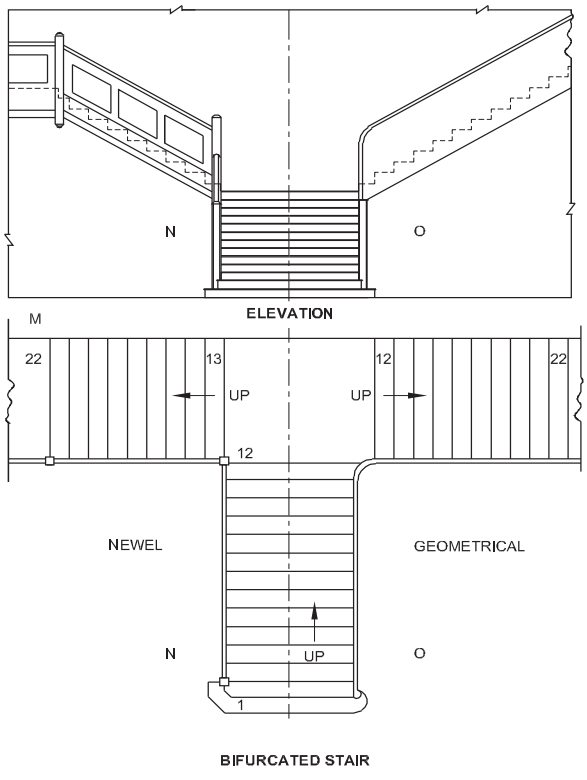


Fig 13

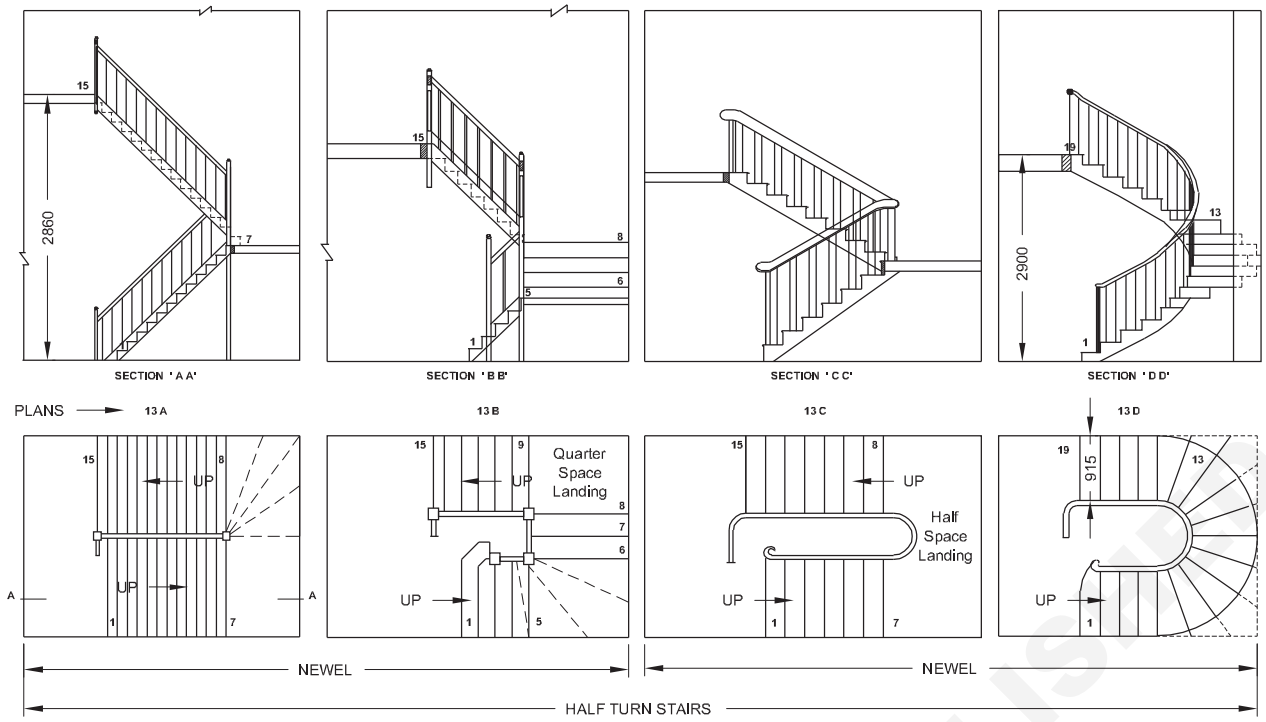
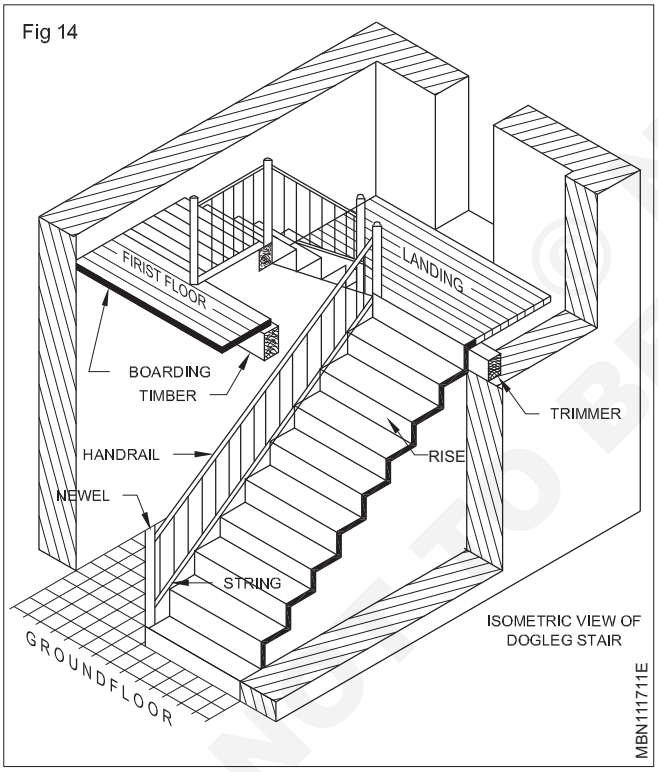


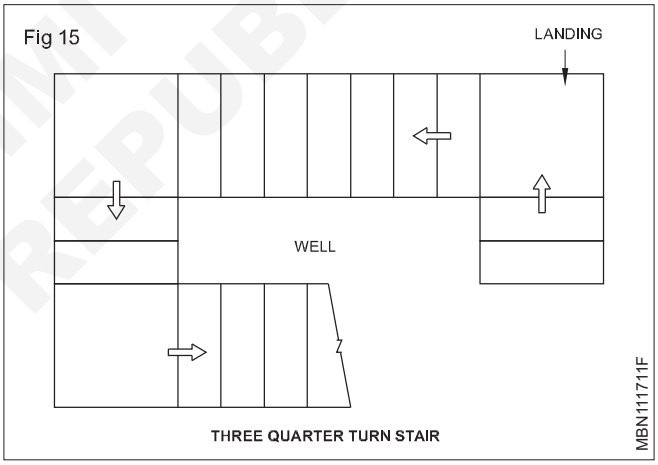
Fig 14



In a half turn geometrical stair without landing, the open well between forward and backward flights is curved. In this type of stair, the change of direction is achieved through winders.

Three quarter turn stairs: In this type, the flights turn to three right angles (270°) An open well is formed in between the flights (Fig 15). This type of stair is provided when the length of staircase is limited and the vertical height between the floors is large.

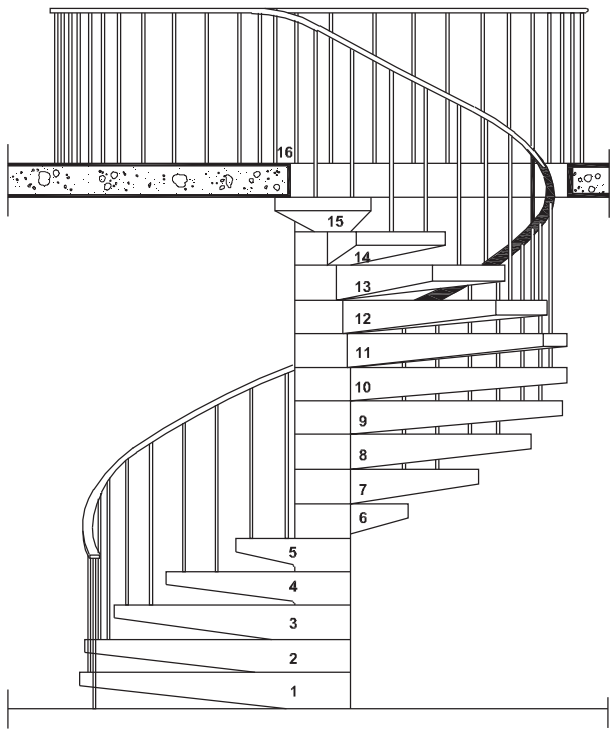
Fig 15



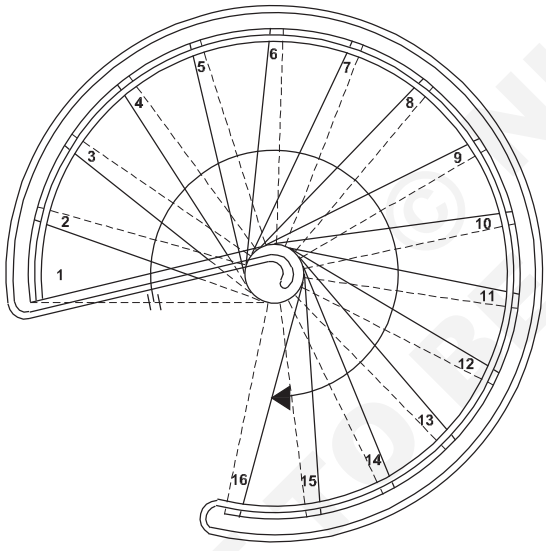
Spiral stairs: Spiral stairs consists of steps (Winders) which radiate from a common centre. In this type of stair, there is no landing and intermediate newel post. (Fig 16)

- Some of the important facts of spiral stairs are given below.
- Winder steps (Fig 17) are used continuously through any desired number of turns. The winders radiate at an angle of 30^0 from core.
- A spiral stair may be constructed in mild steel, cast on or concrete.
- The core of spiral stair may be solid or hollow. All winders are connected with this core.
- It is provided where the space available is limited and where the users are less.

Fig 16



ELEVATION



PLAN

SPIRAL STAIRCASE

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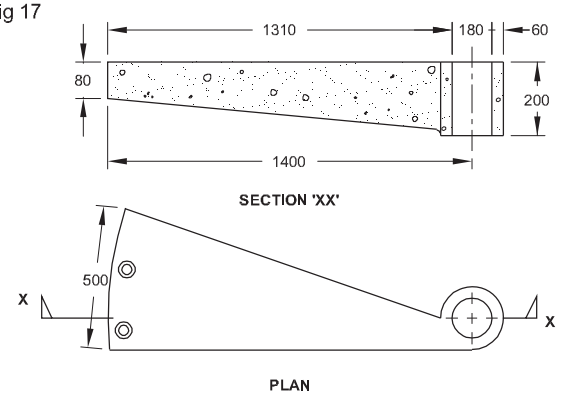
Fig 17



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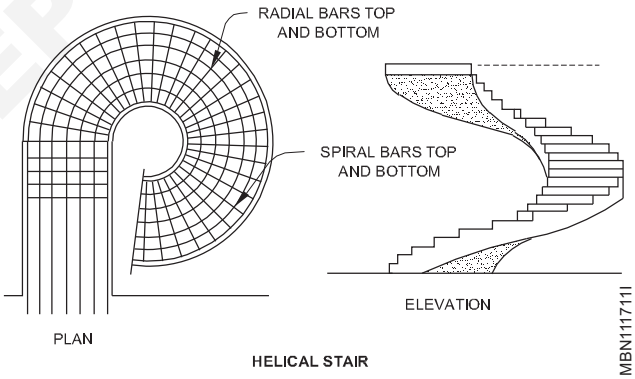
The spiral stair is also known as circular stair.

Helical stair: An helical stair looks similar to spiral stair except there is no central core.

The important features of a helical stair are;

- It gives a good appearance but, its structural design and construction is very complicated.
- This type of stair is constructed only with Reinforced cement concrete.
- This type of stair improves architectural elegance of a building.
- (Fig 18) shows plan and elevation of a helical stair.

Fig 18



HELICAL STAIR

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Types of stair (According to material)

Objectives: At the end of this lesson you shall be able to
- **state the types of stairs**
- **state the need of each types of stairs**
- **state the method of construction and show details.**

The following are the types of stairs according to material of construction.

Stone stairs

Brick stairs.

Metal stairs

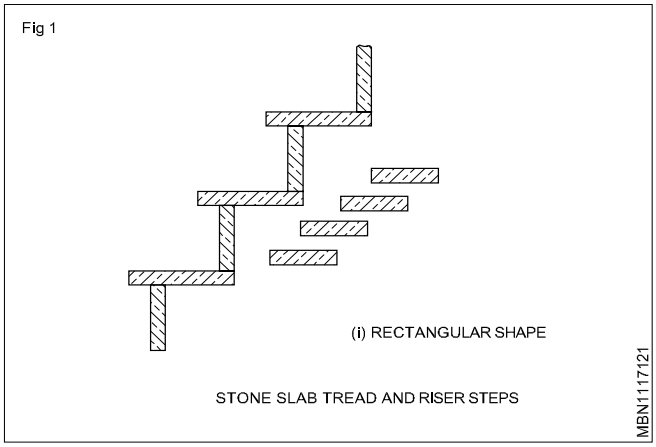
Reinforced concrete stairs.

Timber (wooden) stairs.

The above classified types of stairs according to material of construction and also constructed according to shape. The stone stair further classified as,

Stone stairs

Rectangular stone step (Fig 1)



Spandrel step (Fig 2)

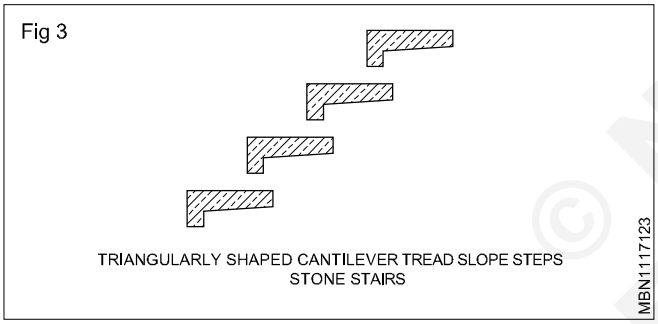
Spandrel step with moulded soffit (Fig 2a)

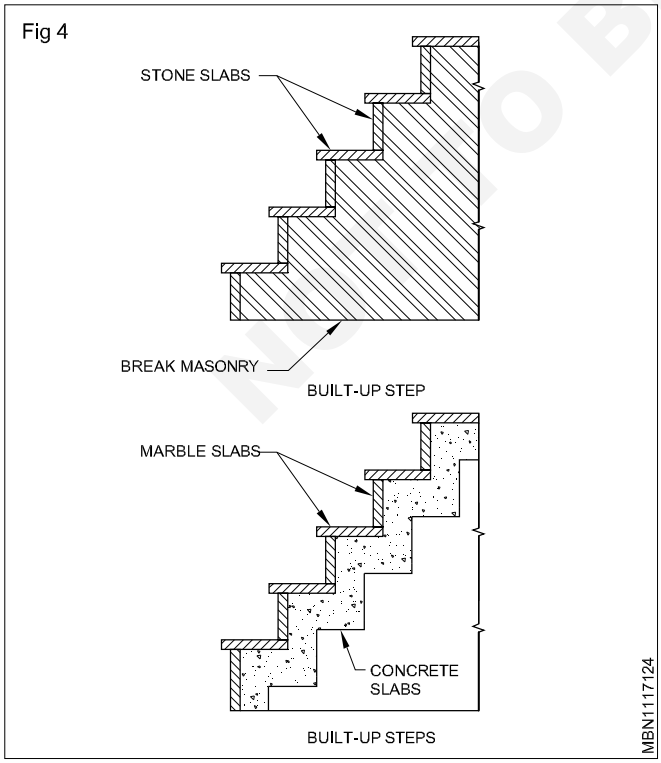
Spandrel step with broken plain soffit (Fig 2b)

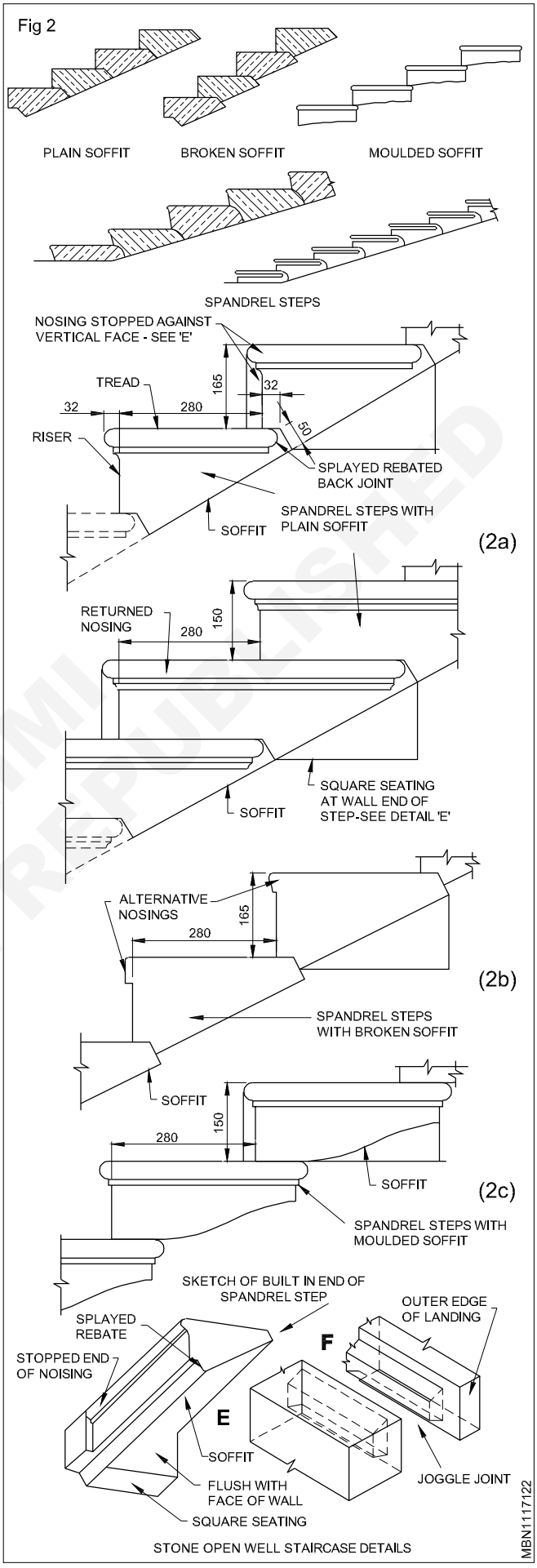
Spandrel step with broken soffit (Fig 2c)

Cantilever tread slab step (Fig 3)

Built up step (Fig 4)







Stone stairs: Stair made out of hard, strong resistant to wear and tear stones are found to be durable and fire resisting.

These are commonly constructed in public buildings, ware houses and workshops etc.

Rectangular steps: Usually the rectangular steps with rebated joint is considered as a best suited because this arrangement result in considerable saving in labour of cutting and dressing stones.

Rectangular steps are cut from solid stone into square or rectangular blocks of uniform size. The defect in this type is the mortar used at the bedding or joint deteriorate due to gauge.

Built up steps: The builtup steps made up of small thin sawn slabs of stones 2cm to 5cm to form treads and risers. They are often used as facing for concrete or brick steps.

Spandrel steps: The stones used in this area of triangular shape and arranged to form plain soffit. The ends of spandrel steps which are built into the wall should be square so as to provide a required bearing.(Fig 2)

Cantilever tread slab step: These steps are formed of treads only. For this purpose, this may be of triangular or rectangular shape. These are used as treads only no rises can be found in (Fig 3).

(Fig 5) can help trainees to under stand overall perspective of a stair at a glance.

Support and fixing stone step

i The steps are normally supported on both ends with minimum bearing of 10cm for a 1.20 m width of stairway.

ii The cantilever support (one end only supported) should not have length of more than 1.20m.

iii The steps may be supported at one end in a wall and other end, It may be supported by a steel work.

Brick stairs: These stairs are not frequently used. The brick stair of solid brick masonry some arches or opening may be provided if required. Usually stretcher bond of brick work is applied to construct the treads and risers are generally made equal to length of 30cm and height of 20cm respectively Finally, the treads and risers may be finished with suitable material (Fig 5).

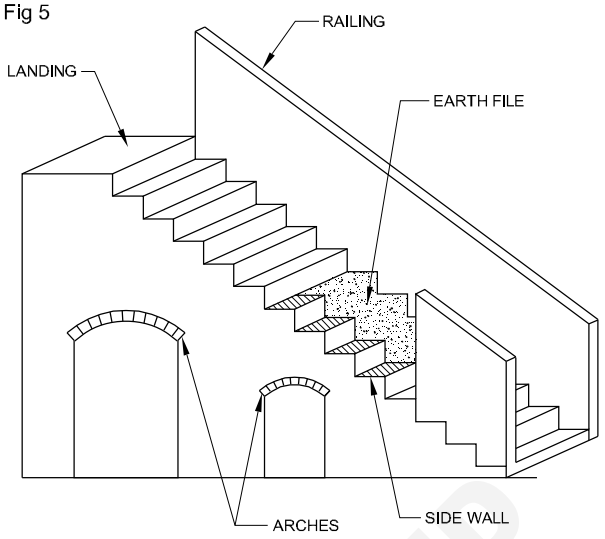
Metal stairs: These are all made up of steel , bronze and cast iron. The both sides may be of closed or open stringers to which steel angles are riveted or welded and metal treads are provided over them.

Reinforced cement concrete stairs: Now a days the most commonly used stairs are R.C.C stairs. This can be constructed both in private and public buildings.

This providers plain soffit.

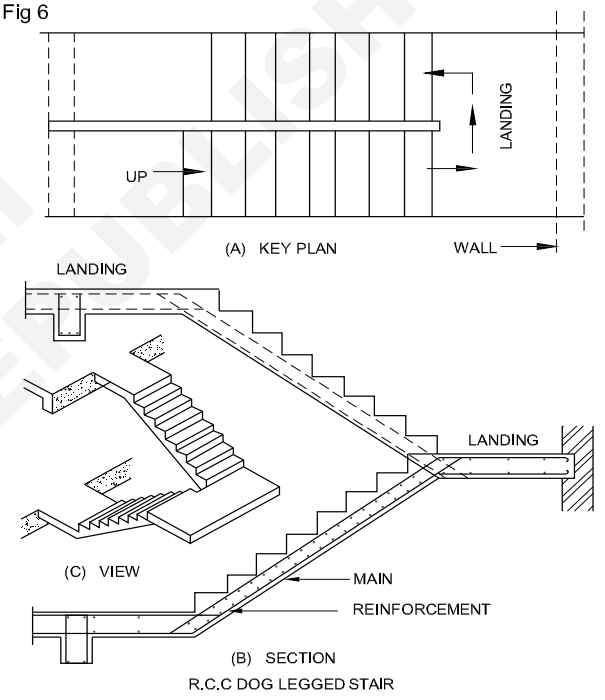
This can easily be moulded to required size and shape. The steel reinforcement arrangements are shown in (Fig6) The surfaces can be finished with terrazzo marble, tile etc.

Fig 5



MASONRY STAIRS

Fig 6



R.C.C DOG LEGGED STAIR

This can easily be maintained cleaned and they are designed to desired strength, durable and pleasing in appearance.

As the reinforced cement concrete stairs are widely used. The (Figs 6&7).

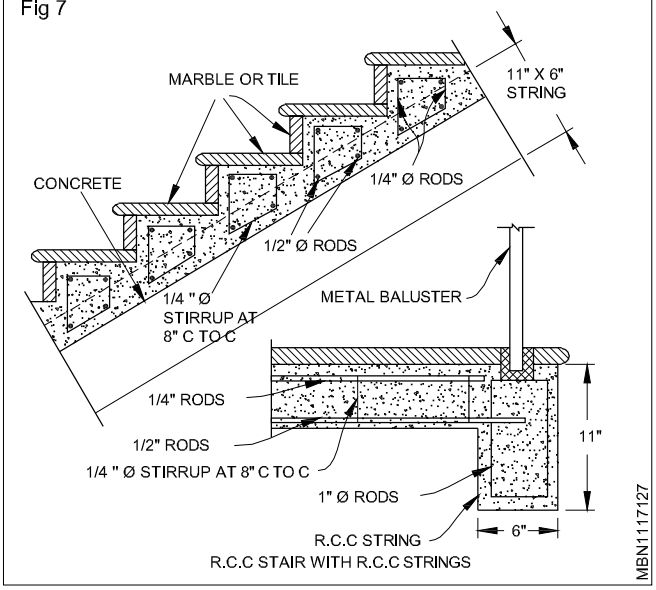
The steps in this type may be RCC or used with bricks commonly residential buildings.

Wooden stair: Timber stairs are light in weight and easy to construct but they are not fire proof. These stairs are used only for small residential buildings.

The timber used for to construct should be well seasoned wood free from fungi decay and insect attack.

Timber stairs are supported by stringers and act as a inclined beams spanning between the floor to floor or floor to landings.

Fig 7



The thickness of steps not less than 40mm (tread) risers are of minimum of 25mm.

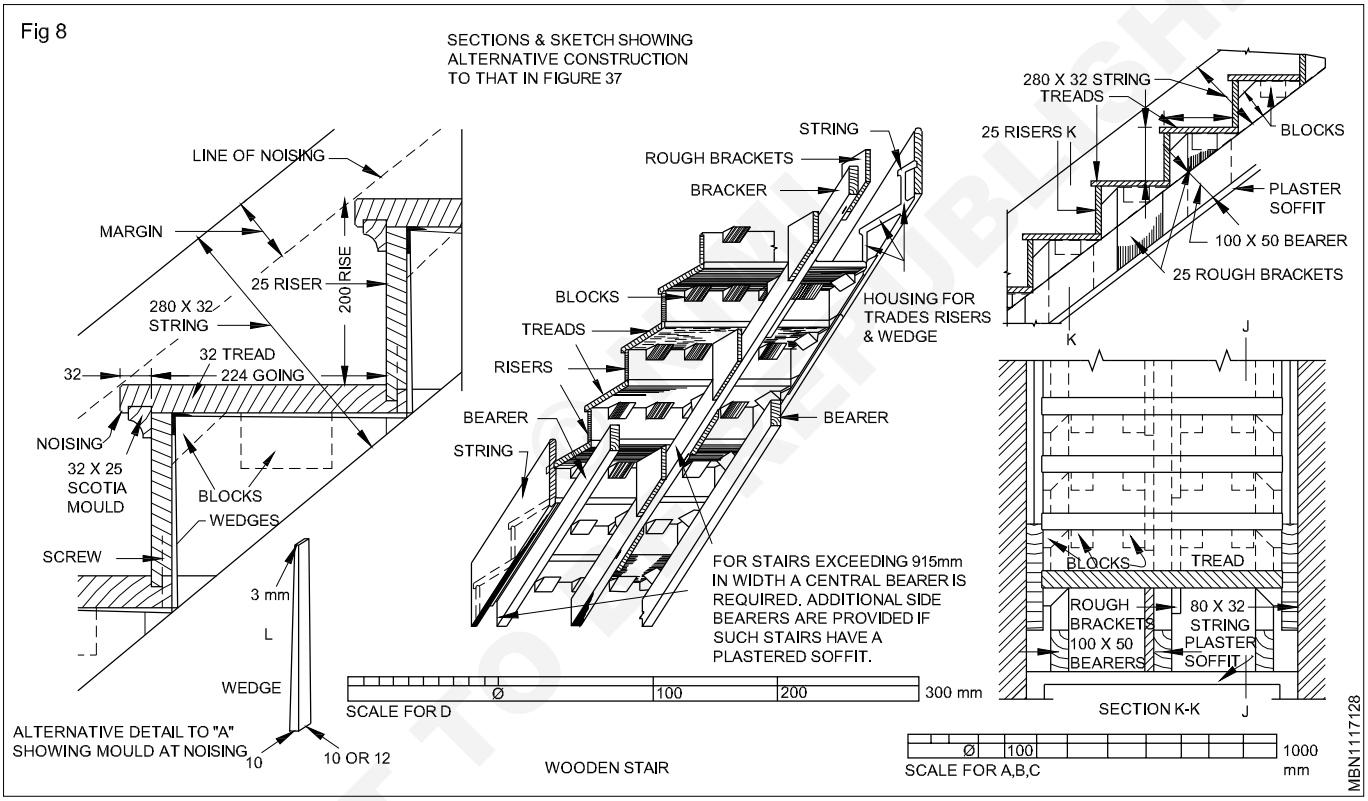
The supporting stringers are of closed or open stringers scotia blocks may be provided to improve the appearance of the steps. The timber stairs may be constructed in all types of stairs (According to shape) These stairs gives a oldage look, more architectural finishings may be done on newel posts, stringers, balusters etc. (Fig 8).

Requirements of good stair:

Location of stair: A stair should be located in buildings in a position to have sufficient light and ventilation, especially in turnings, stair shall be constructed in a position that it can be easily approchable from all parts of the building.

Materials: Good quality of materials and skilled workmanship is required.

Fig 8



Proportion of Going and rise: To avoid tedious ascent and the occupation of excessive space. The following rules must be strictly adhered during construction.

Rule 1: Going in cm + (2 x Rise in cms) = 60cm

Rule 2: Going in cm x (Rise in cm) = 400 to 426cm

Rule 3: Rise in cm + Going in cm = 40 to 45

Rule 4: Rise (14cm) + Going = 30cm as standard.

Rule 5: 2 x risers + 1 x tread = 610 to 650mm

Rule 5: Then, for each 20mm subtracted from the going, add 10mm to the rise Thus, other combinations of rise and going would be,

15cm x 28cm , 16cm x 26 cm

17cm x 24cm

Rule 6:

Maximum rise 23cm

Minimum going 23 cm

in residential builiding

Maximum rise 18cm

Minimum going 27cm for public

Buildings

Generally, the wider the going, the less should be the riser viceversa whatever it may it must be uniform and kept constant. throughout in each flight.

Pitch: The angle of inclination of stair way should be in between 25° to 40°.

Winder: The width of winder at wall is line (45 inner) should be minimum. 45cm. Normally winders should be avoided.

No.of steps: The number of steps should be kept as minimum of 3 to maximum of 12 continuously in a flight.

Nosing: The nosing can be finished with metal in concrete or Brick steps because to avoid wear and tear. In wooden stairs below the nosings, scotias must be provided to the line of nosing should be parallel to the waist slab. (Fig 8).

Stringers: It should made to receive risers and treads, so the stringers should be sufficiently strong and enough in (Fig 8).

Landing : The width of landing should not be lesser than the width of stair.

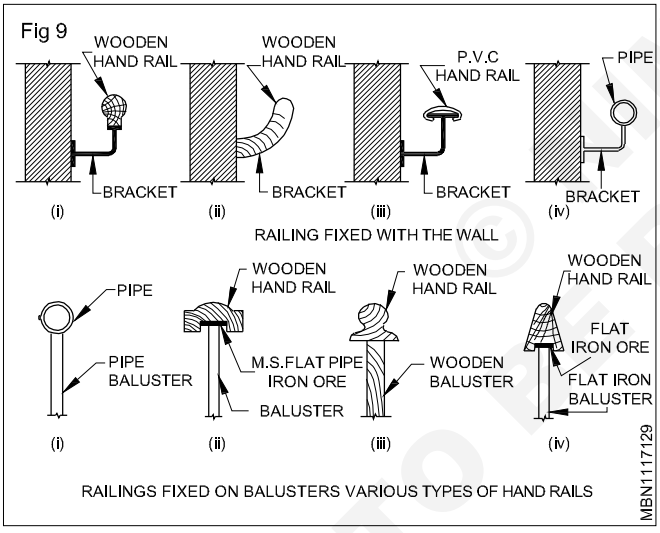
Width of stair: The width of stair should be kept as minimum of 75cm for single storey residential buildings for public buildings it should be minimum 1.50m.

Soffit: It should be finished plain will give aesthetic appearance and helps to keep clean, neat and tidy.

Spandil: This place under soffit may conventiently be designed to use it for an particular use.

Hand rail: It should be of approximately 8cm in ϕ for easy to catch and move on (Fig 9).

Fig 9



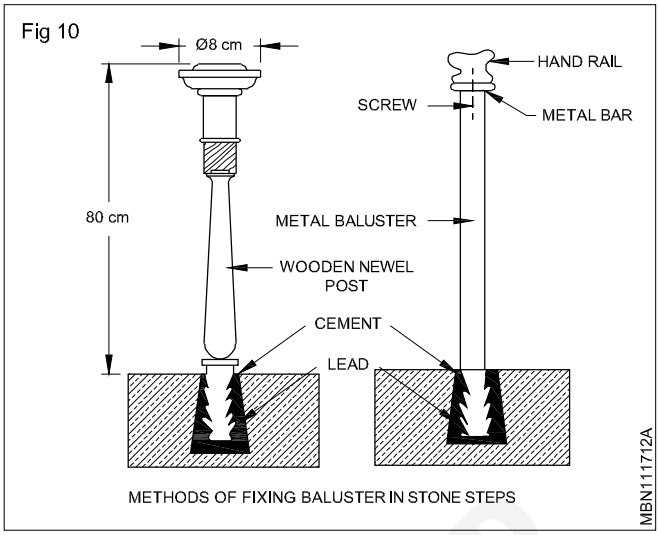
Baluster: The baluster may be used in place of a solid balustrade to enhance sufficient lighting and safety. This should be of approximately 80cm from treads surface. (Fig 10).

Head room: The sufficient height of head room (210cm) may be maintained the terrace from terrace floor level or the landing below. This helps to avoid heading and prevents the building from weathering actions and safety.

Design: The size and shape can be suitably be designed in a manner taking in account of all above requirements of good stair. The fastenings and architectual finishings can also be considered as a greater factor to give a aesthetic appearance of the hall or buildings wherever it located.

Layout of stair cases: The layout of stair cases is influenced by the space available. for the construction of stairs and the height between the two floors.

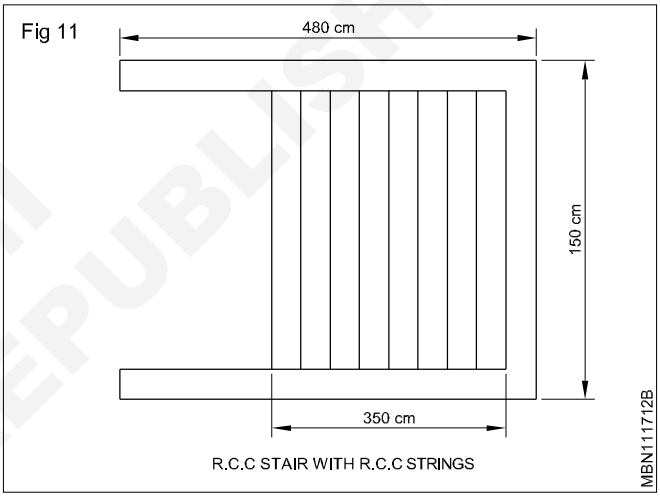
Fig 10



A few examples are worked out below to explain the above.

Problem 1: (Fig 11)

Fig 11



The stair case of a residential building is to located in a stair case measuring 1.8m x 4 If the vertical distance between floors are 3m design and draw the layout plan of the proposed stair.

Assuming a rise of 20 cm

Number of risers required (R) = 300 / 20 = 15

No. of Treads to be provided (T) = R - 1

No. of Treads to be provided so = 15 - 1

= 14 nos.

It is proposed to keep the width of tread as 25cm.

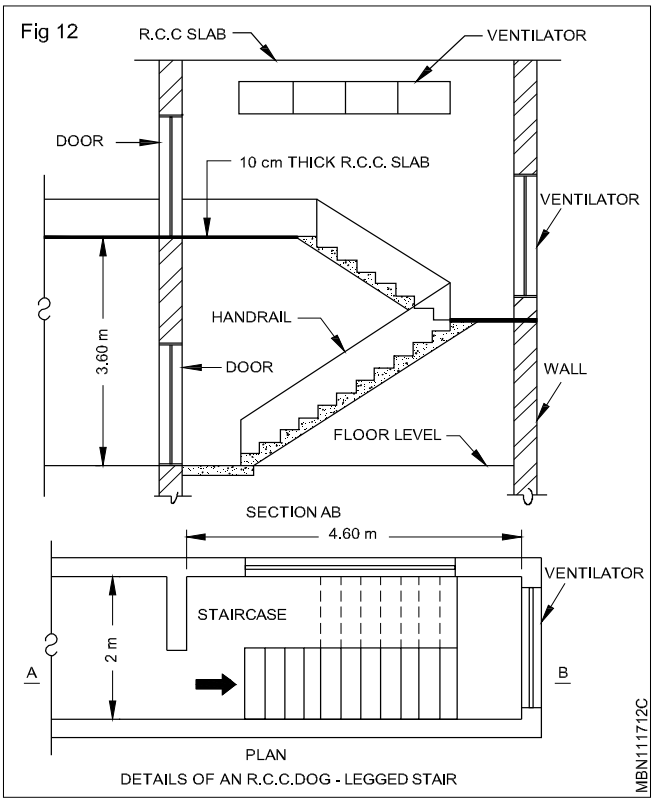
Space occupied by 14 treads

= 25 x 14 = 350 cm

Space left for passage = 480 - 350 = 130 cm

Problem 2: (Fig 12)

The inside dimensions of a stair case in a residential building are 2.00m x 4.60m The height of the floor is 3.60m and the roof consists of RCC slab of 10cm thickness Design a proper layout of an RCC stair of this building.



Solution.

Adopt a dog legged stair

Assume convenient height of riser say 18cm

Then, the number of risers.

$$= \frac{\text{Total height of floor}}{\text{Height of riser}} = \frac{360}{18} = 20 \text{ numbers}$$

In order to provide suitable headroom below landing level, provide 13 risers, in the first flight and 7 risers in the second flight.

Assume a tread of 23cm

Number of treads in the first flight will be 11. (Fig 12)

Problem 3: Plan a dog legged stair for a building in which the vertical distance between the floors is 3.00m the stair case room measures 2m x 6m

Problem 4: Design and Develop the plan and sectional view showing maximum details of a stair room measures 4.25 x 4.25m

Problem 5: Design and develop a stair case in a room of size 4.5 m x 3m the clear room height is 3.36m and draw necessary views to show details.

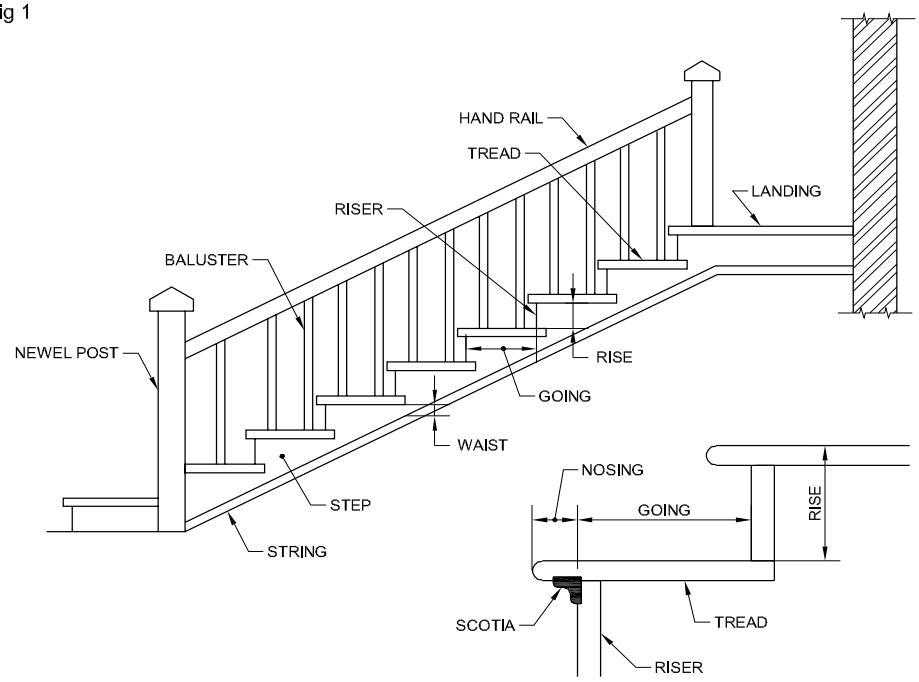
Problem 6: The stair of a residential building to be located in a stair case measuring 1.7m x 6m If the vertical distance between the floors is 3.2m Draw a layout plan of this proposed stair.

Wooden stairs

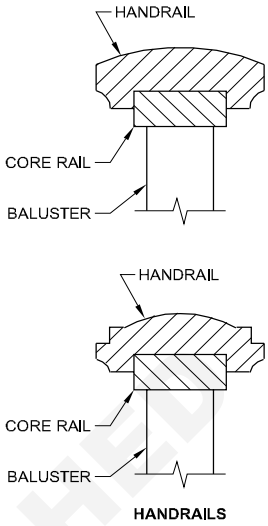
Objectives: At the end of this lesson you shall be able to
- **state the construction details of a stair**
- **state the technical terms used in a stair**
- **state the types and uses of a stair.**

- A stair is a combination of steps leading from one floor to the other floor of a building.
- A stair is provided to afford the means of ascent and descent between the various floors of a building.
- The room or apartment of a building in which the stairs are located is called stair case.
- The opening space occupied by the stair is known as stair way.
- Stair case must be enclosed by fire resisting floors, ceiling and doors.
- Wooden stairs are light in weight and they are easy to construct.
- Wooden stairs are mostly used in residential buildings.
- They are not a fire proof and fire can attract easily.
- The stringers are supporting the ends of the wooden steps.
- The scotia block gives an additional strength and finish to a wooden steps.
- The glue block (triangular in steps) are provided to give more strength to a wooden step. The blocks are used at the inner angle formed between a tread and riser.
- The wooden beams are used at landing space of a wooden stair.
- The timber used in wooden stair construction should be free from all the defects fungi, decay and insect attack.
- **The following technical terms are used in stair case construction (Fig 1)**
- **Step:** A combination of tread and riser. It is a space of stair which permits ascent and descent.
- **Tread:** The horizontal upper portion of a step up on the steps, the foot is placed while ascending and descending
- **Riser:** Their vertical or front member of the step providing a support of the tread.
- **Flight:** The flight is defined as an unbroken series of steps between the landing.
- **Landing:** The horizontal plat from between two flight of a stair is called landing.

Fig 1



TERMS USED IN STAIRS



HANDRAILS

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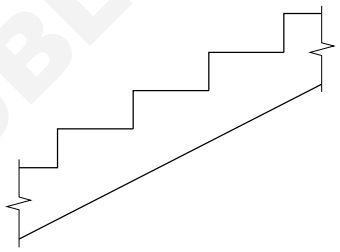
The landing facilities help to change of direction and gives an opportunity to take rest during the use of a stair by a person.

- **Rise:** This is the vertical distance between two successive tread faces.
- **Going:** This is the horizontal distance between the faces of two consecutive risers.
- **Nosing:** The projecting part of the tread beyond the face of the riser. It is usually rounded off in shape.
- **Scotia:** This is an additional finish or moulding provided to the nosing or tread to improve the elevation of the step and to provide strength to the nosing.
- **Soffit (or) plancer:** The under surface of a stair is called soffit. It is generally covered with ceiling or finished with plaster.
- **Pitch:** An angle of inclination of the stair with the floor is called pitch. It also indicates the angle which the line of nosing makes with the horizontal.
- **Strings or Stringers** (Fig 2): The inclined member of a stair which supports the ends of along the slope for the stair.

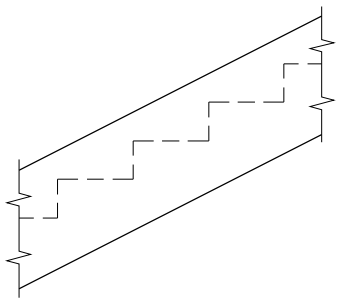
  Strings are in **two** types.

  - cut or open string the upper edge is cut away to receive the ends of the steps.
  - closed or housed strings the end of steps are housed between straight parallel edges of the string.
- **Run:** The total length of a stair in a horizontal plane and it includes the length of landing also.
- **Newel post:** This is the vertical member which is placed at the need of flights to connect the ends of string and hand rails.

Fig 2



CUT OR OPEN STRING



CLOSED OR HOUSED STRING

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- **Hand rail:** The sloped or inclined rail over the string is known as hand rail.

It is generally moulded and some forms of hand rails are shown in (Fig 3).

The serve as a guard rail and it should be provided at a convenient height so as to give grasp to the hand during ascent and descent.

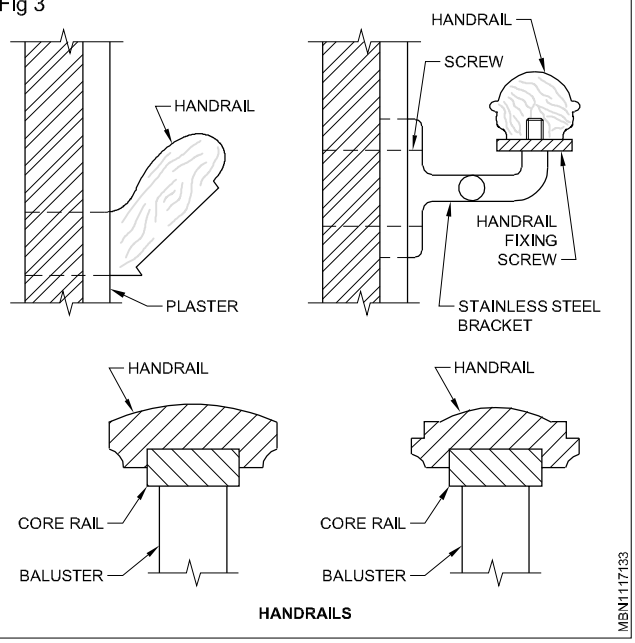
Balustrade

It consist of a row of baluster surmounted the hand rail to provide protection for the users of the stair.

Baluster

This is the vertical member which is fixed between string and hand rail to give support to the hand rail.

Fig 3



Head room

The vertical distance between the tread and over head structure (ceiling).

Header

It is the horizontal structural member supporting stair, stringers or landings.

Types of stairs

- Straight stairs
- Turning stairs
- Circular/helical/spiral stairs
- Geometrical stairs
- Dog legged stairs
- Open newel stairs
- The spiral stairs

Straight stair (Fig 4)

- In straight stairs all the steps lead in one direction between two floors.
- This type of stairs may consist of single flight or more than one flight.
- They are used when the space is available for the stair case in long but narrow in width.

Turning stairs

- In turning stairs the flight or steps take turn in one direction.

Quarter turn stairs (Fig 5)

- This type of stair changes its direction through one right angle. The angle may be either left turn or right turn.
- If a quarter turn stair is branched into two flights at a landing it is called bifurcated stair. (Fig 5)

Fig 4

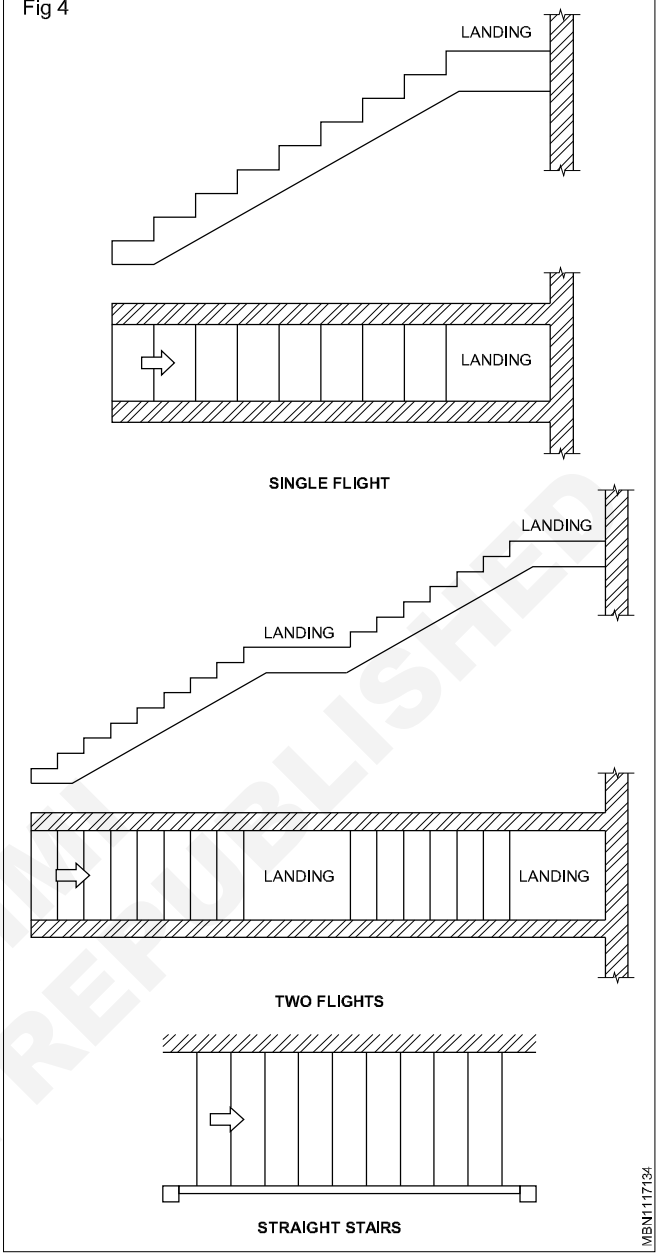
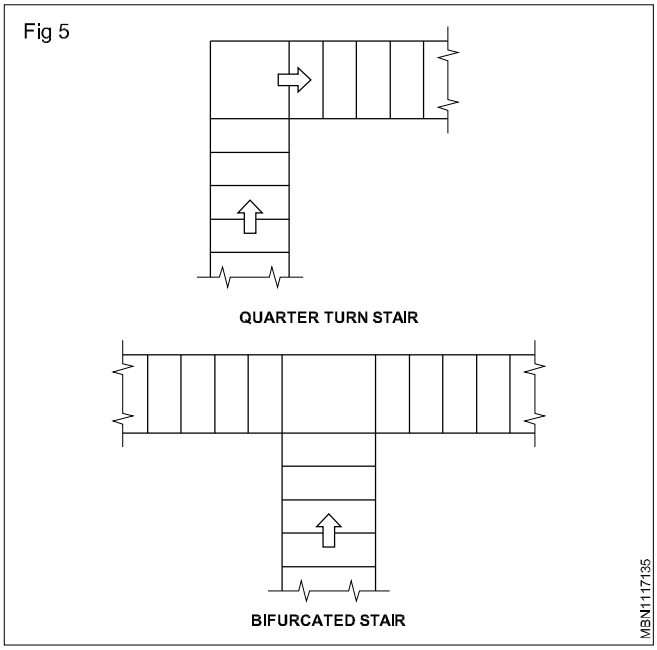


Fig 5



- This types of stair is commonly used in the public building near their entrance hall.
- The stair has a wider flight at the bottom which bifurcates into two flights at the landing one turning to the left and the other to the right.

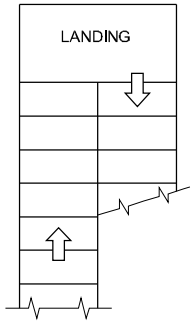
Half turn stairs

- This type of stair is having the running through two right angles.
- The half turn stair may be of ...
  - dog legged type and
  - open newel type.

Dog - legged stair (Fig 6)

- This type is given because of its appearance in the sectional elevation.
- The flights run in opposite directions and there is no space between the outer string of two flights.
- These stair are used where the total width of apace available for the staircase is equal to twice the width of steps.
- The newel post are provided at the beginning and the end of the each flight.

Fig 6



DOG-LEGGED STAIR

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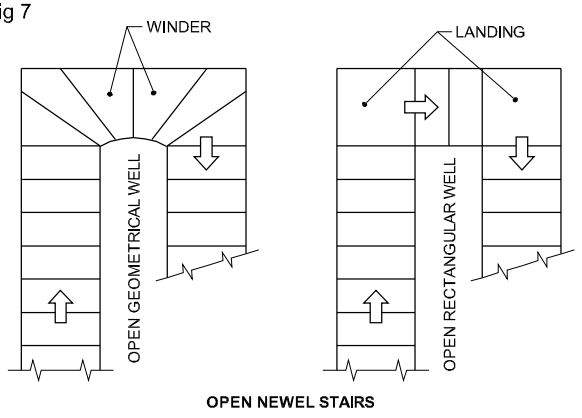
Open newel stair (Fig 7)

- There is a well or opening between the flights. The well may be rectangular or of any Geometrical shape.
- The space of well can be used for fixing the lift.
- These stair can be used where the space is available for staircase has a width more than twice the width of steps.

Three quarter turn stair (Fig 8)

- A stair have a turning through three right angle is called three quarter turn stair.
- These types of stair may be used in newel type or open newel type stairs.
- This type of stair is used where the length of the stair case is limited and when the vertical distance between the two floors is quite large.

Fig 7



OPEN NEWEL STAIRS

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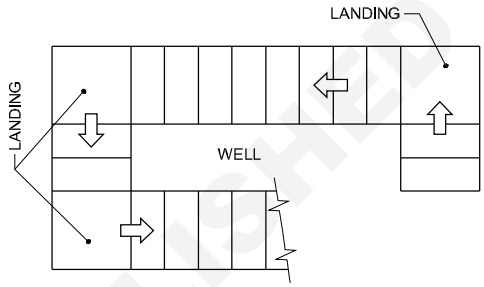
Fig 8



THREE-QUARTER-TURN STAIR

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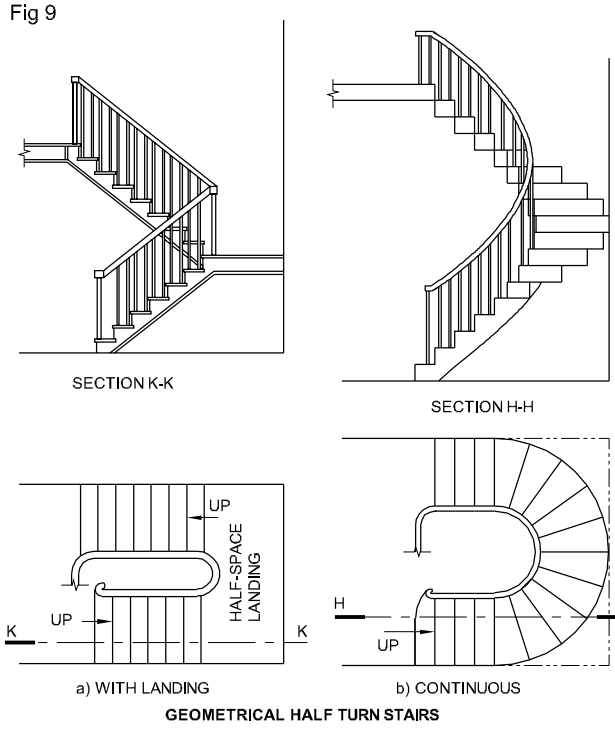
Geometrical stairs (Fig 9)

- The Geometrical stair can have any geometrical shape and they are not required any newel post.
- The hand rail for a geometrical stair continuous without any angular turns.

Fig 9



GEOMETRICAL HALF TURN STAIRS

MBN1117139

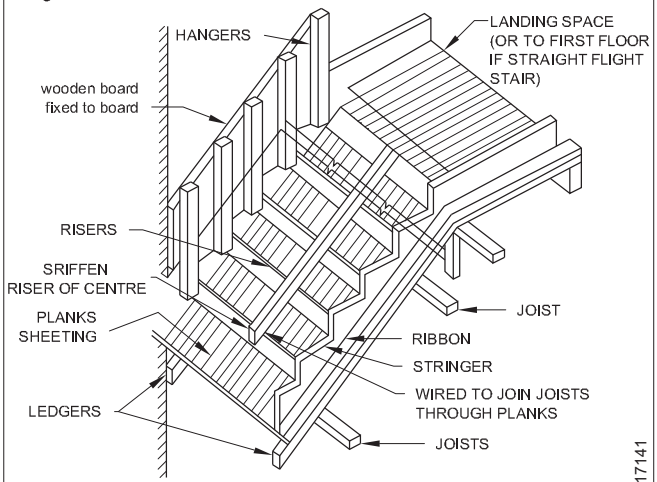
From work for stairs

Objectives: At the end of this lesson you shall be able to
- **state the form work of single straight flight**
- **state the form work of quarter turn stairs.**

From work of single straight flight:

- The form work consists of planks sheeting which are receiving concrete. (Fig 1)

Fig 1



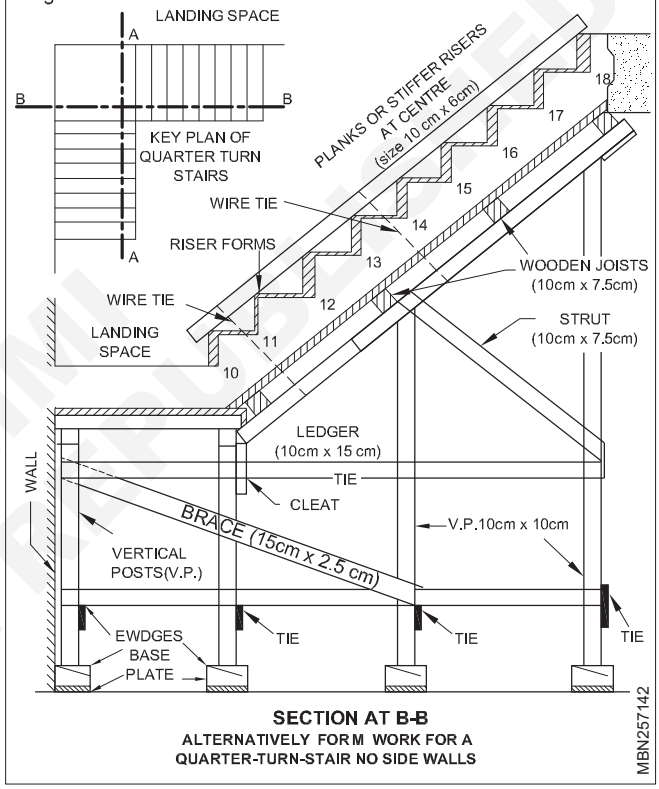
WOODEN FROM WORK FOR A STRAIGHT FLIGHT STAIR

- Stiffen rises to keep risers in position.
- Wooden boards fixed on wall.
- Side and stingers on the open side of stairs.
- The stingers on the open side one latterly supported by ribbon.
- The slopping slab of from work is supposed on ledgers, joints and vertical post.

From work of quarter turn flight (Fig 2)

- In this stair both sides are open, no need the wall supports.
- Stringers are used for lateral confinement.
- The other supports are same as in the form works (single straight flight).
- The stability of stairs form work is depend upon proper design of plants, stringers, joist, vertical post ledgers, braces, ties, base plate and wedges by consider the imposed load.
- The imposed loads transfer from one element to other.

Fig 2



SECTION AT B-B
ALTERNATIVELY FORM WORK FOR A QUARTER-TURN-STAIR NO SIDE WALLS