TOOL AND DIE MAKER
(Dies & Moulds)

(Common for Press Tools, Jigs and Fixtures)

NSQF LEVEL - 4

1st Year

TRADE PRACTICAL

Sector : CAPITAL GOODS AND MANUFACTURING

(As per revised syllabus July 2022 - 1200 Hrs)

कौशलं बलम्
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 : Capital Goods & Manufacturing

Duration : 2 Years

Trades : Tool & Die Maker (Dies & Moulds) - 1st Year - Trade Practical - NSQF level- 4 (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 Media Development Committee members of 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 **Tool & Die Maker (Dies & Moulds) - Trade Practical - NSQF Level - 4 (Revised 2022) in Capital Goods And Manufacturing Sector** under Yearly Pattern**.** The NSQF Level - 4 (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 - 4 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 (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/Directorate General of Training
Ministry of Skill Development & Entrepreneurship
Government of India.

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 syllabus 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.

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 Practical)** for the trade of **Tool & Die Maker (Dies & Moulds)** under the **Capital Goods And Manufacturing** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

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Shri. Nirmalya Nath	-	Deputy Director, NIMI- Chennai - 32.
Shri. V. GopalaKrishnan	-	Manager, NIMI - Chennai -32.

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 intented to be used in workshop . It consists of a series of practical exercises to be completed by the trainees during the course of the **Tool & Die Maker (Dies & Moulds)** 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 - 4.

The manual is divided into Six modules.

Module 1	**-**	**Safety**
Module 2	**-**	**Fitting**
Module 3	**-**	**Turning**
Module 4	**-**	**Milling**
Module 5	**-**	**Grinding**
Module 6	**-**	**Auto CAD & Pro - E**

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 **Tool & Die Maker (Dies & Moulds)** Trade Practical NSQF Level - 4 in Capital Goods and Manufacturing. The contents are sequenced according to the practical exercise contained in NSQF LEVEL - 4 syllabus on Trade Theory attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation 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	Refer Ex:No
1	**Plan and organize the work to make job as per specification applying different types of basic fitting operation and check for dimensional accuracy following safety precautions. [Basic fitting operation – Filing, Marking, Hack sawing, Drilling, Taping, chipping and Grinding etc. Accuracy: ± 0.1mm]**	**1.1.01 - 1.2.27**
2	**Make different fit of components for assembling as per required tolerance observing principle of interchangeability and check for functionality. [Different Fit –Open, Angular, & Square Fit; Required tolerance: ±0.05 mm, angular tolerance: 1 degree.]**	**1.2.28 - 1.3.30**
3	**Set different shaped jobs on different chuck and demonstrate conventional lathe machine operation observing standard operation practice. [Different chucks:3 jaws & 4 jaws, different shaped jobs: round, square, hexagonal]**	**1.2.31 - 1.3.33**

Sl.No.	Learning /Outcome	Refer Ex:No
4	Prepare different cutting tool to produce jobs to appropriate accuracy by performing different turning operations. Different cutting tool – V tool, side cutting, parting, thread cutting (both LH & RH),Appropriate accuracy: ±0.06mm, Different turning operation – Plain, facing, drilling, boring (counter & stepped), grooving, Parallel Turning, Step Turning, parting, chamfering, U -cut, Reaming, internal recess, knurling.	1.3.34 - 1.3.43
5	Set the different machining parameters to produce threaded components applying method/ technique and test for proper assembly of the components with an accuracy of ± 0.05 mm. [Different threads viz., metric/ BSW/ Square]	1.3.44 - 1.3.45
6	Set the different machining parameters and cutters to prepare job by performing different milling operation and indexing. [Different machining parameters – feed, speed and depth of cut. Different milling operations – plain, stepped, angular, dovetail, T-slot, contour, gear milling]	1.3.46 - 1.4.62
7	Produce components of high accuracy by surface grinding operation. [Accuracy of +/- 0.02 mm]	1.4.63 - 1.5.72
8	Produce components of high accuracy by cylindrical grinding operations. [Accuracy of +/- 0.02mm.]	1.5.73 - 1.5.77
9	Sharpen different cutter or multipoint cutting tool. [Different cutters – end mill cutter, side & face milling cutter, single angle cutter, Reamer]	1.5.78 - 79
10	Develop isometric drawing and solid modelling of mould using CAD & Pro-E.	1.6.80 - 1.6.83

SYLLABUS

Duration	Reference Learning outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
Professional Skill 138 Hrs.; Professional Knowledge 40 Hrs.	Plan and organize the work to make job as per specification applying different types of basic fitting operation and check for dimensional accuracy following safety precautions. [Basic fitting operation – Filing, Marking, Hack sawing, Drilling, Taping, chipping and Grinding etc. Accuracy: ± 0.1mm]. NOS:CSC/N0308 Make different fit of components for assembling as per required tolerance observing principle of interchange	1. Introduction of trade skill and work application. (02hrs.) 2. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). (02hrs.) 3. First Aid Method and basic training. (02hrs.) 4. Safe disposal of waste materials like cotton waste, metal chips/ burrs etc. (01hrs.) 5. Hazard identification and avoidance. (02hrs.) 6. Identification of safety signs for Danger, Warning, caution & personal safety message. (01 hr.) 7. Preventive measures for electrical accidents & steps to be taken in such accidents. (02hrs.) 8. Use of Fire extinguishers. (05hrs.) 9. Practice and understand precautions to be followed while working in fitting jobs. (02 hrs.) 10. Importance of trade training, List of tools & Machinery used in the trade. (01 hr.) 11. Safe use of tools and equipments used in the trade. (01 hr.) 12. Knowing games and memory training. (10 hrs.) 13. Motivational talk by experts. (02hrs.) 14. 5S training. (02 hrs.)	All necessary guidance to be provided to the newcomers to become familiar with the working of Industrial Training Institute system including store's procedures. Safe working practices. Soft Skills, its importance and Job area after completion of training.Importance of safety and general precautions observed in the industryshop floor. Introduction of First aid. Operation of electrical mains and electrical safety. Introduction of PPEs. Response to emergencies e.g. power failure, fire, and system failure.mportance of housekeeping & good shop floor practices. Introduction to 5S concept& its application.Occupational Safety &Health:Health, Safety and Environment guidelines, legislations & regulations as applicable. (08 hrs)
		15. Identification of tools &equipments as per desired specifications for filing and marking, visual inspection of raw material for rusting, scaling, corrosion etc. (03 hrs.) 16. Familiarisation of bench vice. (01hr.) 17. Filing- files different sector and measure with steel rule. (25 hrs.)	Bench work – Metal working hand tools and devices –Work bench – vices – files – hacksaw – hammer – spanners – screw drivers. Linear measurements- its units, steel rule dividers, Punch – types and uses. Description use and care of marking table. (05 Hrs.)

		18. Mark with scriber and steel rule. (01 hr) 19. Measuring practice with steel rule, outside & inside callipers. (06 hrs.)	
		20. Dot punching and letter and number punching. (05 hrs.)	Vernier calliper – its parts, principles, reading, uses and care. Outside micrometer – its parts, principles, reading, uses and care, vernier height gauge. Marking tools – scriber.Marking out – Coordinates system, Rectangular – Polar –Rules for marking. Bevel protractor, combination set- their components, uses and cares. Pedestal grinder, star wheel dresser, safety precautions, care and maintenance. (12 Hrs.)
		21. Grinding, centre punch, dot punch, flat chisel and scriber. (10hrs.) 22. Drill grinding practice. (10hrs.)	Marking media, special application. Surface plate and auxiliary marking equipment, 'V' block, angle plates,parallel block, description, types, uses, accuracy, care and maintenance.Drill, Tap, Die-types & application. Determination of tap drill size.Reamer- material, types (Hand and machine reamer), parts and their uses, determining hole size for reaming, Reaming procedure. Drilling machines-types and their application, construction of Pillar & Radial drilling machine. Countersunk, counter bore and spotfacing tools and nomenclature.Cutting Speed, feed, depth of cut and Drilling time calculations. (05Hrs.)
		23. Drill Plate filing to an accuracy of ±0.05mm. (10 hrs.) 24. Marking for centre punching, drilling, reaming, tapping, counter boring, counter sinking. (02 hrs.) 25. Centre punching, drilling, reaming, tapping, counter boring, counter sinking on drill plate. (12hrs.) 26. Die pass on standard material (M8). (08 hrs.) 27. Cutting tool filing and grinding on standard material. (10 hrs.)	Dial test indicator-its parts, types, construction and uses.Interchangeability: Necessityin Engineering. field, LimitˆDefinition, types,terminology of limits and fits-basic size, actualsize, deviation, high and low limit, zero-line, tolerance zone, allowances. Different standard systems of fits and limits. Geometrical tolerance. British standard system, BIS system. (10Hrs.)

Professional Skill 110 Hrs.; Professional Knowledge 20 Hrs.	Marking different of components for assembling as per required tolerance observing principle of interchange ability and check for functionality. [Different Fit – Open, Angular, & Square Fit; Required tolerance: ±0.05 mm, angular tolerance: 1 degree.] NOS:CSC/N0309	28. Make Male & Female 'Open' fitting with accuracy ±0.05 mm. (25 hrs.)	Introduction about metals, difference between Metal and Non-Metal, properties of metal, Classification of metals and its applications, pig – iron, cast iron, wrought iron, steel-plain carbon steel (Low carbon steel, medium and high carbon steels, high speed steel, stainless steel, carbides, etc.) (04 Hrs.)
		29. Make male & female for square fit with accuracy ± 0.05 mm. (30hrs.)	Heat treatment of metals, process-such as annealing, nit riding, hardening, tempering, case hardening, carburizing,cyaniding, flame hardening, Induction hardening, purposes and its effects on the properties of steel. (08 Hrs.) Getting to know the lathe with its main components, lever positions and various lubrication points as well. Definition of machine & machine tool and its classification. (08 Hrs.)
		30. Angular fitting with male & female. (30 hrs.)- Assembly fit with male & female by dowelling and screwing. (25 hrs.)	Getting to know the lathe with its main components, lever positions and various lubrication points as well.Definition of machine & machine tool and its classification. (08 Hrs.)
Professional Skill 32 Hrs.; Professional Knowledge 07 Hrs.	Set different shaped jobs on different chuck and demonstrate conventional lathe machine operation observing standard operation practice. [Different chucks:3 jaws & 4 jaws, different shaped jobs: round, square, hexagonal] NOS:CSC/N0316	31. Identify & function of different parts of lathe. Practice on operation of lathe (dry/idle run). (10 hrs.) 32. Setting lathe on different speed and feed. (02 hrs.) 33. Profile turning using hand tools-radius external and internal. (20hrs.)	Introduction to lathe. Centre lathe construction, detail function of parts, specification. Safety points to be observed while working on a lathe. (07 Hrs.)
Professional Skill 95 Hrs.; Professional Knowledge 21 Hrs.	Prepare different cutting tool to produce jobs to appropriate accuracy by performing different turning operations.[Different cutting tool – V tool, side cutting, parting,	34. Grinding of R.H. and L.H. tools, parting tool, Round nose tool. (05hrs.) 35. Checking of angles with angle gauge / bevel protractor. (02 hrs.) 36. Grinding of "V" tools for threading of Metric/ British threads. (04hrs.)	Different types of Lathe operations - facing, turning, parting-off, grooving, chamfering, boring etc.Lathe cutting tool-different types, shapes and different angles (clearance, rake etc.), specification of lathe tools. Types of chips, chip breaker.Tool life,

	thread cutting (both LH & RH), Appropriate accuracy: ±0.06mm, Different turning operation –Plain, facing, drilling, boring (counter & stepped), grooving, Parallel Turning Step Turning, parting, chamfering, U -cut, Reaming, internal recess, knurling.] NOS:CSC/N0316	37. Plain turning (holding in 4 –jaw chuck), step turning and forming shoulder, chamfering in between centres as per dimensions. (28hrs.) 38. Pillar turning between centres (07 hrs.)	factors affecting tool life. (10 Hrs.)
		39. Bush turning, drilling and boring/ reaming. (14 hrs.) 40.Turning and die passing in a standard material. (03 hrs.) 41. Pin punch turning and knurling (05 hrs.) 42. Using 4 – jaw chuck; face both side of a plate thickness as per drawing. (02 hrs.)	Driving mechanism, speed and feed mechanism of Lathe. Concept of Orthogonal and Oblique Cutting.Chucks & different types of job holding devices on lathe and advantages of each type. Mounting and dismounting of chucks.Knurling-types, grade & its necessity.Vernier Bevel Protractor – parts, reading and uses. (04 Hrs.)
		43. Taper turning male and female work pieces and assembly. (25hrs.)	Various material for single point cutting tools, tip tools- their brazing and grinding process. (07 Hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 05Hrs.	Set the different machining parameters to produce threaded components applying method/ technique and test for proper assembly of the components with an accuracy of ± 0.05 mm. [Different threads viz., metric/ BSW/ Square] NOS:CSC/N0316	44. External thread cutting on step turned work piece. (Metric, BSW & Square Thread) (15hrs.) 45. Turn job for Internal thread and cut internal thread (10 hrs.).	Calculations of taper turning by off-setting tail stock. Sine Bar – description & uses Slip gauge –description and uses. (05 Hrs.)
(Professional Skill 128 Hrs.; Professional Knowledge 18 Hrs.)	Set the different machining parameters and cutters to prepare job by performing different milling operation and indexing. [Different machining parameters – feed, speed and depth of cut. Different milling operations – plain, stepped, angular, dovetail, T-slot, contour,	46. Identification of milling machine. (02 hrs.) 47. Demonstrate working principle of Milling Machine. (02 hrs.) 48. Set vice & job on the table of Milling Machine. (03 hrs.) 49. Set arbor on the spindle of milling machine. (04 hrs.) 50. Set the cutter on arbor. (02hrs.) 51. Safety points to be observed while working on a milling machine. (02 hrs.)	Milling Machine: importance, types, construction and specification. Driving and feed mechanism of Milling Machine Different milling cutter angles, Milling cutter materials. (05 Hrs.)

	gear milling] NOS:CSC/N0316	52. Demonstrate Up Milling and Down Milling Process. (04 hrs.) 53. Perform sequence of milling for six faces of a solid block 2 numbers. (13 hrs.) 54. Check the accuracy with the help of tri-square and vernier height gauge. (02 hrs.) 55. Perform Step milling using side and face cutter checking with depth micrometer. (05 hrs.)	Job holding devices-vice, clamps, V-block, parallel block etc. Milling cutter holding devices, milling process – Up milling and Down milling. (02 Hrs.)
		56. Milling blank piece (plain milling). (10 hrs.) 57. Slot milling with side and face cutter (08 hrs.) 58. 90° angular milling with equal angle cutter. (08 hrs.) 59. Dove tail milling. (09 hrs.) 60. Tee slot milling. (08 hrs.)	Calculation of cutting speed, feed, machining time for milling machine. Milling machine operations. Milling machine attachments – vertical milling attachment, (03 Hrs.)
		61. Concave and Convex milling. (16hrs.)	Introduction to coolant & lubricant-difference between them, types and uses of each. (03 Hrs.)
		62. Simple indexing practice (30hrs.)	Dividing head – Introduction, construction, types. Simple and universal dividing head. Indexing methods – direct indexing, simple indexing, angular indexing, its calculations. (05 Hrs.)
Professional Skill 108 Hrs.; Professional Knowledge 09 Hrs.	Produce components of high accuracy by surface grinding operation. [Accuracy of +/- 0.02 mm] NOS:CSC/N0316	63. Identification of different types of grinding machine. (02 hrs.) 64. Wheel balancing & truing. (06hrs.) 65. Dressing of grinding wheel. (02hrs.) 66. Grinding of block (six sides) in surface grinding machine with an accuracy of ±0.01 mm. (15 hrs.) 67. Grinding of step block in surface grinding machine with an accuracy of ± 0.01 mm. (15 hrs.) 68. Grinding of slot block in surface grinding machine with an accuracy of ± 0.01 mm. (15 hrs.) 69. Set and perform angular grinding using sine plate to stranded angle. (18 hrs.) 70. Make slide fit (male/female) (12hrs.) 71. Perform form grinding. (08 hrs.)	Grinding machine introduction, types, Surface & Cylindrical grinding Machine- their parts, functions, specification, and uses. Safety points to be observed while working on a Grinding machine. (05 Hrs.)

		72. Taper angle grinding fitting. (15hrs.)	Grinding wheel shapes and sizes. Standard marking system. Selection of grinding wheel. (04 Hrs.)
Professional Skill 66 Hrs.; Professional Knowledge 08 Hrs	Produce components of high accuracy by cylindrical grinding operations. [Accuracy of +/- 0.02mm.] NOS:CSC/N0316	**Cylindrical grinding:** 73. External Parallel grinding (Bothholding in chuck/ collet and in between centres. (17 hrs.) 74. Plunge grinding. (04 hrs.)	Procedure for mounting of grinding wheels, balancing of grinding wheels. Dressing, types of dresser. Glazing and Loading of wheels – its Causes and remedies. Roughness values and their symbols. Explain the importance and necessity of quality. (04 Hrs).
		Cylindrical grinding: 75. Internal Parallel grinding (Both holding in chuck/collet). (20 hrs.)	Abrasives - its types, Bond, Grade, Grit, structure. (04 Hrs.)
		76. Grinding of step in Cylindrical grinding machine with an accuracy of ±0.01 mm (15 hrs.) 77. Grinding of external taper in Cylindrical grinding machine with an accuracy of ± 0.01 mm. (10hrs.)	
Professional Skill 30 Hrs.; Professional Knowledge 04 Hrs.	Sharpen different cutter or multipoint cutting tool. [Different cutters – end mill cutter, side & face milling cutter, single angle cutter, Reamer] NOS:CSC/N0316	78. Demonstrate and practice of grinding of end mill cutter of different sizes by using tool & cutter grinding machine. (30 hrs.)	Tool & cutter grinderˆconstruction, use and specification. (04 Hrs.)
Professional Skill 108 Hrs.; Professional Knowledge 28 Hrs.	Develop isometric drawing and solid modelling of mould using CAD & Pro-E. NOS:CSC/N9492	79. Prepare simple mould design drawings with basics of AutoCAD viz., Basic and advanced 2D drafting, draw commands, Constraints, Modify commands, Layers, Line types block, Texts, Attribute, Table, Dimensioning, Isometric, Solid modelling, View port. (58 hrs.)	AutoCAD: Introduction to AutoCAD, creating first drawing, learning the tools trade, organizing the work, drawing the first mould. (14 Hrs.))
		80. Prepare solid modelling of simple mould with Pro-E [Sketch, Part (solid, surface, free style, flexible modelling, sheet metal.), Assembly, Creo direct, Creo simulate]. (25 hrs.) 81. Creating (NC assembly and mould cavity) drawing. (10 hrs.) 82. Part drawing of the universal coupling assembled all the parts and solid modelling and denoted by coloured combination. (15hrs.)	Pro-E: Familiarization of interface/ Windows, Sketching, basic modeling, advanced modeling, assembling, drawing, surface modeling, manufacturing – mould design awareness. (14Hrs.)

Introduction to trade skill and work application

Objectives: At the end of this exercise you shall be able to
- **state who is implementing the vocational training in India**
- **list the role of the tool and die maker in an industries.**

General

The Directorate General of Training (DGT) under Ministry of Skill Development Entrepreneurship offers a range of vocational training courses catering to the need of different sectors of economy/ Labour market. The vocational training programmes are delivered under the aegis of Directorate General of Training (DGT). Craftsman Training Scheme (CTS) with variants and Apprenticeship Training Scheme (ATS) are two pioneer schemes of DGT for strengthening vocational training.

Tool & Die Maker (Press Tools and Jigs & Fixtures) and TOOL & DIE MAKER (Dies & Moulds):

Trades under CTS is one of the popular courses delivered nationwide through network of ITIs. The course is of two years duration. It mainly consists of Domain area and Core area. In the Domain area (Trade Theory & Practical) impart professional skills and knowledge, while Core area (Workshop Calculation and Science, Engineering Drawing and Employability Skills) impart requisite core skill & knowledge and life skills. After passing out the training programme, the trainee is awarded National Trade Certificate(NTC) by DGT which is recognized worldwide.

Tool & Die Maker broadly need to demonstrate that they are able to:

- Read & interpret technical parameters/documentation, plan and organize work processes, identify necessary materials and tools;
- Perform task with due consideration to safety rules, accident prevention regulations and environmental protection stipulations;
- Apply professional knowledge, core skills & employability skills while performing the job of a Tool & Die Maker (press Tools and jigs & Fixtures) and machining work.
- Check the job/components as per drawing for functioning identify and rectify errors in job/ components.
- Document the technical parameters related to the task undertaken

Tool & Die Maker (Press Tools, Jigs & Fixtures)

Tool and Die Makers build, repair and modify custom made prototypes or special tools, press tools, jigs, Fixtures and various types of mechanical devices. Press tools are metal forms used for sheet metal cutting and forming. Tool and Die makers fabricate various parts, like pieces of a puzzle, which require perfect fitting. While this occupation is closely allied with the machinist trade and encompasses many of the same skills, Tool and Die Makers usually specialize in jobs spending more time in fitting and assembling precision components which are required for sheet metal cutting forms. A Tool and Die maker's work depends on precise measurements and accuracy, as such math skills are important. Also, they must be able to read and interpret information from design drawing and specifications to fabricate all types of press Tools Jigs and Fixtures. Being mechanical minded is an additional skill. Plan and organize assigned work; and detect and resolve issues during execution. Demonstrate possible solutions and agree tasks within the team. Communicate with required clarity and understand technical English, sensitive to environment, self-learning and productivity.

The trainee after completion of this course may be designated as Tool & Die Maker (Press Tools, Jigs & Figs & Fixtures) according to nature of work done.

Reference NCO-2015

Tool & Die maker (Dies & Moulds)

Tool and Die Makers build, repair and modify custom made prototypes or special tools, Dies, Moulds, Die casting Moulds and various types of mechanical devices. Dies and moulds are metal forms used for moulding plastics or other moulding material. Tool and Die Makers fabricate various parts, Like pieces of a puzzle, which require perfect fitting. While this occupation is closely allied with the machinist trade and encompasses many of the same skills, Tool and Die Makers usually specialize in jobs spending more time in fitting and assembling precision components which are required for plastic injection moulds and die cast moulds. A Tool and Die maker's work depends up on precise measurements and accuracy, as such math skills are important. Also, they must be able to read and interpret information from design drawings and specifications to fabricate all types of Dies and Moulds. Being mechanical minded is an additional skill.

Plan and organize assigned work and detect & resolve issues during execution. Demonstrate possible solutions and agree tasks within the team. Communicate with required clarity and understand technical English, Sensitive to environment, self-learning and productivity.

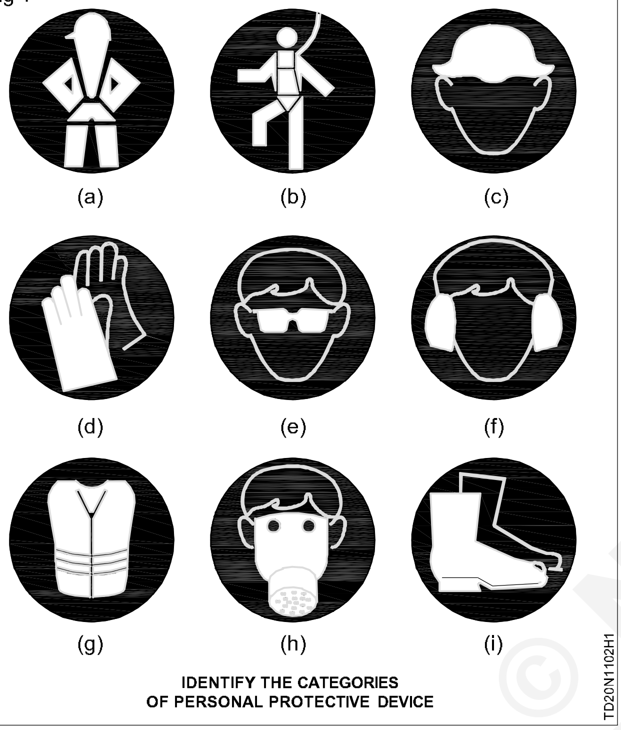
The trainee after completion of this course may be designated as Tool & Die Maker (Dies & Moulds) according to nature of work done.

Reference NCO-2015: 7222.0500

Safety attitude development

Objectives: At the end of this exercise you shall be able to
- **identify and interpret the different types of personal protective equipment**
- **wear all the personal protective equipment correctly**
- **record the meanings of safety sign.**

Fig 1



IDENTIFY THE CATEGORIES OF PERSONAL PROTECTIVE DEVICE

Job Sequence

The instructor may provide or arrange different types of personal protective equipments or chart and explain how to identify and select the PPE suitable for the work and ask the trainees to write names in the given Table 1.

- Read and interpret the personal protection equipment by visually on real or from the charts. (Fig 1)
- Identify and select the personal protection equipment used for suitable type of protection.
- Practice on wearing all the PPE.
- Write the name of the PPE to the corresponding type of protection in Table 1.

Table 1

S. No.	Name of the PPE	Hazards	Type of protection
1			
2			
3			
4			
5			
6			
7			
8			
9			

First aid method and basic training

Objectives: At the end of this exercise, you shall be able to
- **provide first aid for chocking, wound, burn, bites and sting on human.**
- **take care a person with, eye injury, nose bleeding, diabetes, heat exhaustion by first aid treatment**
- **give first aid treatment to person with heat stroke.**

Job Sequence

TASK 1: **Chocking**

1 Severe choking: back blows and abdominal thrusts as shown in Fig 1.

2 Stand behind them and slightly to one side. Support their chest with 1 hand. ...

3 Give up to 5 sharp blows between their shoulder blades with the heel of your hand. ...

4 Check if the blockage has cleared.

5 If not, give up to 5 abdominal thrusts.

Fig 1

CHOCKING

— — — — — — — — — —

TASK 2: **Wound (Fig 2 to 3)**

1 The first step in care of a wound is to stop the bleeding.

2 Locate the source of the bleeding.

3 Wash your hands and, when possible, wear gloves or use a barrier between you and the wound.

4 Remove any loose debris.

5 Apply direct pressure on wound (FIg 1)

Fig 1

6 Dress the wound with cotton bandage (Fig 2)

Fig 2

— — — — — — — — — —

TASK 3: **Burns (Fig 1 to 3)**

Treating minor burns

1 Cool the burn.

2 Remove rings or other tight items from the burned area.

3 Don't break blisters.

4 Apply lotion.

5 Bandage the burn.

6 If needed, take a nonprescription pain reliever, such as ibuprofen (Advil, Motrin IB, others), naproxen sodium (Aleve) or acetaminophen (Tylenol, others).

Fig 1

Fig 2

Fig 3

— — — — — — — — —

TASK 4: **Bites and Stings (Fig 1 to 3)**

1 Stop the wound from bleeding by applying direct pressure with a clean, dry cloth.

2 Wash the wound. ...

3 Apply an antibacterial ointment to the wound. ...

4 Put on a dry, sterile bandage.

5 If the bite is on the neck, head, face, hand, fingers, or feet, call Doctor right away

Fig 1

Fig 2

Fig 3

— — — — — — — —

TASK 5: **Eye injury (Fig 1 & 2)**

1 Ask patient to look up.

2 Draw lower eyelid down. If object visible, remove with corner of moist cloth.

3 If not visible, pull upper lid down.

Fig 1

4 If unsuccessful, wash eye with sterile saline or clean water.

5 If still unsuccessful, cover injured eye only and seek medical aid.

Fig 2

— — — — — — — —

TASK 6: **Nose Bleedings (Fig 1 & 2)**

1 Make a patient to sit straight and bend forward the head portion only(This will reduce blood pressure in the Veins of your nose)

2 Ask the patient to breathe out from the nose.

3 Pinch the nose to take out the blood in the nose.

Fig 1

NOSE BLEED

TD20N1103U1

4 To prevent re-bleeding, don't pick or blow your nose and don't bend down for several hours.

5 If re-bleeding occurs, go through these steps again.

Fig 2

TD20N1103U2

— — — — — — — —

TASK 7: **Diabetes (Low blood sugar) (Fig 1 & 2)**

1 Follow the basic first aid plan to assess the casualty.

2 Give high-energy foods or sugar.

3 Only give food if the casualty is conscious.

Fig 1

4 If medical aid is delayed give sugar every 15 minutes.

5 The casualty will recover quickly if low blood sugar level is the cause.

Fig 2

— — — — — — — —

TASK 8: **Heat Exhaustion (Fig 1 to 2)**

Fig 1

Fig 2

Heat Exhaustion

1 Rest in a cool place. Getting into an air-conditioned building is best, but at the very least, find a shady spot or sit in front of a fan.

2 Drink cool fluids. Stick to water or sports drinks.

3 Try cooling measures.

4 Loosen clothing.

— — — — — — — — —

TASK 9: **Heat Stroke**

1 Put the person in a cool tub of water or a cool shower.

2 Spray the person with a garden hose.

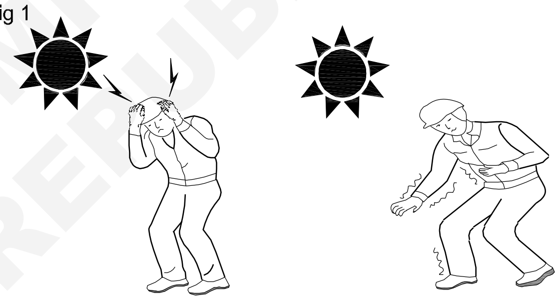
3 Sponge the person with cool water.

4 Fan the person while misting with cool water.

5 Place ice packs or cool wet towels on the neck and armpits.

6 Cover the person with cool damp sheets.

Fig 1



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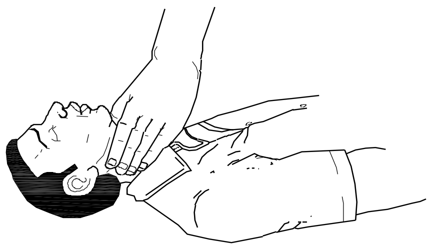
TASK 10: **Resuscitate a victim who is under cardiac arrest by (CPR) cardio pulmonary resuscitation**

In cases where the heart has stopped beating, you must act immediately.

1 Check quickly whether the victim is under cardiac arrest.

Cardiac arrest could be ascertained by the absence of the cardiac pulse in the neck (Fig 1), blue colour around lips and widely dilated pupil of the eyes.

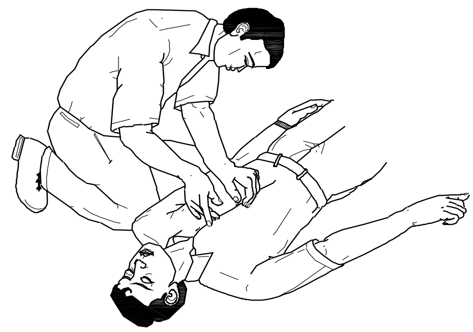
Fig 1



2 Lay the victim on his back on a firm surface.

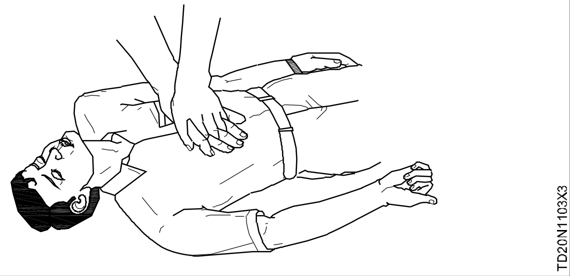
3 Kneel alongside facing the chest and locate the lower part of the breastbone. (Fig 2)

Fig 2



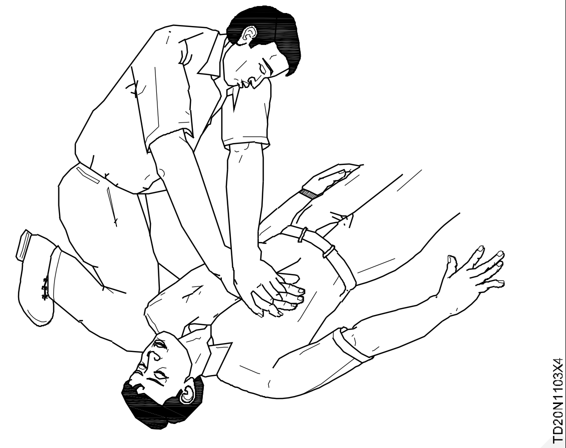
4 Place the palm of one hand on the centre of the lower part of the breastbone, keeping your fingers off the ribs. Cover the palm with your other hand and lock your fingers together as shown in Fig 3.

Fig 3



5 Keeping your arms straight, press sharply down on the lower part of the breastbone; then release the pressure. (Fig 4)

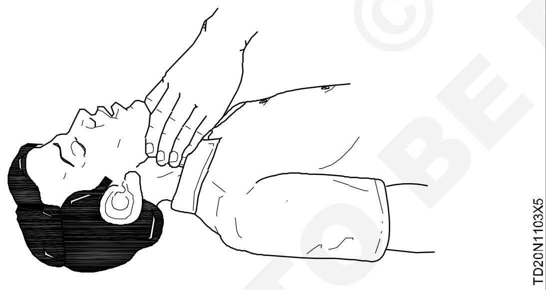
Fig 4



6 Repeat step above, fifteen times at the rate of atleast once per second.

7 Check the cardiac pulse. (Fig 5)

Fig 5



8 Move back to the victim's mouth to give two breaths (mouth-to-mouth resuscitation). (Fig 6)

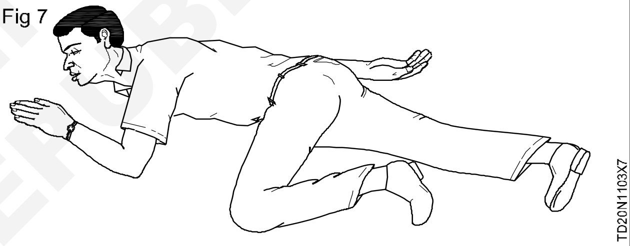
Fig 6

9 Continue with another 15 compressions of the heart followed by a further two breaths of mouth-to-mouth resuscitation, and so on, check the pulse at frequent intervals.

10 As soon as the heartbeat returns, stop the compressions immediately but continue with mouth-to-mouth resuscitation until natural breathing is fully restored.

11 Place the victim in the recovery position as shown in Fig 7. Keep him warm and get medical help quickly.

Fig 7



Other steps

12 Send word for a doctor immediately.

13 Keep the victim warm with a blanket, wrapped up with hot water bottles or warm bricks; stimulate circulation by stroking the insides of the arms and legs towards the heart.

— — — — — — — — —

Safe disposal of waste materials like cotton waste, metal chips / burrs etc.

Objectives: At the end of this exercise you shall be able to
- **identify and segregate the waste material in workshop**
- **arrange the waste material in different bins.**

Fig 1

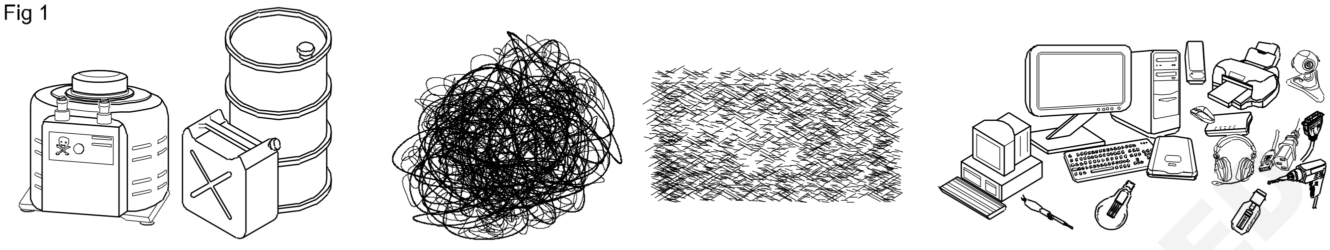
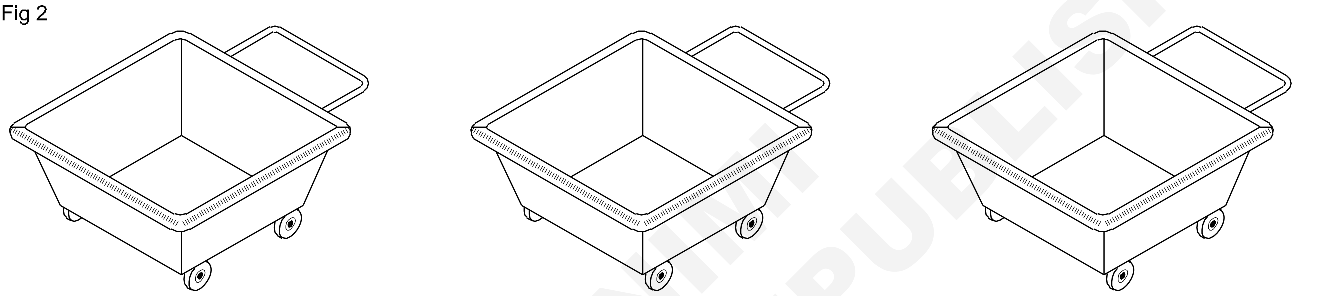


Fig 2



Job Sequence

- Separate the cotton waste.
- Collect the chips by hand shovel with the help of brush. (Fig.2).
- Clean the floor, if oil is spilled.

Do not handle the chip by bare hand

There may be different metal chips. So separate the chip according to metal.

- Separate the cotton waste material and store it in the bin provided to store the waste cotton material. (Fig.2)
- Similarly store the each category of metal chip in separate bins.

Each bin should have name of the material.

Identify the material given in fig 1 and fill in table 1

Table1

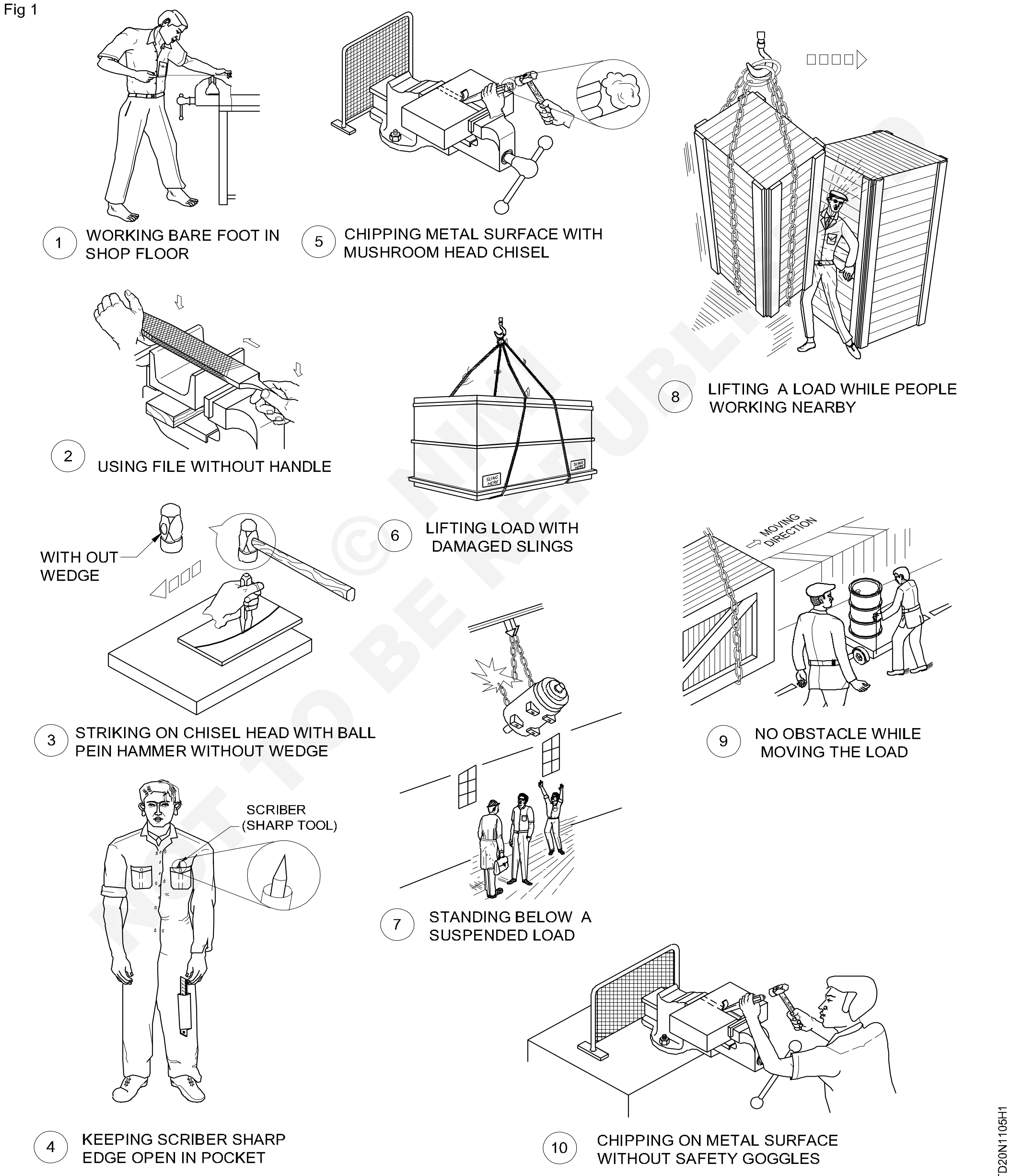
S. No.	Name of the material
1	
2	
3	
4	

— — — — — — — — —

Hazard identification and avoidance

Objectives: At the end of this exercise you shall be able to
- **identify the occupational hazards**
- **suggest suitable methods to avoid occupational hazards.**

Fig 1



Job Sequence

The instructor shall emphasise the importance of hazard and avoidance to the students and insist them to follow properly.

- Study the drawing of industrial hazards.
- Identify the type of hazards.
- Name the hazards against their names.
- Record the hazards and avoidance in Table 1.

Table 1

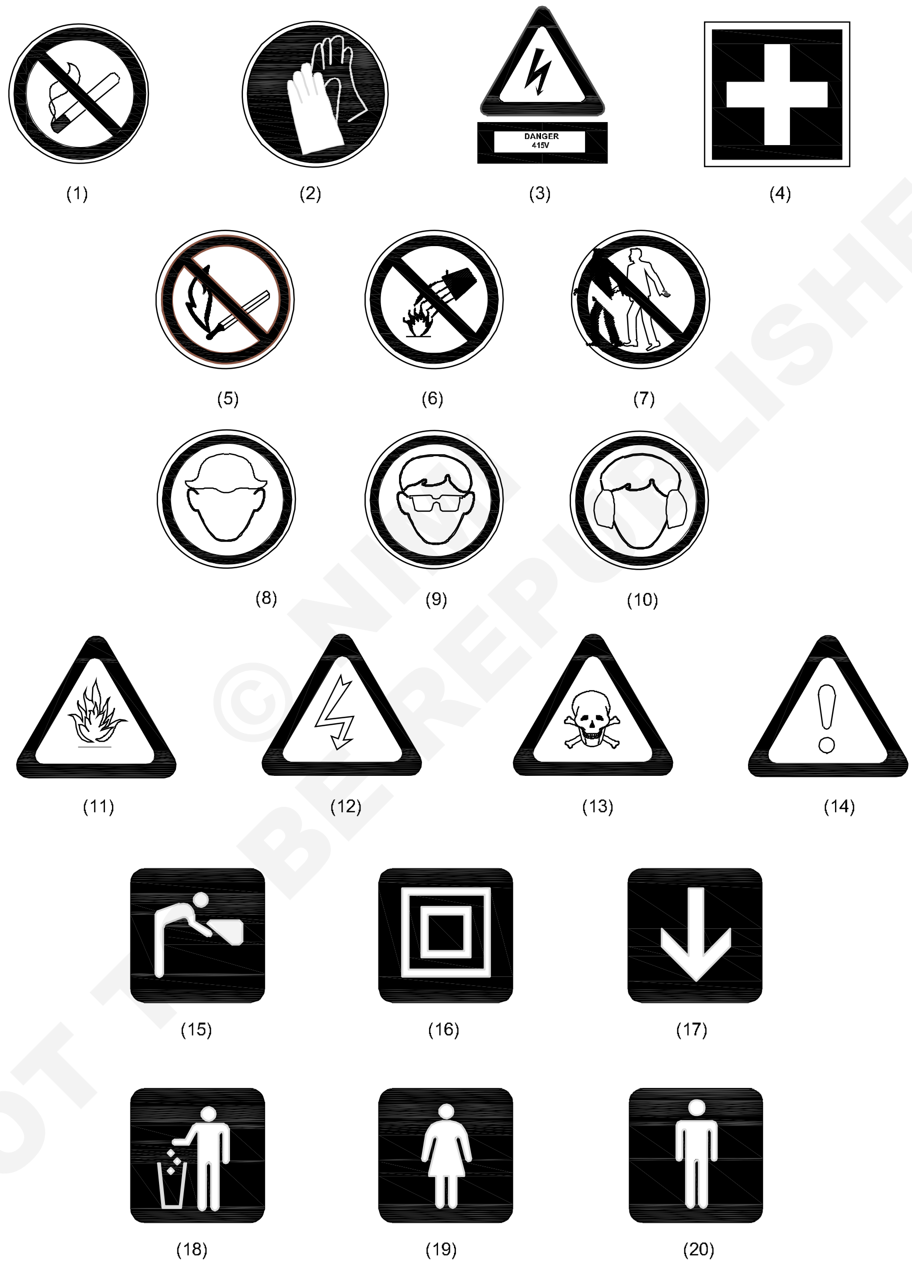
S. No.	Identification of hazards	Avoidance
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

- Get it checked by your instructor

Identification of safety sign

Objectives: At the end of this exercise you shall be able to
- **identify the basic categories of safety sign**
- **record the meaning of safety sign in the table given.**

Fig 1



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Job Sequence

Instructor shall provide various safety signs, chart categories and explain their meaning, description. Ask the trainee to identify the sign and record in Table 1.

- Identify the safety sign from the chart.
- Record the name of the category in Table 1.
- Mention the meaning description of the safety sign in Table 1.

Table 1

Fig. No.	Basic Categories/Safety sign	Meaning - description
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

- Get it checked by your instructor.

Preventive measures for electrical accidents and step to be taken in such accidents

Objectives: At the end of this exercise you shall be able to
- **adopt preventive measures to avoid electrical accidents**
- **take care of a person with electrical accident.**

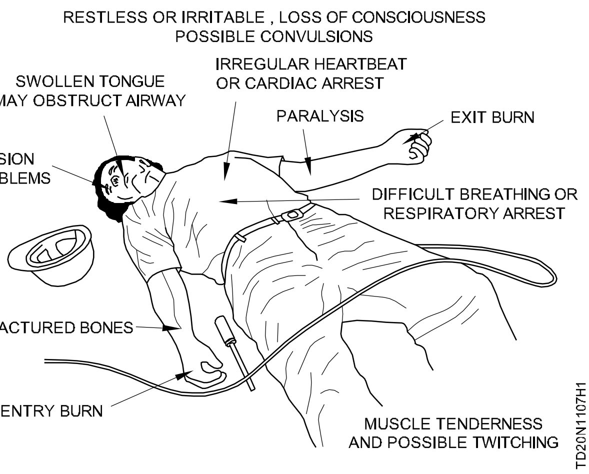
> **Note: The instructor shall arrange suitable electrical Safety poster/chart/slogan appropriate to this exercise**

Preventive measures for electrical accidents

- Never touch any electrical apparatus /machinery with wet hands or while standing in water.
- If you get a tingle or shock when touching any electrical item, a sink, tub, or other wet area, turn off the power at the main panel and immediately call an electrician.
- Don't use damaged or broken cords/ wires or plug in anything with a missing prong.
- When unplugging, don't pull the cord; pull it by the plug.
- Don't overload sockets; use a power extension board with a safety switch.
- Know the location and how to operate shut-off switches and/or circuit breaker panels. Use these devices to shut off equipment in the event of a fire or electrocution.
- Avoid for water or chemical spills on or near electrical equipment. Wear rubber shoes in wet areas.
- Cover unused outlets and keep metal objects away from outlets. you should always take extra care to ensure that you do not come into contact with the exposed live wires as this runs the risk of shock and burns.
- Put a notice nearby to the appliance to inform others of the danger and to ensure that it is protected until you are able to schedule repairs.
- Use safe work practices every time electrical equipment is used.
- All electrical installations regardless of whether at home or in the workplace, must be grounded, which is otherwise known as earthing to track down any excess electricity, the most effective route to return to the ground without posing any safety risks.
- It is safe to work on the electrical equipment that is plugged in with only dry hand and wear non-conductive gloves and insulated-soles shoes.
- Disconnect the device from the source in the period of service or maintenance of the device.
- Disconnect the power source before servicing or repairing electrical equipment.
- All electrical cords should have sufficient insulation to prevent direct contact with wires.
- In a laboratory/workshop it is particularly important to check all cords before each use, since corrosive chemicals or solvents may erode the insulation.
- Damaged cords should be repaired or taken out of service immediately, especially in wet environments such as cold rooms and near water baths.
- Keep away from the energized or loaded circuits Arcing, sparking, or smoking from the equipment
- If the device interacts with water or other liquid chemicals, equipment must be shut off power at the main switch or circuit breaker and unplugged.
- If any individual comes in contact with a live electric line, do not touch the individual or equipment / source/ cord; disconnect the power source from the circuit breaker or pull out the plug using a leather belt.
- always stay at least ten feet away from the overhead power lines, carry highest voltage, which means that should anyone come into contact with them, there is a significant risk of not only electrocution but also severe burns.

First Aid for Accidental Electric Shock Victims (Fig 1)

Fig 1



- Ensure that you are taking sufficient safety precaution to protect yourself before going to help the other person met with accidental electric shock.
- Talk to the person and ask loudly, "Are you OK?"; make him feel comfortable.

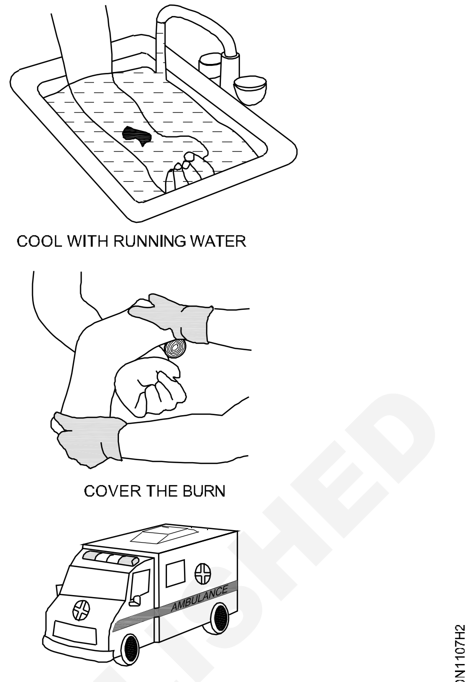
- Check for ventilation and airways; clear obstruction and provide fresh air flow.
- Check for signs of normal breathing; observe breathing.
- If not breathing normally, begin CPR
- Unplug the appliance or turn off the power at the control panel.
- If you can't turn off the power, use a dry wooden piece, like a broom handle, dry rope or dry clothing, to separate the victim from the electrical contact / power source.
- Do not try to move the victim touching a high voltage wire; Call for emergency help/immediate superior for assistance.
- Unconscious victims should be placed on their side to allow drainage of fluids; Keep the victim lying and observe for the symptoms shown in Fig.1
- Do not move the victim if there is a suspicion of neck or spine injuries call for the ambulance service.
- If the victim is not breathing, apply mouth-to-mouth resuscitation. If the victim has no pulse, begin cardiopulmonary resuscitation (CPR). Then cover the victim with a blanket to maintain body heat, keep the victim's head low and get medical attention.

First Aid for Accidental Electrical Burn Victims

Electrical burns vary in severity depending upon the following conditions

- how long the victim is in contact with the electric current;
- the strength of the current flow;
- the type of current AC or DC; and
- the direction of the current takes through the body.
- Observe the person, if the person is conscious and there are no signs of shock (such as being cold, clammy, pale and having a rapid pulse)
- Do not apply grease or oil to the burn.
- Cover the burn with a dry, sterile dressing.
- There may be more than one area burned.
- If the person has electrical burn, check for shock and follow the outlined points shown in Fig.2

Fig 2



- Keep the victim from getting chilled; Seek medical attention as soon as possible.

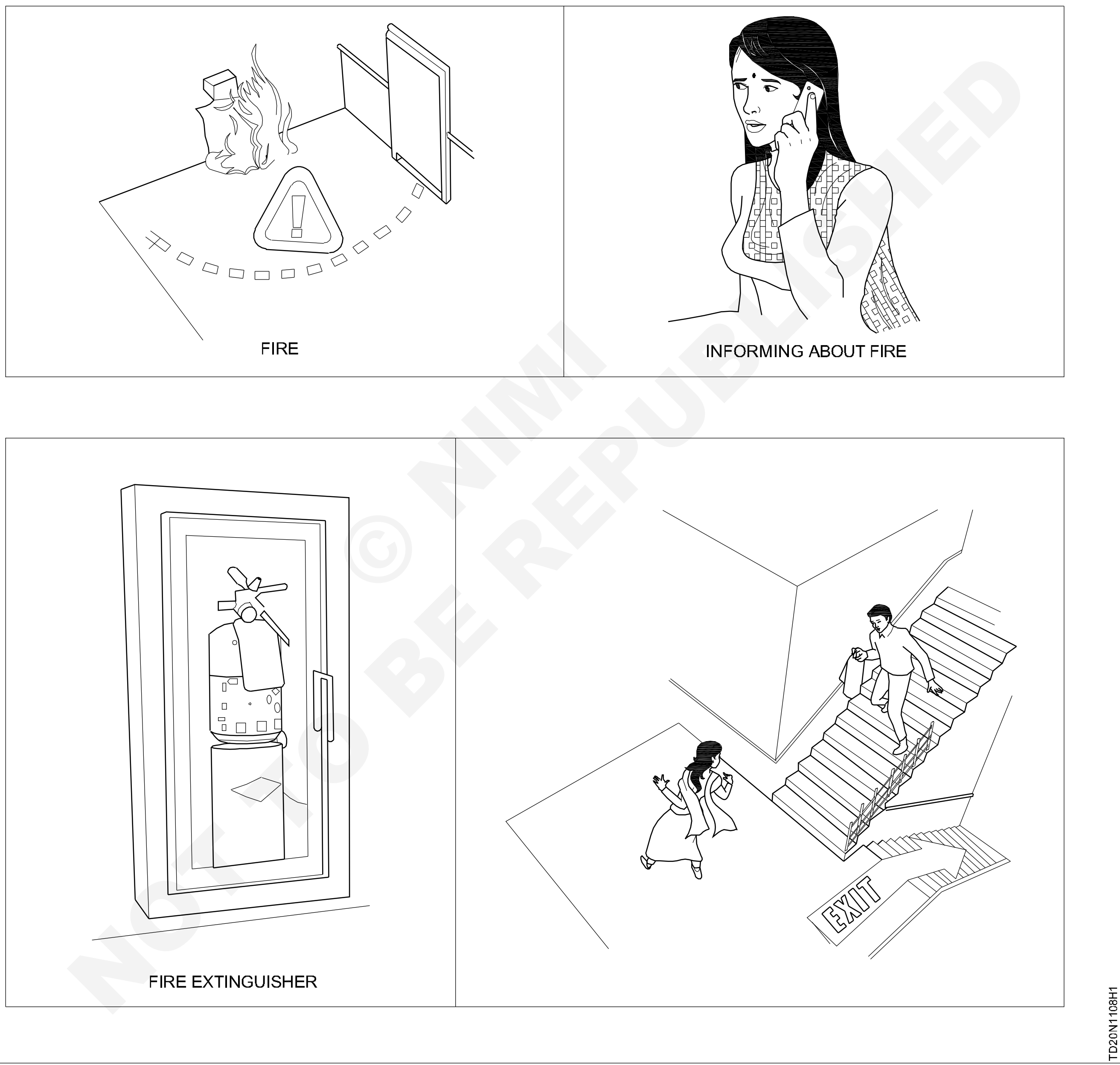
Accidental Electrical Fire

- Keep flammable materials away: Electrical appliances or outlets that come into contact with flammable materials that may trigger a fire.
- Inspect electrical wiring: Have your electric wiring checked to prevent electrical fires. Wiring does not last forever, so it is a good idea to have your wiring checked
- Be wary of certain appliances: If an appliance blows a fuse, trips a circuit, or sparks while being used, unplug the appliance immediately, and check to see if it needs to behave it repaired or replaced.
- Check Switches or outlets that are hot to touch and/or emit an acid odour; Inspect and repair outlets and switches.
- In case of electrical fire, use only CO_2 type of Fire extinguisher.

Uses of fire extinguishers

Objectives: At the end of this exercise you shall be able to
- **select the fire extinguisher according to the type of fire**
- **operate the fire extinguisher**
- **extinguish the fire.**

Fig 1



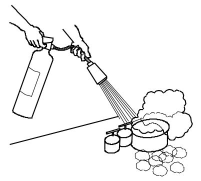
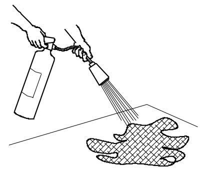
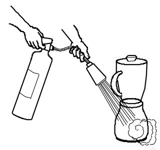
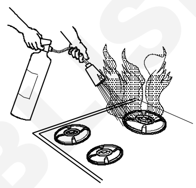
Job Sequence

Extinguishing fire

- Alert people surrounding by shouting fire, fire, fire.
- Inform fire service or arrange to inform immediately.
- Open emergency exist and ask them to go away.
- Analyze and identify the type of fire. Refer Table1.

All fire extinguisher are labelled to indicate which class of fire they are designed to combat.

Table1

Class 'A'	Wood, paper, cloth, solid material	
Class 'B'	Oil based fire (grease, gasoline, oil) & liquefiable solids	
Class 'C'	Gas and liquefied gases	
Class 'D'	Metals and electrical equipment	

Assume the fire is 'B' type (flammable liquefiable solids)

- Select CO_2 (carbon dioxide) fire extinguisher
- Locate and pick up CO_2 fire extinguisher. Check for its expiry date.
- Break the seal.

Stand back: Face the fire and keep your back to the exit stay between six and eight feet away from flame.

Operator: Operate the fire extinguisher

Most of the fire extinguisher operator the same basic way stand six to eight feet away from the fire and remember to PASS - PULL - AIM - SQUEEZE - SWEEP.

PULL the pin: This will allow you to discharge the extinguisher. (Fig 1)

AIM at the base of fire: If you aim at the flames (Which is freuquently the temptation). The extinguishing agent will fly right through and do no good. (Fig 2)

Squeeze the top handle or lever: This depress a button that releases the pressurised extinguishing agent in the extinguisher. (Fig 3)

Sweep from side to side until the fire is completely put off. Start using the extinguisher from distance away. Then move forward. Once the fire is put off keep on eye on the area incase re-ignite. (Fig 4)

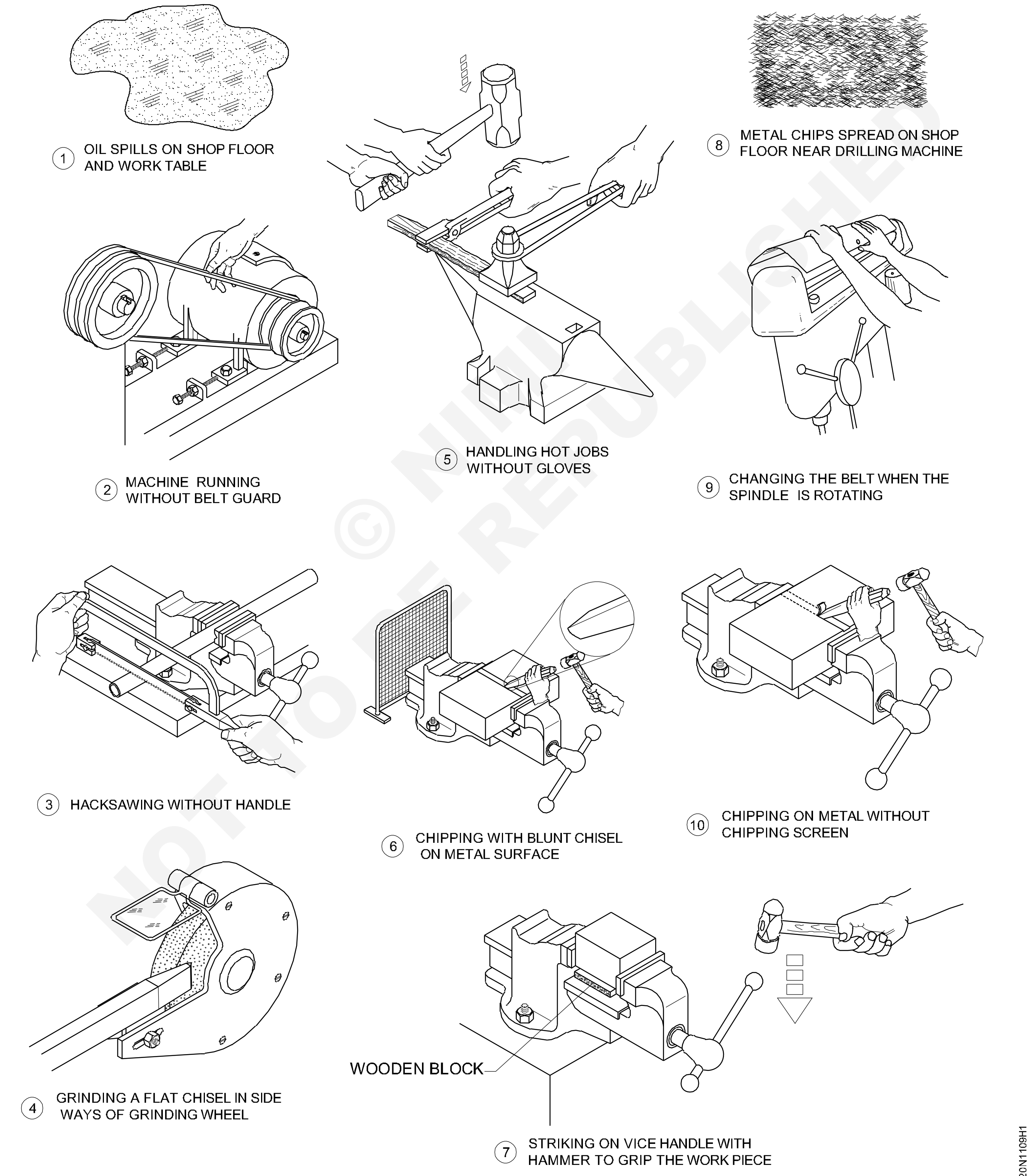
Fig 1

HOW TO USE FIRE EXTINGUISHER

Practice and understand precautions to be followed while working in fitting jobs

Objective: At the end of this exercise, you shall be able to
- **record the precaution to be followed while working in fitting jobs.**

Fig 1



Job Sequence

The instructor shall guide and demonstrate the students to practice and understand precautions to be followed while working in fitting jobs.

- Record the precautions to be followed while working in fitting job in Table 1

Table 1

Fig. No.	Description	Record precautions to be followed while working in fitting job
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

- Fill up and get it checked by your instructor.

Importance of trade training and list of tools and machinery used in the trade

Objectives: At the end of this exercise you shall be able to
- **describe the job opportunity after completion of the training**
- **list out the outcome of the training in tool and die makers trade.**

Tool & Die Maker (Press Tools and Jigs & Fixtures and Dies and Moulds) trade under CTS is one of the popular courses delivered motion wide through netwirk of ITIs. The course is of two years duration. It mainly consists of domain area and Core area. In the domain area (Trade Theory & Practical) impart professional skills and knowledge, while core area (Workshop calculation and science. Engineering drwing and employability skills). Impart requisite core Skill & Knowledge and life skills. After passing out the training programme, the trainee is awarded National Trade Certificate (NTC) by DGT which is recognozed worldwide.

During the two years duration a candidate is trained on subjects-Professional Skill, Professional Knowledge, Engineering Drawing, Workshop Science & Calculation and Employability Skills related to job role. In addition to this, a candidate is entrusted to make/do project work and Extra Curricular Activities to build up confidence. The practical skills are imparted in simple to complex manner & simultaneously theory subject is taugth in the same fashion to apply congnitive knowledge while executing task. THe course covers the detail aspect of mould making & testing and dies and moulds. The broad components covered under Professional Skill subject are as below.

Candidates broadly need to demonstrate that they are able to:

Read & Interpret technical parameters/documentation, plan and organize work processes, identify necessary materials and tools.

Perform task with due consideration to safety rules, accident prevention regulations and environments protection stipulations.

Apply professional knowledge, core skills & employability skills while performing the job of a Tool & Die Maker (Press Tools and Jigs & Fixtures and Dies and Modules) and machining work. Check the job/components as per drawing for functioning identiry and rectify errors in job/components.

Document the technical parameters related to the task undertaken.

Can join industry as technical and will progress further as senior technician, supervisor and can rise up to the level of manager.

Can become entrepreneur in the related field.

Can appear in 10 +2 examinationthrough National Institute of open schooling (NIOS) for acquiring higher secondary certificate and can go further for general/ technical education.

Can take admission in diploma course in notified branches of Engineering by lateral entry.

Can join Apprenticeship programme in different types of industries leading to national apprenticeship certificate (NAC).

Can join crafts instructor training scheme (CITS) in the trade for becoming instructor in ITIs. Can join Advanced Diploma (Vocational) courses under DGT as aoolicable.

LIST OF TOOLS AND EQUIPMENT

TOOL AND DIE MAKER (DIES AND MOULDS) (For Batch of 24 Candidates)

A TRAINEES TOOL KIT

S.No.	Name of the Tool &Equipments	Specification	Quantity
1.	Steel Rule	150 mm English and Metric combined	(24+1) Nos
2.	Engineers Square	100 mm with knife edge	(24+1) Nos
3.	Hacksaw frame solid type	200-300 mm blade	(24+1) Nos
4.	Centre punch	100 mm	(24+1) Nos
5.	Dot punch	100 mm	(24+1) Nos
6.	File flat bastard	300 mm	(24+1) Nos
7.	File flat 2nd cut	250 mm	(24+1) Nos
8.	File flat safe edge	200 mm	(24+1) Nos

S.No.	Name of the Tool &Equipments	Specification	Quantity
9.	File triangular smooth	150 mm	(24+1) Nos
10.	Hammer cross peen	0.5 kg	(24+1) Nos
B :TOOLS AND EQUIPMENT			
11.	Screwdriver	150 mm	4 nos.
12.	Screwdriver	200 mm	4 nos.
13.	File flat smooth	200 mm	5 nos.
14	File flat Second cut with safe edge	200 mm	5 nos.
15.	File half round bastard	300 mm	5 nos
16.	File half round second cut	250 mm	5 nos.
17.	File triangular bastard	250 mm	5 nos.
18.	File triangular second cut	200 mm	5 nos.
19.	File round bastard	250 mm	5 nos.
20.	File square bastard	300 mm	5 nos.
21.	File square second cut	250 mm	5 nos.
22.	Knife edge file	150 mm	5 nos.
23.	Needle file assorted (12 nos.)	150 mm	5 nos.
24.	Hammer Ball Peen	0.5 kg with handle	4 nos.
25.	Hammer Cross Peen	0.5 kg with handle	4 nos.
26.	Chisel cold flat	18 x 150 mm	10 nos.
27.	Scribing block universal	300 mm	2 nos.
28.	Granite Surface plate	600 x 600x80 mm	1 no.
29.	Taps and dies metric	5 mm to 12 mm complete set in a box	2 sets.
30.	Twist Drill with St. Shank	Ø 1 to Ø 12 mm in steps of 0.5 mm	3 set
31.	Twist Drills	Dia. 3.2, 4.1, 4.2, 5.2, 6.8, 8.5, 3.8, 4.8, 5.8, 7.7, 9.7, 11.7	2 nos. each
32.	Taper shank drills	Ø 12 mm to Ø 20 mm in steps of 1 mm	1 set
33.	D.E spanners	3-4, 6-8, 10-12, 13-14, 15-16, 18-19, 20-22, 24-26 (8 spanners)	2 sets
34.	Letter punch	5 mm set	3 set
35.	Number punch	5 mm set	3 set
36.	Drill chuck	12 mm capacity with key	4 no.
37.	Allen key metric	3 to 12 mm set	1 sets
38.	Centre drills	No. 3, 4 & 5	5 each
39.	Parallel hand reamer	6 mm to 12 mm in steps of 2 mm with suitable wrench	2 set
40.	Star dresser		2 nos.
41.	Diamond dresser with holder		2 nos.

S.No.	Name of the Tool &Equipments	Specification	Quantity
42.	Safety goggles (Personal Protective Equipments)		12 nos.
43.	Demagnetizer		1 no.
44.	Snips	200 mm	1 no.
45.	Workbench	150 cm x 80 cm x 75 cm with 150 mm vice (Each bench fitted with 2 vices)	12 nos.
46.	Bench Vice	150 mm	24nos.
47.	Steel lockers for 20 trainees (Pigeon Cup Board)		2 nos.
48.	Steel cupboard	180 cm x 60 cm x 45 cm	8 nos.
49.	Metal rack	180 cm x 60 cm x 45 cm	1 nos.
50.	Fire extinguisher	Arrange all proper NOCs and equipment from Municipal/Competent authorities.	
51.	Feeler gauge	0.05 mm to 0.3 mm by 0.05 and 0.4 mm to 1 mm by 0.1 mm (13 leaves)	2 set
52.	Metric Screw pitch gauge-Range	0.4 -6 mm pitch 600 (21 leaves)	2 set
53.	Radius gauge	1 - 3 mm by 0. 25 mm and 3.5-7mm by 0.5 mm (34 leaves)	2 nos.
54.	Vernier height gauge	Range 300 mm, with 0.02 mm least count	2 nos.
55.	Universal Vernier caliper	150 mm, with 0.02 mm least count	5 nos.
56.	Digital caliper	200 mm, with 0.01 mm least count	2 nos.
57.	Vernier caliper-Range	300 mm Vernier scale 0.02 mm	2 nos.
58.	Vernier bevel protractor-Blade range	150 / 300 mm, dial 1^0, least count 5 (min.) with head, Acute Angle attachment	1 no.
59.	Outside micrometer	0-25 mm, with 0.01 mm least count	4 nos.
60.	Outside micrometer	25-50 mm, with 0.01 mm least count	4 nos.
61.	Outside micrometer	50-75mm, with 0.01 mm least count	4 nos.
62.	Sine bar with stopper plate	150 mm	1 no.
63.	Sine table with magnetic bed	200 mm length	1 no.
64.	Slip Gauge Box (workshop grade) -	87 pieces per set	1 set
65.	V-Block-Approx.	32 x 32 x 41 mm with clamping capacity of 25 mm with clamps	2 pairs
66.	V-Block-Approx.	65x65x80 mm with clamping capacity of 50 mm with clamps	1 pair
67.	Magnetic V-Block	100x100x125 mm	2 pairs
68.	Angle plate	150 x 150 x 200 mm	2 no.
69.	Angle plate-adjustable	250x250x300 mm	1no.
70.	Inside micrometer Range	50-63 mm with std extension rods up to 200mm	1 set

S.No.	Name of the Tool &Equipments	Specification	Quantity
71.	Depth micrometer	Range 0-25 mm, accuracy 0.01 mm with std set of extension rods.	1set
72.	Magnetic stand with magnetic base	60 x 47.5 mm and with universal swivel clamp, dial holding rod (150 mm) scriber	2 nos.
73.	Dial test indicator-Lever type- Range	0-0.8 mm Graduation 0.01mm, reading 0-50-0 with accessories	2 nos.
74.	Dial test indicator Plunger Type-Range	0-10 mm , Graduation 0.01 mm, Reading 0-100 with revolution counter	2 nos.
75.	Magnetic vice	200 m	2 nos.
C. CUTTING TOOLS			
76.	Side and face milling cutter	Ø 100 x 10 X Ø 27 mm	2 nos.
77.	Side and face cutter	Ø 80 x 10 X Ø 27mm	2 nos.
78.	Cylindrical milling cutter mm	Ø 63 x 70 x Ø 27	2 nos.
79.	Slitting Saw cutter	Ø 75 x 4 X Ø 27mm	2 nos.
80.	Single angle cutter	Ø 75 x 16 x Ø 27mm – 60^0	2 nos.
81.	Dovetail cutter	Dia. 20 X 8 mm shank x 60^0	2 nos.
82.	Single angle cutter	Ø 75 x 20 x Ø 27 – 45^0	2 nos.
83.	Equal angle cutter	Ø75x 30 x Ø 27 - 900	2 nos.
84.	Shell End Mill	Ø 50 x 36 x Ø 22 (Indaxable 6 inserted type)	2 nos.
85.	Shell End Mill	Ø 75 mm x 50 x Ø 22 (Indaxable 6 inserted type)	2 nos.
86.	Parallel shank end mills	Ø6, Ø10 and Ø 16 are (double fluted), Ø 20 mm & Ø 25mm (four fluted)	4 nos.
87.	T slot cutter with parallel shank	Ø 17.5 x 8 mm width x dia. of shank 8 mm	2 nos.
88.	Concave Milling cutter	Ø 63 x 6 radius/10 radius x Ø 27 mm	1 no.each
89.	Convex Milling cutter	Ø 63 x 6 radius/ 10 radius x Ø 27 mm	1 no.each
90.	Knurling tool (straight & diamond)		2 nos. each
D. GENERAL MACHINERY & INSTALLATION:			
91.	Pillar/column type Drilling machine	25 mm capacity-motorized with drill chuck, key etc.	1no.
92.	Radial Drill machine	to drill up to 32 mm diameter	1no.
93.	Bend saw machine	to accommodate 21" or more length blade	1no.
94.	Double ended Pedestal Grinder	178 mm wheels(one fine and one rough wheel)	1 no.

S.No.	Name of the Tool &Equipments	Specification	Quantity
95.	SS and SC centre lathe (all geared) with DRO	centre height 150 mm and centre distance1000 mm along with 3 jaws, 4 jawchuck, auto feed system, taper turning attachment, Coolant pump, safety guard and machine light arrangement.	3 nos.
96.	Shearing machine (lever type)hand operated	300 mm blade length	1 no.
97.	Universal Milling Machine With DRO (5 micron accuracy)	Longitudinal traverse 700 - 800 mm Cross traverse 250 - 400 mm Vertical traverse 200 - 350 mm Swivel of table on either side 450 Speed range rpm 30 to 1800 With universal dividing head, circular table, long arbors, slab arbor, slotting attachment, vertical indexing head, etc.	2 nos.
98.	Vertical milling machine	**Table** Length x width 1350x310 mm Longitudinal traverse 700 - 800 mm Cross traverse 200 - 265 mm Vertical traverse 300 - 400 mm Speed range rpm 20 to 1800 or higher specification	1 no. each
99.	Turret Ram Milling machine with DRO (5 micron accuracy)	as per the latest specification	1 no.
100.	**Hydraulic Surface Grinding Machine With DRO (5 micron accuracy)**	**Table** Clamping area 600 x 178 mm Grinding area 400 x 200 mm Distance table-centre of spindle 400 - 500 mm Table speed 1-25 m/min. With standard accessories like dust extractor with water separator, balancing device, table-mounted Radius-tangent wheel dresser, wheel flanges, etc.	2 nos.
101.	Tool & Cutter Grinder With DRO (5 micron accuracy)	Largest diameter of cutter that can be ground 10-100 mm Max. admit between centers 230 mm Max. length of cutting edges ground 120 mm With standard equipment like adaptor bushes, cutter head holder assembly, adaptors, extension spindle, flanges for grinding wheel, etc.	1 no.
102.	**Universal cylindrical Grinding Machine** With DRO(5 micron accuracy)	Max. dia. ground (effective) 250 mm Max. grinding length 300 mm Height of centre 130 mm Max. distance between centers 340 mm With special accessories like face plate, steady, radius and face dressers, find hand feed attachment etc.	1 no.

S.No.	Name of the Tool &Equipments	Specification	Quantity
103.	Muffle Furnace	Heating Chamber 300 x 300 x 450 mm for 10500 C Quenching tank - approx. 600 x600 x 600 mm/ approx. Dia. 600mm x 600mm ht.	1 no.
104.	Rockwell Hardness Testing Machine with standard accessories(Digital type)		1 no.
105.	Spark erosion EDM with standard accessories with DRO		1no.
106.	Polishing kit		1 no.
107.	Hand Injection Moulding Machine	approx. 50 g capacity	1 no.
108.	Hand Compression Moulds type machine	Compression moulding process (Mechanical for 50 gms.) Minimum 25 Ton capacity.	1 no.
109.	Screw Type Injection Moulding Machine	(capacity 50 gms.) (Not required if plastic processing operator trade is available in the institute) Minimum 25 Ton capacity	1 no.
110.	Simulator	[specification as per Annex-A &A(II)]	As per Annex-A &A (II)
111.	Desktop computers with latest configuration with necessary furniture	CPU: 32/64 Bit i3/i5/i7 or latest processor, Speed: 3 GHz or Higher. RAM:-4 GB DDR-III or Higher, Wi-Fi Enabled. Network Card: Integrated Gigabit Ethernet, with USB Mouse, USB Keyboard and Monitor (Min. 17 Inch.) Licensed Operating System and Antivirus compatible with trade related software.	As per Annex-A
112.	CAD/CAM software	Latest version/Free version available	As required
113.	CNC milling machine/ Vertical machining centre (VMC)	[specification as per Annex-A]	As per Annex-A& A (II)
114.	CNC lathe/CNC turn Centre	[specification as per Annex-A & A (I)]	As per Annex-A & A (I)
115.	Co-ordinate measuring machine (optional)		01
116.	Profile projector (Optional)		01
117.	Auto CAD software	Latest Version	25 license
118.	Creo (Pro-E) software	Latest Version	25 license

S.No.	Name of the Tool &Equipments	Specification	Quantity
119.	Smart touch screen panel for smart class room		01 no.

NOTE:

1. **No additional items are required to be provided to the batch working in the second and third shift except the items under trainee's toolkit.**
2. **Institute having centralized computer lab may use the existing infrastructure to impart simulation training and, in that case, not required to procure item No. 148.**
3. **Internet facility is desired to be provided in the classroom.**

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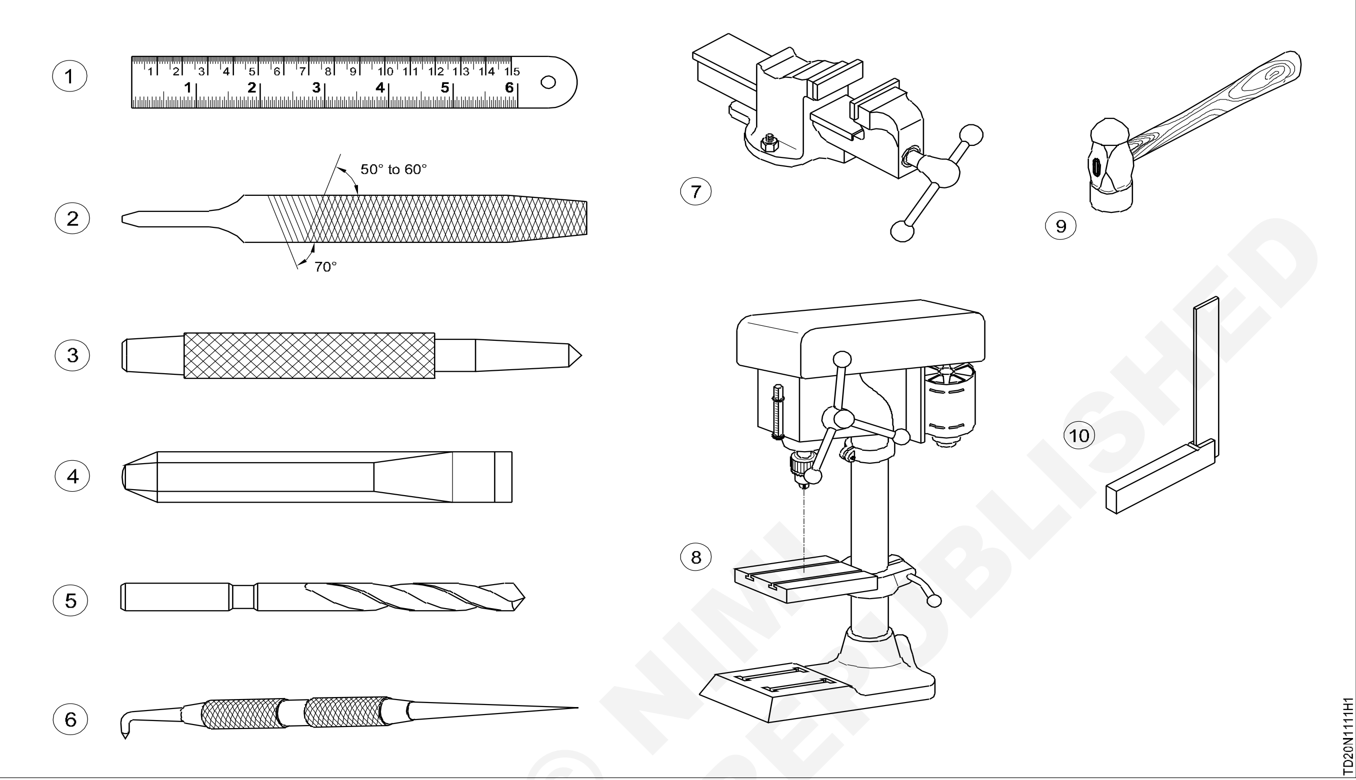
Safe use of tools and equipments used in the trade

Objective: At the end of this exercise you shall be able to
- **record the safety points while using the fitter trade tool and equipments.**



Job Sequence

The instructor shall emphasise the students about the safe use of tools and equipments used in trade and guide them to record the safety points

- Record the precautions to be followed while working in fitting job in Table 1

Table 1

Fig. No.	Description	Record precautions to be followed while working in fitting job
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

- Fill up and get it checked by your instructor.

Knowing games and memory training

Objectives: At the end of this exercise you shall be able to
- **do a crossword given in todays in any news paper**
- **play sudoku given in any news paper**
- **play chess game.**

The trainer shall explain how to do a crossword, sudoku and to play chess

— — — — — — — — —

Motivational talk by experts

Objectives: At the end of this exercise you shall be able to
- **state what is motivation and necessity of motivation**
- **describe the various type of motivation**
- **explain the step involved in motivation.**

Trainer shall engage guest factuty to contact class on "Motivation" covering above mentioned object

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5s Training

Objective: At the end of this exercise you shall be able to
- **adopt 5s pillar in a work place.**

> **Note: The trainer shall guide the trainee to keep the work place according 5s concepts.**

Step 1 (Seiri or sort) Identify the unnecessary items in work place and remove the item.

Step 2 (Serton- Set in order) keep the necessary items in their place and provide easy access.

Step 3 (Seisco- shine) clean the items and work place.

Step 4 (Seiketu- Standardize).

- Standardize and assign regular task
- creates schedules
- display instructions of these activities

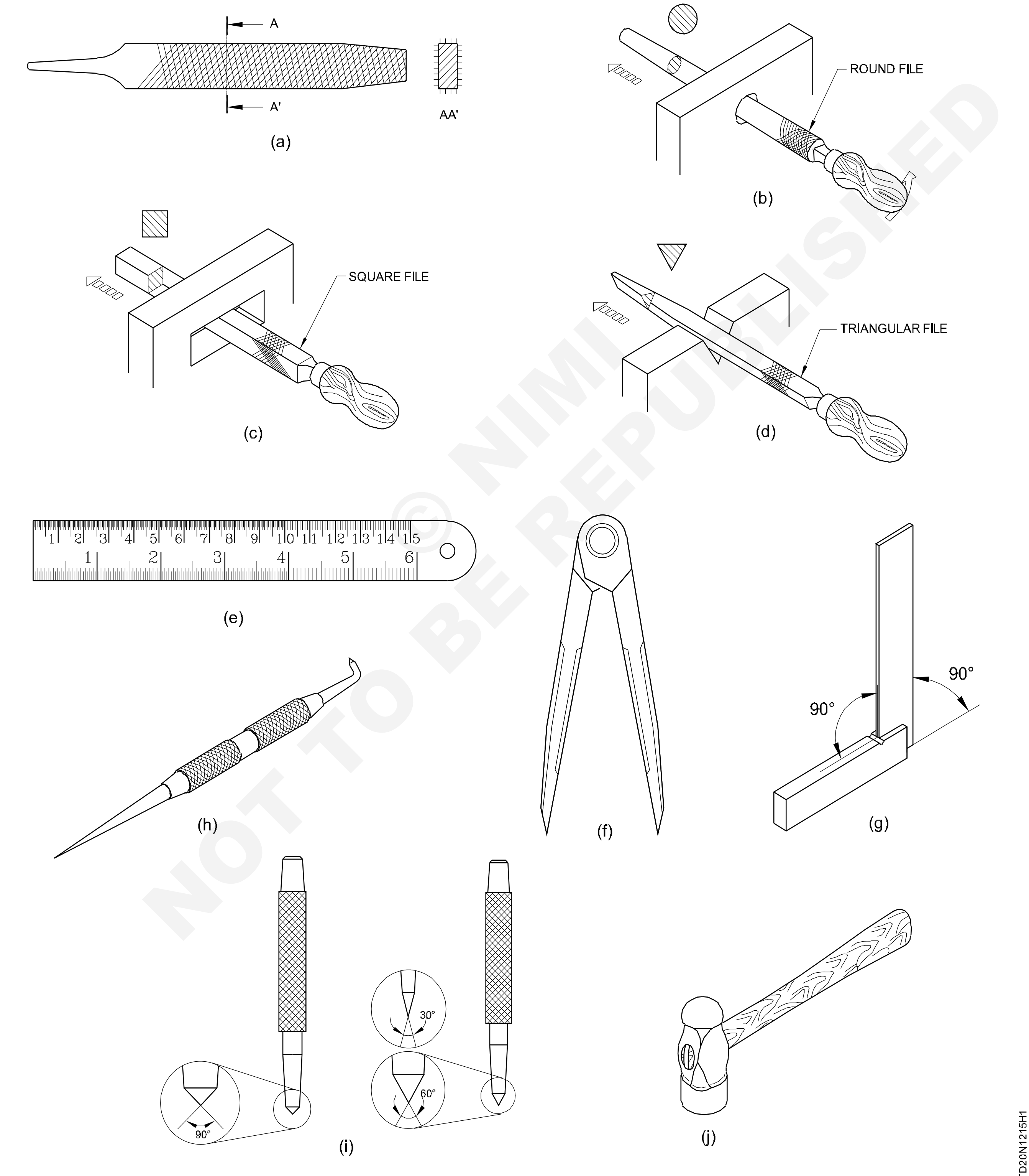
Step 5 (Shitsuke-sustain) Maintain the above pratice running smoothly.

— — — — — — — —

Identification and visual inspection of raw material

Objectives: At the end of this exercise you shall be able to
- **identify the filing and marking tools with their specification**
- **visualy inspect the raw material for rusting, scaling and corrections.**

Fig 1



Job Sequence

TASK 1: **Identification of files and marking tool**

Traineer shall display the different types and sizes of files, and the marking tools and brief their names and specifictions. (Fig 1)

- Trainee will note down the displayed items with theri specification.
- Record it in Table 1.

Table 1

Fig.No.1	Name of tools	Specification
a		
b		
c		
d		
e		
f		
g		
h		
i		
j		

- Get it checked by the trainee.

— — — — — — — — —

TASK 2: **Identification of raw material defects**

Instructor shall arrange to display various section of raw metals with rusting, scaling corroded conditions.

Differentiate with one another.

Ask the trainees to record it in the table.

- Observe the given raw material live. (Fig 2)
- Indentify the formation of materials for rusting, corrosion and scaling.
- Record the appearance of the defects in Table 2.

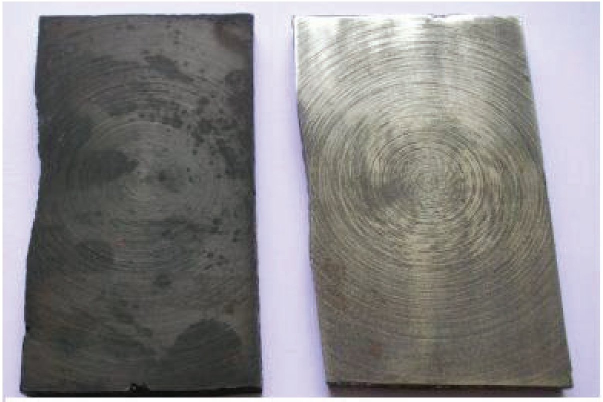
Table 2

Fig.No. 2	Defects on raw material	Brief the Appearance
a		
b		
c		

- Get it checked by the instructor.

Fig 2

(a) RUSTED COMPONENTS



(b) SCALLED PART

(c) CORRODED GEARS

TDN1215H2

Familiarisation of bench vice

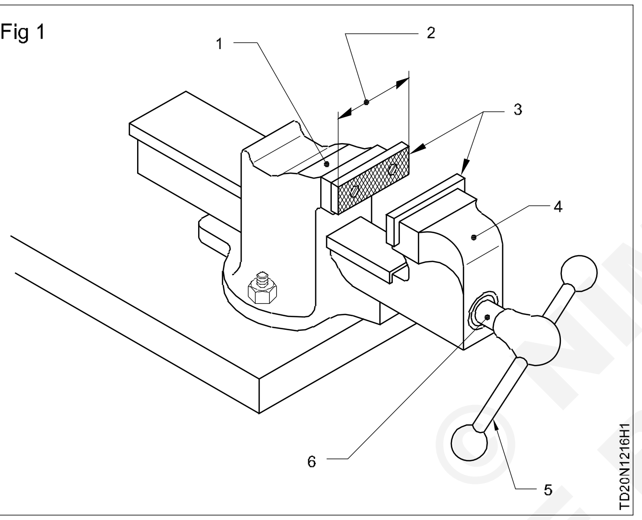
Objectives: At the end of this exercise you shall be able to
- **name the parts of bench vice**
- **clamp and unclamp the work piece.**

Job Sequence

The instructor may give demo to the trainees. Explain the parts of bench vice and how to hold the job and ask the trainees to write each parts name in the table.

- Observe the each part in Fig 1.

Fig 1



- Record the bench vice part name in the Table 1.

Table 1

Part No.	Name of the part
1	
2	
3	
4	
5	

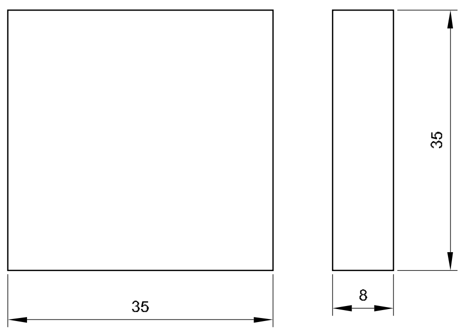
Get it checked by your instructor.

- Open and close the bench vice.
- Clamp and unclamp the work piece, without injuring to the fingers.

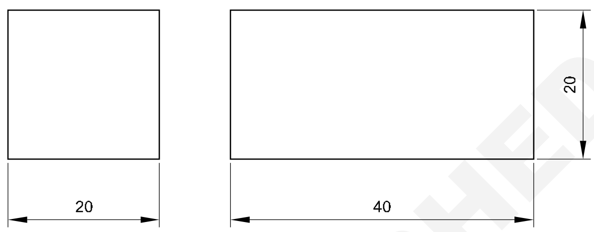
Filing different section of material

Objectives: At the end of this exercise you shall be able to
- **file various sections of metal bar and maintain its shapes and dimensions**
- **measure the dimensionswith steel rule.**

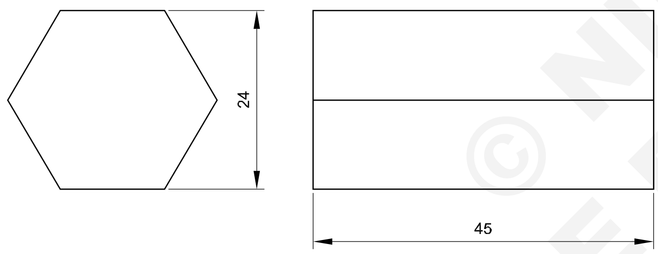
TASK-1 RECTANGULAR SECTION FILING
MATERIAL ISF10x30-40mm Qty-1 Fe 310



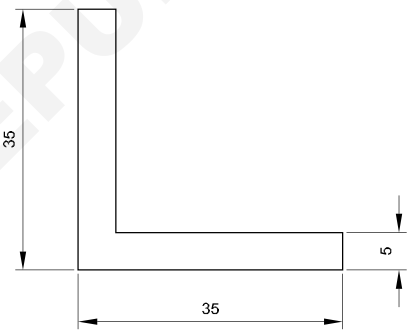
TASK-2 SQUARE SECTION FILING
MATERIAL SQ25x45mm Qty-1 Fe 310



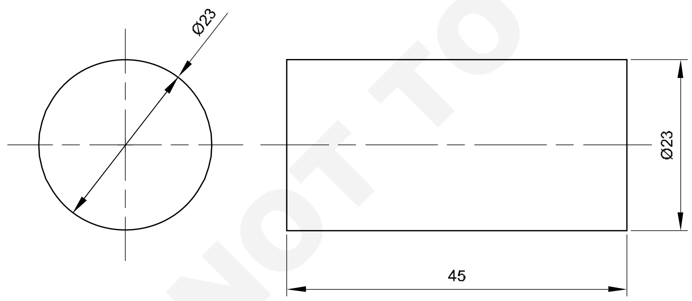
TASK-3 HEXAGONAL SECTION FILING
MATERIAL 30A/F-50mm HEXAGON Qty-1 Fe 310



TASK-4 'L' ANGLE SECTION FILING
MATERIAL ∠40x40x6mm Qty-1 Fe 310



TASK-5 ROUND SECTION FILING
MATERIAL Ø25x50mm Qty-1 Fe 310



Note:

The trainer shall demonstrate on

Holding the workpiece in benchvice

Filing flat surfaces

Checking the dimensions with steel rule safety precaution to be followed in all the above activites

1	Ø25x50mm	-	Fe 310	-	5	
1	Đ40x40x6mm	-	Fe 310	-	4	
1	30A/F-50mm	-	Fe 310	-	3	
1	SQ25x45mm	-	Fe 310	-	2	
1	ISF10x30-40mm	-	Fe 310	-	1	1.2.17
NO.OFF	STOCK SIZE	SEMI PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

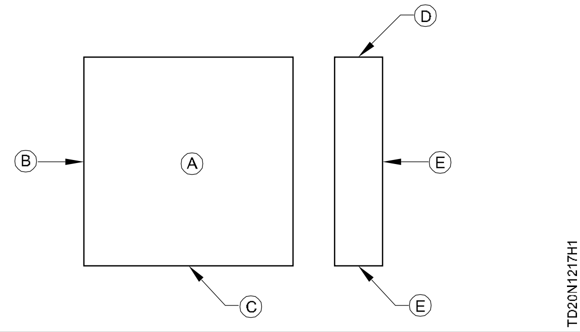
SCALE NTS	**FILING DIFFERENT SECTION OF METALS**	DEVIATIONS	TIME -
		CODE NO. TD20N1217E1	

Skill sequence

TASK 1 : **Rectangular section filing.**

- Check the raw material size by using steel rule
- Remove the scalling by flat rough file
- File side (A) with that flat bastard file and remove 1.00mm material and maintain its shape
- Check the size with steel rule
- Similarly file and remove excess materials on all other sides and maintain it shapes and sizes.
- The order filing may be side A,B,C,D,E&F (Fig 1)

Fig 1



TASK 2,3,4,5 :

- Check the material size using steel rule
- Determine the amount of material to be removed per side considering the actual dimensions in drawing
- File and remove the material and check the size using steel and maintain the actual shapes

Skill sequence

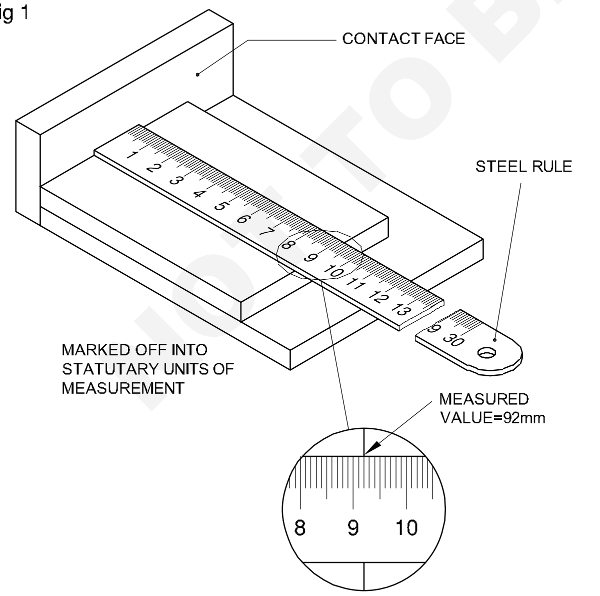
Measuring with a steel rule

Objective: This shall help you to
- **measure the length or a part of a length of objects.**

Place the rule either directly on to the length to be measured or at right angle to the reference plane.

Use a contace face, if possible and read off measurements by looking at the steel rule directly. (Fig 1)

Fig 1



Measure with a rule starting off from the 1cm line if the edge of the rule is worn out or damaged. (Fig 2)

The rule must be held parallel to the edge of the work as otherwise the measurement will not be correct. (Fig 3)

Always keep the steel rule away from the cutting tools to avaoid any scratches/damages.

Fig 2

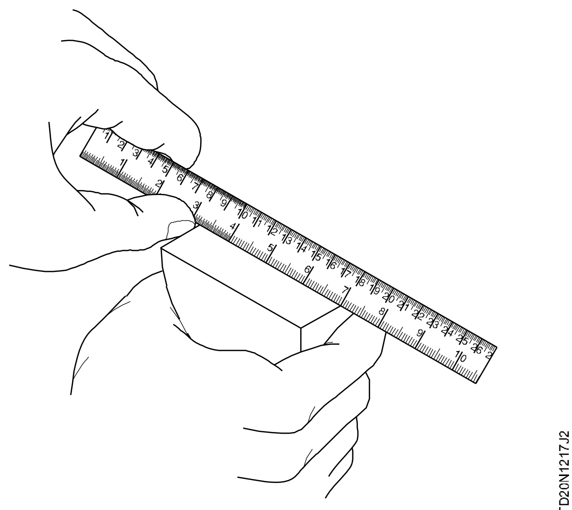
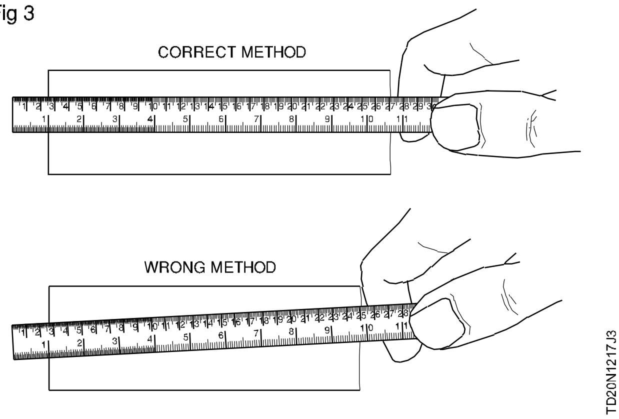


Fig 3



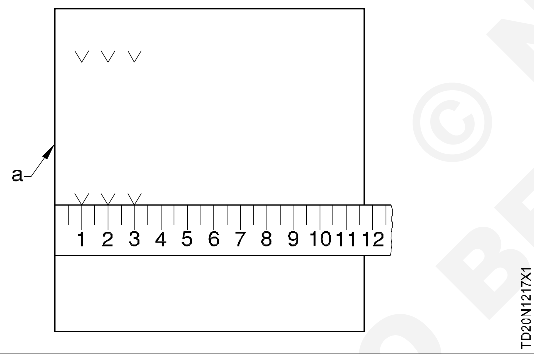
Marking with steel rule and scriber and punching

Objectives: This shall help you to
- **mark with one reference plane**
- **mark with two reference planes**
- **guide the scriber for scribing**
- **punch dot marks.**

Apply lump chalk evenly over the surface

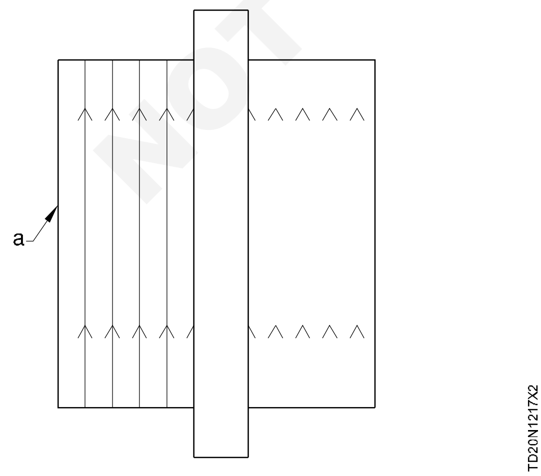
Using a steel rule from the reference plane ‘a’ mark the measurements twice at two points as far away from one another as possible. (Fig 1)

Fig 1



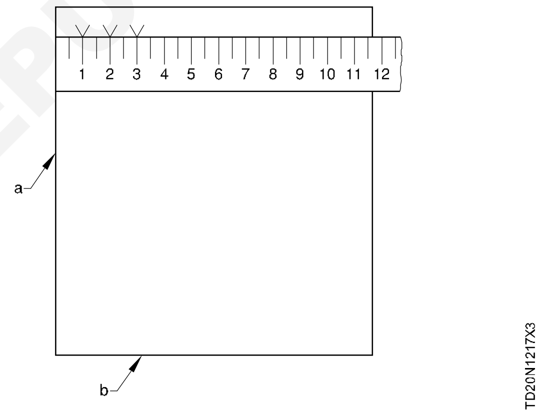
Place the steel rule edge on the marks and draw the marking line with a scriber. (Fig 2)

Fig 2



If there are two reference planes on the job, use a steel rule and working from the reference plane ‘a’ mark the measurements once. (Fig 3)

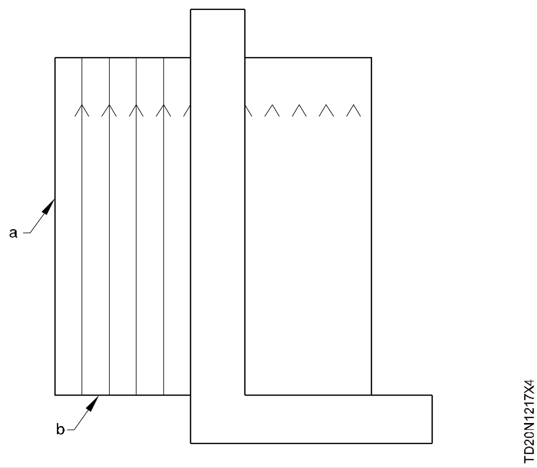
Fig 3



Place the try-square with its stock on reference plane ‘b’.

Push the blade of the try-square right up to the markings. (Fig 4)

Fig 4

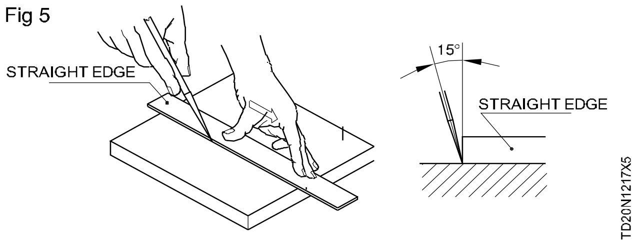


Draw the marking lines with the scriber.

For scribing lines place the point of the scriber on the workpiece against the straight edge.

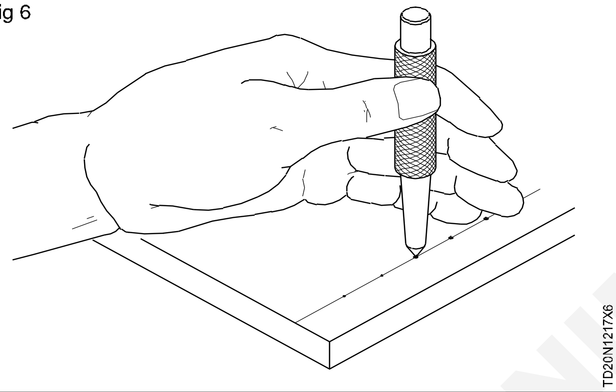
Hold the scriber inclined away from the straight edge and in the direction in which it is to be drawn (Fig 5)

Fig 5



Place the dot-punch in position; while doing so rest your hand on the workpiece (Fig 6)

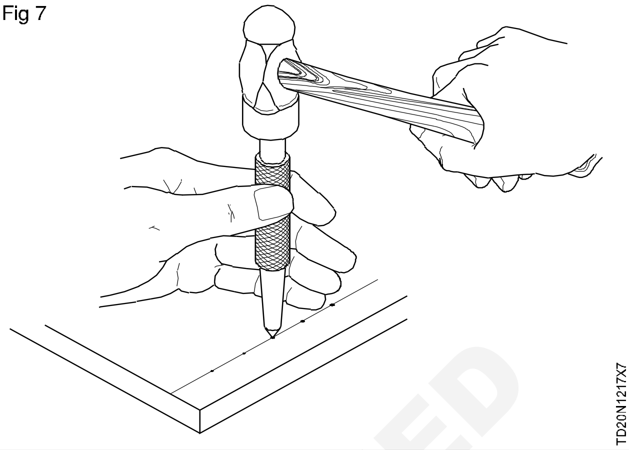
Fig 6



Set the dot-punch upright.

The dot-punch is struck with the hammer; the blow must be delivered in the direction of the dot-punch axis (Fig 7)

Fig 7



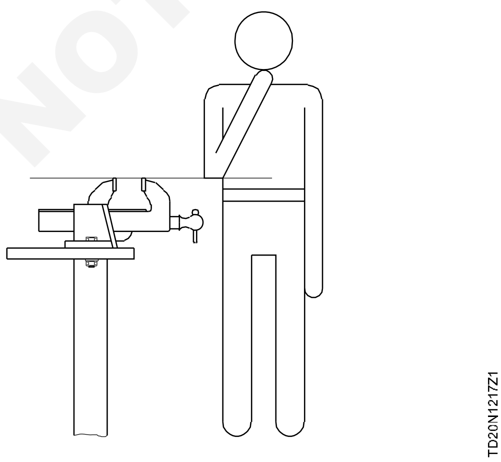
Filing flat surface

Objective: This shall help you to
- **file flat surfaces.**

Check the height of the bench vice (Fig 1). If the height is more use a platform and if it less, select and use another workbench.

Hold the job in the bench vice with a projection of 5 to 10mm from the top of the vice jaw.

Fig 1

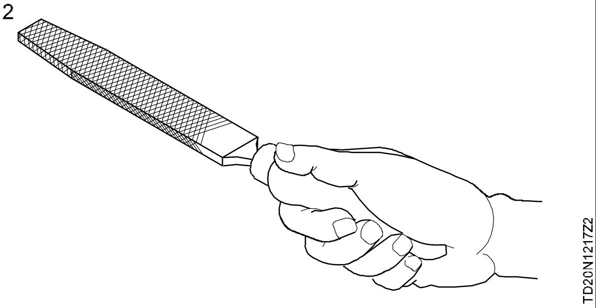


Select flat files of various grades and length according to the,

- Size of the job
- quality of metal to be removed
- Material of the job.

Check whether the handle of the file tightly. Hild the handle of the file (Fig 2) and push the file forward using your right hand palm on left hand palm.

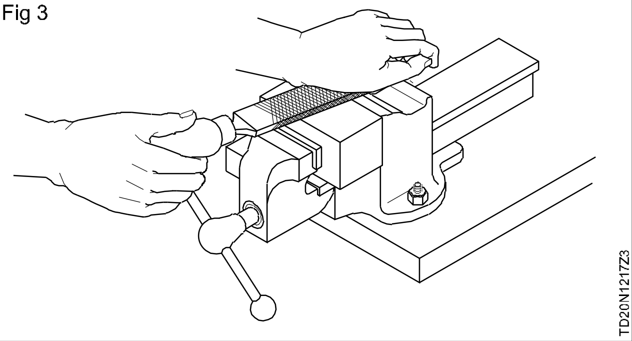
Fig 2



Hold the tip of the file according to the quantity of the metal to be removed.

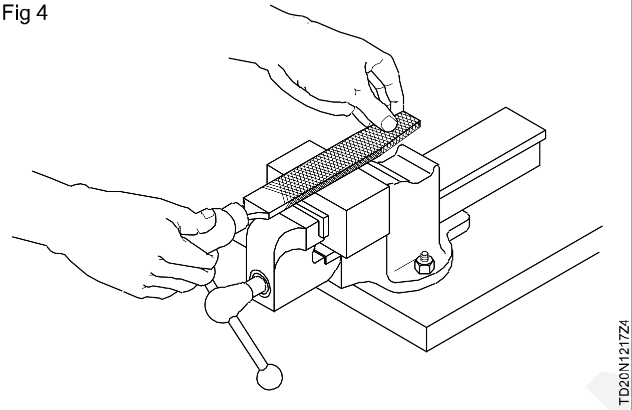
For heavy filing (Fig 3).

Fig 3



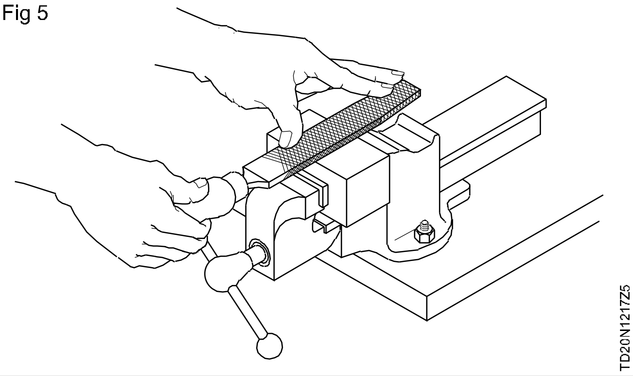
For light filing (Fig 4).

Fig 4



For removing the local uneveness (Fig 5).

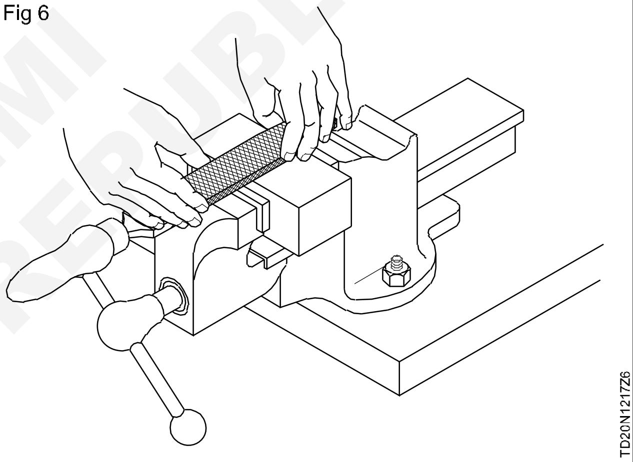
Fig 5



For removing the local uneveness draw filing can also be done (Fig 6). The same filing can also be done for fine finishing start filing by pushing the fine uniformly during the forward stroke and release the pressure during the return stroke.

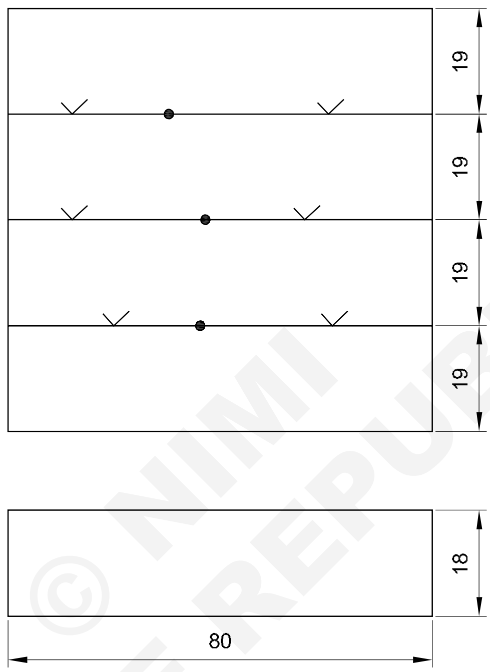
Continue giving strokes. Balance the pressure of the file in such a way that the file always remains flat and straight over the surface to be filed.

Fig 6



Marking with scriber and steel rule

Objectives: At the end of this exercise you shall be able to
- **file squareness and flatness**
- **mark with scriber and steel rule.**



Job Sequence

- Deburr the raw material.
- Check the raw material size.
- Apply marking media.
- Keep the job on the marking table.
- Mark 19mm, 38mm and 57mm from one edge using steel rule and scriber.
- Mark two arrow on the above dimensions.
- Join the two arrows for full length of job by using steel rule and scriber.
- After scribing four lines handover the job for evaluation.

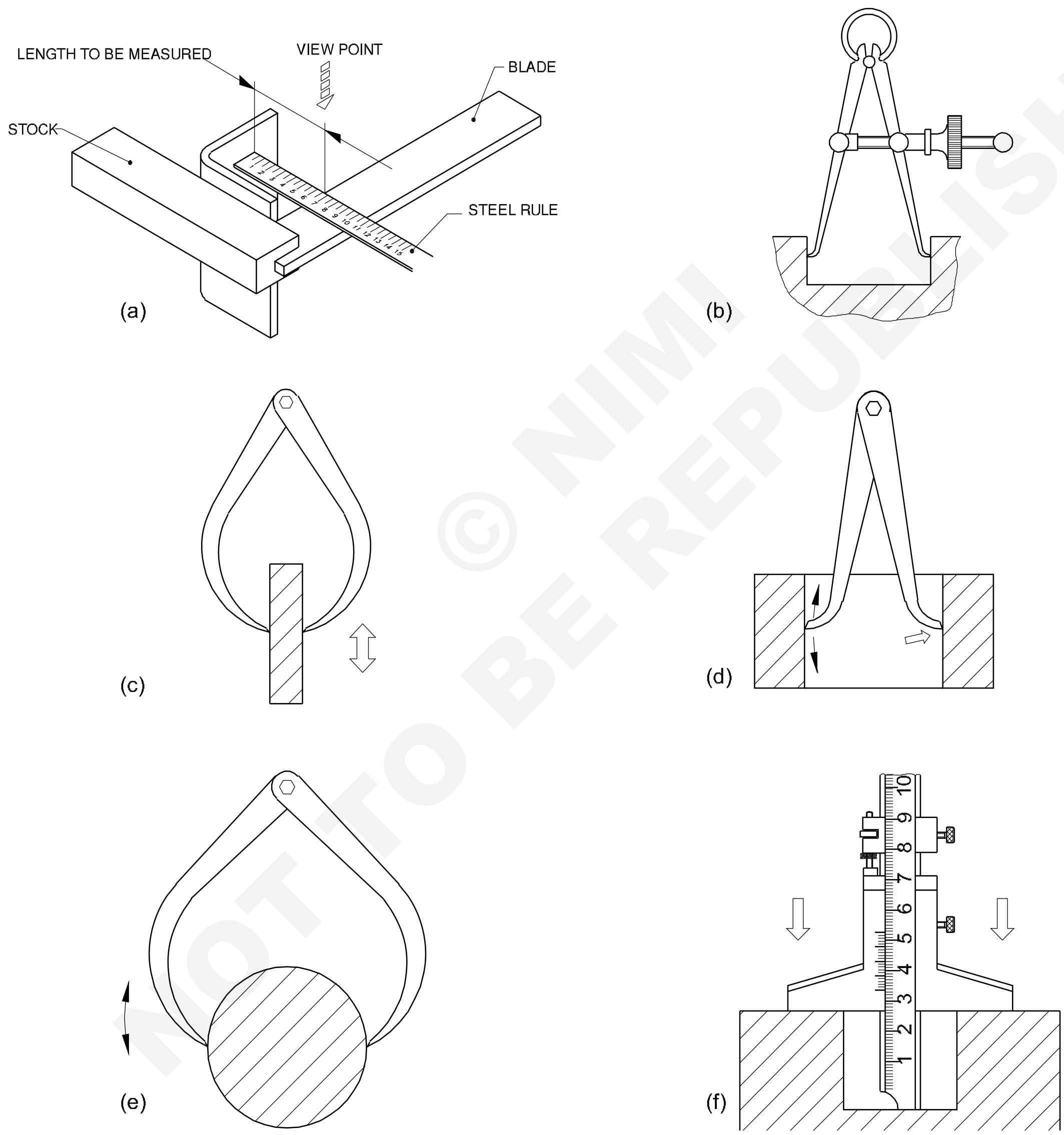
1	80X76X18		Fe310	-	-	1.2.18
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	MARKING WITH SCRIBER AND STEEL RULE	TOLERANCE : ± 0.5mm	TIME :
		CODE NO. TD20N1218E1	

Measuring with simple instruments

Objectives: At the end of this exercise you shall be able to
- **check the dimension with a steel rule**
- **check the external dimensions with outside caliper**
- **check the inside dimensions with inside caliper**
- **check the depth of blind holes and slots with depth rule.**

Note to the instructor: Provide old exercise and models as much as possible to the trainees for acquiring measuring skills with simple measuring instruments.



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NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE	MEASURING WITH SIMPLE MEASURING INSTRUMENTS	DEVIATIONS	TIME :
		CODE NO. TD20N1219E1	

Skill Sequence

Measuring with an outside calipers

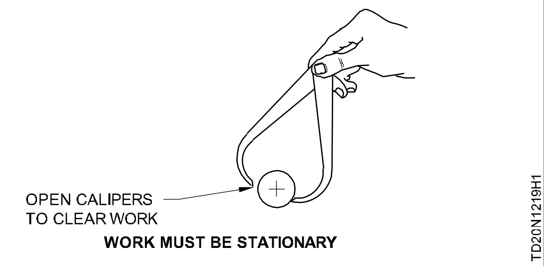
Objectives: This shall be help you to
- **select the right capacity caliper for measurement**
- **set the sizes both in firm joint and spring calipers**
- **read the sizes by transferring them to a steel rule or other precision measuring devices as the case may be.**

Outside calipers: Select a caliper based on the dimension to be measured.

A 150mm capacity outside caliper is able to measure sizes from 0-150mm.

Open out the jaws of the calipers until they pass clearly over the dimension to be measured. The work must be stationary when measuring the sizes. (Fig 1)

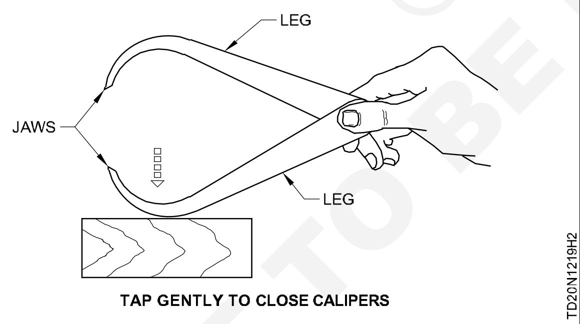
Fig 1



Place one point of the leg over the workpiece and get the sense of feel of the other point of the leg.

If there is clearance on the other point of the leg, gently tap the back of one leg of the firm joint calipers on a wooden piece until it just slips from the external diameter of the workpiece to give the right sense of 'feel'. (Fig 2)

Fig 2



Because the accuracy of reading the sizes depends mainly upon the sense of feel of the user, high care should be exercised to get the correct 'feel'.

In the case of spring outside calipers, adjust the screw nut so that the adjustment of the jaws just slips from the external diameter of the workpiece to give the right sense of feel. (Fig 3)

When you have adjusted the outside caliper for the correct 'feel' transfer the measurement to a steel rule or any other precision measuring instrument as the case may be.

Keep the graduated steel rule on a flat surface and hold the point of one jaw firmly against the rule end. (Fig 4)

Fig 3

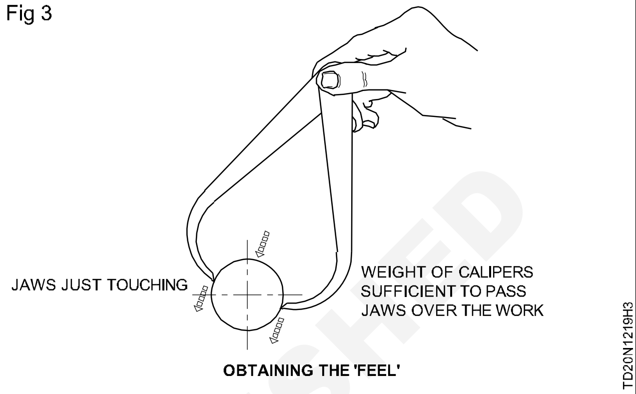
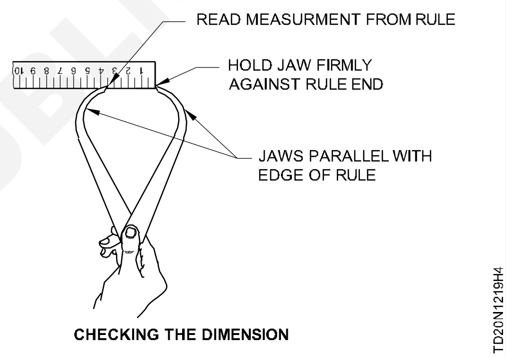


Fig 4



The point of one jaw must be placed over the graduation so that the point of the other jaw is parallel with the edge of the steel rule.

Record the reading to an accuracy of ±0.5mm.

In the case of precision measurements, transfer the measurements over an inside micrometer or vernier caliper. This measurement over an inside micrometer or vernier caliper. This measurement will give an accuracy of + 0.01 or +0.02 mm. Here, the sense of feel of the user is very important in deciding the reading.

Inside caliper: Open out the jaws slightly less than the size to be measured.

Hold the caliper lightly in one hand with your thumb and first finger on the adjusting screws.

The point of one jaw should sit against the surface being measured. Support the weight of the caliper with the middle or third finger. (Fig 5)

Open out the other jaw and until you get the sense of 'feel' by rocking the other measurable surface (Fig 6)

Fig 5

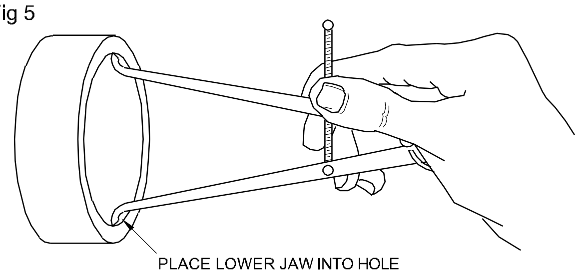
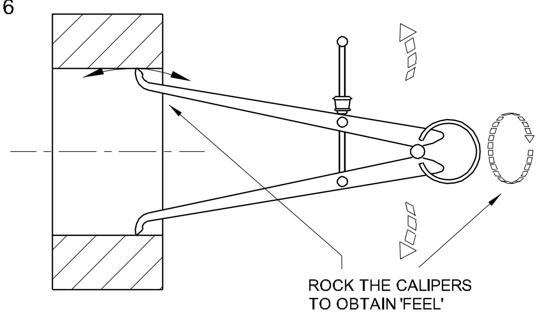


Fig 6



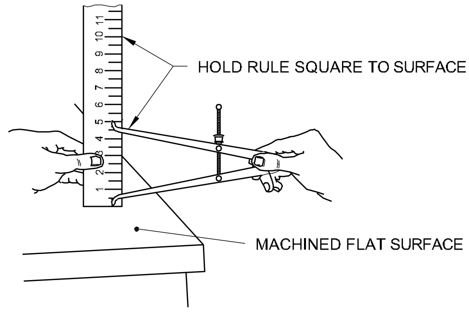
When a satisfactory sense of 'feel' is felt, transfer the measurement over a steel rule or precision measuring instrument as the case may be.

Hold the steel rule square on the machined flat surface.

Place one measuring jaw near the steel rule edge so that the point firmly touches the flat machined surface.

Keep the other measuring jaw parallel to the edge of the steel rule (Fig 7)

Fig 7



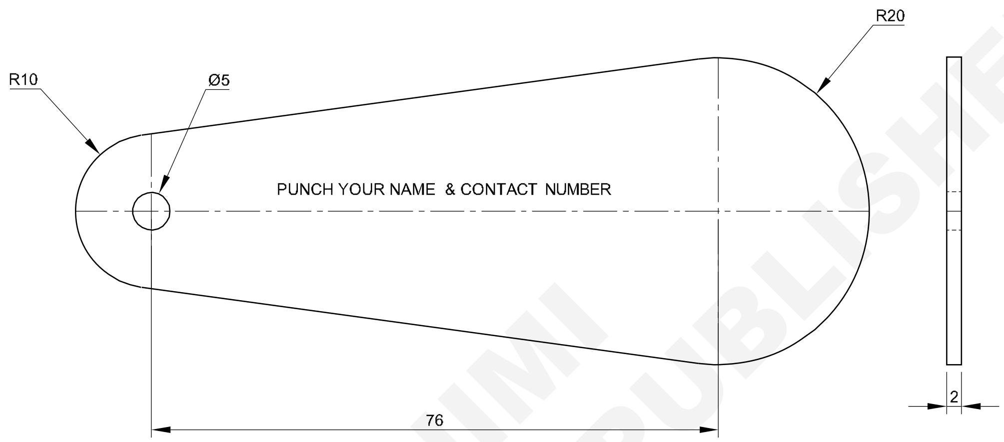
Read the graduation to an accuracy of +0.5 mm.

While transferring the measurement over to outside micrometer or universal vernier caliper, hold the caliper in the left hand, and the micrometer of the vernier caliper in the right hand.

Place one measuring jaw over the anvil surface and close the spindle over the other measuring jaw of the other leg.

Punch letter and number (letter punch and number punch)

Objective: At the end of this exercise you shall be able to
- **punch the letters and numbers.**



Job Sequence

- Check the raw material size.
- Mark and cut as per the drawing.
- File and finish to shape and dimension.
- Drill ϕ 5mm hole as shown in the figure.
- Punch your name and the contact number.
- Deburr and polish it.

1	SS 110 x45 x 2mm	-	STAINLESS STEEL	-	-	1.2.20
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	**PUNCH LETTER AND NUMBER (LETTER PUNCH AND NUMBER PUNCH)**				TOLERANCE : NIL	TIME :
					CODE NO. TD20N1220E1	

Skill Sequence

Punch letters and numbers

Objective: This shall help you to
- **punch letters and numbers.**

Letter and number punches

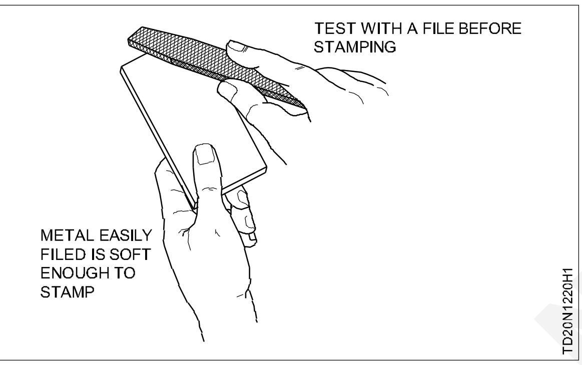
These hardened and tempered steel punches are used to stamp identifying symbols, letters or numbers as required on the work.

They are obtainable with symbols ranging in size from 0.8 mm to 13 mm.

They are kept in boxed sets.

Use a file on the work to be stamped to check the work is softer than the punch. Any attempt to stamp hard material would damage the punch. Use an electric pencil or acid etching to mark hard materials. (Fig 1)

Fig 1



Each symbol must be made with a single blow. A second blow gives a distorted second impression.

Letters such as **M** and **W** may require firmer blows to produce the same depth of impression such as letters **I** and **T** can make.

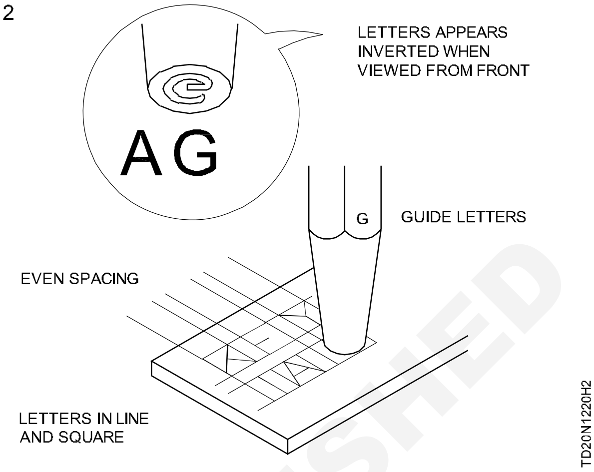
The depth of impression for a given blow varies with the softness of the material.

Practice on different metals.

Use the punches in the following manner:

- Mark out the guidelines for the symbols.
- Check that you have the correct symbol.
- Position the punch so that the symbol will be in line, square, correctly spaced and the correct way up. (Fig 2)

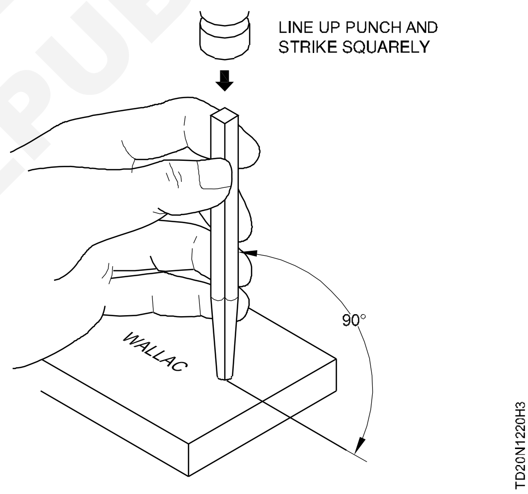
Fig 2



Hold the punch in a vertical position. (Fig 3)

Hold the hammer vertically above the punch. (Fig 3)

Fig 3



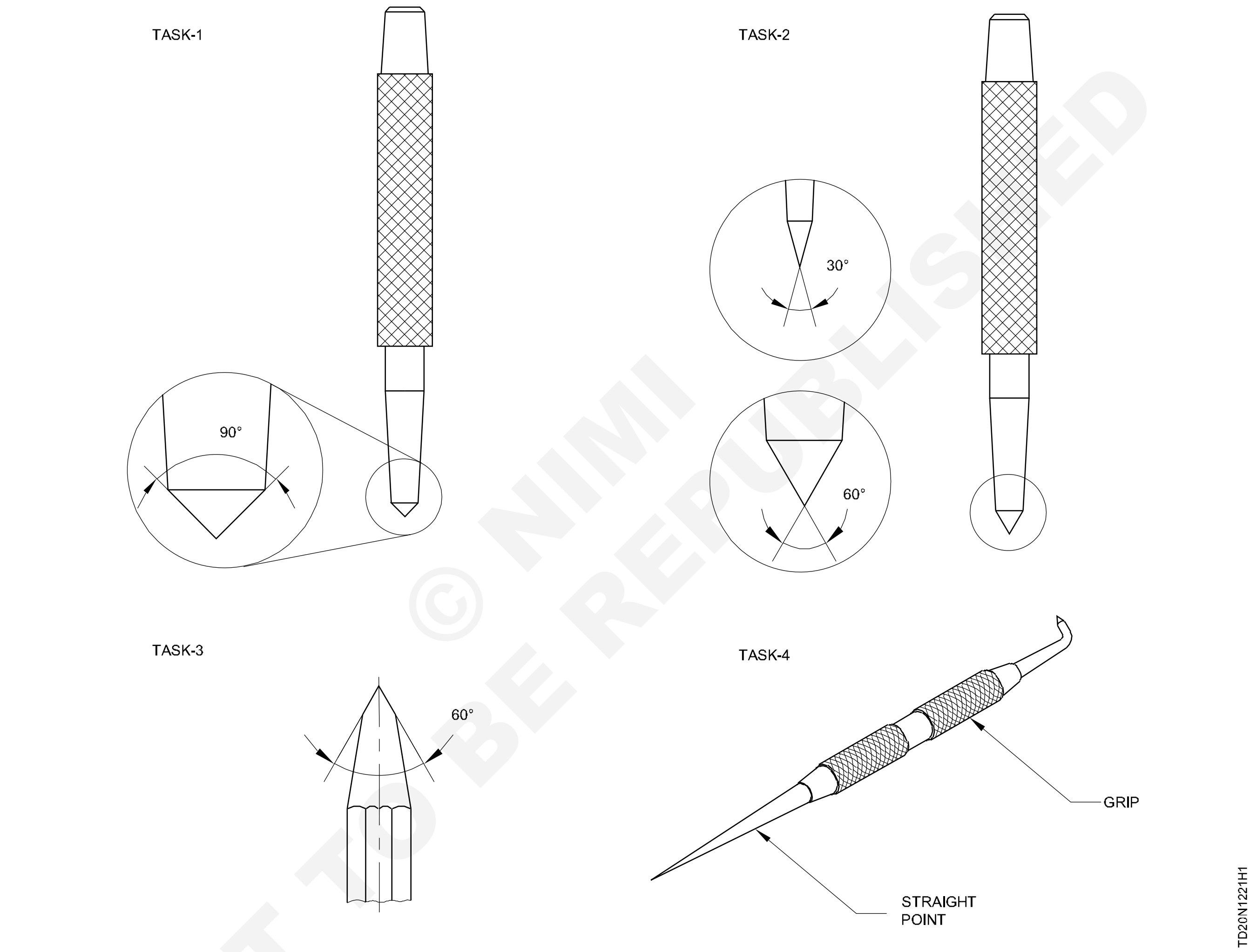
Watch the point of the punch.

Strike the punch squarely with one firm blow.

Grinding, center punch, dot punch, chisel & scriber

Objectives: At the end of this exercise you shall be able to
- **re-sharpen the flat chisel when it becomes blunt using pedestal/bench grinder**
- **re-sharpen the centre punch when it becomes blunt**
- **re-sharpen the dot punch/prick punch when it becomes blunt**
- **re-sharpen the scriber.**

Fig 1



Job Sequence

TASK 1 & 2: **Grinding centre punch and dot punch**

- Check the grinding wheel visually for any cracks.
- Adjust the tool rest so that there is a gap of 2 to 3mm between the grinding wheel and the tool rest.
- Hold the punch in a manner that the fingers of the left hand rest on the tool rest.
- The head of the punch should be held by right hand finger tips.
- Position the punch at an angle to obtain the required included angle.
- 90° for the centre punch and 60°for the dot punch.
- Check for the angle by using bevel protractor.

— — — — — — — —

TASK 3: **Grinding chisel**

- Check the grinding wheel visually for any cracks.
- Adjust the tool rest so that there is a gap of 2 to 3mm between the grinding wheel and the tool rest.
- Hold the chisel parallel to the wheel surface.
- Turn the chisel for 30° one side and 30° otherside.
- Rest the body of the chisel on the tool rest.
- Allow the point to touch the wheel.
- Keep minimum pressure on the chisel body while grinding.
- Grind for slight convexity (Crown) on the face of the chisel.
- Check the point angle with a bevel protector.

— — — — — — — —

TASK 4: **Grinding Scriber**

- Hold the scriber vertical on the grinding wheel face and rotate it with the finger.
- Quench the point frequently in the coolant.
- Sharp the scriber to an angle of 15°.
- Finish the scriber to the required sharp point.

— — — — — — — —

Skill Sequence

Grinding of flat chisel

Objective: This shall be hlp you to

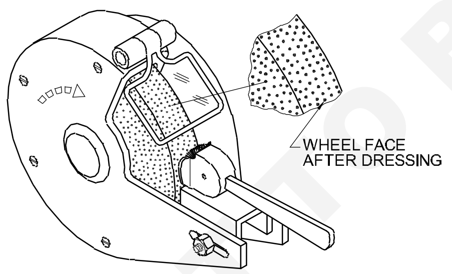
- **grind a flat chisel centre punch and dot punches when they become dull.**

Before grinding : check the grinding wheel by,

- Sliding the finger tip across the grinding wheel to detect glazing.

  (In case the of glazing dress the wheel.) seek the help of the instructor. (Fig 1)
- Visually check for cracks.

Fig 1



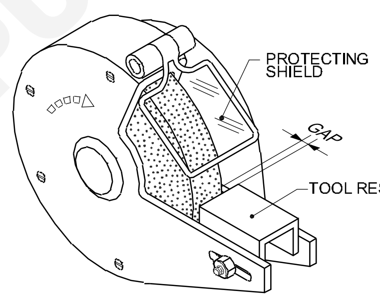
Switch on the grinder but stand by the side of the wheel for safety, and see whether the wheel runs ‘true’ and has no excessive vibration. In case of excessive vibration turning is necessary. Ask the instructor for advice.

Ensure that there is enough coolant in the container.

Protect your eyes with googles or lower the protecting shield near the tool rest.(Fig 2)

Adjust the tool rest 2mm closer to the wheel, if necessary. (Fig 2)

Fig 2

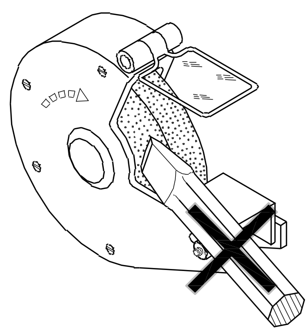


During grinding : Take a blunt chisel for re-grinding. Chisel will become blunt due to use. For efficient chipping, chisel are to be re-sharpened regularly.

Do not use cotton waste or other material for holding the chisel while grinding.

Use only the face of the wheel and not the sides (Fig 3) Switch on the grinder.

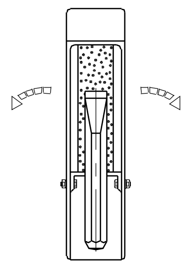
Fig 3



Hold the chisel edge parallel to the wheel surface the body of the chisel must be at an angle of 30°in such a way as to get 60° wedge angle. (Fig 5)

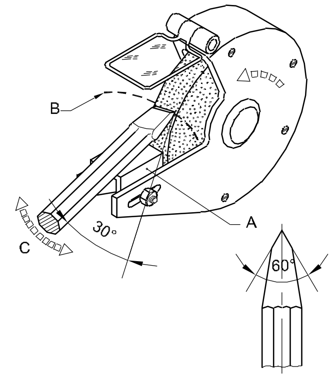
Rest the body of the chisel on the tool rest (A) and allow the point to touch the wheel. (Fig 4 &5).

Fig 4



Keep the pressure as minimum as possible to prevent excessive heating of the cutting edges, (avoid blue colour i.e annealing effect) Rock the point on both sides in an arc to provide convexity at the cutting edge. (Fig 5) See the arrows 'C' separate pare.

Fig 5



Dip the chisel in the coolant as and when it is required so as to avoid overheating.

Repeat the grinding on the opposite side of the cutting edge.

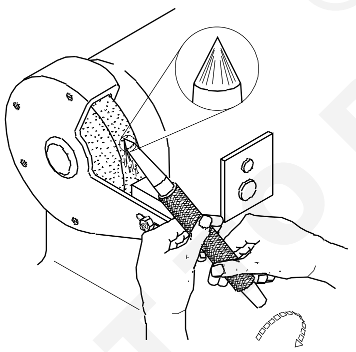
Check the wedge angle with a bevel protractor.

Sharpening a centre punch

Objective: This shall help you to
- **sharpen worn out centre punch.**

- For accurate layout work and hole locations are important that the centre and prick punches are sharpened correctly.
- For grinding, hold the punch in a manner that the fingers of the left hand rest on the tool rest.(Fig 1)

Fig 1



- The head of the punch should be held by the right hand fingers tips.
- Position the punch at an angle - to obtain the required included angle.(90°for centre punch and 60° for prick punch).
- Grinding is always on the front of the wheel. Rotate the punch and exert even and continuous pressure while grinding.
- Do not overheat the point while grinding.
- Dip the point in the coolant frequently.
- Make sure that the tip of the centre punch point is in the centre.

Use goggles to protect your eyes while grinding.

Sharpening a scriber

Objective: This shall help you to
- **sharpen a worn out scriber point.**

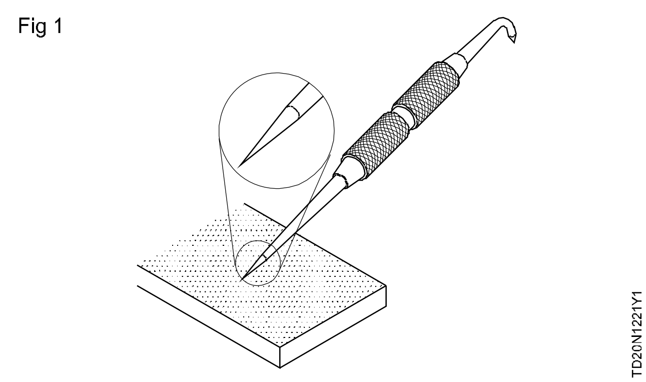
For drawing fine and accurate lines in layout work it is important to ensure that the scriber points are always maintained sharp.

If the scriber point is slightly blunt. It can be re-sharpened using an oilstone. (Fig 1)

When the point cannot be re-sharpened with an oilstone, it should be re-sharpened on a grinder.

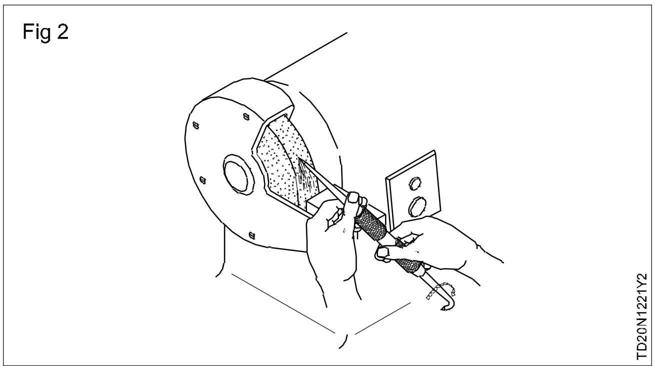
Do not sharpen the scriber by grinding unless it is absolutely necessary.

Fig 1



Re-sharpening of the point should be done on the face of the grinding wheel.(Fig 2)

Fig 2



For grinding the point hold the scriber vertically on the grinding wheel face and rotate it with the fingers.

The point being small can get heated up very quickly quench the point often in the coolant.

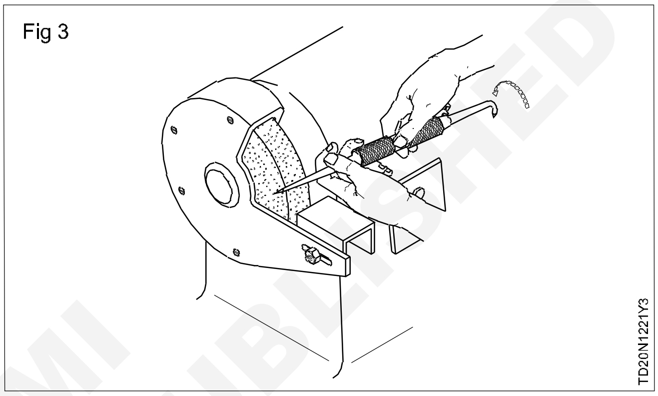
After a few sharpening the diameter of the point will become larger and would need re-sharpening of the tapered portion.

The long tapered portion also can be reground and brought to the required shape and size.

For this the scriber is placed horizontal on the face of the wheel and rotated by fingers. (Fig 3)

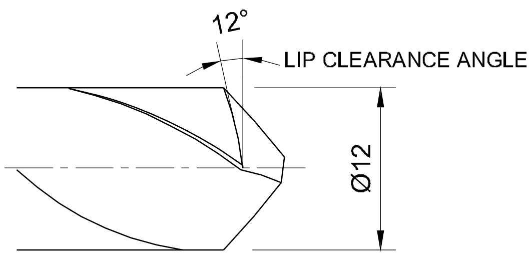
Be sure that the gap between the tool-rest and the wheel is correctly set before grinding.

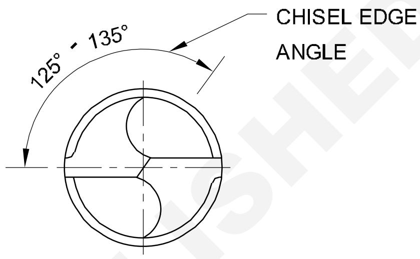
Fig 3

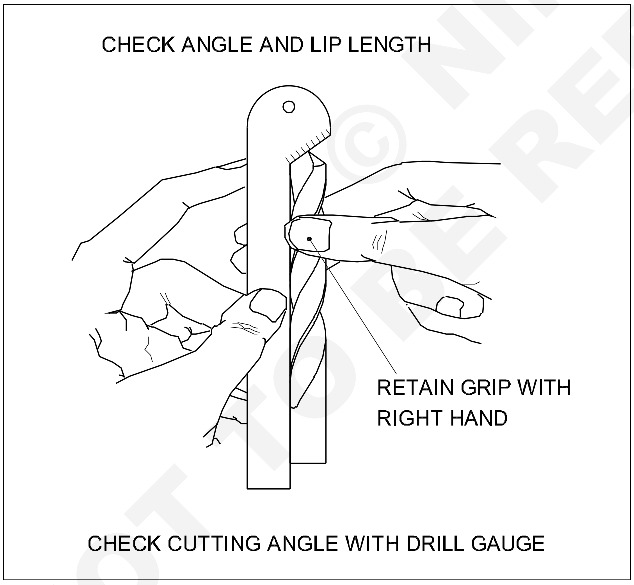


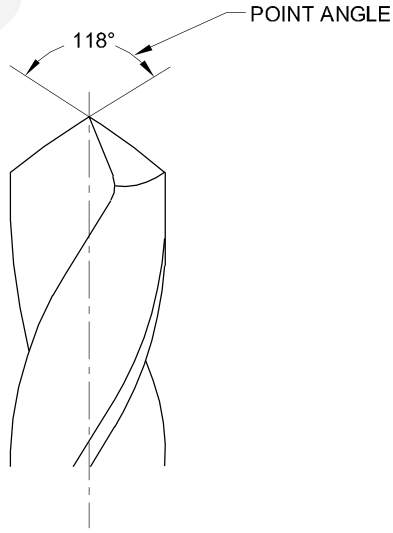
Drill grinding practice

Objectives: At the end of this exercise you shall be able to
- **dress the grinding wheel**
- **sharpen the drill in pedestal grinder**
- **check the drill angle using drill gauge.**









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NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	DRILL GRINDING	TOLERANCE : ± 30 minutes	TIME :
		CODE NO : TD20N1222E1	

Job Sequence

- Hold the blunt twist drill properly in both hands.
- Place the drill on tool rest.
- Touch the cutting edge of a twist drill in grinding wheel face maintaining 31° angle from grinding stone.
- Twist the drill slightly on wheel face and grind one cutting edge to the required angle to get 59°
- Similarly, grind the other cutting edge to the required angle to get 59° maintaining the cutting edges length equal.

Swing the shank of the drill slightly downwards while grinding.

While sharpening drill, the cutting edges length and angles should be equal.

- Check the cutting angle and cutting edge length in drill grinding gauge.
- Switch off the grinding machine and clean properly.

Wear safety goggles while sharpening twist drills.

Skill Sequence

Re-sharpening a twist drill

Objective: This shall help you to
- **re-sharpen a twist drill.**

A twist drill can be successfully sharpened on a bench or pedestal grinder by adopting the following preocedure.

Check that the surface of each wheel is running true and that the wheels are dressed clean.

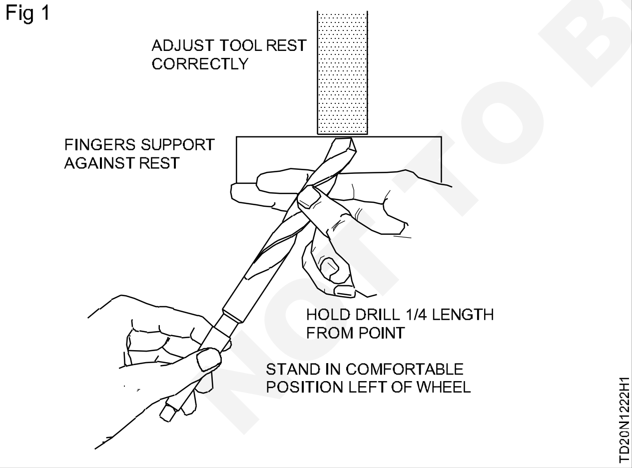
Ensure that the tool-rest are adjusted correctly and tightened.

Wear safety goggles.

Stand in a comfortable position in front of the machine.

Hold the drill at about one quarter of its length from the point, between the thumb and the first finger of the right hand (Fig 1).

Fig 1



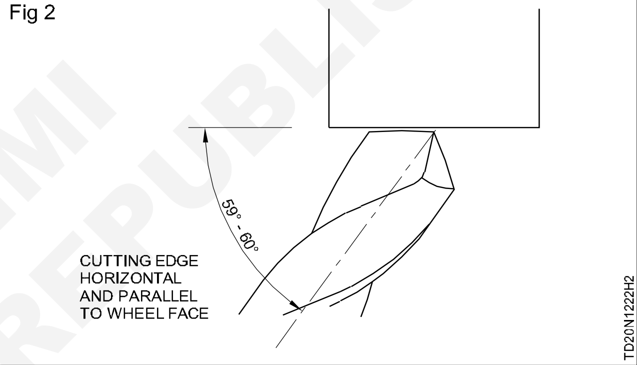
Keep both elbows against the side.

Position yourself in such a way that the drill makes an angle of 59° to 60° to the wheel face (Fig 2).

Hold the drill level. Twist it until one cutting edge is horizontal and parallel to the wheel face.

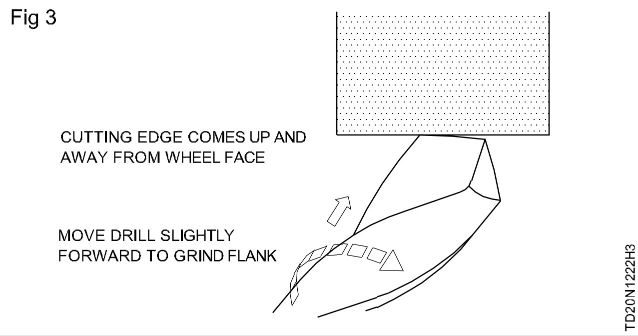
Swing the shank of the drill slightly downwards and to the left with the left hand. The right hand is on the tool-rest

Fig 2



Watch the cutting edge against the wheel. Note that, as the shank, swings down, the cutting edge comes slightly upwards and away from the wheel face. (Fig 3)

Fig 3



Apply a slight forward motion to your hands.

This will bring the flank of the point against the wheel to produce a lip clearance.

Coordinate the three movements of swinging down, twisting clockwise and forward movement. These movements should not be heavy movements. If they are performed correctly, they will produce a cutting edge that has the correct lip clearance and cutting angle.

Practice these movements against a stationary wheel, using a new or correctly sharpened drill.

Notice how only a small movement is required to produce the required clearance.

Also note that, if the drill is twisted too far, the other cutting edge will swing down to contact the wheel face.

Proceed now to sharpen one edge, removing as little metal as possible.

Procedure to obtain equal angles

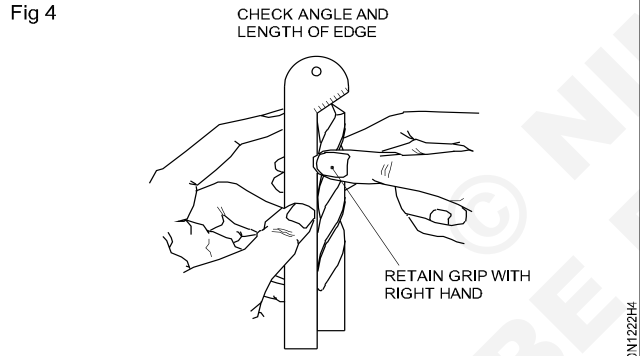
Move the drill back, clear of the wheel face.

Turn the drill over without moving the position. This presents the second edge to the wheel face at the same angle as the first cutting edge.

Proceed to sharpen the second cutting edge, using the same amount of drill movement as before. When these actions are carried but carefully, the drill will be sharpened with equal cutting angles. The lip clearance will be correct and equal.

Use a drill angle gauge to check that the cutting angle is correct (118° for mild steel), the cutting edges are of equal length and the lip clearances are equal and correct (about 12°) (Fig 4)

Fig 4



CHECK CUTTING EDGE WITH DRILL GAUGE

Lift the drill off the wheel face. Retain the grip on the drill with the right hand.

Make such inspection or checks as are necessary. Move the right hand back on- the tool-rest in the same position as before.

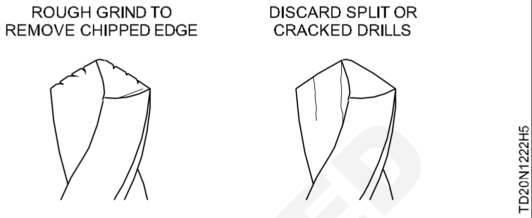
Hold the drill shank again in the left hand with the elbows against the side. The drill will locate back against the wheel face in the same position and at the same angle as before.

Points to be considered when sharpening drills

Grind as little as possible from the drill. Remove only enough to sharpen the cutting edges.

Rough down the drill point with a coarse grit wheel when the edges are badly chipped (Fig 5)

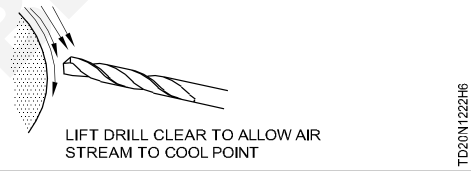
Fig 5



Never re-sharpen a cracked or split drill.
Avoid overheating the drill.

Apply light pressure against the wheel face. Lift the edge clear of the wheel face frequently. This allows the air stream produced by the wheel to cool the drill point. (Fig 6)

Fig 6



Cooling a drill rapidly by quenching in cold water may cause cracking of the cutting edge.

Re-sharpening of very small drills requires great skill. They require proportionally less movement to produce the cutting angles.

Testing a re-sharpened twist drill for its performance

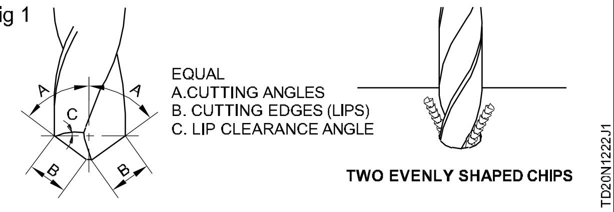
Objective: This shall help you to

- **test the drill that has been re-sharpened by drilling a through hole.**

Set the spindle revolution of the drilling machine to give a cutting speed of 25 to 30 meters per minute. A drill that has been re-sharpened correctly will:

- Produce two evenly curled chips from its cutting edges. (Fig 1)

Fig 1



- Require only moderate pressure to feed it into the work.

When the hole has been drilled through, take the drill out of the machine and try it by inserting into the hole.

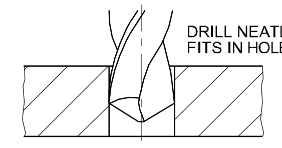
If the drill fits without any play it means that (Fig 2):

The cutting edges and angles are equal.

The drill has produced a hole of the correct size.

Any looseness of the drill in the hole means (Fig 3):

Fig 2

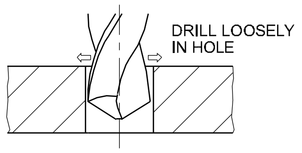


- The cutting edges are of uneven length.
- The drill has produced an oversized hole.

A drill that has been ground with uneven or too great a lip clearance will.

- Tend to chatter during starting.
- Produce an out-of-round hole.

Fig 3



Safe working on off - hand grinders

Objective: This shall help you to
- **work safely on an off- hand grinder.**

How to work on an off- hand grinder ?

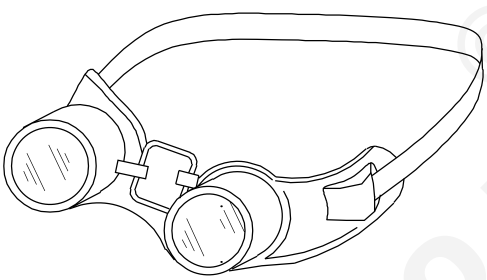
While working on off - hand grinder, it is important to observe the following safety measures.

Before starting

Make sure the grinding wheel guards are in place.

Wear safety goggles while grinding (Fig 1)

Fig 1

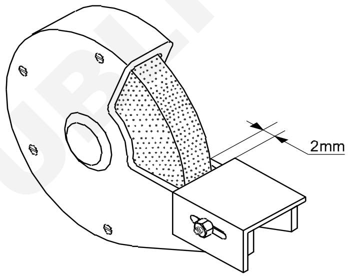


Stand on one side of the machine while starting.

Adjust the tool- rest as close to the wheel as possible.

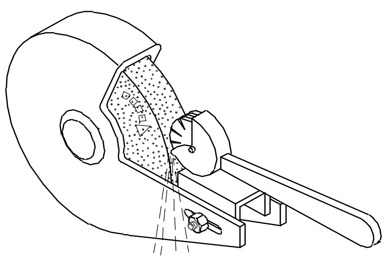
The maximum recommended gap is 2 mm. This will help to prevent the work from being caught between the tool rest and the wheel (Fig 2)

Fig 2



Do not work on grinding wheels which are loaded or glazed. Dress and true wheels whenever necessary. (Fig 3)

Fig 3



Caution; If any abnormal sound is noticed, stop the machine. Cracked or improperly balanced wheels are dangerous.

Dressing a grinding wheel

Objective: This shall help you to
- **dress a grinding wheel.**

When grinding wheels are loaded or glazed, they are rectified by dressing.

Dressing of pedestal grinder wheels is carried out by a star- wheel dresser.

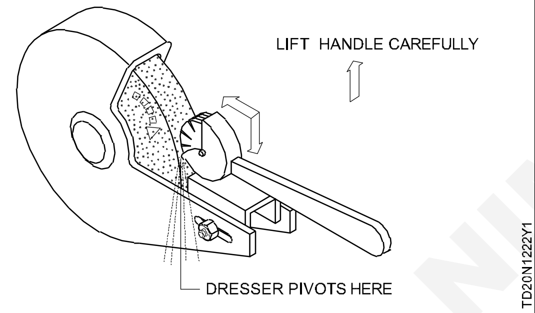
For correct setting of the star- wheel dresser, the work- rest should be adjusted so that the dresser pivots get positioned between the wheel and the work- rest. (Fig 1)

Make the dresser come in contact with the wheel by slowly lifting the handle.

As the dresser star- wheel starts rotating, there can be a jerk. This can be overcome by pressure exerted on the work- rest.

Press the dresser firmly against the grinding wheel and move it across the face.

Fig 1



Do not run off the edge of the wheel while moving across.

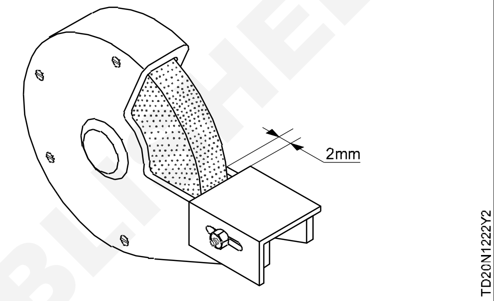
Do not release the downward pressure on the work- rest while lifting the handle.

Do not exert excessive pressure; it can crack the grinding wheel.

Move the dresser across the face of the grinding wheel until all the metal particles are removed, and the face is straight.

Read just the work- rest as close to the grinding wheel as possible (Fig 2)

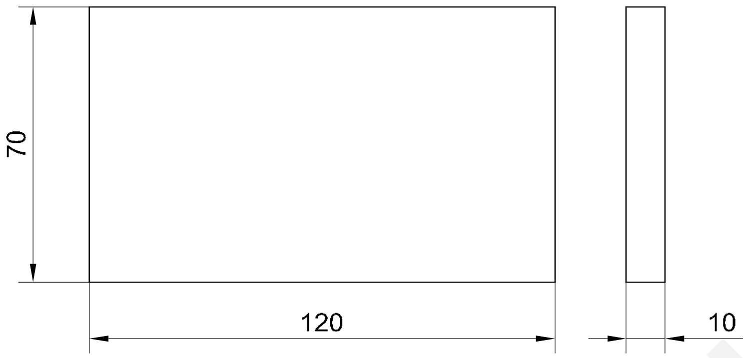
Fig 2



Wear safety goggles and gloves while dressing a grinding wheel. Stand on one side of the grinder while starting. Hold the dresser firmly while dressing. Do not put excessive pressure on the grinding wheels.

Drill plate filing

Objectives: At the end of this exercise you shall be able to
- **hold the job in a bench vice horizontally for filing**
- **file a flat surface and check the flat by try square blade**
- **file adjustant side and check the squareness**
- **file and maintain parallelism squareness and dimensions with in ±0.05 mm.**

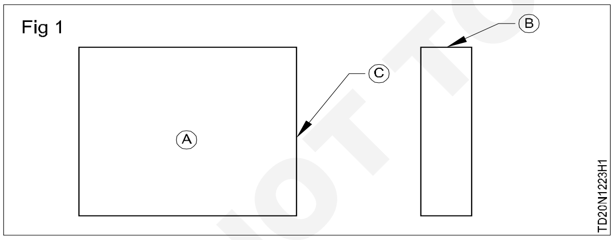


Job Sequence

- Check the raw material size using steel rule.
- Remove scaling by rough file.
- File side (A) with bastard file. (Fig 1)
- Check the flatness by blade of a try square.
- File side (B) and maintain the square ness with respect to side (A).
- Check the square ness with a try square.

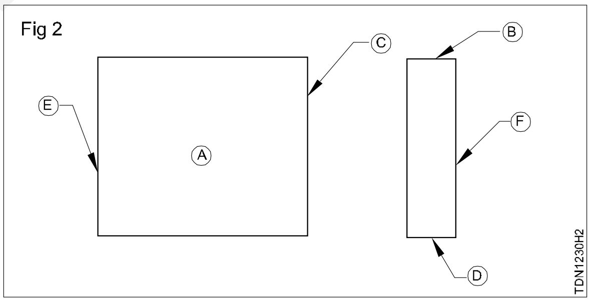
The side A,B and C are mutually perpendicular to each other. (Fig 1)

Fig 1



- Set Jenny caliper to 78 mm using steel rule.
- Draw parallel lines of 78 mm to side (B) and (C).
- Punch the marked line using dot punch and ball pane hammer.
- Set and file sides (D) and (E) to 78mm and maintain square ness to all another sides.
- Maintain (C) and (D) parallel to side (D) and (E). (Fig 2)

Fig 2



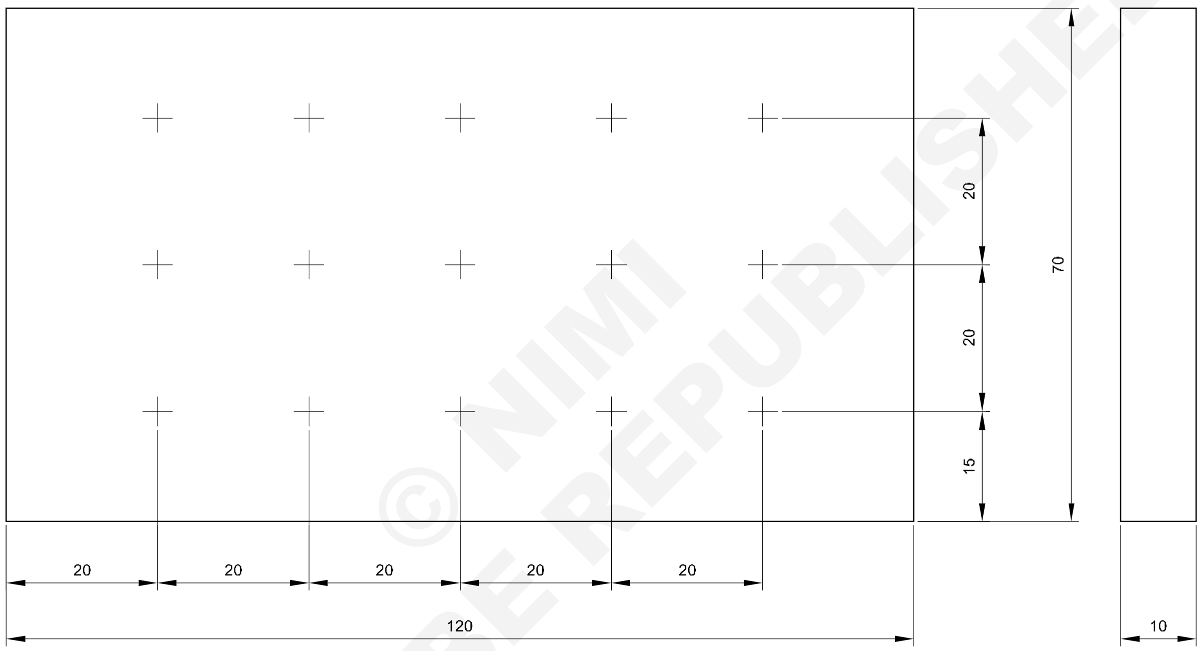
- Check the dimensions with a steel rule and squareness with a try square.
- File surface (F) and material the kickness of 9mm parallelism to side A.
- Remove sharp edges. Apply little amount of oil and pressure it for evaluation.

1	80 ISF12 - 125	→ 1.2.24	Fe310	-	-	1.2.23
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**DRILL PLATE FILING**	TOLERANCE : ±0.5mm	TIME :
		CODE NO. TD20N1223E1	

Marking for drilling operations

Objectives: At the end of this exercise you shall be able to
- **mark the centres of drill holes as per drawing using vernier height gauge**
- **mark the centres of drill holes using vernier height gauge.**



	-	→ EX.NO.1.2.25		-	-	
1	-	EX.NO.1.2.23 ←	Fe310	-	-	1.2.24
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	MARKING FOR DRILLING OPERATIONS	TOLERANCE : ± 0.5mm	TIME :
		CODE NO. TD20N1224E1	

Job Sequence

- Check the size of the pre machined workpiece
- Apply marking media evenly on the surface to be marked.
- Mark the locations of the hole centres with the help of vernier height gauge.

Skill Sequence

Marking with a vernier height gauge

Objective: This shall help you to
- **mark with a vernier height gauge.**

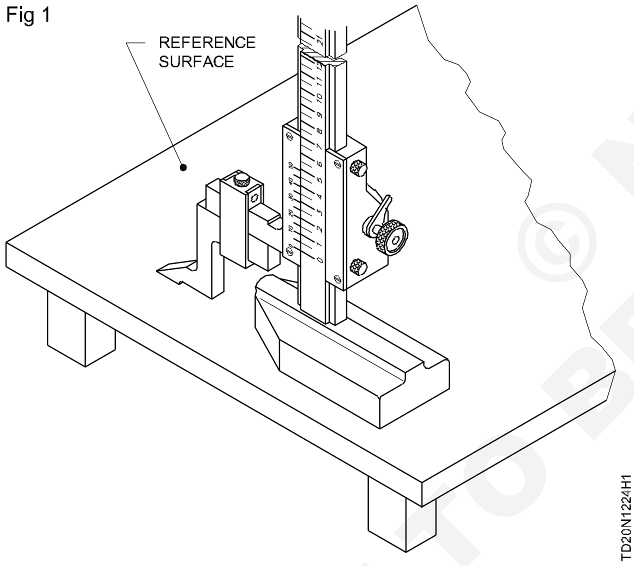
What is the main function of the vernier height gauge?

One of the primary functions of the vernier height gauge is to scribe lines on a workpiece to known heights.

How to use a vernier height gauge?

The height gauge scriber must be checked against the reference surface to confirm whether the zero of the vernier coincides with the zero of the beam scale when the scriber contacts the reference surface. (Fig 1)

Fig 1



Check for free movements of the sliding unit.

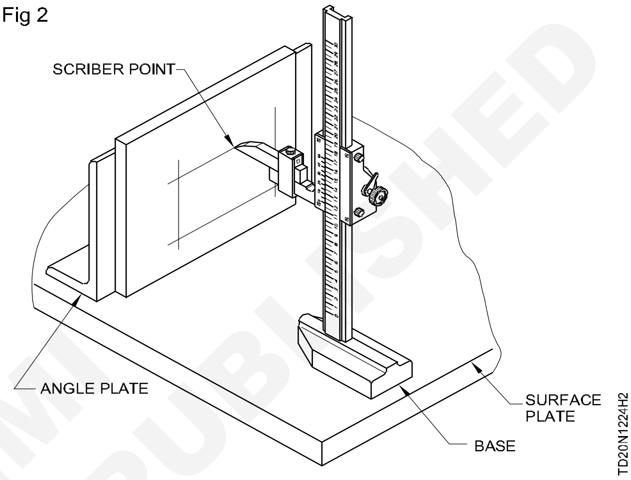
Make sure that the workpiece has no burr and has been properly cleaned.

This work piece need clamping to an angle plate. The application of the marking media should be light, thin and even.

Keep the vernier height gauge base firmly on the surface plate.

Hold the scriber at an angle to the workpiece, and pull the corner of the scriber across the work. (Fig 2)

Fig 2

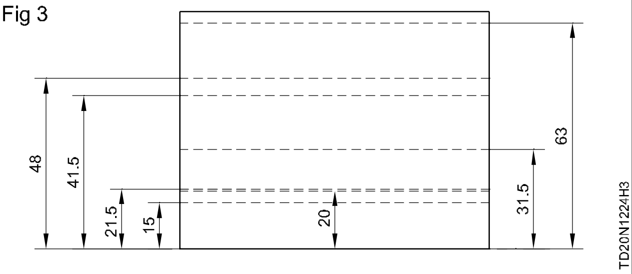


Do not allow the base to lift.

Do not apply too much pressure to peel off metal from the workpiece. This will avoid damage to the scriber point. Centre points can be located by scribing lines at right angles.

Scribe first all lines of dimensions in one direction. (Fig 3
Place the work at 90^0 and scribe the lines to dimensions to intersect one another. (Fig 4)

Fig 3

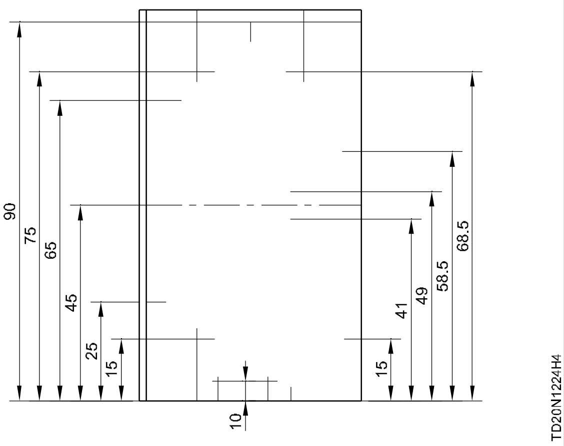


Work surfaces should be finished flat and smooth to avoid lifting during marking.

Precautions to get exact lines

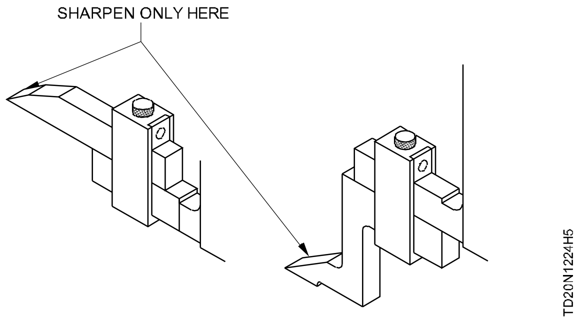
Ensure the scriber point is sharp always. Sharpen only the inclined surface of the scriber point. (Fig 5)

Fig 4



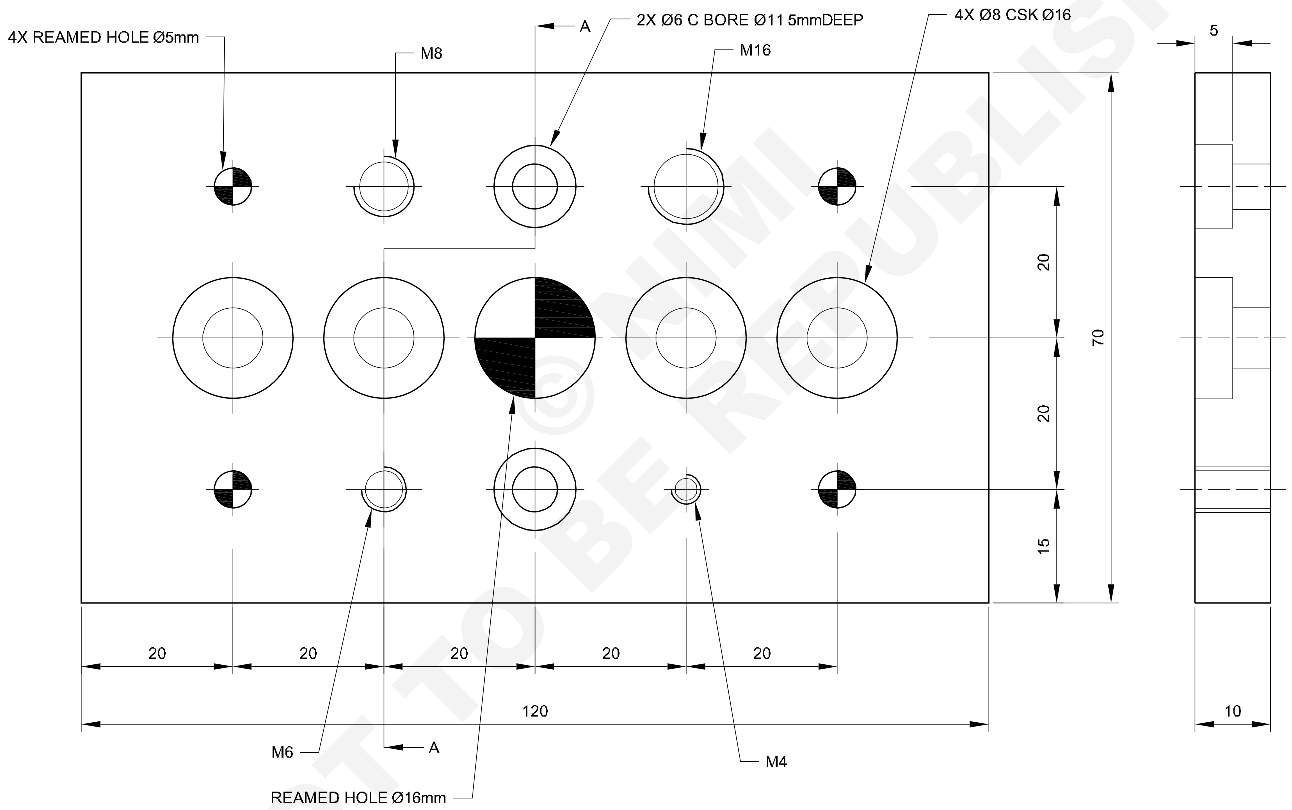
Frequent sharpening should be avoided. Ask the instructor to sharpen the scriber for you.

Fig 5



Drilling operations

Objectives: At the end of this exercise you shall be able to
- **punch the hole locations with centre punch**
- **centre drill and drill through holes**
- **counter sink and counter bore the drilled holes**
- **ream the drilled holes**
- **cut internal thread using hand taps.**



1	80X76X18	← EX.NO.1.2.24	Fe310	-	-	1.2.25
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	DRILLING OPERATIONS	TOLERANCE : ± 0.5mm	TIME :
		CODE NO. TD20N1225E1	

Job Sequence

- Centre punch the previously marked hole locations.
- Set the job on the drilling machine vice.
- Set centre drill, and drill centre drill at hole location.
- Set drill 5 mm and drill holes at the hole location.

Centre drill and drill hole in one setting.

- Set tap drill size for M 6 drill 5.2 mm and drill hole.
- Set tap drill size for M 8 drill 6.9 mm and drill hole.
- Set tap drill size for M10 drill 8.7 mm and drill hole.
- Similary set counter sink bit and perform counter sink and counter bore to the required depth.
- Drill ϕ15.5 at the location.
- Remove the workpiece deburr and set the job on the bench vice.
- Ream ϕ 5 mm at 4 places.
- Tap M10, M8, M6 using hand tap.
- Ream ϕ16.00 mm on ϕ15.5 mm drilled hole.
- Clean and remove the job from the bench vice.

Skill Sequence

Locating hole accurately by drilling centre hole

Objective: This shall help you to
- **drill centre holes with a drilling machine.**

Drilling centre holes by combination drills is an accurate method of locating the position of the holes (i.e. within ± 0.025mm). In drilling operations, this method will be specially helpful while drilling deeper holes, and holes of fairly accurate locations. For doing centre drilling, proceed as follows.

Hold the combination centre drill in the drill chuck and check whether it 'runs true'. Adjust the spindle speed to suit the combination drill.

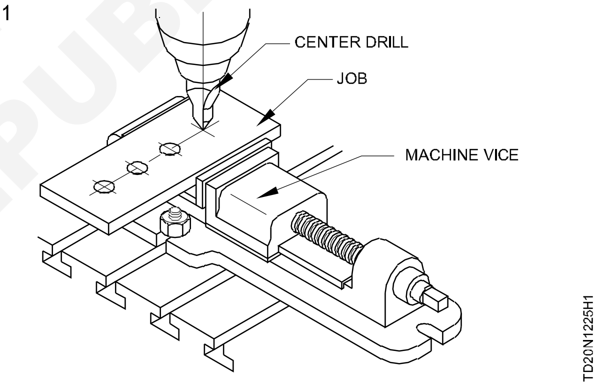
Adjust the job together with the vice and align with the centre punch mark. (Fig 1)

Drill a centre hole up to the depth of 3/4th of the counter sink. Do not apply undue pressure on the centre drill.

Apply sufficient quantity of cutting fluid.

Remove the centre dill, hole the twist drill of the required dia. Check if it 'runs true'. Start drilling the through hole.

Fig 1



Tapping through holes

Objective: This shall help you to
- **cut internal threads using hand taps.**

Determine the tap drill size either using the formula or the table.

Drill the hole to the required tap drill size. [An undersized hole will lead to breakage of the tap].

Chamfer the end of the drilled hole for easy aligning and starting of the tap. (Fig 1)

Hold the work firmly and horizontally in the vice. The top surface of the job should be slightly above the level of the vice jaws. This will help in using a try square without any obstruction while aligning the tap. (Fig 2)

Fig 1

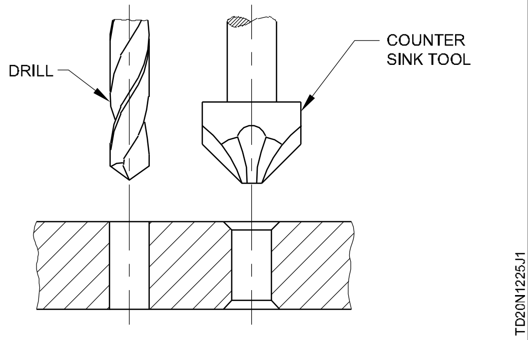
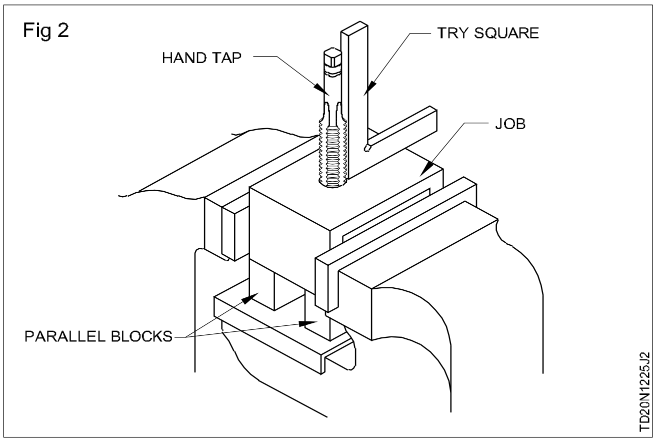


Fig 2

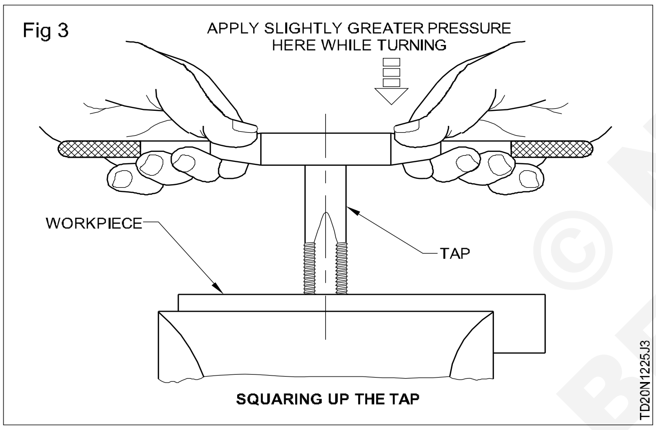


Fix the first tap (taper tap) in the correct size tap wrench. Too small a wrench will need a greater force to turn the tap. Very large and heavy wrenches will not give the ‘feel’ required to turn the tap as it cuts and may lead to breakage of the tap.

Position the tap in the chamfered hole vertically by ensuring the wrench is in a horizontal plane.

Exert steady downward pressure and turn the tap wrench slowly in the clockwise direction to start the thread. Hold the tap wrench close to the centre. (Fig 3)

Fig 3



SQUARING UP THE TAP

Remove the wrench from the tap when you are sure of starting the thread without disturbing the setting.

Check and make sure that the tap is vertical by using a try square in two positions at 90° to each other. (Figs 4 & 5)

Fig 4

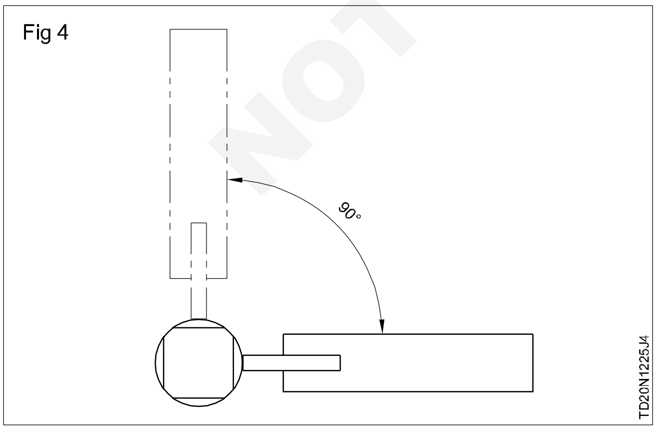
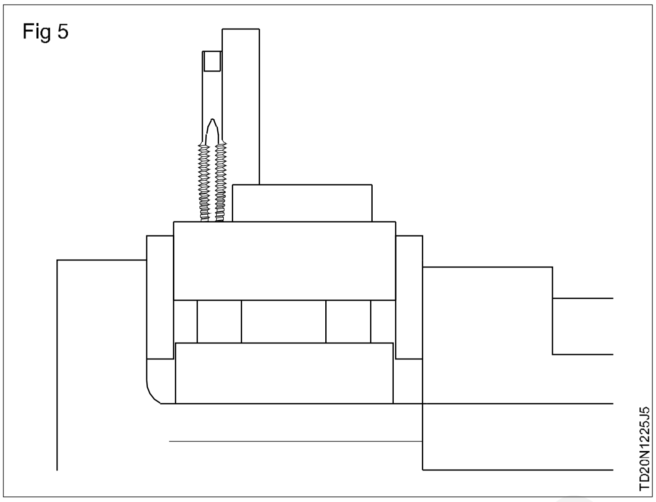


Fig 5

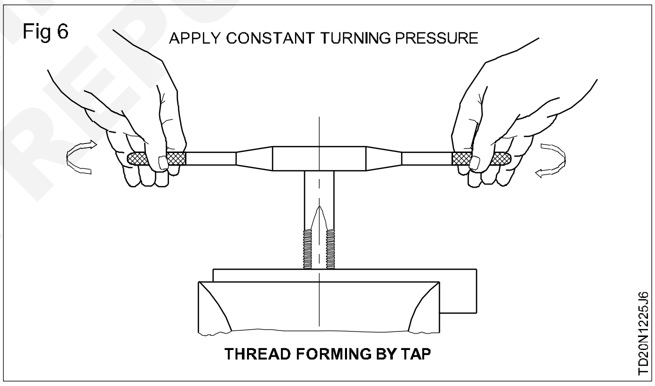


Make correction if necessary by exerting slightly more pressure on the opposite side of the tap inclination.

Check the tap alignment again. The tap alignment should be corrected within the first few turns. If it is tried afterwards there is a chance of breaking of the tap.

Turn the wrench lightly by holding at the ends without exerting any downward pressure after the tap is positioned vertically. The wrench pressure exerted by the hands should be well balanced. Any extra pressure on one side will spoil the tap alignment and can also cause breakage of the tap. (Fig 6)

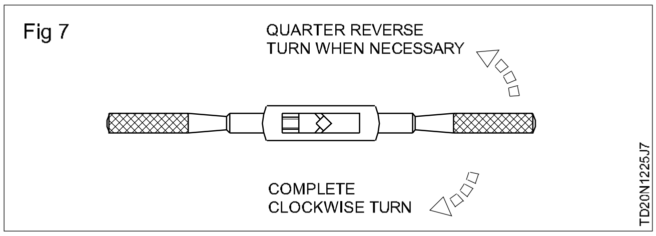
Fig 6



THREAD FORMING BY TAP

Continue cutting the thread. Turn backwards frequently about quarter turn, to break the chips. (Fig 7)

Fig 7



Stop and turn backwards when any obstruction to the movements is felt.

Use a cutting fluid while cutting the thread to minimise friction and heat.

Cut the thread until the hole is totally threaded.

Finish and clean up using the intermediate and plug tap. The intermediate and plug tap will not cut any thread if the first tap has entered the hole fully.

Remove the chips from the work and clean the tap with a brush.

Make sure that the dia of the hole to be tapped is correct for the given size of the tap.

Turn backwards to break the chip after every quarter turn.

Select the length of wrench suitable to the size of the tap. Overlength of wrench may cause the breakage of tap.

Countersinking

Objective: This shall help you to
- **countersink holes of different sizes.**

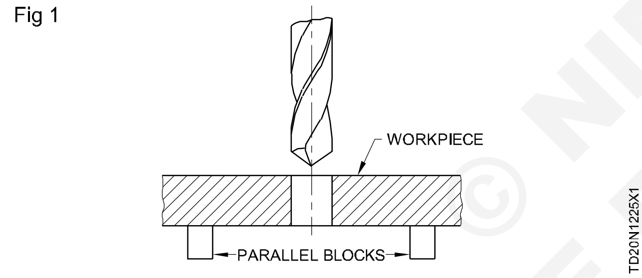
Selection of countersinks

Select the countersink tool according to the angle of the taper head of the screw. Use the table for countersink holes.

Fix the job in the machine vice (if necessary, use parallel blocks) and set it square.

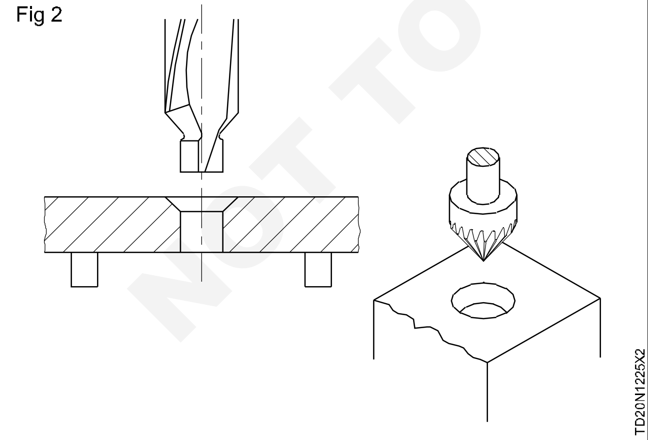
Align the machine spindle with the drilled hole to be countersunk. (Fig 1)

Fig 1



Remove the drill and fix the countersink tool on the machine without disturbing the alignment. (Fig 2)

Fig 2



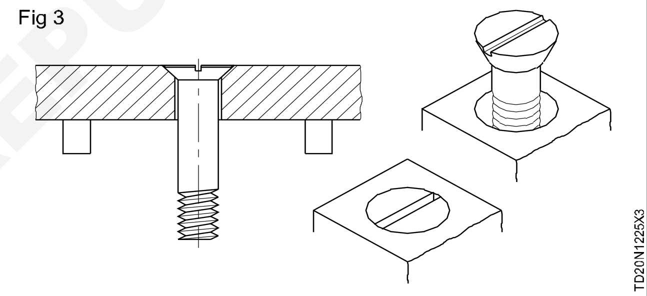
Set the spindle speed of the drilling machine to the nearest calculated RPM. Use the formula,

$$V = \frac{\pi \times D \times N}{1000}$$

Substitute the recommended value of 'V' and diameter of the countersink.

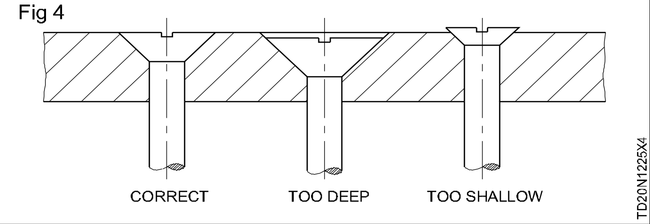
(V = 1/3rd of the cutting speed for drilling) Countersink the hole to a depth equal to the head length of the screwhead. (Fig 3)

Fig 3



Check the countersink hole with a suitable countersink head screw for proper seating. (Fig 4)

Fig 4



Counter boring

Objective: This shall help you to
- **counterbore holes of different sizes concentric to the drilled holes.**

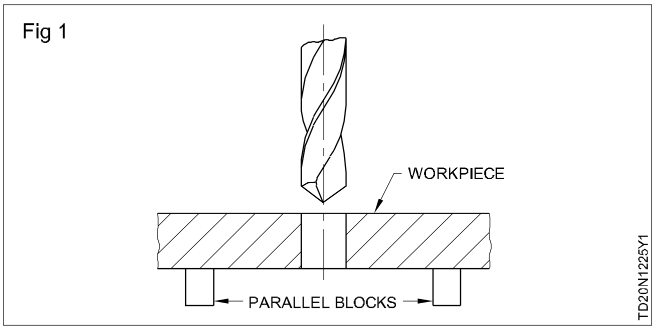
Selection of counterbore sizes

B.I.S. recommends different sizes of counterbores based on the sizes of the clearance holes.

Select the counterbore according to the screw size.

Fix the job in the machine vice, square to the axis of the machine spindle. Use parallel blocks. (Fig 1)

Fig 1

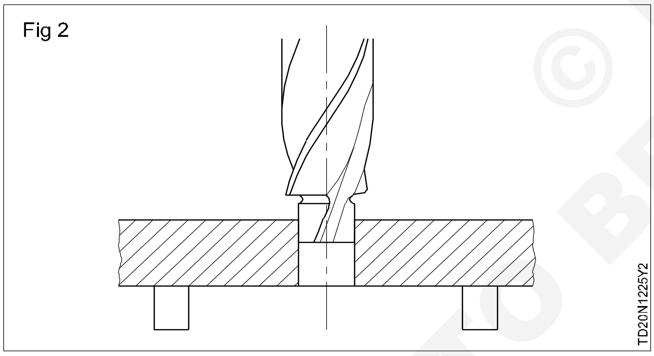


Set the location of the drilled hole position using the correct diameter drills.

Align the spindle axis with the drilled hole. For accurate work, drill and counterbore in one setting.

Mount and fix the counterbore tool on the drilling machine spindle. (Fig 2)

Fig 2



Set the spindle speed of the driling machine to the nearest calculatd RPM. Use the formula,

$$V = \frac{\pi \times D \times N}{1000}$$

(Consider the value of ‘V‘ as 1/3rd of the cuting speed for drilling).

Counterbore the hole to a depth slightly more than the thickness of the screwhead (Figs 3 & 4)

Fig 3

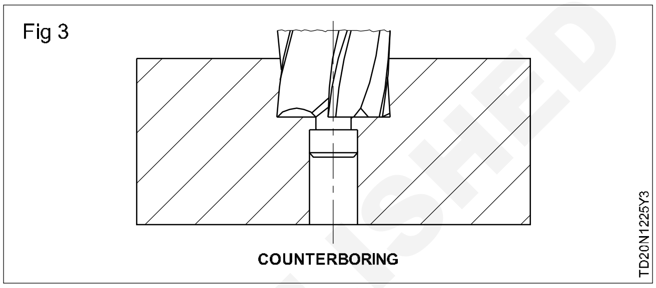
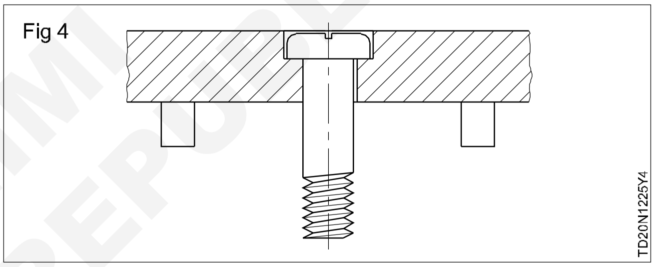


Fig 4



Use the depth stop arrangement for controlling the depth of the counterbore hole.

Check the depth of the counterbored hole. (Use the correct screw for checking the depth and seating.)

Reaming drilled holes using hand reamers

Objective: This shall help you to
- **ream through holes within a limits and check reamed holes with cylindrical pins.**

Determining the drill size for reaming

Use the formula,

drill diameter = reamed hole size. (undersize + oversize)

Refer to the table for the recommended

Drill sizes for reaming

Procedure for hand reaming

Drill holes for reaming as per the sizes determined.

Place the work on parallels while setting on the machine vice. (Fig 1)

Chamfer the hole ends slightly. This removes burrs, and will also help to align the reamer vertically (Fig 2). Fix the work in the bench vice. Use vice clamps to protect the finished surfaces. Ensure that the job is horizontal. (Fig 1)

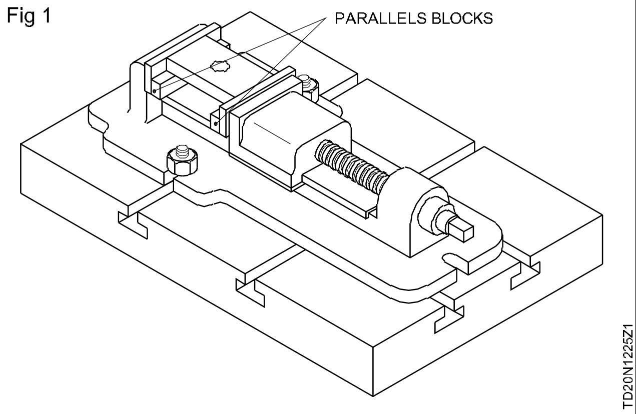


Fig 1

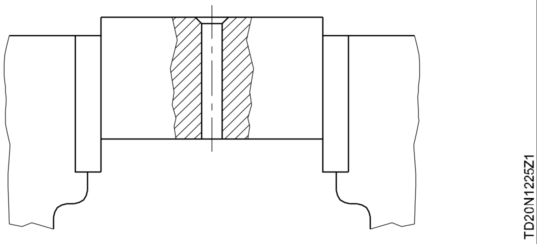


Fig 2

Fix the tap wrench on the square end and place the reamer vertically in the hole. Check the alignment with a try square. Make corrections, if necessary.Turn the tap wrench in a clockwise direction applying a slight downward pressure at the same time (Fig 3). Apply pressure evenly at both ends of the tap wrench.

Apply cutting fluid.

Turn the tap wrench steadily and slowly, maintaining the downward pressure.

> **Do not turn in the reverse direction, it will scratch the reamed hole. (Fig 4)**

Ream the hole through. Ensure that the taper lead length of the reamer comes out well and clear from the bottom of the work. Do not allow the end of the reamer to strike on the vice.

Remove the reamer with an upward pull until the reamer is clear of the hole. (Fig 5)

Remove the burrs from the bottom of the reamed hole.

Clean the hole. Check the accuracy with the cylindrical pins supplied.

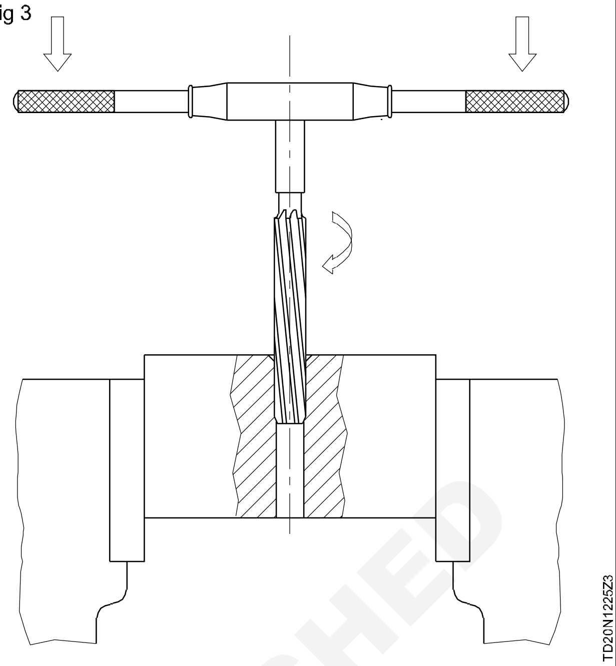


Fig 3

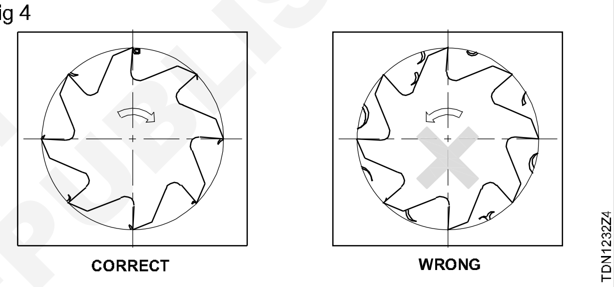


Fig 4

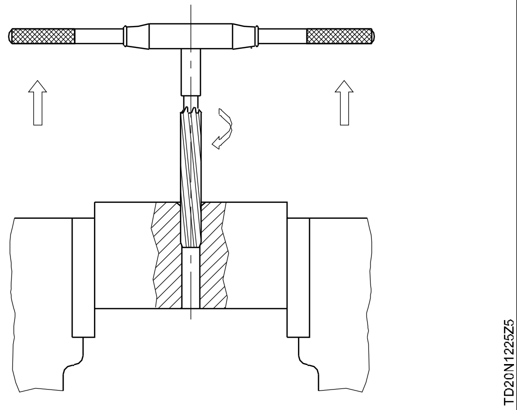
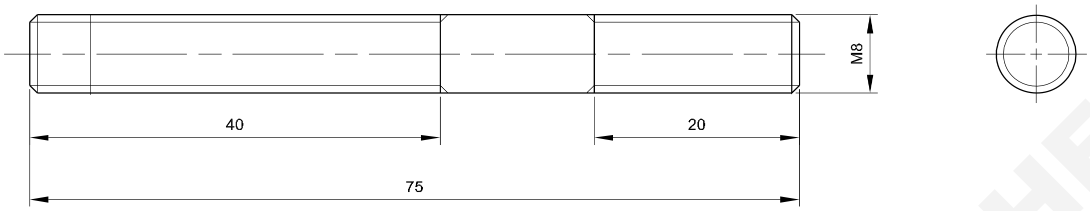


Fig 5

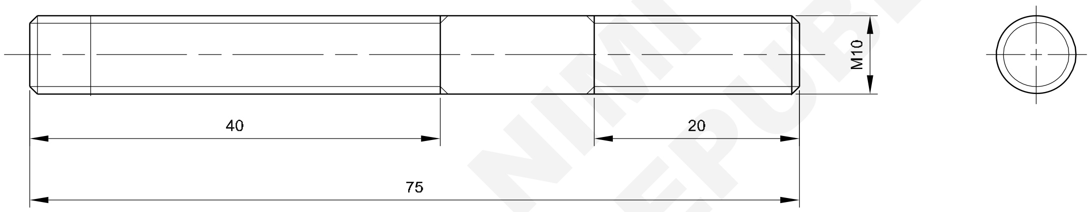
Die pass on Standard material

Objective: At the end of this exercise you shall be able to
- **cut external thread using solid die and die stock.**

TASK 1 : STUD M8



TASK 2 : STUD M10



Job Sequence

- Check the raw material size and deburr.
- Fix the job on the bench vice chamfer the ends with a flat file 1x45°.
- Set the die and die stock for cutting M8 the thread.
- Cut thread by rotating the die stock in a clockwise direction by appling normal pressure at the beginning.
- Apply cutting oil while threading.
- Reverse the direction of the die often while thread cutting.
- Continue till the required length.
- Rotate die in anticlock wise direction to remove die from the workpiece.
- Clean and debrurr.
- Similarly complete the task 2 with M 10 die

1	Ø10 X 77	-	Fe310	-	-	
1	Ø8 X 77	-	Fe310	-	-	1.2.26
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**DIE PASS ON STANDARD MATERIAL**	TOLERANCE : ± 0.5mm	TIME :
		CODE NO. TD20N1226E1	

Skill Sequence

External threading using dies

Objective: This shall help you to
• cut external threads using dies.

Select a correct size and circular rod as blank and chamfer the ends.

Blank size= Thread size-0.1% pitch of the thread

Grip the blank in the vice using a false jaw, projecting the blank above the vice jaws 5mm more than the required length of thread.

Fix the die in the diestock. The leading side of the die must be opposite to the step of the die stock. (Figs 1& 2)

Fig 1

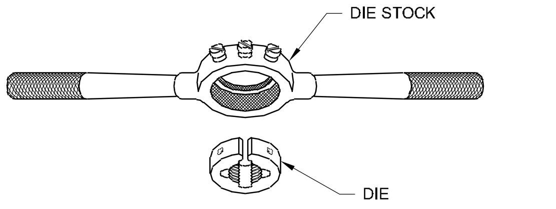
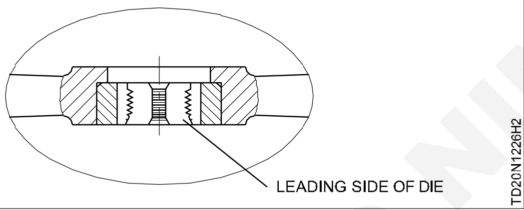
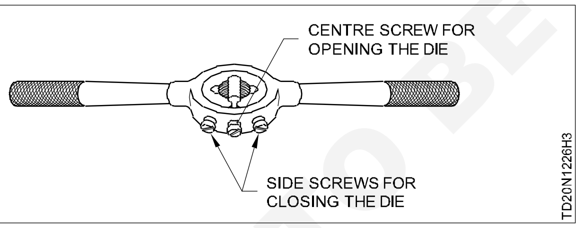


Fig 2



Open the die fully by tightening the centre screw of the die stock. (Fig 3)

Fig 3



Place the leading side of the die on the chamfer of the job.

Start the cutting thread, square to the bolt centre line. (Figs 4 & 5) turn in the clockwise direction to advance the die on the blank with even pressure on both ends of the die stock.

Fig 4

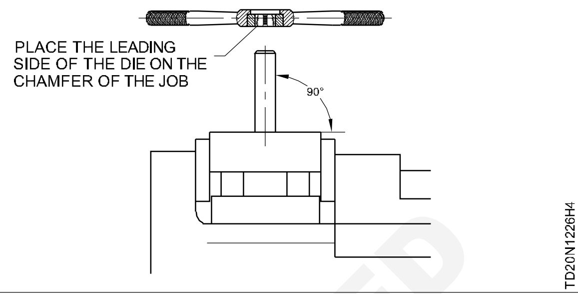
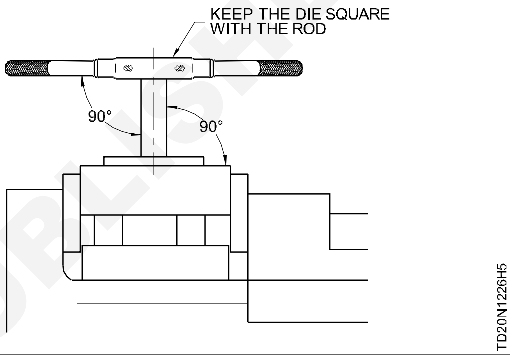


Fig 5



Cut thread slowly and reverse the die for a short distance in order to break the chips.

Use a cutting lubricant.

Clean the die frequently with a brush to prevent the chips from clogging and also from spoiling the thread.

Reverse and remove the die after the full height reached.

Increase the depth of cut gradually by loosening the centre screw and tightening the side screws.

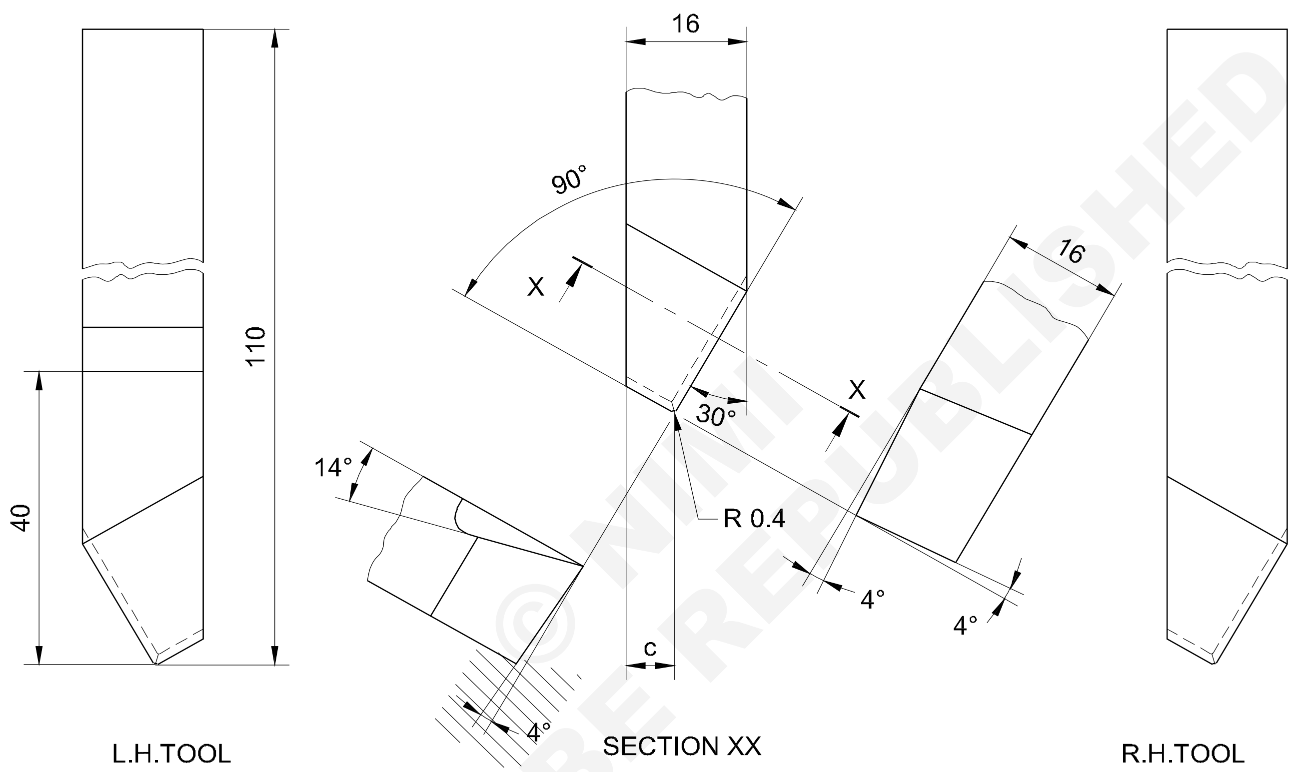
Too much depth of cut at one time will spoil the threads it can also spoils the die.

Check the fit of threads with a matching nut.

Tighten the side screw by hand and repeat the cutting until the standard nut matches with the external and without undue 'play' between the threads.

Cutting tool filing and grinding

Objectives: At the end of this exercise you shall be able to
- **mark the angles of the tool as per drawing using protractor**
- **cut the extra metal by hand hacks**
- **file to shape and check the angles with protractor**
- **grind the angles on the pedestal grinding machine**
- **check the angle with bevel protractor.**



Job Sequence

- Deburr and check the size of the raw material.
- Mark the angles asper drawing using bevel protractor.
- Cut the excess material by hand hacksaw.
- File to shape and check the angles by bevel protractor.
- Grind the angles on pedestal grinder.
- Rotate the wheel by hand and observe for free rotation.
- Check the grinding wheels for true running.
- Wear goggles.
- Dress the wheels by a wheel dresser.
- Adjust the tool-rest to maintain a minimum gap from the wheel face to a minimum of 2 to 3 mm.
- Hold and apply the side flank of the tool to the front face of the grinding wheel at 30° to horizontal.

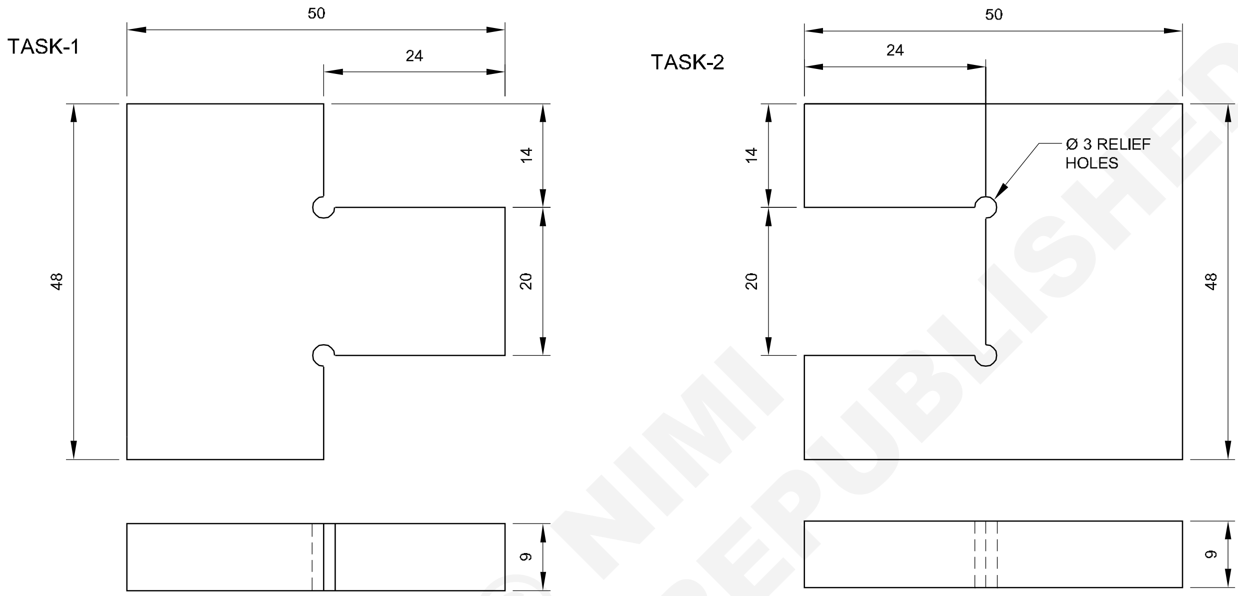
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	SQ16 - 110	–	Fe310	–	–	1.2.27

SCALE 1:1	TITLE : GRINDING A STRAIGHT TURNING TOOL	TOLERANCE	TIME
		CODE NO. TD20N1227E1	

- Move the tool left to right and vice versa to grind the side cutting edge angle to cover 2/3rd width of the tool.
- Grind a side clearance angle of 8°, the bottom of the edge touching the wheel first.
- Rough grind the end cutting edge angle of 30° and the front clearance angle of 5° simultaneously.
- Hold the top flank of the tool against the wheel face inclined at 14°, the rear side contacting the wheel first, and grind the side rake angle of 14°.
- Ensure that the ground portion is parallel to the side cutting edge.
- Finish grind all the faces on the finishing wheel.
- Grind a nose radius of approximately R. 0.4 mm.
- Check the angles with a tool angle gauge and template.
- Lap the cutting edge with an oilstone.
- The top rake (back rake) angle should be kept at 0°.

Make male & female open fitting with an accuracy ± 0.05mm

Objectives: At the end of this exercise you shall be able to
- **file flat surface to flat and parallel within an accuracy of ± 0.05 mm**
- **file and assemble the fitting and obtain the required class of fit.**



Job Sequence

TASK 1: **Male part**

- Check the raw material for its size.
- File and finish to size 50 x 48 x 9 mm maintaining parallelism and perpendicularity.
- Apply marking media ,mark as per job drawing and punch witness marks in part A as shown in Fig 1.
- Drill relief hole ϕ 3mm as per job drawing in part A.
- Mark lines as shown in Fig 2 leaving the metal 1mm away from the object line and cut and remove the excess metal by hack sawing.
- File part A as per drawing to size 14mm x 24mm with safe edge file and check the size with vernier caliper.
- Similarly cut and remove the excess metal and file step B to size and shape and check the size with veriner caliper as shown in Fig 3.

2	50 ISF 10 - 55	-	Fe310	-	A&B	1.2.28
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	Ex. NO.
SCALE 1:1	MAKE MALE & FEMALE OPEN FITTING				TOLERANCE : ± 0.04	TIME :
					CODE NO : TDN1237E1	

Fig 1

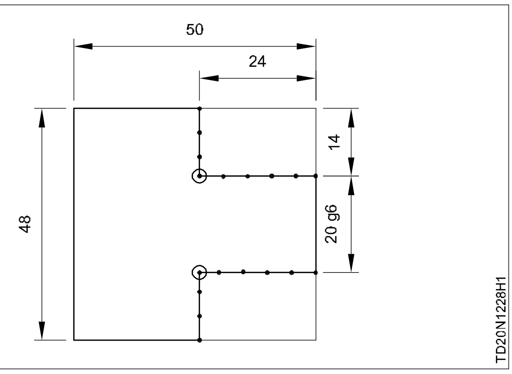


Fig 2

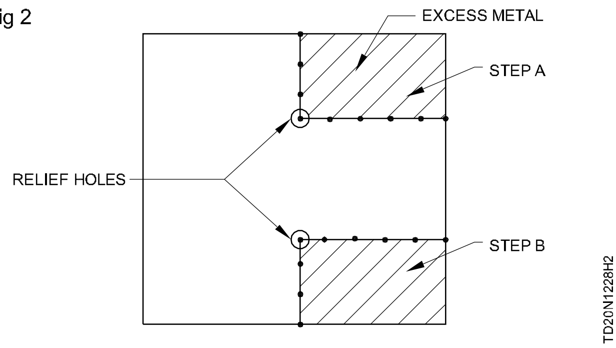
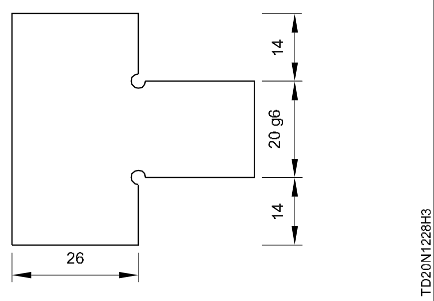


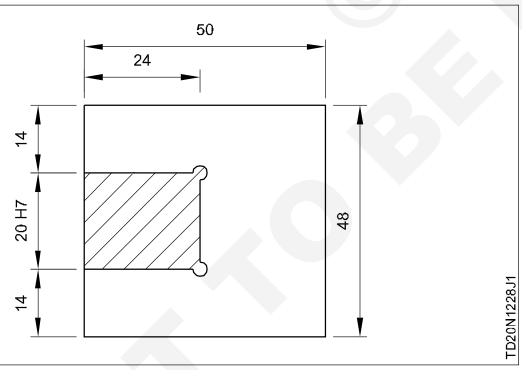
Fig 3



TASK 2: **Female part**

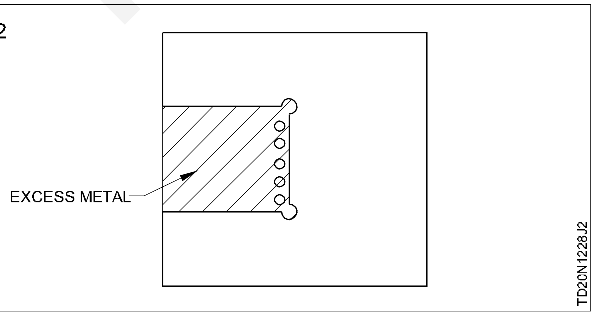
- File and finish to size 50 x 48 x 9mm maintaining parallelism and perpendicularity.
- Apply marking media, mark and punch as shown in Fig 1.

Fig 1



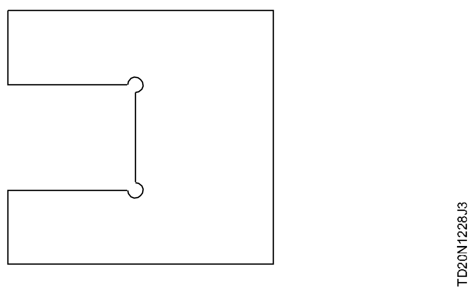
- Drill relief hole ϕ3mm on part B
- Chain drill holes, chips hacksaw and remove the excess metal as shown in Fig 2.

Fig 2



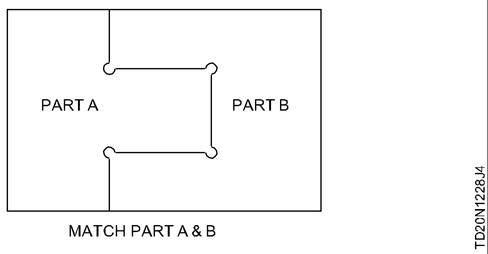
- File to size and shape maintaining the flatness and squareness as shown in Fig 3.
- Check the size with vernier caliper.

Fig 3



- Match part 'A' and 'B' as shown in Fig 4.
- Finish the filing and de- burr in all the surface of the job.
- Apply a thin coat of oil and preserve it for evaluation.

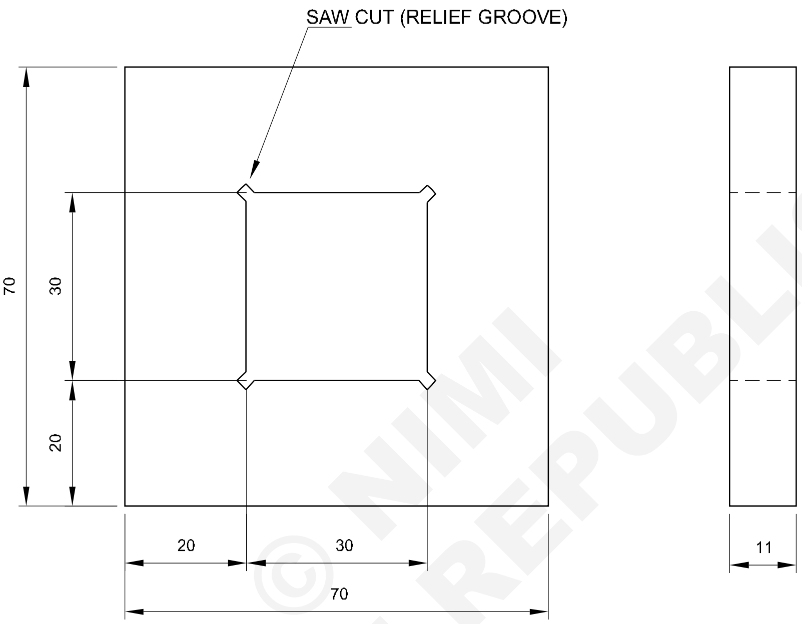
Fig 4



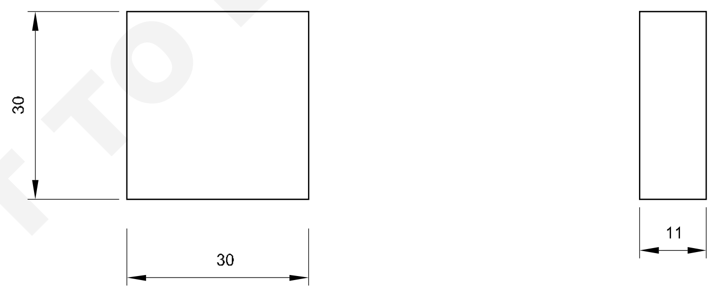
Make male and female square fit with an accuracy ± 0.05 mm

Objectives: At the end of this exercise you shall be able to
- **mark the dimension lines as per drawing**
- **chain drill, cut and remove excess metal by chipping**
- **file square slot maintaining ± 0.05 mm**
- **match square in square slot.**

TASK-1



TASK-2



1	35 ISF 12- 35	–	Fe310	–	-	
1	75 ISF 12 - 75	–	Fe310	–	-	1.2.29
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

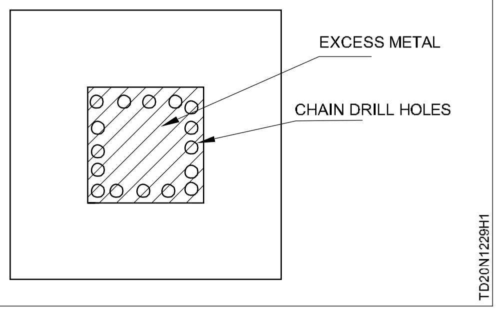
SCALE NTS	**MAKE MALE FEMALE SQUARE FIT**	TOLERANCE : ±0.01	TIME :
		CODE NO : TD20N1229E1	

Job Sequence

TASK 1: **Marking and chain drilling**

- Check the given raw material for its size.
- Rough and finish file on surface flat and square to overall size 70 x70 x11 mm maintaining accuracy ± 0.04mm.
- Mark off sizes in part 1 as per job drawing and punch witness marks.
- Hold part 1 in drilling machine table and drill chain drill holes to remove excess metal as shown in Fig 1 .

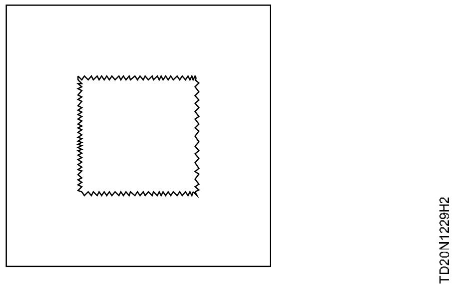
Fig 1



Periphery of the drill should not touch the witness marks.

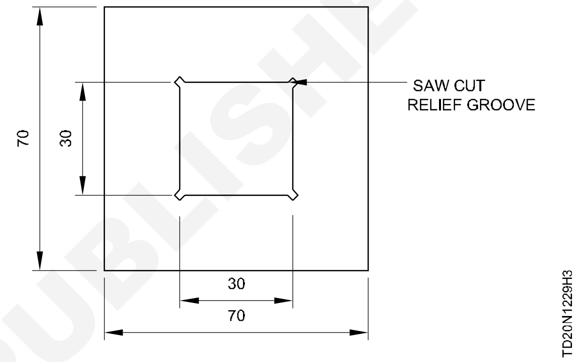
- Cut and remove the chain drilled hatched part using web chisel and ball pein hammer as shown in Fig 2.
- File the chipped portion to size and shape using safe edge file of different grades maintaining accuracy of ± 0.05 mm and check the size with veriner caliper.

Fig 2



- Cut relief grooves using hacksaw at four inside corners as shown in Fig 3.

Fig 3

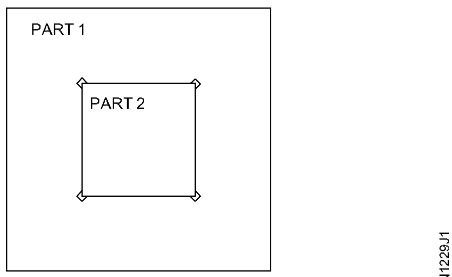


— — — — — — — —

TASK 2: **Filling the square and fitting**

- File to size 30 x 30 x 11mm maintaining accuracy ±0.05mm.
- Check the flatness and squareness with try square.
- Check the size with vernier caliper.
- Match part - 2 into part 1 as shown in Fig 1.
- Finish file in part 1 and 2 with flat smooth file and de burr in all the surface and corners of the job.
- Apply a little oil and preserve it for evaluation.

Fig 1

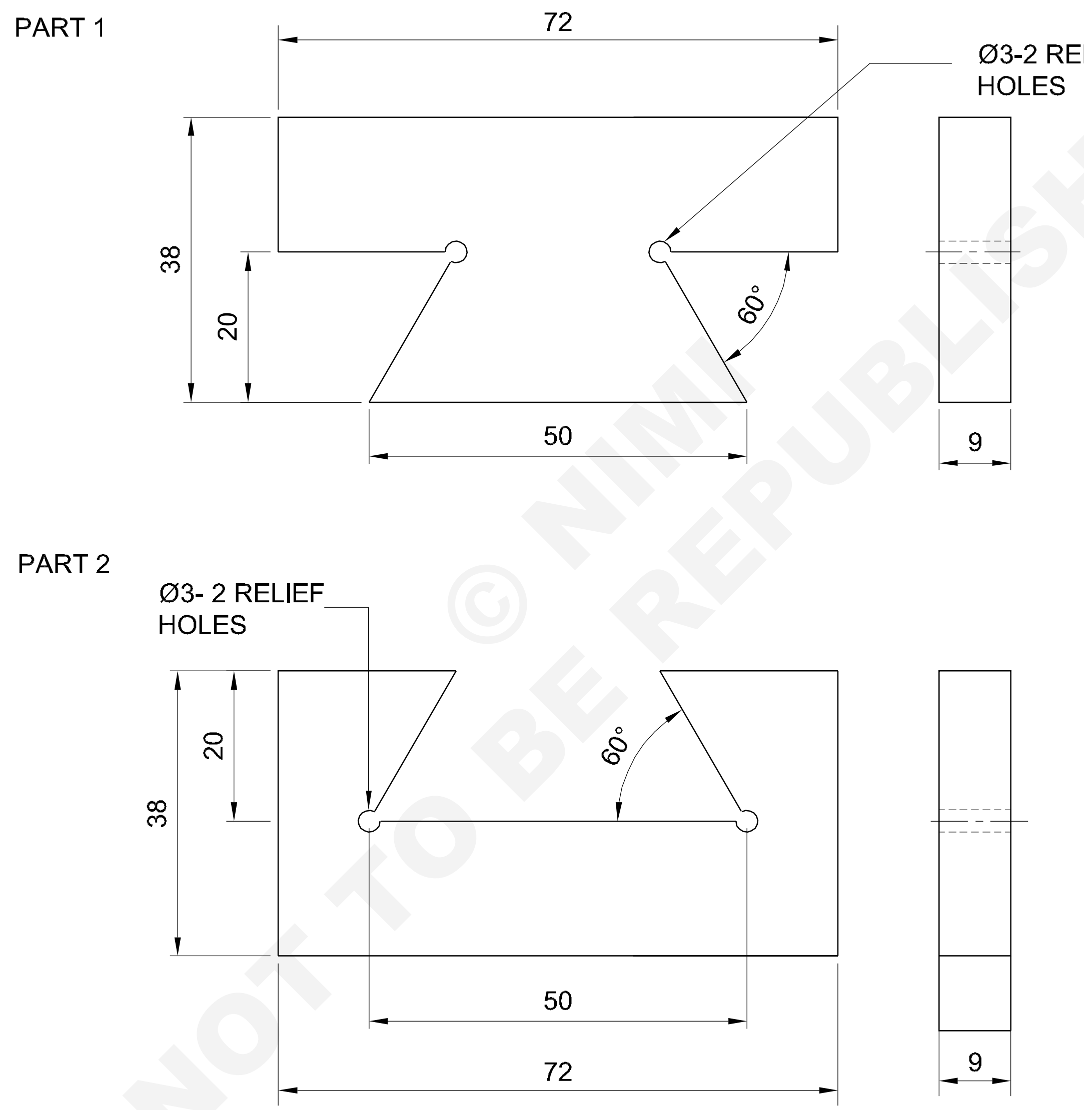


MATCH PART 1 & 2

— — — — — — — —

Angular fitting with male and female

Objectives: At the end of this exercise you shall be able to
- **file and finish to overall size on part 1 and 2**
- **remove excess material by chain drilling on part 2**
- **fix male and female parts and assemble**
- **finish and deburr.**



1	75 ISF 10 - 40	–	Fe310	–	2	
1	75 ISF 10 - 40	–	Fe310	–	1	1.2.30
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE : 1:1	**ANGULAR FITTING**	TOLERANCE : ±0.02	TIME:
		CODE NO: FIN31125E1	

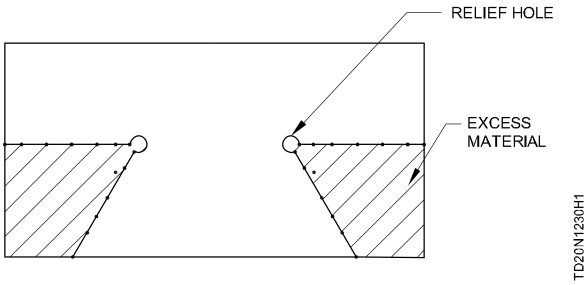
Job Sequence

- Check the raw material for its size.
- File and finish part 1 and 2 for the over all dimensions.
- Mark off lines part 1 and 2 with a vernier height gauge.
- Punch on witness marks and relief hole marks.
- Drill relief holes of ∅ 3 mm in both the parts 1 & 2 and also chain drill in part 2.

Part - 1

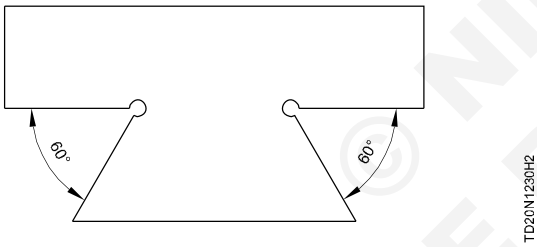
- Hacksaw on side of dovetail of Part 1 to remove excess metal as shown in Fig 1.

Fig 1



- File and check the size with vernier caliper and anlge with vernier bevel protractor as shown in Fig 2.

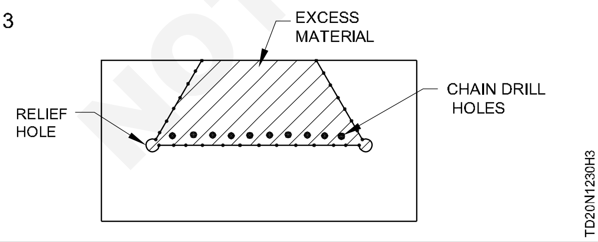
Fig 2



Part - 2

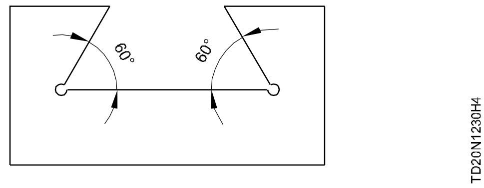
- Hacksaw on side of dovetail to remvoe excess metal as shown in Fig 3.
- Hacksaw and cut off along the chain drilled holes using web chisel and ball pein hammer and and remove as shown in Fig 3.

Fig 3



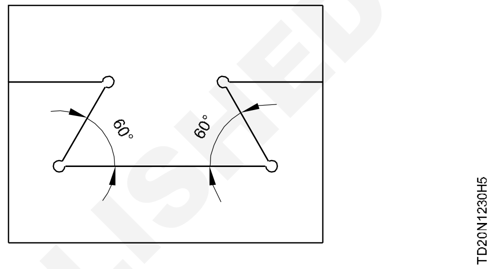
- File the internal dovetail of Part -2 to size and angle and check the size with vernier caliper and angle with vernier berel protractor Fig 4

Fig 4



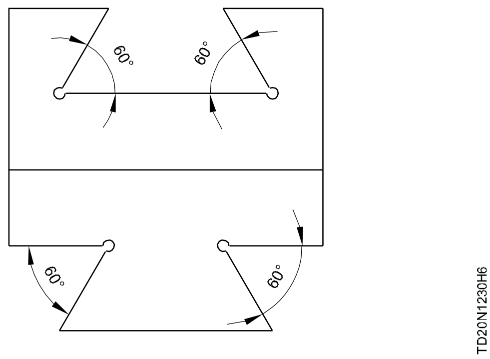
- Match part 1 and 2 to fit both dovetail and half round profile as shown in Fig 5 and Fig 6.

Fig 5



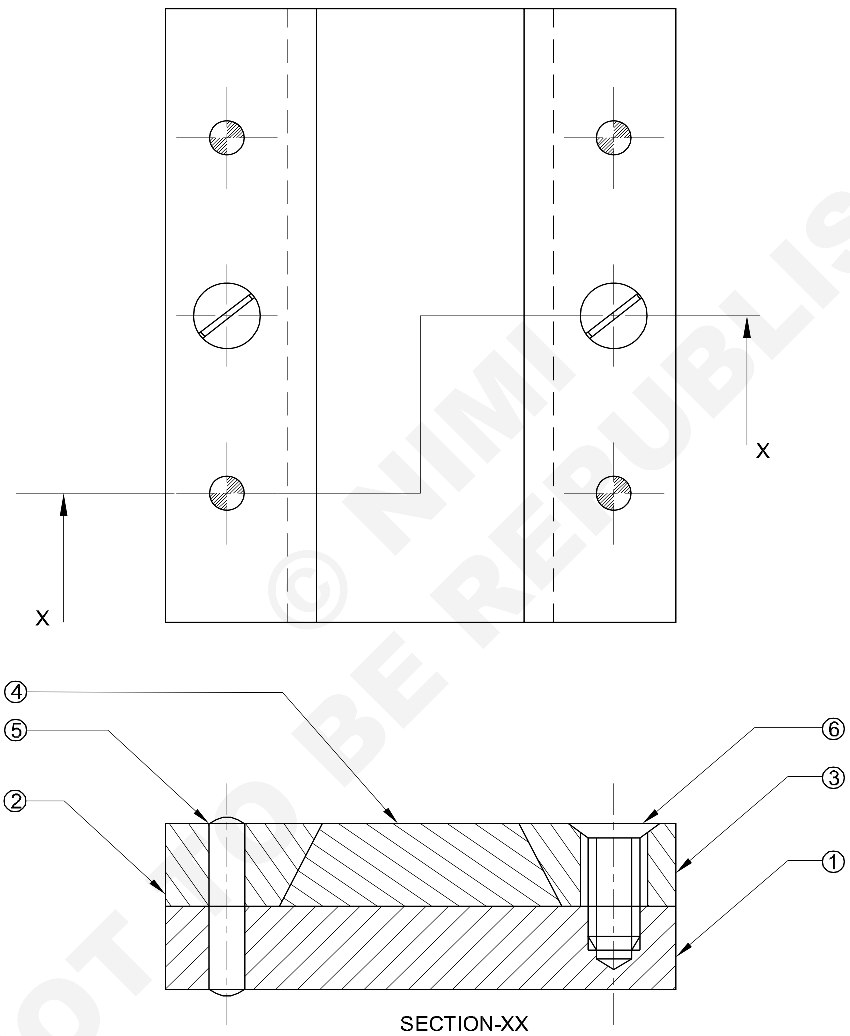
- Separate part 1 and 2, file and finish, de-burr all the corners of the job.
- Apply thin coat of oil and preserve it for evaluation.

Fig 6



Assembly fit with male and female by dowelling and screwing

Objectives: At the end of this exercise you shall be able to
- **file and finish flat and angular surfaces within an accuracy of ± 0.05 mm and ± 30 minutes**
- **mark and drill holes as per drawing**
- **cut internal thread to assemble countersink screws**
- **prepare and assemble components using screws and dowel pins**
- **assemble components to achieve sliding fit with angular mating surfaces.**

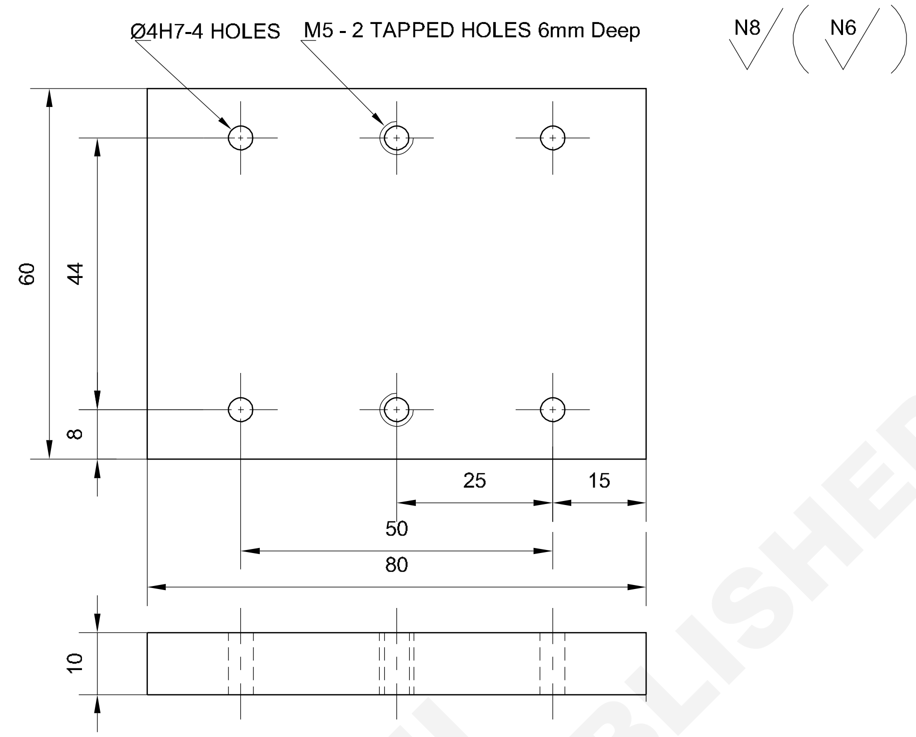


SECTION-XX

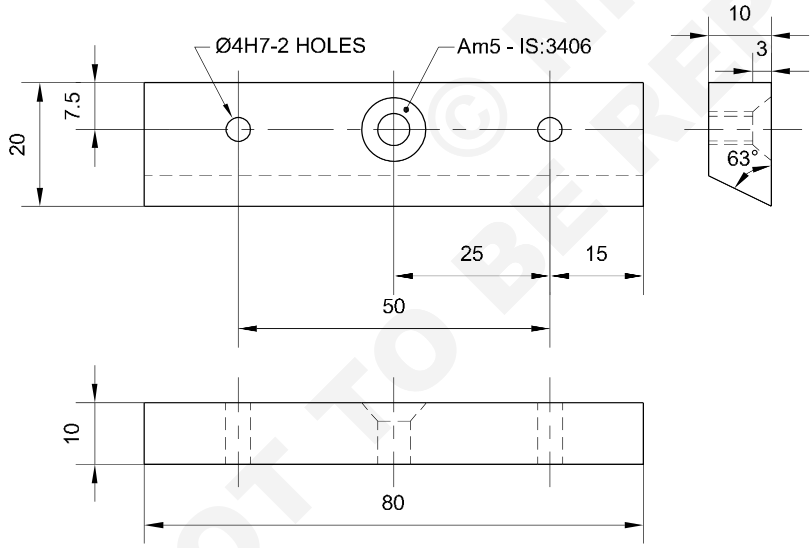
2	AM5-15IS:1365	CSK SCREW	30CB		6	
4	4H8x20IS:2393	CYLINDRICAL PIN	40CB		5	
1	35ISF12-85	SLIDING PLATE	Fe310		4	
2	25ISF12-85	BEVELED SIDE PLATE	Fe310		2&3	
1	65ISF12-85	BASE PLATE	Fe310	–	1	1.2.31
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	ANGULAR FITTING WITH MALE AND FEMALE	TOLERANCE ±0.04 mm	TIME:
		CODE NO: TD20N1231E1	

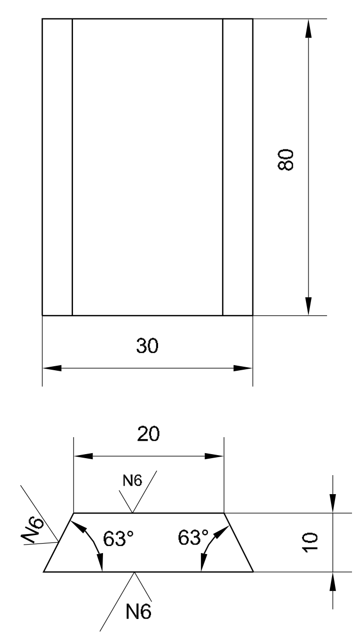
PART-1 BASE PLATE



PART-2&3 BEVELED SIDE PLATE



PART-4 SLIDING PLATE



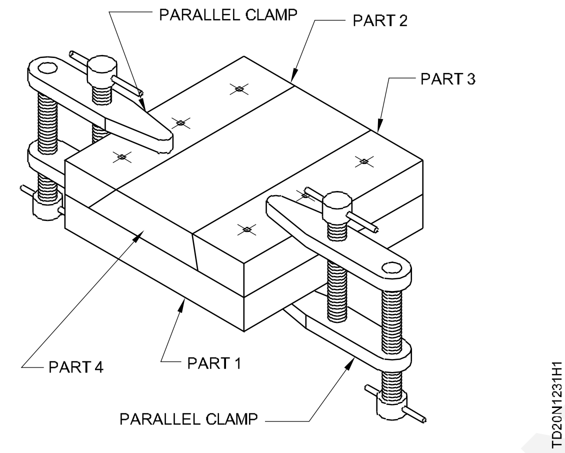
-	-	-	-	-	-	1.2.40-41
NO.OFF	STOCK SIZE	DESCRIPTION	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	BASE PLATE & BEVELED SIDE PLATES	DEVIATIONS	TIME
		CODE NO. TDN1240E2	

Job Sequence

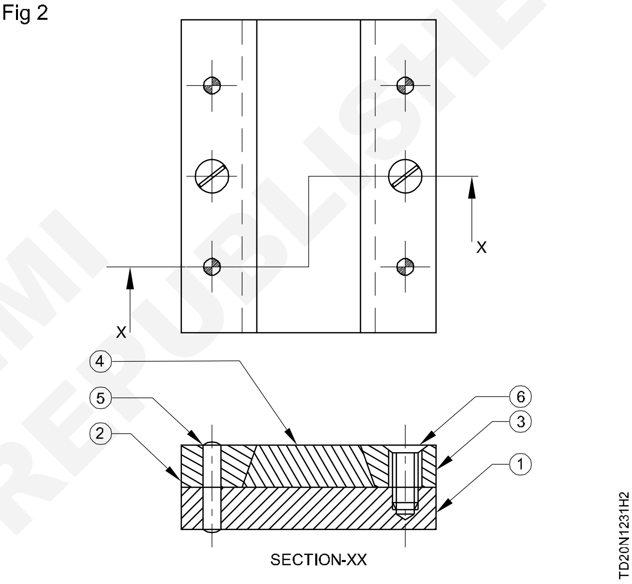
- Check the raw material for its size.
- File the material of part 1,2,3 and 4 to over all sizes maintaining the accuracy of 0.04 mm.
- Apply marking media on part 1,2, 3 and 4 surfaces and mark lines as per drawing.
- Punch witness marks.
- Hacksaw and file in part 2, 3 and 4 and file to size and shape as per job drawings.
- Assemble and clamp part 1, 2, 3 and 4 together in drilling machine table with parallel clamps as shown in Fig 1.

Fig 1



- Fix 3.8 mm drill in drilling machine spindle through drill chuck and drill through hole.
- Fix 4 mm hand reamer in tap wrench and ream the drilled hole to fix 4 mm dowel pin without disturbing the assembly setting.
- Clean the reamed hole and insert 4 mm dowel pin.
- Similarly, drill other dowel pin holes one by one and ream the drilled hole one by one and fix the dowel pins without disturbing the assembly.
- Fix 4.2 mm drill in drilling machine spindle through drill chuck and drill holes for cutting internal thread to fix counter sink screws in assembly without disturbing the setting.
- Separate the assembly parts 1,2, 3 and 4 and chamfer the tapping holes both ends in part 1 using countersink tool.
- Drill free hole 5.5 mm for CSK screw in part 2 and 3.
- Counter sink the drilled holes to seat the counter sink head screws in part 2 and 3.
- Hold the part 1 in bench vice.
- Cut internal thread using M5 hand tap and tap wrench.
- Clean the threads with out burrs.
- Cut and file in part 2, 3 and 4 to size and shape as per job drawing and check the size with vernier caliper and angles with vernier bevel protractor.
- Assemble part 1, 2,3 and 4 as per job drawing along with dowel pins and counter sink screws.
- Fit and slide part 4 in the assembly as shown in Fig 2.

Fig 2



- Disassemble all the parts from assembly.
- Finish file on part 1,2, 3 and 4 and remove burrs in all the corners of the job.
- Re-assemble all the parts together as per job drawing
- Apply a little oil and preserve it for evaluation.

Identify and function of different parts of lathe. Practice on operation of lathe (Dry /Idle run)

Objectives: At the end of this exercise you shall be able to
- **identify the main parts of lathe**
- **operate the lathe on idle/ dry run.**

Job Sequence

TASK 1: **Write the name and function of the main parts.**

- Identify the main parts of the marked in Fig 1.
- Record in Table 1.

Fig 1

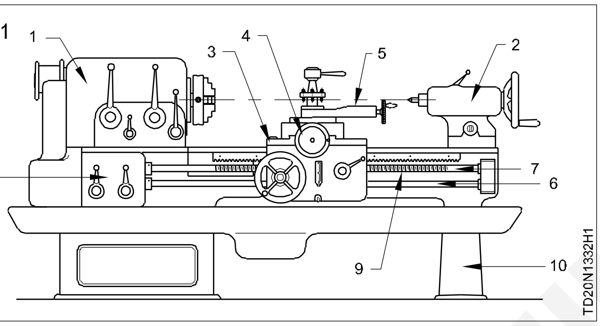


Table 1

Sl. No.	Part name	Function

— — — — — — — —

TASK 2: **Idle/dry run of lathe.**

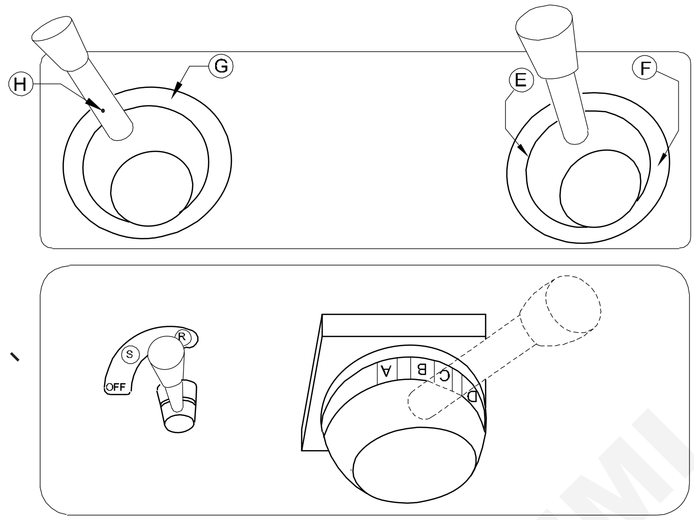
- Instructor may train the trainees to operate the lathe by moving the slides, tailstock and familirise the direction of slides movement.

— — — — — — — —

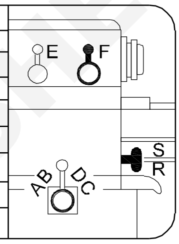
Setting lathe on different speed and feed

Objectives: At the end of this exercise you shall be able to
- **identify the spindle speed lever on the lathe**
- **sel the speed and feed**
- **tabulate the speed in the given table for the task 1.**

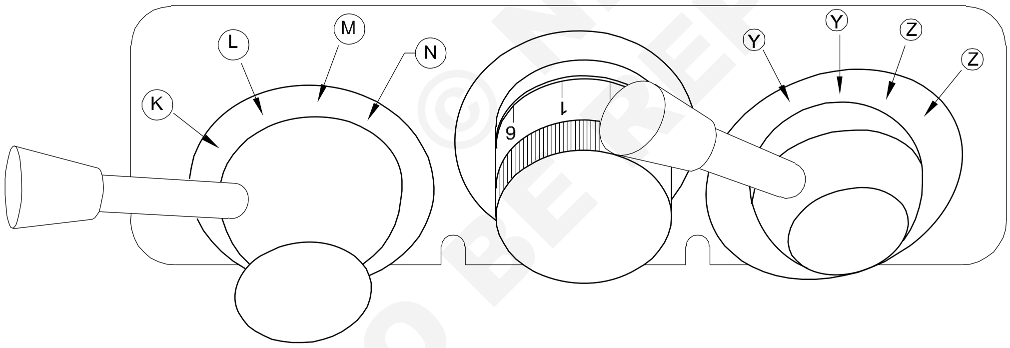
TASK. 1

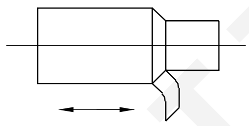
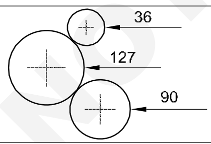
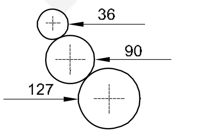


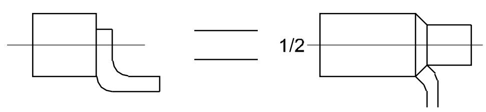
n/min		E	F
D	R	1600	250
C	R	1150	200
D	S	800	140
B	R	740	115
C	S	580	90
A	R	450	71
B	S	360	60
A	S	228	38



TASK. 2



			G			F	H	
			K	L	M	K	L	M
	Z	6	0.07	0.13	0.27	0.53	1.07	2.13
		2	0.08	0.16	0.32	0.64	1.27	2.54
		3	0.09	0.18	0.36	0.71	1.42	2.84
		5	0.11	0.23	0.46	0.91	1.82	3.66
		4	0.12	0.25	0.5	0.99	1.98	3.96
	Z	6	0.05	0.1	0.2	0.4	0.8	1.6
		2	0.06	0.11	0.23	0.45	0.9	1.8
		3	0.07	0.13	0.25	0.5	1.0	2.0
		5	0.08	0.16	0.32	0.65	1.3	2.6
		4	0.09	0.18	0.35	0.7	1.4	2.8



TD20N1333H1

Job Sequence

TASK 1: **Selection of speed**

- Observe the speed chart in the machine.
- Change the right side lever in E
- After that change the bottom side lever in B
- Then change the another bottom lever D
- Switch on the machine the speed is 1600 rpm.
- Set the different spindle speed by observing the chart.
- Identify speed change lever position A,B,C,D & E,FS,R.
- Record in table 1.
- Get it verified by your instructor.

According to the machines available in your instittute prepare the speed chart for the practice of the trainees.

Table 1

M/Min		**E**	**F**
A	**S**		**38**
B	**S**		
C	**S**	**580**	
D	**S**		
A	**R**		**71**
B	**R**		
C	**R**		
D	**R**		**1600**

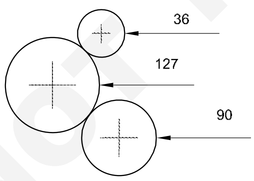
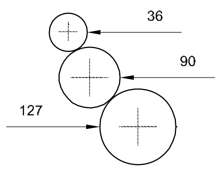
— — — — — — — —

TASK 2: **Selection of feed**

- Observe feed chart in the machine.
- Change the top left side lever G.
- Change the bottom left side lever K.
- Change the bottom right side lever Z.
- After number change shaft rotate the number 6.
- Switch ON the machine and engage carriage feed lever and get feed rate 0.07mm/rev.
- Set the machine for different feeds.
- Identify the feed change lever position Y,G,H & K,L,M.
- identify the feed in different set of change gears
- Record in table 2.
- Get it verified by your insturctor.

According to machine available in your instituteprepare the feed chart for practice the trainees.

Table 2

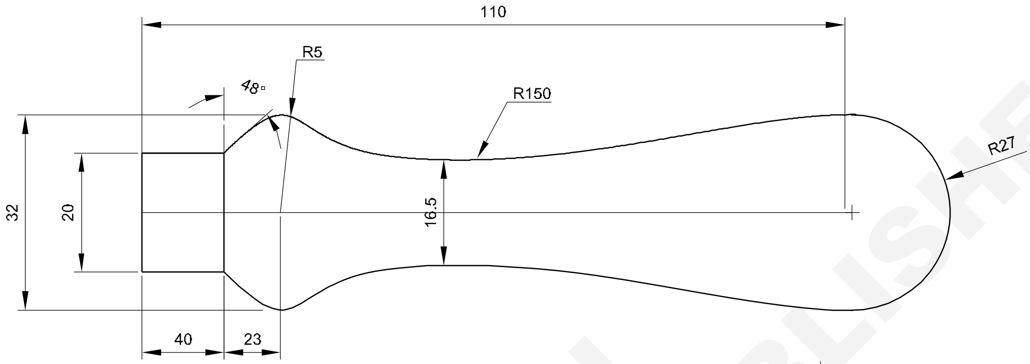
			G			**F H**		
			K	**L**	**M**	**K**	**L**	**M**
	**z**	2	0.16					
		3				0.71		
		4						3.96
		5			0.46			
		6	0.07					
	**z**	2		0.11				
		3				0.5		
		4	0.09					
		5					1.3	
		6			0.2			

— — — — — — — —

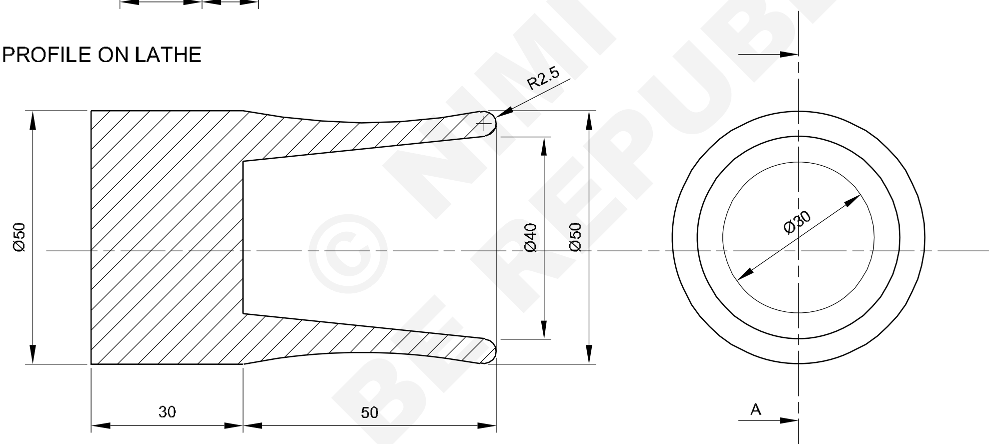
Profile turning using hand tools

Objectives: At the end of this exercise you shall be able to
- **file plain cylindrical surface using flat file**
- **file external radious using half round file and flat file**
- **file external taper using round file**
- **check the shape with template.**

TASK 1 - FILING EXTERNAL PROFILE ON LATHE

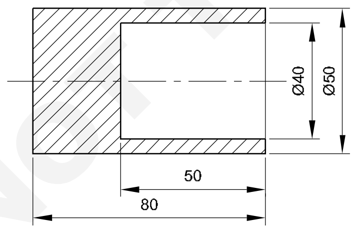


TASK 2 - FILING PROFILE ON LATHE



SECTION AT AA

PRE MACHINED TO SHAPE



Note : Instructor shall demonstrate on
- **Holding the workpiece in 3 jaw chuck**
- **Filing plain and radius surfaces using flat, halfround and round file.**

2	PRE MACHINED Ø50x82mm	-	Fe310	-	1	
1	Ø25x72mm	-	Fe310	-	1	1.3.34
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX NO.

SCALE NTS	**PROFILE FILLING ON LATHE**	DEVIATIONS ± 1°	TIME
		CODE NO. TD20N1334E1	

Task 1 : **Filing external profile of lathe**

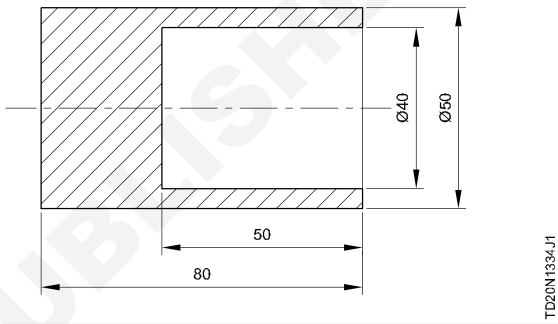
- Check the raw material for its size with steel rule.
- Hold the workpiece on 3 jaw chuck projecting about 50mm.
- File on face to remove cutting marks.
- Use a rough file and file Ø 24mm to a length of 40mm.
- Use smooth file and file Ø 20mm to a length of 40mm
- Check the dimension with steel rule.
- Reverse the workpiece and hold the workpiece on Ø 20mm keeping 35mm inside the 3 jaw chuck.
- File reaming portion to Ø 28mm and check the dimension.
- Face file and maintain its total length.
- Make a template on a thick cardboard or plastic sheet to check profile.
- File radius 27mm using flat file and check the radius with radius gauge.
- File the cancave radius using half round file.
- Check the profile using the template.

— — — — — — — —

Task 2 : **Filing profile on lathe.**

- Check the premachined workpiece for its dimesion with steel rule (Fig 1)
- Hold the workpiece 25 mm insiode the 3 jaw chuck
- Use round file and file the internal taper portion to Ø40 mm as shown in drawing.
- Check the outer most dimension with steel rule.
- File the external radius using hall round file.
- Check the external radius with suitable template. (Prepare the template)
- File corner radious with 6” round file check its radious with radious gauge.

Fig 1



Skill Sequence

Filing on lathe

Objective: This shall help you to
- **file on center lathe**

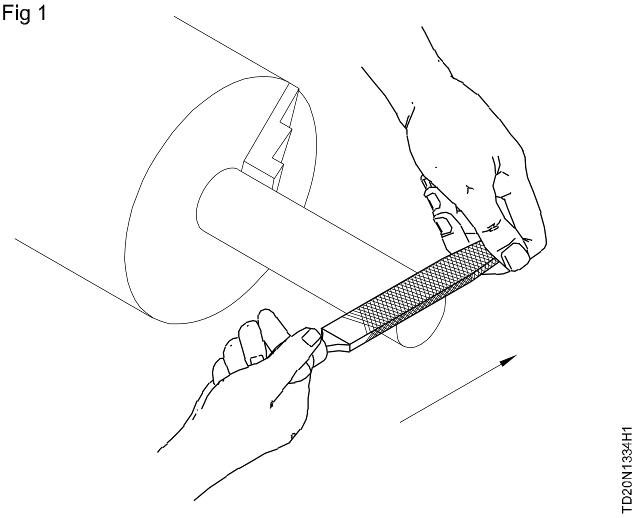
Hold the workpiece on 3 jaw chuck of a lathe.

Start the machine.

Select flat file and file on plain cylindrical surface remove material by gently pressing the file on workpiece and make little forward movement of the file.

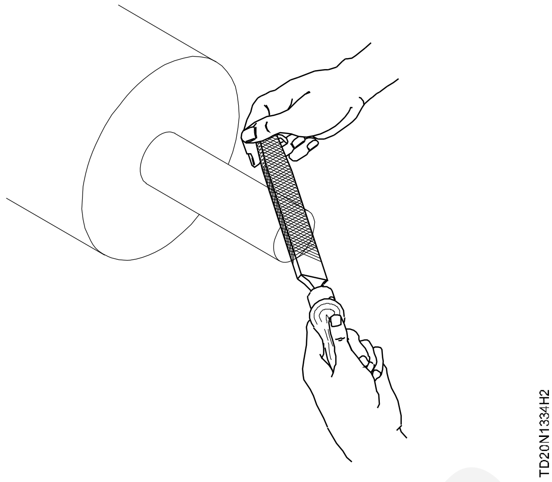
Hold the tip of the left hand and handle on the right hand and start filing (Fig 1& 2)

Fig 1



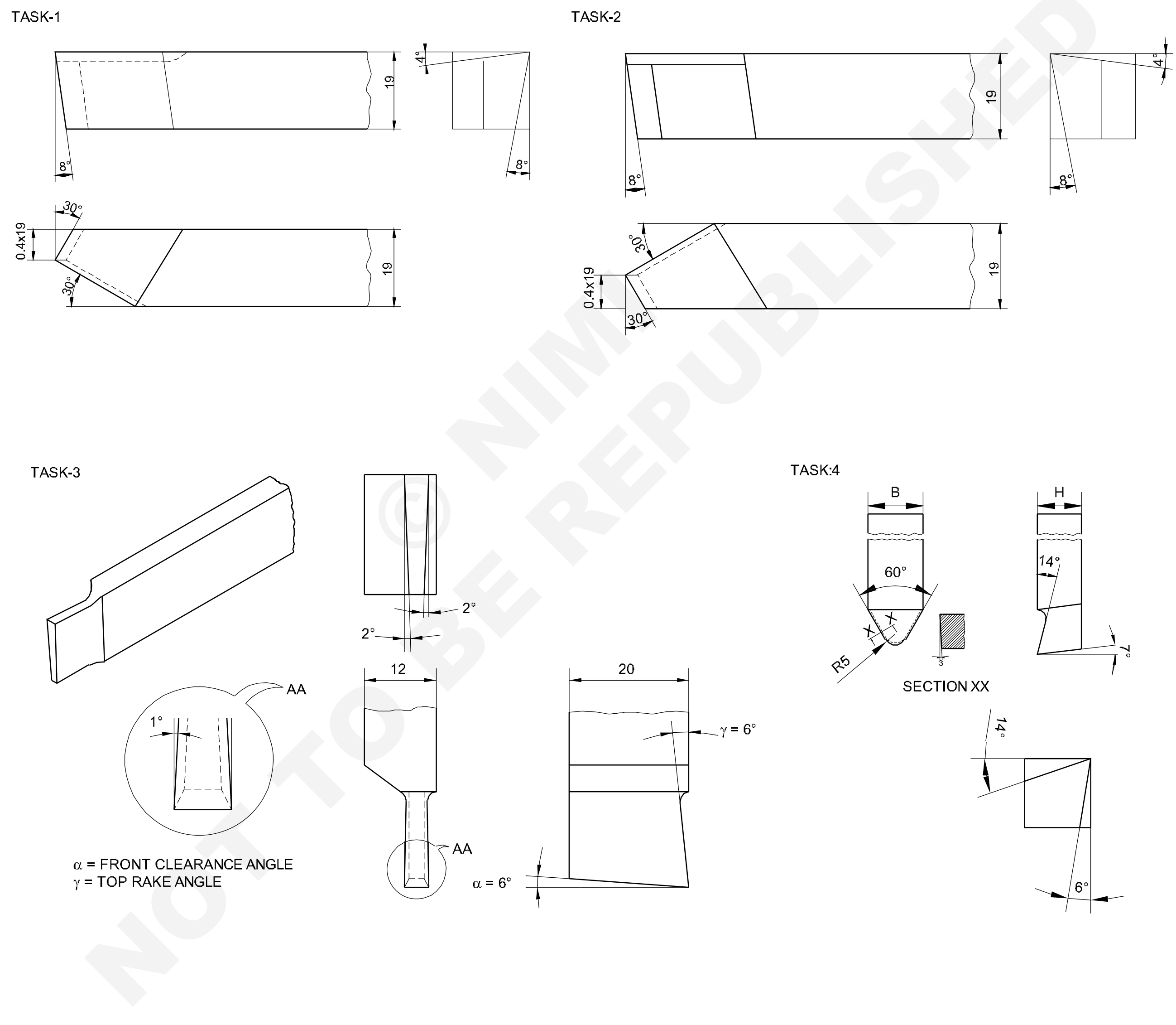
- Take care your hand or shoulder should not come in contact with the rotating check.
- Similarly position the file on conical surface and file the conical position of external surface.
- Select 12mm round file and file the external radius at the junctions.
- Select 150mm half round file and the file the external radius at the front portion.
- Similarly file the external radius using round file.

Fig 2



Grinding of R.H. and L.H tools parting tool, round nose tool

Objectives: At the end of this exercise you shall be able to
- **grind R.H. and L.H. tool**
- **grind round nose tool**
- **grind parting tool**
- **check the angles with a protractor.**



1	20ISF-12-150	–	1	Fe 310	-	
1	SQ 12-110	–	1	Fe 310	-	1.3.35
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX NO.

SCALE NTS	GRINDING OF R.H. AND L.H.TOOLS,V.TOOL PARTING TOOL,ROUND NOSE TOOL	DEVIATIONS ± 1°	TIME
		CODE NO. TDN1335E1	

Job Sequence

TASK 1: **Grinding R.H tools**

- Rotate the wheel by hand and observe for free rotation.
- Check the grinding wheels for true running.
- Wear goggles.
- Dress the wheels by a wheel dresser.
- Adjust the tool-rest to maintain a minimum gap from the wheel face to a minimum of 2 to 3 mm.
- Hold and apply the side flank of the tool to the front face of the grinding wheel at 30° to horizontal.
- Move the tool left to right and vice versa to grind the side cutting edge angle to cover $2/3^{rd}$ width of the tool.
- Grind a side clearance angle of 8°, the bottom of the edge touching the wheel first.
- Rough grind the end cutting edge angle of 30° and the front clearance angle of 4° simultaneously.
- Hold the top flank of the tool against the wheel face inclined at 14°, the rear side contacting the wheel first, and grind the side rake angle of 14°.
- Ensure that the ground portion is parallel to the side cutting edge.
- Finish grind all the faces on the finishing wheel.
- Grind a nose radius of approximately R. 0.4 mm.
- Check the angles with a tool angle gauge and template.
- Lap the cutting edge with an oilstone.
- The top rake (back rake) angle should be kept at 4°.

TASK 2: **Grinding L.H tools**

- To prepare L.H tool follow the same procedure.

TASK 3: **Grinding parting tool**

- Set the pedestal grinder for tool grinding.
- Remove excess of material on right hand side of the tool of length equal to the thickness of tool and width.
- Grind half of the thickness of tool on rough grinding wheel.
- Grind 6° to 8° front clearance angle.
- Hold the tool at an angle of 55° to the face of the wheel.
- Grind 27½° on left hand side of the tool.
- Repeat the above procedure on the right side of the tool to get an included angle of 55° on the tool.
- Grind 2° to 4° side clearance angle on each side of the tool.
- Finish all sides by using smooth grinding wheel. Check the tool by centre gauge; there should not be any light passing through gauge and cutting edges of the tool.
- Cutting point is carefully ground in a smooth wheel.
- Finally lap the tool by applying oil stone on cutting edges.

Remember

- Avoid burning of the tool.
- The cutting edge should be visible during grinding.

TASK 4: **Grinding 'V' tools.**

- Set the pedestal grinder for tool grinding and make sure it is safe to start.
- Remove excess material on right hand side of the tool to length equal to the thickness of tool and width.
- Adjust the tool test to maintain a minimum gap from the wheel face of 2 to 3 mm.
- Wear the goggles, start the wheel, hold the tool firm at an angle of approximately 60° to the face of the wheel, grind the left hand side of tool.
- Repeat the above procedure for right hand side to get the included angle of 60°.
- Grind the top rake angle, back rake angle of 14°.
- Grind the front clearance angle of 7°, the bottom of the edge touching the wheel first.
- Lap the cutting edge with an oilstone.

Precautions:

- Wear goggle.
- Avoid burning of tool by using suitable coolant.

Skill Sequence

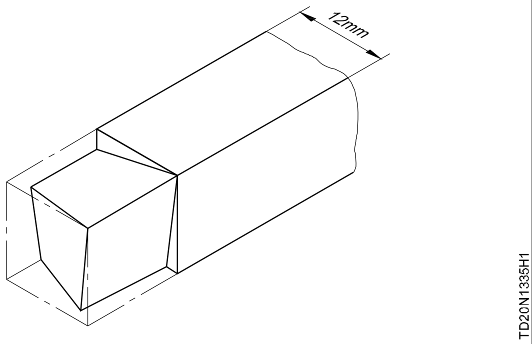
Grinding a side cutting tool for machining steel

Objective: This shall help you to

- **grind a right hand side cutting tool to machine steel.**

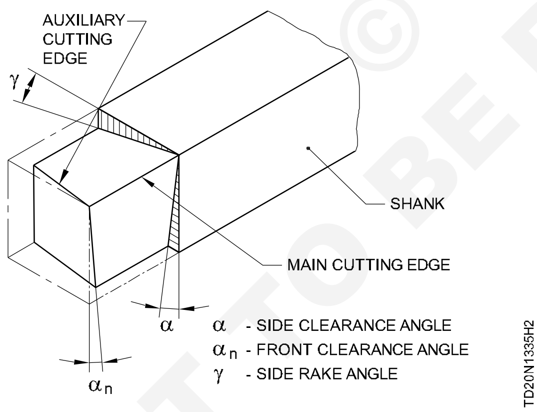
The side cutting tool to be used on steel is illustrated in Fig 1. The right hand portion illustrates the tool blank in dotted lines before grinding, and the ground tool by thick lines. (Fig 1)

Fig 1



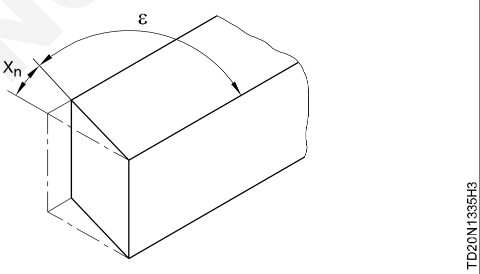
The side cutting edge is in line with the blank edge and the end cutting edge is inclined at an angle of 25°. The side rake angle is 14°. The front and side clearances are ground 6°. The length of the side cutting edge is maintained equal to the size of the square cross-section of the tool blank, i.e. 12 mm. Fig 2 shows the shaded portion to be removed by grinding the tool blank to get the ground tool. The procedure in sequence is as follows.

Fig 2



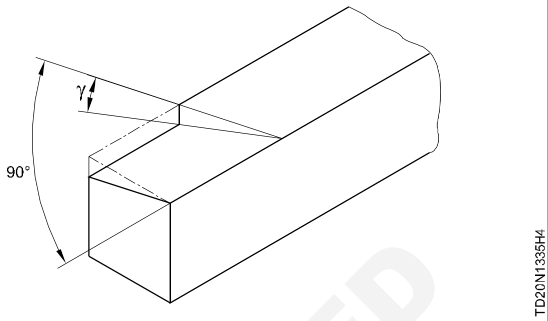
Grind the end cutting edge angle 25°. Angle 'x_n' (Fig 3)

Fig 3



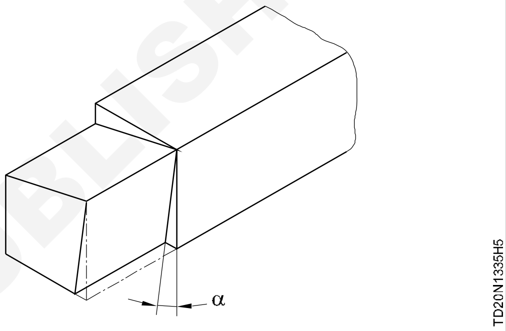
Grind the side rake angle of 14°. Angle. (Fig 4)

Fig 4



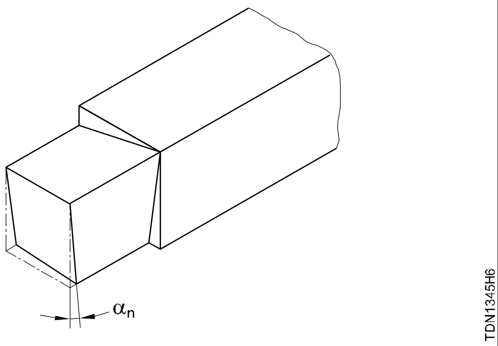
Grind the side clearance angle of 6°. Angle α (Fig 5)

Fig 5



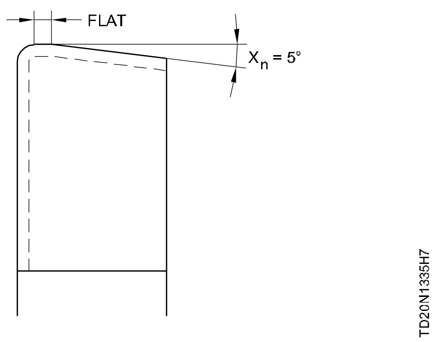
Grind the front clearance angle of 6°. Angle α_n (Fig 6)

Fig 6



Grind and provide a nose radius of R 0.4 to R 0.6 mm at the point of tool. Grind a flat for a short length of 0.2 to 0.3 mm as shown in Fig 7. For the sake of clarity the figure is magnified.

Fig 7

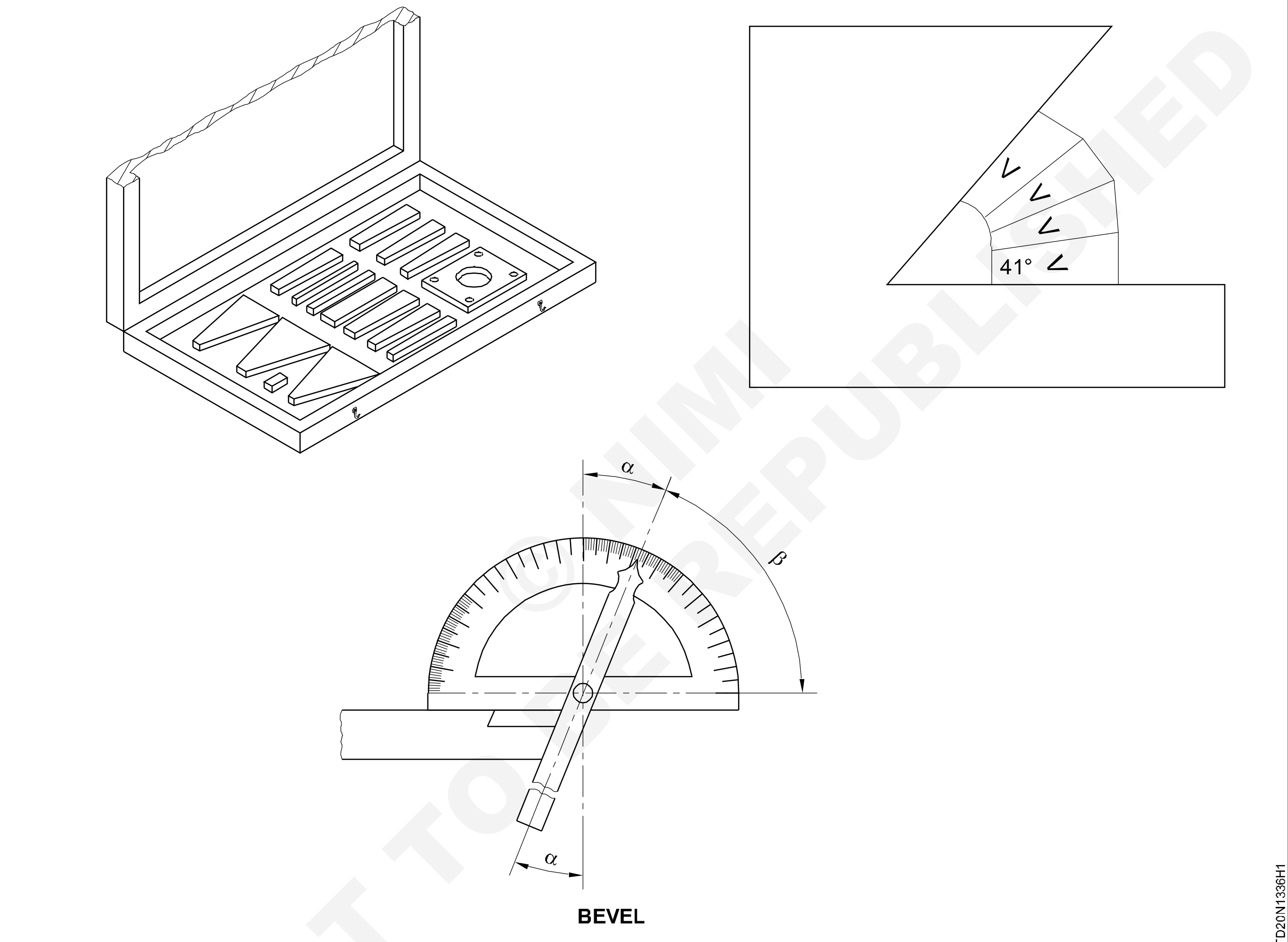


Checking of angles with angle gauge and bevel protractor

Objectives: At the end of this exercise you shall be able to
- **build up different angles using angle gauge**
- **measure angle of a different components using bevel protractor.**

NOTE: Instructor shall provide different type of work pieces for measurement of angles and give the angle to build up angle gauge.

Fig 1



Job Sequence

Instructor shall demonstrate on angle measurement using angle gauge and bevel protractor.

- Trainees should be able to build different angles using angle gauges.
- Trainees should measure the angle of work piece provided by the instructor and record it in table 1.

Note: The instructor may check the build up angle of angle gauge and evaluate.

Table 1

Component	Angle
1	
2	
3	
4	
5	

Skill Sequence

Building up a combination

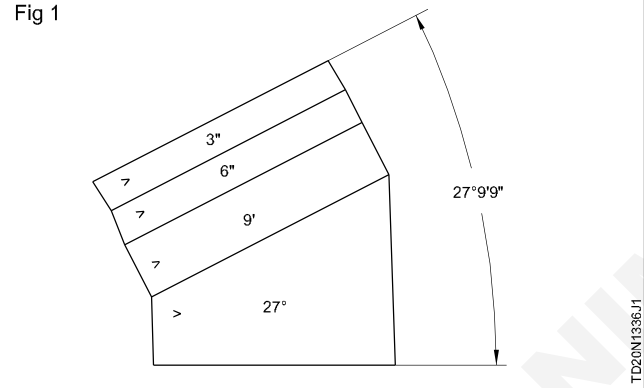
Objective: This shall help you to
- **build up angle using angle gauge.**

To build up a size of 27° 9' 9" (Fig 1)

Gauge required

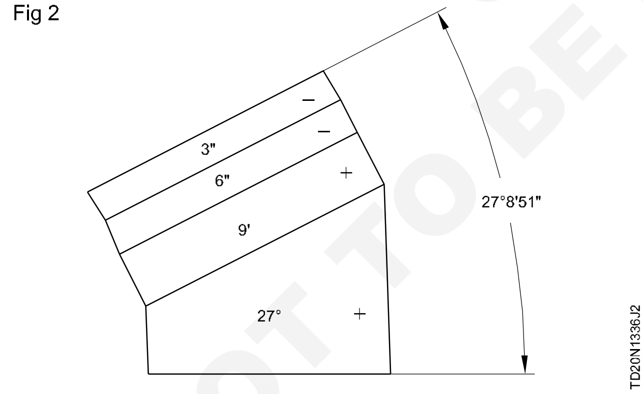
1st series	-	27° 0' 0"
2nd series	-	0° 9' 0"
3rd series	-	0° 0' 6"
Additional Block	-	0° 0' 3"
		27° 9' 9"

Fig 1



To obtain an angle of 27°-8'-51" the same gauges may be used, but they must be wrung together as shown in Fig 2.

Fig 2



Work out the

Gauges required for		27° 8' 51"	
1st series	-	27° 0' 0"	
2nd series	-	0° 9' 0"	To be added
3rd series	-	0° 0' 6"	To be subtracted
4th series	-	0° 0' 3"	

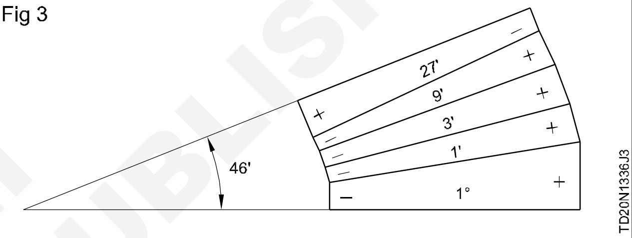
From the sum of the 1st and 2nd series as these two are positioned in the opposite way.

If the angle includes minutes, and is greater than 40 minutes, increase the angle by 1° and subtract the number of minutes necessary to obtain the required minute.

This is because the total minutes available with the pieces in the series is 40' only.

To obtain 46' the build up will be as shown in Fig 3.

Fig 3



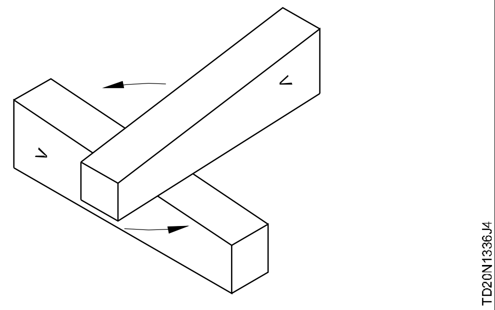
Handling and wringing

Gloves of cotton fabric or chamois leather must be worn to prevent corrosion.

Before the gauges are wrung together the faces should be wiped clean using soft muslin cloth or chamois leather.

The wringing of the angle gauges should be carried as shown in Fig 4.

Fig 4

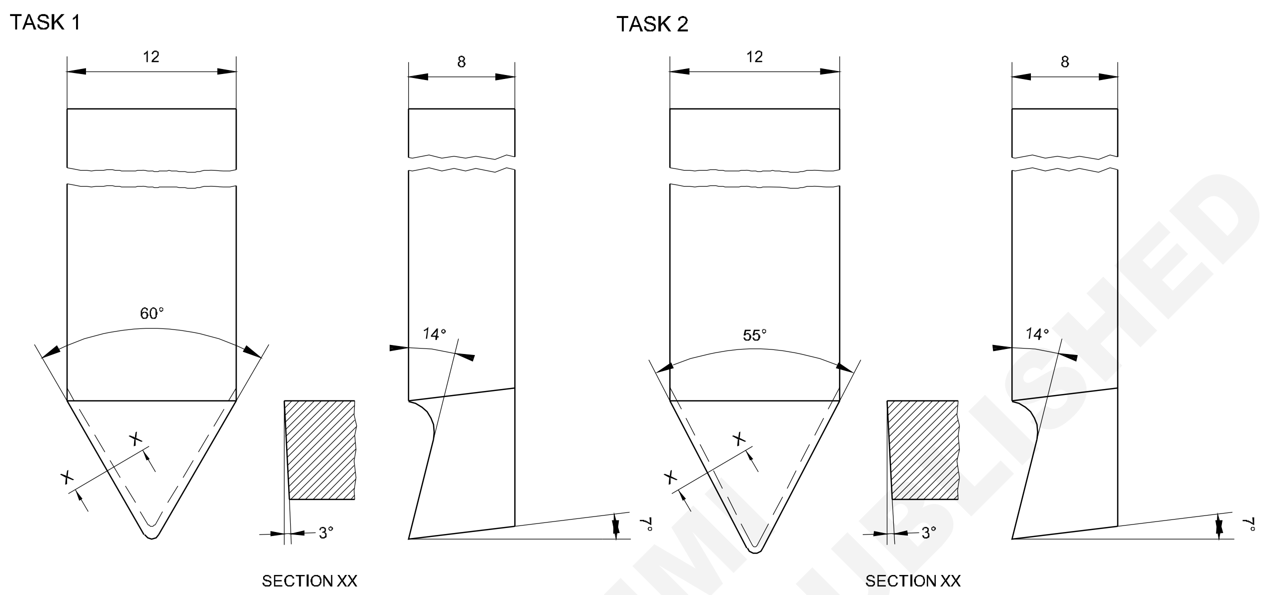


After use, clean the gauges thoroughly with a soft cloth and white spirit.

Apply vaseline lightly and store the gauges in a box.

Grinding of 'V' tools for threading of metric british thread

Objectives: At the end of this exercise you shall be able to
- **grinding 'V' threading tool (metric).**



Job Sequence

TASK 1: **Grinding 'V' threading tools.**

- Remove the excess material on the right hand side to the required width and length by using a rough grinding wheel.
- Grind Half of the thickness of tool on rough grinding wheel.
- Grind 4° to 8° front clearance angle.
- Hold the tool at an angle 30° to the face of the wheel.
- Grind 30° on left hand side of the tool.
- Repeat the above procedure on the right side of the tool to get an included angle of 60° on the tool.
- Grind 3° to 5° side clearance angle on each side of the tool.
- Finish all sides by using smooth grinding wheel.
- Check the tool by centre gauge; there should not be any light passing through gauge and cutting edges of the tool.
- Cutting point is carefully ground in smooth wheel.
- Finally lap the tool by applying oilstone on cutting edges.

Remember

- Avoid burning of the tool.
- The cutting edge should be visible during grinding.

2	12x8x150 H.S.S BIT	-	H.S.S	-	-	1.3.37
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE NTS	GRINDING OF 'V' TOOLS FOR THREADING OF METRIC 60 DEGREE THREADS				DEVIATIONS ± 1°	TIME
					CODE NO. TD20N1337E1	

TASK 2: **Grinding 'V' threading tools.**

- Remove the excess material on the right hand side to the required width and length by using a rough grinding wheel.
- Grind Half of the thickness of tool on rough grinding wheel.
- Grind 4° to 8° front clearance angle.
- Hold the tool at an angle 27½° to the face of the wheel.
- Grind 27½° on left hand side of the tool.
- Repeat the above procedure on the right side of the tool to get an included angle of 55° on the tool.
- Grind 3° to 5° side clearance angle on each side of the tool.
- Finish all sides by using smooth grinding wheel.
- Check the tool by centre gauge; there should not be any light passing through gauge and cutting edges of the tool.
- Cutting point is carefully ground in smooth wheel.
- Finally lap the tool by applying oilstone on cutting edges.

Remember

- Avoid burning of the tool.
- The cutting edge should be visible during grinding.

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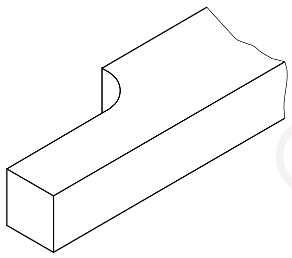
Grinding 60° threading tool

Objective: This shall help you to
- **grind 60° threading tool.**

Set the pedestal grinder for tool grinding.

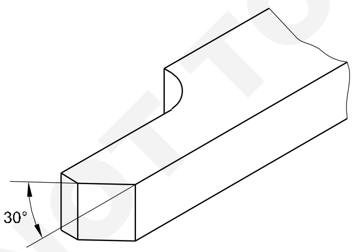
Remove excess of material on right hand side of the tool to length equal to thickness of tool and width being half of the thickness of tool on rough grinding wheel. (Fig 1)

Fig 1



Hole the tool at an angle of 60 to the face of the wheel, grind 30 on left hand side of the tool (Fig 2)

Fig 2



Repeat the above procedure on the right side of the tool to get an included angle of 60 on the tool (Fig 3)

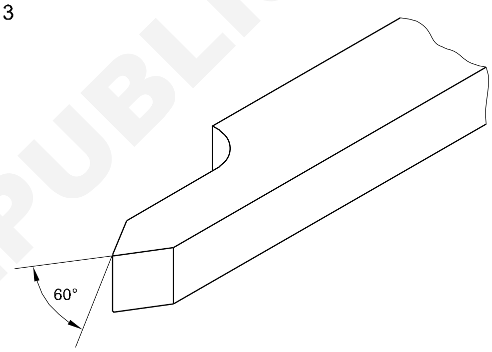
Grind 6 to 8 side clearance angle on each side of the tool.

Grind 4 to 6 front clearance angle.

Finish all slides by using smooth grinding wheel.

Do not Grind Rake Angle.

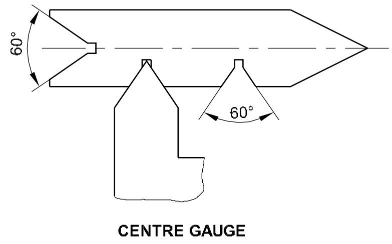
Fig 3



Check the tool by centre gauge, there should not be any right passing through gauge and cutting edge of the tool.

Cutting point is curved to 0.14 x pitch by carefully grinding in smooth wheel.

Fig 4



Finally Lap the tool by applying oil stone on cutting edges.

Safety precautions

Ensure grinding wheels are properly guarded.

Keep 2 mm gap between tool rest and grinding wheel face.

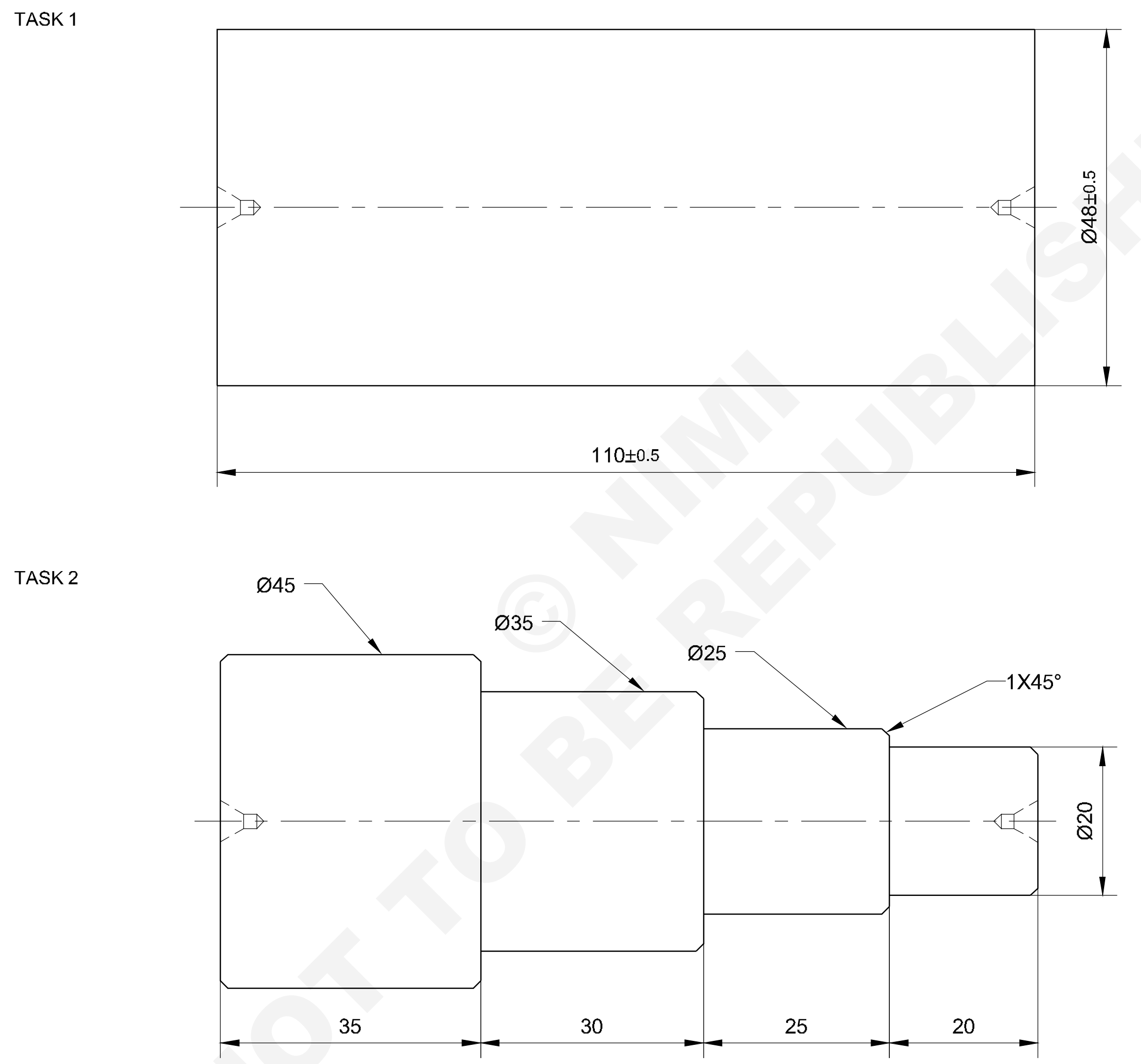
Ensure cutting edge is visible to the operator while grinding.

Do not give too much pressure on the wheel face.

Frequently cool the tool in coolant.

Plain turning (4 Jaw chuck) step turning

Objectives: At the end of this exercise you shall be able to
- **set the round rod in four jaw chuck**
- **face and plain turn the round rod to the required dimensions**
- **centre drill the workpiece**
- **turn step, shoulder and chamber in between centres.**



1	Ø50 x 115	–	Fe 310	–	–	1.3.38
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	TITLE : ROUGH FACING AND ROUGH TURNING	TOLERANCE ± 0.06 mm	TIME
		CODE NO. TD20N1338E1	

Job Sequence

TASK 1: **Set the round rod in four haw chuck**

- Check the size of the raw material.
- Hold the job in a 4 jaw chuck, projecting 60 mm and true it.
- Face one end.
- Centre drill it.
- Turn 48 mm to 55 mm Length.
- Reverse and reset it by holding on 48 mm.
- Face the other end and maintain the total length of 110 mm and turn 48 mm at match it with previously turned diameter.
- Deburr it.
- Check the diameter with micrometer and length with vernier caliper.
- Remove the workpiece from the 4 Jaw chuck.

— — — — — — — —

TASK 2: **Face and plain turn the round rod to the required dimensions**

- Set the job in between centres with suitable lathe carrier.
- Turn 45.5 mm to a length of 80 mm.
- Turn step 35 mm to a length of 45 mm.
- Check the length of 35 should be 30 mm.
- Similarly turn step 25, 20 and maintain the length 25 mm and 20 mm respectively.
- Chamber 1x45° as per drawing.
- Reverse the work piece and turn 45 mm and chamber it.
- Remove the workpiece clean apply oil and preserve it.

— — — — — — — —

Skill Sequence

Truing work in a four jaw chuck with the help of a surface gauge

Objective: This shall help you to
- **true a round rod in a four jaw independent chuck with the help of a surface gauge.**

If truing is not done before turning, the following will be the results.

Uneven load on the cutting tool.

For the same depth more metal will be removed from the out of centre portion.

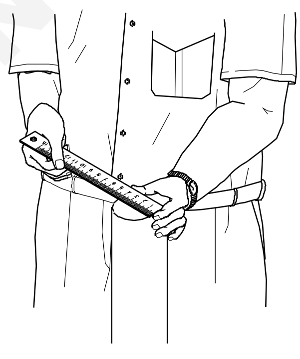
Surface turned may not be cylindrical.

Sequence during truing

Keep the main spindle in a neutral position.

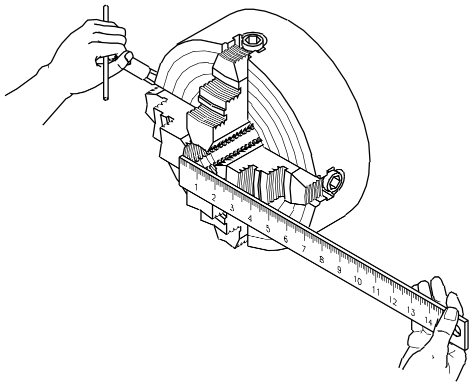
Measure the job diameter with an outside caliper or with a steel rule. (Fig 1)

Fig 1



Position the four jaws of the independent chuck, equidistant from the centre. The distance between the inner face of the opposite jaws is equal to the diameter of the work. (Fig 2)

Fig 2

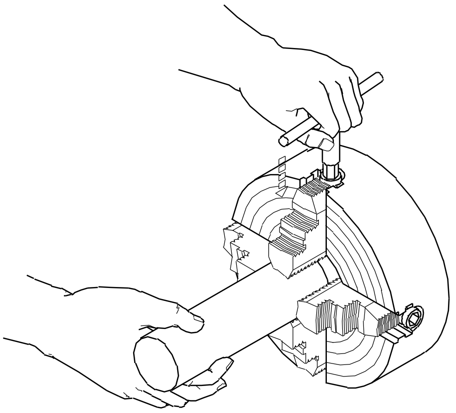


Open the adjacent jaws sufficiently enough to insert the work. (Fig 3)

Place the work inside the chuck, keeping sufficient portion outside the chuck for turning, and tighten the two adjacent jaws, enough to grip the work.

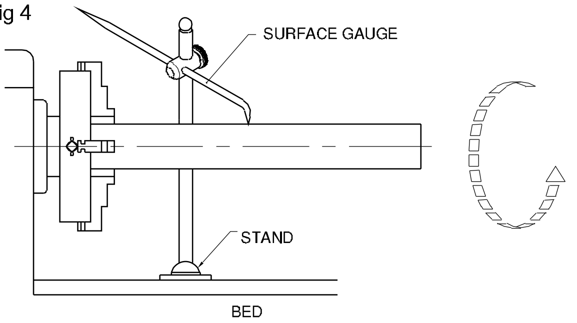
Place the surface gauge on the bed-ways close to the chuck.

Fig 3



Adjust the pointer to make its tip move close to the top or side portion of the work with a minimum gap. (Fig 4)

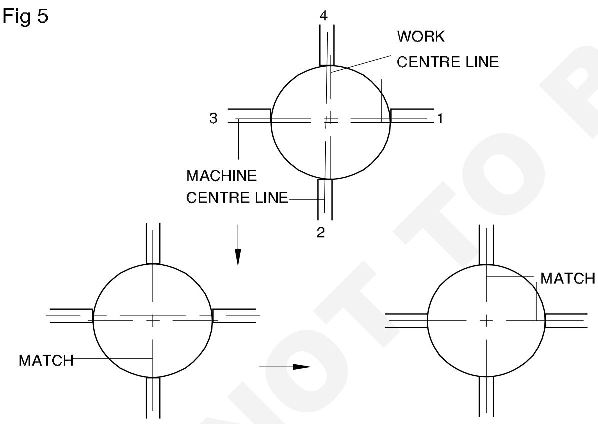
Fig 4



Rotate the chuck by hand and observe the gap between the pointer and work surface for the position of the two opposite jaws.

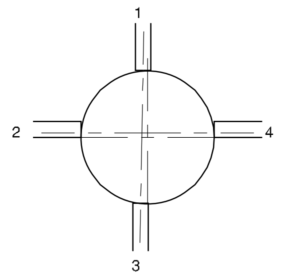
Open the jaw slightly where the gap is more, and tighten the opposite jaw. (Fig 5)

Fig 5



Repeat until the gap is the same. (Fig 6)

Fig 6



Repeat the above sequences for the other set of opposite jaws.

Bring the pointer tip closer to the work surface.

Rotate the chuck by hand and observe the gap.

Engage the spindle levers at about 250 rpm and run the machine.

Give slight pressure on the top of the pointer to make the tip to touch the work, and feel.

If the feel of contacting the pointer tip is uniform, it indicates that the work is trued.

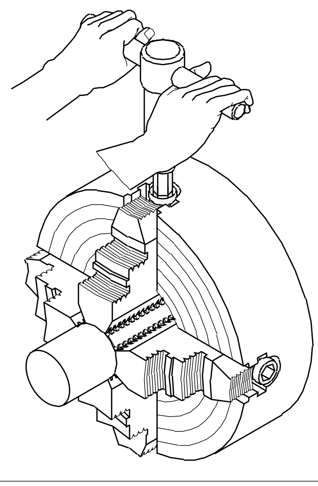
If the `feel' is not uniform tighten the jaw where the feel is high.

Repeat till a uniform feel is felt.

Finally, tighten the opposite jaws with the same amount of pressure.

Check once again for the true running of the work.

Fig 7



Tool setting

Objective: This shall help you to

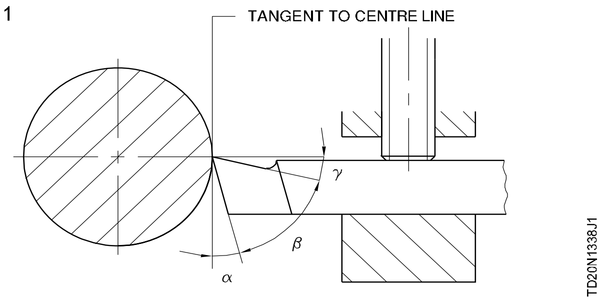
- **set the tool in the tool post for performing the operation.**

For optimum cutting, the effective rake angle and clearance angle of the clamped tool must be equal to the ground angles of the tool. This requires clamping of the tool to have its axis perpendicular to the lathe axis, with the tool tip at the workpiece centre. (Fig 1)

It is difficult to determine the effective angles of the tool when it is not set to the centre height.

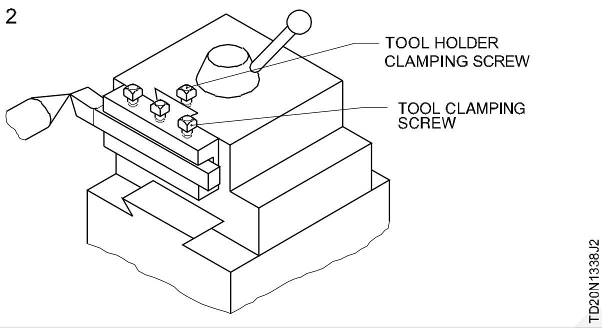
The tool nose can be set to the work centre by means of a tool-holder with adjustable height. (Fig 1)

Fig 1



The tool nose can be set to the exact centre height by placing the tool in the tool post on the shims or packing strips. These packing strips should be preferably a little less in width than the width of the tool but should never be more. The length of these strips should be according to the shank length and the tool seating face of the tool post. (Fig 2)

Fig 2



The procedure to follow is given below.

Clean the tool post seating face, and place the shims on the seating face.

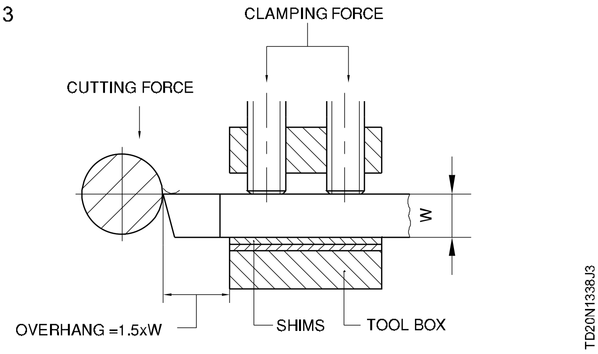
Use a minimum number of shims for height adjustment.

Shims must be flushed with the edge of the seating face.

Place the tool in the tool post on the shims, with the rear butting against the wall of the seating face. (Fig 3)

The unsupported length of the overhanging end of the turning tool should be kept to a minimum. As a rule, the overhanging length of tool is equal to the tool shank width x 1.5.

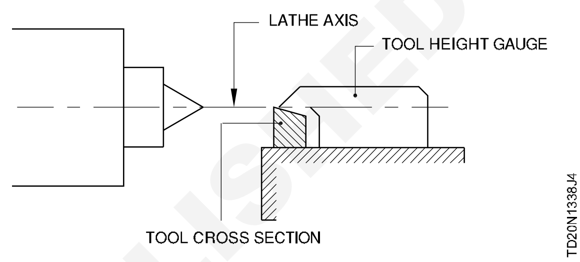
Fig 3



Tighten the tool with the centre screw of the tool post.

Check the centre height with a height setting gauge. (Fig 4)

Fig 4



Remove or add shims and check the height when the tool is tightened by the centre screw.

Tighten the other two tool-holding screws alternately applying the same amount of pressure.

When both the screws have a full gripping pressure, tighten the centre screw fully.

Check once again with a tool height setting gauge.

The gauge should be made according to the size of the machine. If a gauge is not available, use a surface gauge and set the pointer tip to the dead centre height fixed in the tailstock. Use this as the height to which the tool is to be set.

Finish-facing the work with a right hand facing tool

Objective: This shall help you to

- **finish-face the work using a right hand facing tool.**

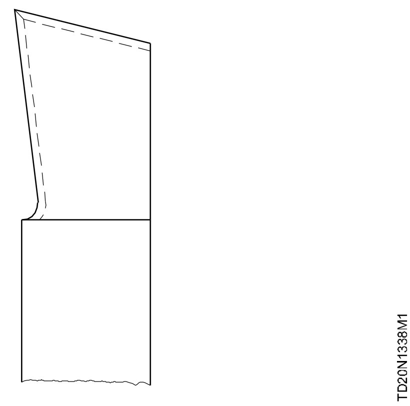
When more metal is to be removed on the face of the work, we prefer to do rough facing by an L.H. facing tool or a L.H. roughing tool, feeding the tool from the periphery of the work towards the centre. Finish-facing is done to get a better surface finish on the face of the work by removing the rough marks caused by the rough facing. The normal R.H. facing tool, having its cutting edge straight, may be kept slightly inclined to the face of the work during facing. A tool, having its cutting edge itself ground at an angle, may be used. (Fig 1)

The procedure of finish-facing the work with such a tool is given in sequence below.

Hold the tool in the tool post to the correct centre height with its axis at right angles to the axis of the work and with a minimum overhang.

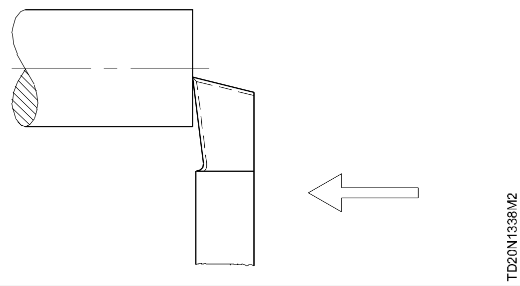
Set the machine to about 500 rpm. (Calculate the spindle speed by choosing the recommended cutting speed for finish-facing and the mean diameter of the work.)

Fig 1



Start the machine and touch the tool point to the work-face at about 4 to 5 mm from the centre, and set the top slide graduated collar to zero, eliminating backlash. Lock the carriage. (Fig 2)

Fig 2



Feed the tool about 0.5 mm by the top slide inside the face of the work. (Fig 3)

Feed the tool towards the centre of the work by the cross-slide till the tool point crosses the centre. (Fig 4)

Advance the tool by a further 0.5 mm inside the work by the top slide.

Fig 3

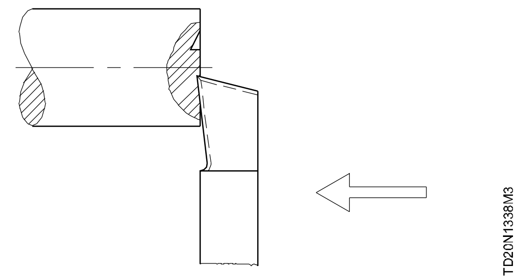
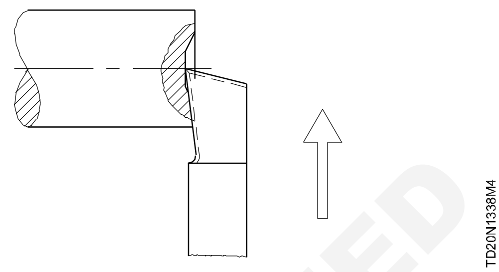


Fig 4

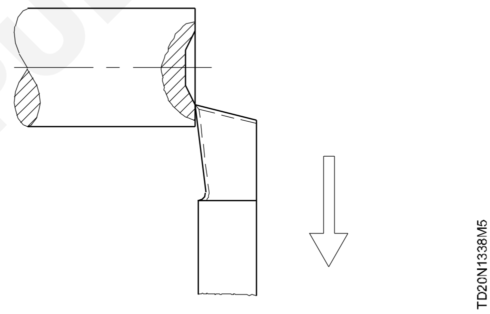


Engage the power feed (set at 0.05 mm/rev.) and allow the tool to travel towards the periphery of the work, removing the metal. (Fig 5)

Repeat the sequence until the required amount of material is removed.

Observe the finish obtained.

Fig 5



Centre drilling on lathe

Objective: This shall help you to
- **centre drill a work held in a chuck.**

Round workpieces can be quickly and accurately centre-drilled without the necessity of centre punch marks.

The procedure to centre drill a work held in a chuck is given below in sequence. (Fig 1)

Hold the work in a four jaw chuck about 50 mm outside and true.

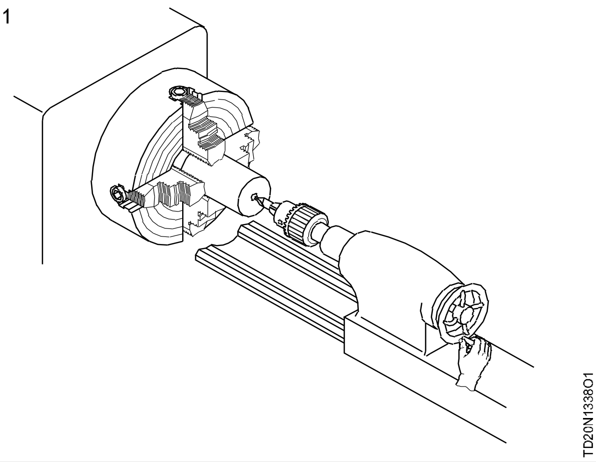
Finish face the work with a facing tool.

Ensure no 'pip' is left out in the centre and the face is at right angles to the axis.

Mount the drill chuck in the tailstock spindle.

Remove dirt on the taper shank of the chuck and the tailstock spindle taper bore.

Fig 1



Mount a suitable centre drill securely in the drill chuck.

Set the lathe to about 1000 r.p.m.

Slide the tailstock over the bed until the centre drill is close to the work face.

Lock the tailstock in this position.

Start the machine and slowly feed the centre drill into the work by rotating the tailstock hand wheel.

Withdraw the drill frequently from the workpiece to clean the chips and to apply the cutting fluid.

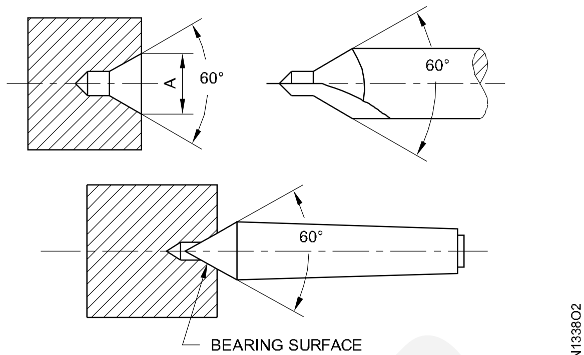
Continue drilling until about three fourths of the tapered portion of the centre drill has entered the work. (Fig 2)

Ensure that uniform continuous pressure is applied during feeding and no extra force is given.

After drilling to the correct depth, withdraw the tailstock spindle.

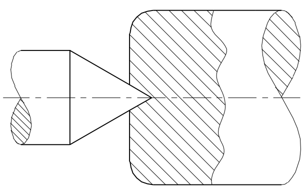
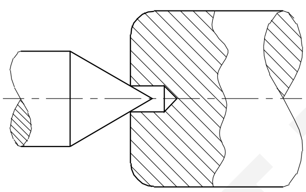
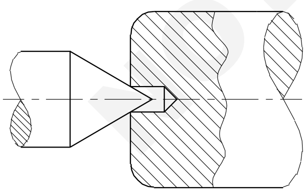
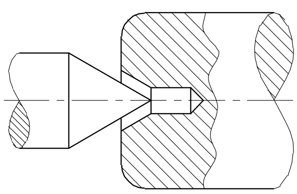
When the diameter of the work is more than 150 mm with the same amount outside the chuck, and when irregular work is held in the chuck, running the machine at 1000 r.p.m. for centre drilling will cause undue load to the spindle. Avoid this method of centre drilling.

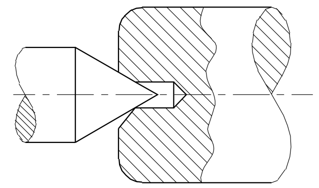
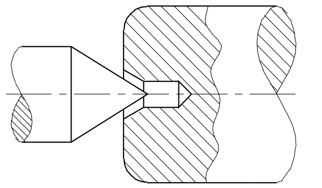
Fig 2



CENTRE HOLE DRILLED CORRECTLY

Common errors in centre drilling

Condition of centre hole	**Errors**	**How to avoid and correct the errors**
	No clearance for point of centre. Centre hole incomplete. Insufficient bearing surface for lathe centre.	Drill pilot hole. Countersink pilot hole at 60°. Drill centre hole with a centre drill
	No bearing surface for lathe centre.	Countersink mouth of hole at 60°.
	Insufficient bearing surface for lathe centres.	Countersink deeper.
	Hole drilled too deep with centre drill. Poor bearing surface.	Face end if the job will allow it. Ream the mouth with a centre reamer.

Condition of centre hole	Errors	How to avoid and correct the errors
	Poor bearing surface. Wrong angle.	Countersink hole with a 60° centre drill.
	Centre hole drilled at angle to the axis of work.	Align work squarely when drilling the centre hole. Face end and re-centre.

Setting the job between centre

Objective: This shall help you to
- **set the job between centres.**

Turning work in between centres avoids the necessity of truing the work. It is limited to external operations only.

Face both sides of the work and maintain the length within the limits.

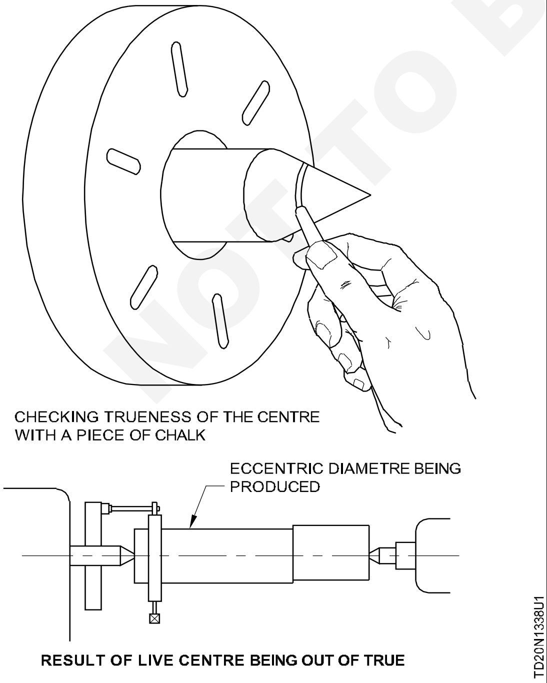
Centre drill on both sides of the work.

Mount a driving plate or catch plate on the spindle nose. Fix the live centre to the spindle nose and the dead centre on the tailstock spindle.

Ensure that both the live and dead centres are free from dirt before assembly.

Check for true running of the live centre. (Fig 1)

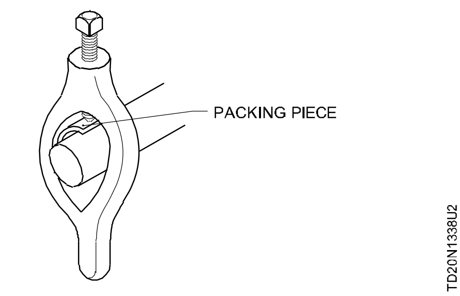
Fig 1



(A run out in live centre will cause misalignment during resetting the work between centres.)

Select a suitable lathe carrier according to the diameter of the work with the bent tail pointing outside, insert a piece of soft metal in between the work and the carrier screw. (Fig 2)

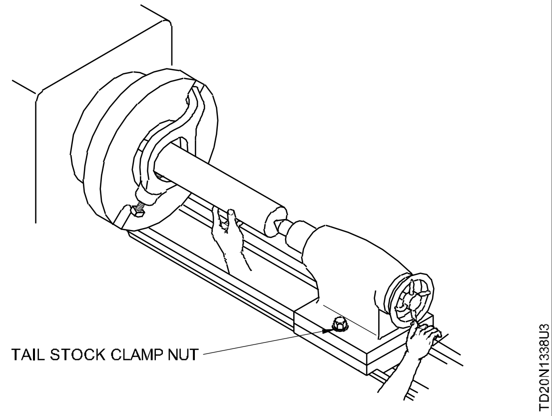
Fig 2



Apply grease to the centre holes of the work in the tailstock side.

Move the tailstock to a distance suitable to hold the work, and clamp it with the bed (tighten the nut). (Fig 3)

Fig 3



Ensure the tailstock spindle is away from the face of the work by 60 to 100mm.

Ensure sufficient space between the spindle and the tailstock for the saddle to operate.

Hold the work in the hand, set the centre of work with the live centre (carrier end). Move the tailstock spindle by rotating the tailstock hand wheel and ensure the dead centre tip enters into the centre hole of the work. Clamp the tailstock in position by tightening the tailstock clamp nut. (Fig 3)

Ensure a slight resistance is felt in the movement of the work between centres.

(Too much tight will cause burring of the dead centres while too light tight will cause chatter turned surface).

Set the machine for about 250 r.p.m. and allow the work to run for a few seconds.

Check once again for the required resistance, and adjust if necessary.

Turning work parallel in between centres

Objective: This shall help you to
- **turn job parallel in between centres.**

Hold the work between centres.

Set the R.H. turning tool rigidly in the tool post.

Set the machine to the required r.p.m. Start the machine, touch the tool tip on the surface and set zero on the cross-slide graduated collar with backlash eliminated.

Give a depth of cut to turn the outer diameter: while giving the cut do not exceed more than 2 mm depth of cut per each pass.

Do check the size immediately after turning for a length of 3 mm.

Continue only after confirmation the size is within the limit.

The movement of the carriage hand wheel must be slow and steady. Otherwise the turned surface will not be uniform.

Repeat the cut till the required diameter is achieved. (Fig 1)

Remove the job from centres.

Remove and refix the carrier at the other end.

Refix the work between the centres.

Turn the remaining part of the work to the same diameter. (Fig 2)

Fig 1

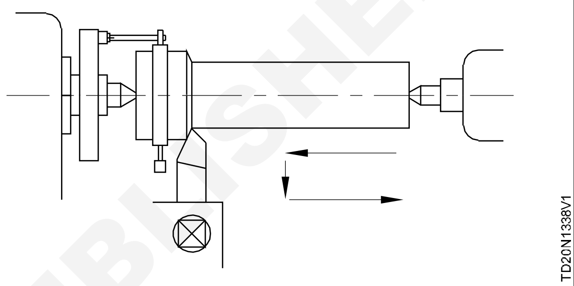
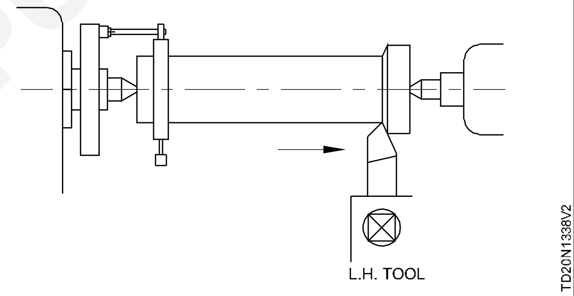


Fig 2



Check the diameter with a outside micrometer.

Turning steps of different diameters

Objective: This shall help you to
- **turn steps of different diameters for definite length on a shaft.**

When the width of step to be turned is more than the width of the tool, it is turned by using a R.H. knife-edge tool.

Hold the previously turned shaft in three jaw chuck and true it at both ends (near the chuck and overhanging end).

Hold the RH Knife-edge tool in the tool post with its cutting edge at centre height and at right angle.

Set the machine to 300 r.p.m.

Start the machine and touch the tool tip on the surface of work to set the cross-slide graduated collar to zero with the backlash eliminated. (Fig 1)

Withdraw the tool from work and make the cutting edge contact the face of the work to set the top slide graduated collar to zero with a backlash eliminated. (Fig 2)

Fig 1

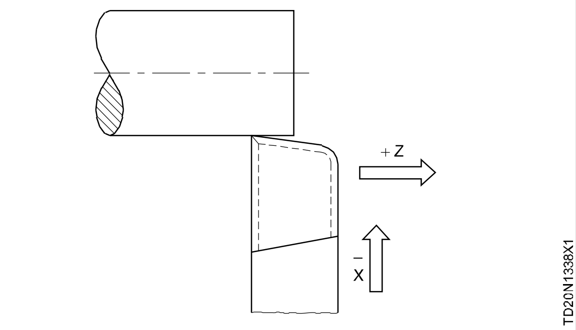


Fig 2

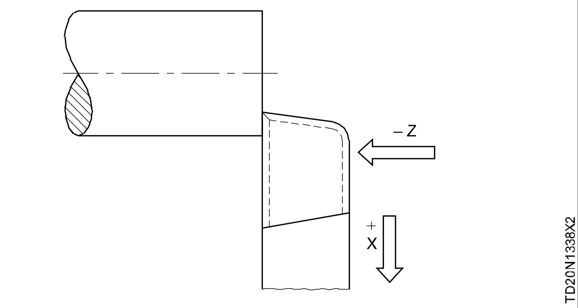


Fig 3

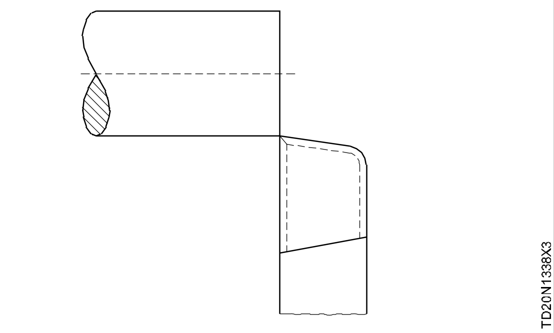
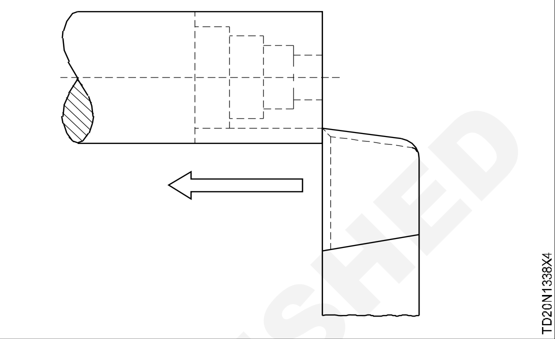


Fig 4



Position the tool tip near the edge of the work. (Fig 3)

Give a depth of cut to turn steps progressively. (Fig 4)

Advance the tool axially to the required length by rotating the top slide hand wheel.

(The rotation of the top slide hand wheel should be continuous and uniform till the required length is reached).

Restrict the depth of cut to a maximum of 3 mm for each cut.

Repeat the depth of cuts till the required diameter is reached.

Keep the carriage in the locked position.

Form an undercut shoulder at the junction of two diameters

Objectives: This shall help you to
- **set the undercutting tool in the tool post**
- **set the tool at the required position**
- **perform undercut operations**
- **check the undercut width and depth with a vernier caliper.**

The end of a section to be threaded is mostly undercut to provide a channel into which the threading tool may run. It allows the mating part to sit squarely against it. When the diameter is to be finished to size by grinding, a channel is generally cut against the shoulder to provide a clearance for the grinding wheel, thus ensuring a square corner.

To form an undercut shoulder at the junction, the following procedure is to be followed.

Select a suitable tool bit or grind one to the shape and size required.

Set correct spindle speed, and start the machine.

Rotate the carriage handle until the tool almost touches the face of the work. (Fig 1)

Lock the saddle in this position.

Rotate the cross-slide handle and touch the work surface lightly with the front cutting edge of the tool. Set the cross-slide graduated collar to zero. (Fig 2)

Fig 1

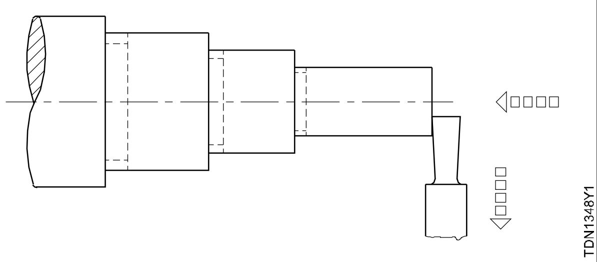
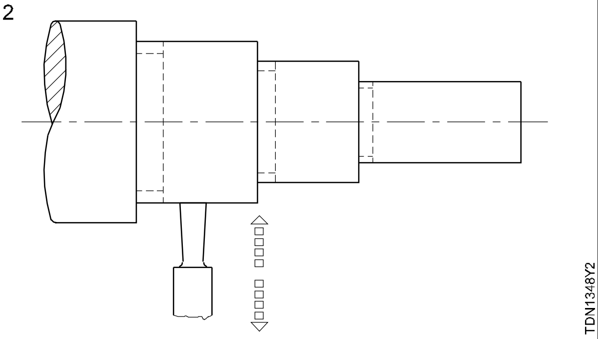


Fig 2



Rotate the top slide handle until the tool marks the shoulder lightly. (Fig 3)

Note the reading on the graduated collar of the top slide feed screw, and set the reading to zero.

Apply cutting fluid.

Feed the tool slowly and evenly into the work to the required depth using cross-slide handle (Fig 4)

Fig 3

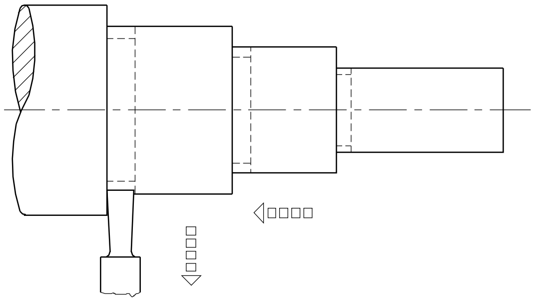
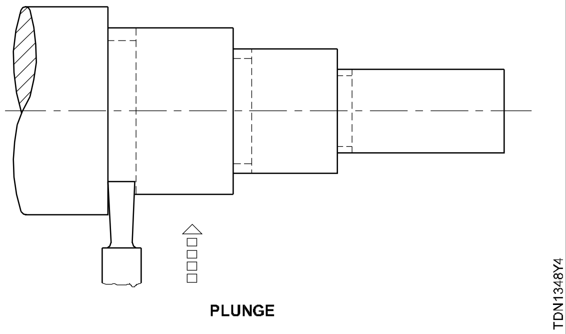


Fig 4



Stop the lathe and check the undercut for its dimensions.

Remove sharp corners, if any.

Machining various shoulders

Objective: This shall help you to
- **machining various shoulders.**

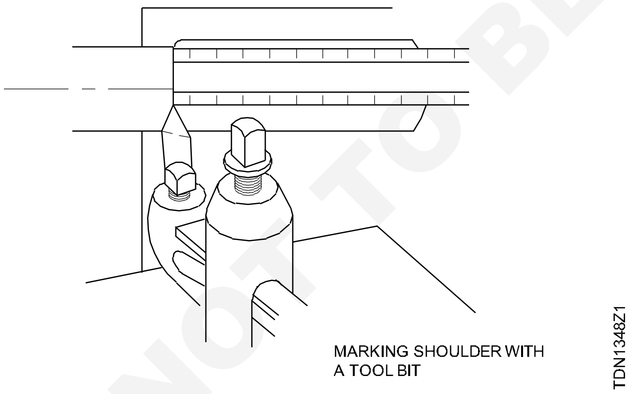
Machining a square shoulder

Face the end of the work to provide a reference surface point from which to take measurements.

Lay out the position of the shoulder by one of the following methods.

Cut a light groove with the point of a sharp tool bit around the circumference of the work to mark the required length. (Fig 1)

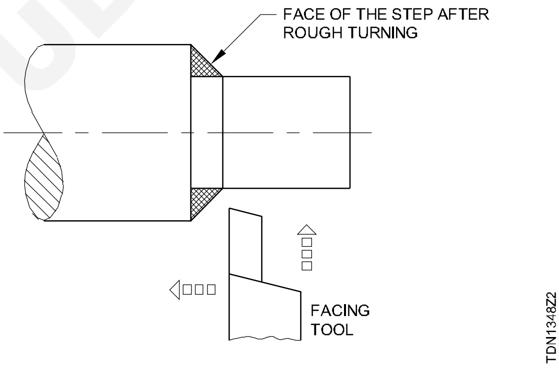
Fig 1



Rough and finish turn the diameter to within about 1 mm of the required length.

Mount a facing tool bit in the tool-holder and set it to centre. (Fig 2)

Fig 2



Make sure that the tool bit is set up with the point close to the work, and with a slight space along the side cutting edge.

Apply chalk or lay out dye to the small diameter, as close to the shoulder as possible.

Before starting the lathe, the tool bit should be brought fairly close to the diameter, by using a piece of paper or thin stock between the tool bit point and the work diameter.

Start the lathe and bring the facing tool in until it just removes the chalk or the layout dye.

Note the reading on the graduated collar of the cross-slide screw.

Bring the tool bit towards the shoulder with the carriage hand wheel until a cut is started.

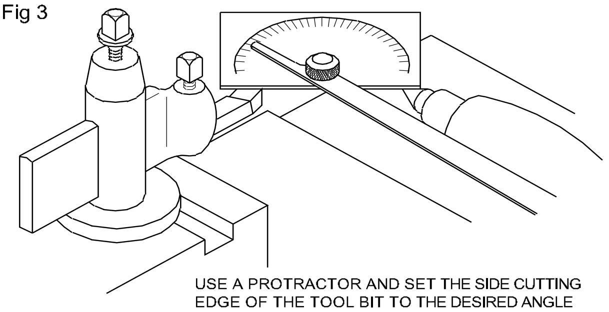
Face the shoulder by turning the cross-slide handle anti-clockwise, thus cutting from the centre to the outside.

For successive cuts, return the cross-slide screw to the same graduated collar setting. Repeat the above procedure until the shoulder is machined to the correct length.

Machining a bevelled shoulder (Fig 3)

Lay out the position of the shoulder along the length of the workpiece, and set the tool as shown in Fig 3.

Fig 3



USE A PROTRACTOR AND SET THE SIDE CUTTING EDGE OF THE TOOL BIT TO THE DESIRED ANGLE

Rough and finish turn the small diameter to size.

Mount a side cutting tool in the tool-holder and set it to centre.

Apply chalk or layout dye to the small diameter as close as possible to the shoulder location.

Bring the point of the tool bit in until it just removes the chalk or layout dye.

Turn the carriage hand wheel by hand to feed the cutting tool slowly into the shoulder.

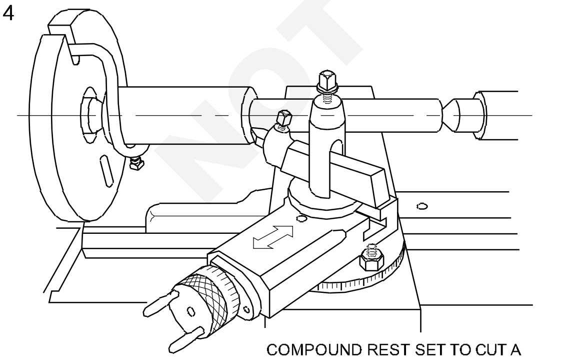
Apply a cutting fluid to assist the cutting action and to produce a good surface finish.

Machine the bevelled shoulder until it is to the required size.

If the size of the shoulder is large, and chatter occurs when cutting with the side of the tool bit, it may be necessary to cut the bevelled shoulder using the compound rest.

Set the compound rest to the desired angle. (Fig 4)

Fig 4



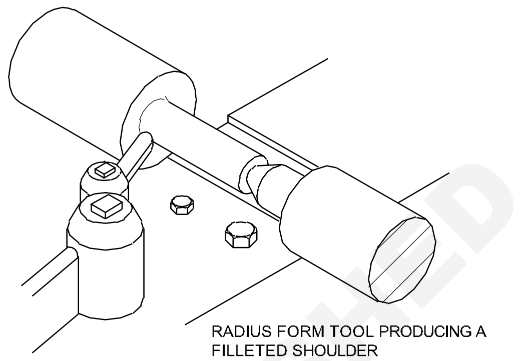
COMPOUND REST SET TO CUT A BEVELLED SHOULDER

Adjust the tool bit so that only the point will cut.

Apply a cutting fluid to assist cutting action. Progressively machine the bevel. Always cut outwards and start each cut near the outermost edge of the face of the shoulder. Be careful not to damage the small diameter when preparing to make each new cut. At the start of the final cut, bring the point of the tool bit in, until it just removes the chalk or layout dye at the innermost edge of the original shoulder face.

Machining a filleted shoulder (Fig 5)

Fig 5



RADIUS FORM TOOL PRODUCING A FILLETED SHOULDER

Lay out or mark the location of the shoulder on the workpiece.

When laying out for a filleted shoulder make allowance for the radius to be cut. If a filleted shoulder has a 4 mm radius and is 60 mm from the end of the workpiece, the layout should be 56 mm from the end. This would leave material for cutting the radius.

Rough and finish turn the small diameter to size.

Mount a radius tool in the holder and set it to centre. Check the tool bit with a radius gauge to be sure that it has the correct radius.

Apply a layout dye or chalk to the small diameter as close as possible to the shoulder location.

Set the lathe spindle speed to approximately one half of the turning speed.

Start the lathe and bring the tool bit in until it just removes the layout dye or chalk.

Note the reading on the graduated collar of the cross-slide screw.

Retract the cutting tool by turning the cross-slide handle anticlockwise one half turn.

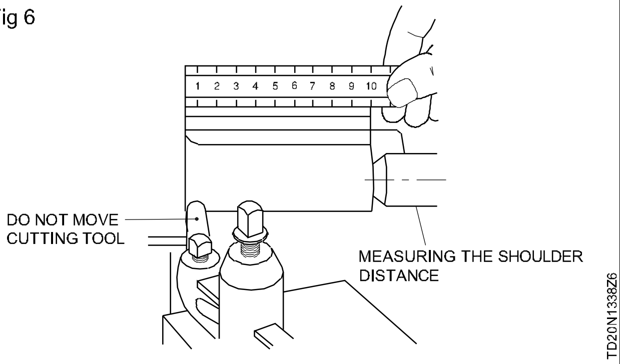
Turn the cross-slide handle clockwise until it is within approximately 1 mm of the original collar setting. The point of the round nose tool bit should now be about 1 mm away from the work diameter. This prevents the cutting tool from undercutting while roughing out the filleted corner.

Turn the carriage hand wheel slowly to start the radius tool cutting the filleted shoulder. If chattering occurs while machining the filleted corner, reduce the lathe speed and apply a cutting fluid to improve the finish of the fillet.

Continue turning the carriage hand wheel slowly and carefully until the length of the shoulder is correct.

When stopping the lathe to measure the shoulder distance, do not move the cutting tool setting by withdrawing it from the diameter. (Fig 6)

Fig 6



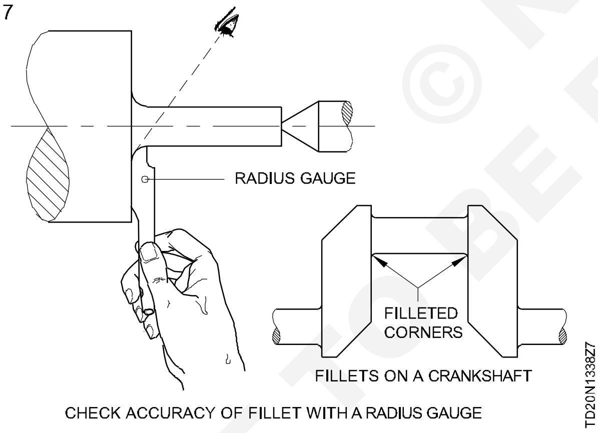
Turn the carriage hand wheel to move the cutting tool away from the shoulder slightly.

Turn the cross-slide handle anticlockwise about 1 mm back to the original collar setting.

Finish the filleted corner by carefully advancing the radius tool bit with the carriage hand wheel.

If the radius is too large for a form tool bit, or too much chattering occurs, cut the fillet in steps, using the largest radius tool that does not cause chattering. Check the accuracy of the fillet with a radius gauge. (Fig 7)

Fig 7



Machining an undercut shoulder

Lay out the position of the undercut shoulder along the length of the workpiece.

Rough and finish turn the small diameter to size.

Mount the undercut tool in the tool-holder and set it to the centre.

Apply chalk or layout dye to the small diameter as close as possible to the undercut shoulder location and also on the face of the larger diameter.

Set the lathe spindle to approximately one half of the turning speed.

Bring the point of the tool bit in until it just removes the chalk or layout dye on the face and set the top slide graduated collar to zero.

Apply a cutting fluid to assist the cutting action and produce a good surface finish.

Retract the cutting tool by turning the cross-slide handle anticlockwise.

Repeat the above procedure until the undercut shoulder is machined to the correct depth.

Bring the tool tip clear off the large diameter face and advance the tool axially by 1 division of the top slide.

Feed the tool into the work from the edge of the larger diameter face, till it just removes the chalk mark applied on the small diameter.

Note the cross-slide graduated collar reading and advance the tool into the work to the number of divisions required according to the depth.

> **Ensure that the tool cutting edge is parallel to the work axis.**
>
> **Ensure that the carriage is locked during the undercutting operation.**

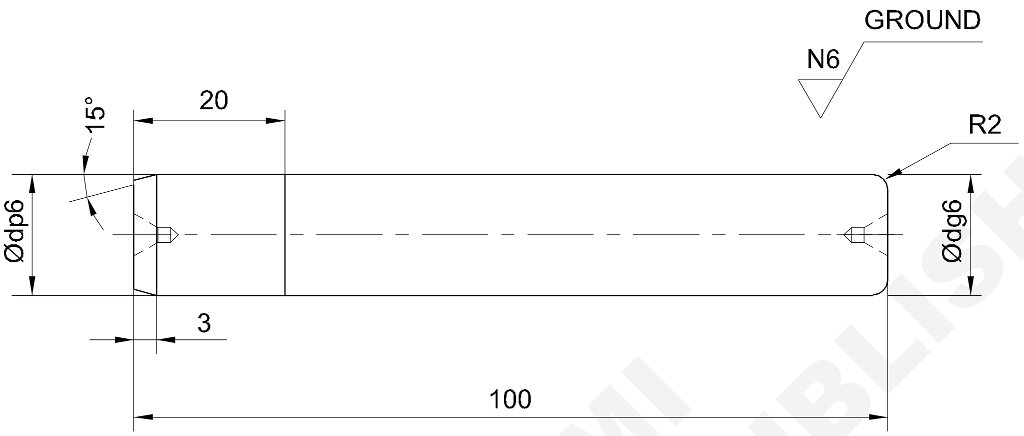
Apply a cutting fluid to assist the cutting action and to produce a good surface finish.

Retract the cutting tool by turning the cross-slide handle anticlockwise.

Repeat the above procedure until the undercut shoulder is machined to the correct depth.

Turning in between centre

Objective: At the end of this exercise you shall be able to
- **prepare a guide pillar for progressive tool.**



$Ø15 / 16\ p6 = Ø15 / 16^{+0.029}_{+0.018}$

$Ø15 / 16\ g6 = Ø15 / 16^{-0.006}_{-0.017}$

	1	2
Ød	15	16

Job Sequence

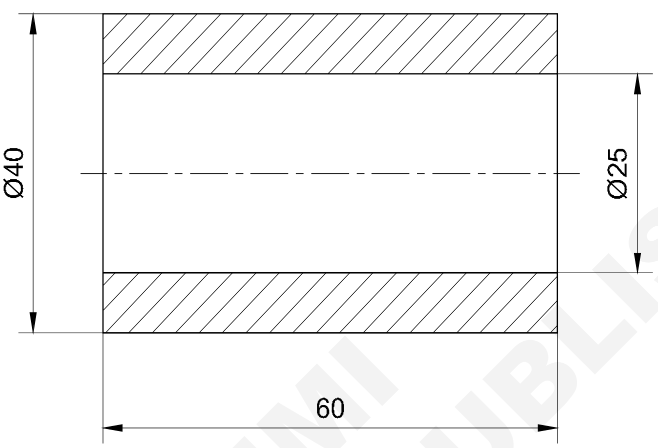
- Check the raw material size
- Face and maintain the length as per drawing
- Centre drill on both side
- Set the workpiece for turning in between centres
- Turn and maintain the diameter as per drawing form corer radious.
- Reverse the job and turn diameter as per drawing and maintain the length
- Turn the taper by compound slide method
- Check the dimensions.

1	ISRO 20 - 120	-	Fe310	-	10	1.3.39
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	PROJECT: PROGESSIVE TOOL	DEVIATIONS ± 0.1	TIME
	PART: GUIDE PILLAR	CODE NO. TD20N1339E1	

Bush turning; drilling and boring/ reaming

Objectives: At the end of this exercise you shall be able to
- **drill through hole**
- **bore a hole to an accuracy of ± 0.2 mm with a tool**
- **measure the bore by using a vernier caliper**
- **chamfer the bore with a suitable tool.**



Job Sequence

- Check the raw material for its size.
- Hold the job in a 4 jaw chuck and true it, keeping about 45 mm outside the chuck.
- Set the facing tool to the correct centre height.
- Select and set the correct spindle speed, for facing.
- Face one side first, and turn the outer diameter to Ø 40 mm for the maximum possible length.
- Spot-face the job for drilling by centre drilling.
- Select the required size of drills including the pilot drill.
- Hold the drill in the tailstock spindle with the help of suitable sleeves after cleaning.
- Select the spindle speed for drilling the pilot hole of 12 mm dia.
- Bring the tailstock to a convenient position for drilling, and lock the tailstock on the bed.
- Run the lathe and advance the drill so that it does the drilling operation on the job held in the chuck.
- Use a coolant while drilling and advance the drill slowly.
- After completion of drilling throughout the job, reverse, and true the job; face to the required length as per drawing, and turn outer dia Ø 40 mm.
- Enlarge Ø 12 mm hole to Ø 20 mm hole by drilling at a reduced spindle speed.
- Set the boring tool in the tool post to the centre height and bore the drilled hole to Ø 25 mm through.
- Check the bore size with a vernier caliper.

Safety precautions
- Select proper spindle speeds as per size and operation.
- Use pilot drill while drilling more than 20 mm drill size.
- Feed the drill slowly while drilling.
- Use a coolant while drilling.
- Make sure that the drill has been ground properly.

1	Ø45 - 65	–	Fe 310	–	–	1.3.40
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	DRILLING AND BORING				DEVIATIONS ± 0.2	TIME
					CODE NO. TD20N1340E1	

Skill Sequence

Drilling a hole on a lathe

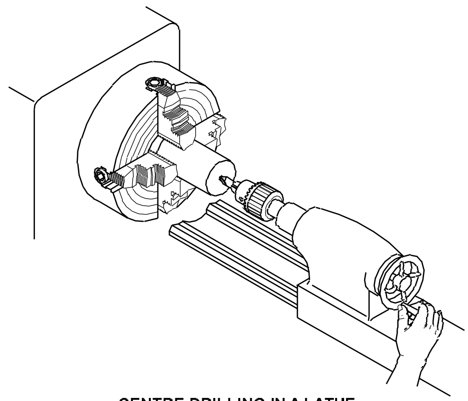
Objectives: This shall help you to
- **set the machine for drilling**
- **drill a hole accurately with a drill.**

Hold and true the job in four jaw chuck. Keeping sufficient length outside chuck.

Face the job.

Centre drill for further drilling. (Fig 1)

Fig 1



CENTRE DRILLING IN A LATHE

TD20N1340H1

Select the required size drill and hold the drill in the tailstock spindle sleeve/ drill chuck.

> **Parallel shank drills are held with drill chuck**
>
> **Taper shank drills are held with the help of sleeves/scokets/directly on the tailstock spindle.**

Extend the spindle of tailstock approximately 30 mm beyond the tailstock to permit maximum drilling depth.

Move the tailstock towards headstock until the point of the drill is about 5 mm away from the end for the job.

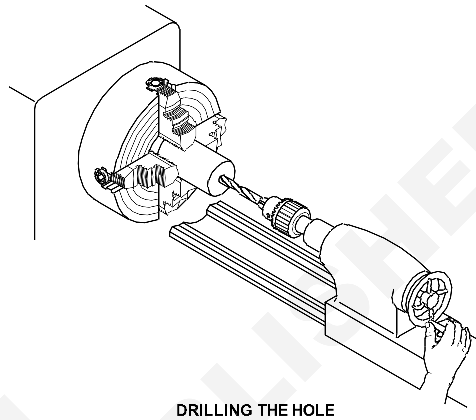
Clamp the tailstock to the lathe bed.

Set the spindle speed depending upon the size of drill and material to be drilled.

Start the lathe and turn the tailstock hand wheel in clockwise direction until the drill enters to its full diameter.

Note the reading of the graduation on the tailstock spindle or place pencil mark on the tailstock spindle adjacent to the casting. The depth of hole drilled can be measured by the tailstock graduation or from the pencil line with a steel rule. (Fig 2)

Fig 2



DRILLING THE HOLE

TD20N1340H2

Apply cutting fluid and drill the hole to the required depth.

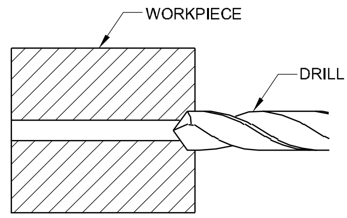
> **Withdraw the drill occasionally and clear out chips and apply cutting fluid to the drill**

Importants of pilot drilling (Fig 3): it reduces the cutting force on the subsequent drills.

Accuracy of the hole is increased.

Helps the operator to feed the drill easily.

Fig 3



PILOT HOLE DRILLED FIRST

TD20N1340H3

Boring a drilled hole

Objectives: This shall help you to
- **set the boring tool in the tool post**
- **bore the drilled hole to the required size**
- **check the hole with the help of a vernier caliper.**

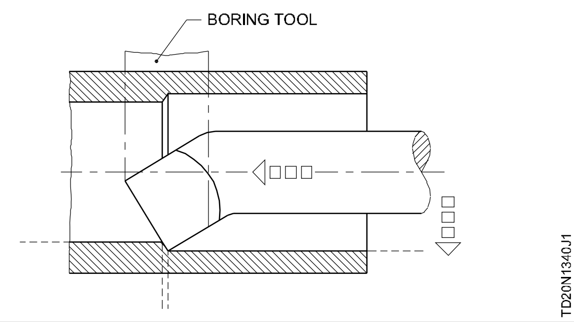
Boring is an internal operation of enlarging a hole with the help of a single point cutting tool. (Fig 1)

To bore the hole the following procedure is to be followed.

Mount the workpiece in a four jaw chuck. True the face of the work and the outer diameter.

Set the lathe to the proper spindle speed for boring.

Fig 1



Mount the boring tool on the tool post of the compound rest.

Fix the boring tool, level and parallel to the centre line of the lathe.

> **Grip the boring tool as short as possible to reduce chatter.**

Use the largest diameter boring tool which can be accommodated in the drilled hole. (Approximately 2/3 size of the bore).

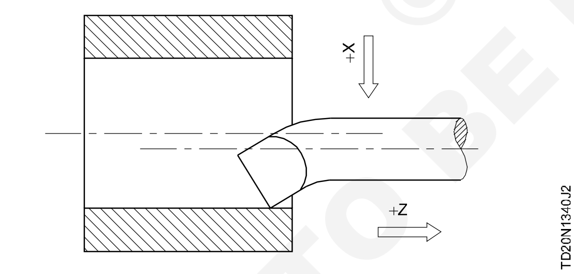
Set the cutting edge of the cutting tool just slightly above the centre line, since there is a tendency for the tool to spring downwards when cutting.

Choose a proper feed for rough boring.

> **The speed for boring is the same as that for turning, and is calculated for the diameter of the bore.**

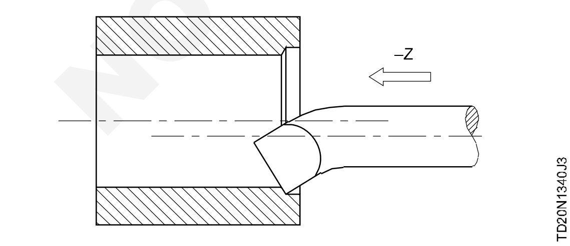
Start the machine and turn the cross-slide handle anti-clockwise until the cutting tool touches the inside surface of the hole. (Fig 2)

Fig 2



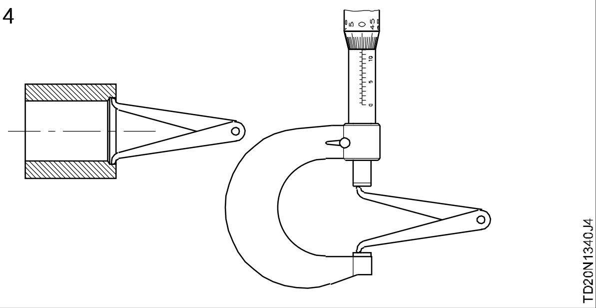
Take a light trial cut about 0.2 mm deep and about 8 mm long at the right hand end of the work. (Fig 3)

Fig 3



Stop the machine and measure the diameter using a telescopic gauge or inside caliper. (Fig 4)

Fig 4

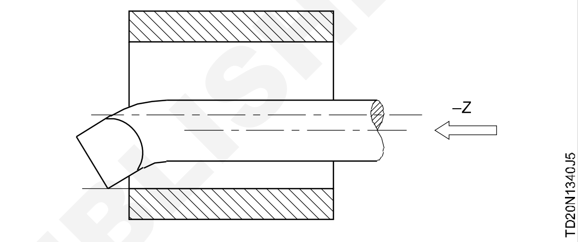


Calculate the amount of material to be removed from the hole for the roughing cut.

> **Leave about 0.5 mm undersize for a finish cut.**

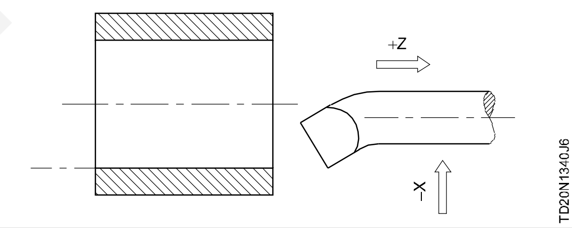
Take a roughing cut for the required length. (Fig 5)

Fig 5



Stop the machine and move the carriage to the right until the boring tool clears the hole. (Fig 6)

Fig 6



Set a fine feed of about 0.1 mm for the finish cut.

Set the cutting tool for the required depth to get the finished bore size.

Use the cross-slide graduated collar.

Finish the boring operation and measure with a vernier caliper.

> **To avoid bell mouth, repeat the same cut.**

Several cuts taken without adjusting the depth of cut would correct bell mouthing.

Remove the sharp corners.

Inside caliper & Outside micrometer used for bore measurement

Objective: This shall help you to
- **take the measurement of a bored hole with an inside caliper, transfer it to an outside micrometer and read the measurement.**

Bores are checked for their dimensional accuracy by using:

1 inside micrometers.

2 universal vernier calipers.

3 inside calipers and outside micrometers (transfer measurement).

4 telescopic gauges and outside micrometers (transfer measurement).

The first two methods give direct reading whereas the 3rd and 4th are by transfer measurement.

For checking the bore diameters using inside calipers and out-side micrometers the following sequence is to be followed.

Select the inside caliper according to the size of the bore to be measured.

Select an outside micrometer of suitable range for the size of the hole.

Open the legs of the inside caliper approximately permitting its entrance into the hole.

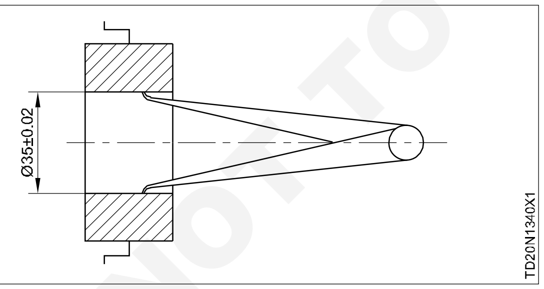
Position one leg in contact with the bottom of the bore.

Keeping this as the fulcrum, oscillate the other leg in the bore.

Adjust the distance between the legs by gentle tapping to increase or to decrease so as to enable the leg to enter.

Rock the inside caliper with respect to the axis of the work so as to make the leg of the inside caliper contact the bore top surface. (Fig 1)

Fig 1



If the 'feel' is hard, reduce the distance between the leg tips and if the feel is less or if there is no feel, increase the distance between the leg tips slightly.

Check once again and repeat till you get the correct feel.

Ensure that the position of the legs is not disturbed, once the correct feel is obtained.

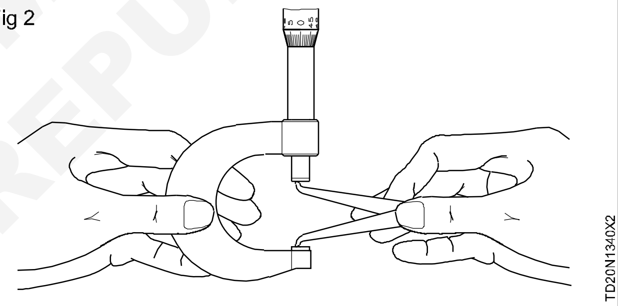
Hold the outside micrometer in one hand, and the spindle away from the anvil face, a little more than the distance between the two legs of the inside caliper.

Hold the inside caliper with the other hand, contacting the tip of one leg with the anvil face of the micrometer.

Oscillate the other leg and rotate the thimble of the outside micrometer to contact the tip of the oscillating leg of the inside caliper. (Fig 2)

Ensure you get the same 'feel' as before.

Fig 2



Note the readings on the barrel and thimble of the outside micrometer, and determine the size of the measurement.

Note:

The accuracy depends on the skill. Practise to get the correct feel for the measurement.

Reaming a hole by a hand reamer on the lathe

Objectives : This shall help you to
- **set the machine for hand reaming**
- **set the reamer on a lathe**
- **ream a hole accurately with a hand reamer.**

The procedure sequence of hand reaming on a lathe is as follows.

Check the drilled hole to ensure that it has the required reaming allowance.

Choose the correct type and size of reamer.

Remove the tool-holder and tool post.

Fix up the tap wrench to the square end of the reamer. The tap wrench must be short enough to clear the lathe bed.

Move the tailstock back so that there is sufficient space for the reamer between the dead centre and the workpiece.

Place the reamer into the pre-drilled hole slightly with the shank supported by the tailstock dead centre. (Fig 1)

Apply cutting fluid to the reamer during reaming.

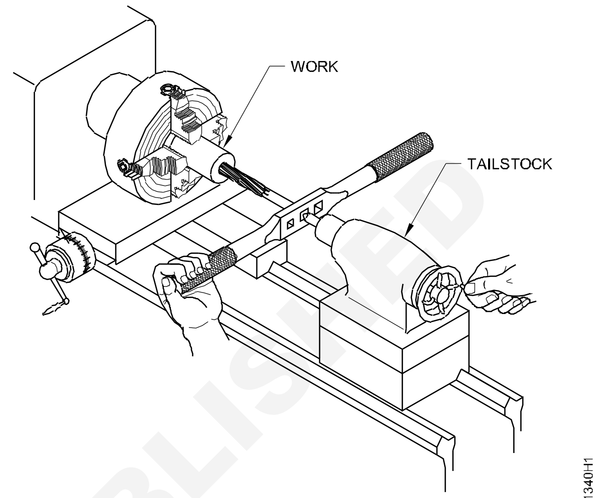
The job should not be rotated by power.

Now gently rotate the reamer clockwise with" the wrench as you turn the tailstock hand wheel to support and advance the reamer into the hole. (Fig 1)

An adjustable wrench can also be used to rotate the reamer instead of the tap wrench.

When the hole is fully reamed, continue to rotate the reamer clockwise as you- pull it out of the hole.

Fig 1



USING A HAND REAMER IN A LATHE

Remove the reamer occasionally by turning it clockwise to clear of the chips from the flutes.

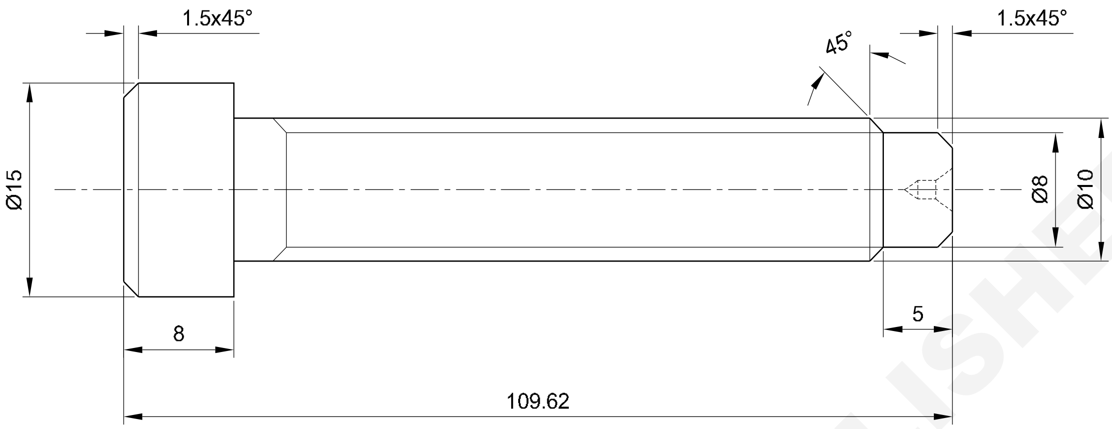
Never use a hand reamer under power.

Never turn the lathe spindle or reamer backward. This will damage the reamer blunting the cutting teeth of the reamer, and will also result in developing scratches on the reamed surface of the hole.

Remove any burrs from the edge of the hole with a scraper.

Turning and die passing

Objectives: At the end of this exercise you shall be able to
- **turn the bolt as per drawing shape and maintain its size**
- **cut external thread using die and die stock.**

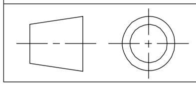


Job Sequence

- Check the raw material size.
- Cut four pieces 70 mm long.
- Hold the job in the chuck with 55 mm overhang and true it.
- Face end and centre drill the work with Ø1.6 x 4.0 IS:6708.
- Turn steps Ø8 x 5 mm and Ø10 x 47 mm.
- Chamfer the end of Ø8 mm to 1.5 x 45°
- Chamfer the end of Ø10 to 45°.
- Reverse and refix the job.
- Turn Ø15 to a length of 8 mm and face the end.
- Chamfer the end of Ø15mm to 1.5 x45°.
- Repeat the above operation for the remaining three pieces.
- Form external thread to M10 x 1.5 mm using hand die and stock on lathe.
- Check the thread by using standard nut M10 x 1.5 mm.

Cut M10 x 1.5 mm threads on all four jobs after the milling operation.

4	ISRO 16-70	-	45 C8	23	6	1.3.41
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**BLOT TURNING**	TOLERANCE ±1	TIME
		CODE NO. TD20N1341E1	

Skill Sequence

Cutting external threads on lathe using hand die

Objective: This shall help you to
- **cut external threads on a lathe using a hand die.**

Hold the job in the chuck and turn the steps as required.

Chamfer the edge.

Select a suitable die and stock and assemble them.

Move the tailstock near the work and clamp it.

Set the die with the stock and guide the stock with the tailstock spindle. (Fig 1)

Keep the spindle in neutral position.

Support the stock in the carriage.

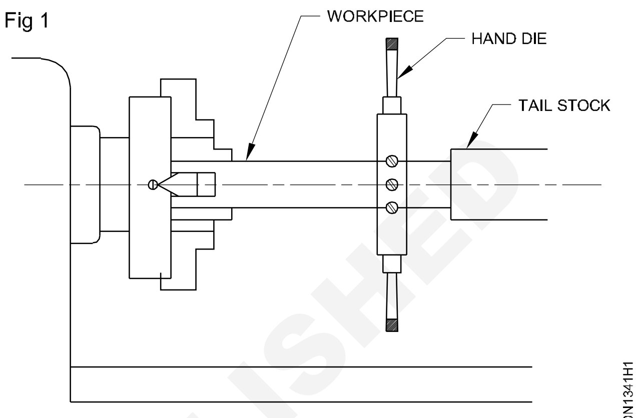
Rotate the chuck to a half turn with the help of the chuck key and simultaneously rotate the tailstock hand wheel to keep the die guided by the tailstock spindle.

Take back the tailstock spindle and reverse the die.

Again turn the die to a further half round. Repeat the operation till the required length of thread is cut.

Use a lubricating oil while the die is cutting the thread.

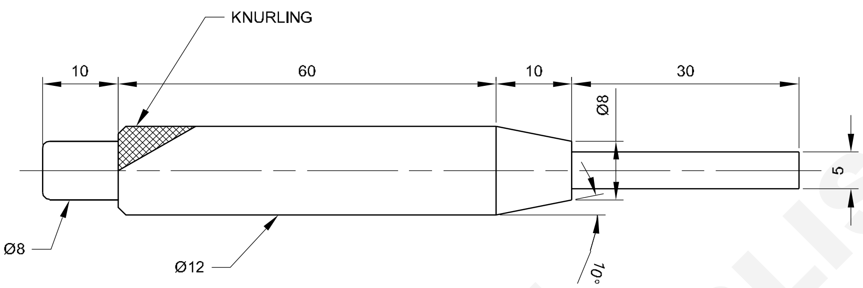
Fig 1



USING A HAND DIE IN LATHE

Pin punch turning and knurling

Objectives: At the end of this exercise you shall be able to
- **turn the workpiece as per drawing**
- **knurl the workpeice**
- **form radious at the end of workpiece**
- **turn taper using compound slide.**



Job Sequence

- Check the raw material size.
- Hold the workpiece in 3 jaw chuck with 75 mm over -hang face and maintain the over all length of 100 mm.
- Turn **Ø** 8.00 mm to 10 mm length.
- Turn 12 mm and to a length of 62.00 mm.
- Chamber it knurl (medium) on **Ø**12.00 mm.
- Reverse the work piece and hold on the knurled position with soft shim packing.
- Turn 5 mm to a length of 30 mm.
- Set the compound slide to 10° (90°-10°).
- Turn taper and maintain the diameter of 8mm.
- Deburr and clean the workpiece

1	Ø15 - 105	–	Fe 310	–	–	1.3.42
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	PIN PUNCH TURNING			TOLERANCE : ± 0.04mm	TIME :	
				CODE NO. TD20N1342E1		

Skill Sequence

Knurling on lathe

Objectives: This shall help you to
- **set the knurling tool in the tool-post**
- **knurl the job using the required grade of knurl.**

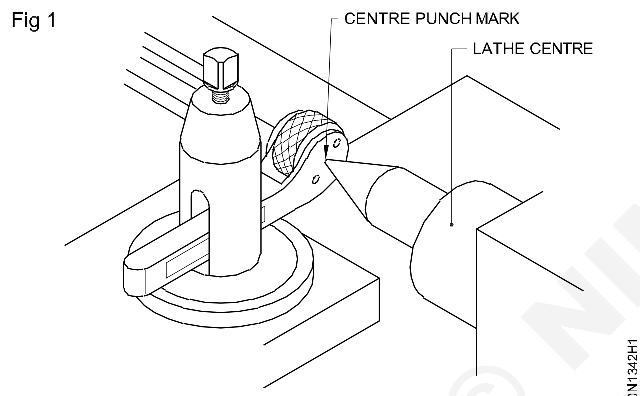
For better grip and for good appearance on cylindrical surfaces, a portion of the component is knurled.

Reduce the diameter of the portion to be knurled depending upon the grade of knurl and material of the job. Reduce approximately 0.1 mm for fine knurling, 0.2 mm for medium knurling and 0.3 mm for coarse knurling.

Support the job with the centre having a minimum overhang.

Set up the knurling tool in the tool-post with the centre of the floating head at the same height as the lathe centre point. (Fig 1)

Fig 1



SETTING THE KNURLING TOOL ON CENTRE

Set the machine for a low speed, preferably 1/3 to 1/4 of the turning speed.

Mark off the length to be knurled.

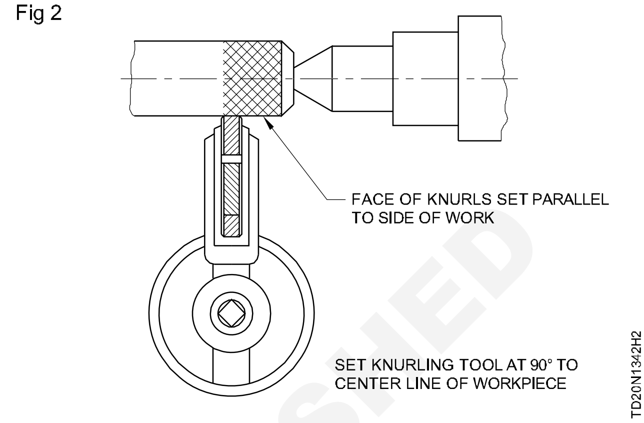
Adjust the knurling tool so that it is at right angles to the axis of the work, and tighten it firmly. (Fig 2)

Feed the knurls and make the pair of knurls to contact the work periphery by the cross-slide hand wheel.

Rotate the chuck by hand and confirm that both the rollers are in contact with the work.

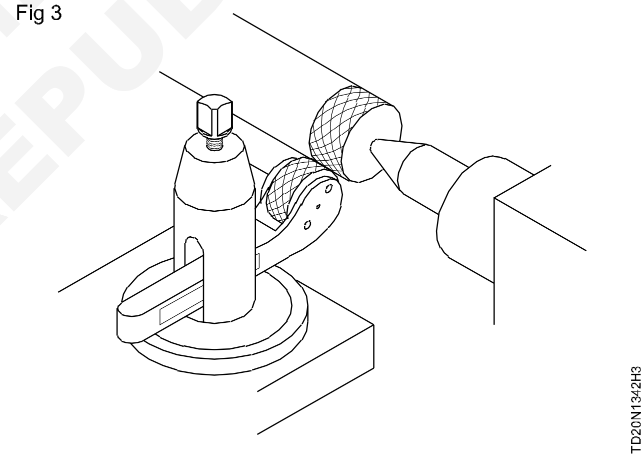
Start the lathe and feed the knurling tool into the work by the cross-slide.

Fig 2



Move the carriage until about half the face of the knurling roll overlaps the end of the workpiece which helps to produce a true pattern. (Fig 3)

Fig 3



Do not feed the knurl on the work before starting the machine to avoid damage of the knurls.

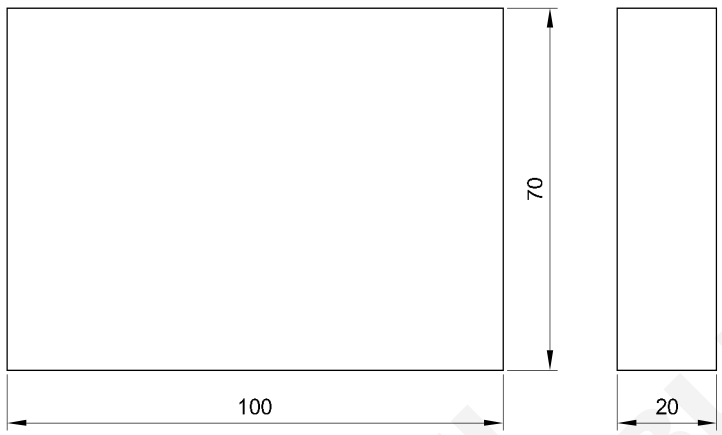
Move the knurling tool longitudinally with uniform movement by the carriage hand wheel up to the required length.

Give the depth by the cross-slide without drawing the tool back.

Feed the knurling tool to the other end. Until a correct pattern is obtained, do not withdraw the knurling tool back.

Face both side of a plate using 4 jaw chuck

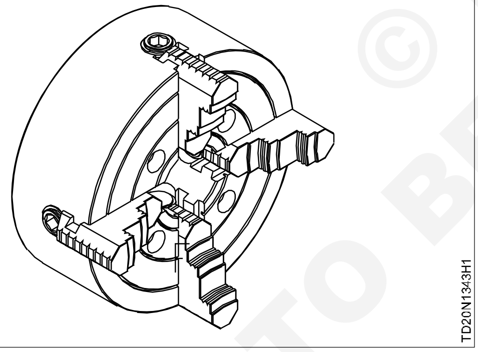
Objectives: At the end of this exercise you shall be able to
- **set the rectangular work piece on 4 jaw chuck**
- **face both side and maintain the thickness as per drawing.**



Job Sequence

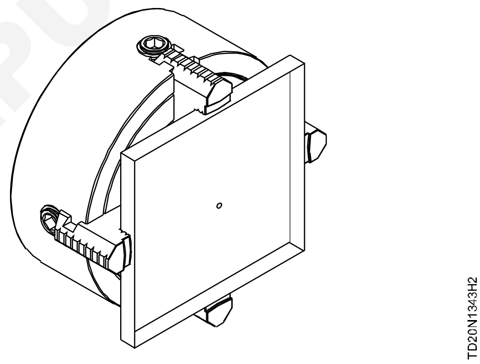
- Check the size of the premachined workpiece.
- Reverse the jaws of the 4 jaw chuck as shown in Fig 1.

Fig 1



- Set the workpiece in 4 jaw chuck butting one face on the jaw surface (Fig 2)
- Set the workpiece centre is approximate aligning with lathe centre.

Fig 2



- Set the facing tool and rough and finish face one side.
- Reverse the workpiece and set the faced surface on face of the jaw and true it, keeping opposite side of the jaws are in equal distance from the centre
- Face the workpiece and maintain the thickness
- Check the thickness and parallelism by micrometer.

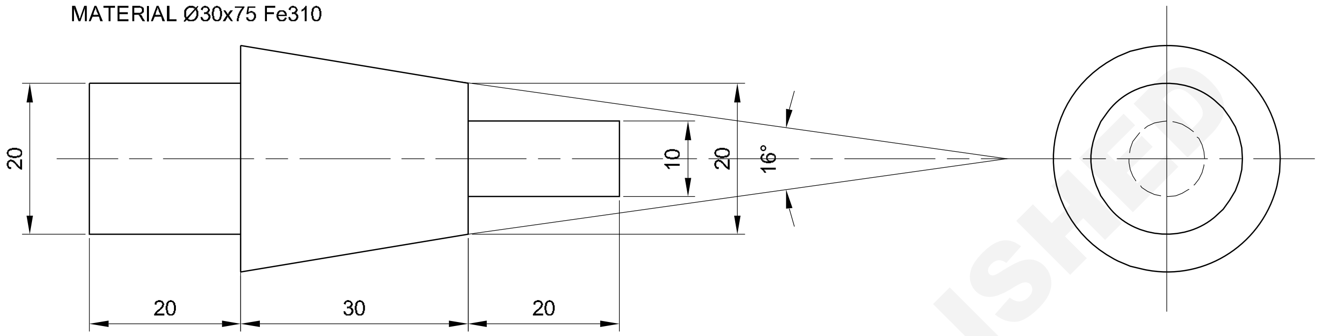
1	72ISF 20 - 105	–	Fe 310	–	–	1.3.43
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	FACE BOTH SIDE OF A PLATE USING 4JAW CHUCK	TOLERANCE : ± 0.05mm	TIME :
		CODE NO. TD20N1343E1	

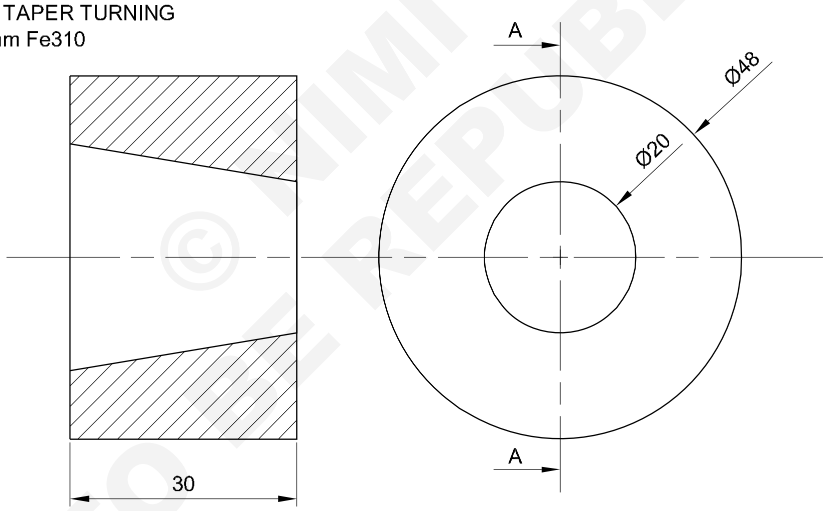
Taper turning male and female

Objectives: At the end of this exercise you shall be able to
- **turn external taper by compound slide method**
- **turn internal taper by compound slide method**
- **check angle with vernier bevel protractor**
- **assemble and check the taper alignment.**

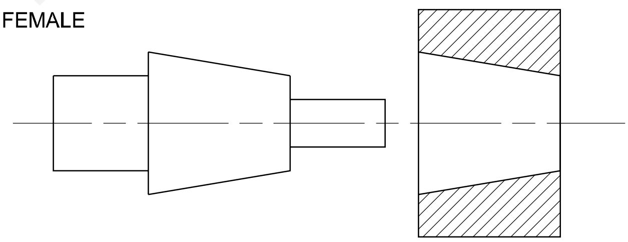
TASK 1 -EXTERNAL TAPER TURNING
MATERIAL Ø30x75 Fe310



TASK 2 - INTERNAL TAPER TURNING
MATERIAL Ø50x60mm Fe310



TASK 3 - ASSEMBLY
ASSEMBLY OF MALE AND FEMALE



-	-	-	-	-	-	1.3.44
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

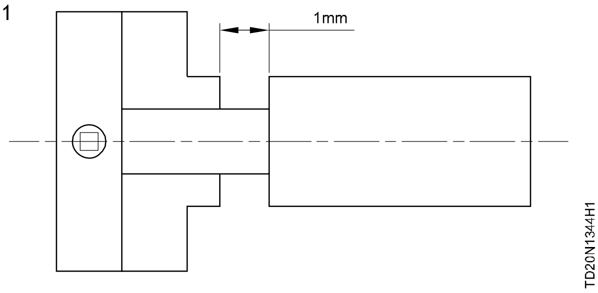
SCALE 1:1	TAPER TURNING MALE AND FEMALE	TOLERANCE ±1	TIME
		CODE NO. TD20N1344E1	

Job Sequence

Task 1 : **External taper turning.**

- Check the raw material for its dimensions.
- Hold the workpiece in the lathe chuck projecting 30mm and true it.
- Set the facing tool and face one end.
- Set the right hand turning tool.
- Turn Ø 20mm to length of 20mm.
- Reverse the work piece and hold the workpiece on Ø20mm leaving 1mm gap (Fig 1) and true it.

Fig 1



- Face the other end and maintain its total length of 70mm.
- Turn Ø10mm to length of 20mm.
- Set the compound slide to 8°.
- Set the tool for taper turning.
- Turn taper and maintain Ø20mm at the small end.
- Check the angle with vernier bevel protractor.
- Remove the workpiece clean and apply oil and preserve it.

— — — — — — — —

Task 2 : **Internal taper turning.**

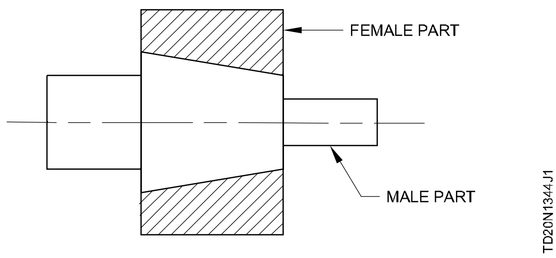
- Check the raw material for its dimension.
- Hold the workpiece in the lathe chuck projecting 40mm and true it
- Set the facing tool and face one end.
- Set the right hand turning tool turn Ø 48 mm to a length of 38mm and chamfer it
- Centre drill and drill Ø10 and 18mm through hole.
- Set the compound rest to 8°.
- Set the boring tool
- Turn internal taper by compound slide maintaining small diameter 20.00mm to a length of 32mm.
- Set the parting tool of 3mm width
- Position parting tool to part 30.5mm length.
- Part the workpiece on the lathe chuck face and maintain the thickness equal to 30mm.
- Chamfer 1x45° with chamfering tool .
- Remove the workpiece, clean and it preserve it.

— — — — — — — —

Task 3 : **Assembling.**

- Assemble the male and female part and check for its alignment with taper portion with prussion blue.
- Ensure that the face of male and female parts are in line as shown in Fig 2

Fig 1



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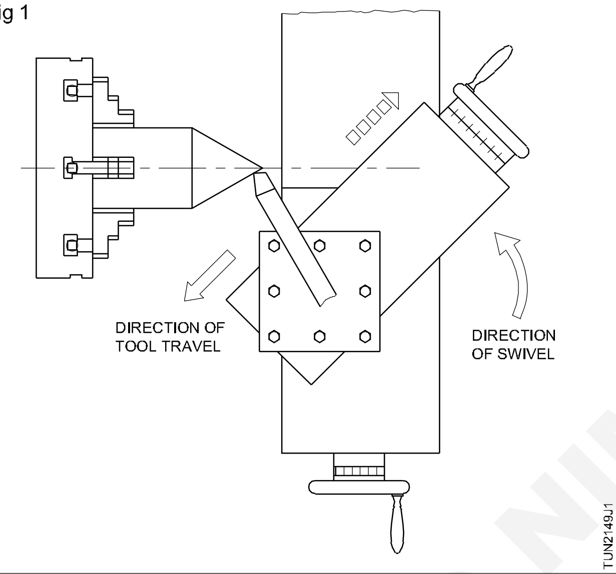
Skill Sequence

Turning taper by compound slide swivelling

Objectives: This shall help you to
- **set and swivel the top slide of the compound rest to the required taper angle**
- **set the tool in the tool post**
- **turn the taper**
- **check the taper with a vernier bevel protractor.**

One of the methods of turning taper is by swivelling the compund slide and feeding the tool at an angle to the axis of the work by hand feed. (Fig 1)

Fig 1



The procedure in sequence is as follows

Set and true the job turned to the bigger diameter of taper.

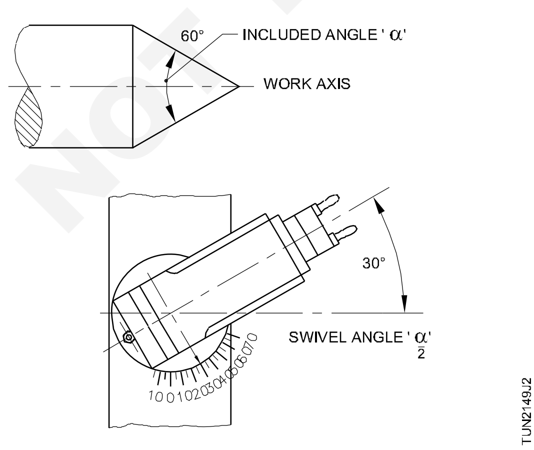
Set the machine to the required rpm.

Loosen the top slide clamping nuts.

Swivel the top slide to half the included angle of the taper away or towards the operator as required.

Tighten the clamping nuts firmly. (Fig 2)

Fig 2



Ensure that equal pressure is exerted by the spanner for both the nuts.

Fix the turning tool in the tool post to the correct centre height.

Keep a minimum overhang of the tool.

Position the top slide to cover the length of the taper turning.

As far as possible ensure that the top slide do not go beyond the edge of the base.

Lock the carriage in position.

Touch the tool to the work surface during running and set the cross - slide graduated collar to zero.

Bring the tool clear off the work by the top slide hand wheel movement.

Give a depth of cut by the cross - slide and feed the tool by the top slide hand wheel till the tool clears from the work.

Feeding by the top slide must be uniform and continuous.

Give successive cuts by the cross - slide, feeding by the top slide each time.

Check the angle of the turned job with a vernier bevel protractor.

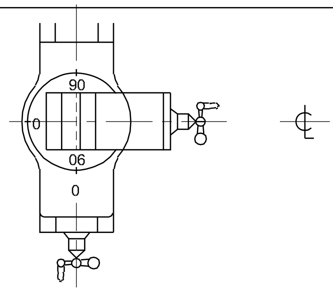
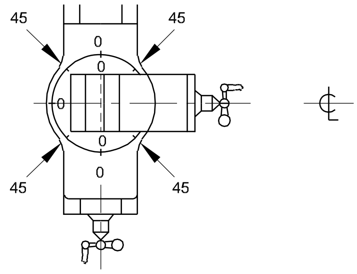
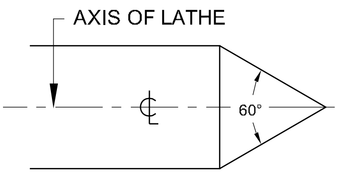
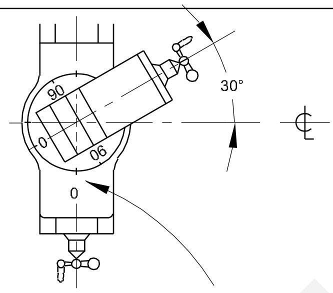
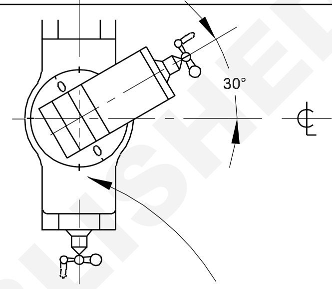
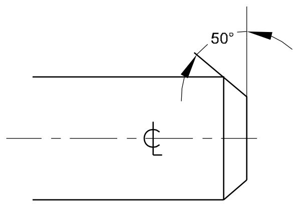
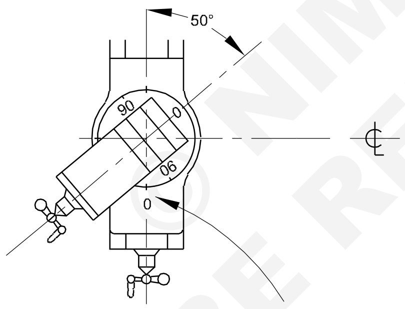
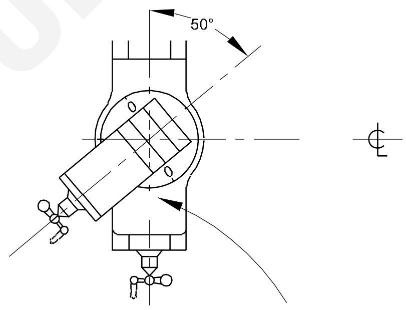
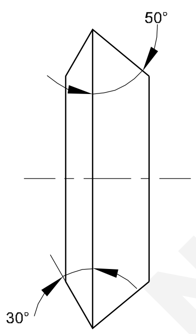
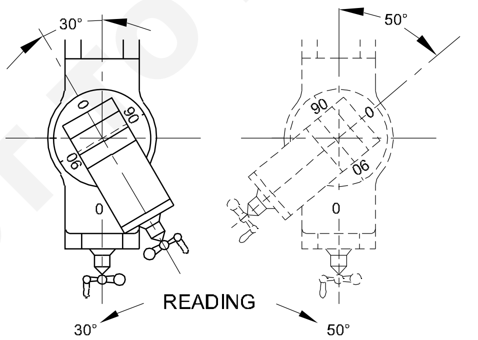
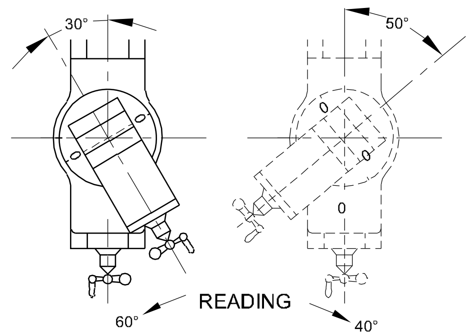
Adjust the swivel if there is any difference.

Continue the taper turning and finish the taper.

Compound rest setup for turning various angle is given in table 1.

Compound rest setup for turning various angles

Table 1

	ARRANGEMENT OF GRADUATIONS ON SWIVEL SLIDE	
SPECIAL ANGULAR SETTING ON COMPOUND REST	 GRADUATED FROM 90-0-90	 GRADUATED FROM 0-45-0
EXAMPLES	READINGS ON GRADUATED SWIVEL SLIDE	
 INCLUDED ANGLE MEASURED IN HORIZONTAL PLANE	 READING ON SCALE 60°	 READING ON SCALE 30°
 ANGLE GIVEN FROM A LINE AT 90° TO AXIS OF LATHE	 READING ON SCALE 50°	
		

Skill Sequence

Measuring with vernier bevel protractor

Objectives: This shall help you to
- **check the various angles of the machined parts up to an accuracy of ±5**
- **check the straightness of the machined surface with reference to the other vertical surface.**

The vernier scale is duplicated to read either side of the ‘zero’ graduation of the main scale. If you read the main scale in the clockwise direction, continue reading the vernier scale also in a clockwise direction. Always make sure that the vernier scale reading is added to the main scale.

Method of using clockwise reading

Set the angular surface of the workpiece between the blade and the face of the base and lock the blade and inner disc firmly with the locking device.

The position of the vernier scale with reference to the main scale is shown in Figure 1.

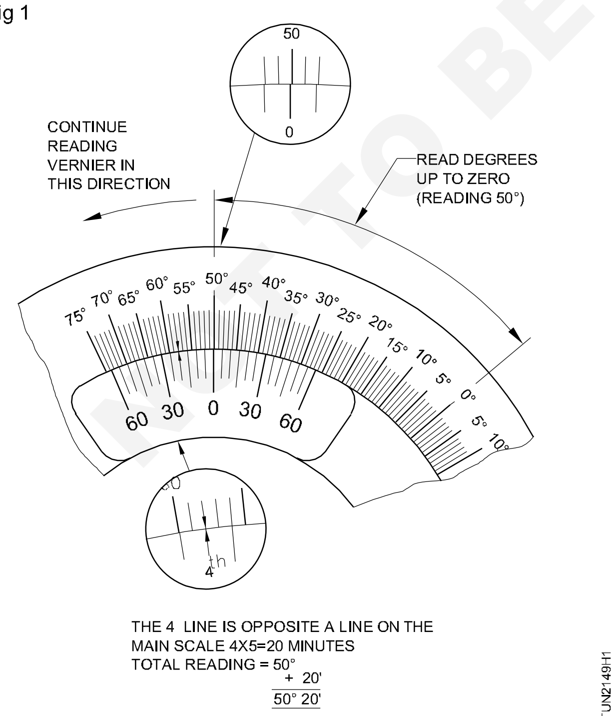
Read the degrees of the main scale up to the graduation ‘0’ of the vernier scale i.e. 50°.

Continue reading on the appropriate vernier scale (towards the left hand side). Note the number of lines in the vernier scale the coincide with a division of the main scale. (i.e. 4th division of the vernier scale is coinciding with one of the main scale division line)

As the least count is 5’ multiply this number by 5. (i.e 4 x 5’ = 20’)

Add this result to the main scale reading of 50° i.e. 50° + 20’ = 50°, 20’.

Fig 1



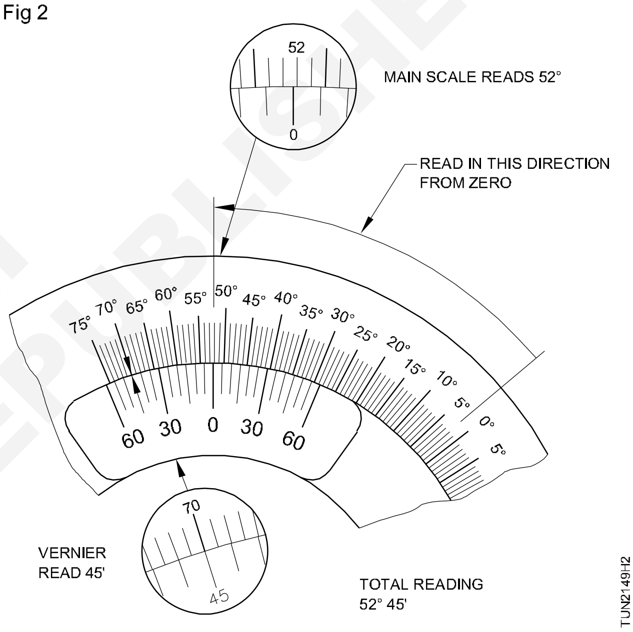
Similarly the reading for figure 2 may be obtained as 52°, 45’. (Fig 2)

Method of checking the straightness with reference to the vertical surface

Set the blade and base firmly on the machined surface.

Lock the blade and base in position with the help of the locking device.

Fig 2



Read the vernier scale with reference to the main scale.

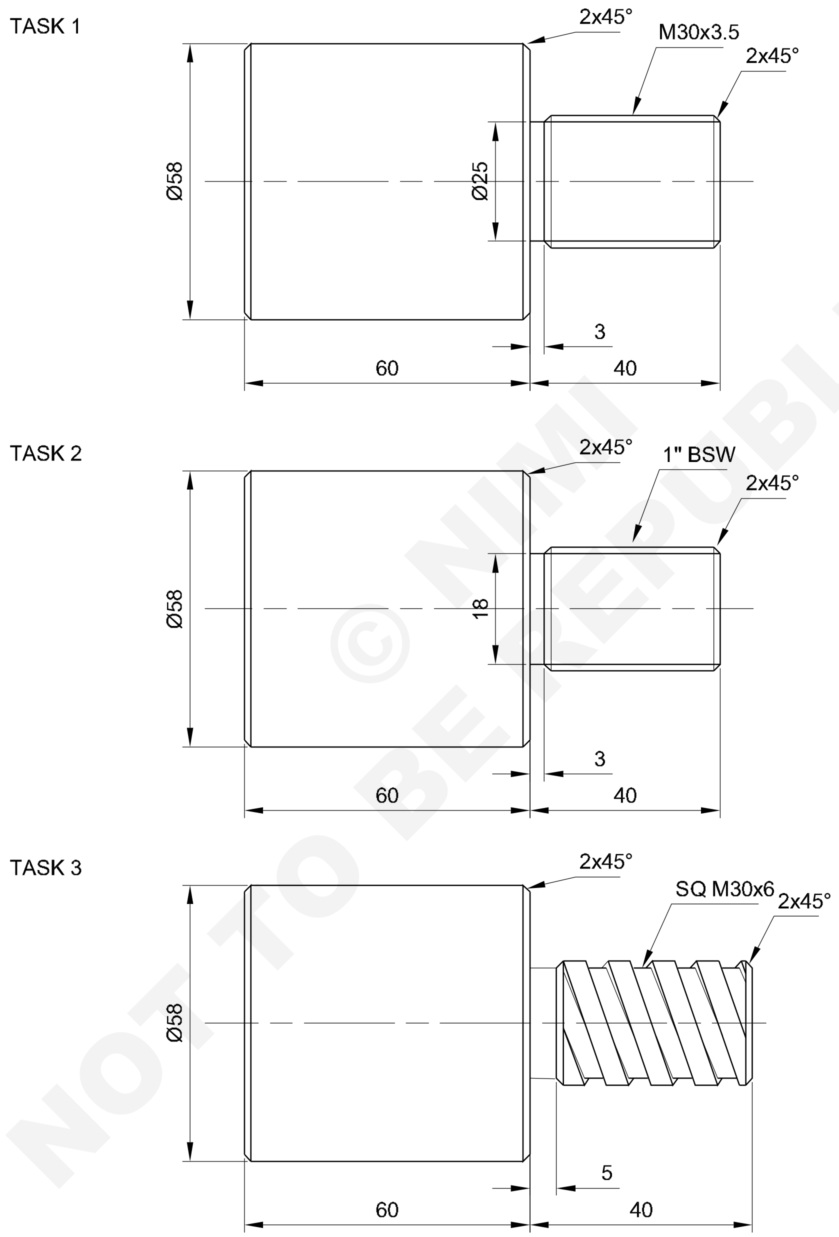
If the ‘0’ graduation of the vernier scale and 90° of the main scale coincide, the machined faces are at right angles, i.e. 90°.

If the ‘0’ graduation of the vernier scale does not coincide, read the appropriate vernier scale and find the error in degrees and minutes.

The error shows the deviation of surface from the straightness.

External Threading on step turned workpiece

Objectives: At the end of this exercise you shall be able to
- **turn the workpiece as per drawing dimensions and shape**
- **cut metric thread on lathe by plunge cut method**
- **cut British thread by half angle method on lathe**
- **cut square thread on lathe and check its dimensions.**



3	Ø60x105mm	-	Fe 310	-	-	1.3.45
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	EXTERNAL THREADING CUTTING	TOLERANCE ±1mm	TIME
		CODE NO. TD20N1345E1	

Job Sequence

Task 1 : **Cutting metric thread by plunge cut method**

- Check the given material for its dimensions
- Hold the work piece 65mm away from the chuck jaw surface
- Face one end
- Turn Ø 58.00 mm to a maximum possible length
- Chamfer the end with chamfering tool 2 x 45°
- Reverse the work piece and hold it on turned diameter projecting 50.00 mm
- True the work piece
- Face the other end and maintain the total length of 100.00mm
- Turn the step to Ø 30.00 mm to a length of 40.00 mm
- Chamfer 2 x 45°as shown in job drawing
- Cut groove of 3mm width and maintain the diameter 25.00 mm
- Chamfer at the groove as shown in drawing
- Set the right hand metric threading tool (60 °) to cut thread
- Set the lever position to cut 3.5 mm pith
- Set the lever position to cut right hand thread
- Set the spindle speed that is 1/3rd of the original spindle speed for mild steel (Fe310)
- Touch the threading tool point on diameter 30.00 mm and set zero on crass slide movement

Note: Take care of the backlash of the cross slide movements

- Calculate the single side depth for 3.5 mm pitch
- Position the tool to cut thread, give 0 .1 mm depth by cross slide movement , engage the half nut and start cutting the thread and with draw the tool and simultaneously reverse the spindle direction when the tool just reaches the undercut position.
- Stop the spindle when the tool moves 5mm away from the starting of the thread
- Check the pitch of the thread with pitch gauge
- Do not disengage the half nut until you completed the threading
- Give the depth of cut and follow the same steps until full depth is reached
- Check the profile with screw pitch gauge
- Check the pitch diameter with screw pitch diameter
- Check thread with thread ring gauge
- Remove the work piece , clean apply oil and preserve it for evaluation

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Task 2 : **Cutting British thread (BSW) by half angle method.**

- Check the given material for its dimensions
- Hold the work piece 65mm away from the chuck jaw surface
- Face one end
- Turn Ø 58.00 mm to a maximum possible length
- Chamfer the end with chamfering tool 2 x 45°
- Reverse the work piece and hold it on turned diameter projecting 50.00 mm
- True the work piece
- Face the other end and maintain the total length of 100.00mm
- Turn the step to Ø 25.40 mm to a length of 40.00 mm
- Chamfer 2 x 45°as shown in job drawing
- Cut groove of 3mm width and maintain the diameter 18.00 mm
- Chamfer at the groove as shown in drawing
- Set the right hand British threading tool (55°) to cut thread
- Set the lever position to cut 9 TPI
- Set the lever position to cut right hand thread
- Set the spindle speed that is 1/3rd of the original spindle speed for mild steel (Fe310)
- Set the compound slide to 27.5°
- Touch the threading tool point on diameter 25.40 mm and set zero on compound slide and crass slide

Note :Take care of the backlash of the cross slide movements.

- Calculate the single side depth for 9 TPI
- Position the tool to cut thread, give 0 .1 mm depth by compound slide movement and engage the half nut and start cutting the thread and with draw the tool by crass slide movement only, and simultaneously reverse the spindle direction when the tool just reaches the undercut position.
- Depth of thread should be given by compound slide only
- Stop the spindle when the tool moves 5mm away from the starting point of the thread

23 Check the pitch of the thread with pitch gauge

24 Do not disengage the half nut until you completed **the** threading

25 Give the depth of cut and follow the same steps until full depth is reached

26 Check the profile with screw pitch gauge

27 Check the pitch diameter with threads micrometer

28 Check thread with thread ring gauge

29 Remove the work piece , clean apply oil and preserve it for evaluation

— — — — — — — —

Task 3 : **Cutting square thread**

1 Check the given material for its dimensions

2 Hold the work piece 65mm away from the chuck jaw surface

3 Face one end

4 Turn 58.00 mm to a maximum possible length

5 Chamfer the end with chamfering tool 2 x 45°

6 Reverse the work piece and hold it on turned diameter projecting 50.00 mm

7 True the work piece

8 Face the other end and maintain the total length of 100.00mm

9 Turn the step to 30.00 mm to a length of 40.00 mm

10 Chamfer 2 x 45°as shown in job drawing

11 Cut groove of 5mm width and maintain the diameter 23.50 mm

12 Chamfer at the groove as shown in drawing

13 Grind right hand square threading tool for 3mm width

14 Set the right hand square threading tool to cut thread

15 Set the lever position to cut 6 mm pith

16 Set the lever position to cut right hand thread

17 Set the spindle speed that is 1/3rd of the original spindle speed for mild steel (Fe310)

18 Touch the threading tool point on diameter 30.00 mm and set zero on crass slide movement

Note: Take care of the backlash of the cross slide movements

19 Calculate the single side depth for 6mm pitch (square thread)

20 Position the tool to cut thread, give 0 .1 mm depth by cross slide movement, engage the half nut and start cutting the thread and with draw the tool and simultaneously reverse the spindle direction when the tool just reaches the undercut position.

21 Stop the spindle when the tool moves 5mm away from the starting of the thread

22 Check the pitch of the thread by venire caliper

23 Do not disengage the half nut until you completed the threading

24 Give the depth of cut and follow the same steps until full depth is reached

25 Check the profile and depth of the thread

26 Remove the work piece , clean apply oil and preserve it for evaluation

Skill Sequence

Cutting 'V' thread by plunge cut method

Objective: This shall be able to
- **cut 'V' thread using a single point tool on a lathe by the plunge cut method.**

Threads have coarse and fine pitches according to their usage. Standard fine pitch threads, both external and internal, are generally cut by using taps and dies. When they are produced in large quantities, different methods are adopted on different machine tools. However, at times, it may be necessary to cut threads by a single point tool on a centre lathe.

The plunge cut method of threading by a single point tool is done by plunging the tool into the work to produce the thread form. The tip of the tool, as well as, the two flanks of the tool will remove metal during thread cutting, and, hence the load on the tool will be more. As the possibility of obtaining a good finish on the thread is limited, this method is applicable to fine pitch thread cutting mostly.

The following is the procedural sequence in cutting the 'V' thread by the plunge cut.

Grind a 'V' thread tool for the required thread angle and according to pitch. (Fig 1)

Ensure that the thread angle ground is symmetrical with respect to the axis of the tool.

Arrange the change gear train and set the quick change gearbox levers for the required pitch and hand of thread.

Clamp the tool in the tool-post to centre height with the centre gauge with a minimum overhang. (Fig 2)

Fig 1

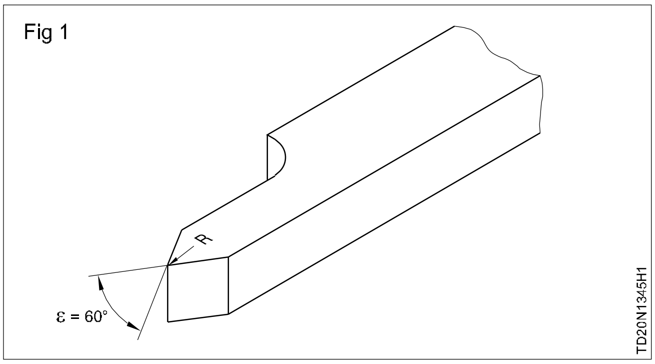
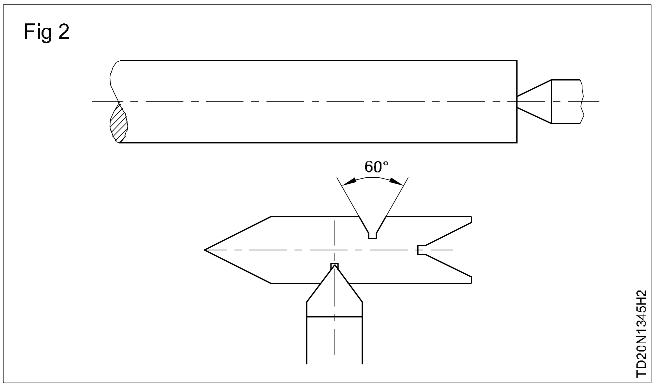


Fig 2

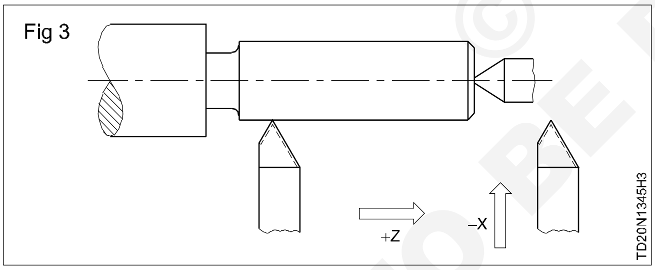


Ensure that the top slide is set at 0°, and slackness is removed by gib adjustment.

Set the machine to about 1/3rd of the rough turning r.p.m.

Start the machine and touch the tool tip to work. (Fig 3) Set the cross-slide and the compound slide graduated collars to zero, eliminating backlash.

Fig 3

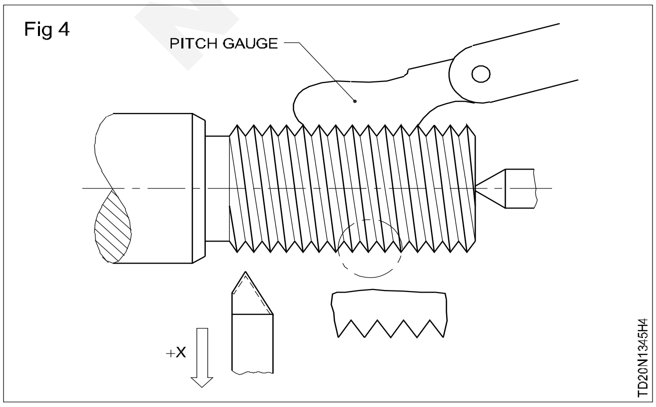


Bring the tool to the starting point and engage the half nut.

Allow the tool to take the trial cut, the depth being given 5 divisions of the cross-slide graduated collar.

Withdraw the tool at the end of the cut and stop the machine. (Fig 4)

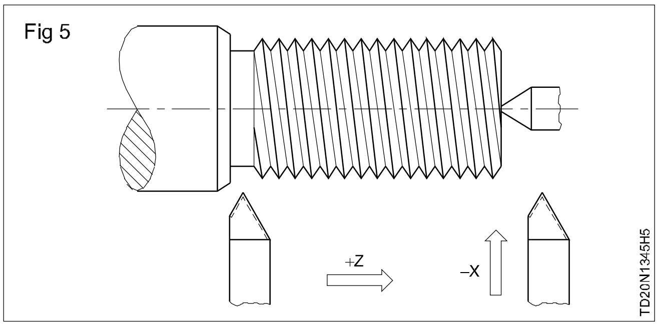
Fig 4



Check with the pitch gauge to confirm the gear box setting. (Fig 4)

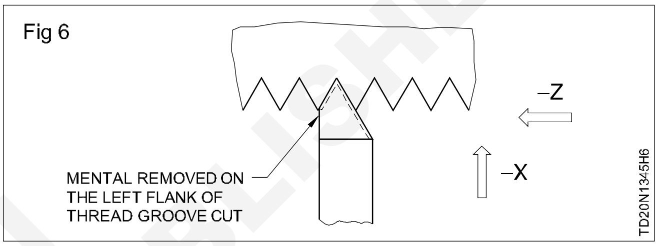
Reverse the machine to bring the carriage to the starting point. (Fig 5)

Fig 5



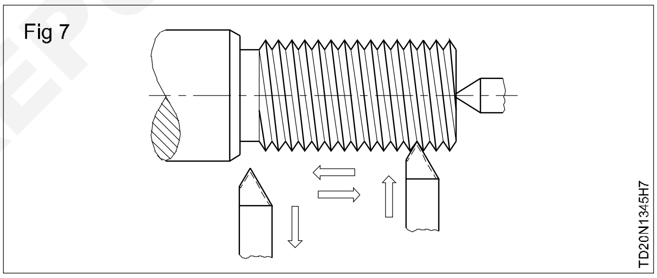
For every 3 depths of cuts by the cross-slide, give one axial cut by feeding the tool axially for 5 divisions of the compound slide. This relieves the load on the tool. (Fig 6)

Fig 6



Continue the sequence till the thread profile is formed. (Fig 7)

Fig 7

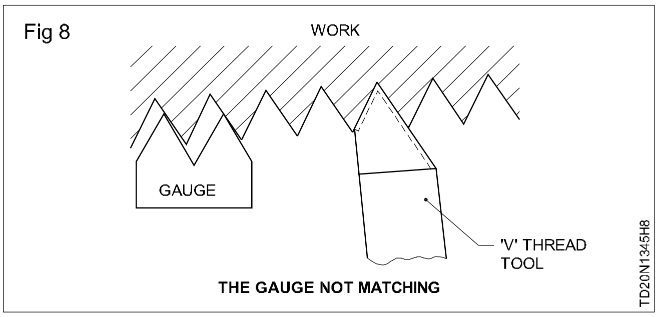


Check with the pitch gauge for the thread form.

Match the mating component to ensure the class of fit.

If the tool is not set square to the axis of the work, the gauge will not match with the thread. (Fig 8)

Fig 8



Note

In the plunge cut method of thread cutting with a single point tool on a lathe, the accuracy of the thread is greatly influenced by:

- the correctness of the tool profile

- the accuracy with which the tool is set square to the axis of the work
- the number of plunge cuts (depth of cut) given
- the relative number of side cuts (preferably on both flanks) given.

Effect of grinding positive back rake angle on 'V' thread tool and on threads cut (Fig 9 & 10)

Fig 9

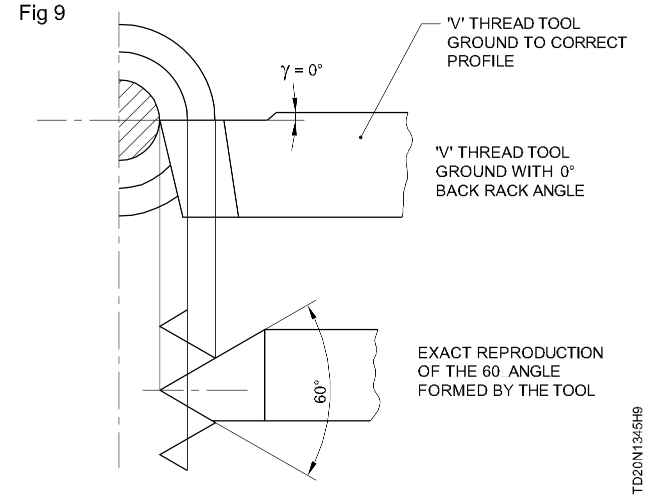
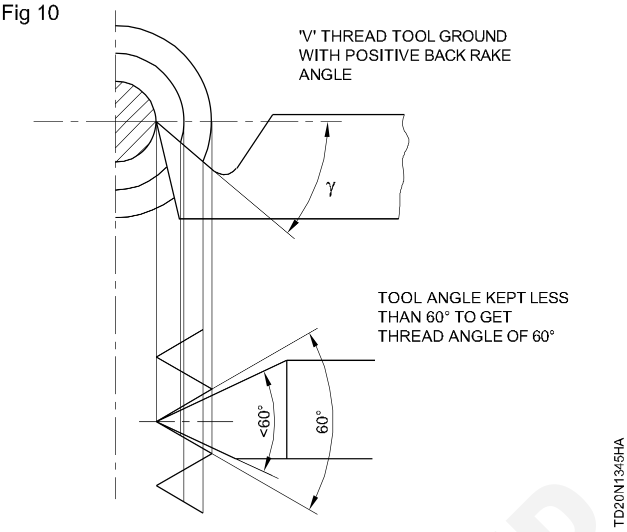


Fig 10



Cutting external 'V' thread by half angle method

Objective: This shall be able to

- **cut external 'V' thread by half angle method.**

The plunge cut method of cutting 'V' thread is limited for fine pitch threads where the depth of cut is less, and the successive cuts to be given are comparatively less. Further in the plunge cut method, the tip of the tool as well as both the flanks will be removing material from the workpiece. This causes heavier load on the cutting tool's cutting face which may result in the breaking of the tool tip, damaged thread and reduction in the tool life. To overcome these defects, the half angle method is adopted to cut threads.

The steps required are given here.

Check the diameter of the workpiece to be threaded by referring to the drawing.

> **To provide thread clearance, it is good practice to turn the diameter of the workpiece undersize depending upon the pitch.**

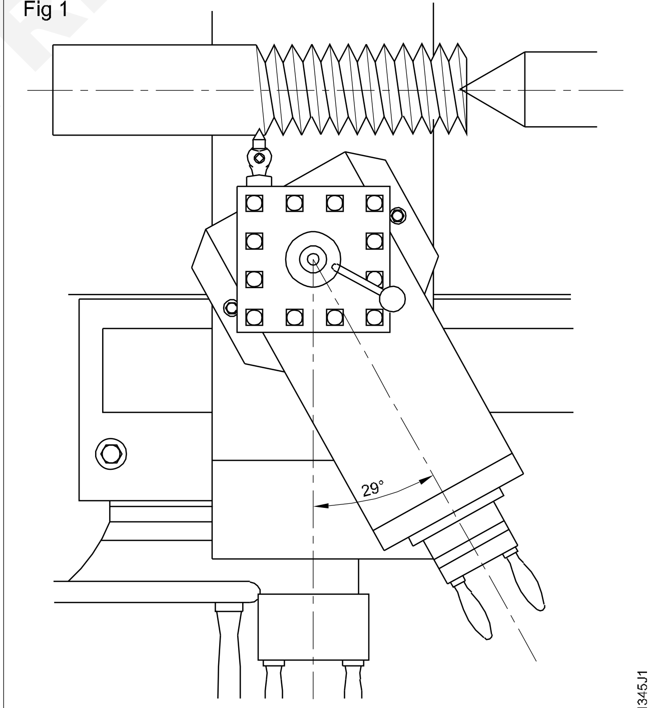
Set the lathe spindle speed to about one fourth of the turning speed.

Set the gearbox according to the pitch of thread to be cut.

Swivel the compound slide to 90° from the horizontal position to bring it in line with the cross-slide.

Swivel to the right 1° less than the half included angle of the thread if it is a right hand thread. (Fig. 1)

Fig 1

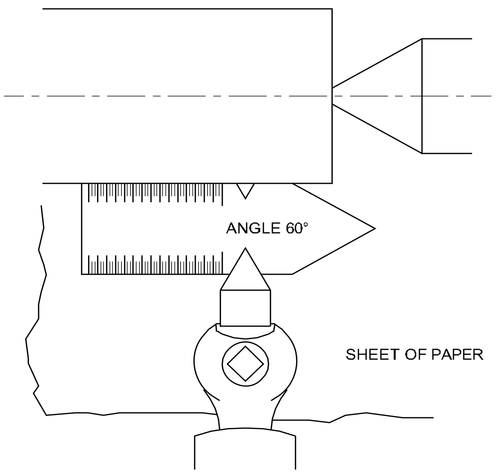


COMPOUND REST SET AT 29° TO THE RIGHT TO CUT A 60° INCLUDED ANGLE RIGHT HAND THREAD

The angle to which the compound rest is set affects the cutting action of the cutting tool by producing a shearing action on the trailing edge of the tool. This produces a smooth cut.

Set the tool in the tool post with a minimum overhang perpendicular to the axis and also set with a centre gauge. (Fig 2)

Fig 2



SETTING 60° CUTTING TOOL SQUARE TO THE WORK USING A CENTRE GAUGE

Mark out the length of the workpiece to be threaded.

Chamfer the end of the workpiece surface with the leading edge of the cutting tool to a depth, just greater than the minor diameter of the thread to be cut.

Advance the cutting tool to the work surface by operating the cross-slide hand wheel.

When the tip of the tool just touches the work surface, stop further advancement and set the cross-slide and compound slide graduated collars to zero.

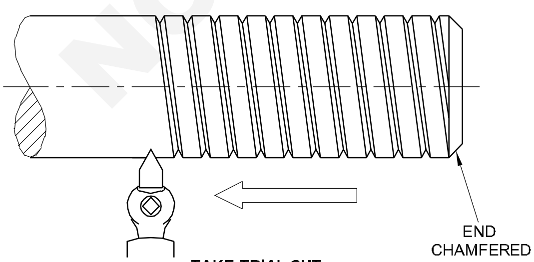
Move the carriage to the right until the end of the tool clears the work.

Feed the tool in about 0.1 mm using the top slide hand wheel.

Engage the half nut referring to the chasing dial.

Take a trial cut along the workpiece to be threaded. (Fig 3)

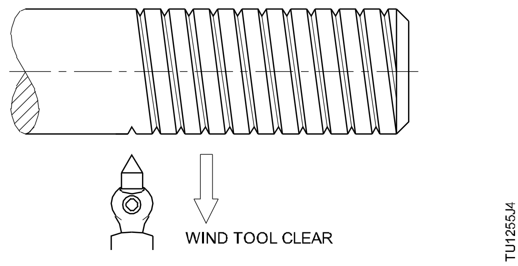
Fig 3



TAKE TRIAL CUT

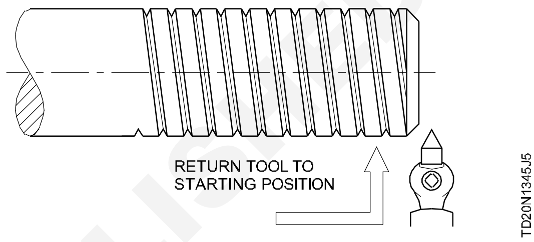
At the end of the trial cut, withdraw the tool immediately, winding it clear off the workpiece by operating the cross-slide hand wheel and simultaneously reversing the machine. (Fig 4)

Fig 4



Allow the carriage to move to the right till it is cleared from the end of the work, and stop the machine. (Fig 5)

Fig 5



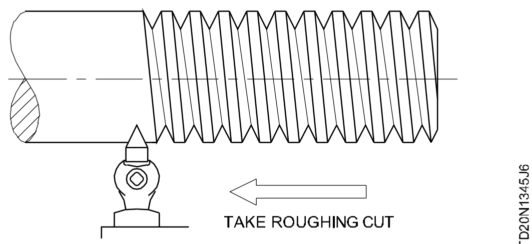
Check the thread formation with a pitch gauge.

Advance the tool by the cross-slide hand wheel till zero position.

Give depth of cut with the top slide handle.

Start the machine and allow the tool to cut the thread. (Fig 6)

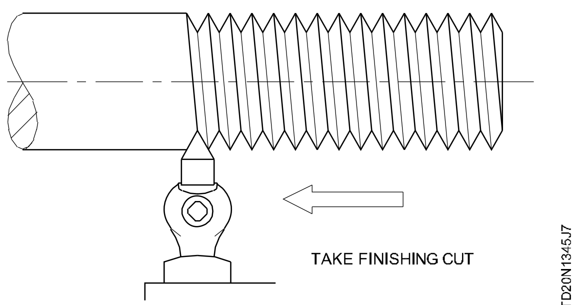
Fig 6



Use plenty of coolant during threading.

Repeat the steps till the required depth is reached. (Fig 7)

Fig 7



Grind an external threading tool

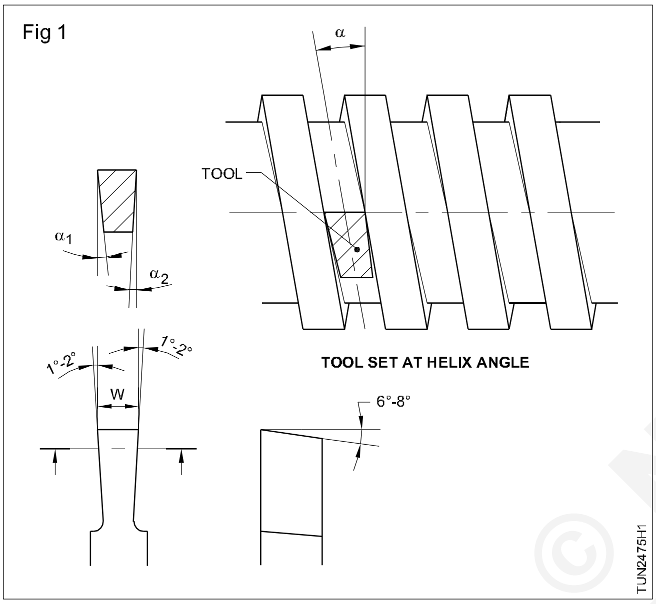
Objective: This shall be able to
- **grind an external square threading tool.**

Determine width and angles required for grinding the external square threading tool.

The side clearance of the square threading tool is of prime importance to prevent the tool from interfering or rubbing against the vertical flank of the thread. As a rule, the forward side clearance angle (a1) is determined by adding 1° to the helix angle of the thread and trailing side clearance angle is obtained by subtracting 1° from the helix angle. (Fig1)

a_1 = 1° + Hexix angle of thread

Fig 1



$$\text{Helix angle} = \tan^{-1} \times \frac{\text{lead}}{\pi \times \text{core diameter}} \quad \text{and}$$

a_2 = Helix angle of the thread - 1°

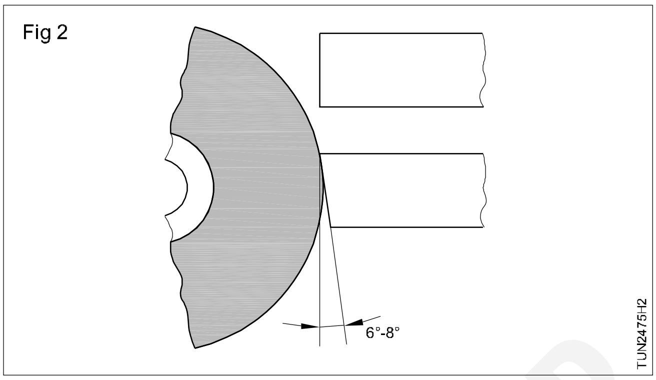
$$\text{Where helix angle} = \tan^{-1} \times \frac{\text{lead}}{\pi \times \text{outside} - \text{diameter}}$$

The width of the nose of the square threading tool should be equal to half of the pitch of the square thread to be cut. W = 0.5 x p

Grind the front flank of the tool to get the front clearance angle 6° to 8°. (Fig 2)

Grind the forward side flank of the tool to obtain side relief angle 1° to 2° and forward side clearance angle a1. (Fig 3)

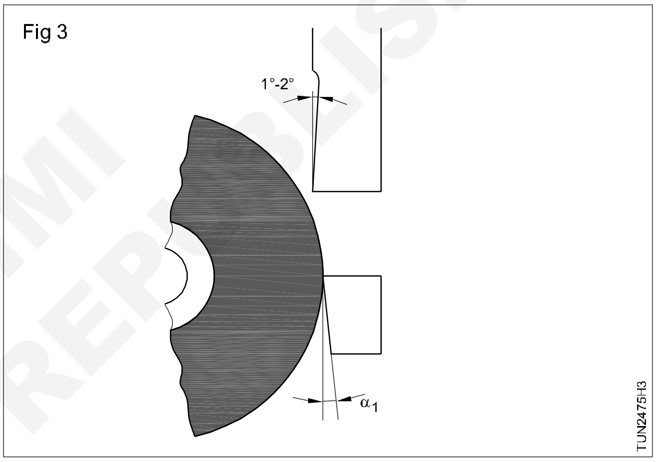
Fig 2



a_1 = a + (1° to 2°)

Grind the trailing side flank of the tool to maintain the side relief angle 1°- 2°, trailing side clearance angle a 2 (a2 = a-

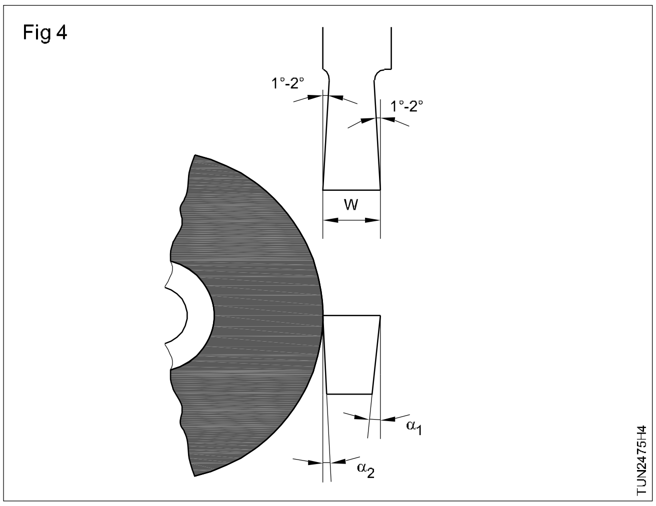
Fig 3



1°) and the width W (W=0.5 x p). (Fig 4)

Deburr and check the width of the angles using a vernier caliper and bevel protractor.

Fig 4



Square thread

Objective: This shall help you to
- **cut a square thread.**

Check the diameter of the portion to be threaded as indicated in the drawing.

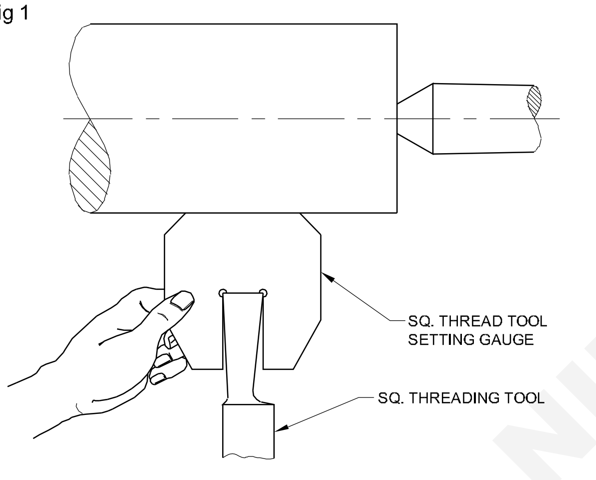
Chamfer the edge of the job to 2 x 45 degree.

Set up the gearbox to cut the required pitch of thread, and hand of thread.

Set the square threading (roughing) tool in the tool post with its height to the centre height of the lathe.

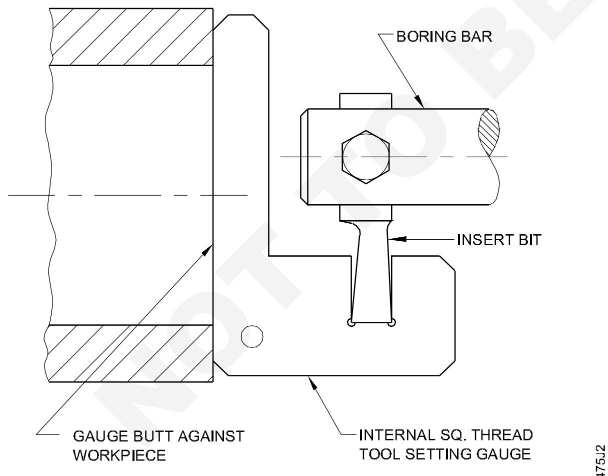
Set the tool square to the axis of the job with the square thread gauge. (Figs 1 and 2)

Fig 1



TOOL SETTING FOR
CUTTING EXTERNAL SQUARE THREAD

Fig 2



TOOL SETTING FOR CUTTING INTERNAL SQ. THREAD

Care is to be taken to prevent overhanging of tool from the holder to avoid chatter.

Set the spindle speed about 1/4th of normal turning.

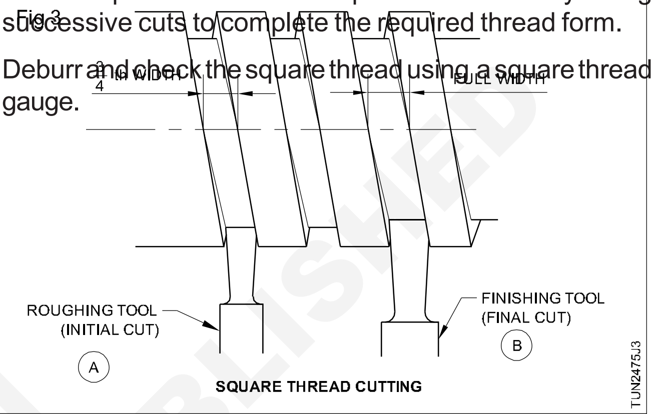
Cut the square thread, by repeated successive depth of cuts to reach 3/4th width and depth of thread. (Fig 3)

Set the finishing square thread tool for finishing cuts.

Cut the square thread to full depth and full width by taking successive cuts to complete the required thread form.

Deburr and check the square thread using a square thread gauge.

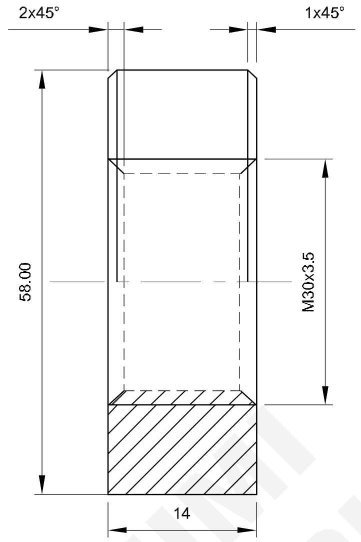
Fig 3



SQUARE THREAD CUTTING

Internal thread cutting

Objectives: At the end of this exercise you shall be able to
- **cut internal 'V' thread by single point threading tool.**



Job sequence

- Check the given material for its size by steel rule.
- Hold the work in a four jaw chuck about 10 mm inside the chuck and true it.
- Turn the outer dia to 58.00 mm to possible length.
- Chamfer the edge 1×45° by chamfering tool.
- Centre drill, and drill a pilot drill of Ø10 mm through hole.
- Enlarge the drilled hole dia 10 mm to Ø22.00 mm by drilling.
- Bore the drilled hole to the core (root) diameter of the thread i.e. 25.706 mm.
- Chamfer the bore to 2×45°.
- Set the machine to cut 3.5 mm pitch internal thread.
- Cut the internal thread.
- Check the thread with external thread mating parts.
- Reverse and hold the work on Ø58 mm and true it.
- Face the end of the work, and maintain a total length of 14 mm.
- Turn Ø40 mm for the remaining length.
- Chamfer 1×45° on the outer edge and 2×45° on the threaded bore.
- Remove the sharp edges and have a final check

1	Ø60x20	–	Fe 310	–	-	1.3.46
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	INTERNAL THREAD CUTTING	DEVIATION ±0.06mm	TIME
		CODE NO. TD20N1346E1	

Skill sequence

Cutting an internal thread

Objective: This shall help you to
- **cut an internal thread on a centre lathe.**

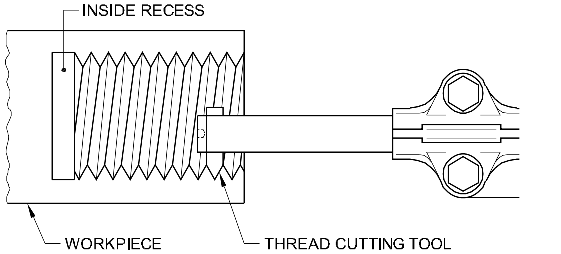
Mount the job on four jaw chuck / three jaw chuck/ collect.

Drill and bore the job to the core diameter of the thread to required length/ through hole.

For a blind hole, cut a recess at the end of the bore enough to permit the cutting tool to clear thread.

The recess must be larger than the major diameter of the thread. (Fig.1)

Fig 1

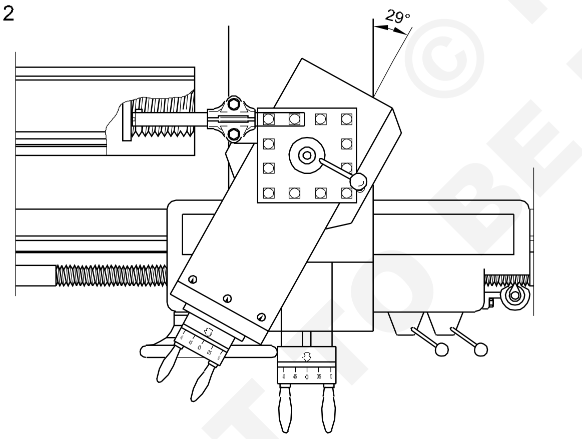


CUTTING AN INTERNAL THREAD

Chamfer the front end to 2×45°.

Set the compound rest at 29° to cut 60° included angle as shown in Fig.2.

Fig 2



COMPOUND REST SET AT 29° TO THE LEFT TO CUT A 60° INCLUDED ANGLE INTERNAL THREAD

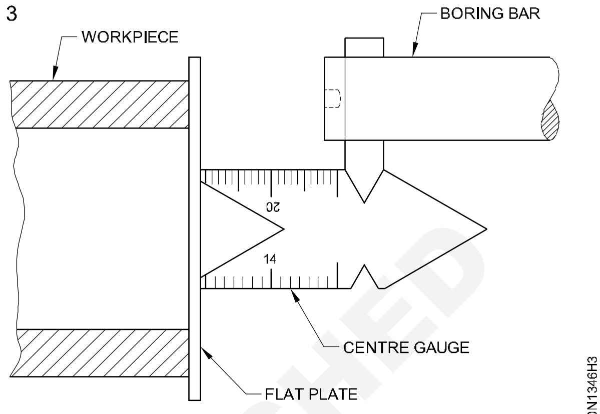
Set the gear box levers to the required pitch.

Fix the correctly ground threading tool in a boring bar.

Fix the boring bar parallel to the lathe centre line and set the point of the cutting tool to lie on the centre.

Align the cutting tool with a help of centre gauge as shown in Fig.3.

Fig 3



ALIGNING THE CUTTING TOOL WITH A CENTRE GAUGE

Mark the boring bar to indicate the required depth of entry into the bore.

Ensure that the boring bar does not foul anywhere on the job.

Reverse the cross slide until the tool point just touches the bore.

Set the cross-slide and compound slide graduated collars to zero.

Withdraw the cutting tool from the bore.

Set the spindle speed to 1/3rd of the calculated r.p.m.

Start the machine.

Adjust the depth of cut to 0.1 mm.

Engage the half nut.

At the end of the cut, simultaneously reverse the chuck and clear the tool just away from the thread.

Ensure that the tool should not touch the thread in both side of the bore.

When cutting tool comes out of the bore stop the machine.

Give the depth of cut and run the machine in forward direction. Similarly finish the thread until final depth is achieved.

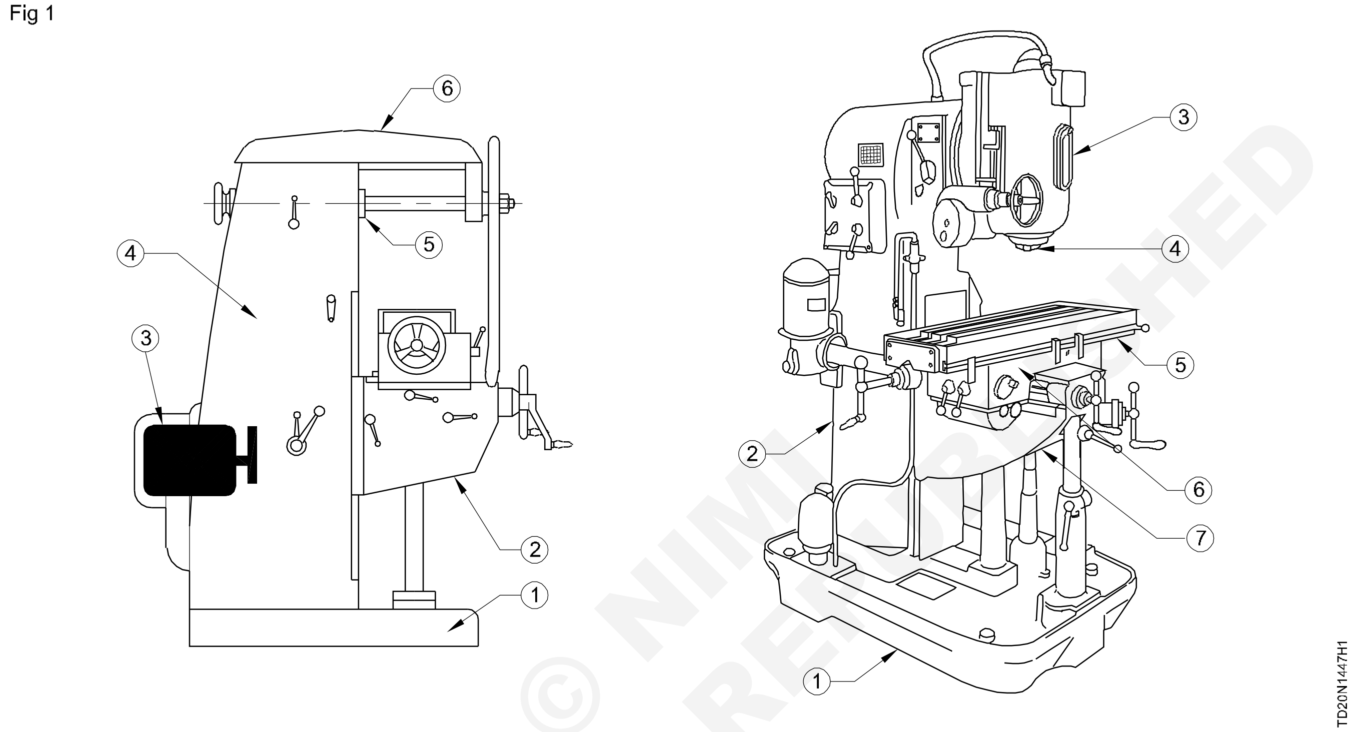
Check the finished thread with a thread plug gauge or a threaded bolt.

— — — — — — — — —

Identification of milling machine

Objectives: At the end of this exercise you shall be able to
- **identify and record the type of milling machine**
- **identify the parts of milling machine**
- **record the parts name in table.**

Fig 1



Job Sequence

Instructor shall show the horizontal and vertical milling machines. Brief the each part of milling machines, ask the trainees to fill the parts name in Table - 1 for horizontal milling machine and Table - 2 for vertical milling machine.

- Trainees to note down the part names of both milling machines.

Table 1 - Horizontal milling machine

Sl. No.	Name of the parts
1	
2	
3	
4	
5	

- Record the parts name in Table - 1 for horizontal and Table 2 for vertical milling machine.

Table 2 - Vertical milling machine

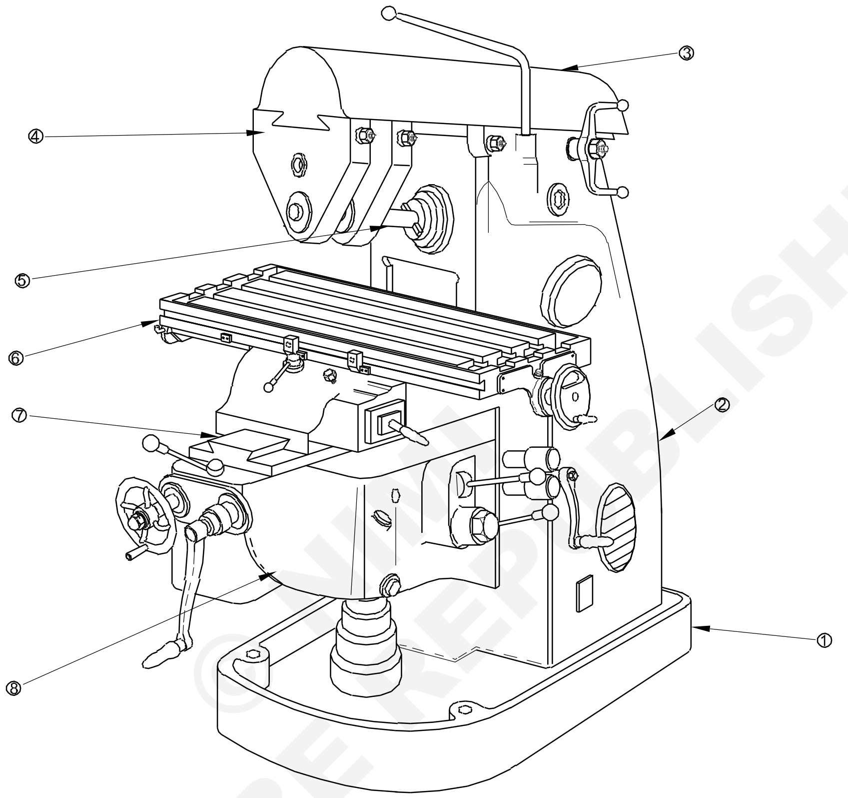
Sl. No.	Name of the parts
1	
2	
3	
4	
5	
6	
7	

- Get it checked by instructor.

Demonstrate working principle of milling machine

Objectives: At the end of this exercise you shall be able to
- **movement of the slides manual and automatic**
- **run the machine in different spindle speed**
- **put ON and OFF the machine.**

Fig 1



Job Sequence

- Identifiy the machine parts and its sliding movements.
- Move the slides manually and get it familiar.
- Set the different spindle speed.
- Practice on mounting of different arbor.
- Practice on automatic feed and rapid movement.

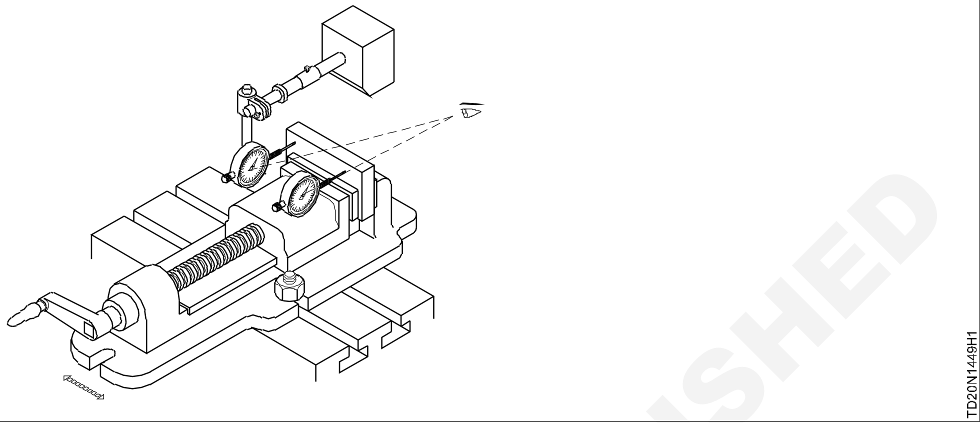
Table 1

Sl.No	Name of the parts	Type of movement
1		
2		
3		
4		
5		
6		
7		
8		

Set vice & job on the table of milling machine

Objectives: At the end of this exercise you shall be able to
- **align a machine vice on the table of the milling machine**
- **fix the workpiece in machine vice.**

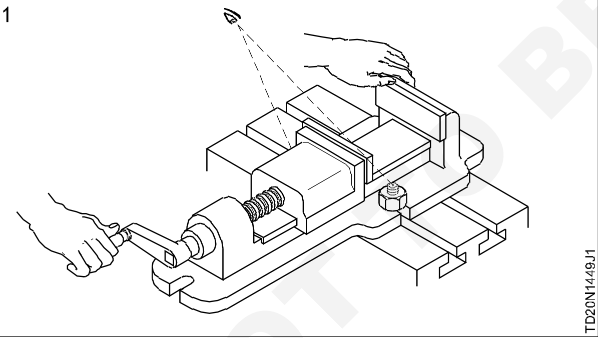
Fig 1



Job Sequence

- Clean the vice base and the machine table top, free from dust for seating.
- Place the vice at the middle of the table with maximum support to avoid falling off of the vice. (Fig 1)
- Position the ‘T’ bolts into the ‘T’ slot. (Fig 1) While shifting the vice towards the slots ensure that there is 1mm to 2mm clearance between the ‘T’ bolt and the vice slot to allow for adjustment.

Fig 1



- Tighten all the ‘T’ bolt nuts by hand.
- Clamp the parallel block in the vice. (Fig 2) Set the vice such that the jaws are at right angle to the direction of cut.
- Position the dial indicator with the magnetic base firmly on the reference surface (X). (Fig 3).
- Engage the dial indicator stylus on one end of the parallel. (Fig 3) Ensure that the dial indicator and stand do not foul anywhere.
- Adjust the position of the dial pressure and set the reading to zero on one end of the parallel.

Fig 2

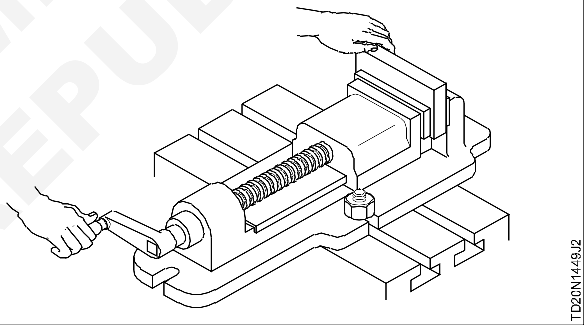
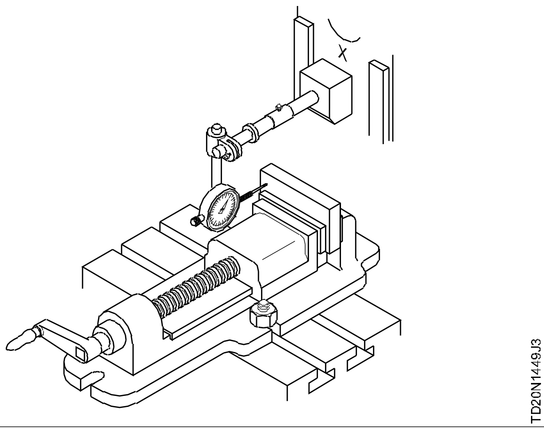
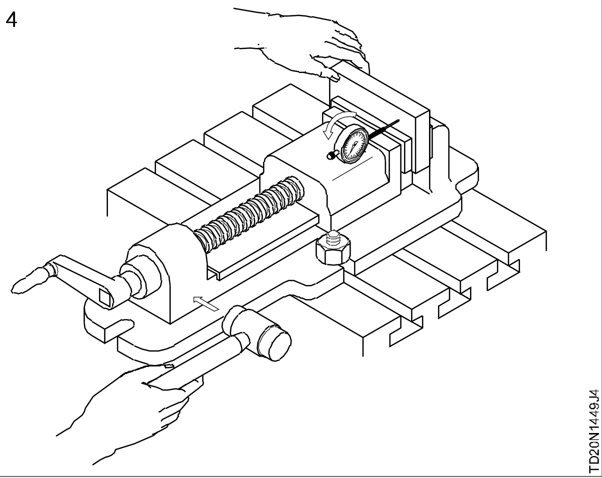


Fig 3



- Move the table so that the dial indicator is at the other end of the parallel. (Fig 4) observe the pointer movement.
- If the pointer deviates from zero, adjust the vice by gentle tapping in the direction as needed. (Fig 4) Ensure that the plunger is not lifted while tapping.
- Repeat the step until the dial indicator reads zero along the length.

Fig 4

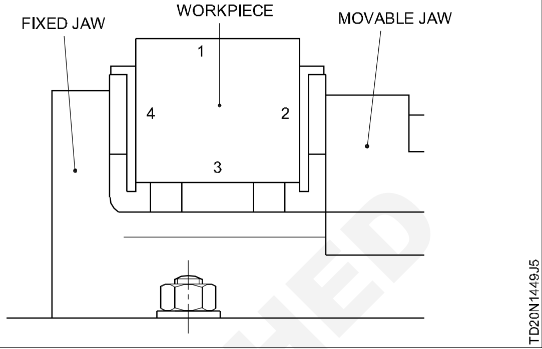


- Tighten the vice clamping nuts without disturbing the setting.
- Check the alignment after clamping, and adjust, if necessary.

Lubricate the vice screw and the slide ways.

- Place one of the larger surfaces of the workpiece on the parallel to prevent its downward movement while machine.
- Ensure that the workpiece is projecting the vice jaws by about 3 to 5 mm more than the total depth of cut. This avoids resetting of the job now and then also it prevents the vice jaws, tools and workpiece from damage.
- Place a rod of diameter 6 to 15mm between the middle of the unfinished side and the movable jaw. This gives line contact between the job and prevents lifting off the workpiece. (Fig 5).

Fig 5

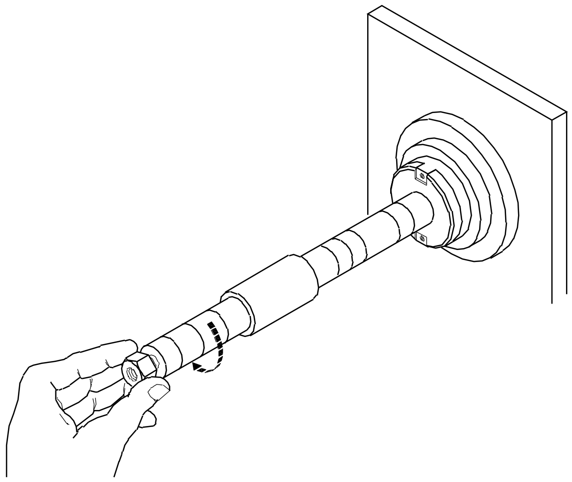


- Tighten the workpiece.
- Tap the workpiece gently with a soft hammer for seating on the parallel. Ensure that the parallel block does not shake.

Set arbor on the spindle of milling machine

Objective: At the end of this exercise you shall be able to
- **mount arbor on the machine spindle of milling machine.**

Fig 1

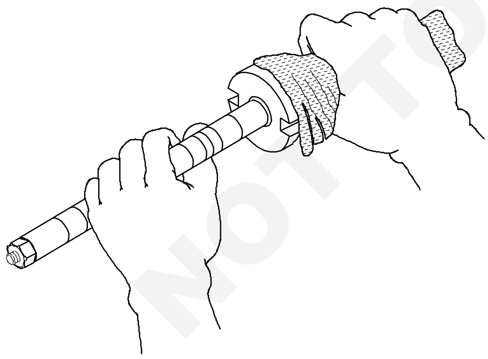


Job Sequence

- Set the lowest available spindle speed to avoid free rotation of the spindle nose.
- Ensure that the machine is switched off. Consult your instructor.
- Select the arbor with correct diameter and taper to suit the machine spindle nose.

  Clean the internal thread and taper portion of the arbor. (Fig 1)

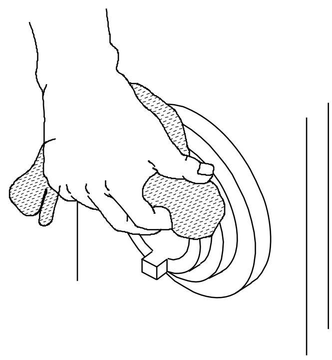
Fig 1



- Clean the spindle nose of the machine. (Fig 2)

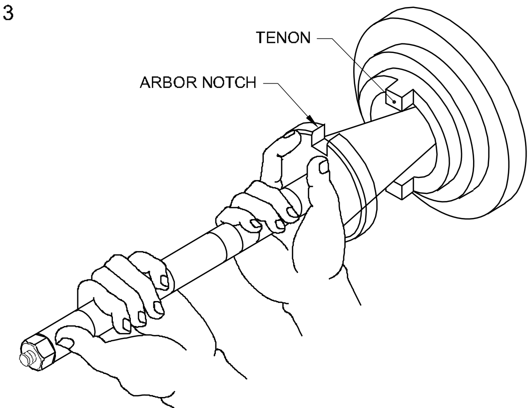
For cleaning, use soft cloth free from dust, chips etc. to avoid scratches on the surface.

Fig 2



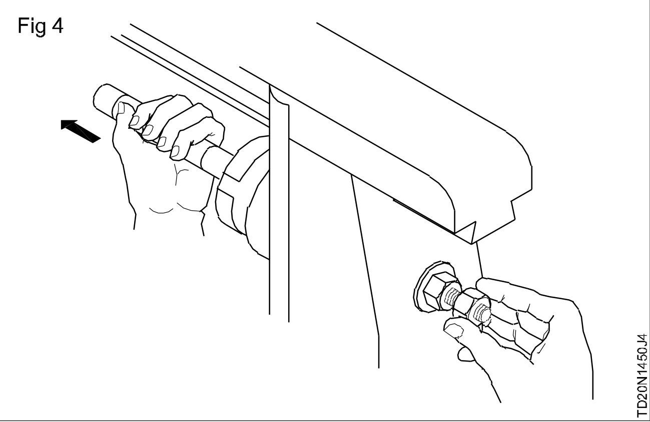
- Hold the arbor and ensure that the arbor notches fit on to the nose of the tenon to get the drive. (Fig 3)

Fig 3



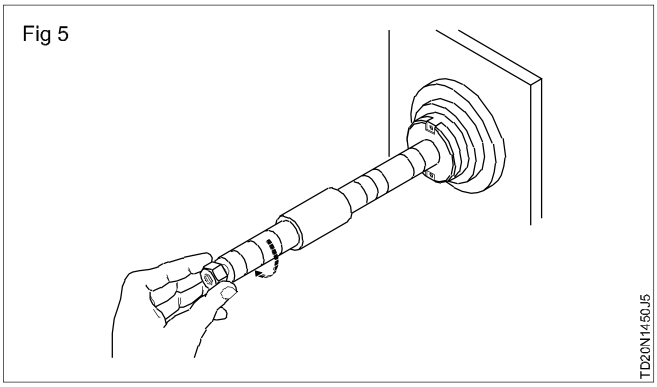
• Tighten the draw - bar from the rear side of the spindle and secure the arbor into machine by tightening the lock - nut. (Fig 4)

Fig 4



• Unscrew and remove the nut from the arbor end by rotating it in the clockwise direction. (Fig 5).

Fig 5



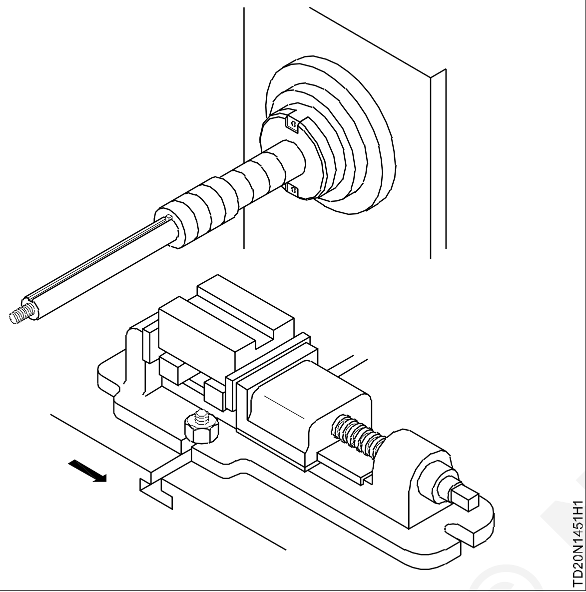
Set the cutter on arbor

Objective: At the end of this exercise you shall be able to
• mount and position the cutter on milling machine arbor.

Job Sequence

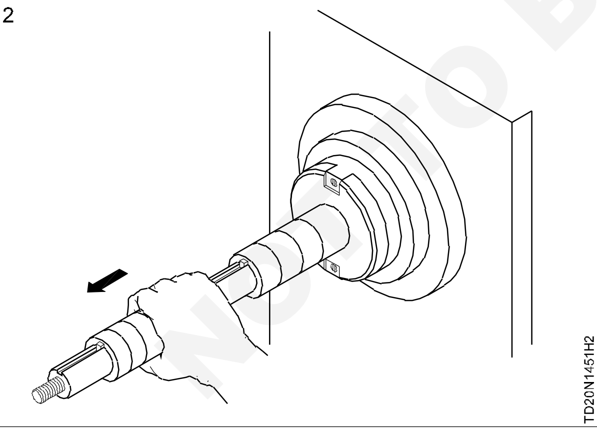
• Remove the spacers and bearing bushes and clean them. (Fig 1)

Fig 1



• Insert enough spacers on to the arbor so that the last spacer extends over the rear edge of the workpiece. This will enable you to fix the cutter in the middle of the workpiece for milling. (Fig 2)

Fig 2

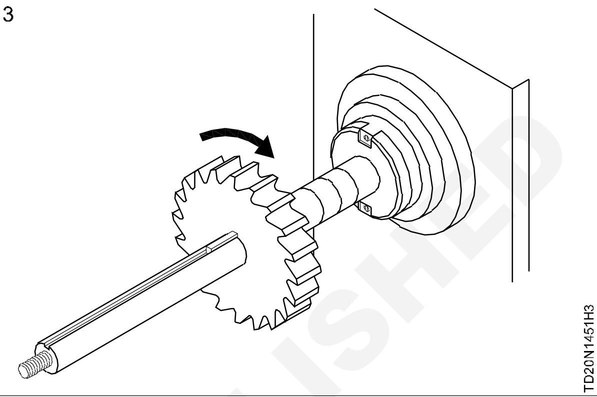


• Clean the side and face the cutter and the bore of the - cutter.

• Select the key to suit the cutter keyway.

• Place the cutter on the arbor such that the direction of rotation of the cutter is in the opposite direction of the job feed for up-milling at the initial stage. Depending upon the condition of the machine, down-milling may be performed at a later stage of practice. (Fig 3)

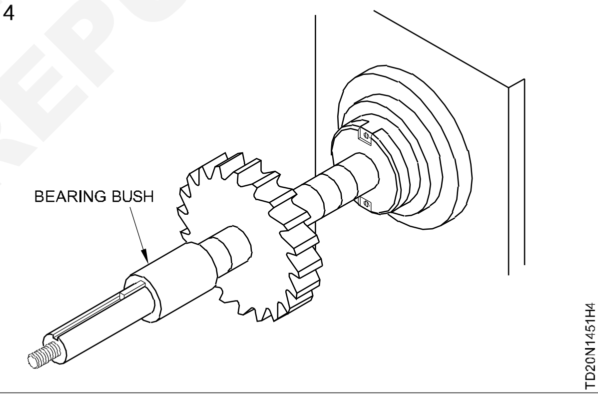
Fig 3



• Ensure that the key is placed into the keyway, and milling cutter.

• Slide the bearing bush on to the arbor. (Fig 4)

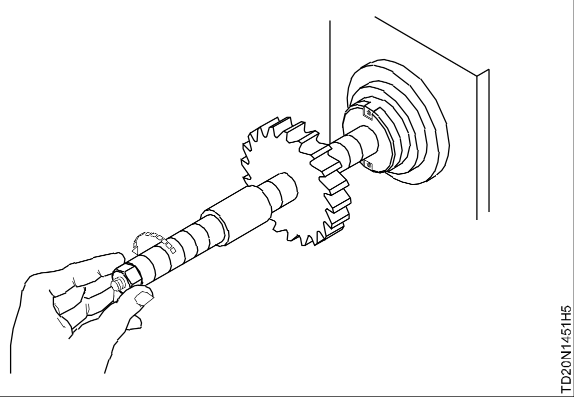
Fig 4



• Slide on more spacers until one or two threads on the arbor screw are covered so that the spacers are pressed while tightening.If not, the cutter may not be tightened sufficiently.

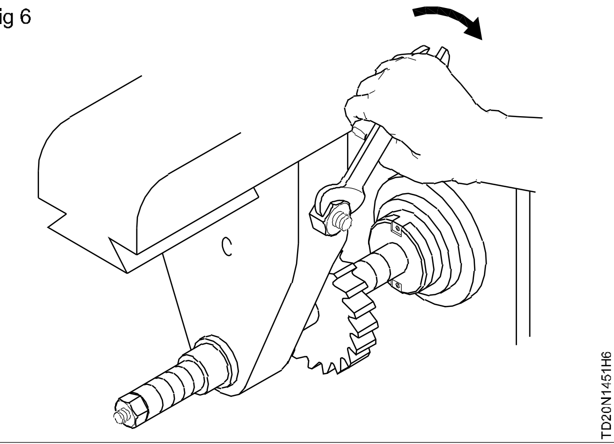
• Tighten the arbor nut by hand. (Fig 5)

Fig 5



- Carefully slide the arbor support. (Fig 6)

Fig 6

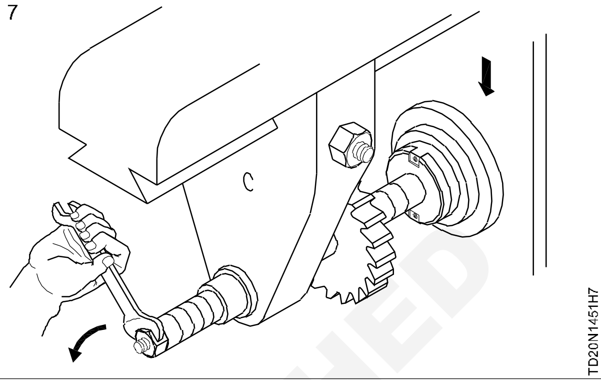


Ensure that the bearing bush extends equally on both sides of the arbor for uniform support.

Tighten the arbor nut and switch on the machine and check visually that the cutter runs true. (Fig 7)

The milling machine, like all machine tools, should be cleaned after each work period. A medium width paint brush may be used to remove the accumulated chips.

Fig 7



Safety points to be observed while working on a milling machine

Objective: At the end of this exercise you shall be able to
• **adopt the safe procedures while working on milling machine.**

Do not use this machine unless a instructor has instructed you in its safe use and operation and has given permission.

- Safety glasses must be worn at all times in work areas.
- Appropriate footwear with substantial uppers must be worn.
- Rings and jewellery must not be worn.
- Long and loose hair must be contained.
- Close fitting/protective clothing must be worn.
- Gloves must not be worn when using this machine.
  - Use a guard wherever possible.
  - Do not take any measurement while the machine is in running condition i.e stop the machine first and then take measurement.
  - Use proper feeds and depth of cuts avoid heavier feeds and cuts.
  - Before taking any cut ensure that the job is properly clamped.
  - Clean the cutter or workpiece while the machine is in still position.
  - Do not use machine table as storage space for spanners, mallets and other tools. These tools may fall down and injure the workmen when the machine table is moving.
  - While using cutting fluid or lubricant directly from the machine, make sure that the flow pipe outlet is well clear of the milling cutter.
  - Do not fix a heavier job than recommended for the mahine.
  - Check the job for proper clamping.
  - Use a piece of cloth for protection of the cutter and your hands when handling the milling cutter.
  - Do not be distracted or talk to others while operating the machine.
  - Only remove chips using gentle air blasting or chip brushess.
  - Be aware of cutting tools.
  - Never reach any where over around or near any rotating cutters.

Demonstrate up milling and down milling process

Objectives: At the end of this exercise you shall be able to
- **set the cutter on the arbor and decide the direction of rotation**
- **set the job correctly on the vice**
- **mill the surface by up milling**
- **mill the surface by down milling.**

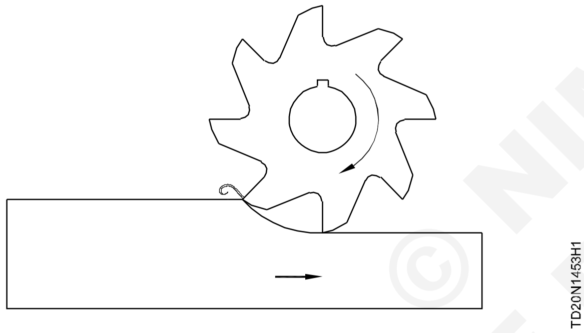
The two operating procedures are distinguished by the directions in which the teeth of the cutter and the feed of the workpiece move.

Job Sequence

TASK 1: **Up-cut milling**

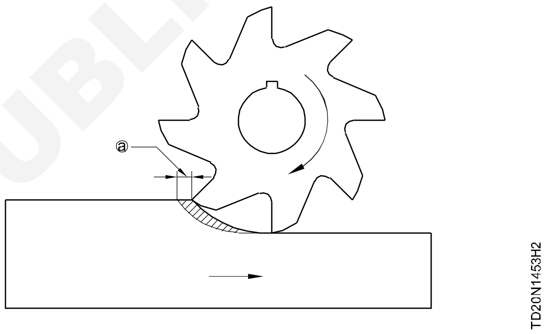
- The most commonly used method of feeding is to bring the work against the direction of rotation of the cutter. (Fig 1) This is otherwise known as convention milling. This is the most commonly used method.

Fig 1



- In up-milling the removal of chip by each cutting edge starts at the thinnest part of the chip (a) and progresses to the thickest part. (Fig 2) The cutting edge slides in the material before it starts to cut. This scraping causes a good deal of heat and wear on the cutter. As the cutter teeth emerge from the material, the accumulated cutting forces are suddenly released.

Fig 2



- The cutter and workpiece suddenly spring apart, the machine chatters, and the material surface is flawed by ripples. The spindle for the milling is tensioned in the direction of the feed. The forces involved are taken up by the flank of the thread in contact.

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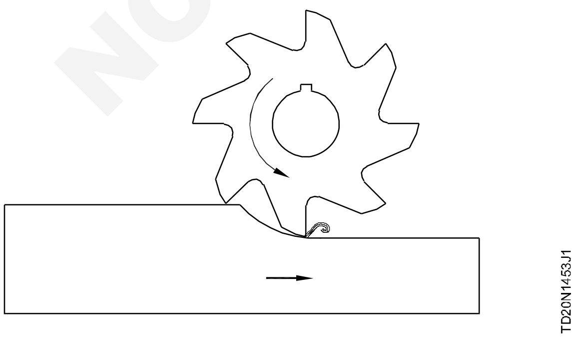
TASK 2: **Down-cut milling**

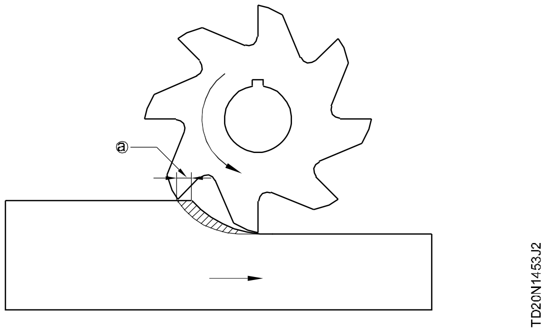
- In down-milling or climb-milling the feed moves in the same direction as the rotation of the cutter. (Fig 3)

Fig 1

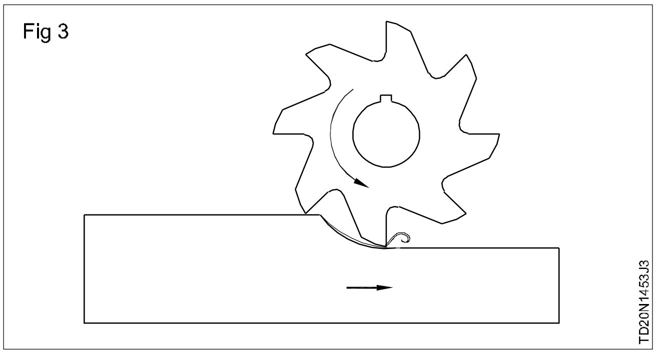


- In this method, chip removal starts at the thickest part. The cutter cuts into the material straightway and does not slide. (Fig 4) As a result less heat is developed and there is less wear on the cutter.

Fig 2

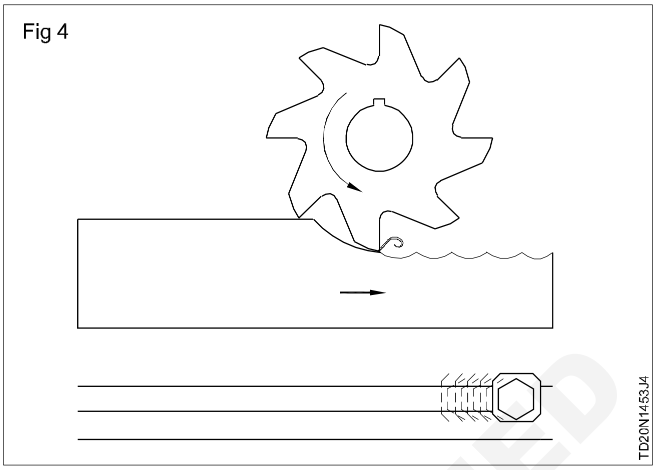


- In this method, the workpiece is pressed down on the work table by the cutting pressure and thus prevents the workpiece from lifting. (Fig 5) This is an advantage, especially when milling long workpieces.



- Because in climb-milling the cutter is pulling the workpiece, it should only be carried out on a machine having a 'backlash eliminator'. This is because the backlash eliminator takes up any clearance in the feed drive mechanism and prevents the cutter from being pulled along.

- If down-milling is tried on a machine without a backlash eliminator, the workpiece will move along in a series of jerks (Fig 6), resulting in very poor finish and even breakage of the cutter.



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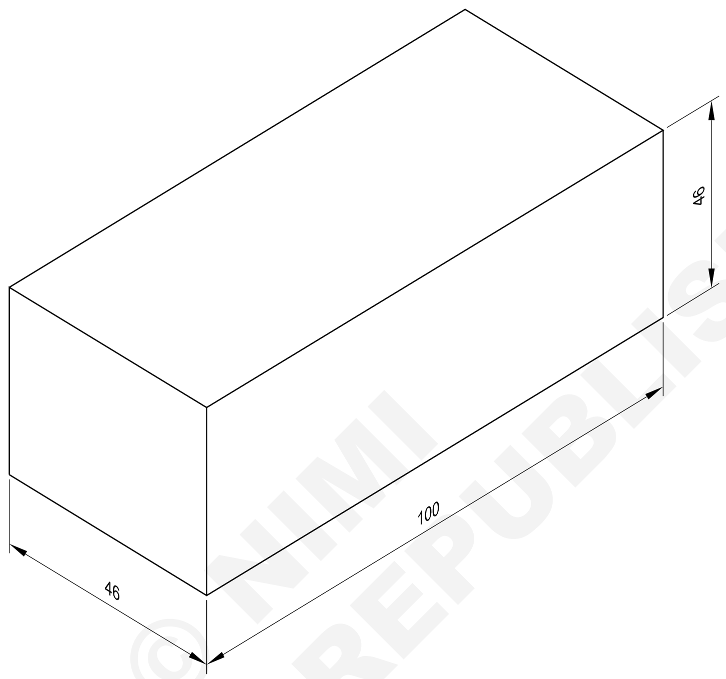
Sequence of milling six faces of a solid block

Objectives: At the end of this exercise you shall be able to
- **set the workpiece on a horizontal milling machine**
- **mill six faces perpendicular to each other**
- **maintain the size of the workpiece.**



Job Sequence

- Clamp the machine vice securely on the machine table and align jaw parallel to the coloumn.
- Fasten the cutter in the machine.
- Set the required RPM.
- Place surface 'C' on the parallel block, clamp the job. Ensure that the parallel block dose not move.
- Mill surface 'A' flat. (Fig 1).
- Keep surface 'A' against the fixed jaw and surface D on the parallel block.
- In the middle of the surface C, a round rod is kept between the job and the movable jaw for line contact to avoid lifting of the job. This roller enables for maintaining squareness of the surfaces A&B. (Fig 2)
- Mill surface 'B' at right angle to surface 'A'. (Fig 2)
- Keep the surface 'A' on the parallel blocks and butt the surface B to the fixed jaw.
- Place a round rod in between movable jaw and surface D.
- Mill surface C maintaining the size of 46mm (Fig 3).
- Keep surface C on the parallel blocks.
- Set the work, projecting it atleast 10mm from the sides of the vice.

1	-	→ 1.4.58	Fe310	-	-	1.4.54
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	SEQUENCE OF MILLING SIX FACES OF A SOLID BLOCK	DEVIATIONS ± 0.1	TIME :
		CODE NO. TD20N1454E1	

Fig 1

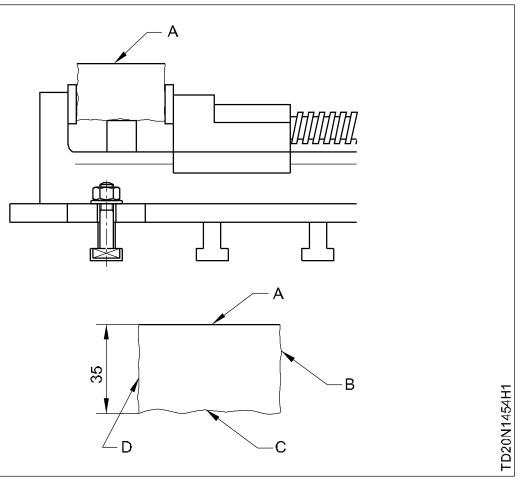


Fig 2

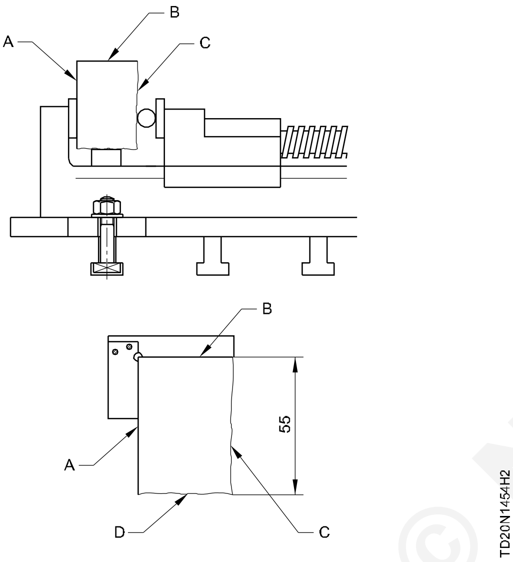
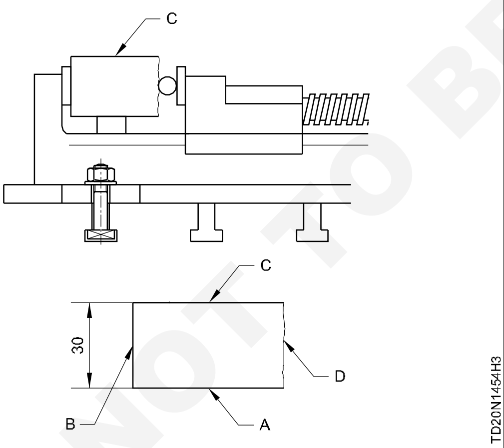


Fig 3



- Mill surface ‘D’ maintaining a size of 46 mm (Fig 4)
- Keep surface ‘C’ on the parallel blocks (Fig 5)

Fig 4

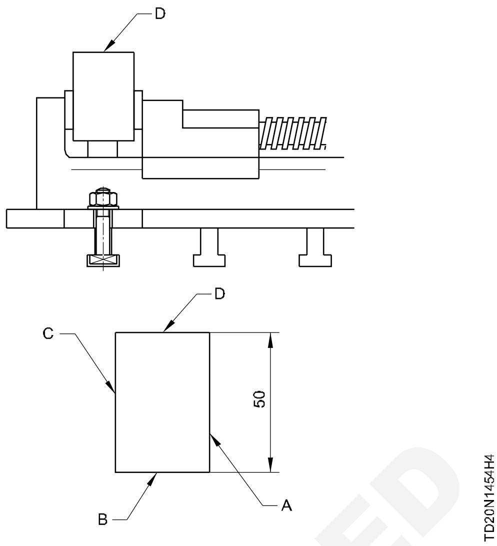
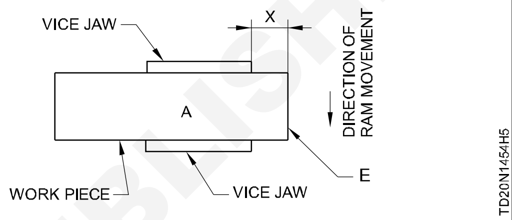
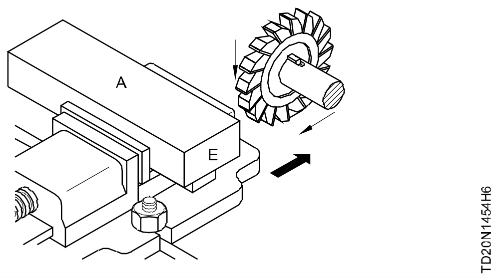


Fig 5



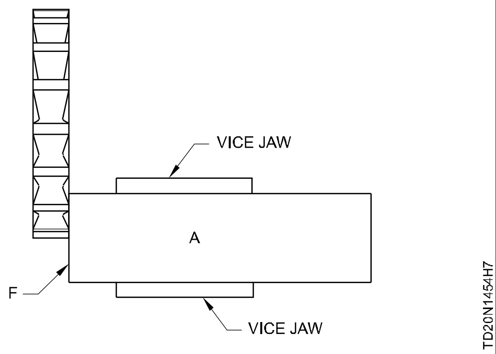
- Set side and face milling cutter and mill the surface ‘E’ (Fig 6)
- Set the RPM for side and face cutter.

Fig 6



- Mill the ‘F’ side by the side and face cutter and maintain the size (Fig 7)
- Deburr the job and check all the dimensions.

Fig 7



Check the accuracy with the help of try square and vernier height gauge

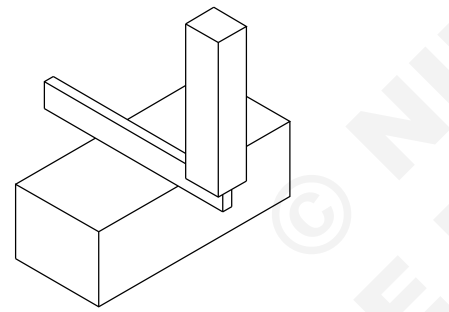
Objectives: At the end of this exercise you shall be able to
- **check the flatness with try square**
- **check the squareness with try square**
- **check the height with the vernier height gauge.**

Job Sequence

TASK 1: **Checking flatness with try square**

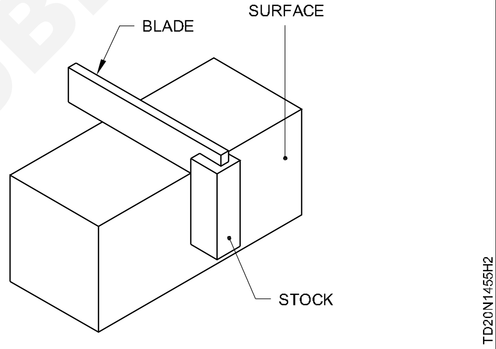
- During the initial stages of filing the evenness of the surface can be visually observed to a reasonable degree of perfection from the surface texture of diagonal filing.
- To ensure perfection, the surface should be checked with a straight edge. To do this, the blade of a try square can serve as a straight edge.
- Flatness should be checked in all directions so as to cover the entire surface. Light gap will indicate high and low spots. (Fig 1)

Fig 1



- Checking sequareness.
- While checking for squareness, the large finished surface is taken as a reference surface. (Fig 2)
- Ensure that the reference surface is finished perfectly before filing other surfaces.
- Burrs, if any, should removed before checking with a try square.

Fig 2



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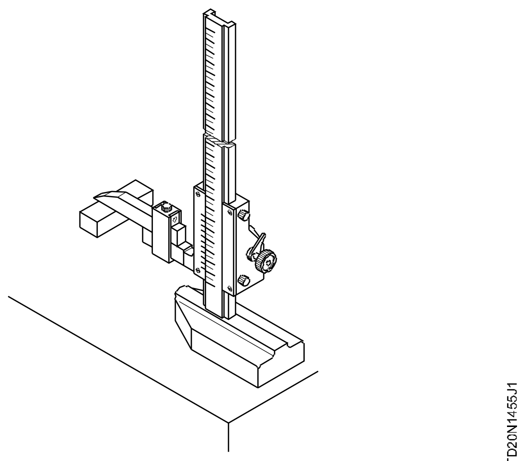
TASK 2: **Check the accuracy with the help of vernier height gauge (Fig 3)**

- Keep the job on the surface table.
- Set the vernier height gauge on the surface table.
- Zero set the instrument using the offset scribes.
- Zero setting of the instrument is at a level above the datum surface for using the straight scriber.
- Check the height of the job to a accuracy of ± 0.02mm.

Fig 1



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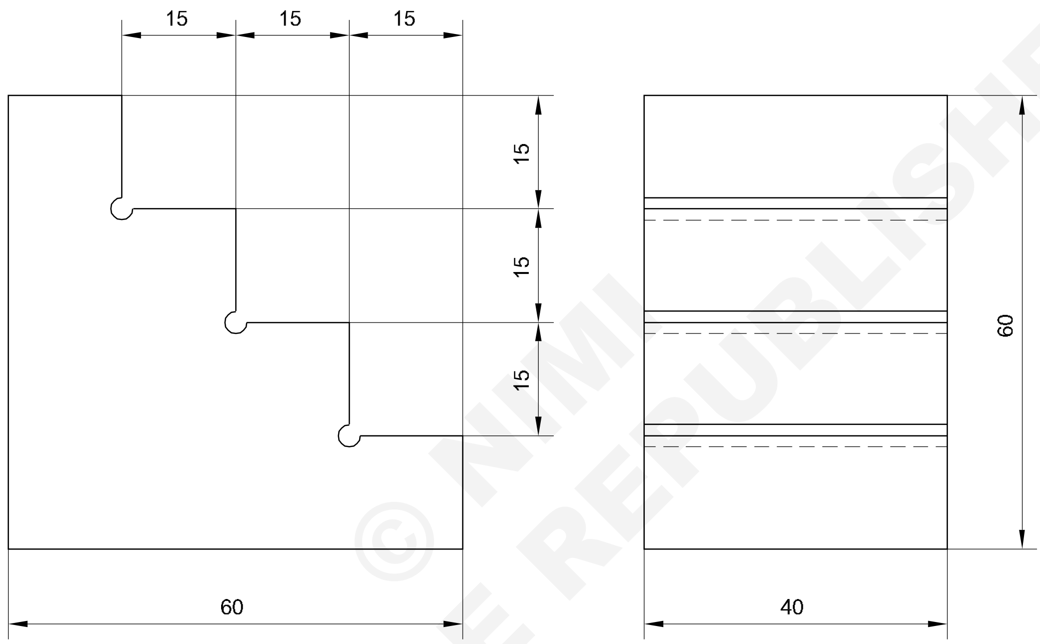
Perform step milling using side and face cutter checking with depth micrometer

Objectives: At the end of this exercise you shall be able to
- **lay out the job as per drawing with a vernier height gauge**
- **set the job in the machine vice for machining**
- **mount a side and face cutter on the arbor**
- **mill steps on the job**
- **check the dimensions of the steps using a depth micrometer.**



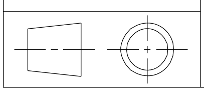
Job Sequence

- Check the dimensions of the block. (Deburr, if necessary).
- Mark the steps on the block (steps) as per the dimensions and punch witness marks.
- Align the machine vice with reference to the column using dial indicator.
- Mount a Ø32 mm long arbor and a side and face milling cutter of Ø125x16x32mm bore for the horizontal milling machine.
- Set the r.p.m. of the cutter near to 50.
- Clamp the job in the machine vice to mill all the steps in one setting.
- Align the cutter and the job for milling the step.
- Mill the steps in sequence and check with a depth micro meter.

Mill the relief groove before grinding for grinding purpose.

- Drill relief hold Ø3 mm at the junction of steps.

1	PRE MACHINED 60X60X40	→ 1.5.68	CI BLOCK	-	-	1.4.56
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	PERFORM STEP MILLING USING SIDE AND FACE CUTTER CHECKING WITH DEPTH MICROMETER	DEVIATIONS ± 0.1	TIME :
		CODE NO. TD20N1456E1	

Skill Sequence

Mill steps on plain milling machine

Objective: This shall help you to
- **mill steps on plain milling machine.**

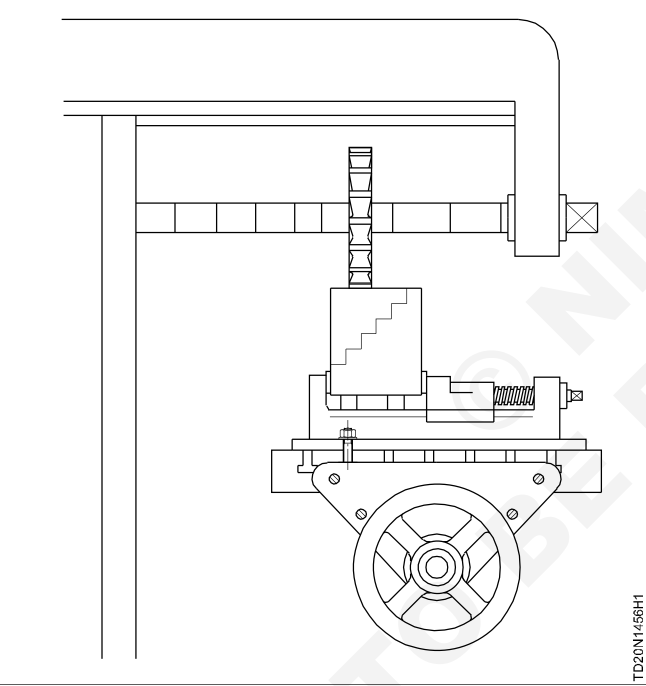
Align and mount the plain machine vice on the machine such that the vice jaws are parallel to the column.

Mark the job as per drawing and punch witness marks.

Hold the job in the machine vice.

Clamp the job in the machine vice such that all the steps can be machined in one setting. (Fig 1) If the job cannot be accommodated on the plain milling machine, step mill on the vertical milling machine.

Fig 1



Mount the long arbor and the side and face milling cutter.

Ensure that (D - S)/2 is 5 to 6 mm more than the maximum depth to be machined.

D = diameter of the cutter

S = outside diameter of the spacers

The gap of 5 to 6 mm is provided to avoid fouling of the spacers with the job while machining. (Fig 2)

Set the machine for up-milling.

Calculate and select suitable r.p.m. for the cutter.

Stick tissue paper (T) on the side face of the job. (Fig 3)

Raise the vertical slide such that the upper surface of the job is 10 to 15 mm above the cutter.

Fig 2

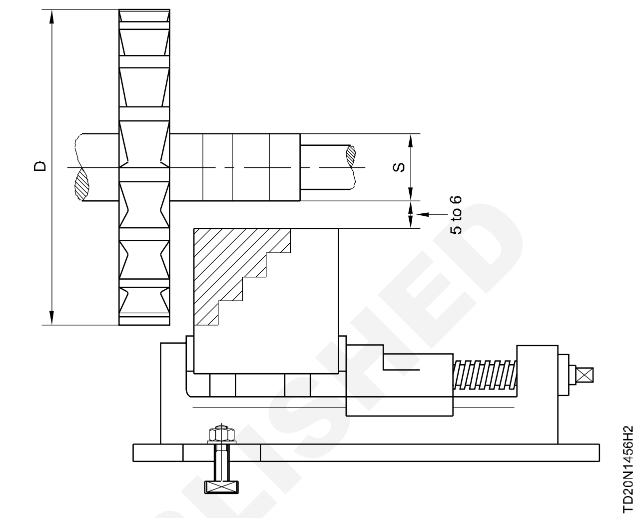
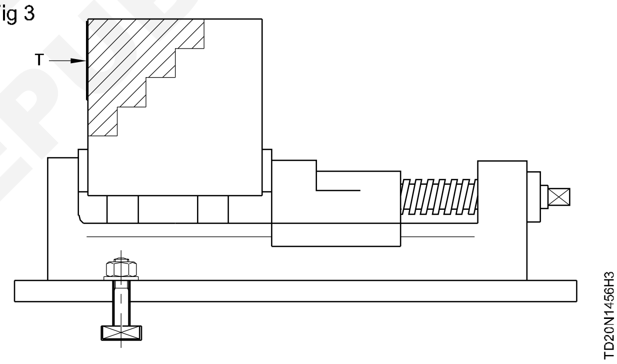
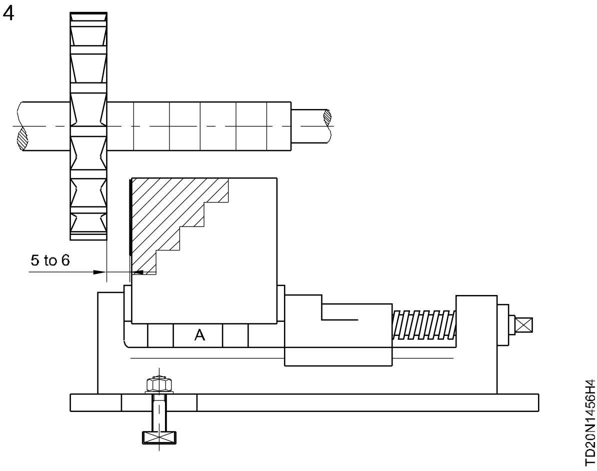


Fig 3



Move the table and bring the tissue paper side of the job parallel to the side of the cutter with a gap of 5 to 6 mm. (Fig 4)

Fig 4



Start the spindle.

Move the cross-slide slowly till the tissue paper is just displaced from its position.

Stop the machine as soon as the tissue paper slips.

Lock the cross-slide.

Adjust the graduated scale to zero of the cross-slide.

This is the datum in one axis for milling the steps horizontally.

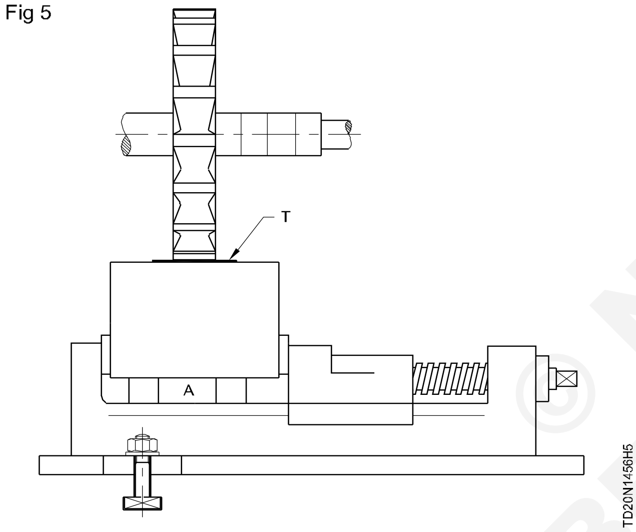
Stick the tissue paper on the top surface of the job.

Clear the workpiece from the cutter and set the cutter 10-15 mm above the top surface of the job.

Start the machine.

Raise the workpiece slowly and manually till the job just touches the cutting edges and the tissue paper slips away by the rotation of the cutter. (Fig 5)

Fig 5



Stop the machine as soon as the tissue paper slips.

Adjust the graduated scale to zero of the vertical slide.

This is the datum in another axis for milling the steps vertically.

Unlock the vertical slide.

Clear the job from the cutter.

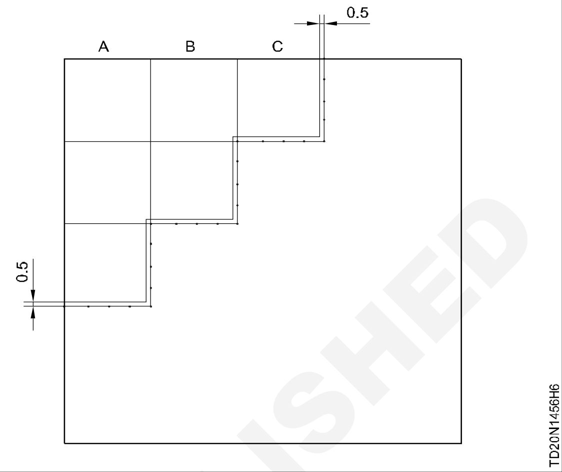
Take care that the datum, set for both the axes, is not disturbed.

Set the coolant nozzle towards the cutter.

Depending upon the condition of the machine, rough milling is possible by using a heavy feed, with a depth of cut from 5 to 10 mm and a low cutting speed. Rough milling is done to remove surplus material in the shortest time. Consult the instructor when and if necessary.

Rough mill the steps a,b,c in that order. (Fig 6)

Fig 6



Leave 0.5 mm allowance of material on both the axes for the final finish.

While machining observe for abnormal noise, vibration of job or cutter and bad surface finish. If you are in doubt stop the machine and check that the

- job is tightened firmly, without any shake.
- cutter is tightened securely without play.
- cutter teeth are not blunt.

Ensure defect-free machining condition, restart the machine and complete the rough milling operation.

Clear the job from the cutter and deburr the job.

Measure the job and confirm that that 0.5 material is left for final finishing.

Set the machine and complete the steps to the final dimension and finish to a smooth surface by automatic feed.

A fine finish is achieved by relatively high cutting speed and fine feed - check the dimension after completion of each step - consult the instructor.

Stop the machine and deburr the job.

Remove the job and measure for its size.

Stop the machine before attempting to make adjustments or measurements.

Measurement by depth micrometer

Objectives: At the end of this exercise you shall be able to
- **select and fix the suitable extension rod for the measurement**
- **position the depth micrometer for the depth measurement**
- **read the value of depth micrometer**

Depth micrometer is shown in Fig 1. A set of extension rod is generally supplied they are 0-25, 25-50, 50-75, 75-100, 100-125 and 125-150.

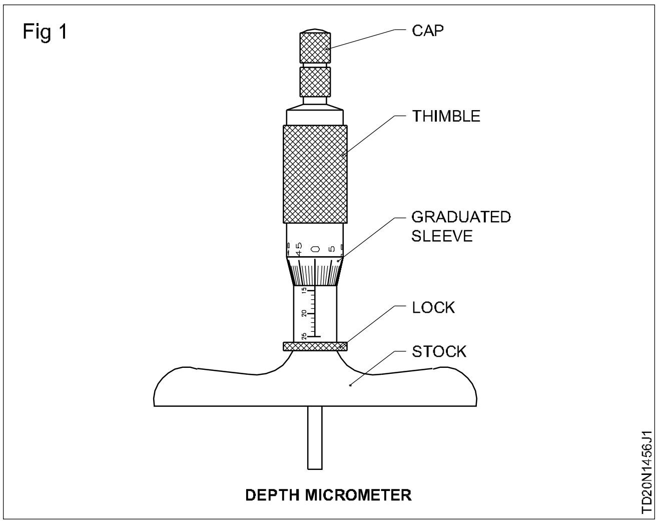


Fig 1 DEPTH MICROMETER

Select the suitable extension rod and insert inside the thimble and sleeve (Fig 2).

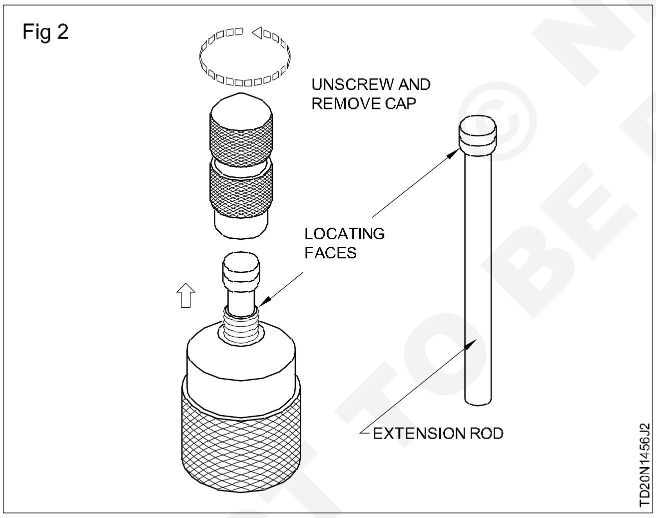


Fig 2

Check for the zero error

Place the depth micrometer on a surface plate and rotate the thimble screw until it touches the surface plate. Note that zero on barrel and zero on thimble should coinsides. If not adjust the error (Fig 3).

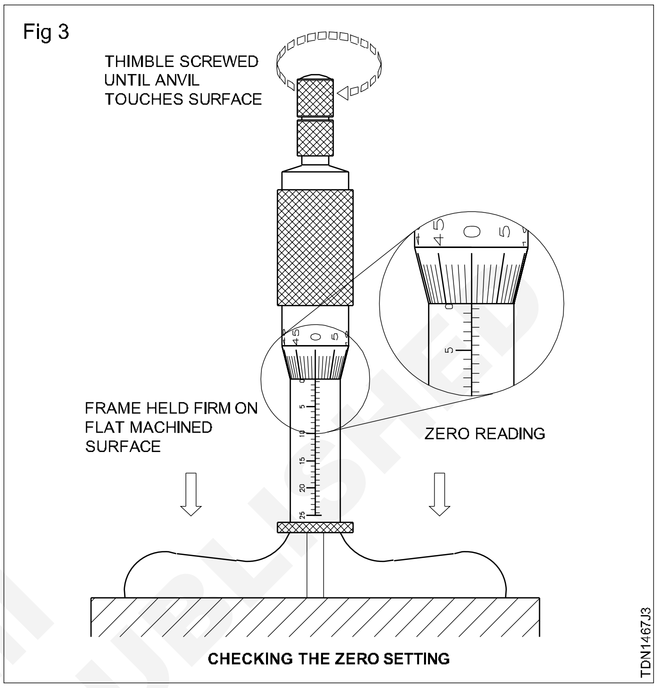


Fig 3 CHECKING THE ZERO SETTING

Depth measurement

Position the depth micrometer base and extension rod in position and rotate the thimble until it touches the bottom position of the workpiece. (Fig 4).

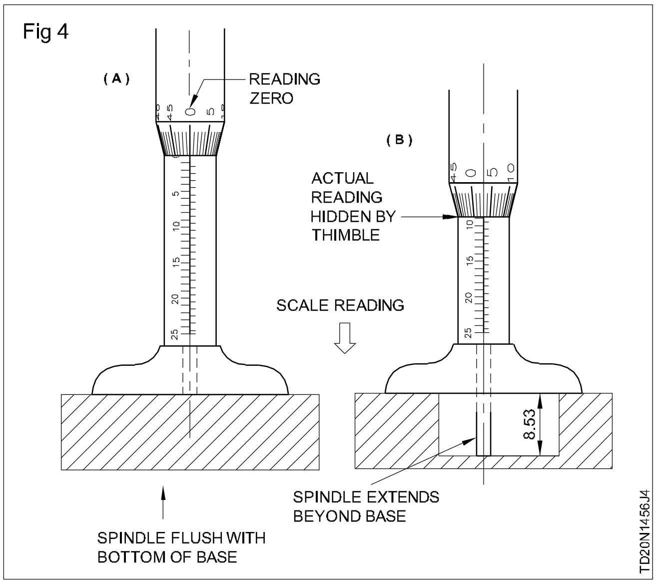


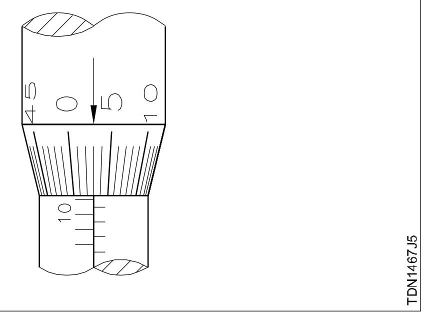
Fig 4

Reading of depth micrometer (Fig 4B & 5).

Barrel reading (1mm division	=	8 x 1mm	= 8.00mm
Sub division (0.5mm division)	=	1 x 0.5mm	= 0.50mm
Thimble	=	3 x 0.01mm	= 0.03mm
(Thimble division x L.C)		Total reading	= 8.53mm

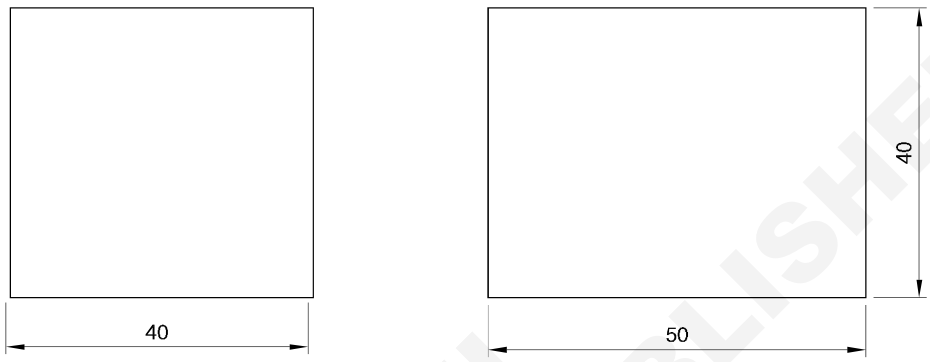
In barrel reading main division and sub division have been hidden covered by thimble.

Fig 5



Milling blank piece plain milling

Objectives: At the end of this exercise you shall be able to
- **set the workpiece on a horizontal milling machine**
- **mill six faces perpendicular to each other**
- **maintain the size of the workpiece.**



Note : Trainee shall write the job sequence

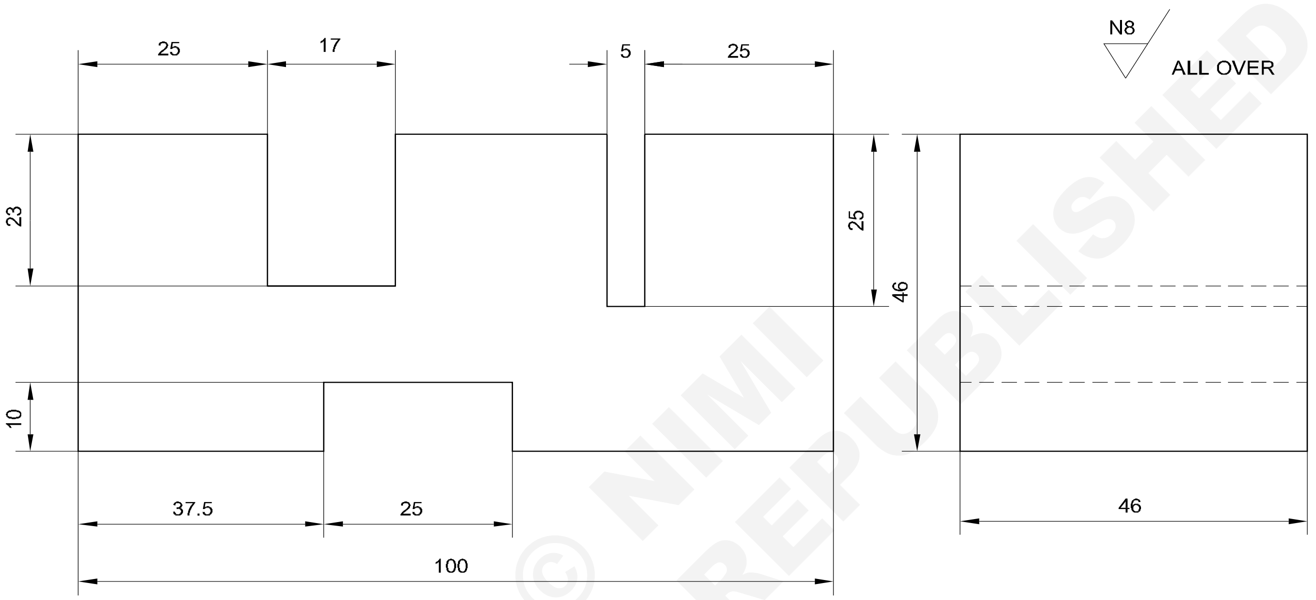
- **Mill the workpiece using plain milling cutter and maintain the dimensions**

1	ISSQ 50X55	→ 1.4.59	Fe310	-	-	1.4.57
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	MILLING BLANK PIECE C PLAIN MILLING	DEVIATIONS ± 0.05	TIME :
		CODE NO. TD20N1457E1	

Slot milling with side and face cutter and slot cutting by sitting saw

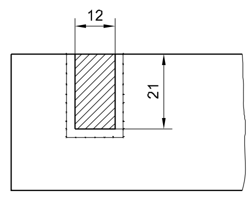
Objectives: At the end of this exercise you shall be able to
- **set the job in the machine vice for machining**
- **align the job with respect to the cutter**
- **mill the slot by side and face cutter to an accuracy of ± 0.04 mm**
- **mill slot using sitting saw**
- **check the width of the slot using a vernier caliper**
- **check the depth of the slot using a vernier depth gauge.**



Job Sequence

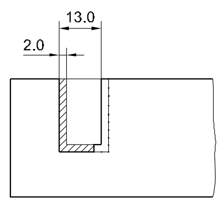
- Check the dimensions of premachined block, 100 x 46 x 46 mm.
- Mark the groove as per drawing and punch witness marks.
- Hold the job on the machine vice using parallel blocks.
- Mount the side face milling cutter ∅100 x 12 x 27 mm bore at the centre of the arbor and set the spindle speed to 100 r.p.m.
- Align the workpiece with reference to the cutter.
- mill the slot in the middle of the slot (17x23) giving a depth of cut of 4 mm up to a depth of 21 mm (Fig 1).
- Offset the job towards the column by 2.0 mm (Fig 2) and give depth of cut to 2mm (total 23mm), mill the width to 14.0 mm (Fig 2). Offset the job away from the column by 5 mm and mill the slot to 17 mm (Fig 3).
- Check the size of the slot.

Fig 1



TD20N1458H1

Fig 2

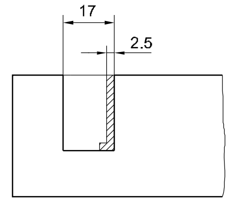


TD20N1458H2

		→ 1.4.62				
1	100X50X50	1.4.54 ←	Fe 310	-	-	1.4.58
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

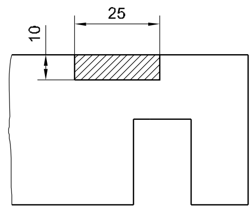
SCALE 1:1	**PERFORM SLOT MILLING USING SIDE AND FACE CUTTER**	DEVIATIONS ± 0.05MM	TIME :
		CODE NO. TD20N1458E1	

Fig 3



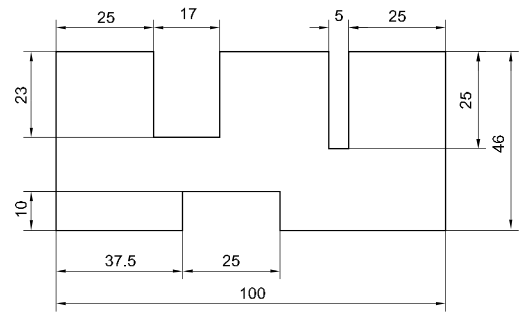
- Reset the job and mill a slot of 25 x 10 on the opposite side (Fig 4).

Fig 4



- Mill the slot 5x25mm by sitting saw of 5mm thickness (Fig 5).
- Deburr and measure.

Fig 5



Skill Sequence

Mill a slot by side and face milling cutter

Objective: This shall help you to
- **mill a slot by a side and face milling cutter.**

Deburr and clean the workpiece.

Mark the job as per drawing and punch witness marks on the lines.

Mount the plain machine vice on the plain milling machine such that the vice jaws are parallel to the column.

Select the cutter size.

The width of the cutter should be less than the width of the slot required.

Calculate the diameter of the cutter approximately, using the following thumb rule.

Select the nearest higher diameter available.

Dia. of cutter/2 = (depth of slot + bore dia./2 + 20) x 2.

Mount the long arbor and the side and face milling cutter on the machine.

Ensure that the cutter is mounted at the middle of the arbor to facilitate the free traverse of the cross-slide.

Clamp the job with its marked surface on the top, between the vice jaws firmly.

Keep the job on the pair of parallels in such a way that the top surface of the job is above the top surface of the jaws by 4 to 5 mm. (Fig 1)

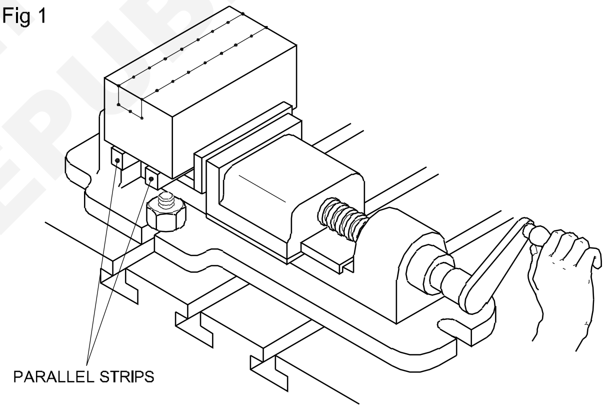
Calculate the r.p.m. for the selected dia. of the side and face cutter.

Calculate the feed per minute of the longitudinal traverse.

Set the r.p.m. and feed.

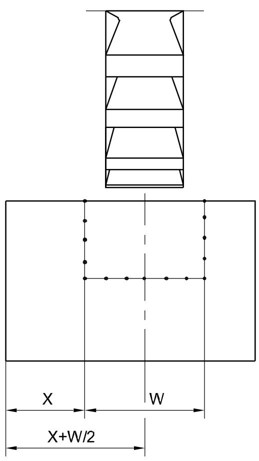
Stick tissue paper to the reference sides of the workpiece and set the datum for the cross and vertical slides.

Fig 1



Set the cutter at the middle of the slot to (X+W/2) mm taking reference from the side datum (cross-slide). (Fig 2) W is width of the slot.

Fig 2



Set the depth of cut taking reference from the top surfaceof the job.

Be sure that whenever the depth of cut is taken, the cutter is away from the job.

Keep 0.4 to 0.5 mm on both the sides and depth of the slot for final finish.

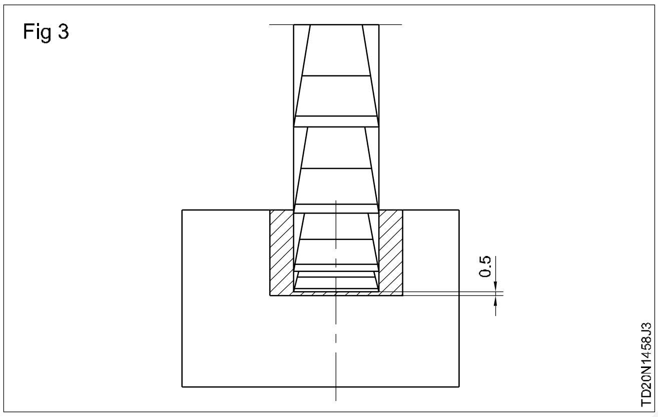
Lock the vertical and cross-slides. Adjust the coolant nozzle point on the cutter.

Start the machine and the coolant pump.

Move the longitudinal slide manually towards the cutter such that the workpiece comes in contact with the cutter gently. Sudden contact may damage the workpiece and the cutter may break.

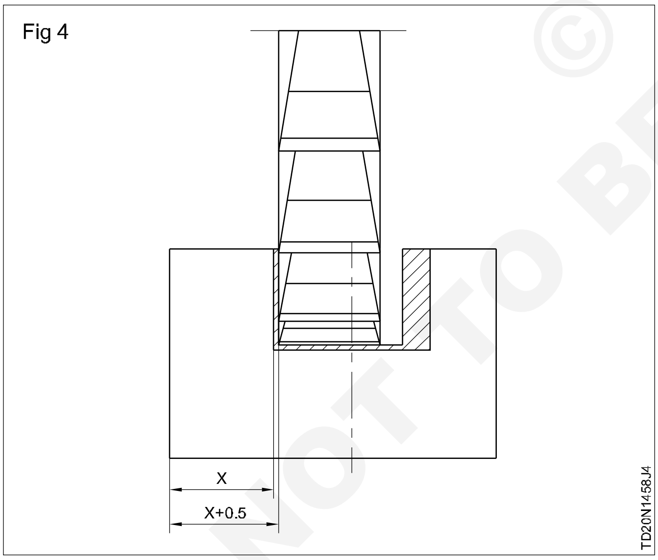
Mill the depth at the middle of the slot leaving 0.4 to 0.5mm for final finish. (Fig 3)

Fig 3



Move the cutter to the left to a distance of X + 0.5 mm and mill the side of slot. (Fig 4)

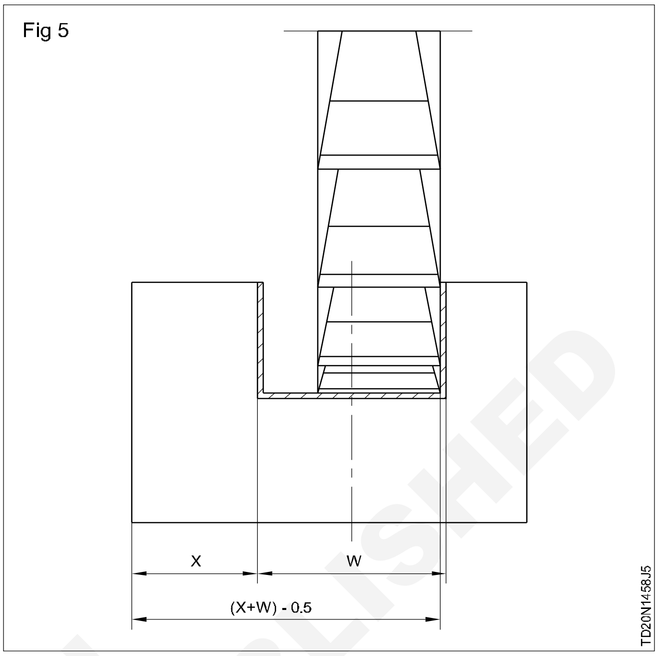
Fig 4



Ensure that the datum is again set whenever the cutter is changed or the job disturbed.

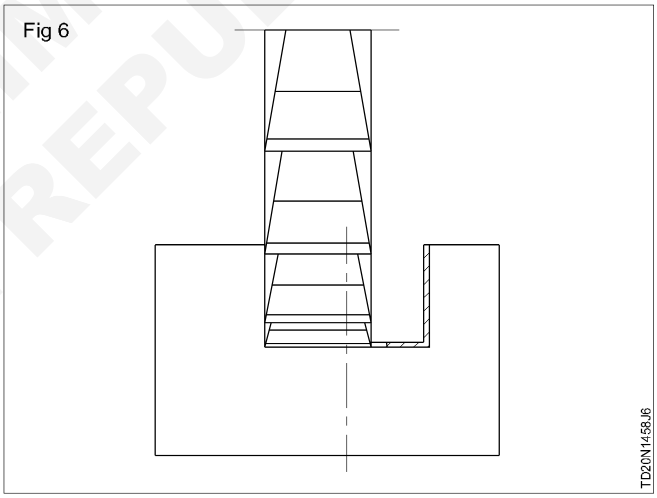
Move the cutter to the right to a distance of (X+W) = 0.5mm and mill the right side of the slot. (Fig 5)

Fig 5



Follow the above procedure and mill the slot to size. (Fig 6)

Fig 6



Deburr the job.

Check the slot for dimension.

Be sure the holding device is mounted solidly to the table and the work is held firmly. Spring or vibration can cause thin cutters, like the slitting saw, to jam and chatter.

Mill narrow groove by using slitting saw

Objective: This shall help you to
- **mill a narrow groove by using a slitting saw.**

Mark the job as per drawing to mill a narrow groove.

Mount a plain machine vice on a plain milling machine such that the jaws are parallel to the column.

Set a pair of parallel blocks in such a way that the top surface of the job is 5 to 6 mm above the top surface of the jaws.This will help to measure the dimensions of the slot from the sides using a vernier caliper.

Clamp the workpiece in the machine vice.

Select the slitting saw.

The thickness of the slitting saw sholud be equal to the width of the groove.

The diameter must be sufficiently large so that the desired depth can be achieved.

Check that the slitting saw is sharp and undamaged.

A blunt or damages slitting saw may create excessive vibration and may result in the breakage of the slitting saw.

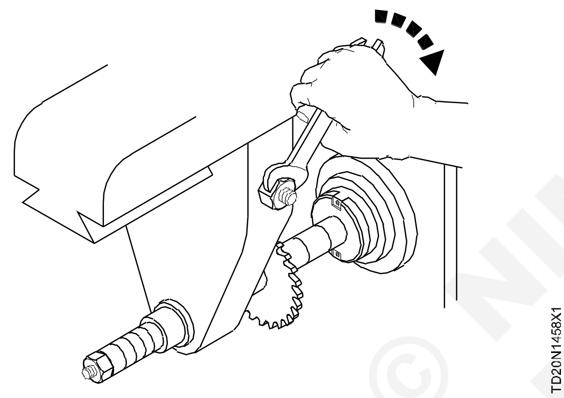
Select the arbor having the same diameter as the bore of the slitting saw.

Mount the long arbor on the plain milling machine.

Mount the slitting saw on the centre of the arbor.(Fig 1)

Do not insert the key between the arbor and slitting saw, if the slitting saw is less than 4mm thick.

Fig 1



The use of a key may result in the breakage of the slitting saw if it gets jammed into the cut during cutting.

Select the cutting speed, the feed for the slitting saw considering the material the saw is made of .

Calculate the r.p.m., and the feed/min.

Set the r.p.m. cutter rotation and table feed.

If a higher r.p.m. is set the cutting edges may get blunt, and if a lower r.p.m. is set the cutting time will be more.

Set the nearest lower speed and feed available if the machine does not have the exact values.

By using a hand traverse of the vertical, cross and longitudinal, position the work such that the slitting saw is close to the top of the work. (Fig 2)

Set the workpiece under the slitting saw such that the distance (x) is as indicated in the drawing.(Fig 3)

For this, move the cross-slide manually. Check 'x' distance with a vernier depth gauge.

Ensure that the spindle is disengaged. This will ensure that the spindle will not rotate accidentally.

Fig 2

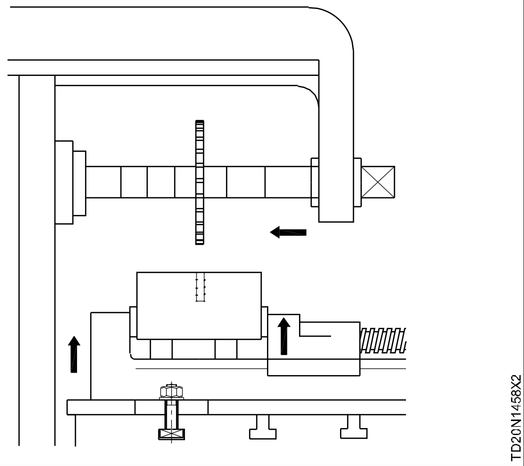
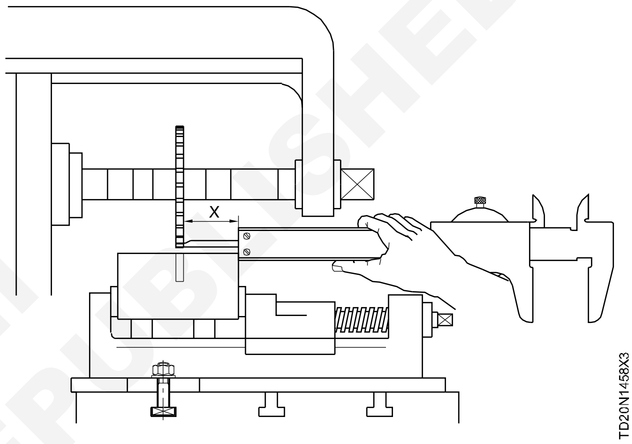


Fig 3

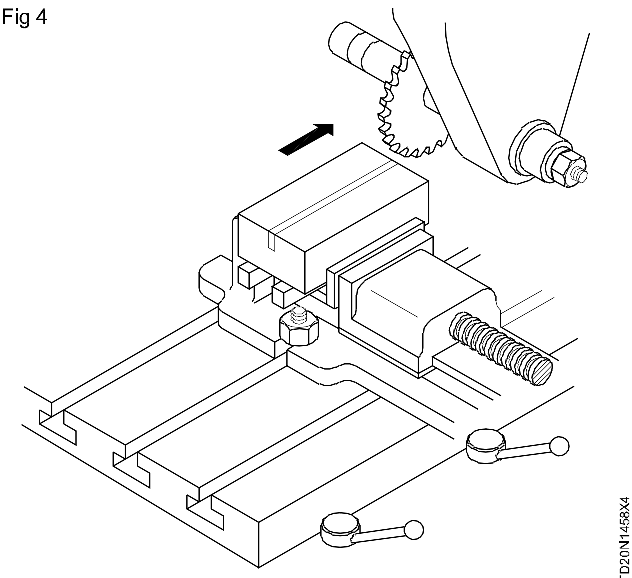


Lock the cross - slide.

Stick tissue paper on the top surface of the workpiece and set the datum for the vertical slide.

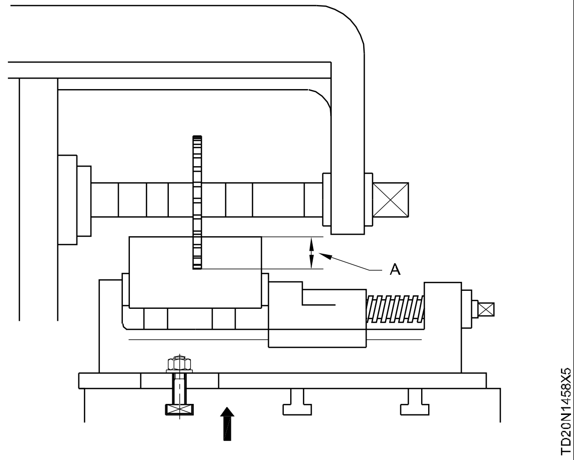
Move the longitudinal slide so as to clear the cutter from the workpiece. (Fig 4)

Fig 4



By moving the vertical slide upward, apply a depth of cut. (Fig 5)

Fig 5



Lock the vertical slide.

If the depth of the groove is more by 3 to 4 times than that of the thickness of the cutter (width of the groove), then the total depth of the groove should not be achieved in the first attempt. It should be completed with 2 to 3 passes.

Set the nozzle of the coolant pipe and start the coolant pump.

Start the spindle.

Mill the groove.

Observe the following points during grooving.

Apply only manual longitudinal feed. This facilitates withdrawing the workpiece from the cutter if it jams into the cut during cutting.

Ensure that there is no abnormal noise in the machine during cutting.

If abnormal noise is generated:

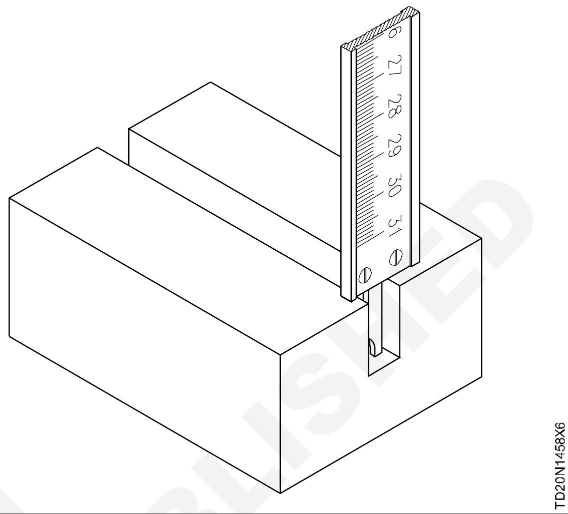
1 Reduce the r.p.m and feed

2 Check the sharpness of the cutter

3 Check the build up edge is generated in the teeth of the slitting saw.

Move the table to its initial position. Check the dimension (depth) by a vernier caliper. (Fig 6)

Fig 6



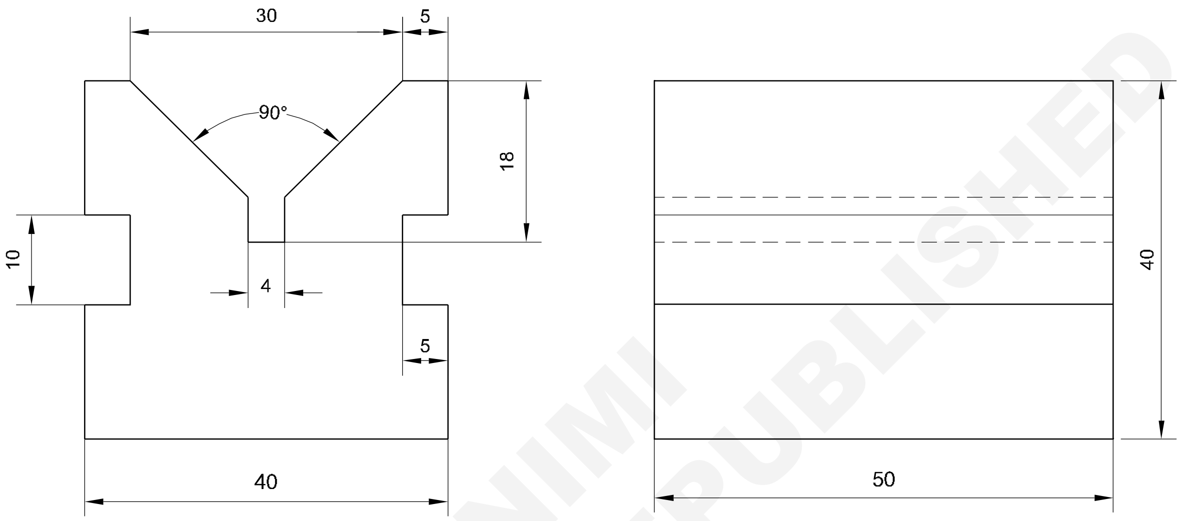
If required, take further cuts till the required depth is achieved.

Deburr and remove the workpiece.

Keep the floor around the machine clear of chips and wipe off spilled cutting fluid immediately. Use sawdust, sweeping or special oil absorbing compound on slippery floors.

90° angular milling with equal angle cutter

Objectives: At the end of this exercise you shall be able to
- **mill slot using sitting saw**
- **mill 'V' groove by 90° double angle cutter**
- **mill slot with side and face milling cutter**
- **check the dimension with vernier caliper.**



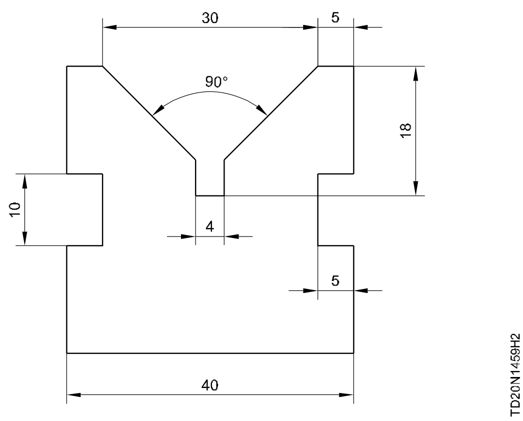
Job Sequence

- Check the premachined block flat and square, to size 50 x 40 x 40mm. (Fig 1)

Fig 1

- Mark and punch the job as per drawing. (Fig 2)
- Set the slitting saw 4mm width.
- Hold the job on machine vice.

Fig 2

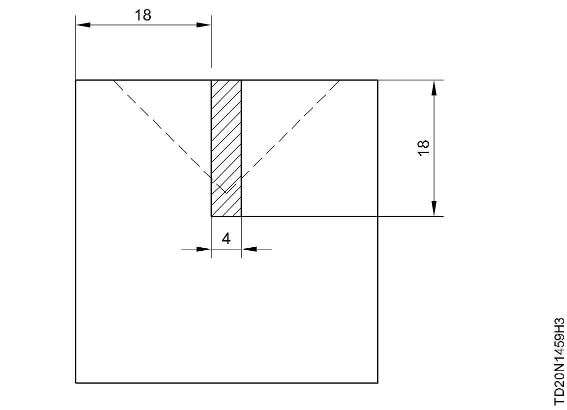


		→ 1.5.70				
1	ISSQ 50-60	1.4.57 ←	Fe310	-	-	1.4.59
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	V - BLOCK	DEVIATIONS ± 0.02MM	TIME :
		CODE NO. TD20N1459E1	

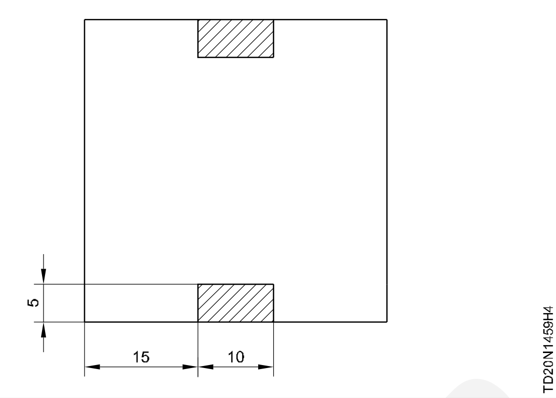
- Mill the slot maintaining dimensions 18,18 and 4mm. (Fig 3)
- Machine angular surface using 45 double angle cutter both the sides.

Fig 3



- Cut slot (shaded portion) maintaining dimensions 15,10 and 5 mm on both sides (Fig 4) using 10mm width side face cutter.

Fig 4



- Check the angular dimensions using vernier bevel protractor.
- Check the dimensions with vernier caliper.
- Remove the burrs.

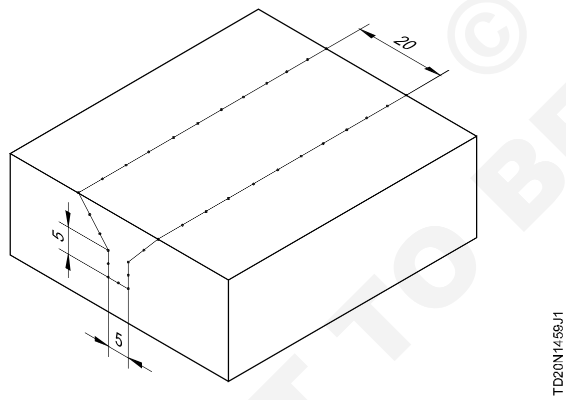
Skill Sequence

Mill angular surface on horizontal milling machine

Objective: This shall help you to
- **mill an angular surface on a horizontal milling machine.**

Mark the workpiece as per drawing. Punch witness marks on the lines. (Fig 1)

Fig 1



Mount a plain machine vice on a horizontal milling machine such that the vice jaws remain parallel to the column.

Select pair of parallel blocks which will lift the workpiece, bringing the top surface of the workpiece above the vice jaws.

Clamp the workpiece in the machine vice.

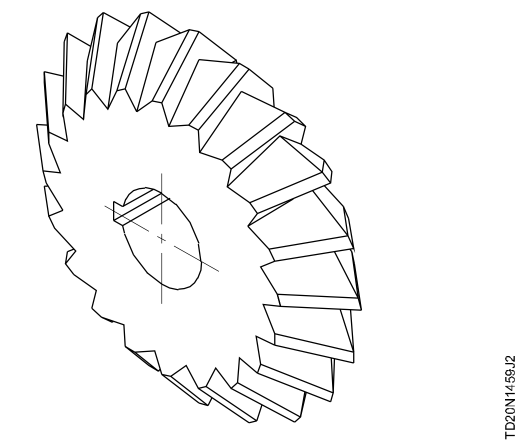
Select an angular milling cutter.

Selection of the angular milling cutter depends upon the angle to be milled.

There are 90°, 60° equal angle cutters. And 45°,30° single side angle cutters.

Here select 90°equal angle cutters. (Fig 2) The cutter thickness should be more than the width of the 'V' groove.

Fig 2



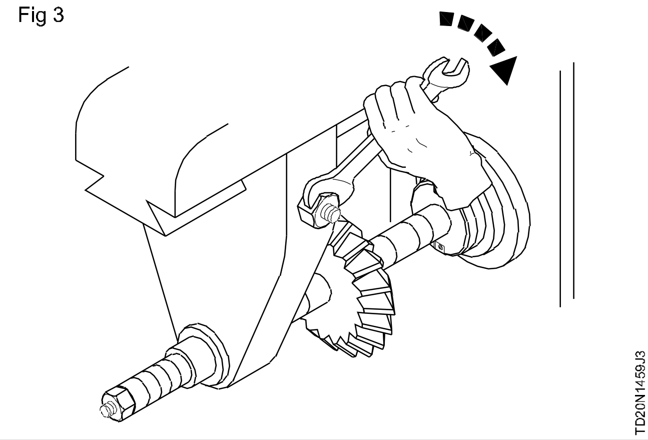
Ensure that the cutter is sharp and undamaged.

Select and mount the long arbor on the horizontal milling machine spindle.

Mount an equal angle cutter of 90° on the long arbor. (Fig 3)

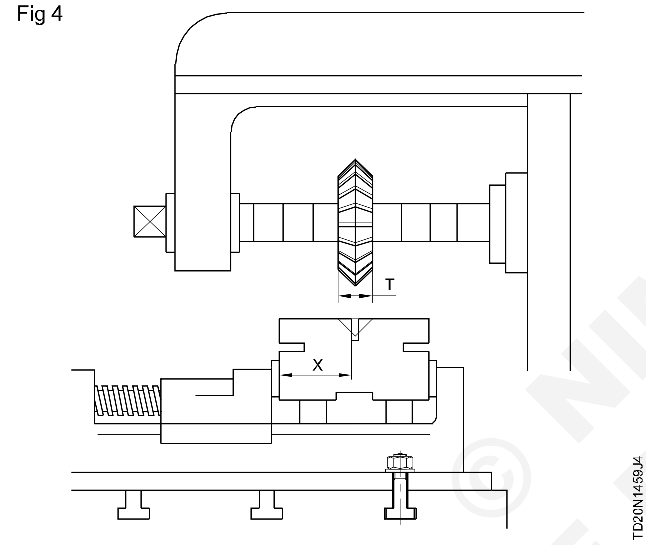
Calculate the r.p.m for the given material and cutter. Set the nearest lower speed and feed available on the machine.

Fig 3



Use hand feed in vertical, longitudinal and cross directions to position the workpiece such that the cutter is close to the top surface of workpiece. (Fig 4)

Fig 4



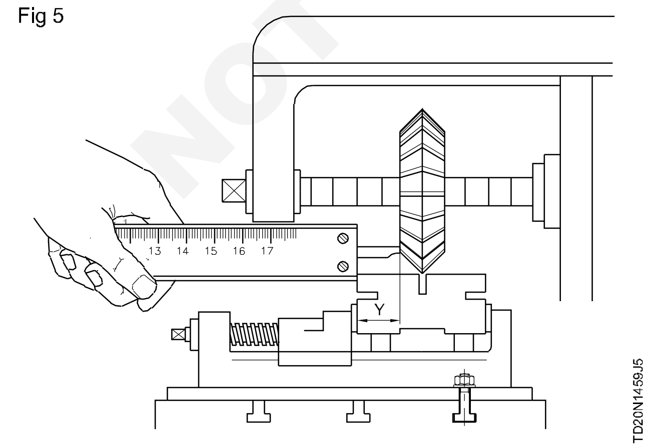
Measure the thickness of the cutter (T).

Find out the centre distance of the ‘V’ groove from the edge[X].

Now Y = X - T/2.

Set the Y distance on the depth gauge or vernier caliper. (Fig 5)

Fig 5

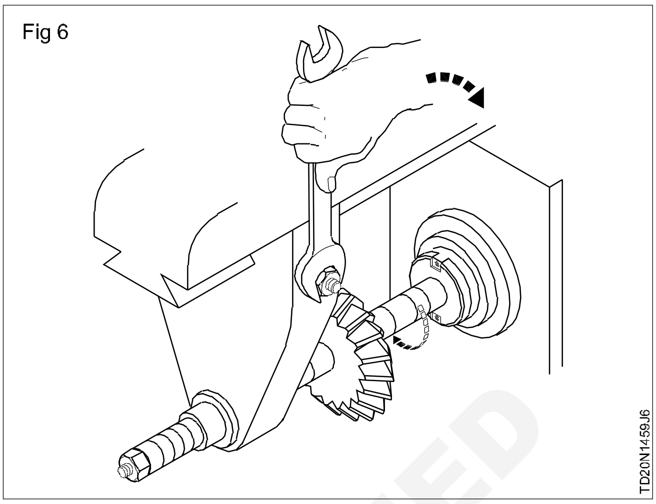


Use the cross - hand feed and adjust the workpiece such that the cutter surface and the workpiece edge are at [Y] distance.

Ensure the dimension with a vernier caliper depth gauge.

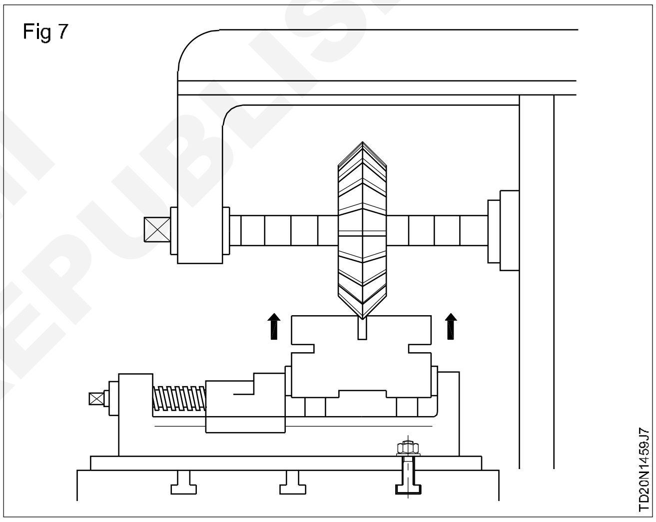
Set the spindle to clockwise direction. (Fig 6)

Fig 6



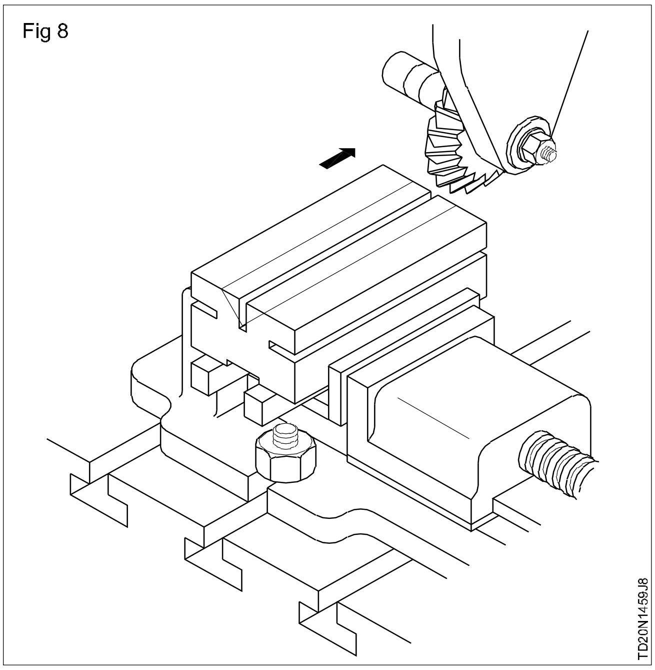
Set the datum at the top surface using tissue paper. (Fig 7)

Fig 7



Move the table to the left hand side to clear the cutter and workpiece. (Fig 8)

Fig 8



Unlock the vertical slide.

Set the depth of cut of 2 mm by vertical hand feed.

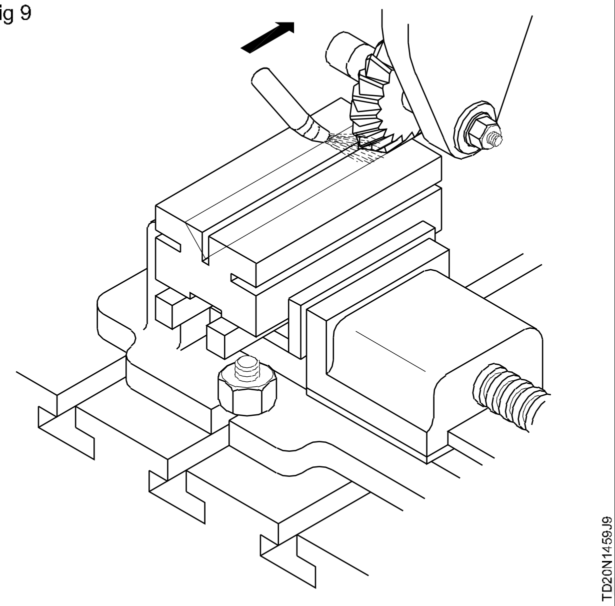
Lock the vertical slide.

Adjust the coolant nozzle and start the coolant pump.

Start the machine spindle.

Move the table to the right hand side slowly and mill the groove by rotating the longitudinal hand wheel manually. (Fig 9)

Fig 9

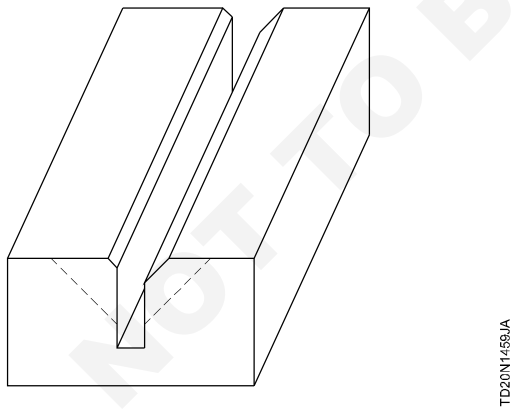


Stop the spindle.

Move the table to the left hand side to clear the cutter from the workpiece.

Check the position of the ‘V’ groove layout for any error. (Fig 10)

Fig 10



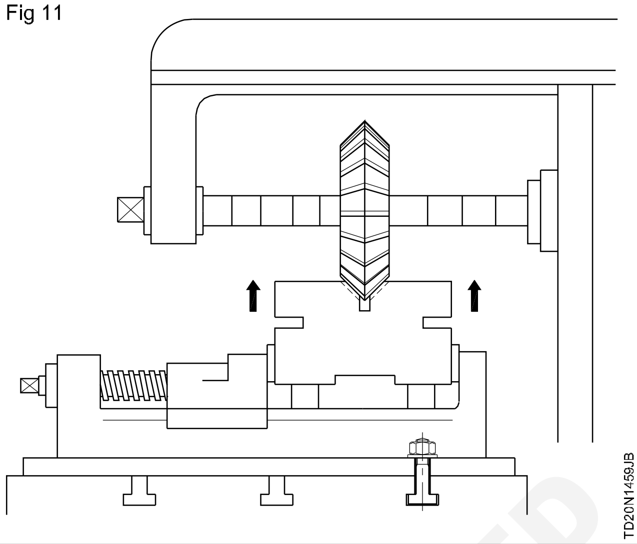
Adjust the cross -side to correct the error.

Lock the cross - slide.

Unlock the vertical slide and set final depth by rotating the vertical slide manually. (Fig 11)

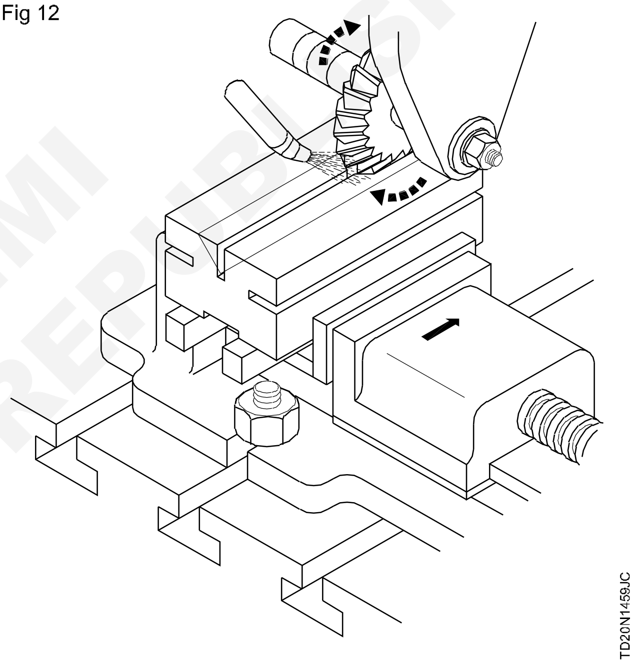
Lock the vertical slide.

Fig 11



Start the machine spindle and mill the ‘V’ groove. (Fig 12)

Fig 12



Apply automatic feed if your machine permits. If not, apply manual feed.

Stop the machine spindle.

De - clamp and deburr the sharp edges at the milled surface.

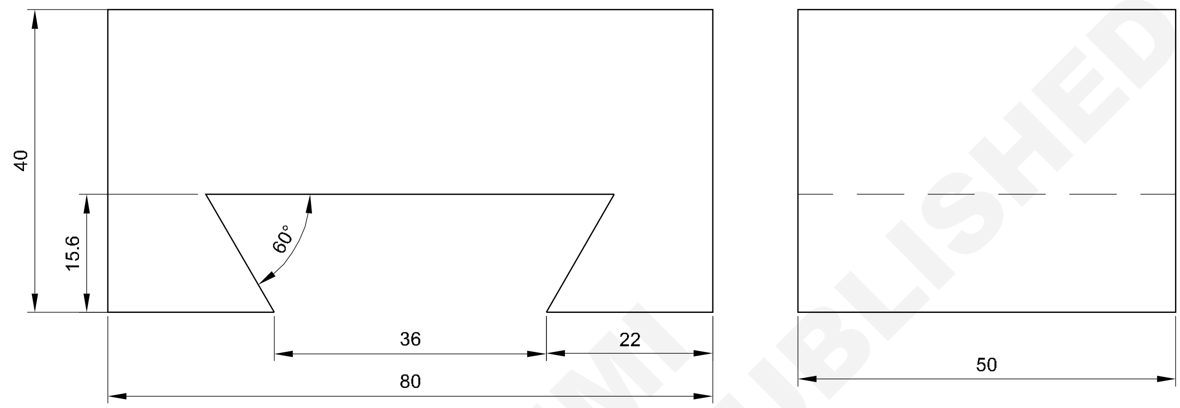
Check the ‘V’ groove for the following parameters.

- Central position
- Depth of groove

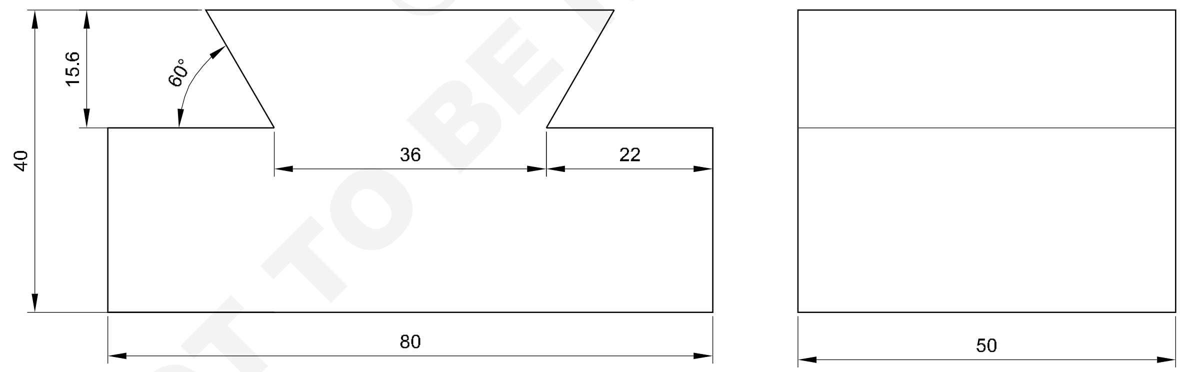
Be thoroughly familiar with the placement of the stop lever.

Dove tail milling

Objectives: At the end of this exercise you shall be able to
- **lay out the job as per the drawing using vernier height gauge and vernier bevel protractor**
- **mount and align the job with respect to the cutter**
- **mill the internal and external dovetails to an accuracy of ± 0.05 mm**
- **check the dimensions of the internal and external dovetails using rollers and assemble it.**



PART - A (FEMALE)



PART - B (MALE)

2	A PRE MACHINED BLOCK - 80x50x46	-	CAST IRON	-	B	
1	A PRE MACHINED BLOCK - 80x50x40	-	CAST IRON	-	A	1.4.60
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**DOVE TAIL MILLING**	DEVIATIONS ±0.02 mm	TIME
		CODE NO. TD20N1460E1	

Job Sequence (Part 'A')

- Check the premachined block size.
- Mark the dovetail as per drawing.
- Calculate the r.p.m for the selected cutter and set it.
- Set a end mill cutter with collet chuck on vertical machine spindle.
- Set the workpiece on the machine vice.
- Set the datum on the top surface of the block using tissue paper.
- Cut the slot 36 x 15.6mm between the dovetail marking.
- Set the dovetail cutter for clockwise direction on vertical milling machine by changing end mill cutter.
- Set the datum on the bottom surface of the slot using tissue paper
- Set the vertical surface also by touching the edge of the dovetail cutter 60° x 25 mm shank dia.
- Cut first side and then another side cut of the dovetail with dovetail cutter.
- Check the size ofdovetails with rollers and vernier caliper.

Job Sequence (Part 'B')

- Check the premachined block size.
- Mark the dovetail as per drawing.
- Calculate the r.p.m for the selected cutter and set it.
- Set the end mill cutter on vertical milling machine spindle.
- Set the block on the vice of vertical milling machine.
- Touch the vertical surfaces of the block by end mill cutter and cut shoulders 13x15.6mm both side of the block.
- Set the dovetail cutter for clockwise direction on vertical milling machine changing end mill cutter.
- Set the datum on the surface of the block using tissue paper.
- Set the vertical surface by touching the edge of the dovetail cutter 60° x 25 mm cut first side dovetail then another side of the dovetail upto punch line.
- Check the dovetail by rollers method.
- Fit the job with female part of the dovetail (Part A).

Skill Sequence

Mount dovetail cutter and mill external and internal dovetail on vertical milling

Objective: This shall help you to
- **mill internal and external dovetail.**

Internal dovetail

Mark the job as per drawing and put witness marks.

Mount the machine vice such that the vice jaws are perpendicular to the column.

If the length of the job is more than the width of the vice jaws, mount the vice such that the jaws are parallel to the column. And if the length of the job is smaller than the width of the vice jaws mount the machine vice such that the jaws are perpendicular to the column.

Hold the job in the machine vice on the pair of parallel blocks (C) such that the bottom surface remains 5 to 6 mm above the vice jaws (B). (Fig 1)

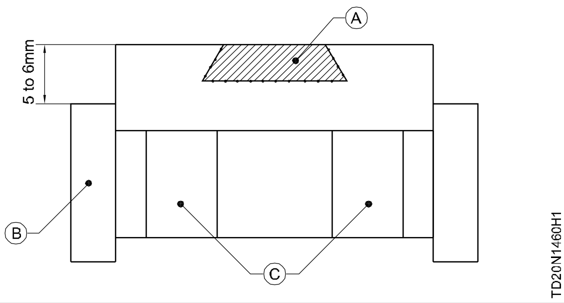
Mill the central slot by the end mill cutter.

Select the dovetail cutter to suit the dovetail groove dimensions.

Mount the collet chuck on the vertical milling machine.

Hold the dovetail cutter in the collet chuck and tighten it using a hook spanner.

Fig 1



Ensure that the cutter is sharp and not damaged.

Ensure that the cutter is not gripped overhung.

Calculate the r.p.m. for selected cutter and set it.

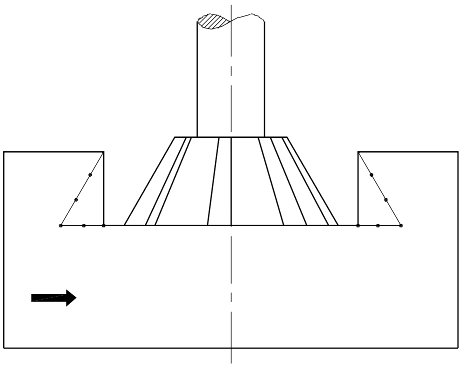
Calculate the feed per minute to the selected cutter, and set to the nearest lower feed available.

Set the cutter for clockwise rotation.

Position the workpiece so that the cutter is over the previously milled slot.

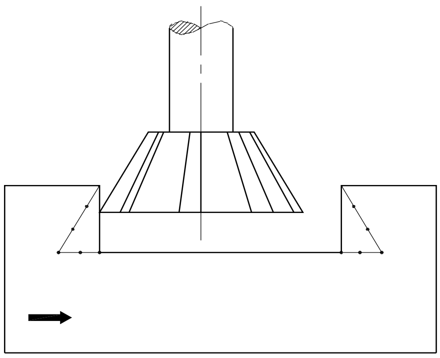
Set the datum on the bottom surface of the slot (Fig 2) using tissue paper.

Fig 2



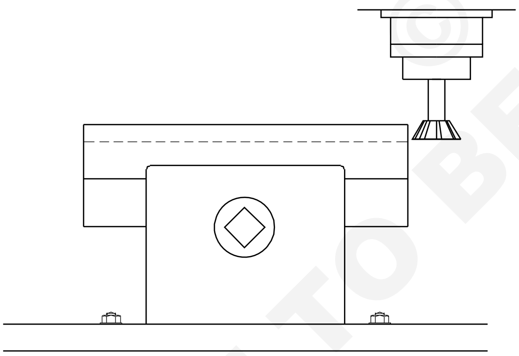
Set the datum at the vertical face of the slot by touching the edge of the dovetail cutter. (Fig 3)

Fig 3



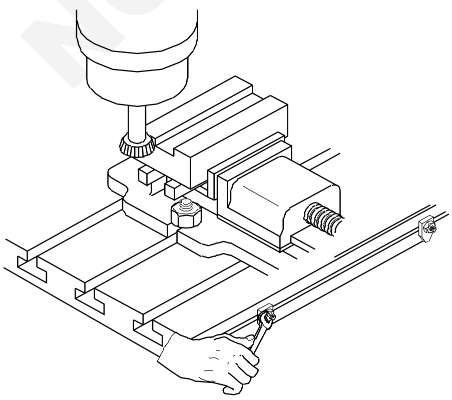
Clear the workpiece from the cutter by moving the longitudinal slide. (Fig 4)

Fig 4



Set the longitudinal feed stops so that the cutter will clear each end of the workpiece. (Fig 5)

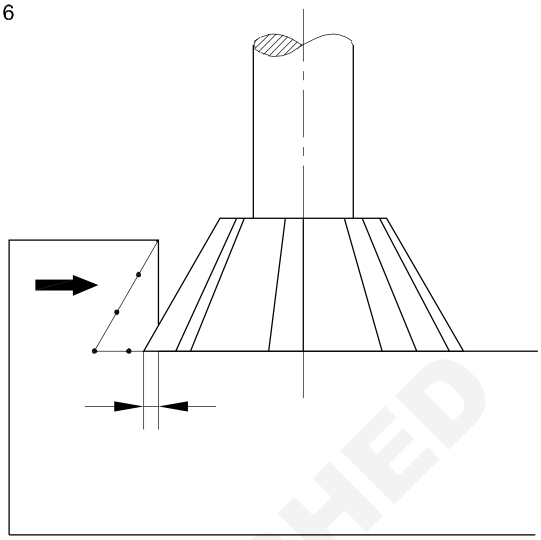
Fig 5



Unlock the cross-slide.

Use the hand cross-feed and set the depth of cut for the first roughing cut of about 1to 5 mm. (Fig 6)

Fig 6



Lock the cross-slide.

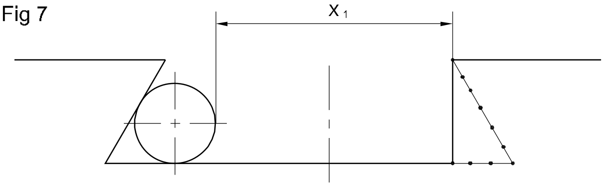
If the depth to be milled is more than 5 mm then rough out the dovetail in two passes.

Engage the longitudinal feed and mill the dovetail. When the feed stops, stop the spindle. Return the table to the starting position.

Calculate the roller dimensions using 6 mm rollers.

Check the dimension (X_1) by vernier calipers and roller. (Fig 7)

Fig 7



Find out the difference between the actual dimension and the calculated dimension.

Unlock the cross slide.

Adjust the cross slide so as to get the calculated dimension.

Lock the cross slide.

Start the spindle.

Move the longitudinal slide manually and mill the dovetail.

Stop the spindle.

Bring the workpiece to its original position.

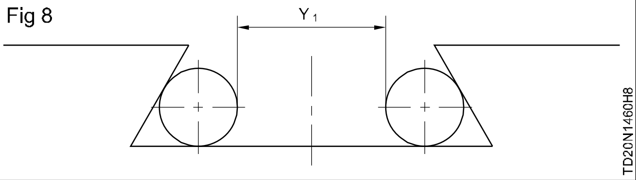
Check the roller dimensions (X_1) and confirm.

Mill the opposite dovetail following the required steps.

Ensure that the feed is from the opposite side of the previous one to adopt up-milling.

Check (Y_1) dimension by using a 6 mm dia. roller and vernier caliper. (Fig 8)

Fig 8



External dovetail

Mark the job as per the drawing and put witness marks on it.

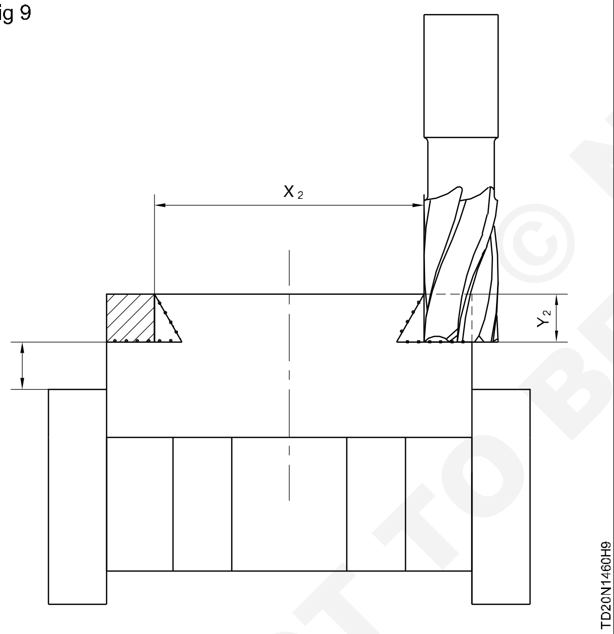
Mount the plain milling vice on the vertical milling such that the vice jaws are perpendicular to the column.

Hold the job in the vice on a pair of parallel blocks. The bottom surface of the dovetail marking should remain 5 to 6 mm above the vice jaws.

Mount the collet chuck on the vertical milling machine.

Mill the hatched portion using an end mill cutter by maintaining X_2 and Y_2 dimension to suit the dovetail groove dimensions. (Fig 9)

Fig 9



Mount the dovetail cutter in the collet chuck and tighten.

Calculate and set the r.p.m. and feed for the dovetail cutter.

Set the datum at the bottom surface of the step and the vertical face of the step, using tissue paper.

Take the workpiece to the left side to clear from the cutter.

Apply a depth of cut (0.2 to 0.3 mm) depending upon the material to be rough cut by rotating the cross-slide.

Lock the cross-slide.

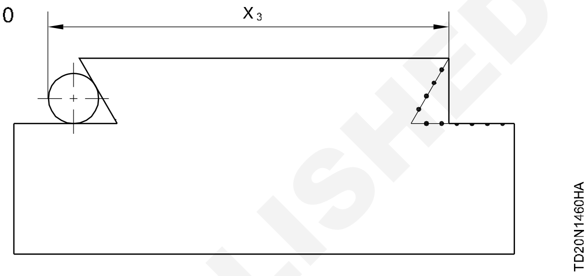
Move the longitudinal slide slowly towards the rotating cutter and rough cut the dovetail on one side.

Stop the spindle.

Calculate the roller dimension X_3 and check it with a vernier caliper.

Use a 6 or 8 mm dia. roller. (Fig 10)

Fig 10



Adjust the cross-slide to get the correct calculated dimension.

Start the spindle.

Move the longitudinal slide towards the cutter and finish the dovetail.

Check X_3 dimension by using ∅6 or ∅8 roller.

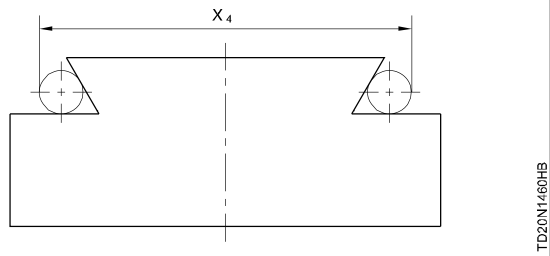
Calculate X_4 dimension using a ∅6 or ∅8 roller.

Mill the opposite dovetail following the necessary steps.

Check X_4 dimension by using ∅6 or ∅8 dia. roller. (Fig 11)

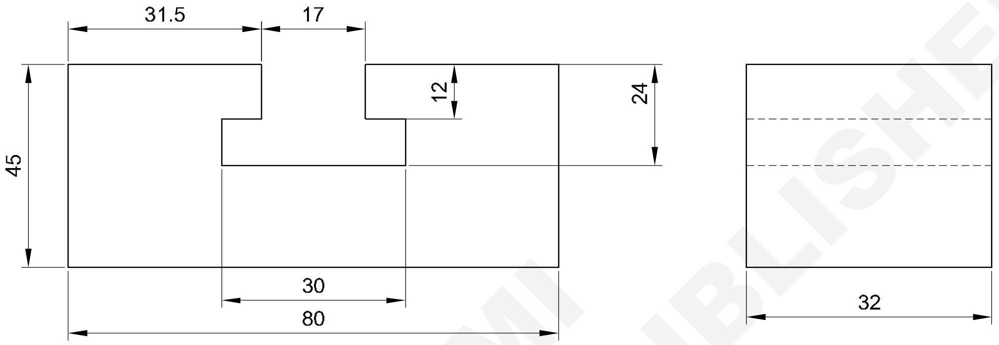
Deburr and remove the job.

Fig 11

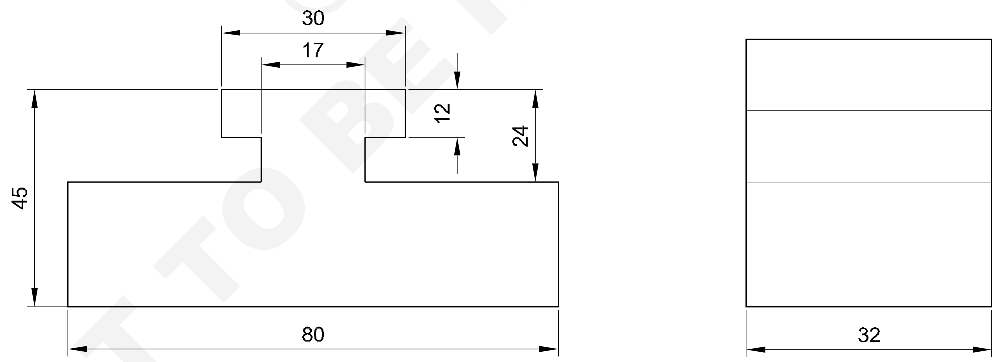


Tee slot milling

Objectives: At the end of this exercise you shall be able to
- **layout male and female 'T' slot using vernier height gauge**
- **mill female 'T' slot on vertical milling machine**
- **mill male 'T' slot**
- **match part 'A' with part 'B'.**



PART - A (FEMALE)



PART - B (MALE)

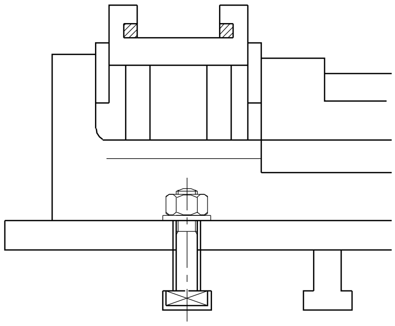
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
2	A PRE MACHINED BLOCK - 45x32x80	-	Fe310	-	B	
1	A PRE MACHINED BLOCK - 45x32x80	-	Fe310	-	A	1.4.61

SCALE 2:1	MAKE 'T' SLOT FITTING (MALE & FEMALE) ON MILLING MACHINE WITH AN ACCURACY ±0.02MM	DEVIATIONS ± 0.02MM	TIME :
		CODE NO. TD20N1461E1	

Job Sequence (Part 'A')

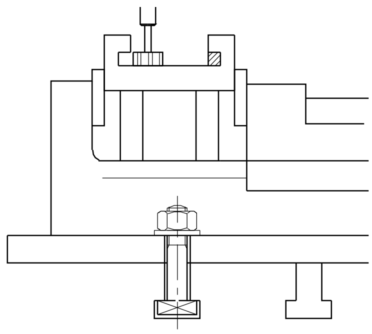
- Mark the 'T' slot as per the drawing.
- Mount and align the vice on the vertical milling machine.
- Hold the job in the vice supported with parallel blocks. (Fig 1)

Fig 1



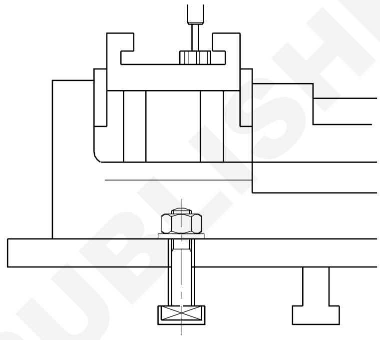
- Mount the 'T' slot cutter Ø25 x12 mm on the machine with an adapter and collets.
- Align the job for 'T' slot milling with respect to the cutter. (Fig 2)
- Set the spindle nearest to 275 r.p.m.
- Mill the 'T' slot on the left side to size. (Fig 2)
- Deburr and check the size.

Fig 2



- Mill the 'T' slot on the right side to size. (Fig 3)
- Deburr and check the dimensions of the 'T' slot with a telescopic gauge and a 25 to 50 mm outside micrometer.

Fig 3



Job Sequence (Part 'B')

- Mark the 'T' as per drawing
- Mount and align the vice on the horizontal milling machine.
- Hold the job in the vice supported with parallel blocks.
- Cut the both side of the block by side and face milling cutter on horizontal milling machine.
- Mount a 'T' slot cutter of Ø25 x 12 mm into the vertical milling machine spindle
- Set the r.p.m near to 275
- Mill the 'T' on the vertical milling machine check the dimension of the 'T' slot with vernier caliper and out side micrometer.
- Fitting the job with the female part of part A.

Skill Sequence

Mill a 'T' slot on vertical milling machine

Objective: This shall help you to
- **mill a 'T' slot on a vertical milling machine.**

Mark the workpiece as per drawing. Remove burrs if any.

Mount the plain machine vice on the table with its jaws parallel to the column.

Keep the workpiece on a pair of parallel blocks such that the workpiece is above the jaws of the vice.

Clamp the workpiece.

Mill the slot as per the given dimension.

Select a 'T' slot cutter to match the 'T' slot dimensions to be cut.

Check if the cutter is sharp and undamaged.

Select a collet of the same size as that of the cutter shank and set the cutter in the chuck. (Fig 1)

Start the spindle for a while to ensure that the cutter is running true and in the correct direction, and stop the spindle.

Set the datum for the top and side using tissue paper. (Figs 2 and 3)

Fig 1

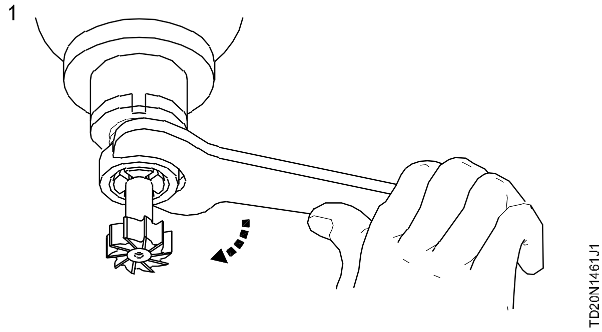


Fig 2

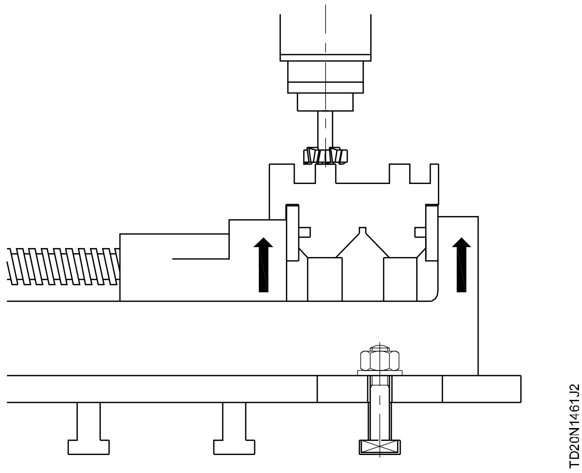
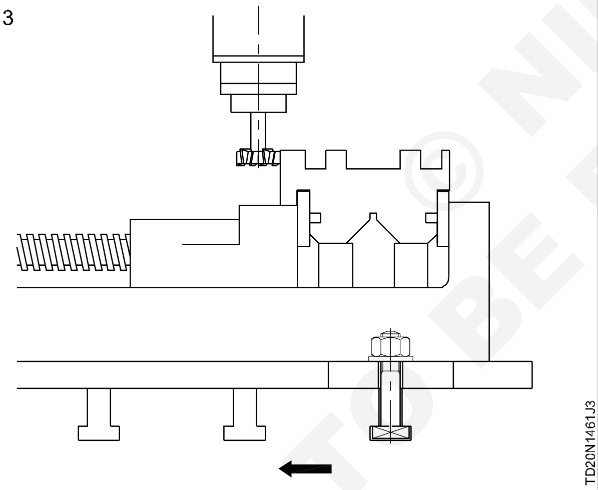


Fig 3



Set the spindle speed and table feed.

Move the table to clear the cutter from the workpiece by using the hand cross-feed after fixing the datum.

Position the table to correct dimension (L+D/2), using hand cross-feed, so that the cutter is into the centre of the 'T' slot. (Fig 4)

Lock the cross-slide.

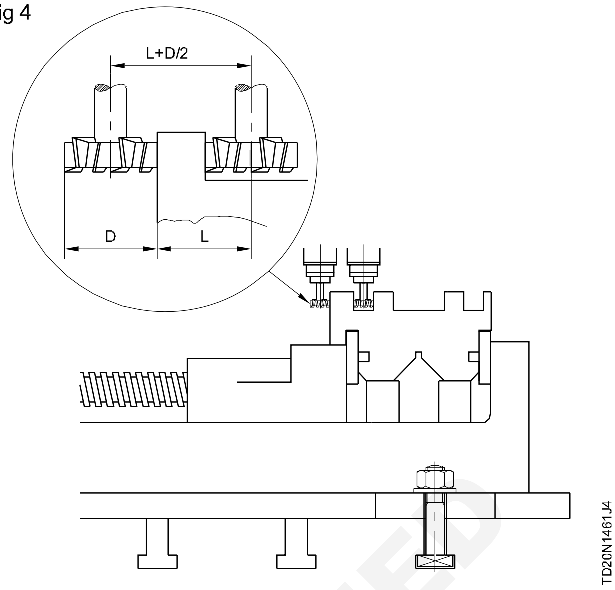
Use a vertical slide and raise the table to bring the cutter to correct depth of the 'T' slot.

Lock the vertical slide.

Set the longitudinal feed stops so that the cutter will clear both ends of the workpiece.

Start the spindle.

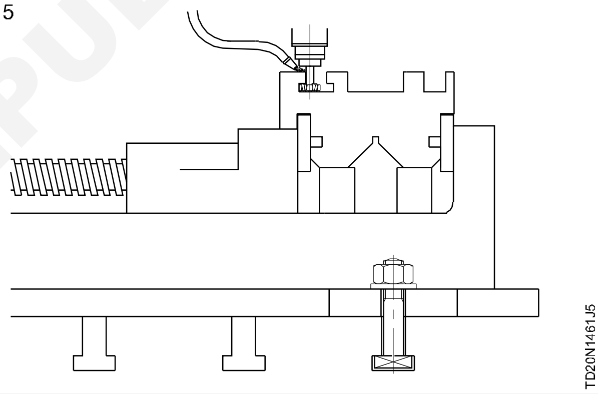
Fig 4



Ensure that the guard is in position and safety goggles are put on. This is required for personal safety.

Use longitudinal hand feed and move the table slowly until the cutter begins to cut the workpiece. (Fig 5)

Fig 5



Ensure that the table movement is gentle and smooth to avoid damage to the cutter.

Start the coolant.

Engage the longitudinal feed and mill the slot.

Ensure that the chips collecting in the slot are carried away by the flow of the coolant while the slot is being cut. In 'T' slot milling blocked chips may cause breakage of the cutter.

Stop the spindle when the feed stops.

Clear away the chips.

Deburr the slot.

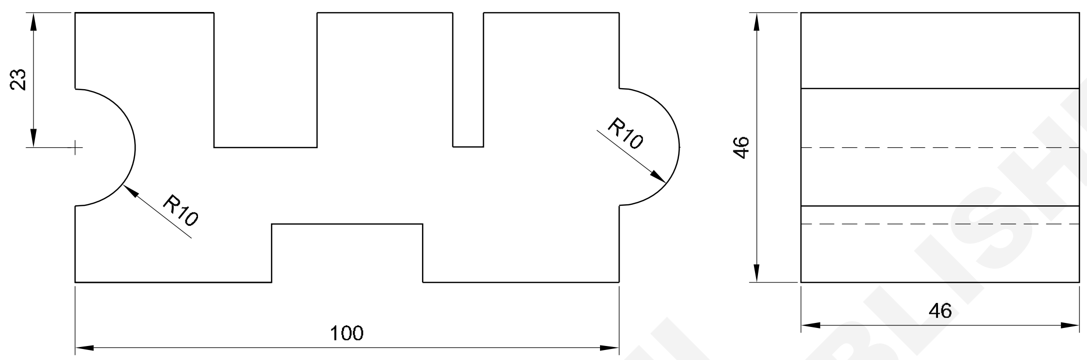
Clear the slot and check the dimension.

Repeat the process, if more than one slot are to be milled.

Put all the oily rags, used to wipe the machine, in a metal container that can be closed tightly.

Concave and convex milling

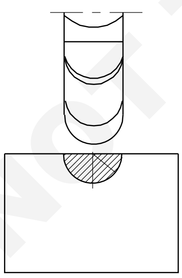
Objectives: At the end of this exercise you shall be able to
- **layout the job as per the drawing using a vernier height gauge and spring divider**
- **align the workpiece with respect to the cutter**
- **mill a concave and convex surface and check with radius gauge.**



Job Sequence

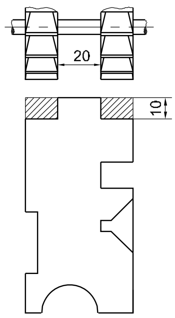
- Check the dimensions of the job.
- Lay out the job for concave milling as per drawing.
- Hold the job in the vice for milling the concave surface.
- Mount the convex milling cutter of Ø90 x 10R x 27mm bore on the arbor and set the spindle speed to 60 r.p.m.
- Align the job such that the cutter width is symmetrical with the centre line of the concave marking, and mill the concave surface. (Fig 1)
- Deburr the job and measure by a radius gauge.
- Set and hold the job for convex milling.
- Mount two side and face milling cutters of the same size 100 x 15x 27 mm bore with a spacer of 20 mm in between for straddle milling. Set the speed to 90 r.p.m.
- Align the job with reference to the cutter and mill the job by straddle milling to a depth of 10 mm in two passes of 5 mm each (Fig 2)

Fig 1



TD20N1462H1

Fig 2



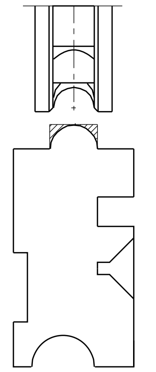
TD20N1462H2

		1.4.72 →				
1	100x50x50mm	← 1.4.58	FE310	–		1.4.62
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**CONCAVE AND CONVEX MILLING**	TOLERANCE ± 0.02	TIME
		CODE NO. TD20N1462E1	

- Replace the cutter with a concave milling cutter Ø90x 10R x 27 mm bore and set the speed at 60 r. p. m.
- Align the job with reference to the cutter and mill the convex surface (Fig 3)
- Deburr the job and measure by a radius gauge.

Fig 3



Skill Sequence

Mill a form concave surface on plain milling

Objective: This shall help you to
- **mill a concave surface on plain milling machine.**

Mark the job as per drawing and put witness marks.

Mount a plain machine vice at the middle of the table on the milling machine such that the jaws are perpendicular to the column.

Hold the workpiece in the vice on a pair of parallel blocks such that the profile marking is 10 to 15 mm above the vice jaw surface.

Select a convex milling cutter which suits the form of the workpiece.

Ensure that the cutter is sharp and undamaged.

Calculate the r.p.m. feed per minute and set on the machine.

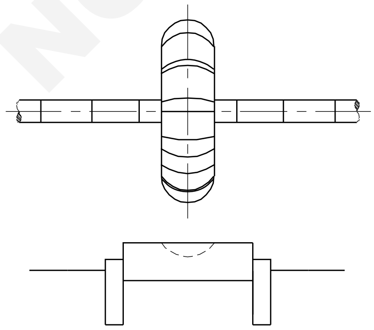
Mount the selected cutter on the arbor of the plain milling machine.

Set the nearest lower r.p.m. for form cutters.

If a higher r.p.m. is set chatter marks may appear on the cut surface.

Bring the job to the central position with respect to the centre. This is to be done visually, and be confirmed after cutting a shallow cut. (Fig 1)

Fig 1



If any error is found adjust the work suitably.

Clear the job from the cutter to do ‘up-milling’. The job is to be fed against the cutter rotation. In form milling, if the surface in contact is more, more cutting force is required. In down-milling the cutter may tend to slip over the job.

Lock the cross-slide.

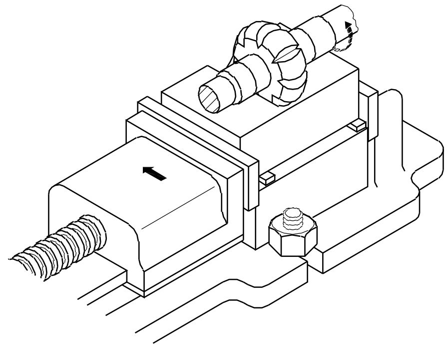
Apply 1 mm depth of cut and lock the vertical slide.

Set the coolant nozzle and start the coolant pump.

Start the spindle.

Feed the job against the cutter rotation by rotating the longitudinal slide. (Fig 2)

Fig 2



Stop the machine.

After completion of the first cut, return the workpiece to its original position. Confirm the form whether if it is in the centre as per the marking. If it is not do the necessary adjustment by moving the cross- slide and lock the cross slide.

Unlock the vertical slide.

Apply 4 to 5 mm depth of cut for rough milling.

Start the spindle.

Rough out the form by feeding the longitudinal slide against the rotation of the cutter.

Stop the spindle.

Clear the job from the cutter.

Unlock the vertical slide.

Apply the necessary depth of cut.

Reset the feed at a low rate of [0.02 to 0.03 mm/tooth] for finishing the profile.

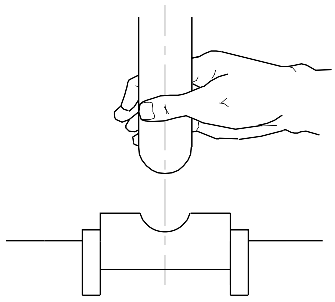
Start the spindle.

Bring the job near to the cutter longitudinally and set the automatic feed.

After completion of the cut, disengage the auto-feed and stop the machine, deburr and check the form of the profile using a gauge. (Fig 3)

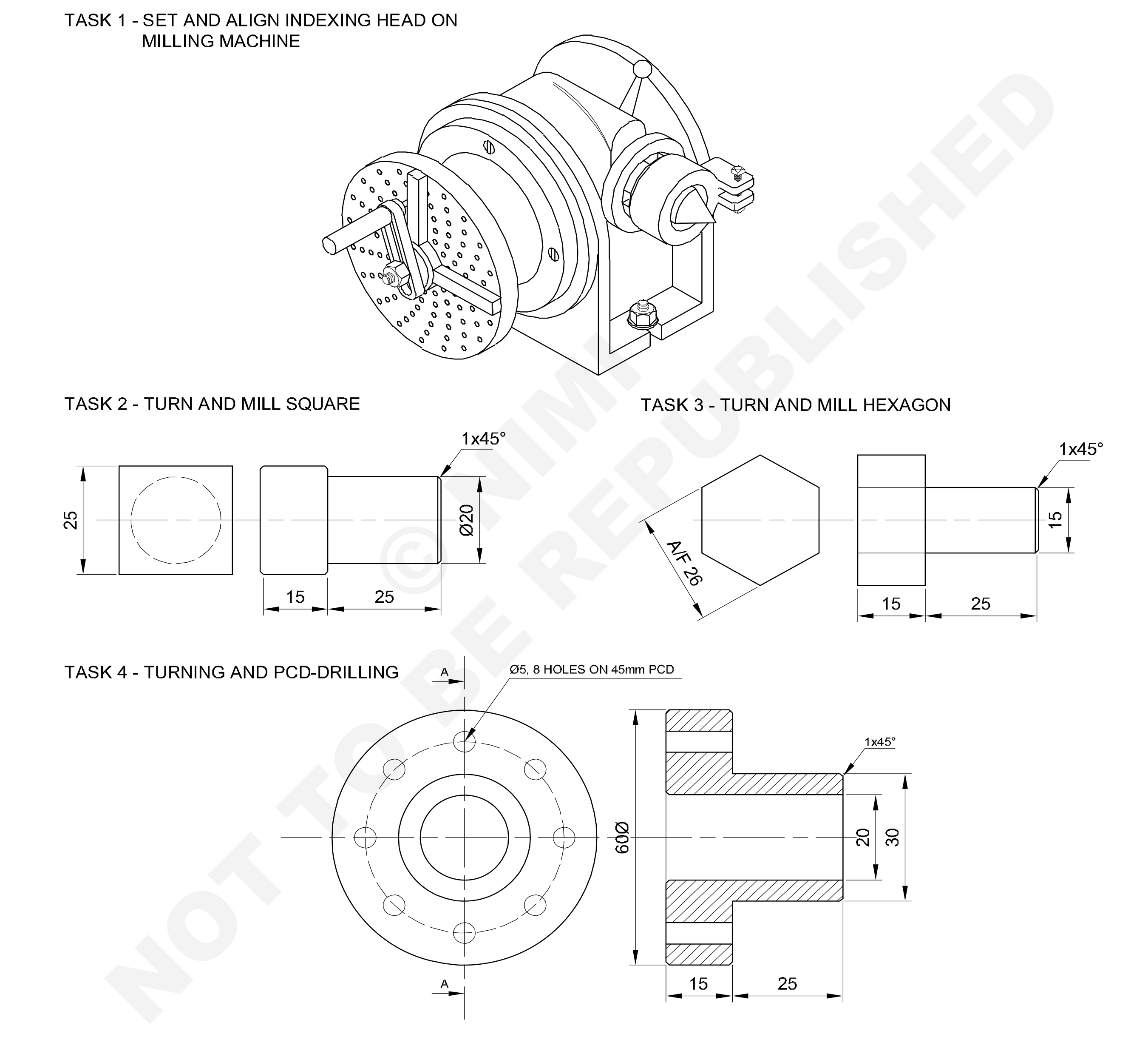
De-clamp the job.

Fig 3



Simple index practice

Objectives: At the end of this exercise you shall be able to
- **set and align indexing head on vertical milling machine turn and mill square by direct indexing method**
- **Turn and mill hexagon by simple indexing method**
- **turn and drill on pitch circle diameter.**



NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
1	Ø65x45	-	Fe310	-	-	
1	Ø55x45	-	Fe310	-	-	
1	Ø40x45	-	Fe310	-	-	1.4.63

SCALE NTS

SIMPLE INDEXING PRACTICE

TOLERANCE ±1 | TIME

CODE NO. TD20N1463E1

Job Sequence

Task 1 : **set and align indexing head on milling machine**

A dividing head is used to hold workpieces that must be machined with accurate division on the circumference.

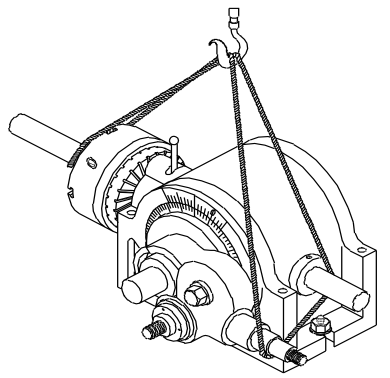
The universal dividing head is the type most commonly used.

Clean the table top and Tee slots thoroughly.

Insert a rod of suitable length through the head spindle to protrude 75 to 100 mm at each end and tighten the chuck on the bar.

Sling the head with a strong rope. (Fig 1)

Fig 1



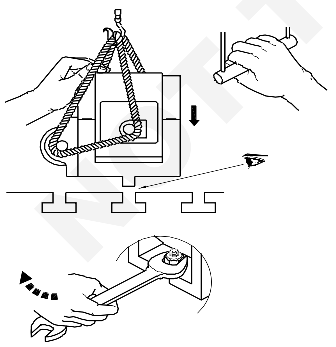
Lift the indexing head with help of crane and position it on the milling machine table.

The rope should be free from wear. The crank hook should be at the centre of the head to balance the head. Stand clear when lifting to avoid any injury to you in case of an accident.

Clean the base of the dividing head.

Lower the head gently and engage the tenons in the table slot and tighten the securing bolt. (Fig 2)

Fig 2



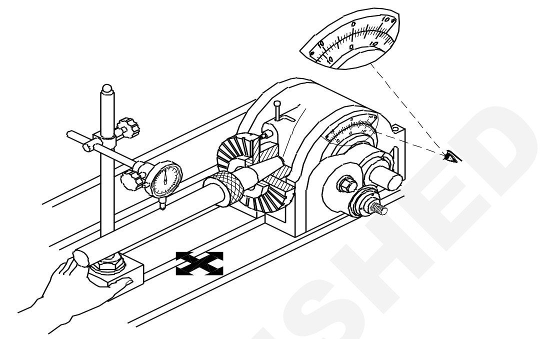
Keep your hands clear of the bottom of the dividing head when lowering the head.

Setting head horizontal

'Zero' the index scale.

Insert the tapered shank test-bar in the spindle, making sure both are clean. (Fig 3)

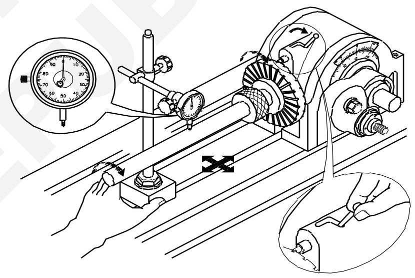
Fig 3



Disengage the worm from the worm-wheel for rapid indexing.

Set the dial indicator as shown in Fig 4.

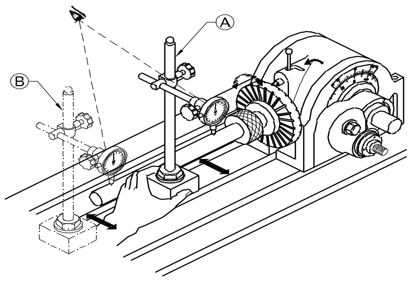
Fig 4



Rotate the head manually to ensure the bar is running true.

Take a reading with the dial indicator as near the spindle nose as possible. (Fig 5)-A

Fig 5



Take the reading at the opposite end of the bar. (Fig 5)-B Note any variation.

In case of any variation, remove the dial indicator and slightly loosen the locking nuts at the back of the head.

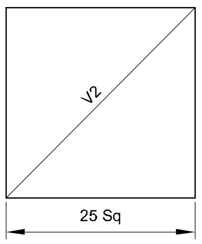
Tap lightly with a soft hammer in the required direction and check again.

— — — — — — — —

Task 2 : **Turn and mill square by direct indexing method**

- Check the raw material for its size
- Turn the blank as per drawing and maintain its dimesion
- Calculate the diagonal for the given size of square (Fig 1)

Fig 1



Diagonal of square = side x 2

= 25x 1.4.1

=35.35 rounded of to 36.00mm

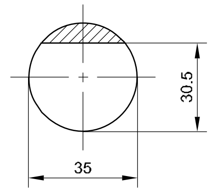
- Turn the step diameter to 36.00 mm
- Clean the machine table and dividing head from dirt and burrs
- Set the dividing head for direct indexing with 24 holes plate
- Calculate the indexing move movement of 4 quall parts

  Formula = 24/N

  =24/N

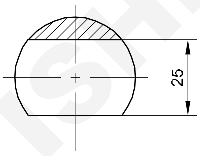
  = 6 holes on 24 direct indexing hole plate
- Hold the workpiece on 20 mm to mill square
- Set the indexing plate to zero position
- Mount 20mm end mill on the vertical milling machine spindle
- Set the RPM closer to 300
- Set the datum at the highest point on diameter 36.00mm
- Mill the flat and maintaining the size to 30.5mm (Fig 2)

Fig 2



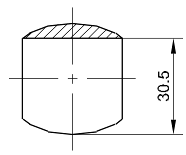
- Index the work piece to 180° that is 12 holes on direct index plate.
- Mill the flat surface and maintain the size to 25mm (Fig 3)

Fig 3



- Index the work piece to 90° that is 6 holes on 24 holes direct index plate
- Mill the flat surface with same depth of cut maintain the size to 30.50mm (Fig 4)

Fig 4



- Index by 180° that is 6 holes on 24 holes direct index plate.
- Mill the flat surface to size 25mm
- Deburr, check and confirm the dimension of the square

— — — — — — — —

Task 3 : **Turn and mill hexagon by simple indexing method**

- Check the raw material for its size.
- Turn the blank as per draawing and maintain its dimesions
- Calculate the diagonal for the given size of hexagon

  Diagonal of hexagon = 2x side of hexagon

  = 2x26

  =52mm
- Clean the table and dividing head from durt and burrs and set and align the dividing head on the vertical milling machine.
- Set the dividing head for simple indexing which the indexing plate of 21 hole circle.
- Calculate the indexing move movement of 6 quall parts by simple indexing method.

  Formula = 40/N

  = 40/6

  = 6x4/6=2/3

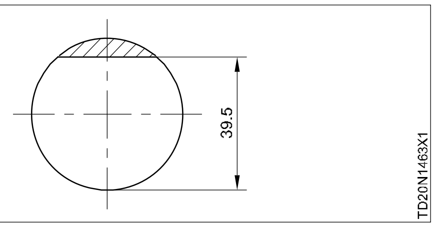
  =2x7/3x7

  =14/21

  Indexing movement for 6 divissions is
- Complete rotation of the crank and 14 holes on 21 hole circle plate
- Set the index plate and sector arm for the indexing 14 holes on 21 hole circle plate

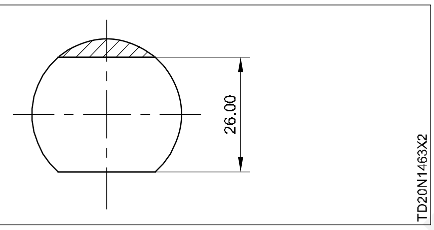
- Hold the workpiece on 15mm to mill hexagon.
- Set the index position to zero position
- Mount 20mm end mill on the vertical milling machine spindle.
- Set the RPM closer to 300
- Set the datum at the highest point on diameter 52.00mm.
- Mill the flat and maintain the size to 39.00mm.(Fig 1)

Fig 1



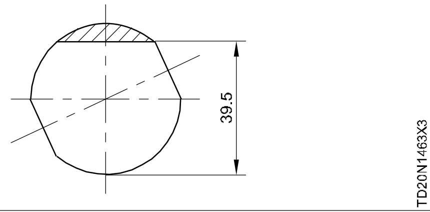
- Index the work piece for 3 times that is 180° or 20 full roatation of the crank
- Mill surface flat maintain the dimension 26.00mm (Fig 2)

Fig 2



- Index for next side (60°)
- Mill surface flat maintain the dimension 39.00mm (Fig 3)

Fig 3



- Once again index for 180°
- Mill the flat surface maintain the size 26.00mm
- Repeat the above procedure and complete the hexagon
- Deburr, check and confirm the dimension of the square.

— — — — — — — —

Task 4 : **Turn and PCD drilling by angular indexing method.**

- Check the raw material for its size
- Turn the blank as per drawing and mainatin its diemsion
- Clean the machine table and universal dividing head from dirt and burrs
- Set and align the dividing head on the vertical milling machine in vertical position for PCD drilling
- Mount the centre drill with a help colect chuck
- Set the RPM close to 750
- Align centers of universal dividing head and spindle of vertical milling machine in one line
- Move the table (longitudinal movement) to half of the PCD that is 22.50mm
- Lock the table in both lingitudinal and tranverse movement.
- Calculate angular indexing movement for 8 equally spaced division

  Formula = 360/angle to be indexed

  = 360/45

  = 8

  8 complete rotation of the crank
- Set the sector arm pin in any number of holes circle plate and lock the indexing head and the sector arm
- Put on the machine and drill the centre drill to the required depth
- Unlock the indexing head and index to next hole posotion by rotating the crank handle to 9 full roatation and lock it
- Drill the centre drill to the required depth
- Similarly drill all other holes
- Fix 5mm parallel shank drill in colect chuck
- Set rpm close to 500
- Index and drill 5mm in all center drilled position
- Similarly cahmfer all the hole with conubtersink tool
- Remove the work piece, clean and apply oil and preserve it for evaluation.

— — — — — — — —

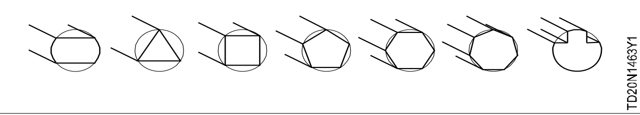
Skill Sequence

Milling square and hexagon

Objective: This shall help you to
- **mill flats on shafts.**

Some shapes of slots are shown in Fig 1 which are normally done by direct indexing.

Fig 1



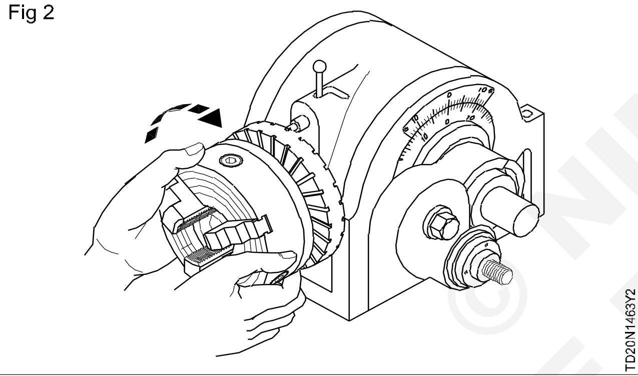
Mount and align the index head on the vertical milling machine.

Ensure that the index head is mounted at the extreme left side on the machine table to facilitate easy approach for cutting.

Set the index head for direct indexing.

Mount a three-jaw chuck on the index head. (Fig 2)

Fig 2



Hold the job in the three-jaw chuck at the index head and lock it.

The portion to be milled should be 10 to 20 mm away from the face of the chuck jaw to avoid damage to the cutter and the chuck.

Select a suitable diameter of an end mill cutter or shell end mill cutter to cut the entire surface in one pass.

Mount the collet chuck and end mill cutter or stub arbor with a shell end mill cutter on the spindle nose of the machine. (Fig 3)

Calculate and set the r.p.m. and feed per minute for the above selected diameter of the cutter.

Set a lower range of speed and feed to avoid metal cutting problems.

Engage the locking pin into the index plate and note the number on the plate.

Bring the workpiece in line with the cutter by moving the cross-slide. Raise the top surface of the job 5 to 6 mm above the face of the cutter. (Fig 4)

Fig 3

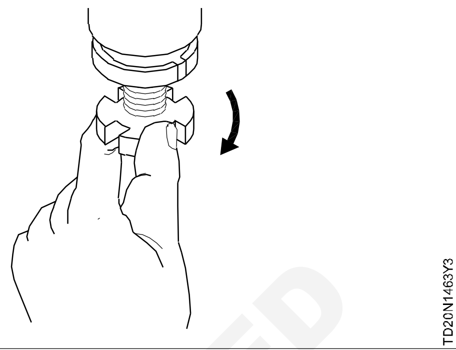
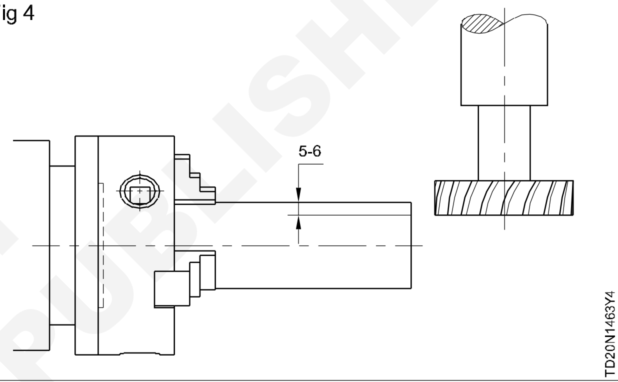


Fig 4



Start the spindle.

Move the longitudinal slide towards the cutter till the cutter just touches the end face of the workpiece.

Stop the spindle.

Set the datum for the longitudinal slide.

Clear the cutter by moving the cross-slide.

Move the longitudinal slide to the required length of the square to be milled, and lock it.

Lower the vertical slide to clear the cutter.

Start the spindle.

Bring the workpiece under the cutter by moving the cross-slide.

Raise the vertical slide slowly manually. As soon as the cutter touches the top surface of the workpiece, stop the spindle.

Clear the workpiece from the cutter by moving the cross-slide.

Set the graduated dial to zero at the vertical slide.

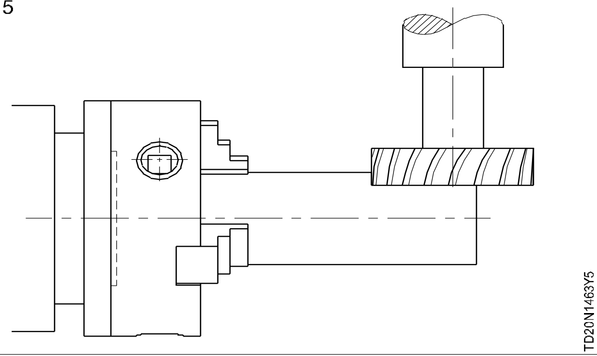
Apply a 0.5 mm depth of cut and lock the vertical slide.

Set the coolant nozzle.

Start the spindle and the coolant pump.

Move the cross-slide and mill the first side by hand feed. (Fig 5)

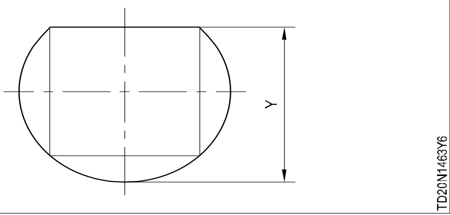
Fig 5



Stop the spindle.

Bring the workpiece to the original position. Check the Y-dimension with an outside micrometer. (Fig 6)

Fig 6



Unlock the vertical slide and apply a depth of cut equal to the difference in dimension Y and the measured dimension, and lock.

Start the spindle.

Move the cross-slide and mill the first side of the square.

Stop the spindle.

Bring the workpiece to its original position.

Remove the locking pin of the index plate.

Unlock the index head spindle.

Index the work by 180°.

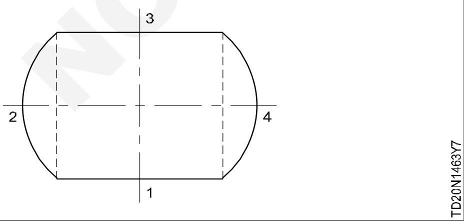
Insert the locking pin in the hole at the index plate (12 holes). Lock the index head spindle.

Start the spindle.

Move the cross-slide manually and feed it slowly. (Reduce the depth of cut if it is more)

Complete the milling of the opposite side (side 3). (Fig 7)

Fig 7



Stop the spindle.

Bring the workpiece to its original position and check flat to flat.

Unlock the index head and index the workpiece by 90° (6 holes).

Insert the index pin into the hole of the index plate and lock the index head.

Start the spindle.

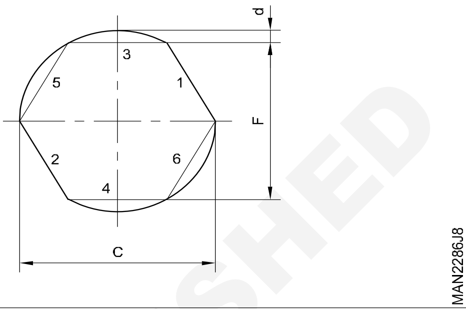
Move the cross-slide and feed it manually, and complete the milling of the 2nd side.

Repeat the above procedure to mill the 4th side.

Check the job for size.

For milling a hexagon the same procedure is adopted and the sides are milled as numbered in Fig 8.

Fig 8

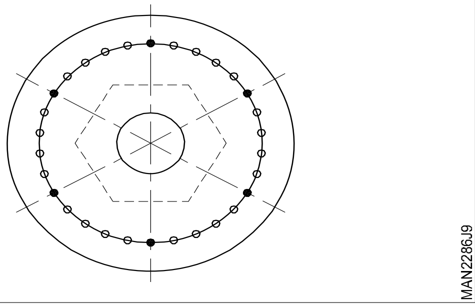


To determine the depth of cut use the following formula.

The depth of cut(d) is $\frac{C-F}{2}$ (Fig 7)

If the 30 hole circle is used, the division is as shown in Fig 9.

Fig 9

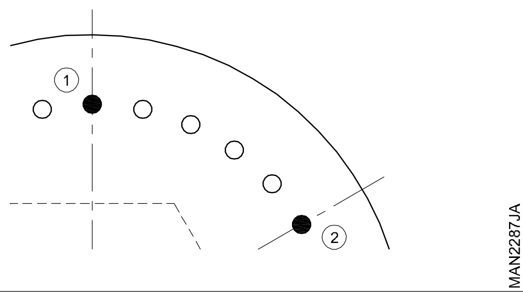


The hexagon is shown in the centre with a dotted line. To index from one side to the adjacent side, the crank is rotated to

$$\frac{30(\text{number of holes})}{6\,(\text{number of divisions})} = 5 \text{ holes}$$

That means that you place the pin of the crank into the fifth hole and pass over 4 holes. (Fig 10)

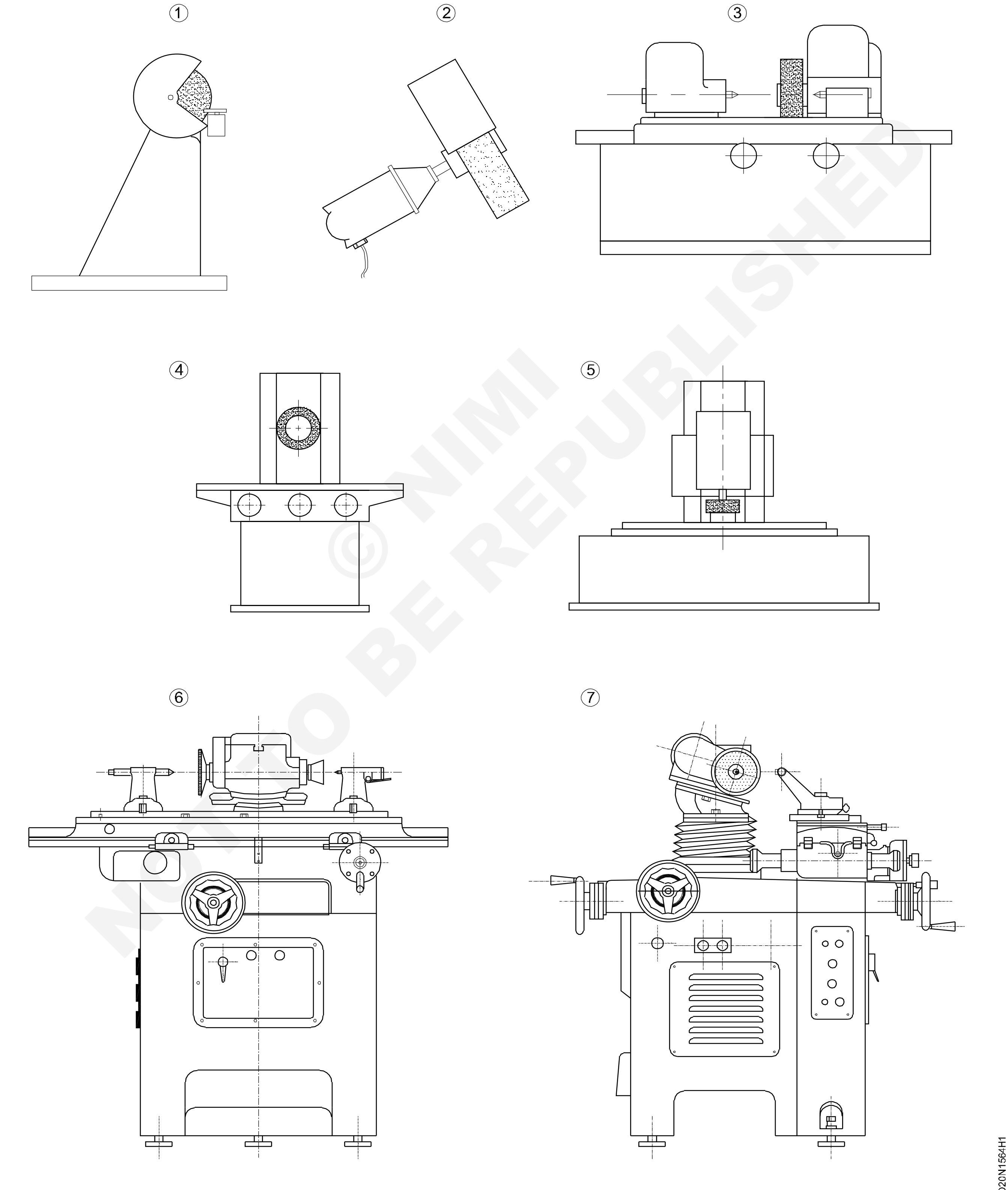
Fig 10



Identification of different types of grinding machines

Objective: At the end of this exercise you shall be able to
- **identify the different types of grinding machine.**

Fig 1



Job Sequence

Instructor should arrange to visit the difference types of grinding machines available in the ITI

- Trainees will note down the types of grinding machines in the ITI.
- Record it in table 1.
- Get it checked by the instructor.

Table 1

Sl.No.	Name of the machines	Remarks
1		
2		
3		
4		
5		
6		
7		

— — — — — — — —

Wheel balancing & truing

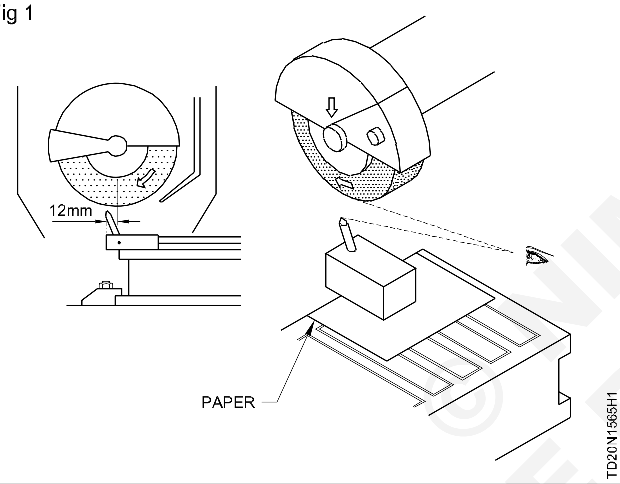
Objectives: At the end of this exercise you shall be able to
- **true the grinding wheel**
- **balance the grinding wheel.**

Job Sequence

TASK 1**: True the grinding wheel**

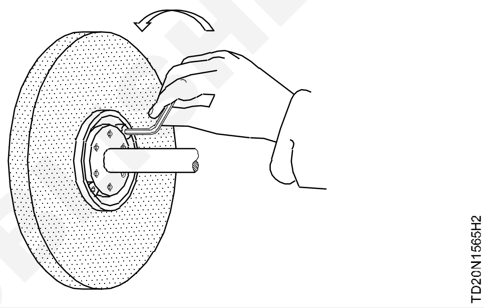
- Clean the grinding machine table
- Select and hold the dresser in proper holder
- Mount the holder with dresser in grinding machine table (Fig 1)

Fig 1



- Start the wheel head and allow it to run, for the machine to attain normal working temperature.
- Dress the wheel on the periphery (Fig 2)

Fig 2



Dress the sides if the wheel diameter exceeds 250mm. Apply a small in feed of the diamond until eccentricity of the wheel is removed.

- Stop the machine.

TASK 2: **Balancing a grinding wheel**

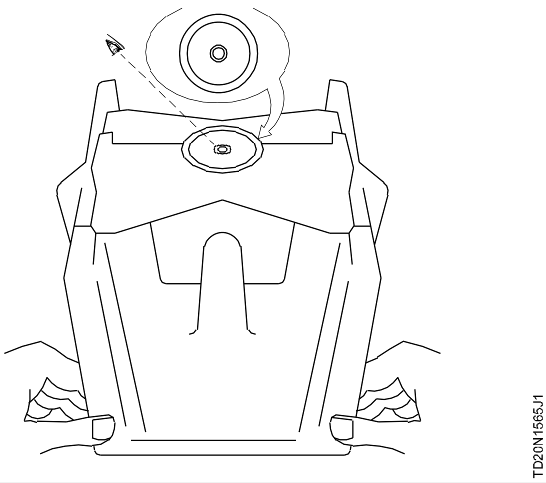
- Mount the Wheel on the machine.
- Remove the balance weight.
- Clean the internal and external cones
- Place the wheel unit on the spindle nose, and tighten the lock-nut
- Replace the Wheel guard
- Remove the Wheel guard and lock-nut
- Screw on the collet Extractor and remove the wheel assembly.

Use both hands when removing the wheel assembly. Take care not to knock on any machine part to prevent any damage to the wheel.

Preparing the balancing unit

- Lower the protection guards
- Place the levelling plate on the balancing stand. (Fig 1)

Fig 1

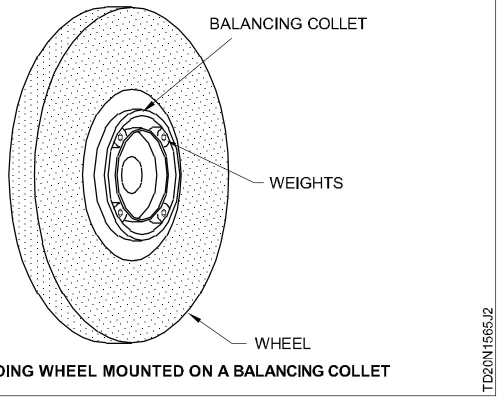


- Adjust the unit, using two knurled Screws on the base until the bubble in the levelling plate is concentric with the circle engraved on the glass.

Positioning Wheel on unit

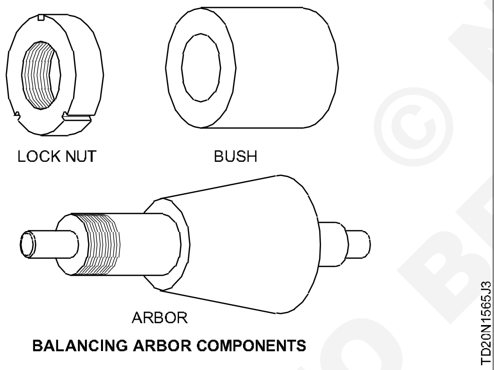
- Clean the bore of the unit (Fig 2) and the balancing Mandrel, (Fig 3) then mount the Wheel assembly on the mandrel. (Fig 4)
- Tighten the nut on the mandrel. (Fig 4a)
- Raise the protection guards.(Fig 4b)
- Place the wheel to be balanced on the top of the protection slides and lower gently on to the balancing stand. (Fig 4c)

Fig 2



GRINDING WHEEL MOUNTED ON A BALANCING COLLET

Fig 3



BALANCING ARBOR COMPONENTS

Balancing the wheel

- Visually ensure that the balancing mandrel is at right angles to balancing ways. (Fig 5a)
- Allow the wheel to revolve slowly, by its own momentum until stationary.
- Place a chalk mark at the bottom to indicate a heavy point. (Fig 5b)
- Turn the wheel 90° to the heavy point, and diametrically opposite. (Fig 5c&d)

Fig 4

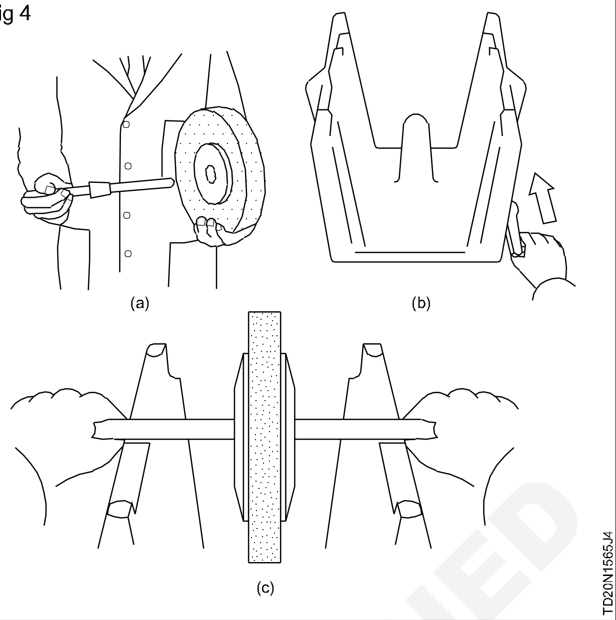
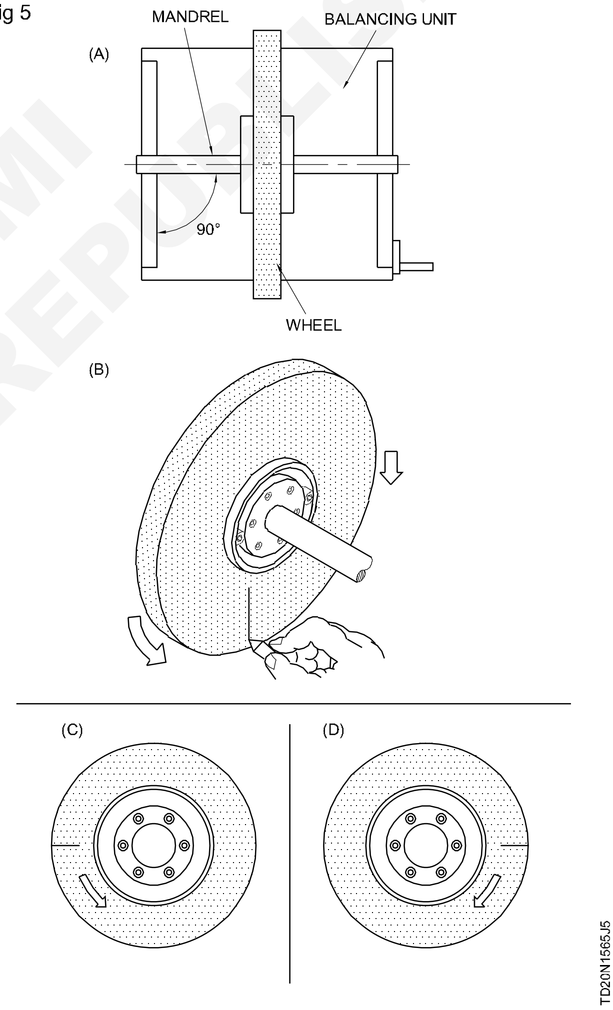


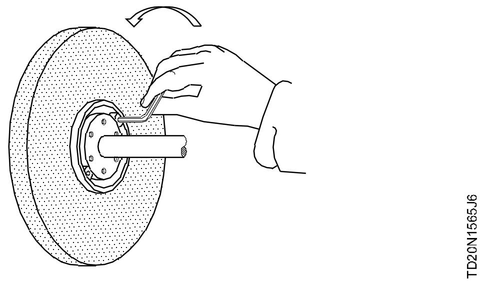
Fig 5



If the wheel finds the heavy points quickly, the balancing weights could be moved approximately 180°. (This indicates that the wheel is considerably out of balance). Move the weights equally towards the lighter side, approximately 3 mm at a time. Fig 6)

- Repeat until the assembly remains static in any position.
- Remount the assembly on the wheel head, replace the guard and re-dresss the wheel before putting it into further operation.

Fig 6



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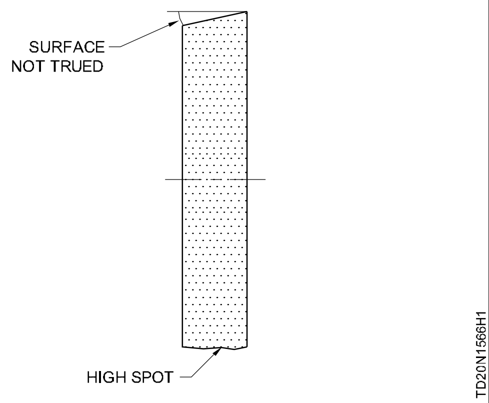
Dressing of grinding wheel

Objectives: At the end of this exercise you shall be able to
- **set the grinding wheel**
- **mount the holder with dresser.**

Job Sequence

- This operation is done after mounting the grinding wheel for removing any high spots on the face of the wheel with a diamond dresser. (Fig 1).

Fig 1

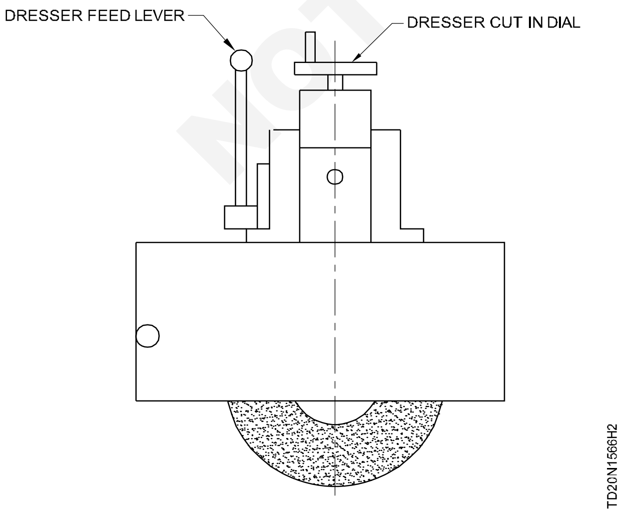


- The high spots are removed for uniform contact of the wheel over the job. Otherwise only the high spots on the wheel will contact the surface resulting in poor surface finish.
- Dressing is the operation of removing dull grains and metal particles from the cutting surface of a grinding wheel. This operation exposes sharp cutting edges of the abrasive grains to make the wheel cut better.

They are two method of dressing a grinding wheel for the surface grinder.

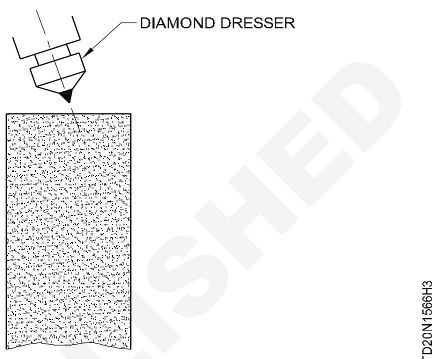
- Dressing of grinding wheel by grinding head dresser. (Fig 2)

Fig 2



- Dressing of grinding wheel by attached to holder. (Fig 3)

Fig 3



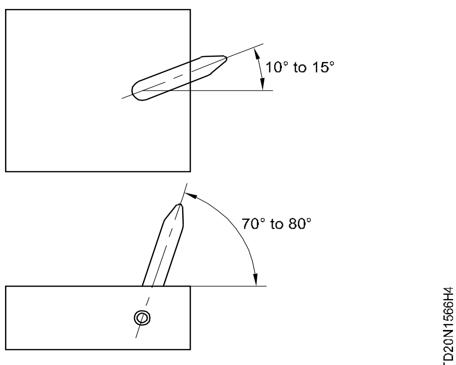
Dressing grinding wheel by grinding head dresser

- Start the motors for the grinding spindle and coolant.
- Open the cover of the grinding wheel, and shift the dresser to the centre of the grinding wheel as shown in Fig 2 by pulling the dresser feed lever to the front side.
- Turn the dresser cut in dial gently to let the dresser tip touch the perimeter of the grinding wheel.
- Restore the dresser feed lever to the original position and shut the cover of the grinding wheel.
- Set the depth of cut in the dresser by means of the dresser dial and carry out the dressing by operating the dresser feed lever. (The depth of cut for dressing is 0.015-0.025mm at a time, and the dresser feed speed is 250-500mm/min in case of the finish).

Dressing of grinding wheel by dresser attached to holder

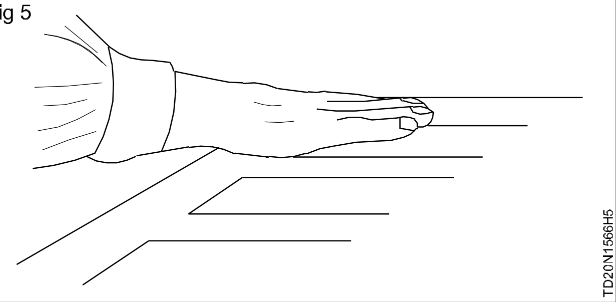
- Keep the dresser on the base as shown in Fig 4. This position helps to prevent chattering and the tendency to drag in during the dressing operation.

Fig 4



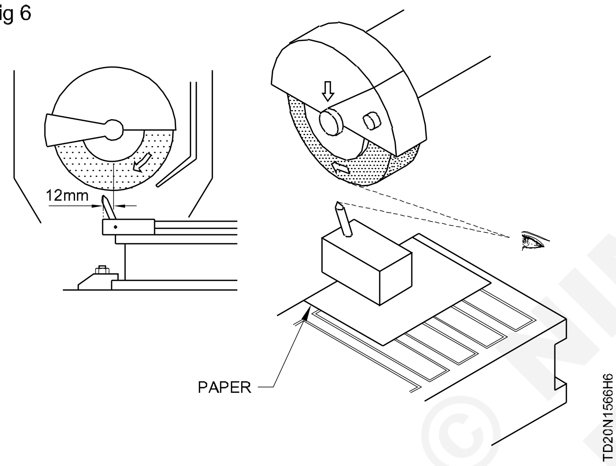
- Clean the magnetic chuck thoroughly with a cloth and then (Fig 5) feel for any dirt with your palm. Remove it if any.

Fig 5



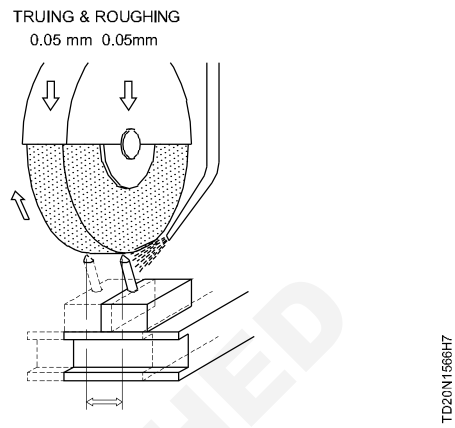
- Place the diamond on the last two magnetic poles on the left hand end of the magnetic chuck Paper should be placed between the diamond holder and the chuck is prevent scratching the chuck surface when removing the diamond holder. (Fig 6)

Fig 6



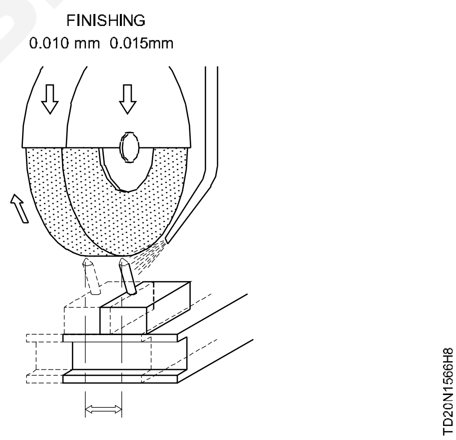
- The point of the diamond should be offset about 12mm from the grinding wheel centre line with reference to the direction of rotation of grinding wheel (Fig 6)
- Make sure that the diamond clears the wheel, then start the grinder.
- Lower the wheel until it touches the diamond.
- Move the diamond slowly across the face of the wheel. (Fig 7)

Fig 7



- Take light cuts (0.02mm) until the wheel is clean, sharp and is running true.
- Take a finish pass with 0.01mm across the face of the grinding wheel. (Fig 8)

Fig 8



Skill Sequence

Preparing surface grinding machine for grinding

Objective: This shall help you to
- **prepare the surface grinding machine for grinding operations.**

Preparing wheel spindle

It is very essential to check the different controls of the machine before actually starting the grinding operation. This will help the preparation of the machine for work. Check the following before the grinding operation.

Checking and oiling before start

Supply oil to all the lubricating points.(Consult your instructor)

Check that the button on the operation board is at the stop position. (Fig 1)

Check that the clutch of the table traverse feed handle is cut.

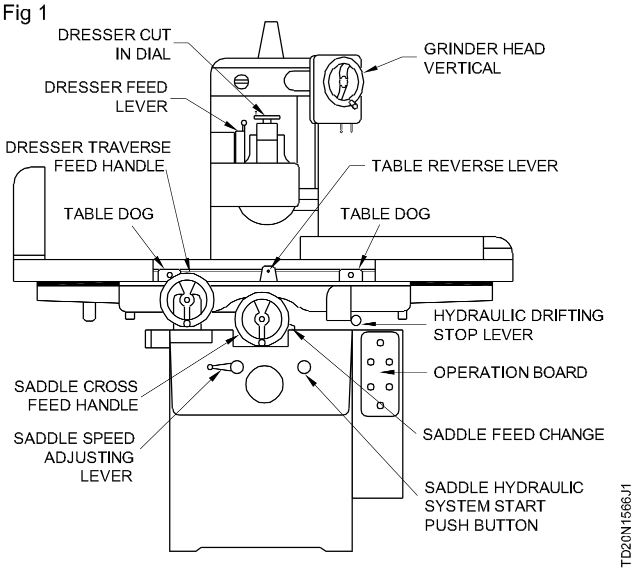
Check that the table dog is fixed.

Manual feed of table

Set the table reverse lever at the neutral position (Fig 1) Engage the clutch of the table traverse feed handle.

Move the table to the right and left by turning the handle clockwise and anticlockwise respectively.

Fig 1



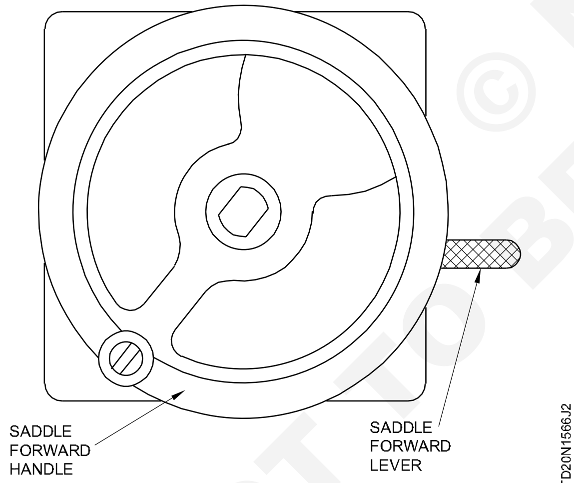
Manual and automatic feed of saddle

Move the saddle forward by turning the saddle cross-feed handle clockwise. (Fig 1)

Move the saddle backward by turning the saddle cross-feed handle anticlockwise.

Set in the automatic feed by turning the saddle feed change lever upward and downward. (Fig 2) (when the lever is pushed up or down, the saddle moves forward or backward respectively).

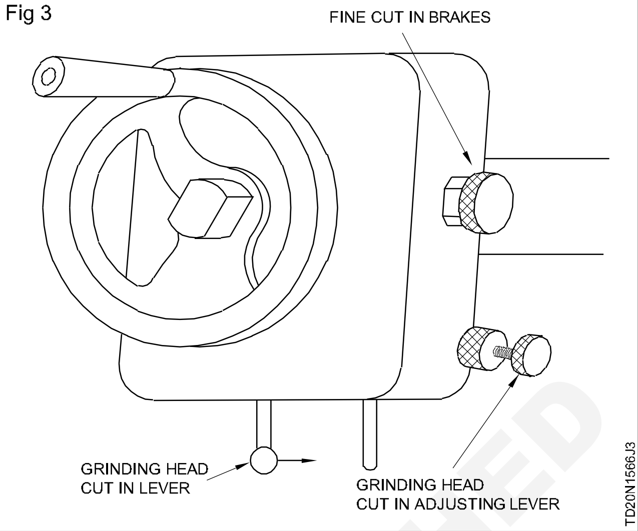
Fig 2



Raise and lower the grinding wheel.

Disengage the fine feed knob. (Fig 3)

Fig 3



Turn the grinding wheel elevation handle anticlockwise to lower the grinding wheel. (Fig 1)

Turn the grinding wheel elevation handle clockwise to raise the grinding wheel.

Hydraulic operation of table

Pull the table traverse feed handle to the front side to disengage the clutch.

Push the hydraulic driving push-button to drive the table hydraulically. (Fig 1)

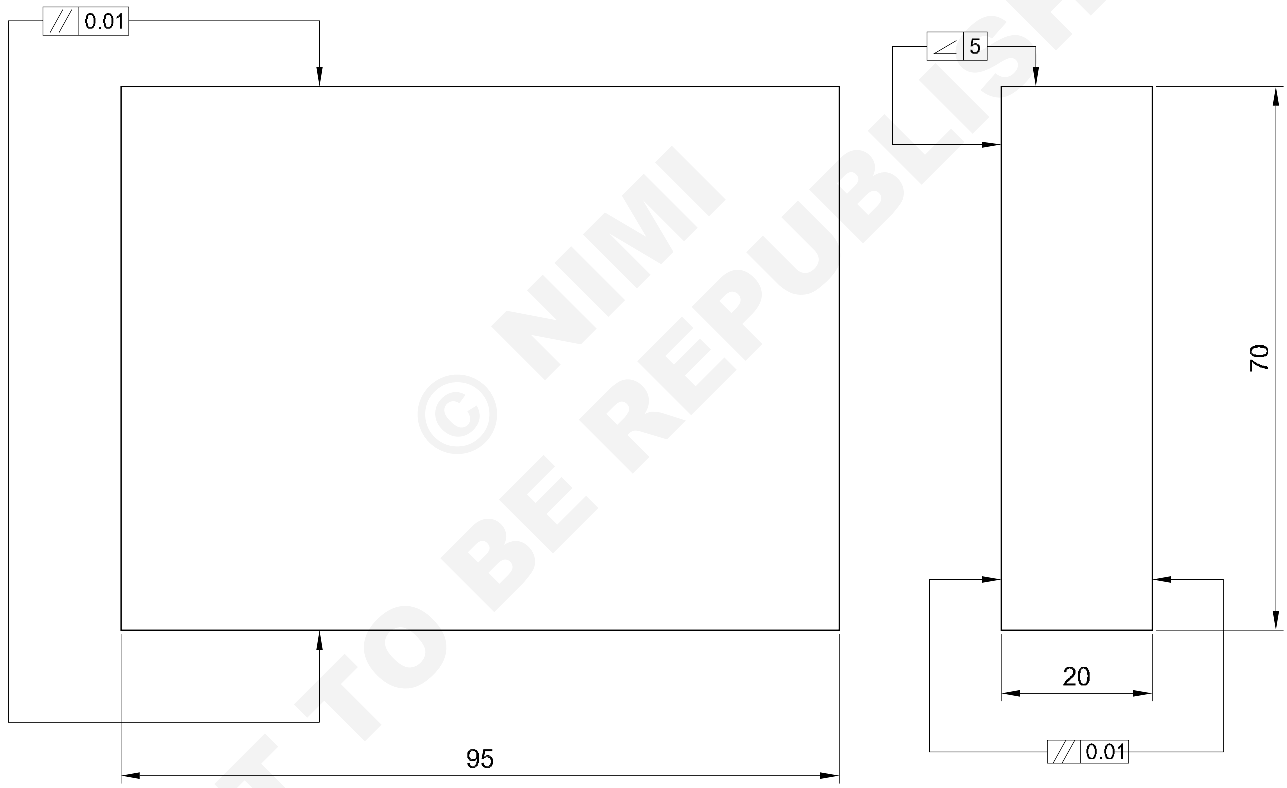
Adjust the table speed by the use of the table speed adjusting lever. (When the lever is pushed up, the table speed is increased. The speed is decreased by lowering the lever and the hydraulic drive is stopped at the lowest position of the lever).

Stop the hydraulic drive by pushing or pulling the hydraulic drive stop lever. (The table is stopped at the right end position).

— — — — — — — —

Grinding of block(six sides) by surface grinding machine with an accuracy of +/- 0.01 mm

Objectives: At the end of this exercise you shall be able to
- **grind parallel surface to an accuracy of ± 0.01 mm**
- **grind surface at 90° to an accuracy of ± 5'.**



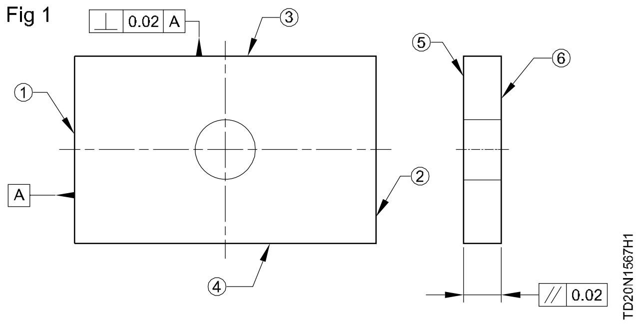
1	ISF 100X25X75	-	FE310	-	-	1.5.67
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	GRINDING SIX SIDES	DEVIATIONS ± 0.04	TIME :
		CODE NO. TD20N1567E1	

Job Sequence (Fig 1)

- Check the size of the raw material.
- Mill the workpiece to the given size providing necessary grinding allowances.
- Measure the job and determine the grinding allowance for each surface to be ground.
- Prepare the surface grinding machine grinding wheel (Plain disc) for grinding parallel surfaces using magnetic chuck, angle block and 'C' clamps.
- Place the job on magnetic chuck and skin grind surface one by one to clear the tool marks.
- Finish grind the thickness 20 mm and maintain parallelism 0.02 on sides 5 and 6.
- Set the job in angle block to grind face (1).
- After grinding face (1) set the job to grind face (2) and finish grind.
- Set the job, align face (1) perpendicular to face (3).

Fig 1



- Grind face (3) maintaining perpendicularity with respect to (A), datum within 0.2.
- Then grind face (4) parallel to face (3) and maintain dimension.
- Deburr the job with fine grain oil stone.
- Oil it and tag it for next operation.

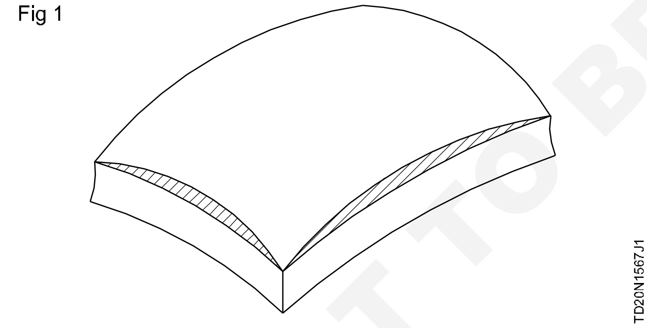
Skill Sequence

Grinding parallel surfaces

Objective: This shall help you to
- **grind parallel surfaces to an accuracy of ± 0.01.**

Always assume that the workpiece is distorted in one or more planes. (Fig 1) For this reason a true reference face must first be produced.

Fig 1



Check the flatness with a straight edge and locate the lowest spot by visual examination.

Check the parallelism using an outside micrometer and mark the high spot. (Fig 2)

Clean the work table surface and the bottom of the magnetic chuck. (Fig 3)

Place, align and clamp securely the magnetic chuck over the work table.

Dress the grinding wheel for rough grinding. (Fig 4) (Seek the help of your instructor)

Clean the abrasive particles spread over the magnetic chuck and table.

Fig 2

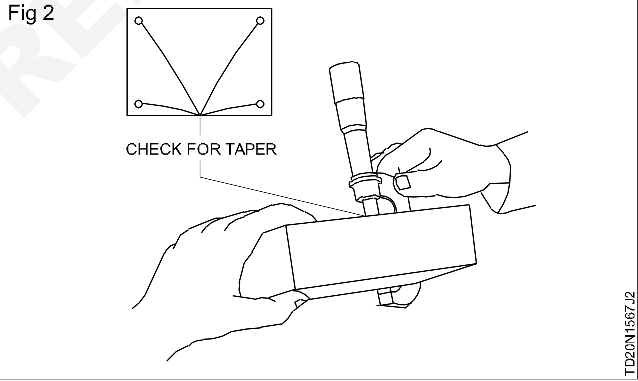
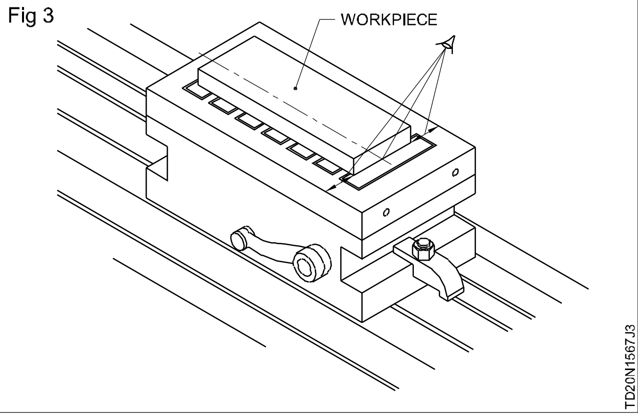


Fig 3



Mount the workpiece on the magnetic chuck, (Fig 5) resting the lengthier surface with the side stopper plate of the magnetic chuck.

Fig 4

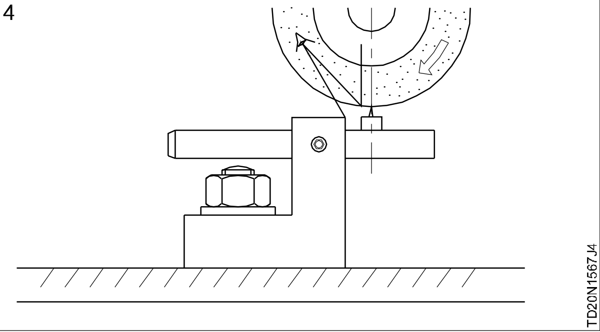
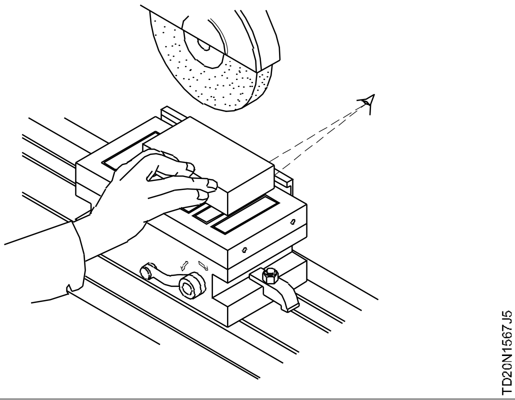
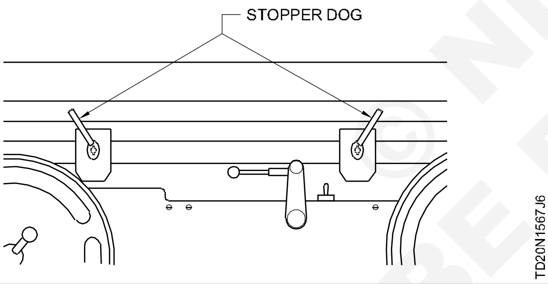


Fig 5



Set the table traverse-stopper dog considering the (Fig 6) approach length and over travel. Also set for the clearance of the job width.

Fig 6



Set the feed rate of the table to 10 to 15 m/mm.

Hand-feed the wheel head down, and watch the narrowing of the gap. Stop at 0.25 mm gap approximately.

Clear the job from the grinding wheel.

Switch on the grinding wheel spindle.

Engage the longitudinal power traverse using the fine feed mechanism and 'pick up spark' at the high spot.

Cross-traverse the workpiece to clear the wheel.

Start the coolant pump and direct the stream of the coolant between the wheel and the workpiece. (Fig 7)

This will reduce the heat of the job, and the ground particles will be washed away.

Apply a 0.03 mm depth of cut by the fine feed mechanism when the workpiece clears the grinding wheel after each cut. (Fig 8)

Keep your hands away from the revolving wheel at all times to avoid injuries to yourself.

Fig 7

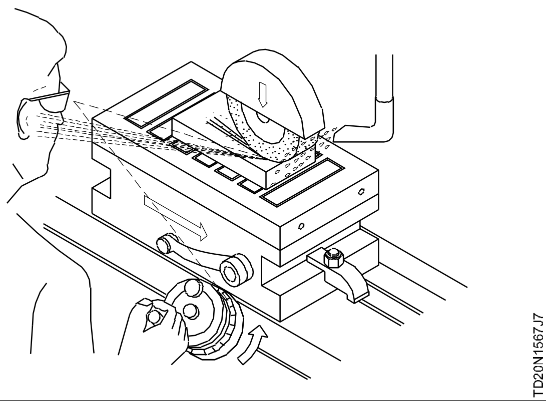
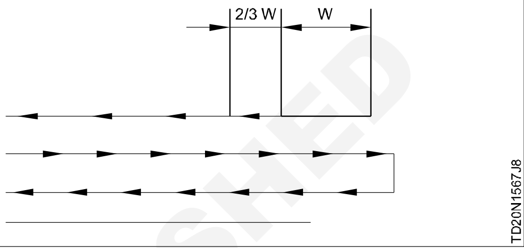


Fig 8



Repeat rough grinding till the grinding allowance for that side is ground away.

Cross-traverse the workpiece to clear the wheel.

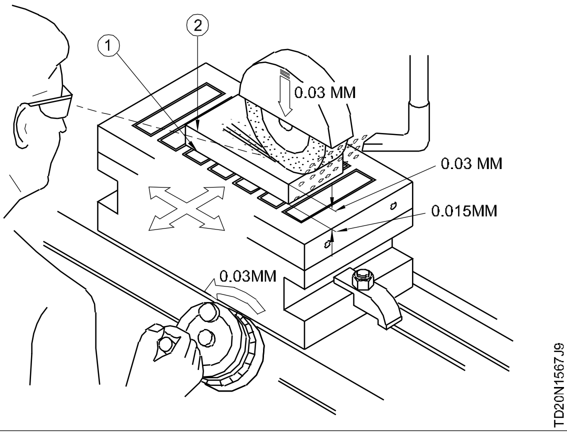
Re-dress the grinding wheel for finish grinding. (Seek the help of your instructor). Clean the table and workpiece thoroughly.

Engage the longitudinal travel feed.

Apply 0.012 mm cut and finish grind the workpiece allowing the wheel to 'spark out'. (Fig 9)

Always apply the depth of cut at the end of the stroke.

Fig 9



Stop all traverses and turn off the coolant. Position the workpiece away from the wheel.

Remove the workpiece from the magnetic chuck. While so doing see that no scratches are formed on the magnetic chuck. (Consult your instructor)

Remove the sharp edges of the workpiece by using a fine abrasive stick or stone.

Check the ground face with a straight edge and the thickness with an outside micrometer. This will be the reference surface for grinding the other surfaces.

Dress the grinding wheel for rough grinding.

Clean the magnetic chuck face and mount the ground surface of the workpiece over the face of the magnetic chuck.

Set table traverse stops.

Clean up the face by removing minimum material.

Remove the workpiece, deburr and clean it.

Determine the stock of material to be removed with an outside micrometer.

Check parallelism with an outside micrometer and determine the amount of taper if any. (To correct taper ask your instructor for advice)

Remount the workpiece in the same position and continue rough grinding, leaving an allowance of 0.012 mm for finish grinding.

Remove the workpiece and dress the wheel for finish grinding.

Remount the workpiece and give a depth of cut of 0.005 mm and grind the surface.

Remove the workpiece from the magnetic chuck.

Thoroughly clean the workpiece and the surface of the chuck.

Measure the thickness and parallelism and decide the remaining allowance.

Remount the workpiece and apply another 0.005 mm depth of cut and finish grind.

Using the graduated dial of the wheel head, down feed for grinding the remaining allowance.

Allow the wheel to spark out.

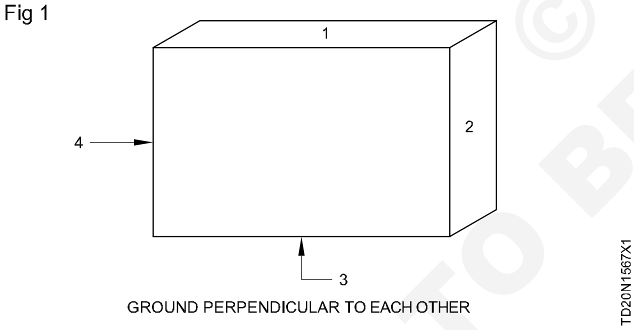
Remove the workpiece and clean thoroughly. Check the thickness, parallelism and flatness of the surface texture.

Grinding a surface at 90° to an accuracy of 5'

Objectives: This shall help you to
- **set the workpiece for grinding a surface at 90°**
- **grind adjacent surface at 90°.**

Clean and remove all burrs from the workpiece, the angle plate and the magnetic chuck. All the four side are to be ground perpendicular to each other (Fig 1)

Fig 1



GROUND PERPENDICULAR TO EACH OTHER

Place a piece of paper which is slightly larger than the angle plate on the magnetic chuck.

Place one end of the angle plate on the paper.

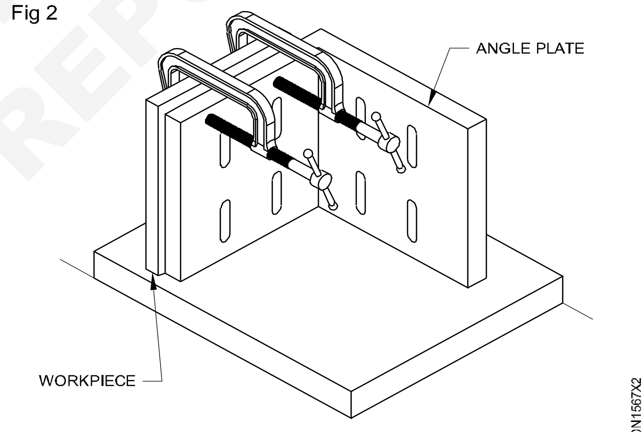
Place a piece of paper which is slightly larger than the angle plate, so that the top and one edge of the workpiece project about 12 mm beyond the edges of the angle plate (Fig 2)

Be sure that the edge of the work does not project beyond the base of the angle plate.

If the workpiece is smaller than the angle plate length, a suitable parallel block must be used to bring the top surface beyond the end of the angle plate.

Hold the work firmly against the angle plate.

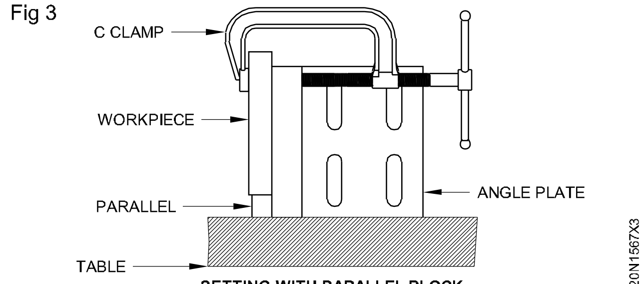
Fig 2



SETTING WORKPIECE

Clamp the work securely to the angle plate and set the clamps, so that they will not interfere with the grinding operation (Fig 3)

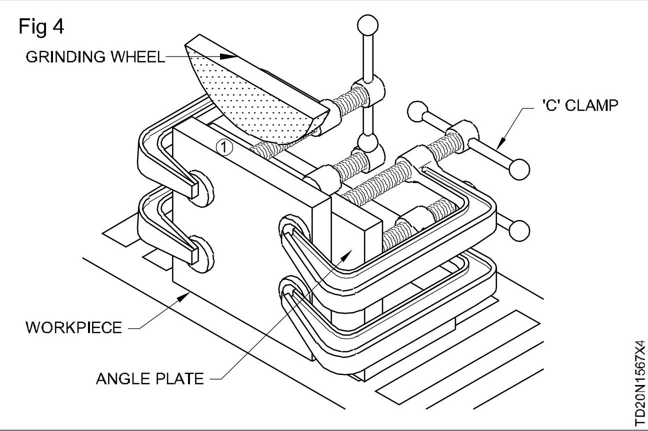
Fig 3



SETTING WITH PARALLEL BLOCK

Turn off the magnetic chuck and carefully place the base of the angle plate on the magnetic chuck for grinding the surface (Fig 4)

Fig 4



Carefully fasten two more clamps, on the end of the workpiece to hold the work securely.

After the work has been properly setup on the magnetic chuck the following steps are to be followed for grinding the edges for the workpiece.

Raise the wheel head, so that it about 12 mm above the surface of the job.

Adjust the table reverse dogs, so that each of the work clears the grinding wheel by about 25 mm.

With the work under the centre of the wheel, turn the cross-feed handle until about 3 mm of the wheel overlaps the edge of the work.

Start the grinding wheel and lower the wheel head until the wheel just sparks the work.

Move the work clear from the wheel with the cross-feed handle.

Check the further high spots by feeding the table by hand, so that the entire length of the workpiece is under the wheel.

Engage the table reverse lever and grind the surface until all the marks are removed.

The depth of cut should be 0.03 to 0.15 mm for the rough cuts and 0.01 to 0.02 mm for the finish cuts. Stop the machine and remove the clamps from the right hand end of the work.

Turn off the magnetic chuck and remove the angle plate and workpiece as one unit. Be careful not to disturb the work set up.

Clean the chuck and the angle plate.

Place the angle plate (with the attached workpiece) on its end with the surface (2) to be ground on the top. Fasten two clamps to the right hand side for the workpiece and the angle plate.

Remove the previous clamps from the top of the set up.

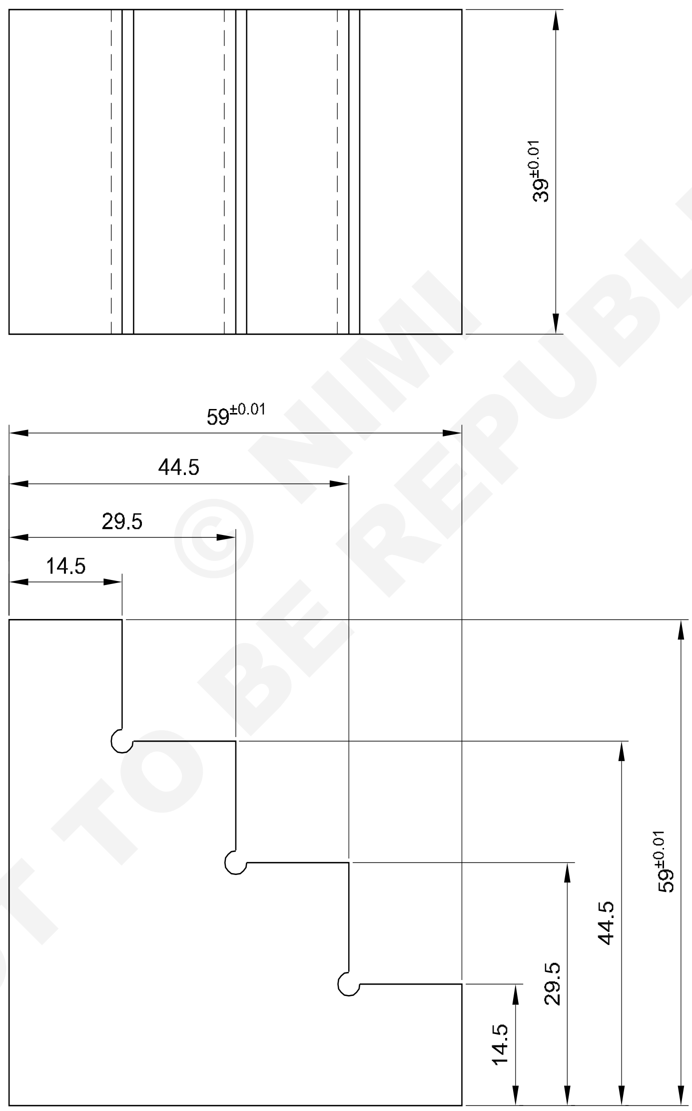
Repeat the above steps and grind the second edge

When two adjacent sides have been ground, they are then used as reference surfaces to grind the sides, (3) and (4) square and parallel.

Note: If the workpiece is at least 25mm thick and long enough to span three magnetic poles on the magnetic chuck no angle plate is required for grinding sides.

Grinding of step block by surface grinding machine with an accuracy ± 0.01mm

Objectives: At the end of this exercise you shall be able to
- **mount the grinding wheel**
- **set the job on the magnetic chuck**
- **align the job on the magnetic chuck using dial test indicator**
- **grind stepped surfaces flat and square**
- **check the dimensions by an out side micro meter.**

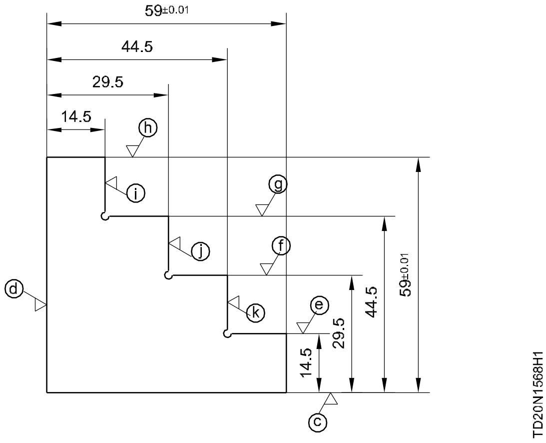


1	60x60x40mm	1.4.56 ←	Fe 310	-	1	1.5.68
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX.NO.
SCALE 1:1	STEP GRINDING				DEVIATIONS ±0.04	TIME
					CODE NO. TD20N1568E1	

Job Sequence

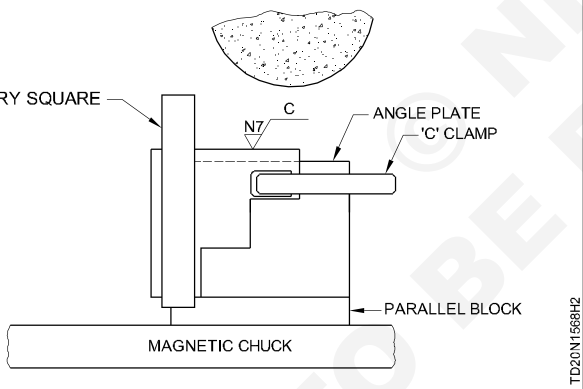
- Study the job drawing, measure the job and determine the grinding allowance on each surface and step to be ground. (Fig 1)

Fig 1



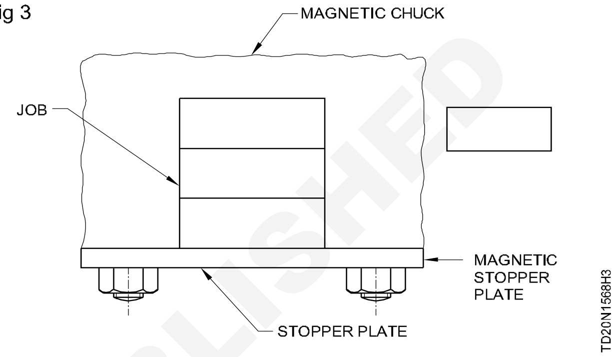
- Prepare the machine, the magnetic chuck and grinding wheel for the surface grinding operation.
- Rough and finish grind the surfaces (a) and (b) to parallel and maintain the size to 39 ± 0.02 mm removing half of the grinding allowance.
- Set the job on the angle plate (150 x 100 mm) with a 100 mm 'C' as shown in Fig 2.

Fig 2



- Ensure that the surface (c) is 1 to 2 mm above the top surface of the angle plate.
- Do not seat the job tight on the parallel, after aligning with the try square.
- Rough and finish grind the surface 'C' removing half of the grinding allowance.
- Repeat the above steps for grinding the surface (d).
- Rough and finish grind the surface (d) removing half of the grinding allowance.
- Mount the surface (C) on a magnetic chuck,and align the surface (d) against the stopper plate. (Fig 3)

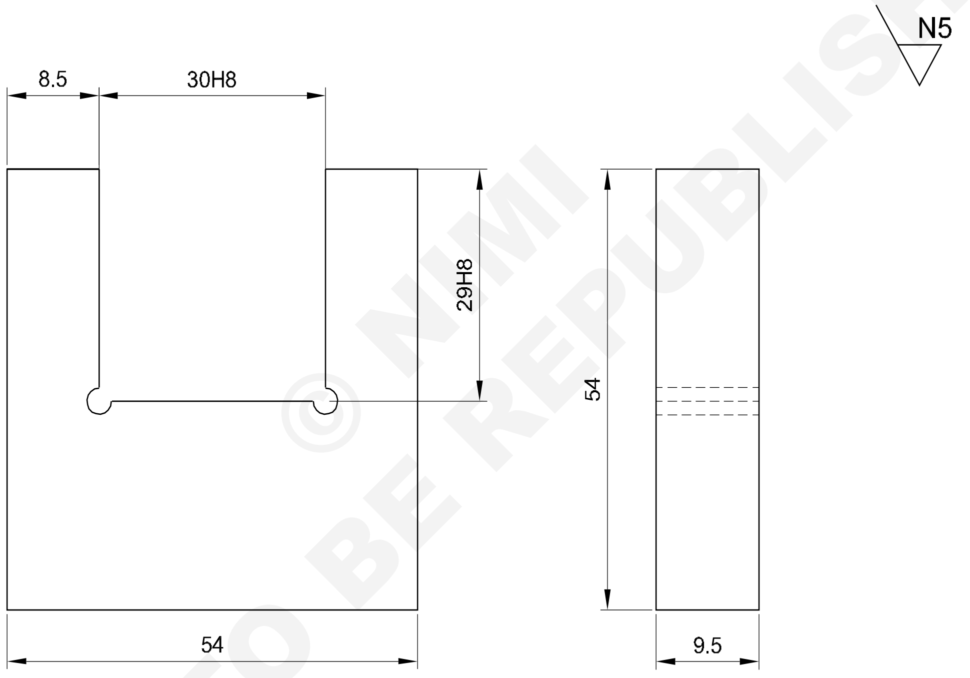
Fig 3



- Rough and finish grind the step (e) to 14.50 mm. Check with a depth micrometer.
- Rough and finish grind the step (f) to 29.50 ((f) - (e) = 15.00). Check with a depth micrometer.
- Rough and finish grind the step (g) to 44.50, (g) - (f) = 15.00). Check with a depth micrometer.
- Rough and finish grind the surface (h) to 59 ± 0.02 (h) - (g) = 15.00). Check with depth micrometer.
- Mount the surface (d) on a magnetic chuck,and align the surface (c) against the stopper plate. (Fig 2)
- Rough and finish grind steps (i) to (2) to the dimensions as per the dimensions given in the drawing.
- Check the steps with a depth micrometer at every stage.
- Deburr all the edges.

Grinding of slot in surface grinding machine with an accuracy of ± 0.01mm

Objectives: At the end of this exercise you shall be able to
- **grind the slot to an accuracy of ± 0.01 mm**
- **mount the job on magnetic chuck.**



1	A PRE MACHINED	-	Fe310	-	-	1.5.69
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	**GRINDING OF SLOT IN SURFACE GRINDING MACHINE**	TOLERANCE ±0.01mm	TIME
		CODE NO. TD20N1569E1	

Job Sequence

- Perpare the machine and dress the grinding wheel for grinding parallel surfaces.
- Mount the job on the magnetic chuck. Rough and finish grind the surfaces parallel, to maintain the thickness to 9.5mm.
- Deburr the edges.
- Rough and finish grind the width to 54mm using an angle plate and 'C' clamps with suitable parallels.
- In the same setting, rough and finish grind the 54x9.5mm surface at 90° and remove half of the grinding allowance on the length of 54 mm.
- Dress the grinding wheel for the grinding slot.
- Mount the plain vice on the magnetic chuck and align its fixed jaw parallel to the grinding wheel axis.
- Hold the job in the vice such that the bottom of the slot is 2mm above the top surface of the vice jaws.
- Rough and finish grind the top surfaces of the slot to maintain the length to 54.00mm.
- Measure the bottom of the slot with a depth micrometer and decide the grinding allowance.
- Rough and finish grind the bottom of the slot to maintain the depth to 29.00mm using face of the grinding wheel. Check the depth with a depth with a depth micrometer.
- Rough and finish grind the shoulder to 8.50mm using the rear side of the grinding wheel.
- Grind only half of the grinding allowance.
- Check the size, 8.5mm, with an outside micrometer.
- Rough and finish grind the other shoulder until the width of the slot becomes 31.00.
- Check the slot for its centricity with an outside micrometer and the width by a snap gauge, (Consult your instructor)
- Remove the job, deburr the edges, and demagnetize.

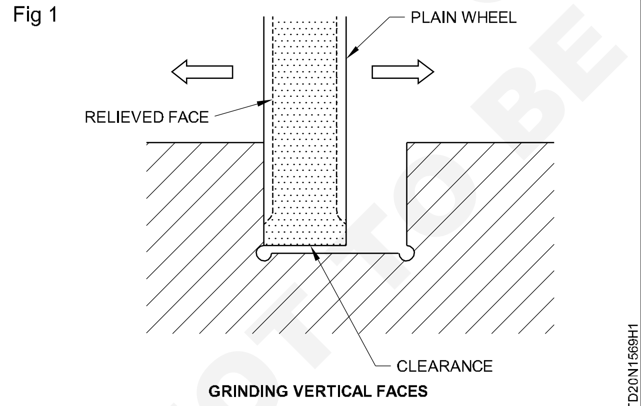
Skill Sequence

Grinding a slot to an accuracy of ±0.01mm

Objective: This shall help you to
- **grind a slot to an accuracy of ±0.01mm.**

Select and mount the grinding wheel such that the face width of the wheel is less than the width of the slot to be ground. (Fig 1)

Fig 1



GRINDING VERTICAL FACES

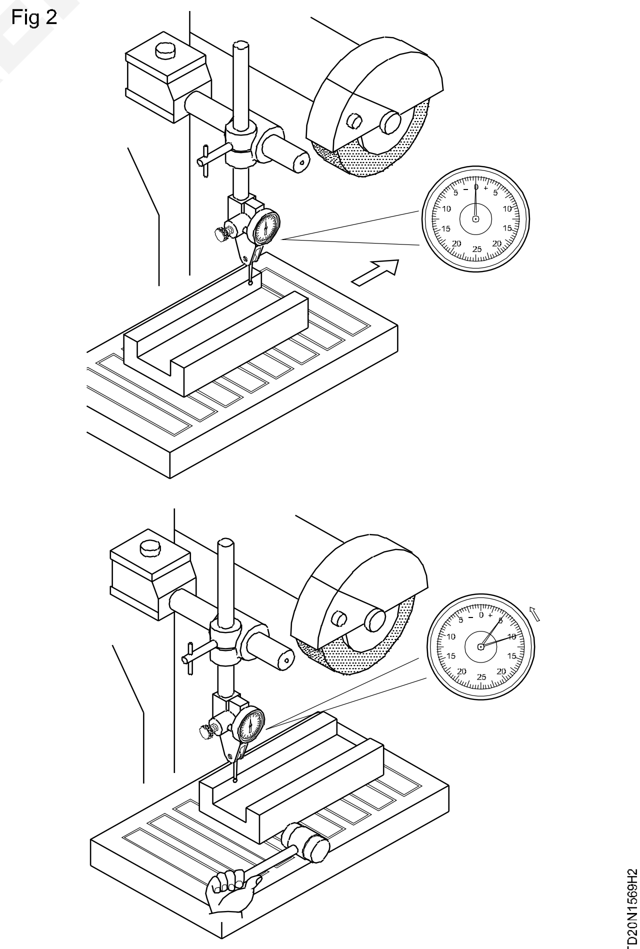
Dress the wheel for the faces, clean up and relieve both sides of the wheel if a straight wheel is used.

Mount the workpiece on to the magnetic chuck directly if it is of a sufficiently large size.

If the job is small in nature, take the support of an angle plate.

Align the workpiece accurately in the correct plane and secure. (Fig 2) (Consult your instructor)

Fig 2



Set the table traverse stops in position.

Position the wheel approximately 0.4mm above the horizontal face of the slot and switch on the wheel.

Engage the table traverse and feed wheel in until it just touches the horizontal surface.

Keep the wheel clear of the vertical faces.

Clean up the whole horizontal surface by the table traverse and careful cross-feed operation. (Consult your instructor)

Stop the wheel and clear it from the work and determine the amount of material to be removed.

Reposition the wheel into the slot, start up the wheel and engage the traverse.

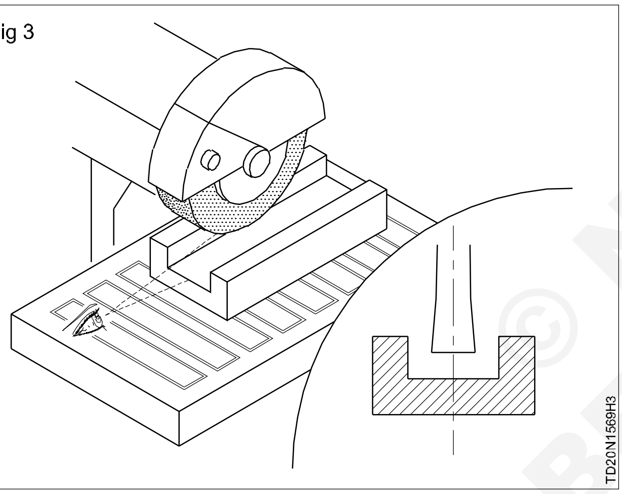
Feed in the wheel and grind the whole surface with 0.04mm accuracy.

Keep the wheel clear of the horizontal face.

Determine the material to be removed on the vertical faces.

Position the wheel and touch the vertical face of the job with the wheel. (Fig 3)

Fig 3



Keep the wheel away from the job.

Set the depth of cut.

Feed the Wheel down and grind the vertical face down up to the corner (recessed). (Fig 4)

Keep the wheel away from the slot.

Position the wheel and touch the other vertical face of the job with the wheel. (Fig 5)

Keep the wheel away from the job and set the depth of cut.

Fig 4

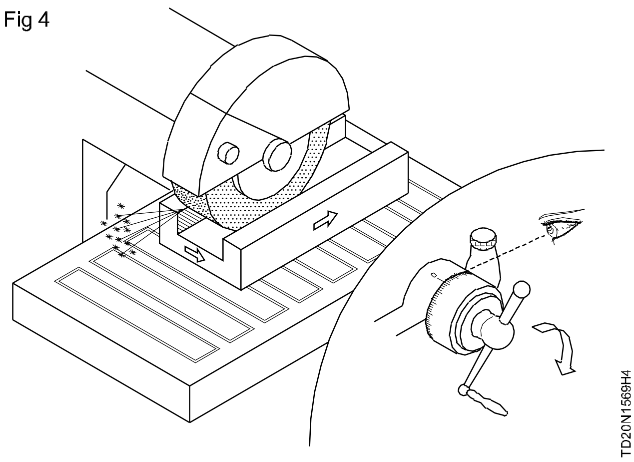
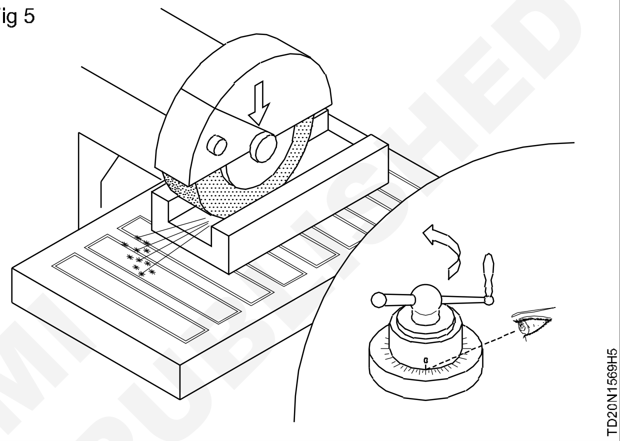


Fig 5



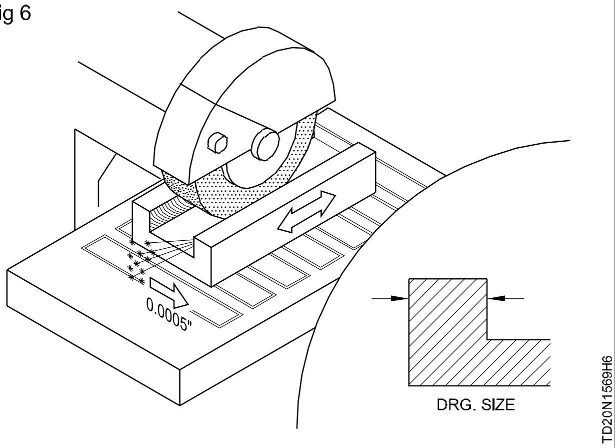
Down-feed the wheel and grind the vertical face down up to the space corner. (Fig 6)

Stop the job away from the grinding wheel.

Deburr and clear the ground surfaces.

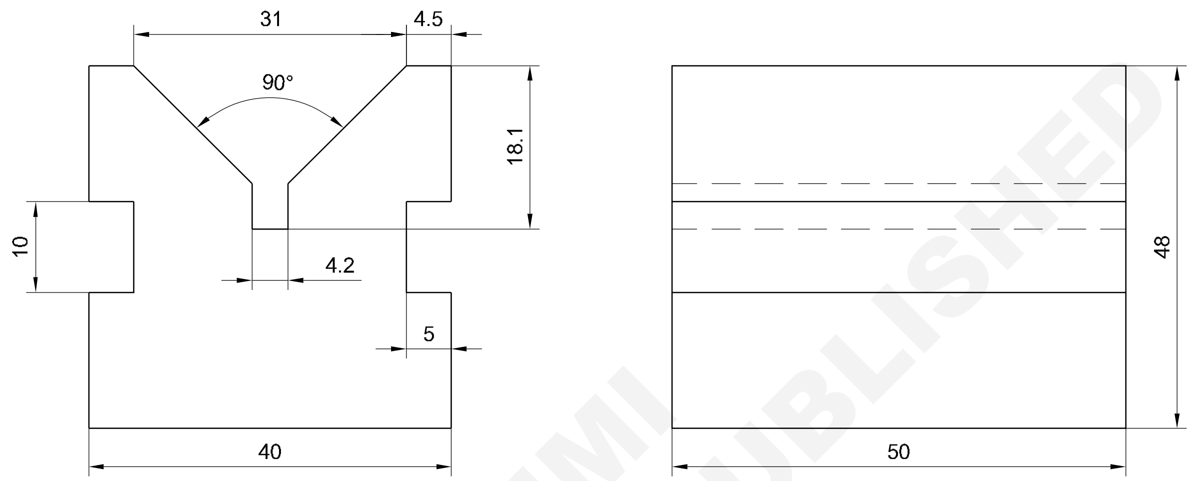
Check the slot for its dimension with a vernier caliper and depth micrometer.

Fig 6



Set and perform angular grinding using sign plate to standard angle

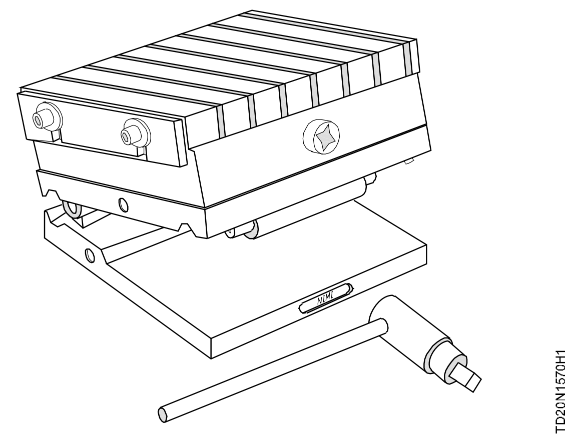
Objectives: At the end of this exercise you shall be able to
- **mount the grinding wheel**
- **set the universal vice on the magnetic chuck**
- **hold the job & grind the angular surface.**



Job Sequence

- Study the drawing. Observe the surface to be ground and determine the grinding allowance for each surface by measuring.
- Prepare the machine dress the grinding wheel for grinding angular surface.
- Mount the magnetic sine plate and align its side perpendicular to the grinding wheel axis by using the dial test indicator.
- Set the job parallel to the sine plate and put the magnetic ON.
- Calculate the slip gauge height for 45° depending upon the size of sine plate. (Fig 1)
- Set the slip gauge in the sine plate.
- Rough and finish grind the surface, (a) using the face of the grinding wheel. Record the amount of materials removed by noting down the divisions on the graduated dial of the wheel head.

Fig 1



- Remove the same amount of material from the surface (b) using the front side of the grinding wheel by manual cross-feeding in the same setting.
- Remove the job. Deburr and demagnetise the job.

1	-	1.4.59 ←	Fe310	-	-	1.5.70
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE	SET AND PERFORM ANGULAR GRINDING USING UNIVERSAL VICE / SINE VICE TO STANDARD ANGLE	TOLERANCE ±0.01mm	TIME
		CODE NO. TD20N1570E1	

Skill Sequence

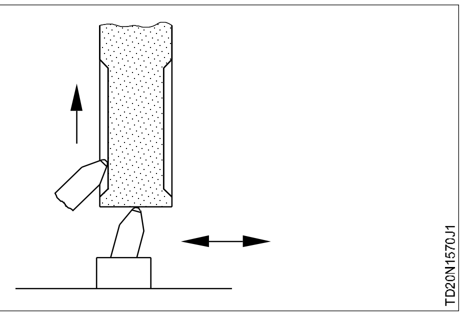
Grinding angular surface using universal vice

Objective: This shall help you to

- **grind angular surfaces using a universal vice.**

Dress the grinding wheel on the sides for relief and on the face for trueness. (Fig 1)

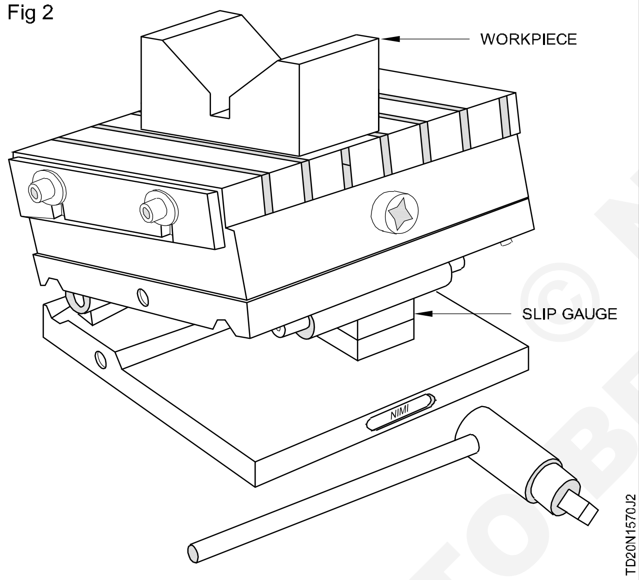
Fig 1



Clean the machine table and mount magnetic sine table.

Align the side perpendicular to the axis of the spindle. (Fig 2)

Fig 2



Clean the job and measure it to determine the grinding allowance. (Ask your instructor for help in determining the allowance).

Set the sine table to 45° using slip gauges.

Fix the job and put on the magnetic such that the horizontal surface to be ground is aligned parallel to the surface of the table using a dial test indicator. (Fig 2)

Position the stop dogs for longitudinal traverse.

Start the wheel and lower the wheel head until the wheel just sparks the high spot of the job.

Start the table travelling automatically and feed the entire length of the job and clear off the job from the wheel.

Engage the vertical depth for rough and finish cut as predetermined, and feed from the cross-feed manually. (Fig 3a)

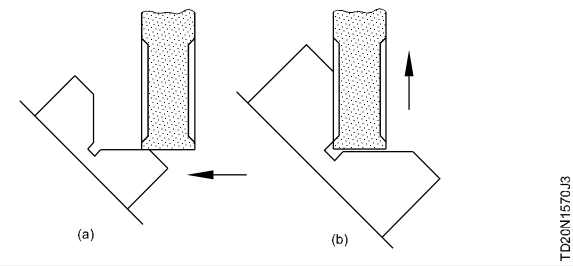
Grind the longitudinal surface up to the corner relief.

Remove only that much of material pre-determined as grinding allowance, and record the amount of material removed.

Raise the wheel head to 0.20mm and without releasing the wheel, plunge the wheel little by little against the vertical surface of the job to be ground to the depth equal to the horizontal surface.

Raise the wheel gradually to finish grind the vertical surface. (Fig 3b).

Fig 3



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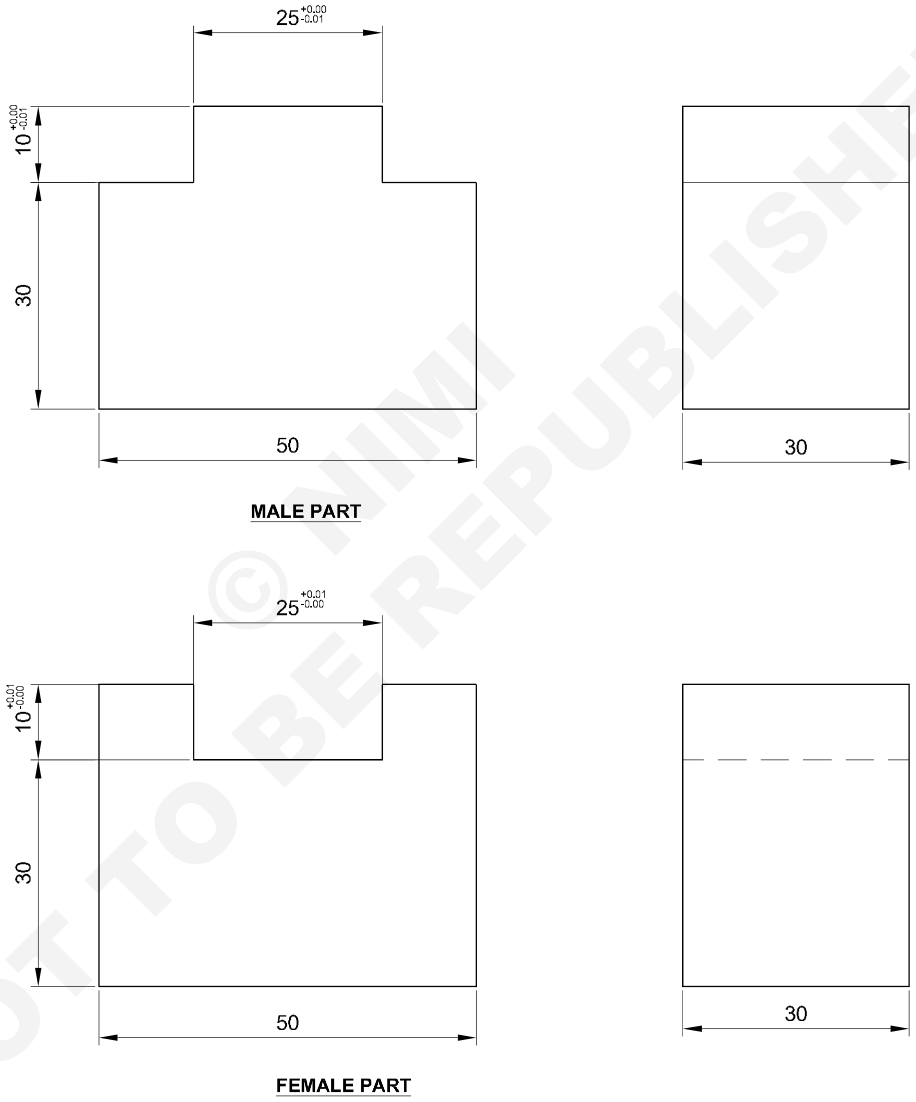
Exercise 1.5.71

Make slide fit (male & female)

Objectives: At the end of this exercise you shall be able to
- **set the grinding wheel**
- **mount the job**
- **grind the male & female part as per drawing with an accuracy of ± 0.01.**

TASK-1



NOTE: PRE MACHINED TO SIZE WITH GRINDING ALLOWANCE

1	-		Fe310	-	-	1.5.71
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	MAKE SLIDE FIT WITH AN ACCURACY (MALE FEMALE)	TOLERANCE ±0.01mm	TIME
		CODE NO. TD20N1571E1	

Job Sequence

TASK 1: **Male part grinding**

- Clean the work piece.
- Check the work piece to determine the grinding allowance.
- Select the machine tool and dress the grinding wheel .
- Clean the machine table.
- Set the magnetic chuck and align by using Dial Test Indicator.
- Set and align the work piece.
- Start the machine and touch down the wheel and then finish grind the job.
- Stop the machine.
- Remove the job and check measurement by measuring instrument.

— — — — — — — —

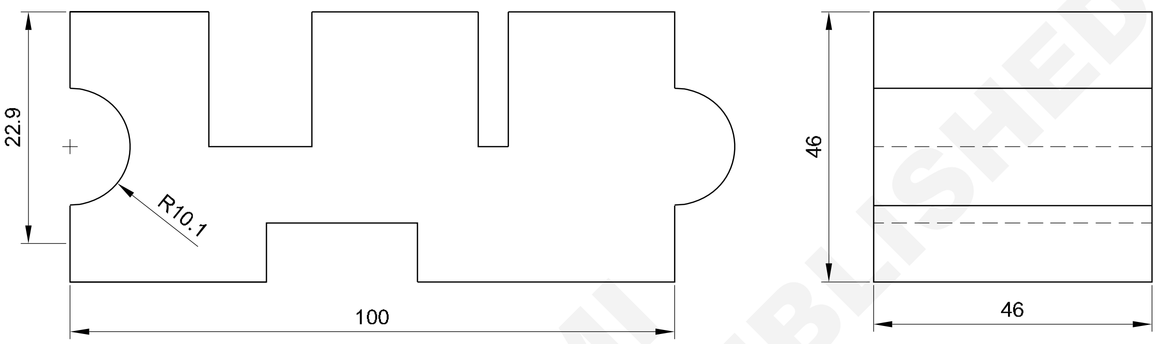
TASK 2: **Female part grinding**

- Clean the work piece.
- Check the work piece to determine grinding allowance.
- Select the suitable grinding wheel and dress the grinding wheel.
- Clean the machine table.
- Clean the magnetic chuck.
- Set and align the work piece.
- Start the machine and touch down the wheel and then finish grind the job.
- Stop the machine.
- Check matting part (slide level).
- Remove the job and clean the job.
- Measure and check the dimension.
- Match and slide the job.

— — — — — — — —

Perform form grinding

Objectives: At the end of this exercise you shall be able to
- **select and set the grinding wheel**
- **mount the job on magnetic chuck**
- **grind the concave surface.**



CONCAVE SURFACE

Job Sequence

Concave surface grinding

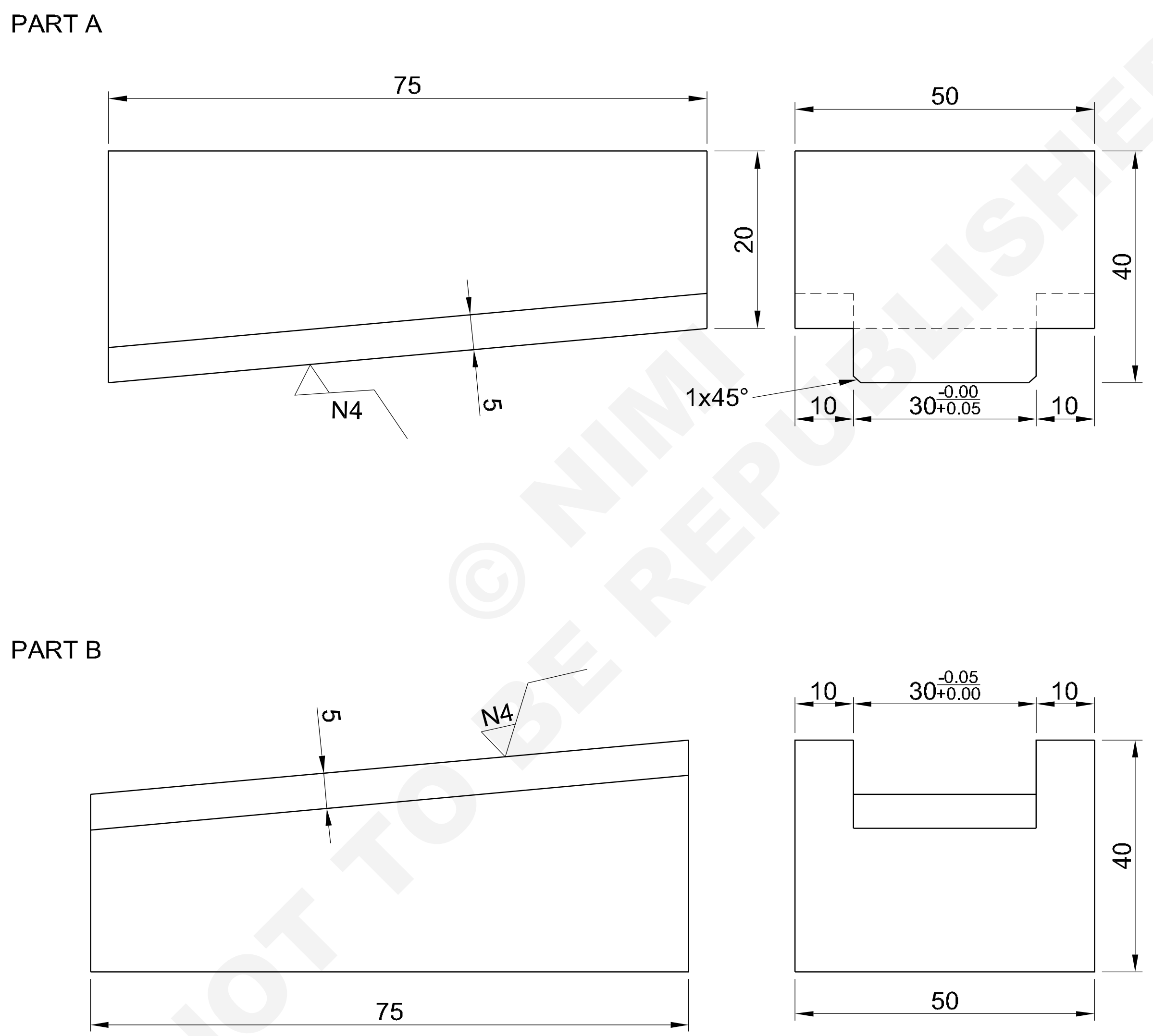
- Clean the work piece.
- Check the work piece to determine grinding allowance.
- Select the machine tool and dress the grinding wheel.
- Clean the machine table and magnetic chuck.
- Set the magnetic chuck and align by using Dial Test Indicator.
- Set and align the work piece to grind concave surface
- Start the machine and touch down the wheel and then finish grind the top surface of workpiece.
- Stop the machine and check the measurement.
- Set the radius attachment on magnetic chuck and form the wheel in according to radius.
- Remove the attachment after completing the job.
- Set the job and align with form wheel.
- Finish the form grinding to required depth.
- Stop the machine and check machine by radius gauge.
- Clean the job.

1	-	1.4.62 ←	-	-	-	1.5.72
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PERFORM FORM GRINDING	TOLERANCE ±0.01mm	TIME
		CODE NO. TD20N1572E1	

Taper angle fitting

Objectives: At the end of this exercise you shall be able to
- **set the workpiece using sine magenit table and align with dial test indicator (DTI)**
- **grind the taper position**
- **check the taper with sine bar and DTI.**



2	A PRE MACHINED - 77x52x42	-	FE310	-	-	1.5.73
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	TAPER GRINDING USING SINE BAR	DEVIATIONS ± 0.04	TIME :
		CODE NO. TD20N1573E1	

Job Sequence

- Check the size of the pre machined workpiece and determine the machining allowances.
- Mill the work piece as per drawing provide 0.75 mm only on Top anglur surface.
- Prepare the surface grinding for grinding angular surface.
- Set the sine magenic table on the surface grinding machine table.
- Align using dial test indicator.
- Select set of slip gauges for 5° and build up the height of slip gauges.
- Place the build up slip gauges on the sine magenic table and clamp it.
- Set the Part A (Workpiece) on the sine magnetic table and align it.
- Rough and finish grind the angular surface and maintain the height 40.00 mm + 0.05mm.
- Similary set and grind Part B in step surfaces only.
- Check the angle with vernier bevel protractor.
- Assembly part B with Part A.

Skill Sequence

Checking angles

Objective: This shall help you to
- **check the angle using vernier bevel protractor (Fig 1)**
- **check the angle using sine bar, slip gauge and DTI.**

Set up sine bar

- Select and clean appropriate size sine bar.
- Select slip gauges to build up sine bar to required angle.
- Clean slip gauges on chamois or soft cloth.
- Wring slip gauges together.
- Place sine bar on surface and position slip gauges.

Position workpiece

- De-burr and clean workpiece.
- Position workpiece angle face resting on sine bar.
- Hold parallel strip against the side of the sine bar. Slide workpiece against strip, ensuring that workpiece is flush to sine bar edge.

Check angular face

- Position dial indicator on surface plate with dial stylus engaged on one end of workpiece face.(Fig 2)
- Set dial face at zero.
- Slide dial indicator to bring stylus to other end of workpiece face.
- Note any error, from zero.

If angle is correct, dial stylus will be zero for full length of angle face.

Fig 1

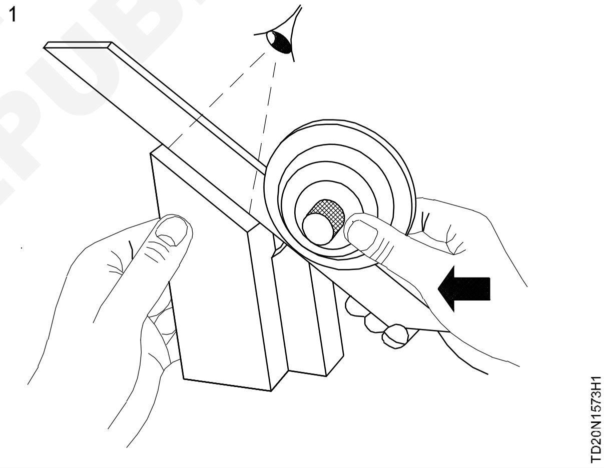
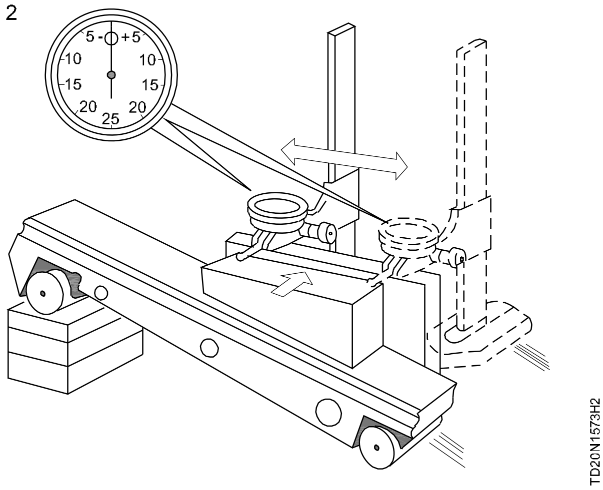
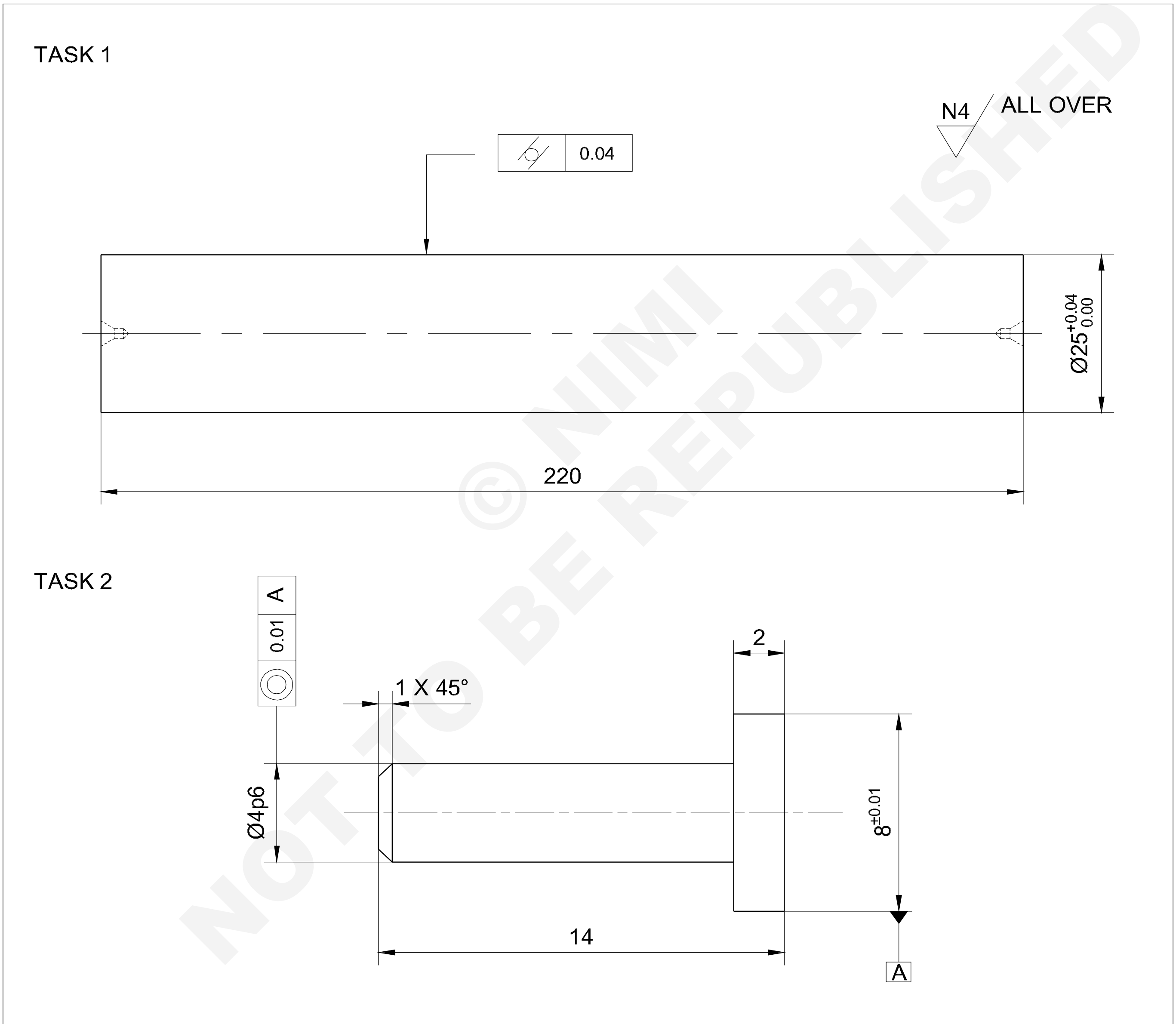


Fig 2



External parallel grinding (Both holding in chuck/collet and in between centres)

Objectives: At the end of this exercise you shall be able to
- **select and set the grinding wheel**
- **mount the job**
- **check the parallelism with dial test indicator.**
- **hold the workpiece in a chuck and grind out side diameter by table traverse method**
- **hold the work in a collect chuck and grind outside diameter by plung grinding method**
- **check the dimension.**



1	Ø10x25	–	Fe310	–	TASK - 2	1.5.74
1	PRE MACHINED Ø26x220	–	Fe310	–	TASK - 1	1.5.74
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	EXTERNAL PARALLEL CYLINDRICAL GRINDING (BOTH HOLDING IN CHUCK/COLLET AND IN BETWEEN CENTERS)	DEVIATIONS ±0.04	TIME
		CODE NO. TD20N1574E1	

Job Sequence

TASK 1: **Grind the job for the given dimension - 1**

- Prepare the cylindrical grinding machine for operation.
- Study the drawing and measure the grinding allowance for given job.
- Dress the grinding wheel make sure that the abrasive particles are removed uniformly.
- Mount the job in between centres.
- Set the length of stroke using reversing dogs.

Fix the safety guard in proper place.

- Put on the grinding wheel.
- Start the work table traverse.
- Bring the grinding wheel forward to engage the workpiece by operating the cross feed hand wheel on the machine.

Wear goggles at all times while using a grinding machine.

- Take a moderate cut (0.04mm) measure the workpiece diameter and the work is parallel after the first traverse.
- Continue traverse and give depth of cut at the end of each traverse until the job is within 0.05-0.10mm of the required final size.
- Reserve the position of the job in the centres.

Use a soft metal spacer to protect the job.

- Grind the end of the job previously covered by the carrier to the same size as the other end of the job.
- Dress the grinding wheel.
- Grind the work piece to the finished size Ø25mm like roughing cycle.
- Remove the job from centres.
- Remove burrs of the job using fine abrasive stone.
- Measure the diameter of the job used by 0-25mm outside micrometer.
- Check the cylindrical of the job.

— — — — — — — —

TASK 2: **Grind the job for the given dimension - 2**

- Turn the workpiece with allowance of 0.5 mm for grinding.
- Hold dia 8.5 mm in three jaws chuck on cylindrical grinder, such that the job length 12.5 mm projects out.
- Grind diameter 4.5 to diameter 4p6 to length 12 ± 0.1 mm.
- Hold diameter 4.6 in a collet and grind diameter 8.5 mm to 8.00 ± 0.01 mm.
- Grind diameter 8.00 face to a total length of 14± 0.1 mm.
- Remove the workpiece from collet, deburr, clean and oil it.

Skill Sequence

Cylindrical grinding

Objective: This shall help you to
- **grinding cylindrical surface**
- **check the parallelism**
- **measure the dimension by outside micrometer.**

Prepare the cylindrical grinding machine for grinding

Throughly clean the machine with banian cloth.

Don't use cotton waste for cleaning the grinding machine.

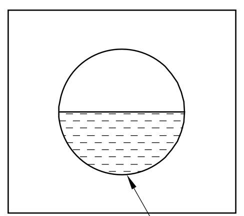
Check the oil level in the workhead and wheel head. (Fig 1)

If it is below the recommended oil level inform to the instructor. (Fig 2)

Apply oil in all oil points use oil gun.

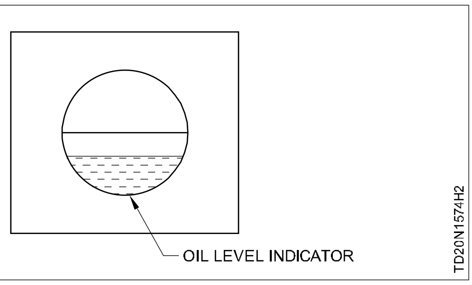
(IOC SAE 30/40)

Fig 1



Apply grease in all grease points with grease gun (servo gem No.2)

Fig 2

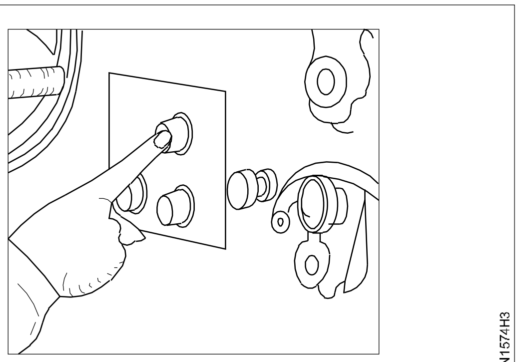


Ensure that the work head and wheel head are set to zero position.

Check the wheel guards are in proper position.

Start the hydraulic motor by pressing the hydraulic motor switch. (Fig 3)

Fig 3

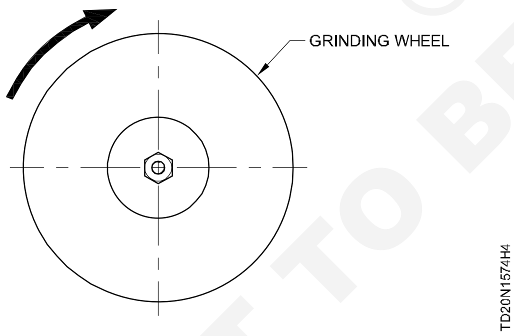


TURN ON THE START SWITCH WITH SWITCH ON-OFF.

Check the oil pressure gauge.

Start the grinding wheel and check the direction of rotation. (Fig 4) by viewing the direction of arrow provided on the wheel guard.

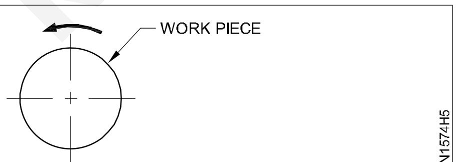
Fig 4



Workhead

Start the work head spindle by pressing the work head motor switch. (Fig 5)

Fig 5



VIEWING FROM WORK HEADCENTRE SIDE

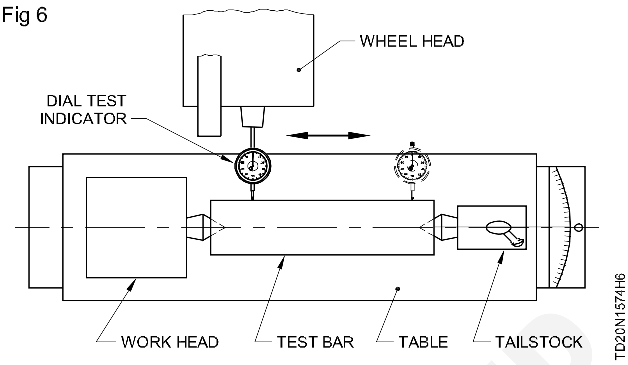
Check for the job rotation.

Align the work table perpendicular to the wheel head

Clean the wheel head of front side.

Hold the dial test indicator with magnetic base on wheel head slide. (Fig 6)

Fig 6



Fix the test bar in between centres.

Set the work head wheel head and table at zero degree.

Touch the dial on job and giving light pressure as shown in figures.

Move the table from work head to tailstock.

Check the dial reading zero.

Incase variation of reading ±10 divisions.

Loose the table top Allen screws and adjust slightly side screw.

Check the dial reading at zero so that the work head centre and tail stock centre at same line.

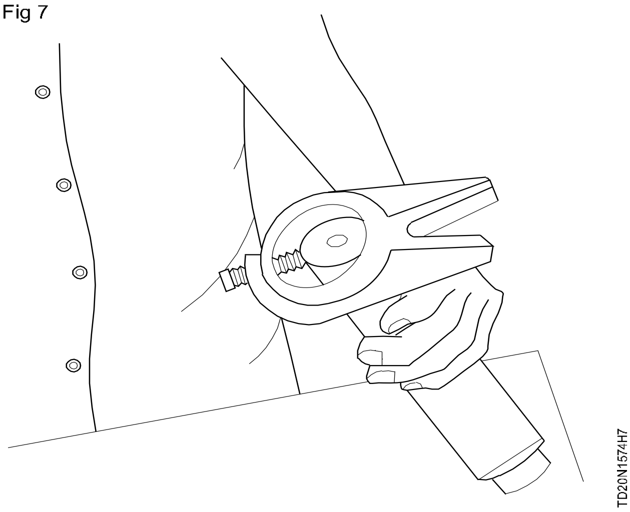
The table at zero degree aligning is correct position.

Set the job in between centres

Select a dog corresponding to the work diameter.

Fit a dog at right angles to the end of the work. (Fig 7)

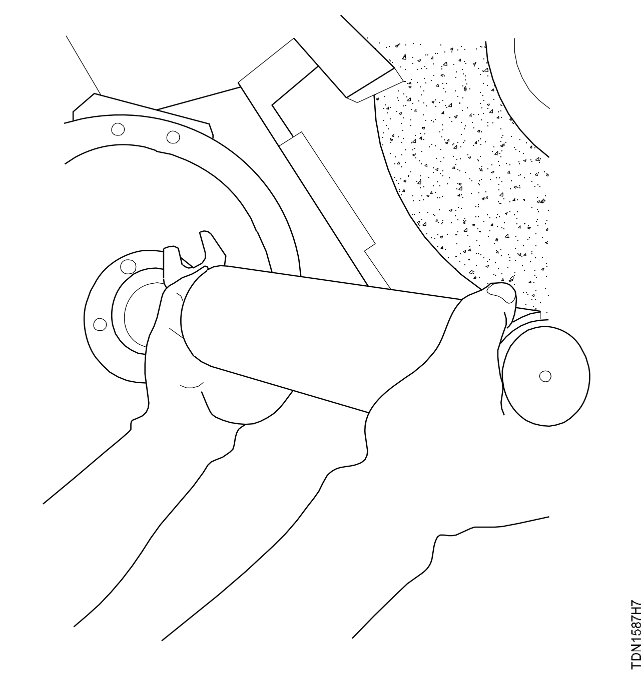
Fig 7



Too long bolt on a dog may become loose in the course of grinding.

Hold the work securely in both hands and fit the centre hole carefully to the centre on the work head side. (Fig 8)

Fig 8

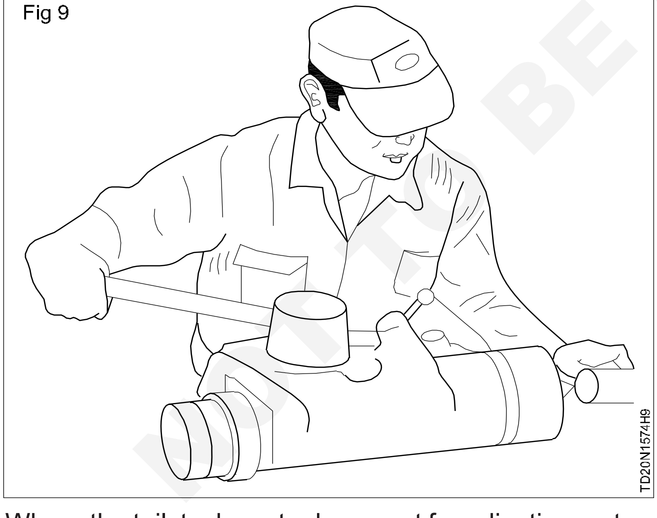


Hold the work with the left hand as illustrated while holding the work to prevent the centre hole coming out.

As illustrated support the work with the left hand and fit the centre to the centre hole by operating the lever of the tailstock with the right hand. (Fig 9)

Before support the job in between tailstock centre gap is 5mm should be maintained. (Fig 9)

Fig 9

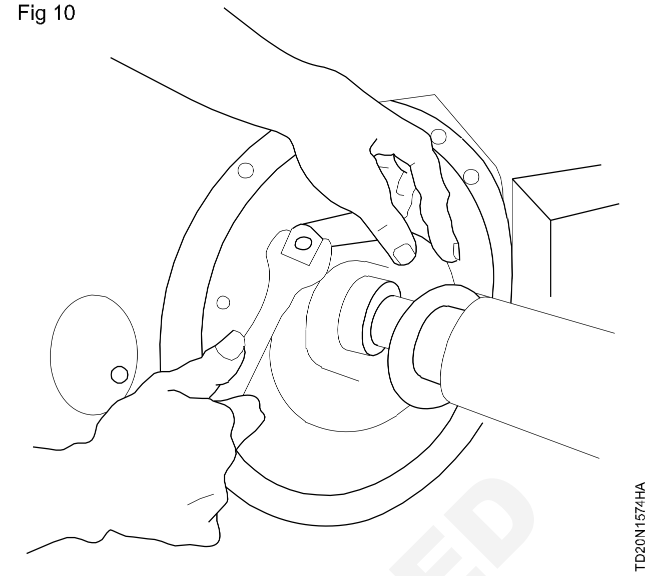


Where the tailstock centre has a nut for adjusting nut so as to allow the work to be turned lightly by the fingers.

Where the tailstock centre has a nut for adjusting nut so as to allow the work to be turned lightly pin in accordance with the dog with the dog leg length. (Fig 10)

So the workpiece mounted in between centres. (Fig 11)

Fig 10



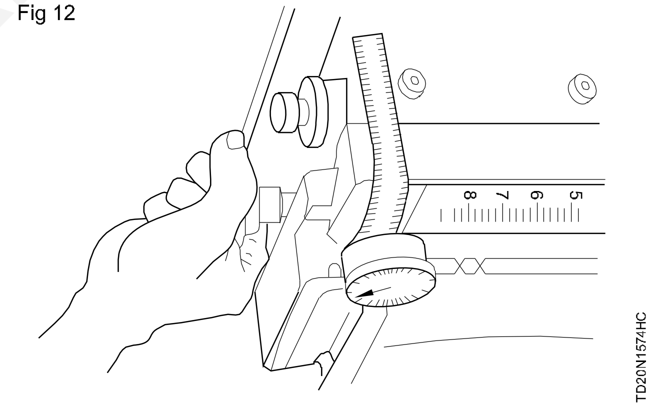
Adjustment of taper

When the work has been tapered beyond expectation loosen the four fasteners. Allen screw of the upper table, set the dial gauge at zero and then a mind the swivelling of the table with the adjusting screw as illustrated. (Fig 12)

When the diameter at the side of the work head is larger than the other turn the table clockwise and when the diameter at the tailstock side is too large turn in counter clockwise.

As for table tilting give the specified conversion value to the dial gauge according to the length and the difference in size of the work. (Fig 12)

Fig 12



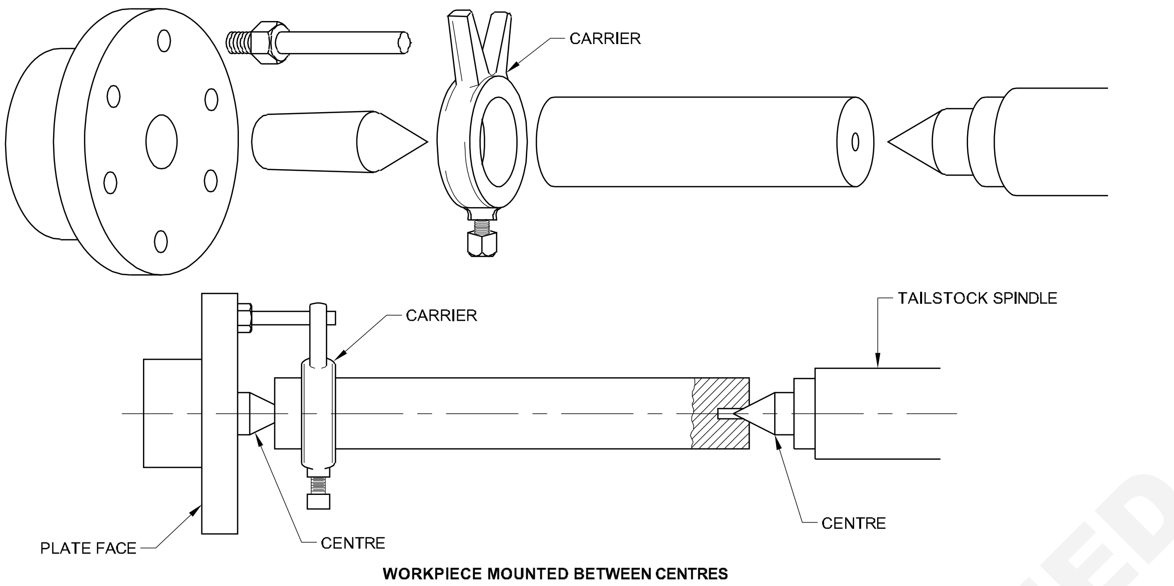
Fix the upper table do trial grinding to repeat adjustments for obtaining the given taper.

When the given taper has been obtained, do rough grinding leaving a finish margin of 0.02 -0.05mm in the outer diameter.

To finish grind

Determine the numbers of work revolution so as to make the peripheral speed of the work 12-15m/min.

Fig 11



Adjust the table speed so as to be fed at about (1/8-1 10) of the wheel thickness per work revolution.

If necessary do finish dressing.

Make the depth of cut from 0.0025mm to 0.01mm per stroke, while measuring from time to time as grinding by making the depth of cut by graduations.

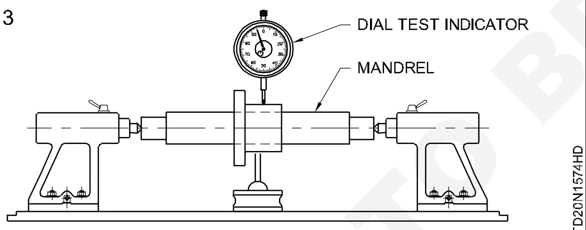
In the final stages the depth of the cut shall not be made, but reciprocate the table 2-3 times to do spark out.

Back the wheel spindle stock and do fine chamfering with an oil-stone.

Measure the size of the work when it stops fully.

Parallelism checking ref. (Fig 13)

Fig 13



Clean the surface plate without any dust and oil.

Fix the tailstock centres on surface plate.

Hold the dial in magnetic base.

Keep it on the surface plate.

Hold the job in between centres.

Touch the job and give the pressure on the dial and set zero.

Move the dial traversely.

Check the reading for variation.

Incase of variation on job go for regrinding.

Recheck the job for parallelism.

Rotate the job by hand and check for cylindrical.

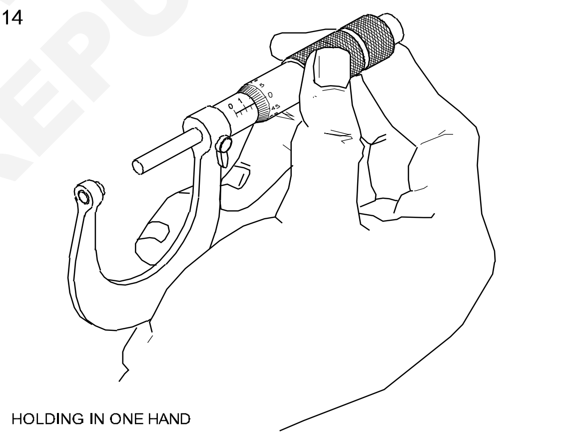
If the error is repeated and it is within the permissible limit then the same may be accepted as finished job.

Holding the micrometer for measurement

The micrometer may be held either in one hand or both the hands.

Holding in one hand (Fig 14)

Fig 14



Hold the outside micrometer in your right hand, keeping the graduations on the main scale towards you.

Support the frame on the lower centre of your palm. Use your little or third finger to hold the frame in the palm.

Palm the middle finger behind the frame to support it.

Keep the first finger thumb free to adjust the knurled thimble.

Holding by both the hands. (Fig 15)

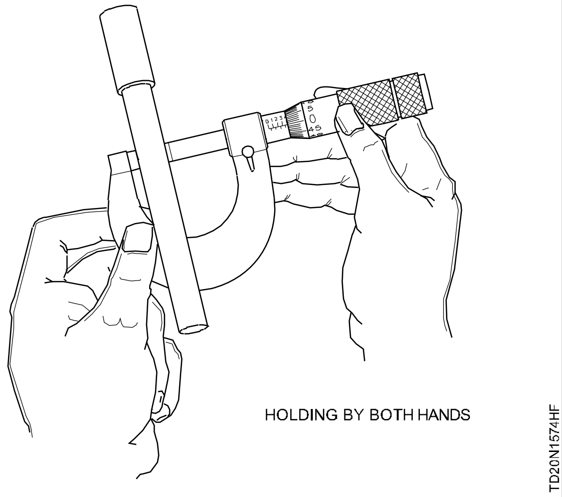
Sometimes, it may be more convenient to hold the micrometer with both the hands.

Support the frame between the fingers and the thumb of

Use the thumb finger of your right hand to adjust the thimble.

Set the micrometer on the workpiece for measurements.

Fig 15



High skill is needed for obtaining accurate measurement with the outside micrometer. A wrong setting of the micrometer over the workpiece may cause,

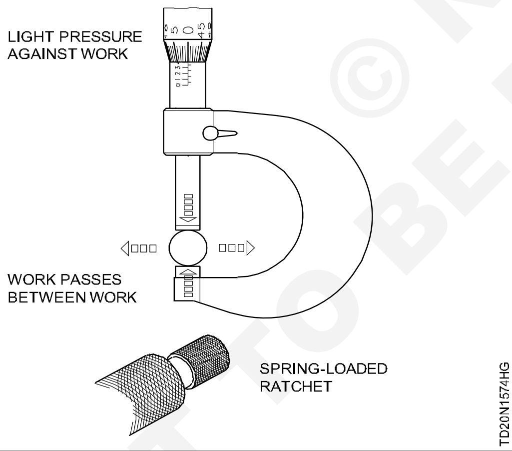
1 inaccurate reading

2 excessive strain on the screw thread

3 distortion in the frame.

Fig 15 shown the adjustment of the spindle and anvil over the workpiece. As you adjust the workpiece between the spindle and the anvil you should feel a light pressure or resistance against the workpiece surface. Use the spring-loaded ratchet stop to ascertain the feel. (Fig 16)

Fig 16



Measuring outside diameter using outside micrometer.

While using only one hand.

Close the anvil and spindle until you feel them just touching the work.

Move the work slightly between the spindle and the anvil or pass the micrometer over the workpiece by moving your wrist. (Fig 17)

Make further adjustments of the thimble as required until you obtain the right 'Feel' (Fig 18)

When satisfied with the feel remove the fingers from the thimble.

Turn the micrometer towards you.

Fig 17

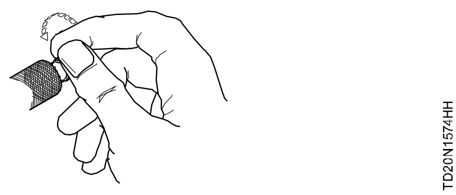
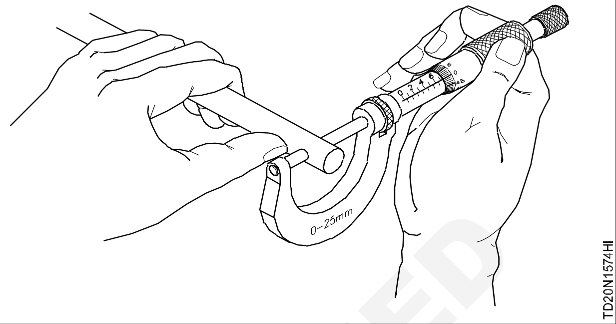


Fig 18 DEVELOP THE FEEL WITH YOUR FINGERS ALLOW THEM TO SLIP ON THE KNURL OF THE THIMBLE.



Read the measurement.

Method of reading the micrometer 0-25 range.

Look at the reading the which has been taken from the workpiece.

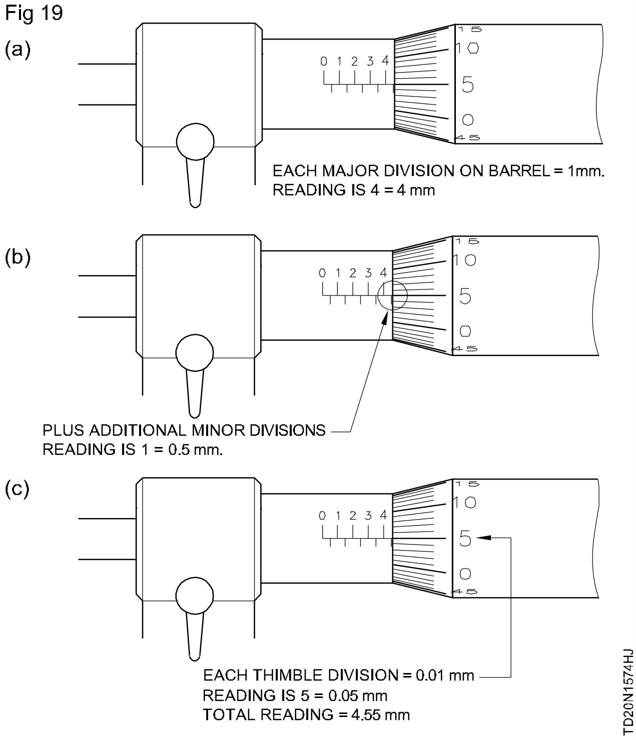
Read on the barrel scale the number of whole millimetres that are completely visible from the bevel edge of the thimble.Fig 19a shows 4 divisions = 4mm.

Add any half millimetres that are completely visible from the bevel edge of the thimble. (Fig 19a)

Fig (19b) shows 1 division =0.5mm.

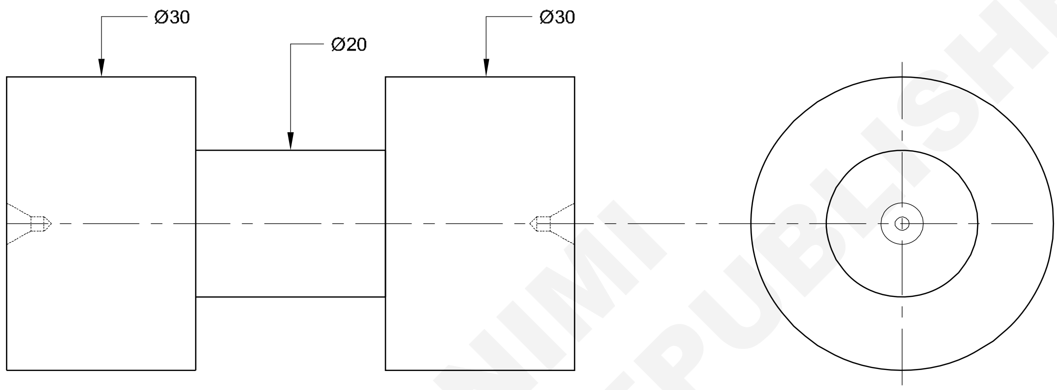
Add the thimble reading to the main scale reading which has already been taken. Fig 19c shows the 5 th division of the thimble scale is coinciding with the index line. So thimble reading =5x0.01=0.05mm. (Fig 19c)

Fig 19



Plunge grinding

Objectives: At the end of this exercise you shall be able to
- **mount the grinding wheel on the cylindrical grinding machine**
- **hold the job between centres in eccentric position**
- **grind the job to the required dimension and accuracy.**



Job Sequence

- Clean the machine completely.
- Determine the grinding allowance.
- Select the suitable grinding wheel.
- Balance the grinding wheel.
- Mount the wheel on the cylindrical grinding machine.
- Dress the grinding wheel.
- Hold the job between centres.
- Set the longitudinal position and tighten the longitudinal traverse.
- Start the grinding wheel and the job rotation.
- Work rotates in a fixed position as the wheel feeds.
- Grind the job to an accuracy of 0.01mm.
- Move the wheel away from the job and stop the movement of the wheel and the job.
- Check the dimensions with a micrometer.
- And then follow the above procedure for next plunge grinding operation.

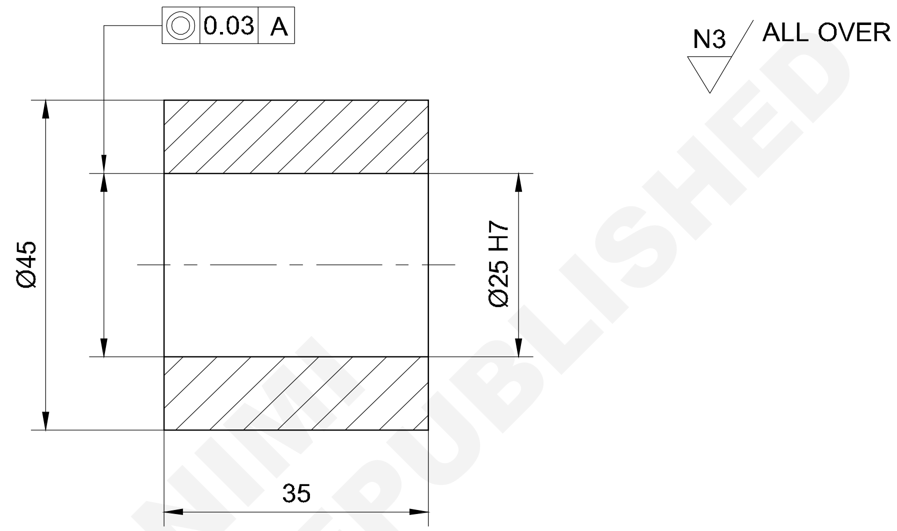
NOTE: PRE MACHINED TO SHAPE AND SIZE WITH GRINDING ALLOWANCE OF 0.5mm

1	Ø30x55mm	-	Fe310	–	–	1.5.75
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	PLUNGE GRINDING	DEVIATIONS ±0.02 / TIME
		CODE NO. TD20N1575E1

Internal parallel grinding

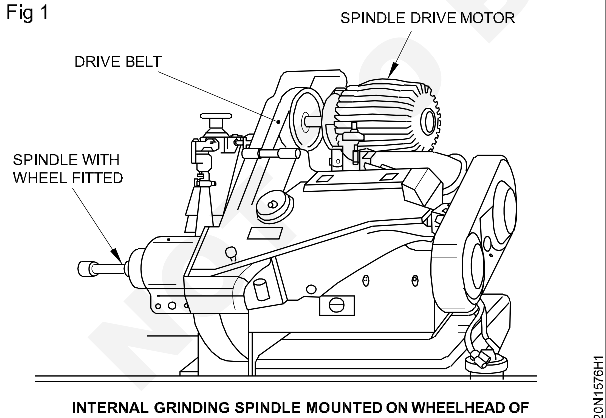
Objectives: At the end of this exercise you shall be able to
- **mount the internal grinding attachment**
- **mount the grinding wheel and dress the wheel by diamond dresser**
- **set the job in four jaw chuck by using dial test indicator**
- **grind the plain bore with an accuracy of ± 0.04**
- **measure the bore diameter by using telescopic gauge.**



Job Sequence

- Turn the part as per drawing with required grinding allowance.
- Prepare the machine for internal grinding. (Fig 1)

Fig 1



INTERNAL GRINDING SPINDLE MOUNTED ON WHEELHEAD OF UNIVERSAL GRINDING MACHINE

- Fit the spindle and mount spindle.
- Dress the wheel with a diamond tipped dressing tool.
- Measure the bore diameter of the workpiece to check the grinding allowance.
- Determine the work and wheel surface speeds and set the machine accordingly.
- Mount the workpiece in a chuck.
- True the workpiece used by dial test indicator.
- Set the length of stroke using reversing dogs.

Make sure that the traverse setting do not cause the wheel to contact any internal shoulder in the workpiece and that the wheel does not leave the workpiece surface completely at the end of the traverse strokes.

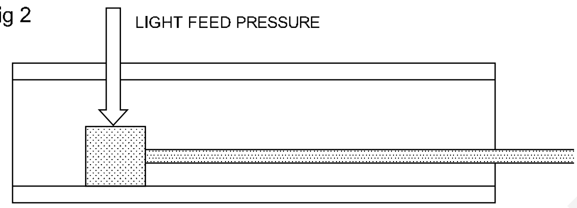
1	Ø50x40mm	-	Fe310	–	–	1.5.76
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	INTERNAL PARALLEL GRINDING	DEVIATIONS as per IS : 2102(F)	TIME
		CODE NO. TD20N1576E1	

- Put on your goggles.
- Start the grinding wheel.
- Start the head stock spindle drive.
- Check that the directions of rotation of the wheel and workpiece are opposed.
- Grind the Ø 25 x 35mm bore.
- Start coolant supply and table traverse if necessary.
- Run the grinding wheel to the workpiece by hand and advance the wheel against the bore taking a light cut.
- When cut is complete measure the bore and reset the feed.
- Make repeated cuts until close to the desired size.
- Dress the wheel again for finish grinding.
- Check the bore size, parallism and make the final cuts.
- Remove burred edges.
- Measure the base by using telescopic gauge bore.

Mounting the spindle (Fig 2&3)

Fig 2



LONG SPINDLE REQUIRES LIGHT FEED PRESSURE TO AVOID FLEXING

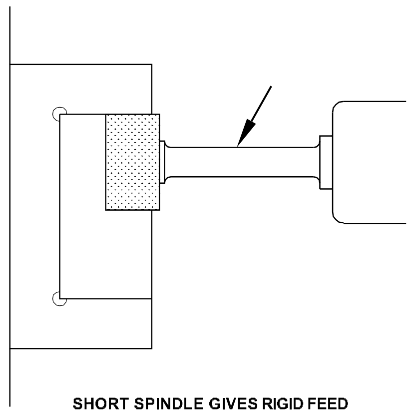
TD20N1576H2

For setting up the internal grinding spindle of a universal grinding machine, the general procedure is as follows:

- Position the internal grinding attachment, including the spindle on the wheel head and fix securely. Refer to the operators handbook for the particular machine.
- Mount the drive belt between the internal grinding drive motor and the pulley on the internal grinding attachment and adjust to proper tension.
- If a machine motor selector control is provided turn it to the 'internal' position.
- Disengage the power operated cross - feed.
- Replace any guards removed to set the attachment in place.

The spindle chosen should be as rigid as possible. Where a long workpiece is to be ground the spindle will be correspondingly long and thus subject to flexing under load. If care is not taken this flexing will cause chatter of the wheel with resultant marking of the bore surface. It will also produce a bore of uneven diameter.

Fig 3



SHORT SPINDLE GIVES RIGID FEED

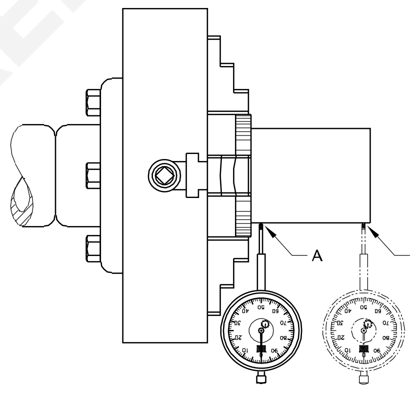
TD20N1576H3

Warning

Due to the nature of the operation a wheel guard is not used during internal grinding operations. The workpiece serves as a guard during actual grinding, but remember that the unguarded wheel is a definite safety hazard when not within a workpiece. Keep your hands away from the moving wheel and wear close fitting clothing. If a guard is available on the machine to the wheel when not actually grinding, make sure this set in place after the wheel is retracted from the workpiece.

Set the job in four jaw chuck using dial test indicator. (Fig 4)

Fig 4



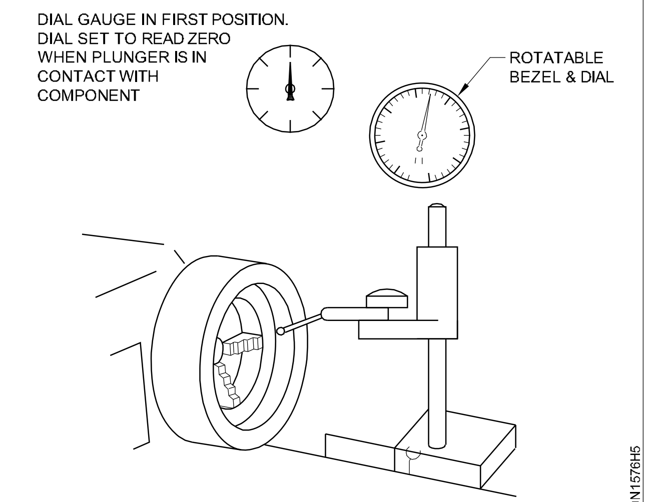
WORK MUST BE TRUED IN THE FOUR-JAW CHUCK SO THAT THE INDICATOR READINGS AT A & B ARE THE SAME.

TD20N1576H4

- Hold the job in a four jaw chuck.
- Mount the dial stand on machine table.
- Fix the dial and touch on the job.
- Move the dial and rotate the job.
- Check the trueness of the job with the indicator at zero position.
- Incase of difference in reading adjust the jaw and rotate the chuck.
- The dial moving at A and B are the same reading at zero.

Grinding a parallel bore (Figs 5&6)

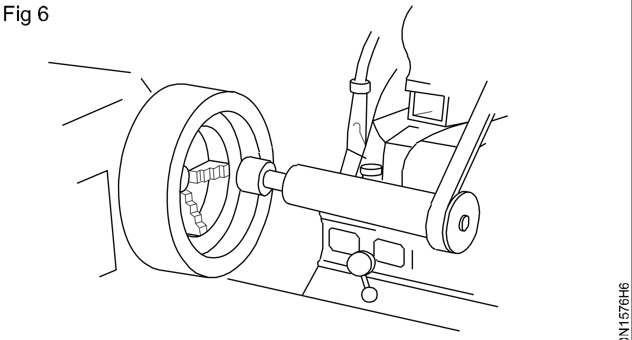
Fig 5



GRINDING A PARALLEL BORE IN A CHUCK MOUNTED WORKPIECE

- Set up the machine for internal grinding
- Fit the spindle and mount the wheel.
- Dress the wheel with a diamond tipped dressing tool.
- Measure the diameter of the workpiece to check the grinding allowance.
- Determine the work and wheel surface speeds and set the machine accordingly.
- Mount the workpiece in a chuck or other suitable support on the machine headstock.
- True the workpiece in the head stock and align the headstock to the work table.

Fig 6



GRINDING A PARALLEL BORE IN A CHUCK MOUNTED WORKPIECE

- If table traverse is necessary, adjust the machine by setting the table reversing dogs.

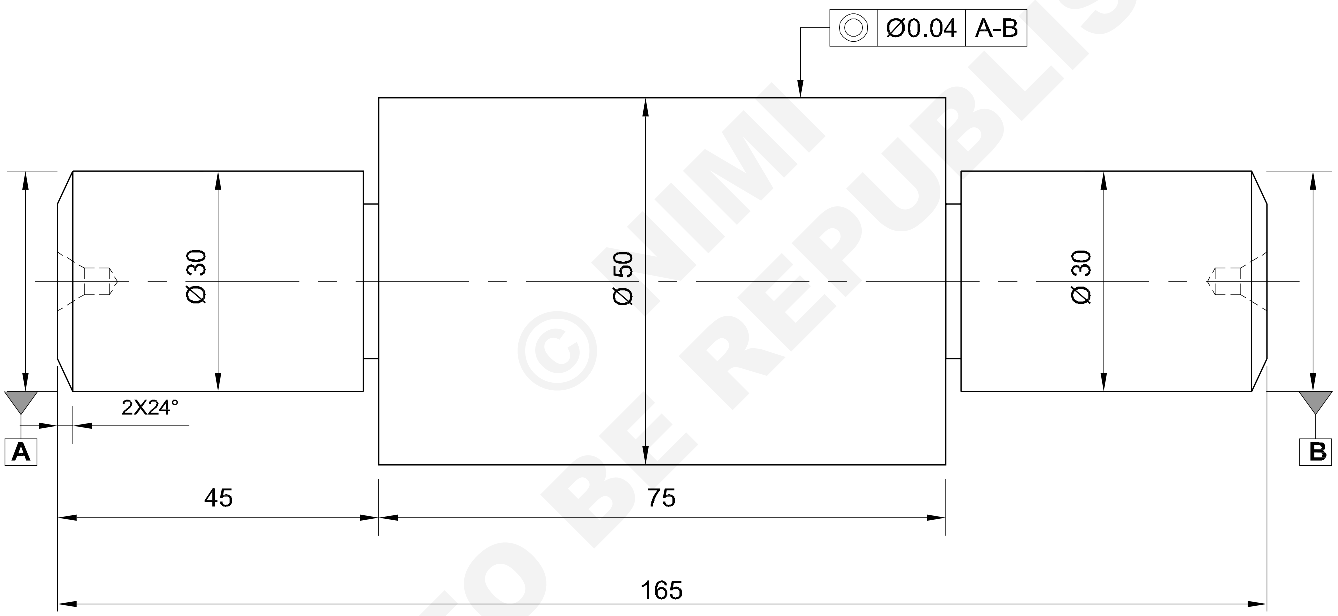
Caution

Make sure that the traverse settings do not cause the wheel to contact any internal shoulder in the workpiece and that the wheel does not leave the workpiece surface completely at the end of the traverse strokes.

- Put on your goggles.
- Start the grinding wheel
- Start the headstock spindle drive
- Check that the directions of rotation of the wheel and workpiece are opposite.
- Start coolant supply and table traverse if necessary.
- Run the grinding wheel to the workpiece by hand and advance the wheel against the bore, taking a light cut.

Grinding of step cylindrical grinding with an accuracy of ± 0.01mm

Objectives: At the end of this exercise you shall be able to
- **grind by the traverse feed method with an accuracy ±0.01mm**
- **dress the grinding wheel**
- **grind steps with shoulder**
- **check and measure the dimension with an outside vernier micrometer**
- **check the concentricity of the job.**



NOTE: PRE MACHINED TO SHAPE AND SIZE WITH GRINDING ALLOWANCE OF 0.5mm

1	Ø55x170mm	-	Fe310	-	-	1.5.77
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE NTS	EXTERNAL STEP CYLINDRICAL GRINDING	DEVIATIONS ±0.01	TIME :
		CODE NO. TD20N1577E1	

Job Sequence

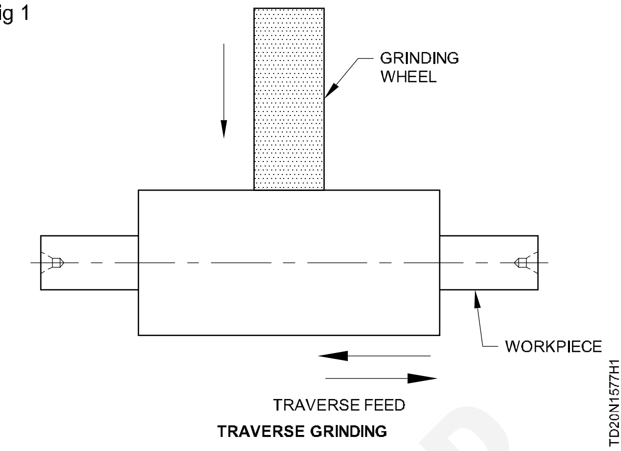
- Study the drawing, turn the job as per drawing and maintain the size with grinding allowance.
- Ascertain the grinding allowance.
- Check the grinding wheel is rotating in correct direction.
- Set the work head, wheel head and table at 0º.
- Dress the wheel.
- Mount the workpiece in between centres with carrier.
- Start the machine for grinding wheel rotating.
- Move the grinding wheel back about 50 mm from the workpiece to allow the wheel to clear the carrier.

This will prevent accidental contact between the wheel and the carrier.

- Set the length of stroke.
- Move the table automatically in traverse feed. (Fig 1)
- Rough finish to grind the step ∅50 x 75 mm long.
- Feed the work traversely.
- Grind the step ∅30 x 45 mm long rough and finish grinding at both ends one after other. (Fig 2)
- Remove the job from the centres and dog carrier.
- Measure and check the job using by outside vernier-micrometer (25-50 mm).
- Check the concentricity of job using Dial Test Indicator.

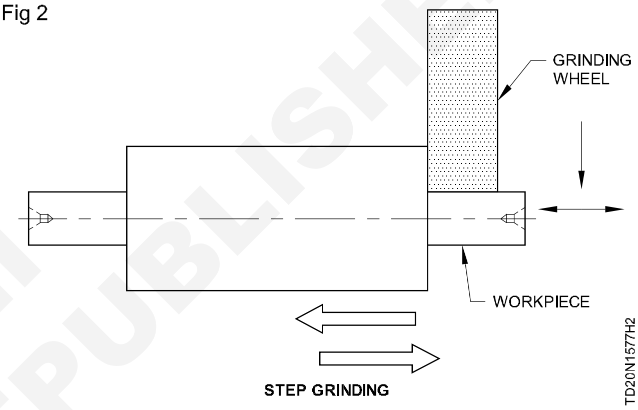
Keep your hands away from the revolving wheel at all times to avoid injuries to yourself.

Fig 1



TRAVERSE GRINDING

Fig 2



STEP GRINDING

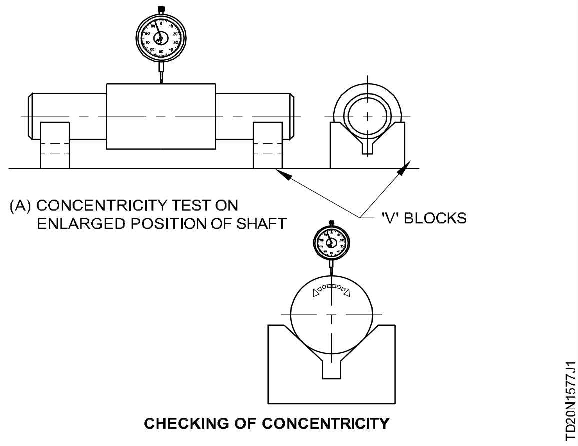
Skill Sequence

Checking the concentricity of job (Fig 1)

Objective: This shall help you to
- **check the concentricity of the cylindrical job using 'V' block and DTI.**

- Mount the job in 'V' blocks.
- Touch the dial plunger on job.
- Rotate the job for concentricity test.
- See the reading of dial.
- Measure the reading position of Dial Test Indicator for concentricity.

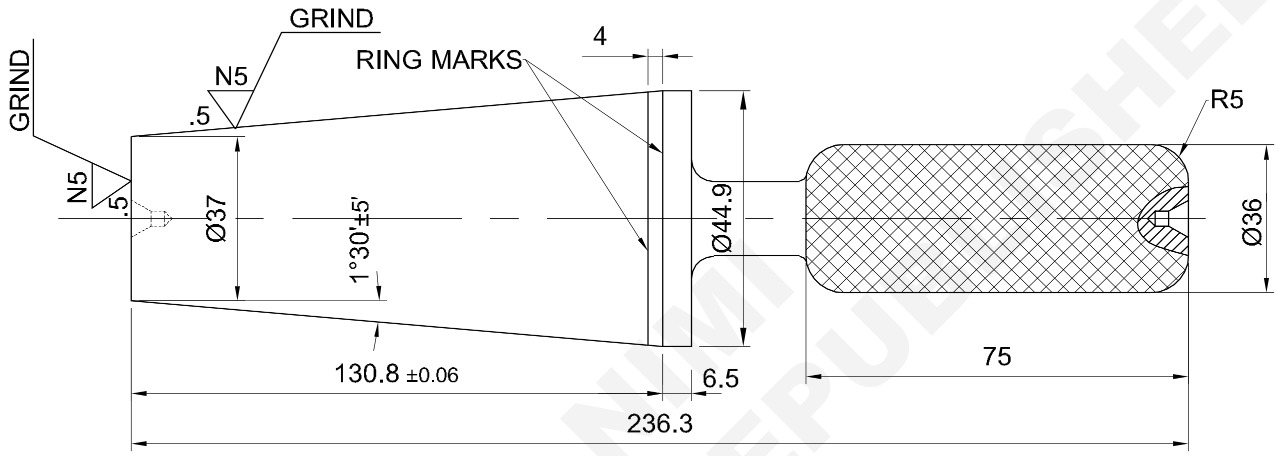
Fig 1



CHECKING OF CONCENTRICITY

External grinding taper in cylindrical grinding with an accuracy of ± 0.01mm

Objectives: At the end of this exercise you shall be able to
- **hold the job in chuck**
- **set the table according to taper angle**
- **set cutting speed, feed and depth of cut**
- **rough grind & finish grind the workpiece within accuracy**
- **check the taper by using standard gauge.**



Job Sequence

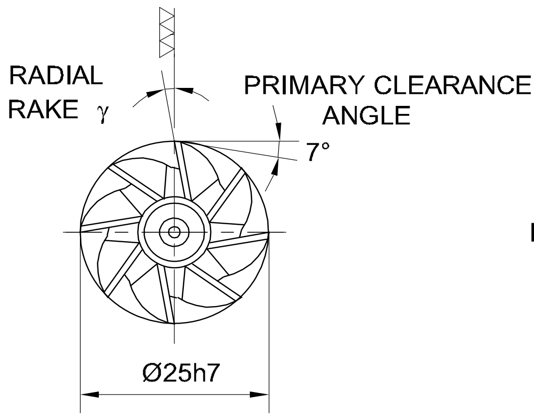
- Determine the grinding allowance.
- Balance the grinding wheel.
- Mount the wheel on the cylindrical grinding machine.
- Dress the grinding wheel.
- Hold the job in between centres.
- Tilt the table of 1°30 to grind.
- Set the table traverse dog to grind 130.8 mm length on the taper end.
- Start the grinding wheel and the job for rotation.
- Bring the wheel to the job and allow it to touch.
- Grind the job (giving required feed) to an accuracy of ± 5 minutes.
- Move the wheel away from the job and stop the movement of the wheel and job.
- Check the taper angle with a vernier bevel protractor.

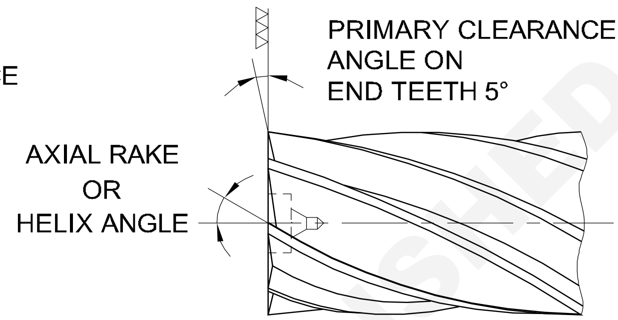
Note: Pre machined workpiece with 0.5 mm grinding allowance only on taper.

1	Ø45x236.3mm		Fe310			1.5.78
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.
SCALE 1:1	EXTERNAL TAPER CYLINDRICAL GRINDING WITH AN ACCURAY OF ±0.01mm				DEVIATIONS ±1	TIME
					CODE NO. TD20N1578E1	

Demonstrate and practice of grinding of end mill cutter

Objectives: At the end of this exercise you shall be able to
- **set tool and cutter grinder for sharpening end mill cutter**
- **sharpen peripheral teeth of helical fluted teeth**
- **sharpen end teeth of end mill cutter.**





RECOMMENDED TOOL GEOMETRY (END MILL CUTTER)

MATERIAL	MILLING OPERATION	TOOL MATERIAL	AXIAL RAKE	RADIAL RAKE	CLEARANCE ANGLE ON END TEETH	PRIMARY CLEARANCE				
						DIA mm				
STEEL OPERATION	END	H.S.S	30 TO 35	10 TO 20	3 TO 7	6	10	12	16	20
						12°	11°	10°	9°	8°
CAST IRON MACHINABLITY	"	"	"	12	"	"	"	"	"	"
ALUMINIUM	"	"	30 TO 45	15 TO 20	8 TO 12	15°,14°,13°,12°, 10°				

Note: Trainer shall demonstrate on resharpening of end mill Ø32, Ø20 and Ø10mm and ask trainees to practice it with recommended tool geometry given in table

1	-	BLEND END MILL	-	-	-	1.5.79
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX. NO.

SCALE 1:1	**DEMONSTRATE AND PRACTICE OF GRINDING OF END MILL CUTTER**	DEVIATIONS ±0.06	TIME :
		CODE NO. TD20N1579E1	

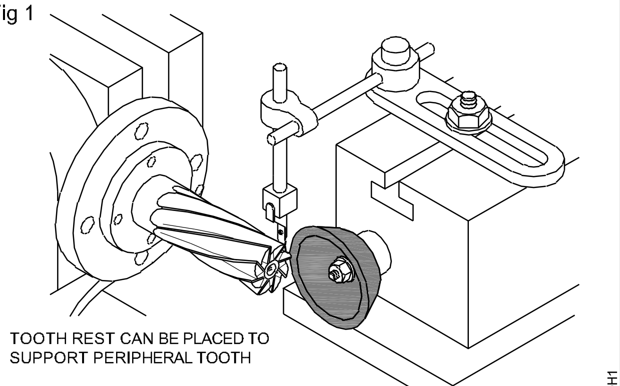
Job Sequence

Sharpen an end mill cutter

- An end mill cutter is sharpened in two separate operations.
  - Sharpening of peripheral teeth
  - Sharpening of end teeth.

Peripheral teeth (Fig 1)

Fig 1



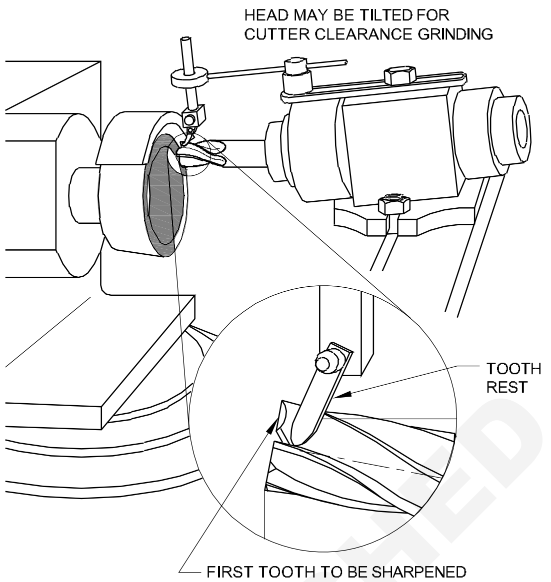
SET-UP FOR GRINDING PERIPHERAL TEETH OF END MILL

- Mount the end mill in the cutter head.
- Mount a taper cup wheel and true its cutting face.
- Align the axis of the wheel spindle and cutter head spindle using a centre gauge.
- Set the work head at zero graduation.
- Fix tooth rest to the wheel head and set it to the desired clearance angle (7°) and helix angle of the flute.
- Offset the wheel head axis by 1° or 2° to clear opposite rim of grinding wheel.
- Sharpen the edge of first tooth by traversing the wheel using the table traverse and at the same time rotate the cutter head spindle by hand following the helical path.
- Rotate the cutter through 180° and sharpen the opposite teeth.
- With a micrometer, check the ground teeth for taper.
- Adjust the cutter head if necessary to eliminate taper.
- Sharpen all other teeth.

End teeth

- Rotate the cutter head to 90°.
- Mount the tooth rest on the cutter head and set it to level with centre gauge.
- Till the cutter head to the required primary clearance angle i.e. 7° (Fig 2)

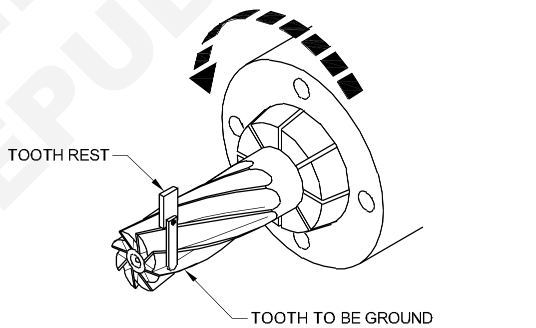
Fig 2



SET-UP FOR GRINDING END TEETH ON END MILL

- Set the first tooth on the tooth rest, parallel to the top surface of the table (Fig 3)

Fig 3



SET-UP FOR GRINDING CLEARANCE ON END TEETH

Tooth rest should support the peripheral tooth edge as close as possible to the edge of the end tooth.

Sharpen the first tooth, taking only light cuts.

Sharpen all the remaining teeth in turn.

Secondary clearance

- Tilt the cutter head to 15° and adjust the tooth rest suitably to grind secondary clearance.
- Grind secondary clearance on all the teeth, leaving 1 mm land.

Skill Sequence

Preparing tool and cutter grinder for re-sharpening end mill cutters

Objectives: This shall help you to
- **keep the tool and cutter grinder ready for re-sharpening work**
- **use particular holding arrangement according to the type of cutter.**

Study your machine and understand the purpose and effect of every handle and hand wheel.

Refer to the instructional manual supplied by the machine manufacturers for function and identification of each operating control.

Clean thoroughly the working surface of the work table and other working area with a clean banian cloth waste.

Ascertain the position of every lubricating point and see that all get the required quantity of correct grade of oil regularly.

Make sure that the oil in the wheel head, the work head, and the traverse gearbox is maintained at the correct level with the oil recommended by the machine manufacturers.

Check the lubrication of the table ways each morning , as they wear rapidly if allowed to run dry.

Avoid spots of oil on the grinding wheel while refilling.

Always warm up the machine before commencing to grind or to dress the wheel.

Be familiar with the following electrical controls.

- Wheel spindle- 'ON-OFF' switch for changing the direction of rotation.
- Switch for power elevating 'UP' and 'DOWN'
- Dust extractor - 'ON-OFF' switch.

Be familiar with the following mechanical arrangements.

- Swivel the wheel head to the required angle and locking it firmly.
- Adjust the height of the wheel head and direction of rotation of the hand wheel manually for 'UP' & 'DOWN' movement and the method of locking it.
- Swivel the work table to the required angle and lock it.

Remove 'Taper dowels' if provided for 'O' setting before swivelling the table.

Cross- traverse movement of the work table and remember the value of the graduations on the graduated dial.

Lock the work table in position.

Mount the cutter head on the work table and be familiar with the method of swivelling it or tilting it to the required angle.

Mount and adjust the indexing attachment on the cutter head.

Mount the tailstock centres on the work-table.

Spring loaded tailstock should always be mounted on the RIGHT HAND END of the work table.

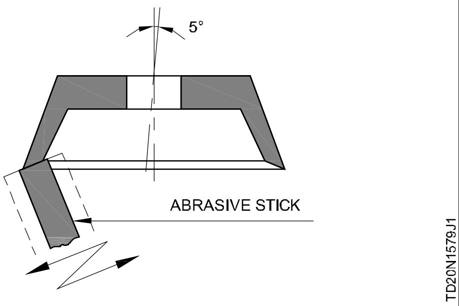
- Mount the clearance angle setting gauge on the left hand tailstock.
- Tilt the wheel head to the required clearance angle, if the machine is of tilting wheel head type.

Mount the taper cup wheel and dress the edge to 5° (Fig 1)

If the face of the cup or saucer wheel is dressed flat and smooth with a diamond, it will not freely cut, but will create heat and cause distortion. Hence it is advised to dress the wheel by off-hand method with a carborundum stick (25 mm, SQ-8) forming an angle of 5° on the face of the wheel thus presenting a single edge to the work.

Select and mount the correct type of cutter holding device suitable for the given cutter and grinding operation.

Fig 1



- Cutters with bore are held on plain mandrel and the mandrel, in turn, is held between centres of tailstocks. e.g. slab mills side and face cutters, form relieved gear cutters etc.
- Cutters with bore, peripheral and face teeth are held in the stub arbor, which, in turn is fitted with a cutter head through draw- in bolt. Eg. Shell end mill or face mill, angular cutters etc.
- Cutters with Morse Taper shank are held in suitable M.T. sleeves in the cutter head. Eg. End mills, Tee-slot cutters etc.
- Cutters with parallel shank are held in suitable collets, which in turn are fitted in the cutter head through draw-in bolt. Eg. End mills of small sizes, slot drills, wood-ruff key seat cutters etc.

Creating simple mould design drawing

Objectives: At the end of this exercise you shall be able to
- **open auto CAD, create file, view file, save file, close file end quit AutoCAD**
- **start new drawing with commands, lines circles arcs, polygons rectangles ellipse**
- **opening existing file and editing**
- **creation of object properties with layers**
- **execute the dimensioning command**
- **creating isometric views**
- **creating 3D views in view ports**
- **draw the hand injection mould parts and assemble it.**

Job Sequence

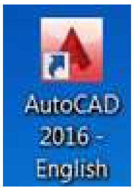
TASK 1: **Opening AutoCAD, Creating File, Viewing File, Saving File, Closing File and Quit AutoCAD**

Start a Drawing in AUTOCAD

Method 1

- Ensure the System is ON, otherwise boot the system.
- Windows screen will appear.
- Place cursor on AutoCAD Icon and double click to switch on AutoCAD Screen (FIg 1).

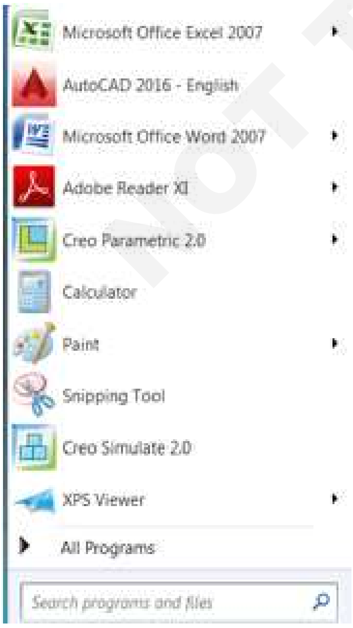
Fig 1



Method 2

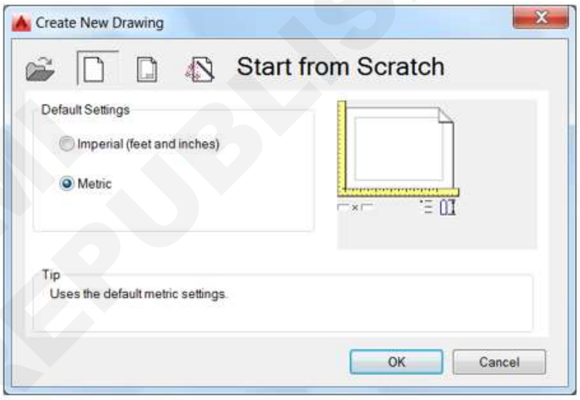
- Place cursor on start button and Main menu options appear.
- Double click AutoCAD - English as shown bellow (FIg 2).

Fig 2



Starting a new Drawing (Fig 3)

Fig 3



Command : New (Start from Scratch)

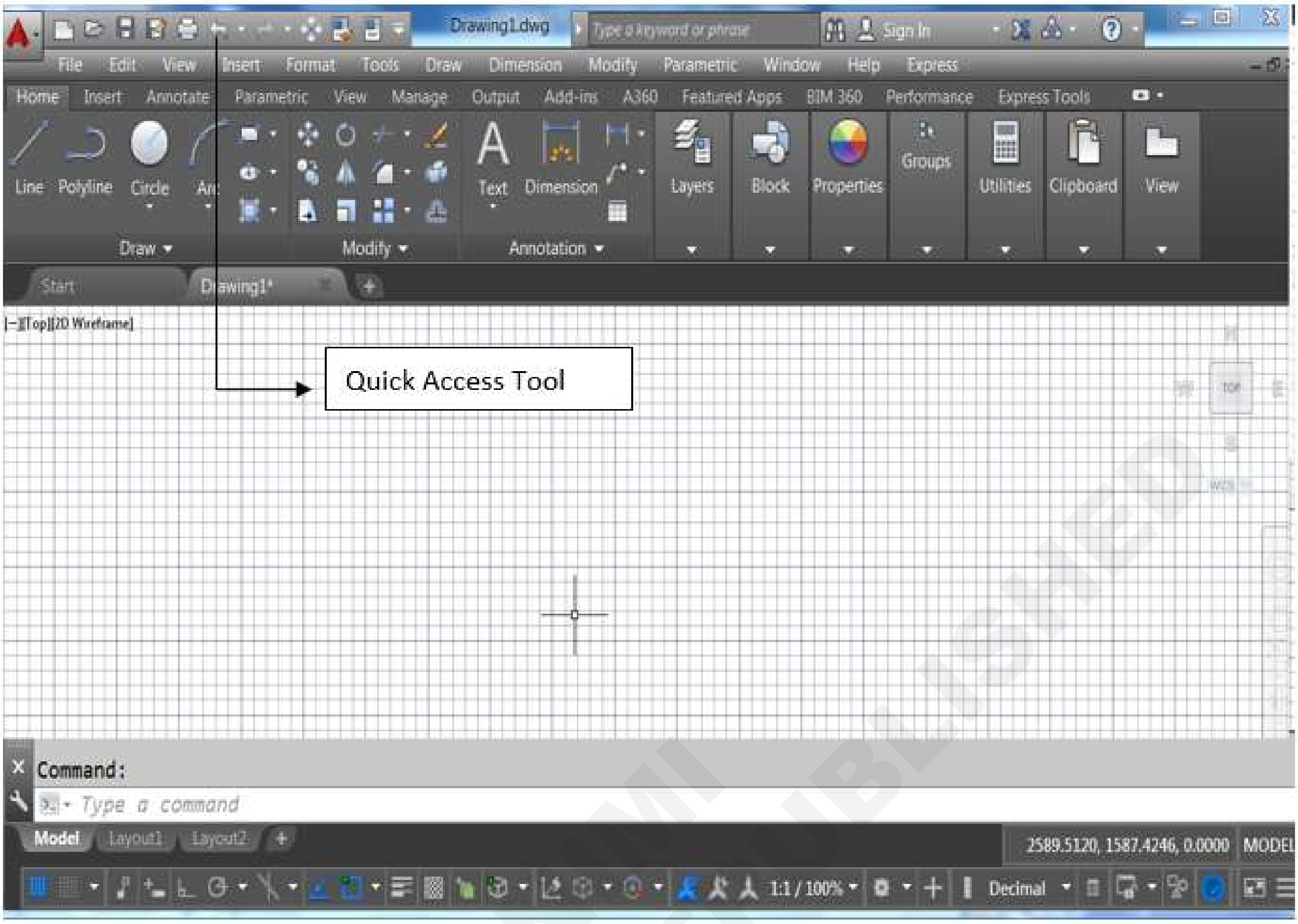
Metric

OK

Observe the Drawing area (FIg 4)

- Move Mouse -The cursor moves
- Position the cursor and place it on any Toolbar and observe the tool tip given.
- Pick on Draw Tool - All tools will be displayed- Observe that some of the tools have bottom pointing arrows
- Place the cursor on the icon with bottom pointing arrows- more tools will be displayed.
- Observe the coordinate system icon display X and Y axis.
- Type U at the command prompt will undo any previous action.

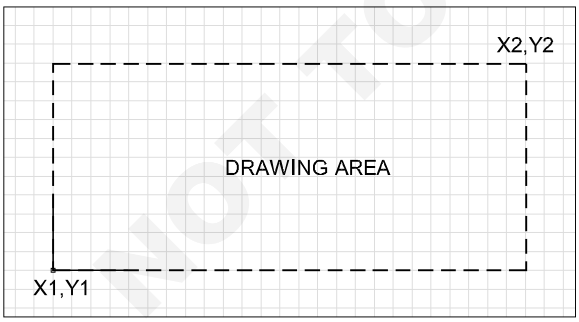
Fig 4



Set the Limits (Fig 5)

- Command: Limits
- Specify the lower left corner
- Specify the upper right corner.

Fig 5



TDN1693H5

Zoom to the Limits

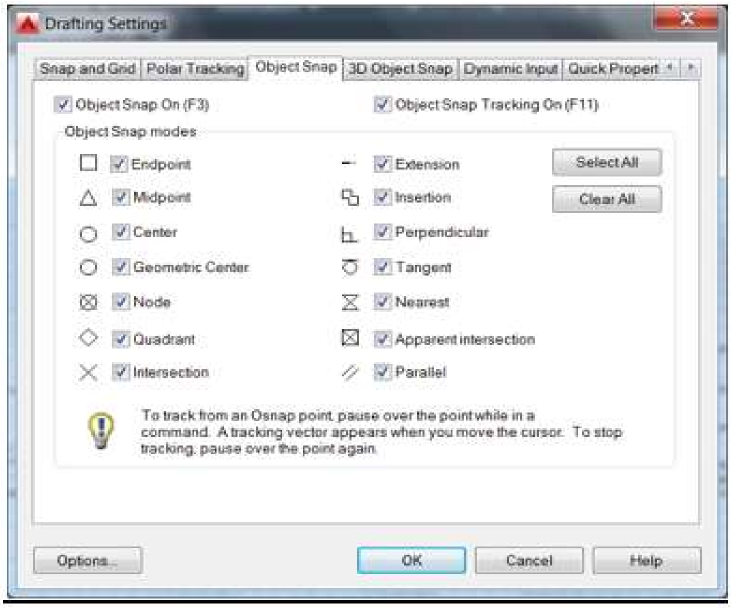
- Command : **Zoom**
- Specify corner of window, enter a scale factor (Nx or Nxp)or,
- (All, Center, Dynamic, Extents, Previous, Scale, Window)
- Select All
- Screen will be regenerated.

It is not possible to give a higher value for the lower left corner than the upper right corner

Set Cursor snap points (Fig 6)

- Command : **Osnap**
- Following screen will popup. Select all the snap modes and switch on object snap and object tracking on.

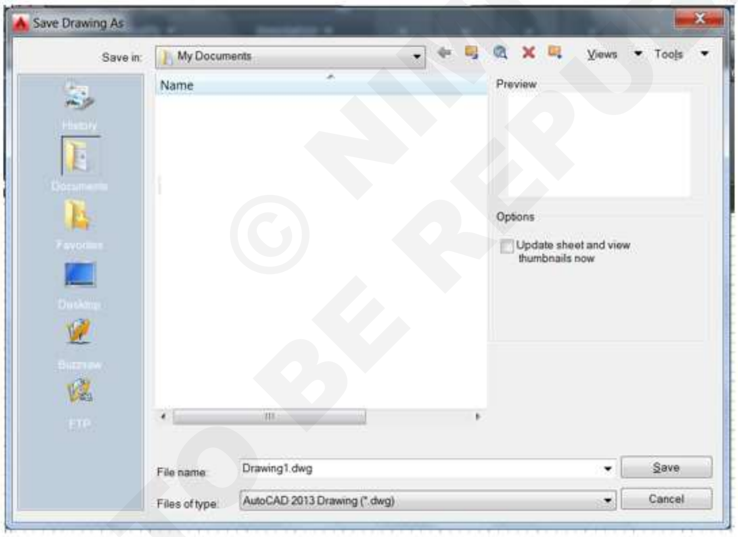
Fig 6



Save the file

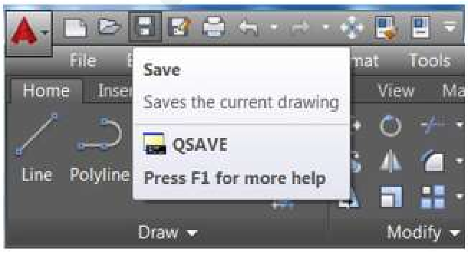
- Command : **Save (Fig 7)**
- The following screen will appear. Save file with respective file name to the respective folder.

Fig 7



- You can also click on the save icon on quick access toolbar on right hand top of screen (Fig 8).
- Quick Access Tool bar
- Save – File

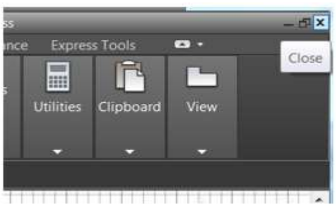
Fig 8



Quit AutoCAD (Fig 9)

- Command : **Quit**
- You will be prompted to save the file and close.
- Or select icon on the right top corner and close drawing.
- Close File and Quit AutoCAD

Fig 9



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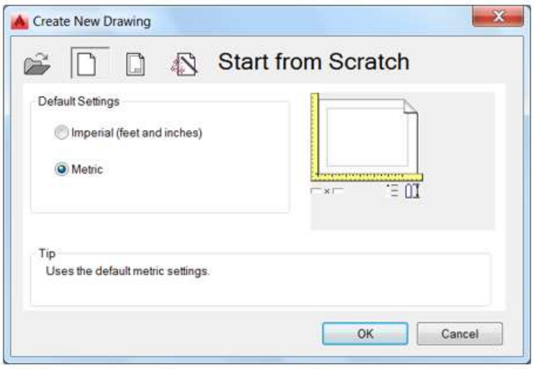
TASK 2: **Starting a new drawing and executing line, circles, arcs, polygons, rectangles elipse**

Method of beginning a New Drawing

- From startup dialogue pick Start from Scratch, Metric and pick OK (FIg 1).
- Set limits on screen and Zoom all.

Fig 1



Draw line in absolute coordinate system (Fig 2)

Fig 2

Using Absolute coordinate system

Command : Line

Specify the first point (0,0)

Specify the next point (20,0)

Specify the next point (14,9)

Specify the next point (45.2,9)

Specify the next point (40,0)

Specify the next point (60,0)

Specify the next point (60,40)

Specify the next point (50,50)

Specify the next point (10,50)

Specify the next point (0,40)

Specify the next point (0,0)

Close

Draw line in Relative coordinate system

Command : Line

Specify the first point (0,0)

Specify the next point (@20,0)

Specify the next point (@-5.2,9)

Specify the next point (@30.4,0)

Specify the next point (@-5.2,-9)

Specify the next point (@20,0)

Specify the next point (@0,40)

Specify the next point (@-10,10)

Specify the next point (@-40,0)

Specify the next point (@-10,-10)

Specify the next point (@0,-40)

Close

Draw line in Polar coordinate system

Command: **Line**

Specify the first point (0,0)

Specify the next point (@20<0)

Specify the next point (@9<120)

Specify the next point (@30<0)

Specify the next point (@9<240)

Specify the next point (@20<0)

Specify the next point (@40<90)

Specify the next point (@10<135)

Specify the next point (@47<180)

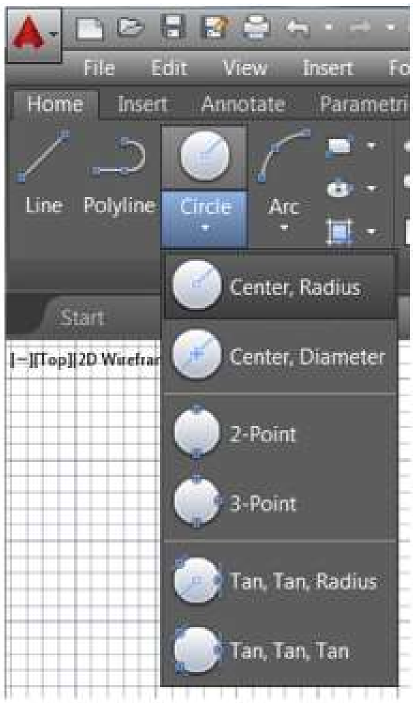
Specify the next point (@10<225)

Specify the next point (@40<270)

Close.

Draw a Circle (Fig 3)

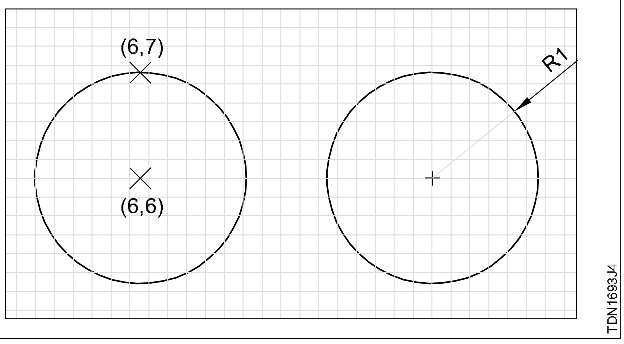
Fig 3



Command : **Circle (Fig 4)**

- Specify Center of Circle
- Specify Radius of Circle

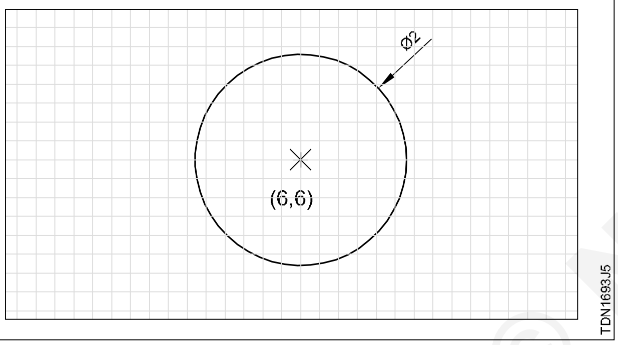
Fig 4



Command : **Circle (Fig 5)**

- Specify Center of Circle
- Specify Diameter of Circle

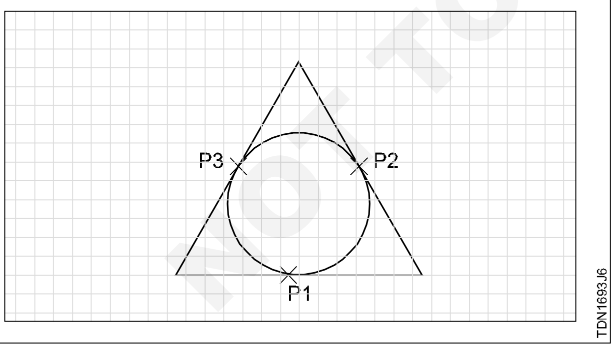
Fig 5



Command : **Circle (Fig 6)**

- Specify First point of circle P1
- Specify First point of circle P2
- Specify First point of circle P3

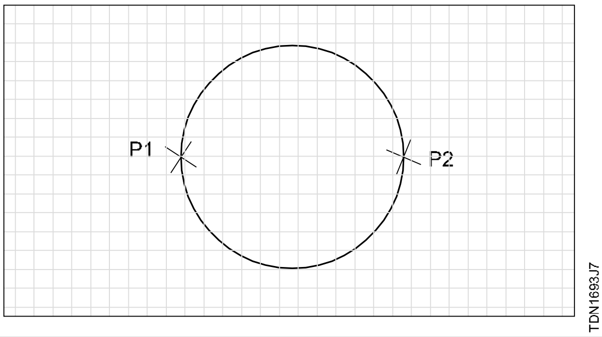
Fig 6



Command : **Circle (Fig 7)**

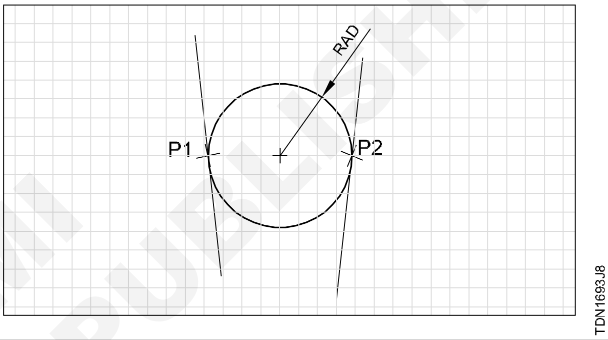
- Specify First point of circle P1
- Specify First point of circle P2

Fig 7



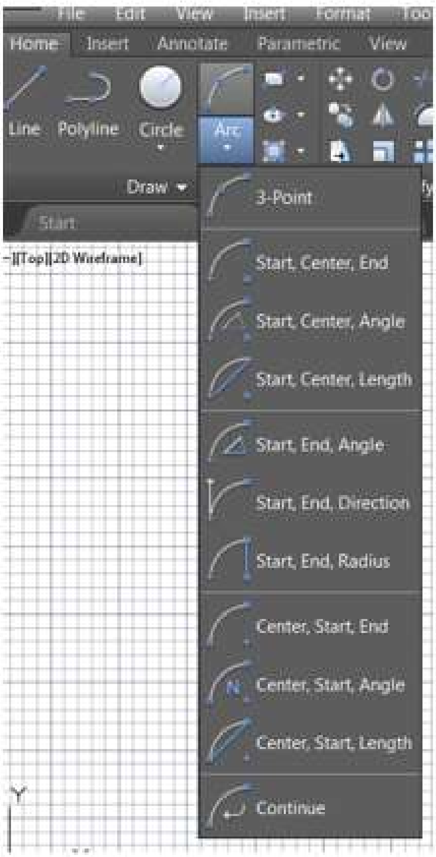
- Command : **Circle (Fig 8)**
- Specify First Tangent of circle P1
- Specify Second Tangent of circle P2
- Specify Radius of Circle

Fig 8



To draw an Arc (Fig 9)

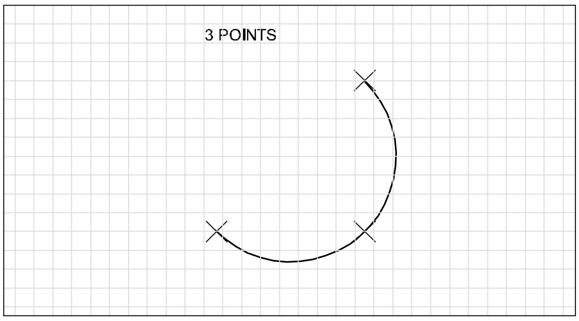
Fig 9



Command : Arc (Three Points) (Fig 10)

- Specify First of Arc
- Specify Second Point of Arc
- Specify Third Point of Arc

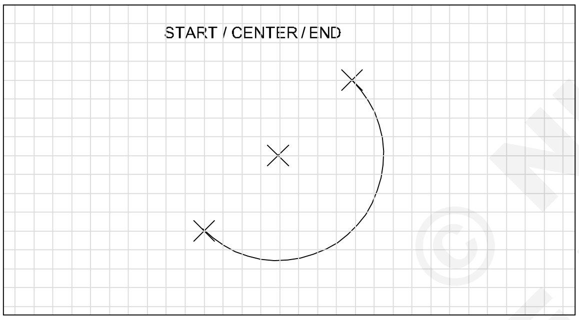
Fig 10



Command : Arc (Start, Center, End) (Fig 11)

- Specify Start Point of Arc
- Specify Center Point of Arc
- Specify End Point of Arc

Fig 11



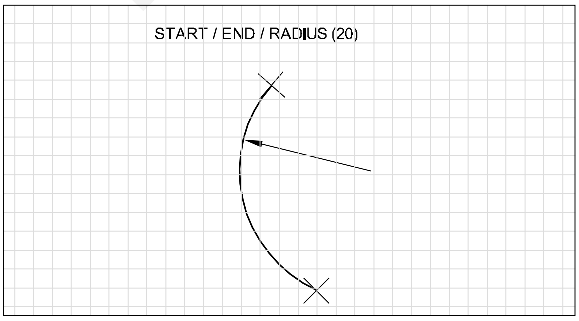
Command : Arc (Start, End, Radius) (Fig 12)

- Specify First Point of Arc
- Specify End Point of Arc
- Specify Radius of Arc

Command : Arc (Start, Center, Angle)

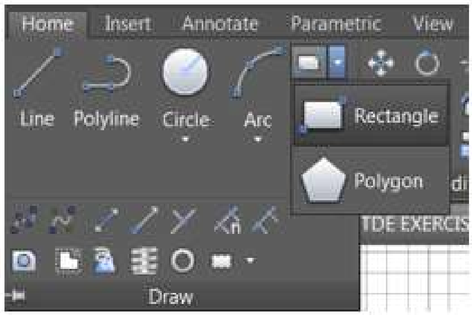
- Specify Start Point of Arc
- Specify Center Point of Arc
- Specify Included Angle of Arc

Fig 12



Draw a Polygon (Fig 13)

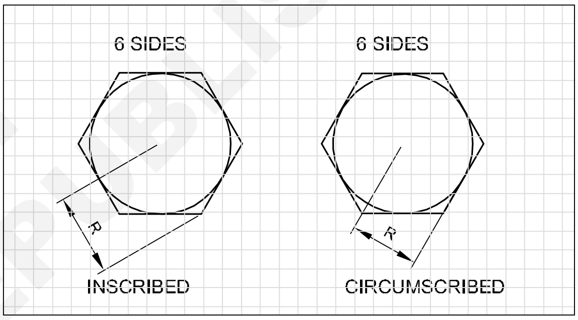
Fig 13



Command : **Polygon (Fig 14)**

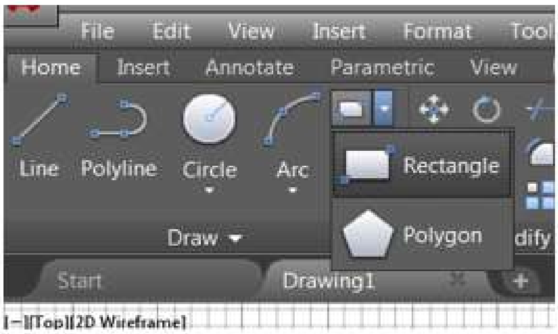
- Specify No of sides
- Specify Center of Polygon
- Enter an option (Inscribed in circle, Circumscribed in circle)
- Specify Radius of Circle

Fig 14



Draw a Rectangle (Fig 15)

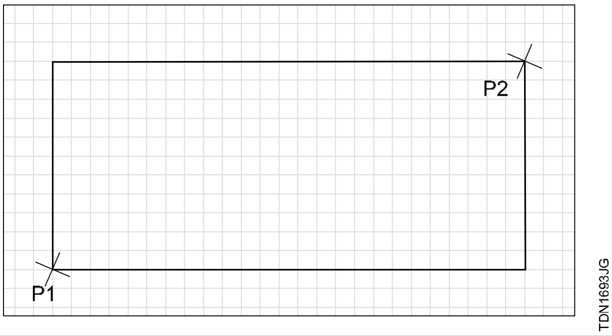
Fig 15



Command : **Rectangle (Fig 16)**

- Specify first corner point
- Specify second corner point

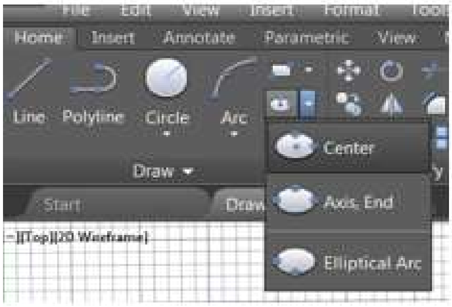
Fig 16



Draw an Ellipse (Fig 17)

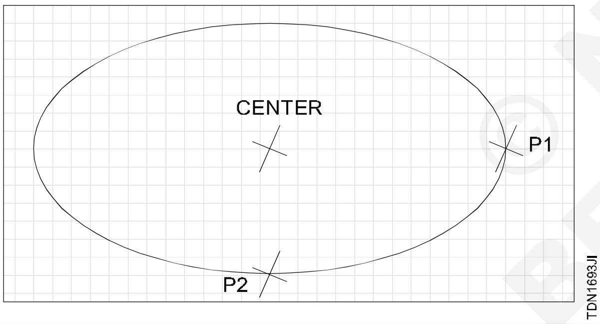
- Command : **Ellipse**

Fig 17



Draw an ellipse with Center (Fig 18)

Fig 18

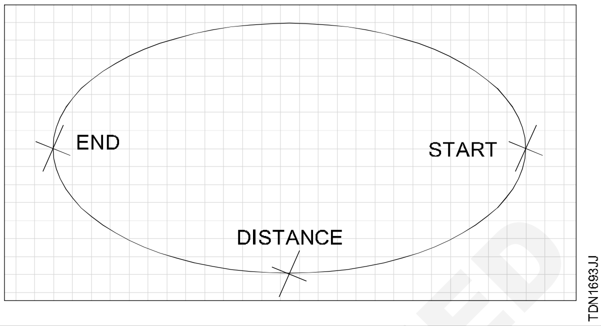


- Command Ellipse
- Specify Center Point of Ellipse
- Specify major Radius of Ellipse
- Specify Minor Radius of Ellipse

Draw an ellipse with Axis and End (Fig 19)

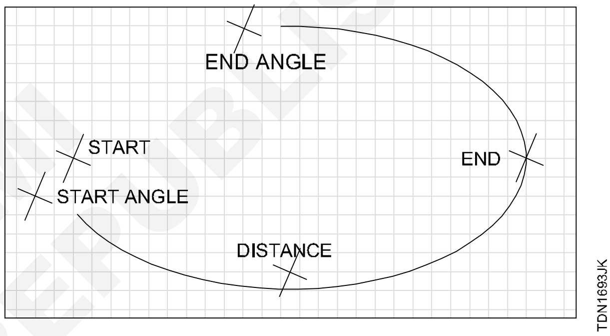
- Command **Ellipse**
- Specify start point of Major axis
- Specify end point of major axis
- Specify Distance to the other axis of Ellipse

Fig 19



Draw an ellipse with Elliptical Arc (Fig 20)

Fig 20



- Command **Ellipse**
- Specify end point of elliptical arc
- Specify other end point of elliptical arc
- Specify distance to the other axis
- Specify start angle
- Specify end Angle

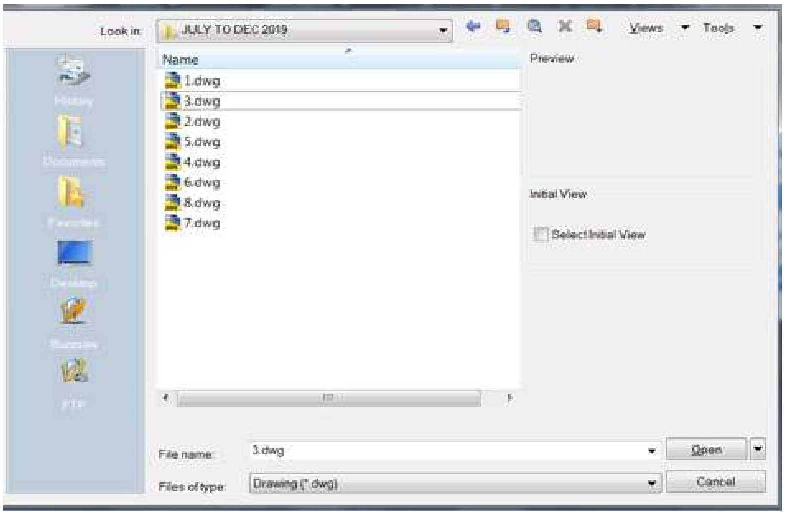
— — — — — — — —

TASK 3: **Opening existing file and editing.**

Drawings saved with the .dwg format , can be opened for viewing, plotting ,or for editing commands like Erase, Move, Rotate, Copy, Scale, Mirror, Array , Fillet, ,Chamfer , Extend, Trim , Break, Join

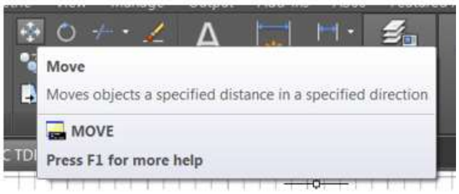
- Command: Open
- Following screen will appear.
- Select the desired file to open and click open on the screen. (Fig 1)

Fig 1



Command: Move (Fig 2)

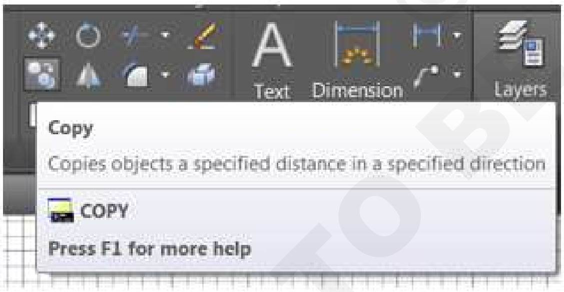
Fig 2



- Select objects
- Specify first corner
- Specify opposite corner
- Select base point of displacement
- Specify second point of displacement.

Command: Copy (Fig 3)

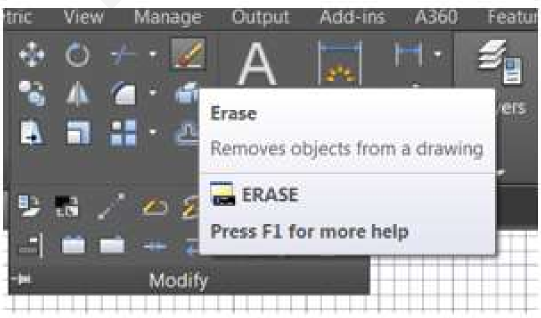
Fig 3



- Select objects to copy
- Select base point of displacement
- Specify second point of displacement.

Command: Erase (Fig 4)

Fig 4



- Select objects to erase
- Press enter

Command : Mirror (Fig 5)

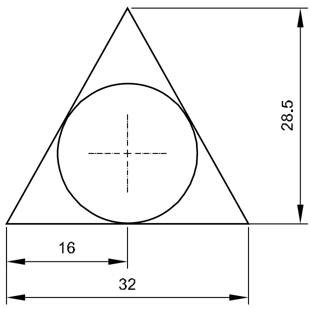
- Select objects Mirror
- Select first point of mirror line
- Select second point of mirror line
- Erase source objects (yes / no)
- Press Enter

Fig 5

Command : Line (Fig 6)

- Start point 0,0 --- Next point 32,0 --- Next point 16,28.5 --- Next point 0,0
- Command : Circle (Tan, Tan , Tan)
- Command : Mirror the Triangle
- Command : Trim
- Command : Scale

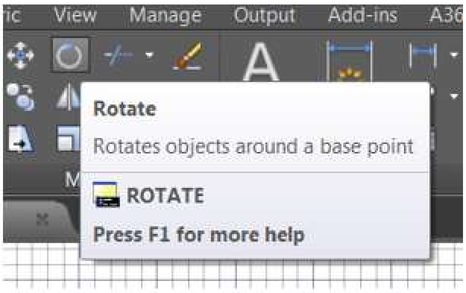
Fig 6



TDN1693M6

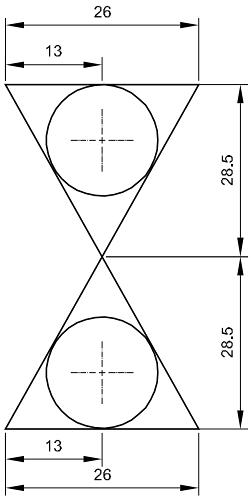
Command : Rotate (Fig 7)

Fig 7



- Select objects to Rotate
- Select base point of rotation
- Specify rotation angle (FIg 8)

Fig 8



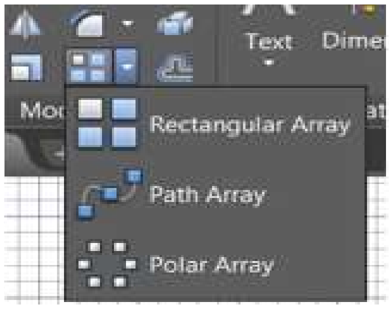
Command : Scale (Fig 9)

- Select objects to Scale
- Select base point
- Specify scale factor

A positive angle rotates in counter clockwise direction and negative angle rotates in clockwise direction.

Using Command Array (Fig 10)

Fig 10



Command: Rectangular Array (Fig 11)

- Select objects (dia 25 circle)
- Specify no of items in rows (5 nos)
- Specify no of items in columns (5 nos)
- Specify distance between rows (15 mm)
- Specify distance between columns (15 mm)

Fig 11

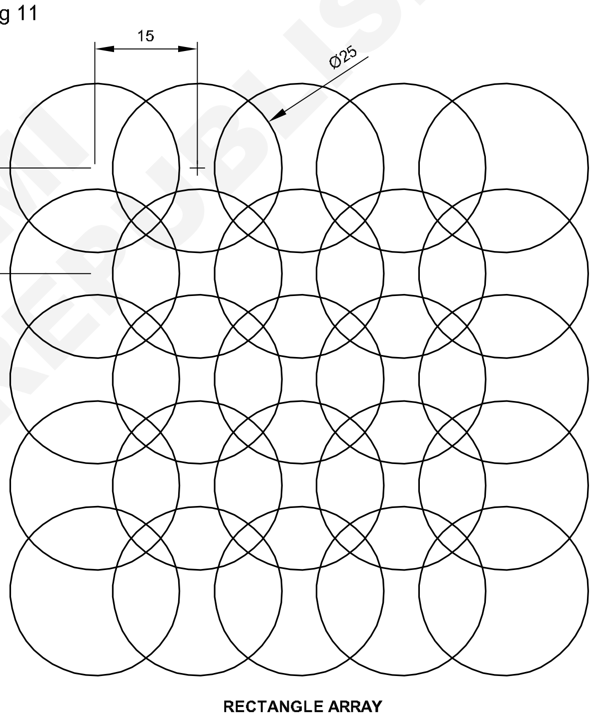
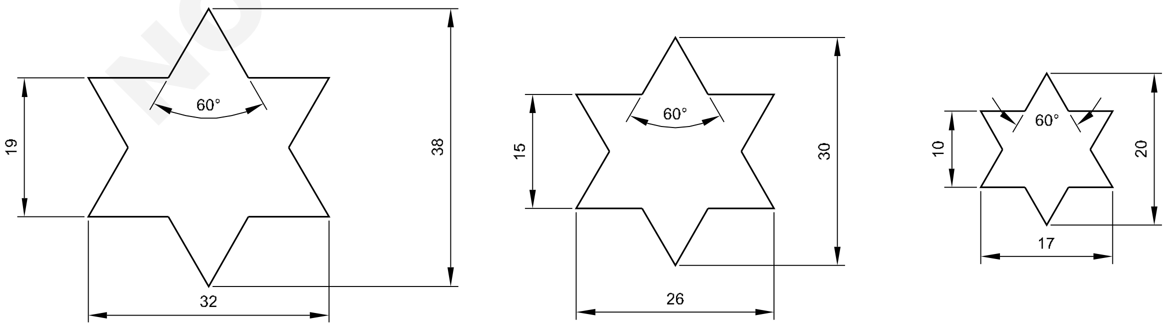


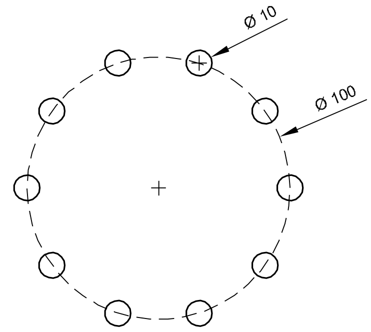
Fig 9



Command: Polar Array (Fig 12)

- Select objects (dia 10 circle)
- Specify base point of array (center of 100 mm dia)
- Specify no of items in pcd (10 nos)
- Specify distance between rows (360 deg).

Fig 12

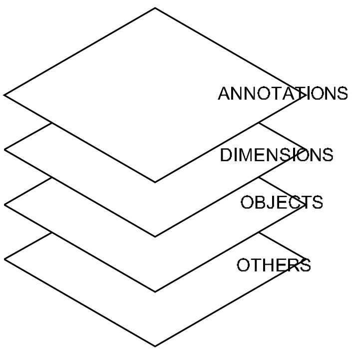


POLAR ARRAY

TASK 4: **Creation of Object Properties with Layers**

Setting up Layer properties (Fig 1)

Fig 1

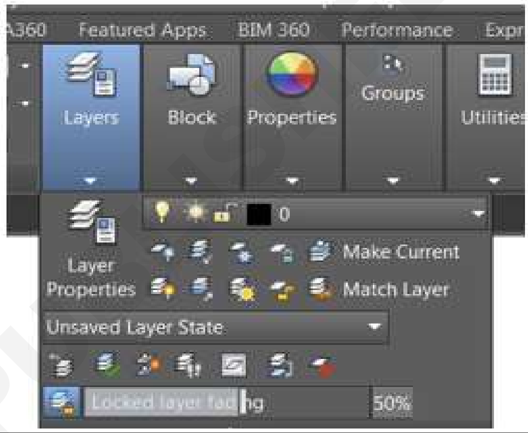


Command: Layer (Fig 2)

Click on layer properties and the following screen will popup (Fig 3).

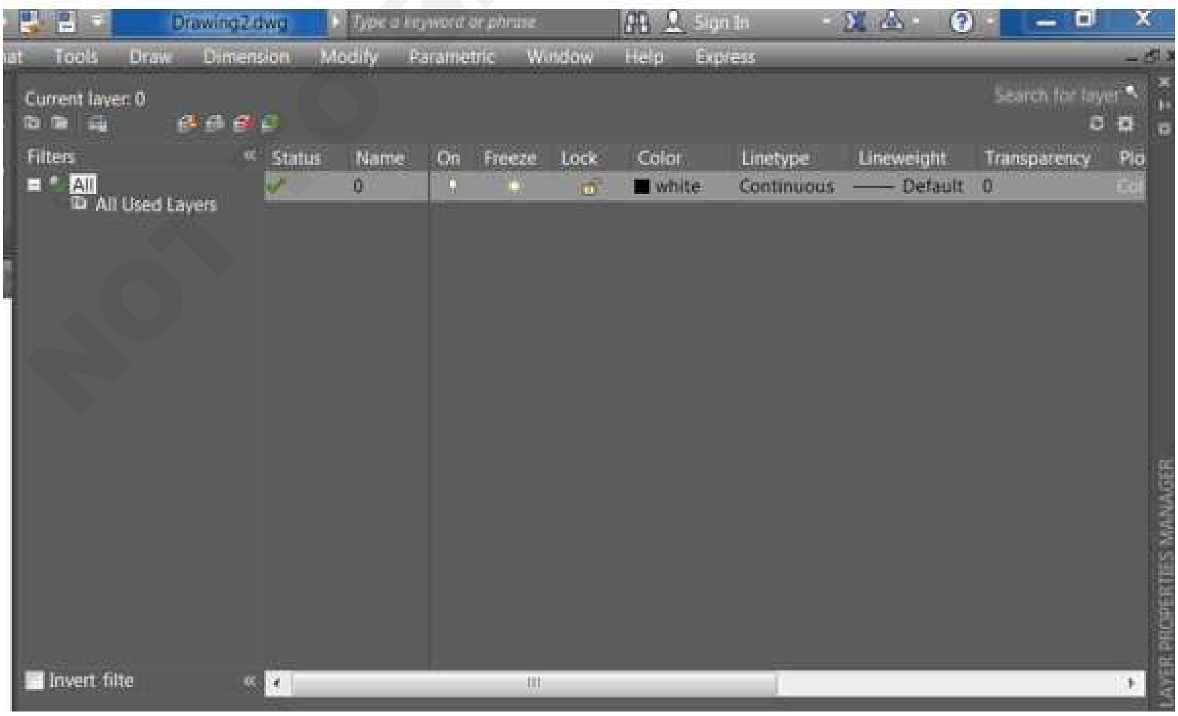
- Add layers as required for dimensions, annotations, objects, etc.

Fig 2

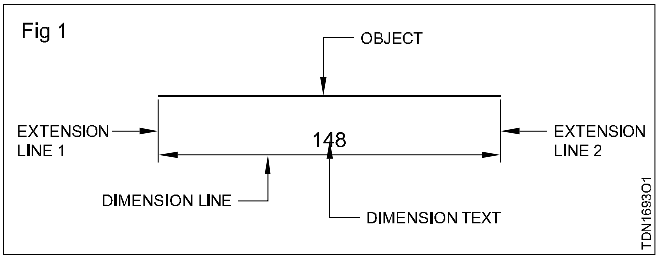


- Change colour as required.
- Change Line type for the respective lines.
- Provide line weight as per standard.

Fig 3



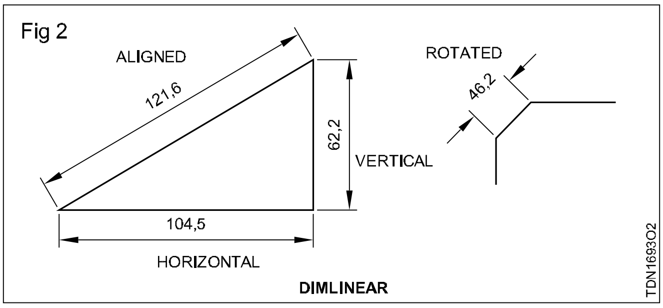
TASK 5: **Dimensioning practice (Fig 1)**



Linear Dimensioning (Fig 2)

Command: **Dimlinear**

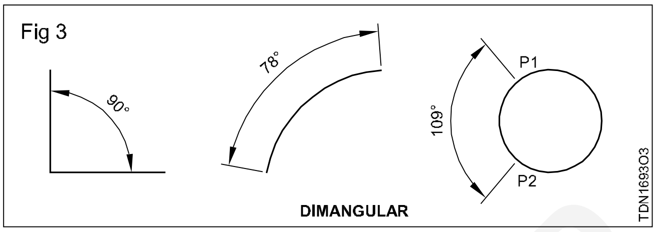
- Specify first extension line
- Specify second extension line
- Specify dimension line location (mtext, text, angles, horizontal, vertical, rotated).



Angular Dimensioning (Fig 3)

Command: **Dimangular**

- Select arc, circle , line
- Specify second line
- Specify dimension line location (mtext, text, angles).



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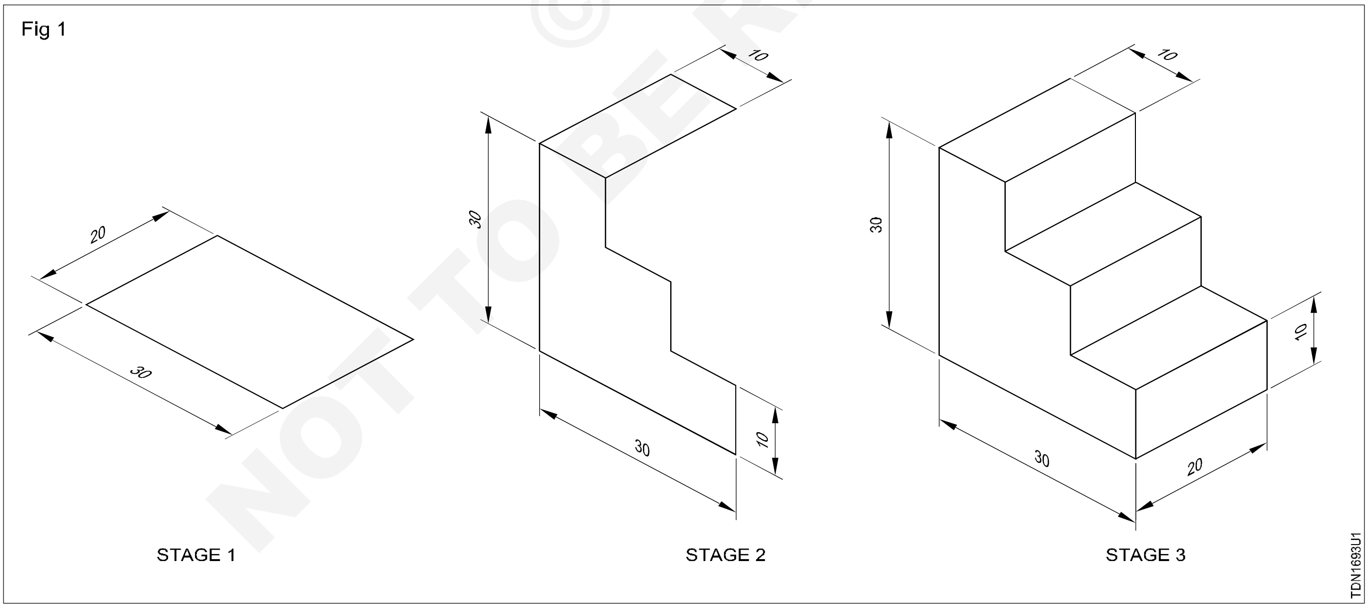
TASK 6: **Creating Isometric Views (Fig 1)**



- Start AutoCAD – Start from Scratch-English
- Set limits to 210 mm x 297 mm
- Save the drawing as ISO.
- To enter into ISOMETRIC MODE

Command: Snap

- Specify snap spacing (on/off, aspect, rotate, style, type)
- Enter snap/grid style (standard/isometric) <S> : i
- Notice the orientation of the cursor- you are now in Isoplane

- Tap key F5 the cursor direction changes to right-left-top.

Set Ortho ON

Set Isoplane to TOP

Click command Line

Draw line 30 mm length

Draw line 20 mm wide

Draw line 30 mm length

Draw line 20 mm wide

Set Isoplane to LEFT

Click command Line

Draw line 30 mm length

Draw line 30 mm height

Draw line 10 mm length

Draw line 10 mm depth

Draw line 10 mm length

Draw line 10 mm depth

Draw line 10 mm length

Draw line 10 mm depth

Copy profile and paste on 30 x 20 profile

Join the corners to form object.

Use Command Dimension Aligned and dimension the object.

With command Dimension Oblique Rotate dimensions on Left Isoplane to align with dimensions.

Similarly align dimensions on Top Isoplane.

— — — — — — — —

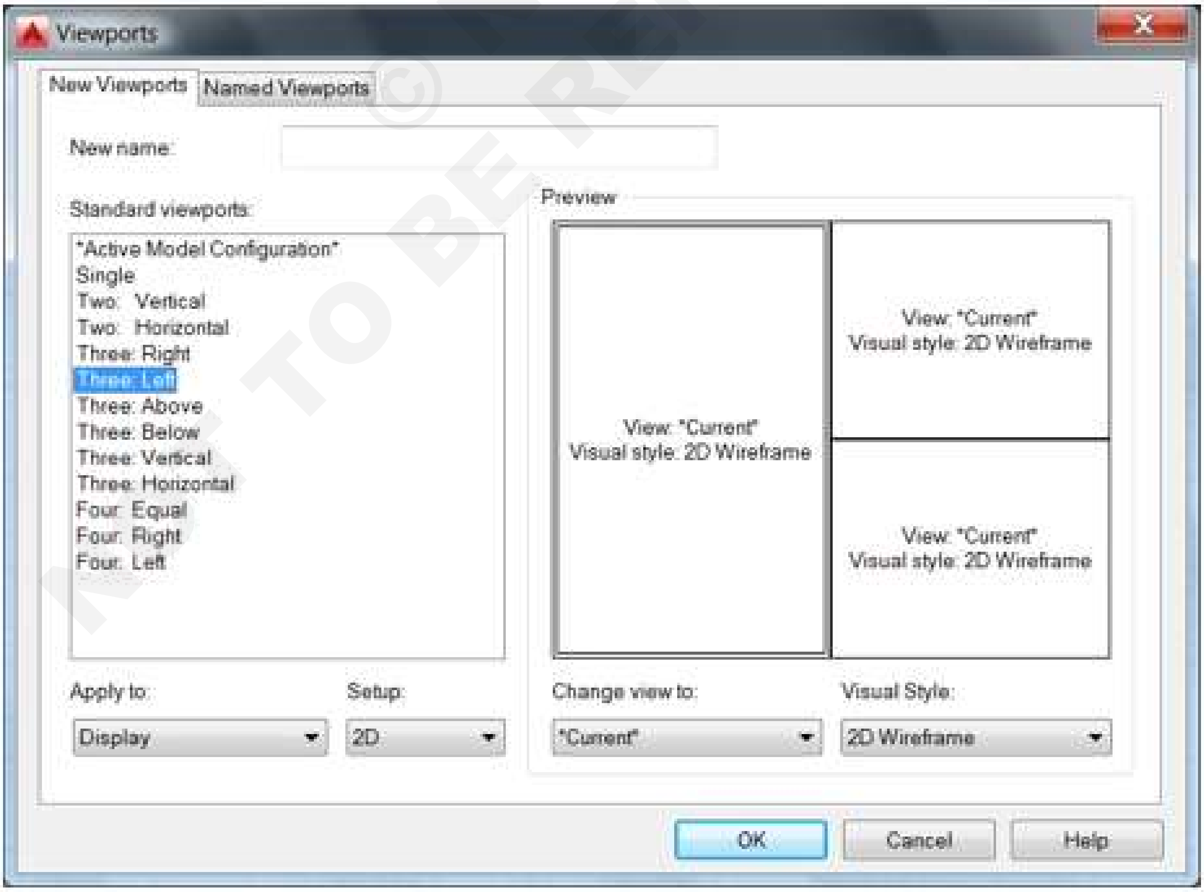
TASK 7: **Creating 3D views in view ports**

- Start AutoCAD
- Set Limits
- Save the drawing file with respective Name

To view a cubical box in wire frame mode, divide the screen into three view ports and set different views

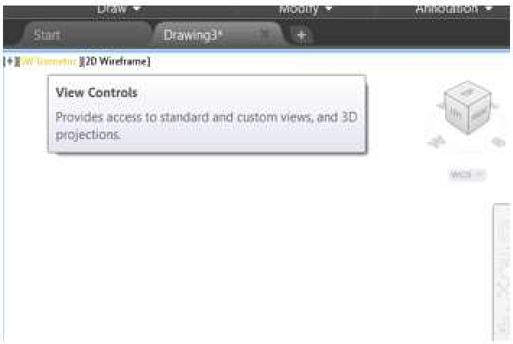
- Command: **Vports (Fig 1)**
- Select Three left.

Fig 1



- Click on first view port
- Set the view on the top left corner (view controls)of drawing area (Fig 2)

Fig 2



- Set this to (SW Isometric) (2 D Wireframe).
- Click on the second view port
- Set the view on the top left corner (view controls)of drawing area
- Set this to (front view) (2D Wireframe)
- Click on the third view port
- Set the view on the top left corner (view controls)of drawing area
- Set this to (side view) (2D Wireframe).

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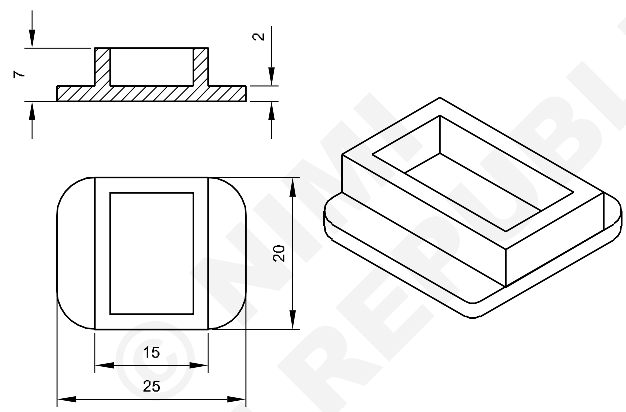
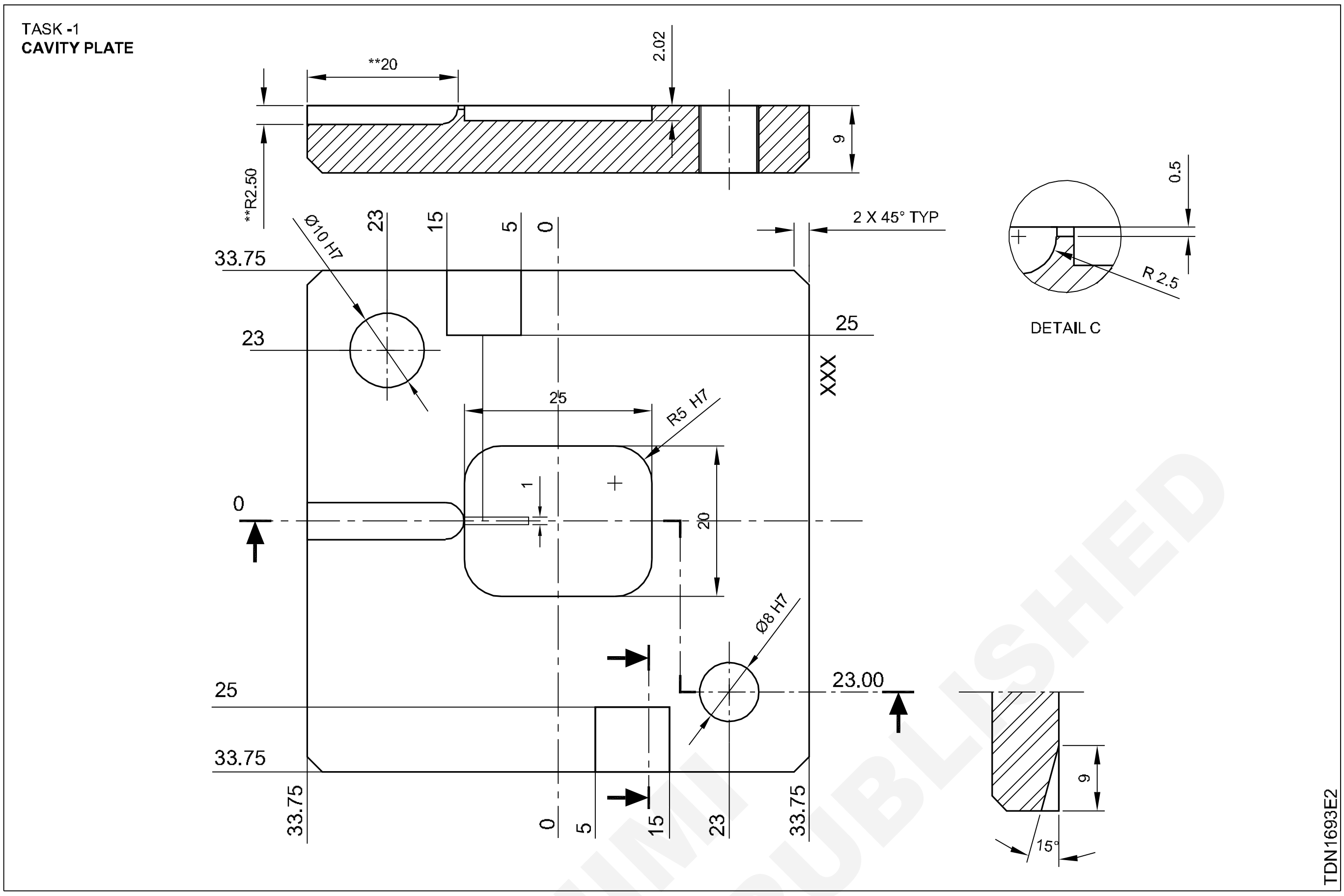
TASK 8: **Drawing of hand injection mould parts and assembly**



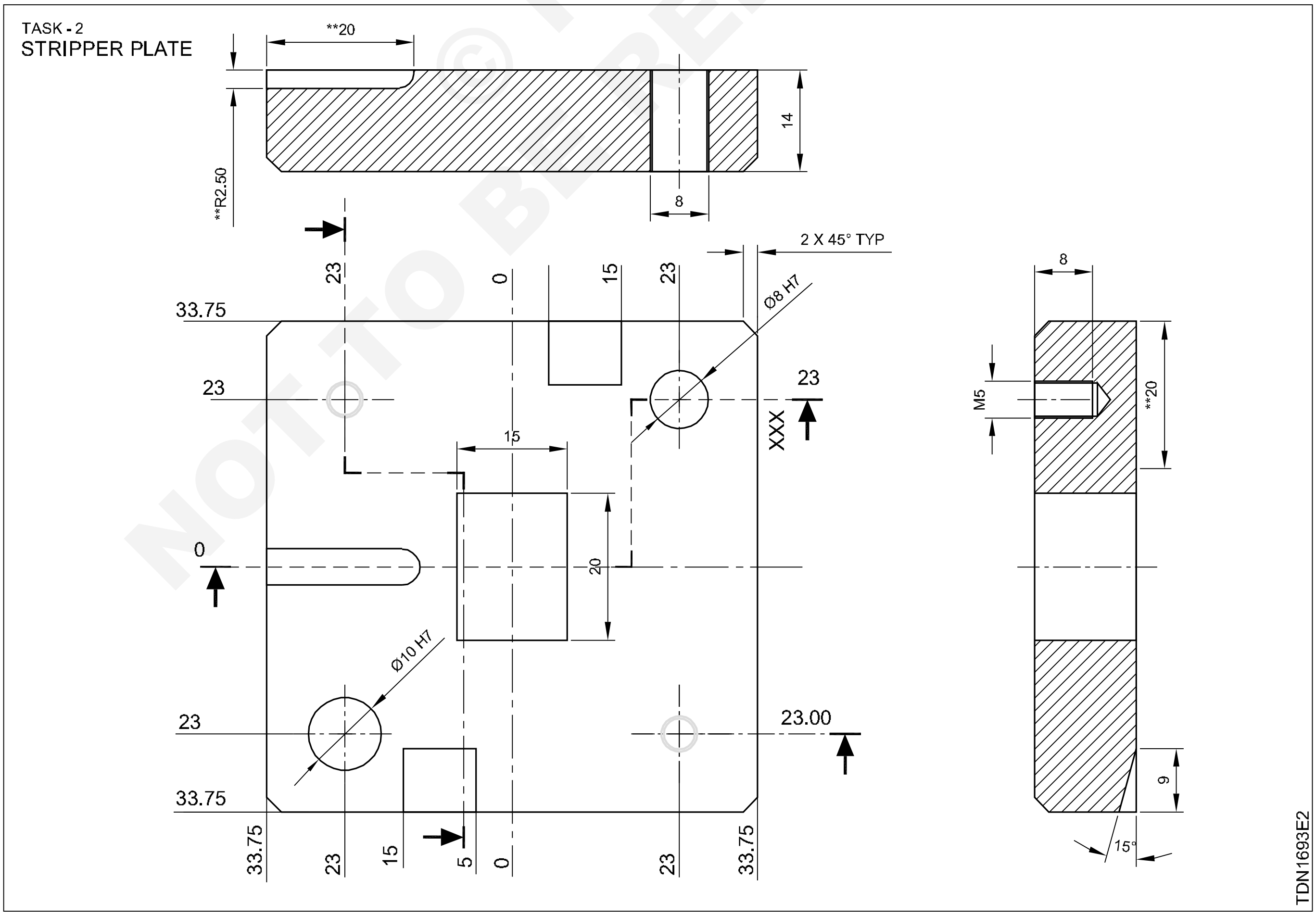
1	-		FE 310	-	1	1.6.93
NO.OFF	STOCK SIZE	SEMI-PRODUCT	MATERIAL	PROJECT NO.	PART NO.	EX.NO.
SCALE 1:1	COMPONENT				DEVIATIONS ±0.04	-
					CODE NO. TDN1693E1	

- Open a new Drawing
- Set limits for A4 size sheet
- Set dimension styles as required
- Set layers as required
- Set line thickness as 0.30 mm for object lines and 0.05 mm for center lines, hidden lines etc.
- Draw template
- Save file to folder with appropriate name.
- Start drawing plan view of cavity plate considering the required shrinkage as specified in component drawing. Once after the plan view draw position of guide pins , runner and gate for the mould.
- Dimension drawing as given bellow with ordinate dimension method.

Cavity plate



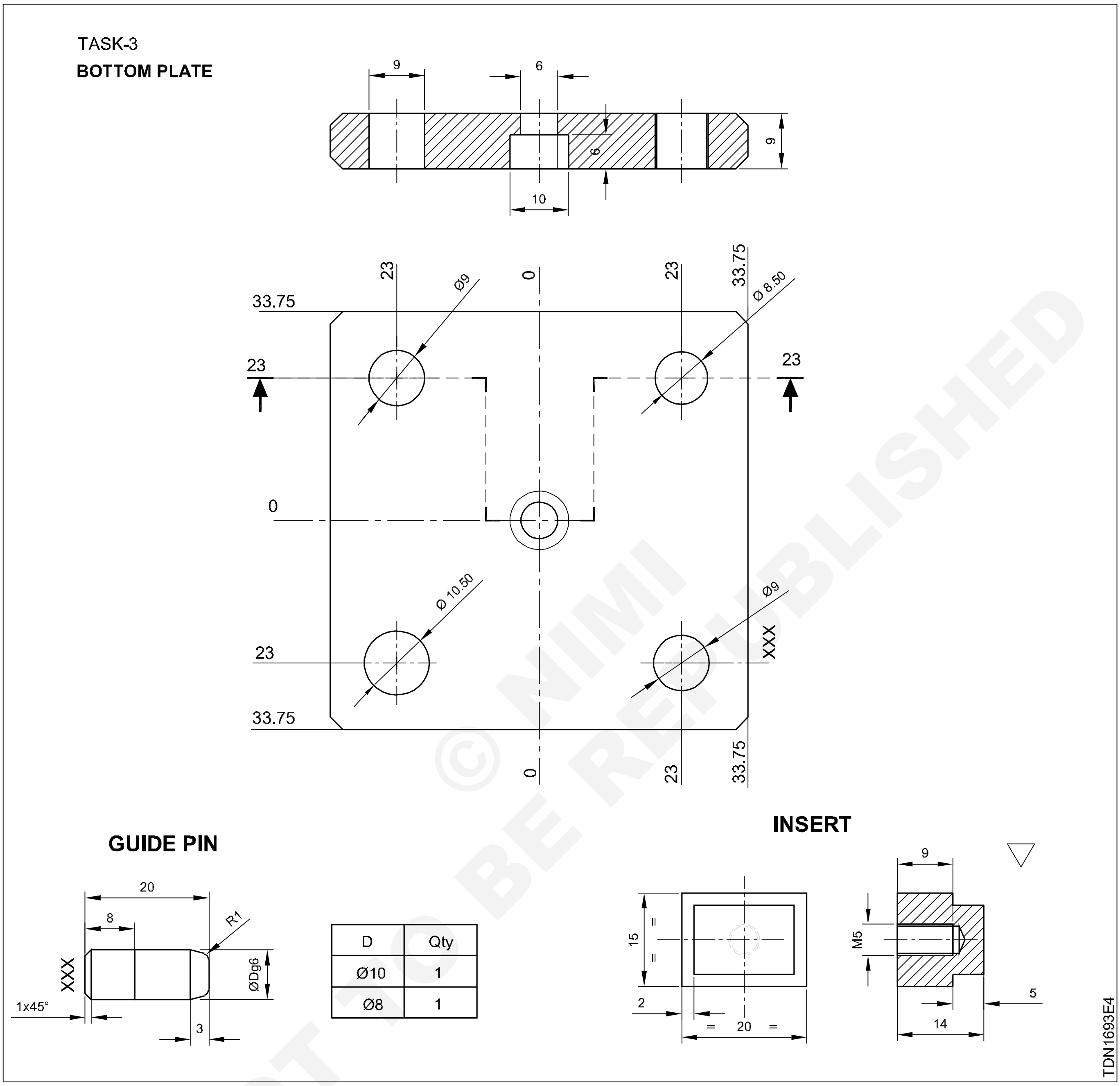
Stripper plate



Bottom plate

Guide pins

Insert

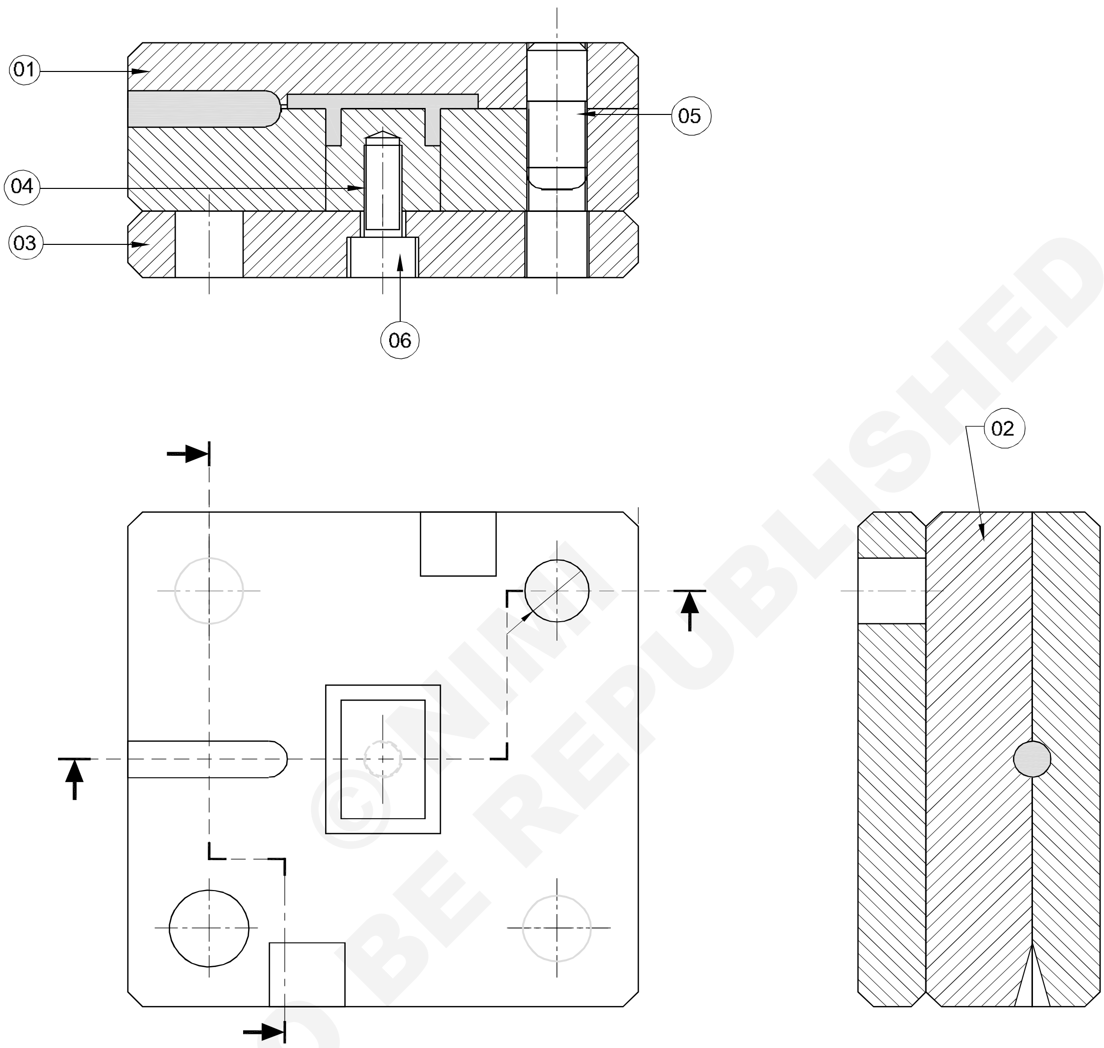


D	Qty
Ø10	1
Ø8	1

Assembly drawing

- Show assembly drawing with position marked in serial number

Material list



SHOW THE ASSEMBLY DRAWING WITH POSITION MARKED IN SERIAL NUMBER

NO.OFF	DESCRIPTION	SIZE	MATERIAL	PROJECT NO.	QTY	EX. NO.
6	SCHS	M5 x 12	STD			1.6.93
5	GUIDE PIN	Ø8 x 20,Ø10 x 20	MS			1.6.93
4	CORE INSERT	14 x 15 x 20	MS			1.6.93
3	BOTTOM PLATE	9 x 67.5 x 67.5	MS			1.6.93
2	STRIPPER LATE	14 x 67.5 x 67.5	MS			1.6.93
1	CAVITY PLATE	9 x 67.5 x 67.5	MS			1.6.93

SCALE : 1:1	**ASSEMBLY DRAWING**	TOLERANCE ±0.5	-
		CODE NO. TDN1693E5	

Mould

Part 1

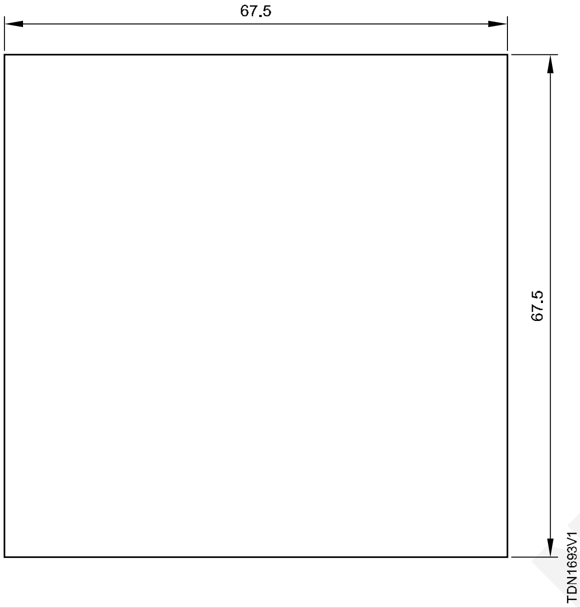
Cavity plate

- Open Auto Cad
- Click start drawing GUI will appear
- Type limits command. Enter (0,0) entre (20, 297) enter.

Step 1

- Draw rectang using line command (Fig 1)

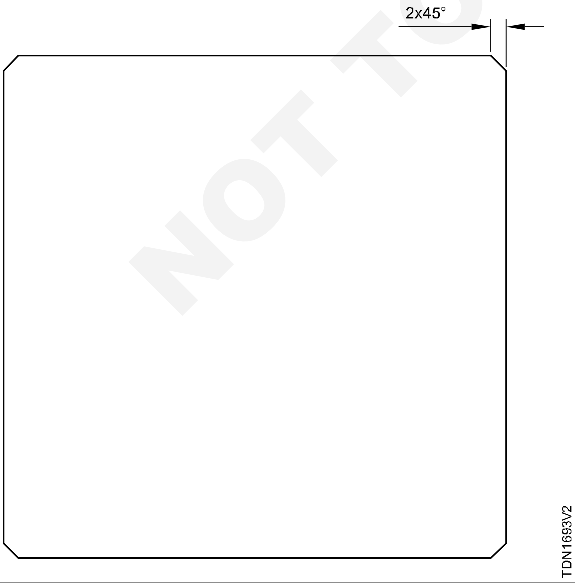
Fig 1



Step 2

- Select the “Chamfer” tool to create chamfer.
- Sub command
- “Angle (A)
- Enter 2 enter 45 enter (Fig 2).

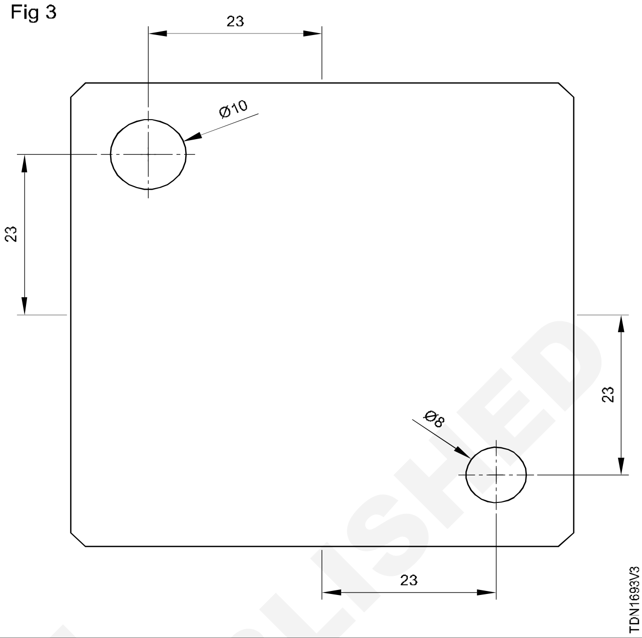
Fig 2



Step 3

- Draw circle using “click” command
- Top left click P 10mm bottom right circle 8mm (Fig 3).

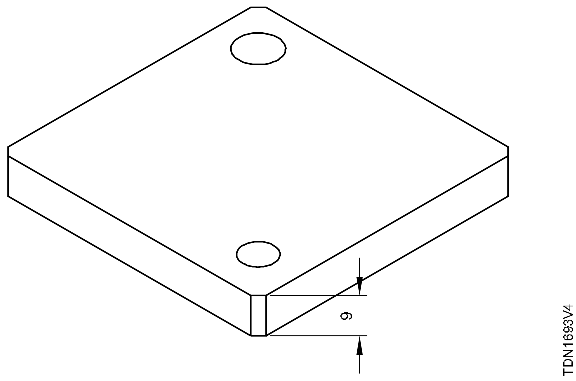
Fig 3



Step 4

- Go to 3D modeling workspace
- Right bottom corner of AutoCAD > setting symbol select 3D modeling.
- Select all the object in the screen and type command “Join” (“J”).
- Select the “Pres pull” icon type the height 9mm.
- Press the ↑ button for better view (Fig 4).

Fig 4

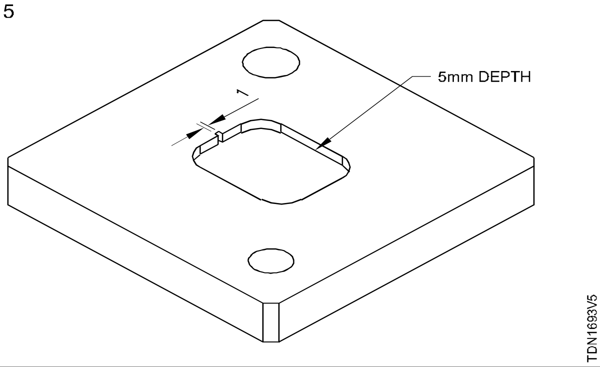


Step 5

- Draw rectangle (x25.25, Y20.20) Using ‘line’ command
- To make the corner radius

  <> Fillet < Radius (R) < value (5) >
- Click the top view before doing fillet
- To make a cut
- Select the rectangle <> Pres pull < drag reverse direction < value (-2.02mm) >< (Fig 5)

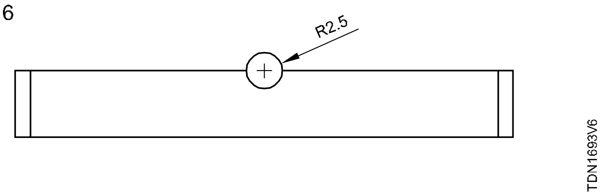
Fig 5



Step 6

- To make circle slot, select left view of the view cube and in the co-ordinates tool bar.
- Select the view tool.
- Select the middle of the top edge rectangle
- Draw “Circle” © < value (2.25R) (Fig 6)

Fig 6



- Select the prespull icon.

  <> Prespull < drag the click right side < value (-20.25).
- To subract
- Type “Subract” command
- Type < Click left click right in rectangle < and left click right click in circle > result (Fig 7 & 8).

Fig 7

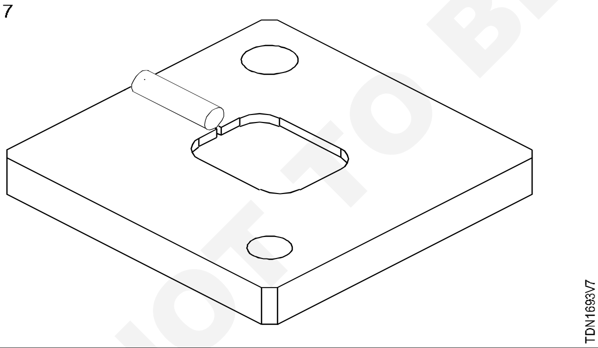
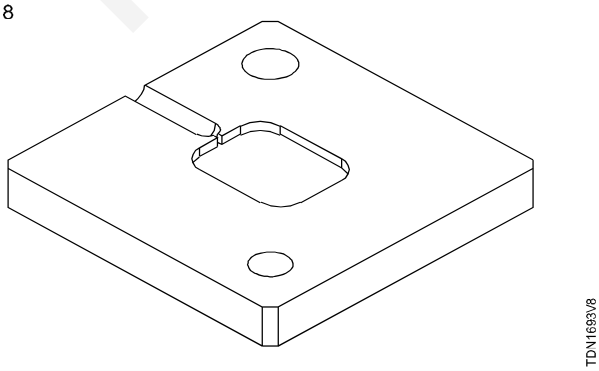


Fig 8



Step 7

- To draw a square slot.
- First draw right angle triangle plane the 2D sketch in the edge of the object from the centre 5mm gap. (Fig 9 & 10)
- Select prespull select the object < value - 10mm >.

Fig 9

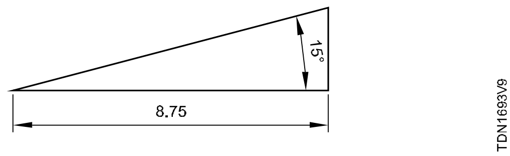
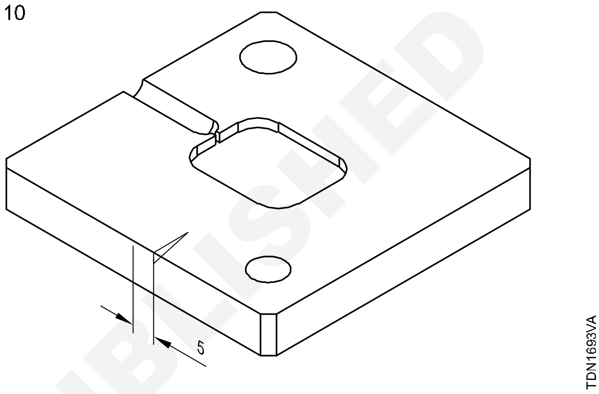


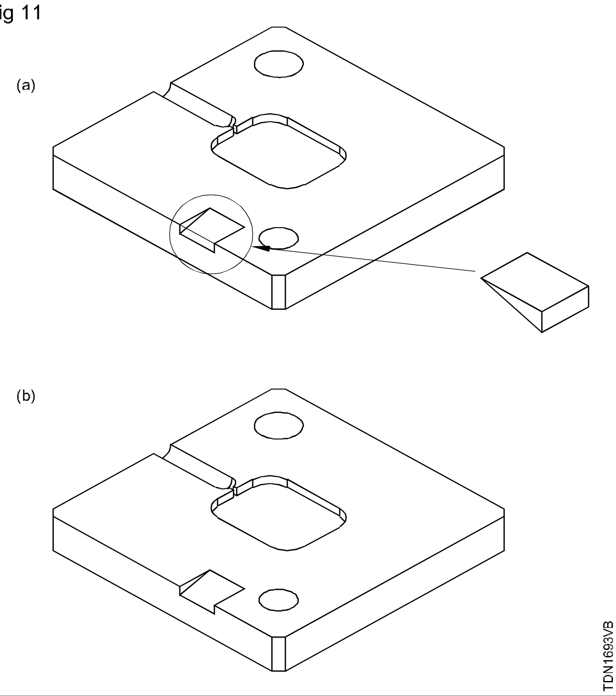
Fig 10



Step 8

- A solid object is created
- To subract
- <Subract < select the first object (to stay) < select the second object to disappear> before subract
- After subract (Fig 11)

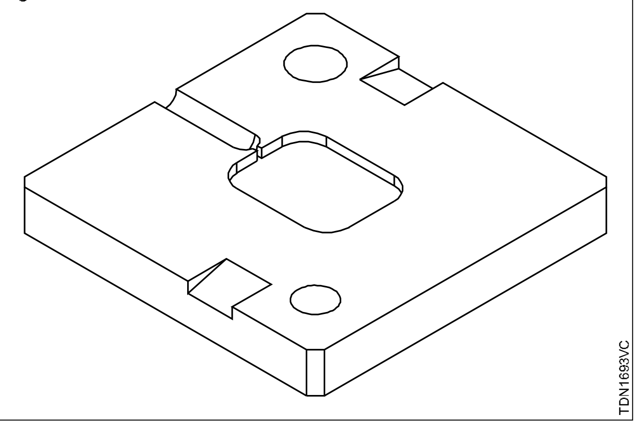
Fig 11



Step 9

Follow the same procedure followed in step 7 & 8 and the final product of the cavity plate will appear like this (Fig 12).

Fig 12



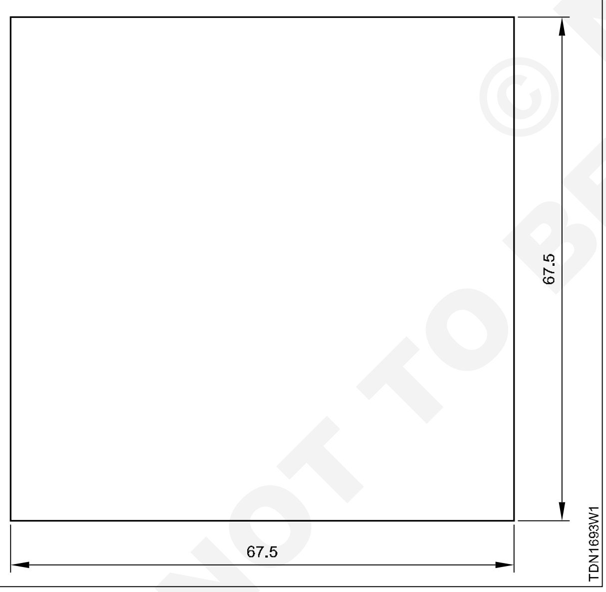
Part 2

Stripper plate

Step 1

- Open new drawing
- Draw rectangle square of 67.5m for four sides
- Command 'line' (L) (Fig 1).

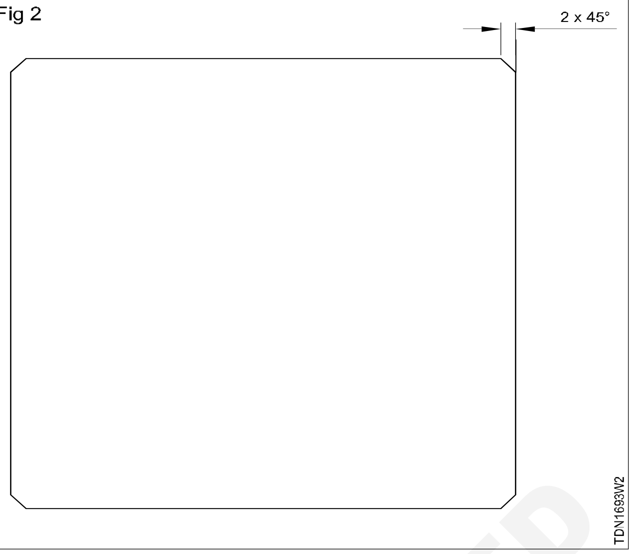
Fig 1



Step 2

- Apply chamfer for all corner's. (Fig 2)
- <Chamfer<Angle<Value (2x45°)>

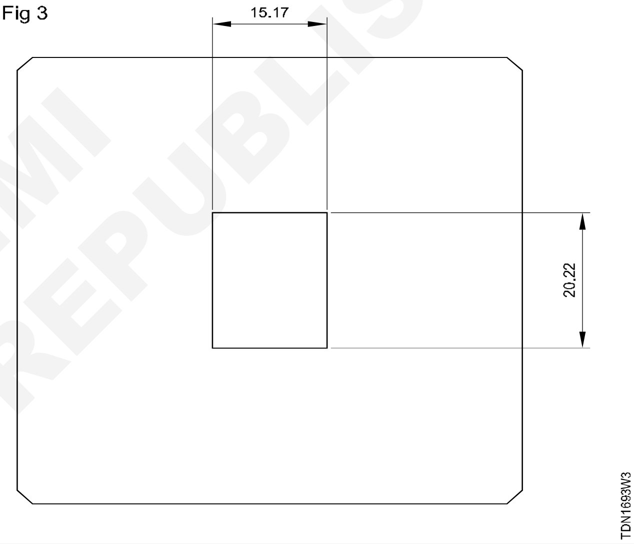
Fig 2



Step 3

- Draw another rectangle <LINE> value 15.17 (a), (y) 20.22 < (Fig 3).

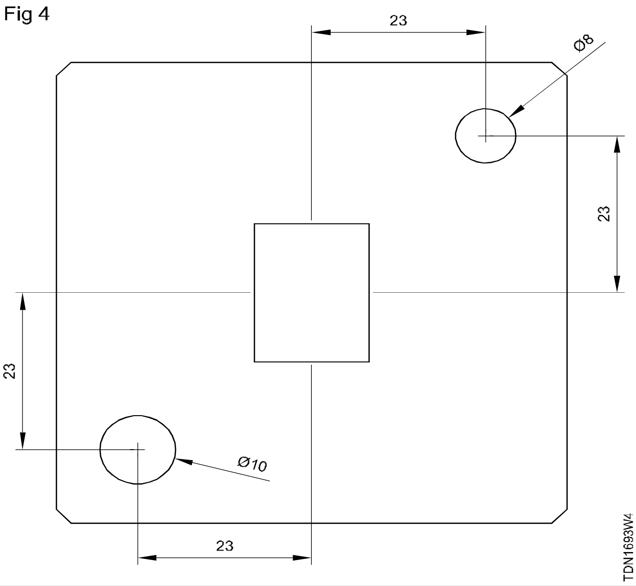
Fig 3



Step 4

- Draw the circle same as the cavity plate (Fig 4).

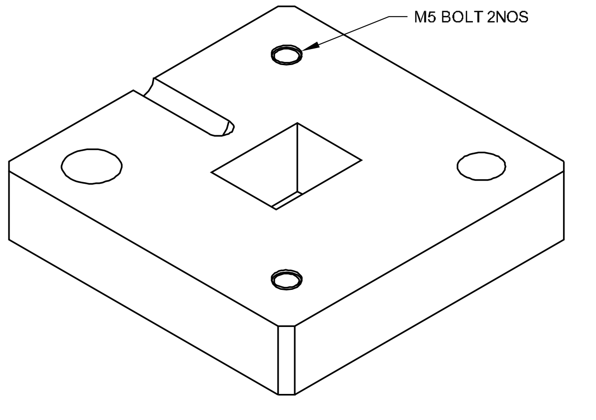
Fig 4



Step 5

- Go to 3D modeling workspace and <prespull < Select the object < value 14.00mm)
- After selecting use join” command (Fig 5).

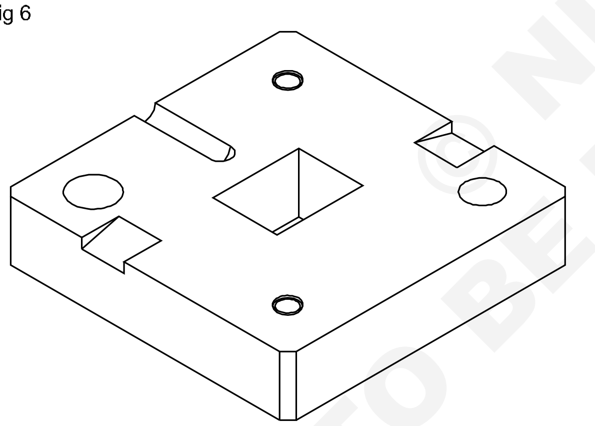
Fig 5



Step 6

- To take a circular slot <view cube< view icon (co-or tool bar) < circle © (left view) < Rodin’s < value 2.50 < Enter
- < Prespull < Select the circle < value – 20.25 ><.
- Make M5 holes and place as shown in the Fig 6.

Fig 6



Step 7

- To make square slot.
- Follow the same procedure in Part 1 (Cavity plate)
- Commands < line < Join < prespull < value (-10)
- < Subract < Select the first object < select the second object result shown in the Fig 6.
- Ctrl + S to same the part 2.

Part 3

Bottom plate

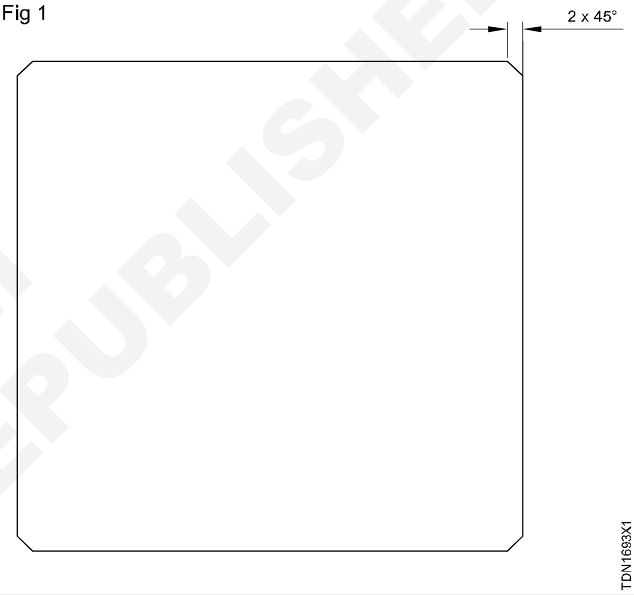
Step 1

- Open new drawing
- Set the limits
- < limits < value (0,0) < (420, 297)
- Draw a rectangle
- < line < value 67.5 < for all sides.
- < join < select all object<>.

Step 2

- To make chamfer
- < Chamfer < Angle < value (2x45°)> (Fig 1).

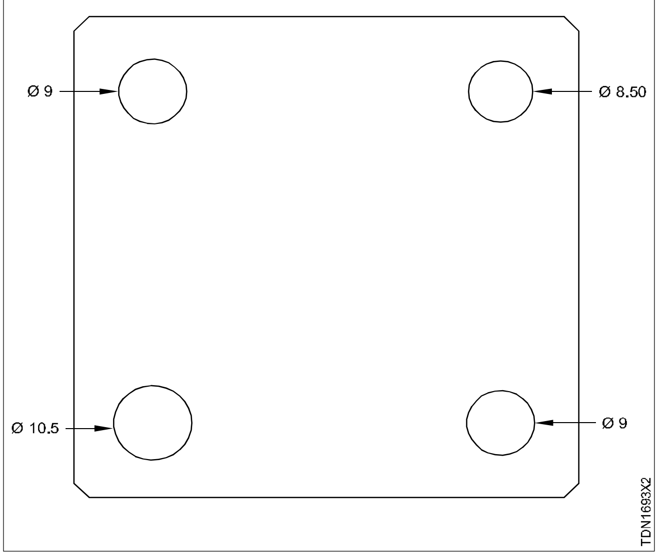
Fig 1



Step 3

- Draw the circle
- <Circle (c) < Radin’s or diameter < value> do it for all circles (Fig 2).

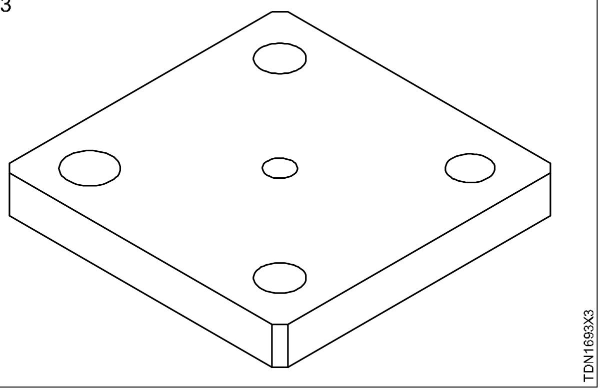
Fig 2



Step 4

- Switch to 3D workspace modeling
- < prespull < select all object < value (9.0mm) (Fig 3).

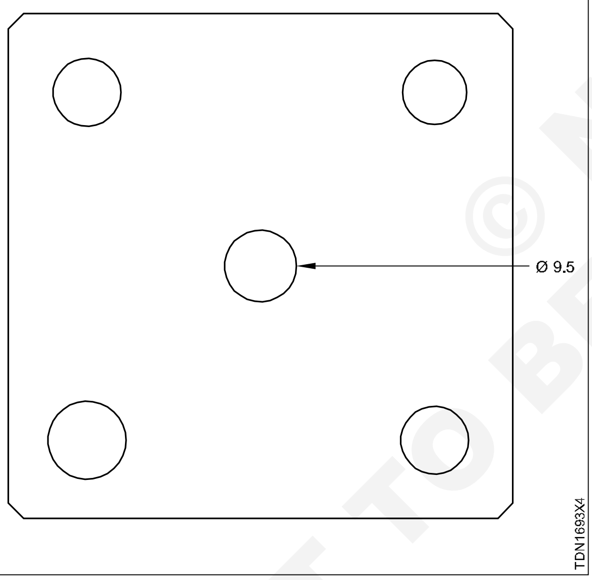
Fig 3



Step 5

- To create centre hole.
- < tap view< at the centre of the object 1.
- < circle (c) < diameter < value (9.5) > (FIg 4).

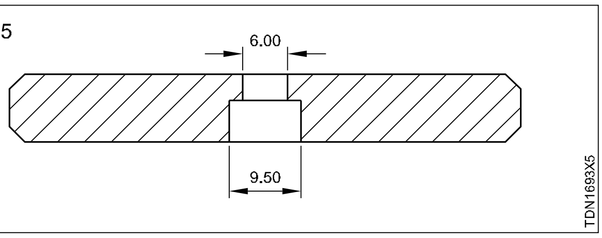
Fig 4



Step 6

- To take a cut
- <prespull < select the circle < value (-5)> and inside the circle draw another circle.
- <Circle <Select enter part a circle < diameter < value (60) >

Fig 5



Step 7

- Save the document .
- < Ctrl + S< type file name>.

Part 4

Guid pin φ 10

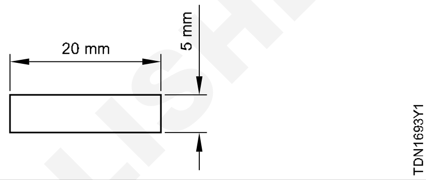
Step 1

- Open new drawing
- Set the limits
- <limits < value (0,0) < (420,2P7)>

Step 2

- Draw half part of the object
- <line < value (5mm) < (20mm) < 5mm
- Join with centre line (Fig 1).

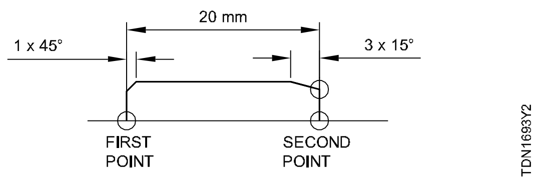
Fig 1



Step 3

- Apply chamfer on both side at left side
- <chamfer < Angle (A) < value (1x45°) >
- At right side
- <Chamfer < angle (A) 45° < value (3x15) (Fig 2).

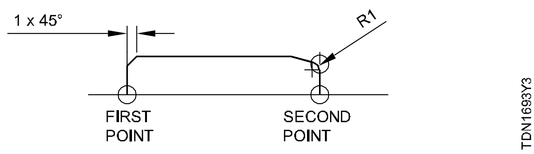
Fig 2



Step 4

- Apply filled on right side of the object <fillet (F) < radius < value (1)> (Fig 3).

Fig 3



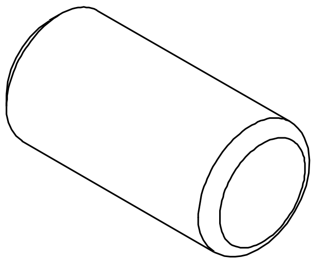
Step 5

- Switch to 3D modeling workspace.
- Select all the object and join.
- < Revole < select the object < select the first point < second point < enter (Fig 4).

Step 6

- Follow the some procedure for φ 6 “Guide pin”.

Fig 4



Part 5

Insert

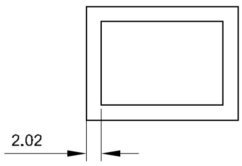
Step 1

- Open the new drawing
- Set the limits
- <limits < value < (0,0) < (420, 297)>

Step 2

- Draw a rectangle
- <line < value (20.20mm) x < y (15.15mm) y >
- Select all the object (join) (J) (Fig 1).

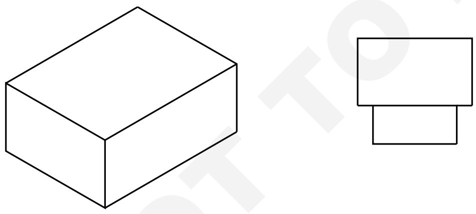
Fig 1



Step 3

- Switch to 3D modeling workspace
- <prespull < value (9mm)> (FIg 2).

Fig 2



Step 4

- Select the bottom face, draw the rectangle < line < value x(18.18) < y (13.13)

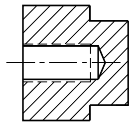
Step 5

- <Prespull < select the object < value 5)

Step 6

- Draw the M5 bolt
- Place in the centre of the rectangle.
- <Subract < select the first object < select the second object> (Fig 3).

Fig 3



Step 7

- Save the drawing
- <ctrl + s>.

Isometric view

Bottom plate

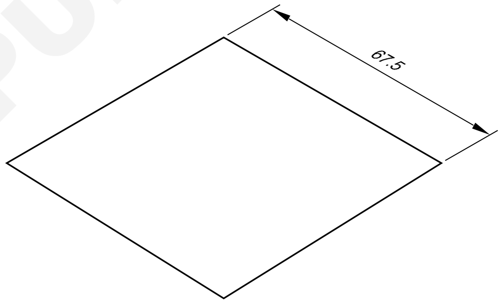
Step 1

- Open new drawing
- Set the limit
- Click the isodraft icon, will displayed below the command box.

Step 2

- (Here take the bottom plate sepee or clim).
- Draw a line & length 67.5mm for all sides of the square length (‘L’) < value (67.5) >
- F8 ortho on (Fig 1)

Fig 1



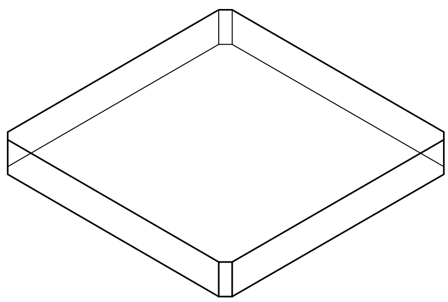
Step 3

- Draw a vertical line of length (9mm).
- Change the direction press F5 (F5 is plane change).
- Draw the vertical line in all end point.

Step 4

- Join all the vertical line. (Fig 2)

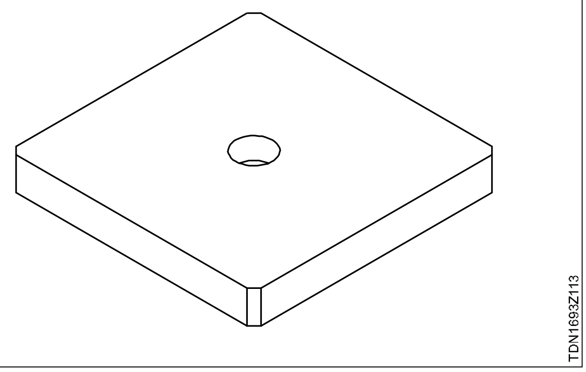
Fig 2



Step 5

- To draw a circle.
- <Elipse (EL) < (isocircle)< click on the centre of the square < diameter < value (4.5) (95)>.
- Copy the circle in downward direction of length 4.5 downwards.
- Join the edges of the circle.
- Draw the same thing for the smaller circle. (FIg 3)

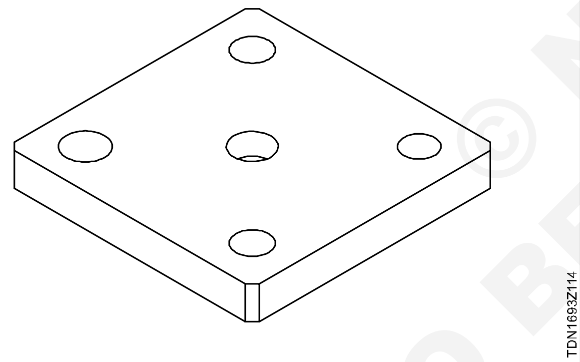
Fig 3



Step 6

- Draw the circle by same method shown in the bottom plate (Fig 4).

Fig 4



Step 7

- Save the document
- <Ctrl + S>.

Layer

Step 1

- In the same drawing.
- Select the layer properties on the ribbon tool (or) command (LA) layer.
- Dialogue box will appear.
- Select new layer (or) add layer icon (or) (Alt + N).
- Fix the colour for the layer you created.

Step 2

- Select the hidden lines and enter of bottom plate.
- Select the layer or select line <.
- Select the another layer on the ribbon tool.
- <Laycur < select the hidden lines< enter.

Step 3

- Select the another layer for circles.
- Laycur < select the circle < enter.

Step 4

Command (in the ribbon tool)

- <Lay LocK> to lock the object
- <LAY ON>
- <LAY OFF>
- <LAY FKZ>
- <LAY THW>

To appear and disappear of objects

Blocks

Step 1

- Draw open new drawing
- Draw any object for example rectangle and square.
- Select the both object

Step 2

- Command
- <Block, ('B') < type a name < press ok)

Step 3

- Block created
- To separate <"Explote") Command

View port

- Select the view menu bar.
- In the view bar select the view configuration.
- Select which type of view reeded

Constraints

- Open parametric menu bar
- Geometric constrain & dimensional constraint will appear.
- Example: for open constrain
- Coincident tool
- Start one end of the object 1 or line and select another end of the another object.
- Example for dimensional constraint
- Click draw a rectangle
- Select "Linear dimensional constrain
- Select the two points
- Here dimension value can be changed corresponding object will also change.

Attribute

Step 1

- Open new drawing

Step 2

- Select text command
- Type Name Separately

  Place

Step 3

- <AH (Attribute < dialogue box will appear <
- <In that select the verify option <left side type in tag column type and default column, type your name.
- (Name vignesh) and place it near the name text.

Step 4

- Same thing for (place text)

Step 5

- Select all the object and <Block ‘B’< type the name < enter

Step 6

- Attribute will work when it is converted into block.

Table

Step 1

- <Table< dialogue box will open. < adjust the option for you requirement.

Step 2

- And press enter ok and place it in screen, and type the text you needed.

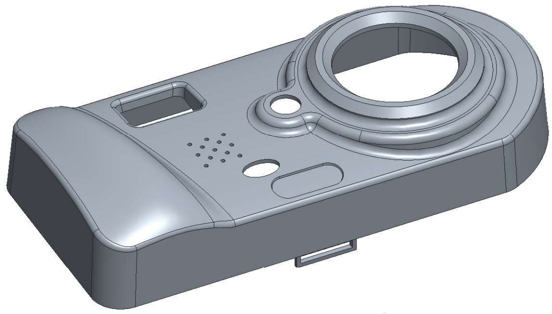
Step 3

- To edit < Tab edit < select the cell < type the text>.

— — — — — — — —

Prepare solid modeling for simple mould with pro-E

Objectives: At the end of this lesson you shall be able to
- **perform reference curve, point and plane creation**
- **perform sketch the model in Pro-E / creo 3.0**
- **perform developing sample mould part**
- **perform mould assembly creation**
- **perform creo direct**
- **perform creo simulation.**



TASK 1: **Reference curve, point and plane creation**

Step 1

Open the CREO 3.0 software from the desktop screen by double clicking or right click the mouse button & select open option

Step 2

Now close the resource centre dialogue box

Step 3

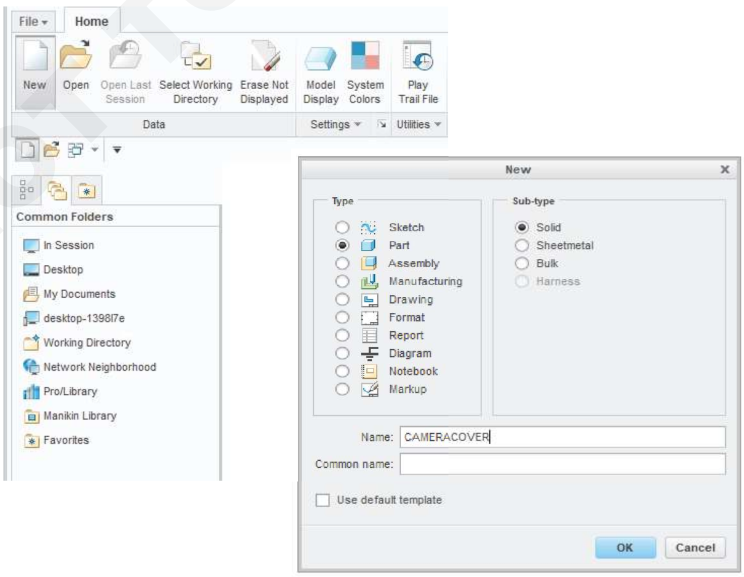
Select new option from home TAB.

Step 4

The dialogue box opens select Part ⟶ From Type, select Solid ⟶ from Sub-type as shown in Fig 1.

- **Prepare solid mould on Pro - E.**
- **Appropriate dimension may be provided wherever applicable**

Fig 1

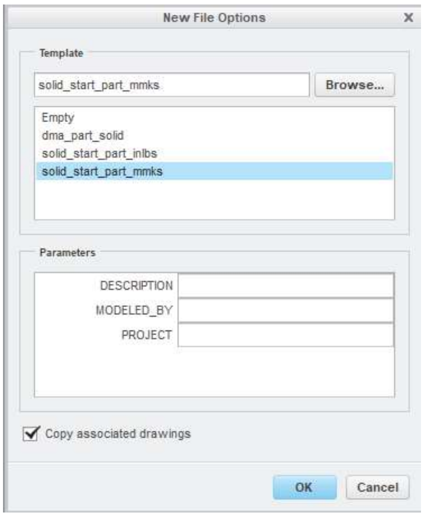


Step 5: In name box enter a name for the model as camera cover

Step 6: unselect – use default template, then select ok option.

Step 7: Next dialogue box appears, select solid_start_part_mmks (Or required unit as per user) as shown in Fig 2. select ok option to move to the sketch area.

Fig 2

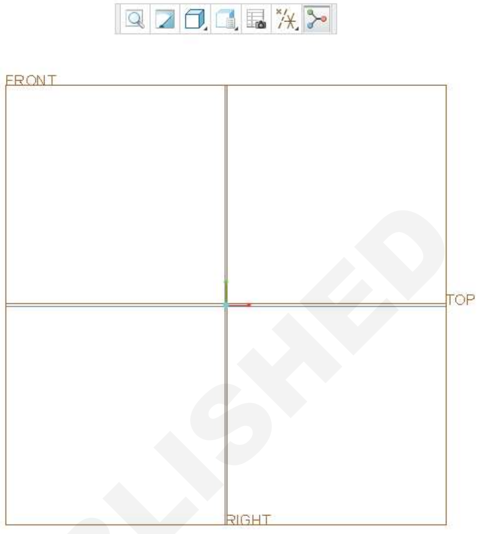


Sketch:

Step 8: Select the plane in which the sketch should be drawn (Right, front & top), select it directly by clicking the part & then select sketch option from the datum section in model TAB.

Step 9: Here the front plane is selected. The plane is shown in straight view in the screen. as shown in Fig 3.

Fig 3



Step 10: Select the plane option from the datum plane, the datum plane dialogue box opens placement select → right (Datum plane) select offset option translation → 75.00, click ok option, rename the plane to length_1 by double clicking on plane name in model tree (Fig 4.), repeat the same process with offset plane distance as 55 and click ok option (Fig 5), rename it as length_2

Fig 4

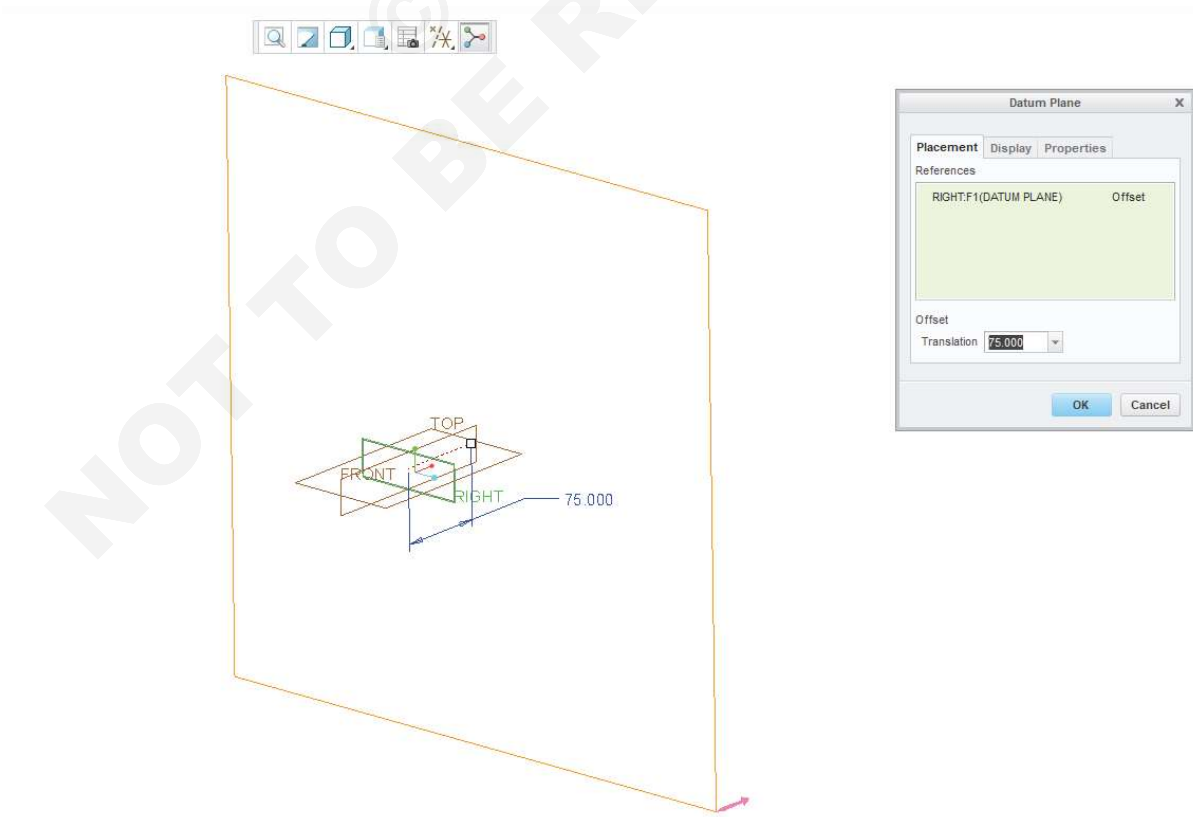
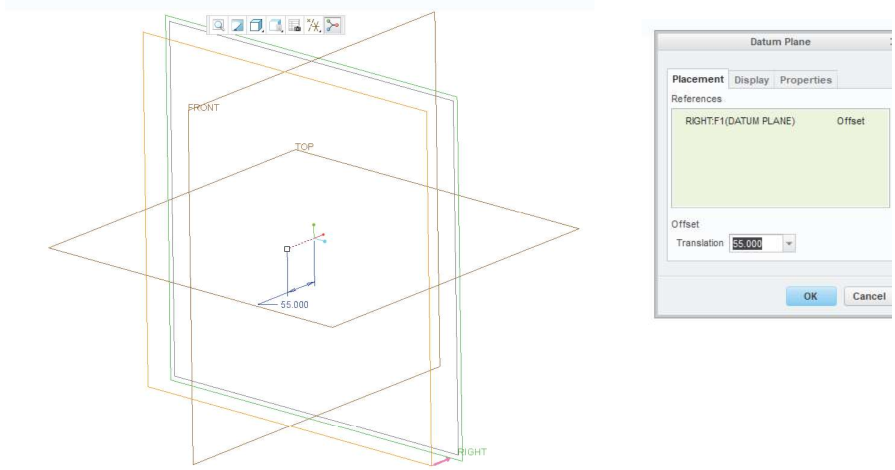


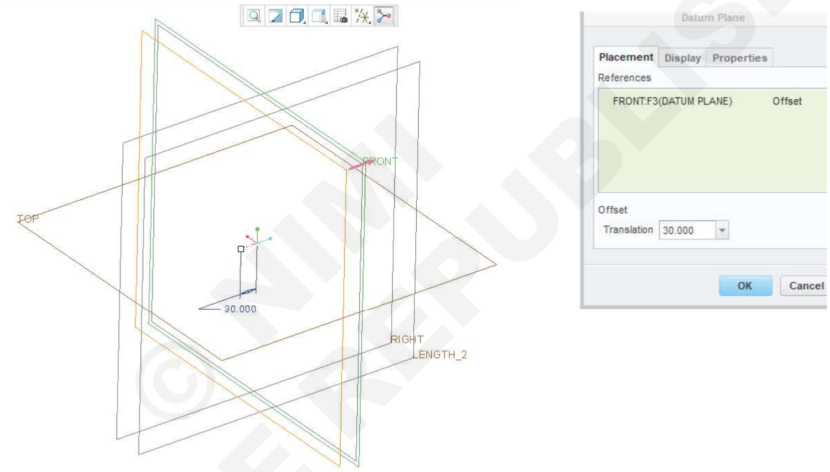
Fig 5



Step 11: Once again select the plane option in the datum tab, In datum plane dialogue box, placement tab reference select the front plane & give offset translation value to 30.00 & then select ok option. (DTM 3)

Step 12: Repeat the above step once again to create another plane with offset value – 30 but direction on other side. (DTM 4) (Fig 6)

Fig 6



Step 13: Select the point option from datum tab, datum point dialogue box appear as follows create four points with following reference planes for each point. (Fig 7)

Placement - PNT9 – References- Length_2.

DTM3

Top

PNT10 – References-Length_1

Top

DTM 3

PNT 11 – References – DTM 4

Top

Length_2

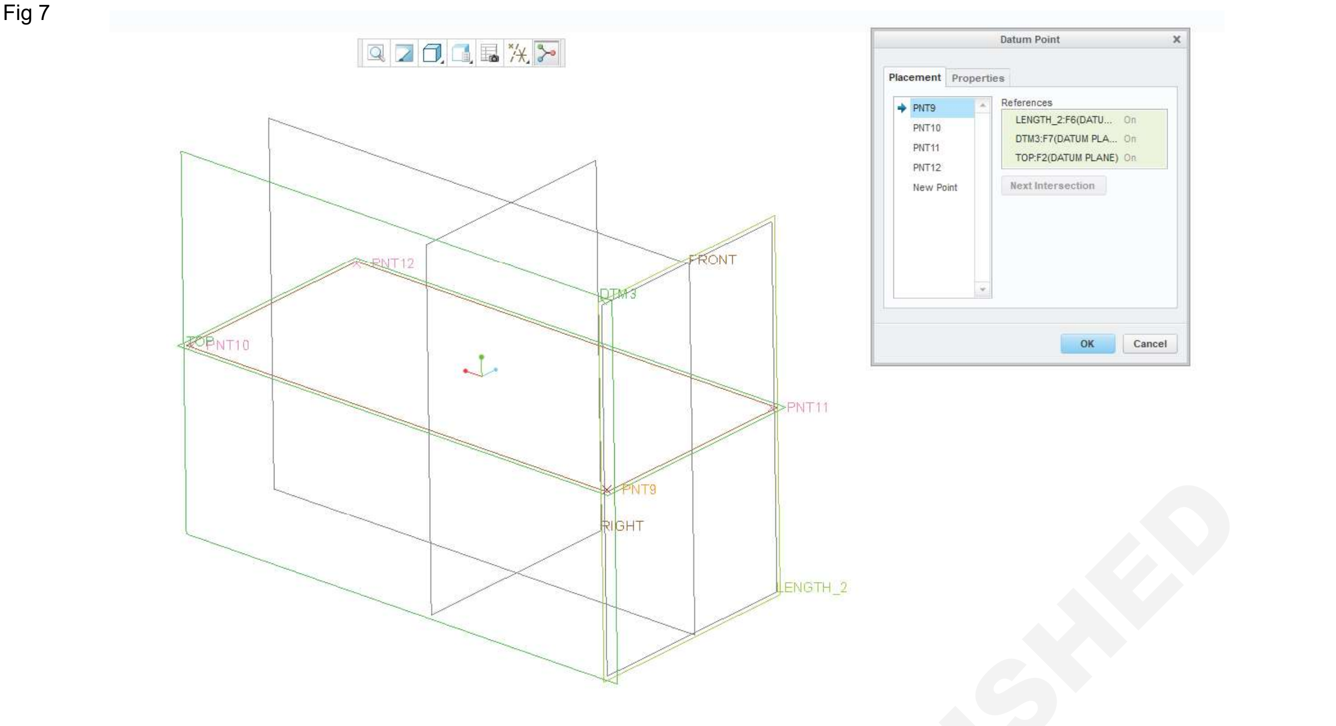
PNT 12 – References – Length_1

Top

DTM 4

Note: For selecting more than one planes press ctrl and select each plane.

Fig 7



Finally select ok option

Step 14: For creating reference profile as shown in figure. select style from surfaces tab then select curve in curve tab & Join the two point inline to form curves separately as shown in Figure 8 & 9.

Fig 8

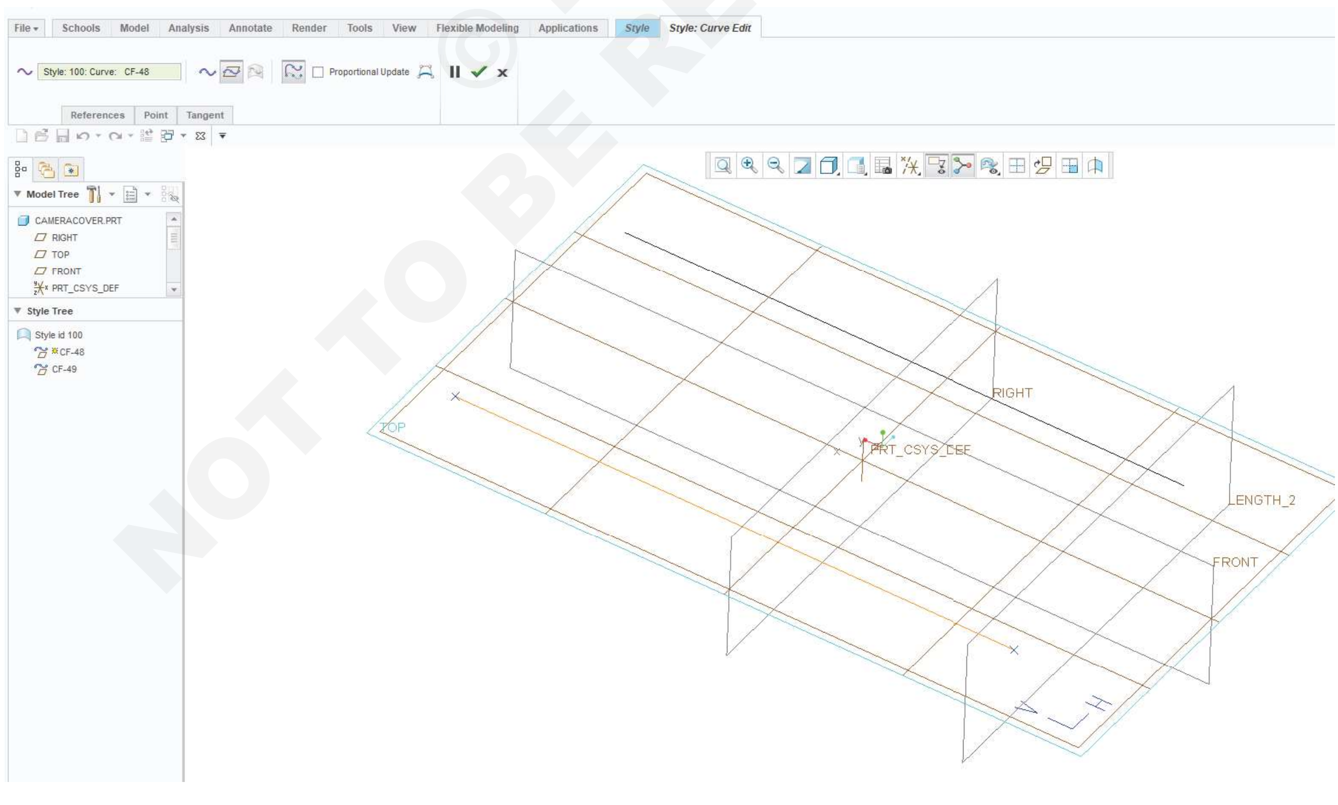
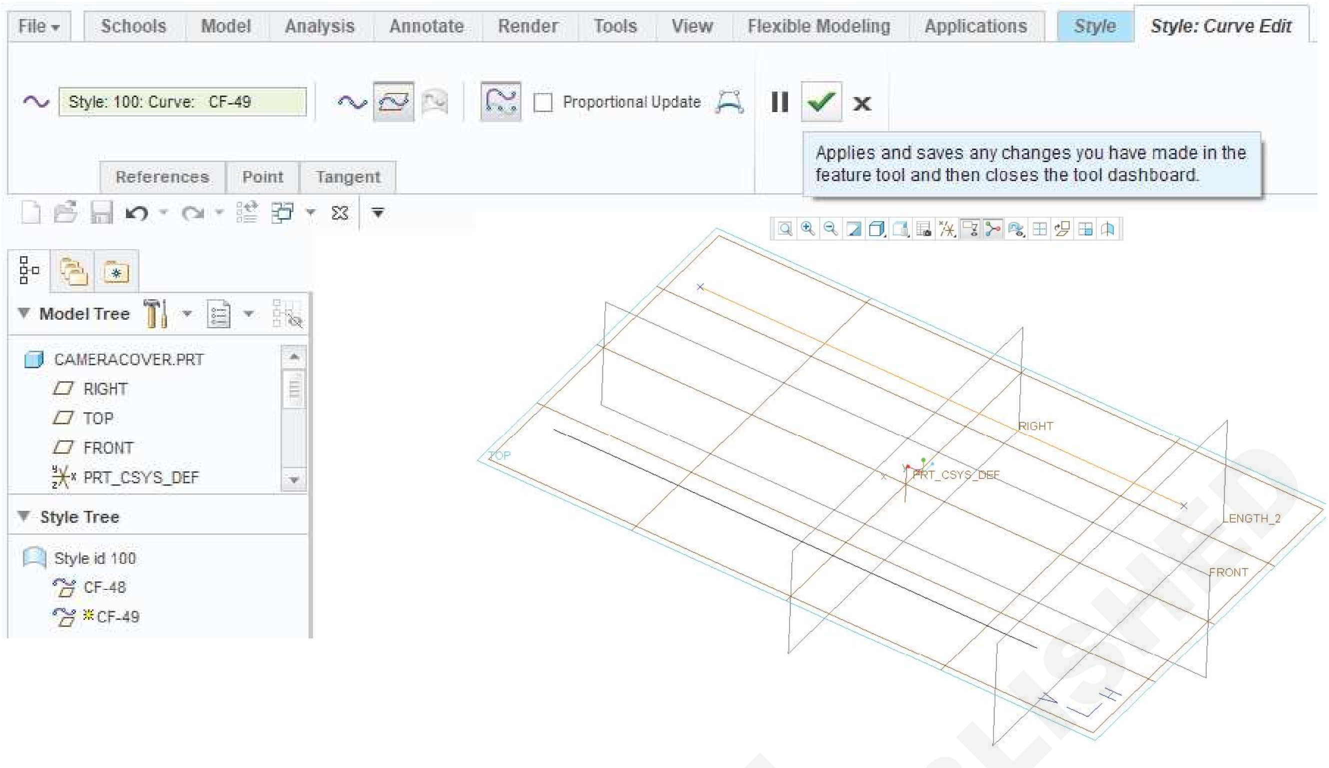


Fig 9



Step 15: Create another two datum points with curve F10 as point reference & to the offset distance as 30mm with offset reference as length_2 plane (PNT 13) & (PNT 14) curve F10 as point ref & to the offset distance as 15mm & offset reference distance 15.00 from length_2 plane. (Fig 10 & 11)

Fig 10

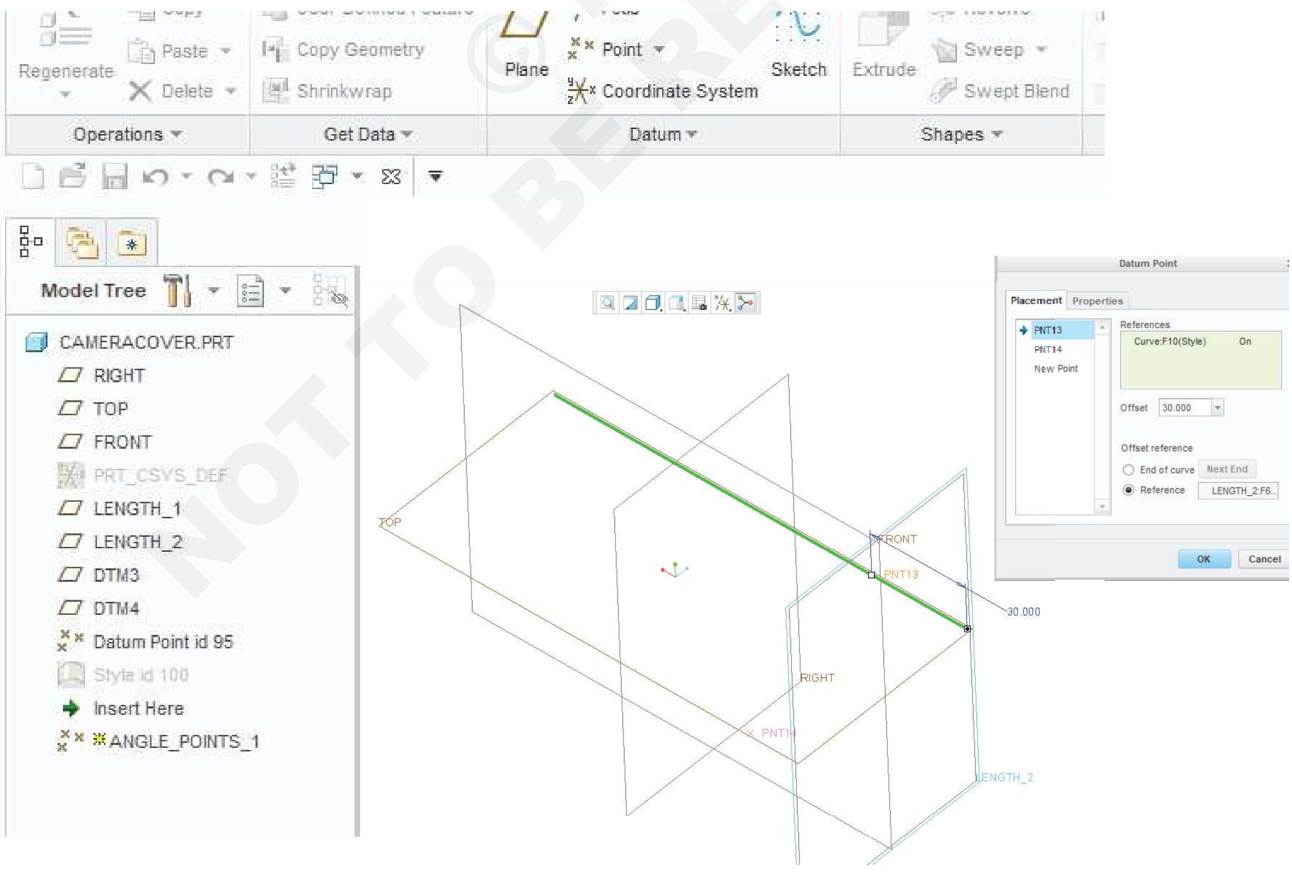
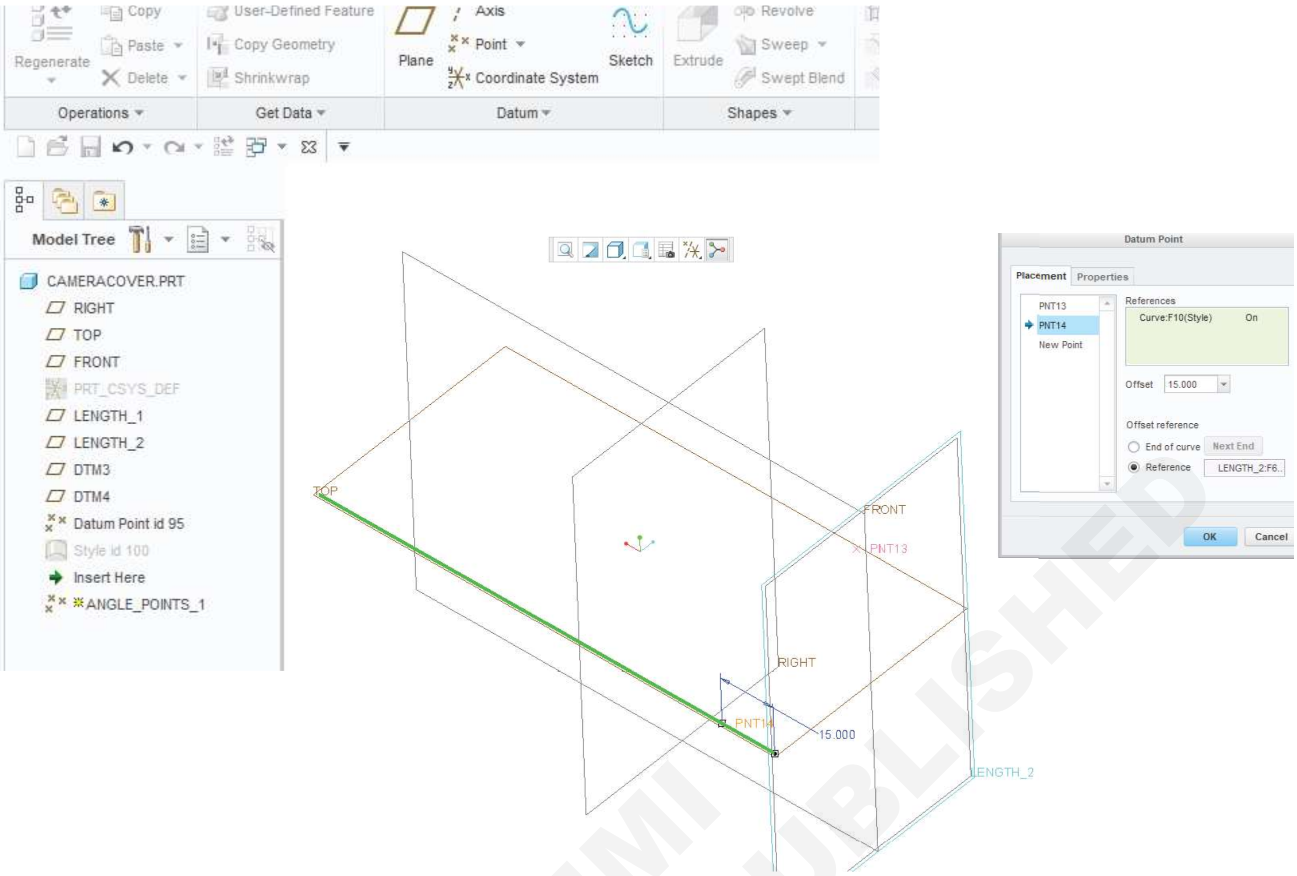
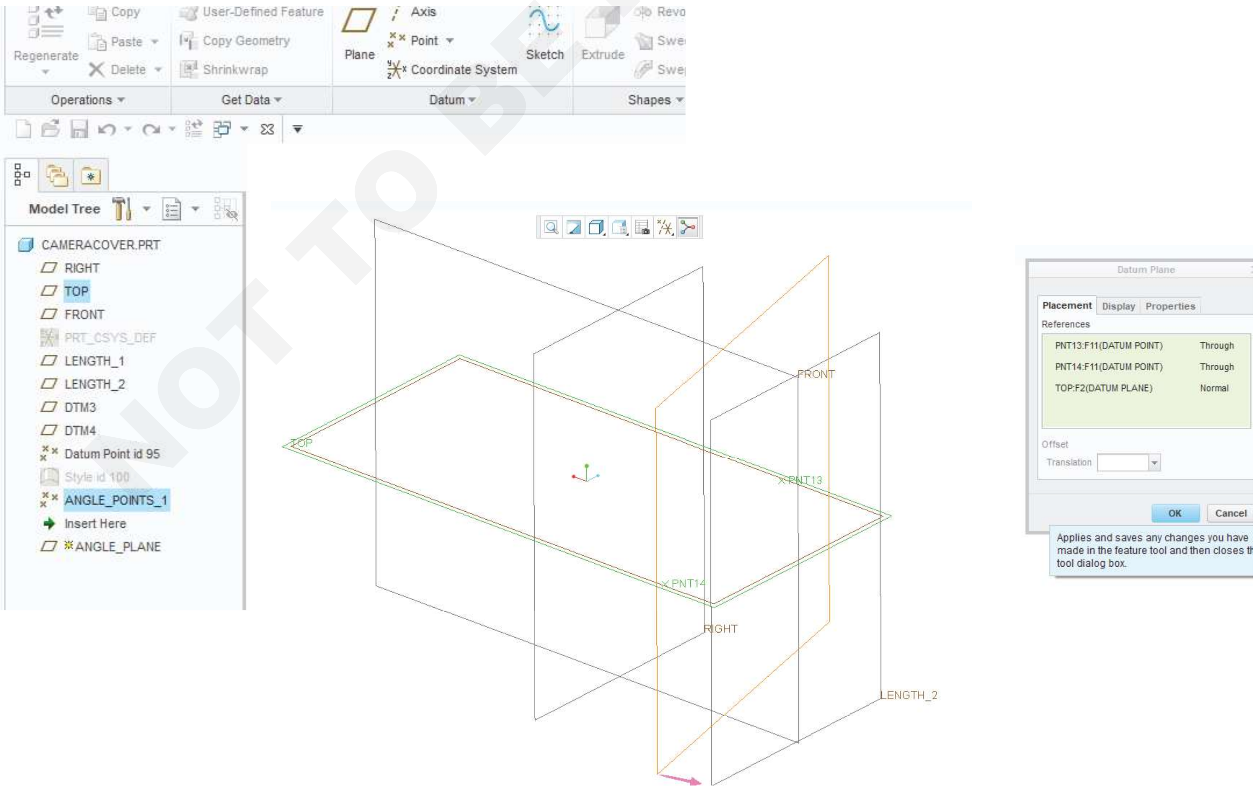


Fig 11



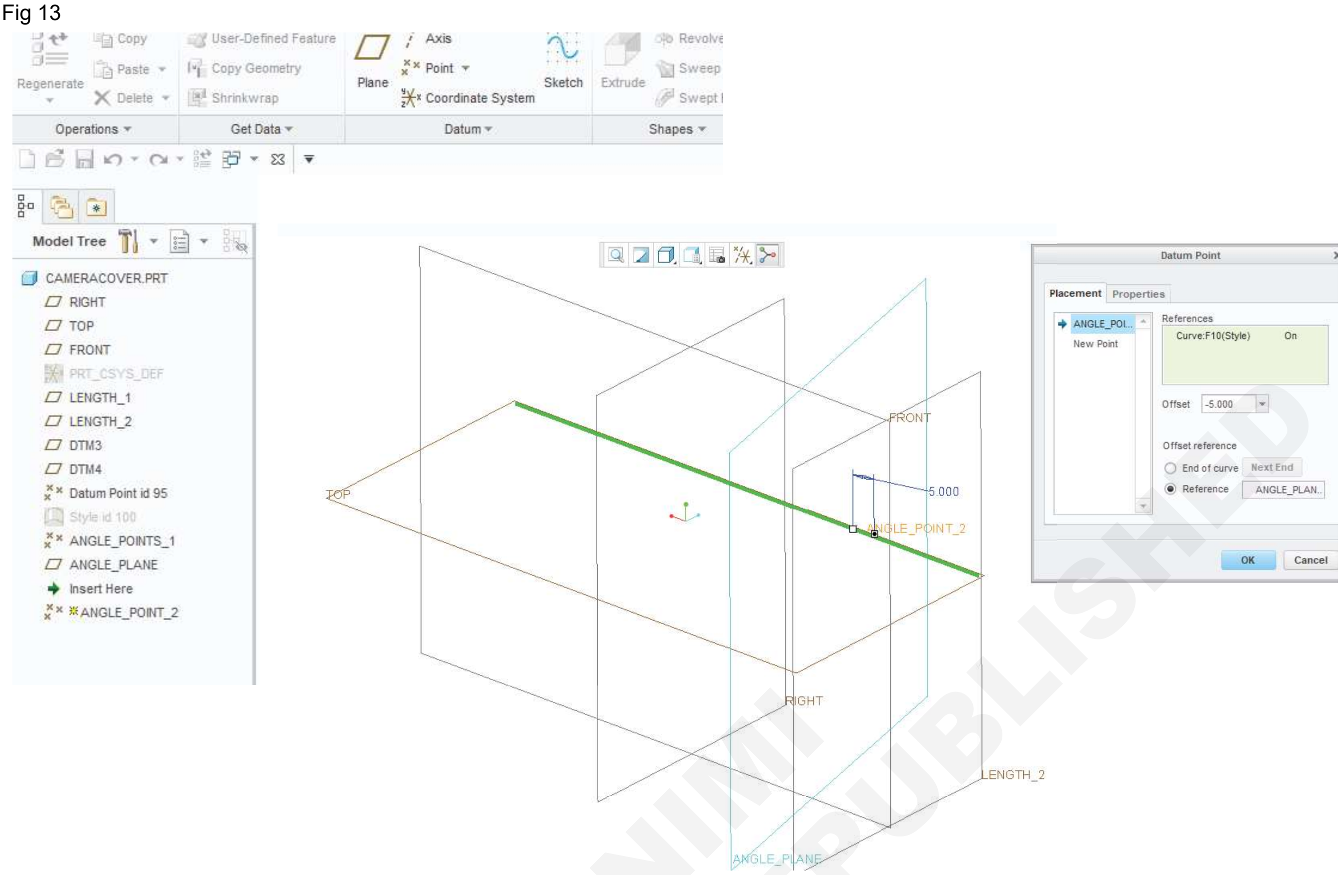
Step 16: Create Datum plane / angle plane with PNT 13, PNT 14, Top plane as placement references with rotation angle value as 0 (Fig 12)

Fig 12



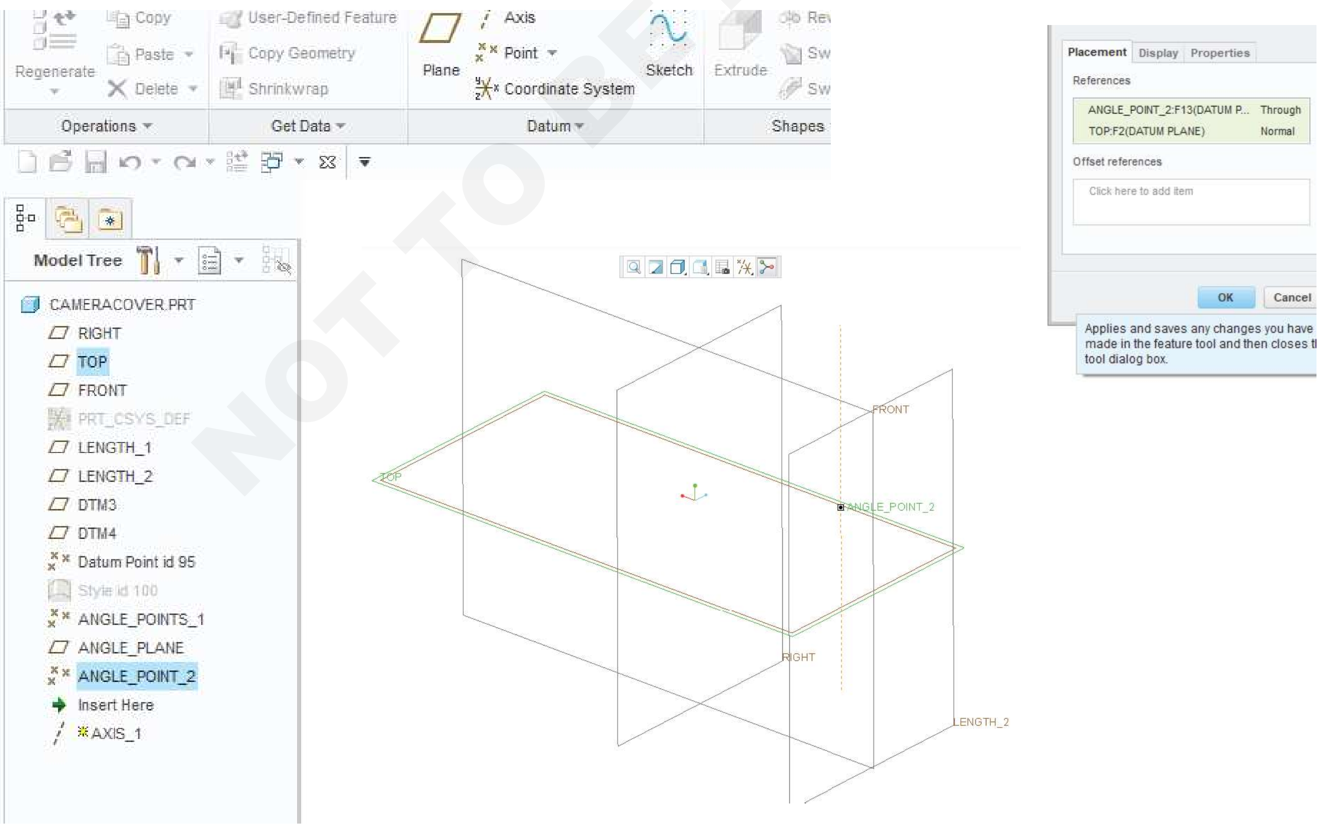
Step 17: Creating another datum point / angle point with curve F10 as references with offset distance (-5.00) with offset references as angle plane. (Fig 13)

Fig 13



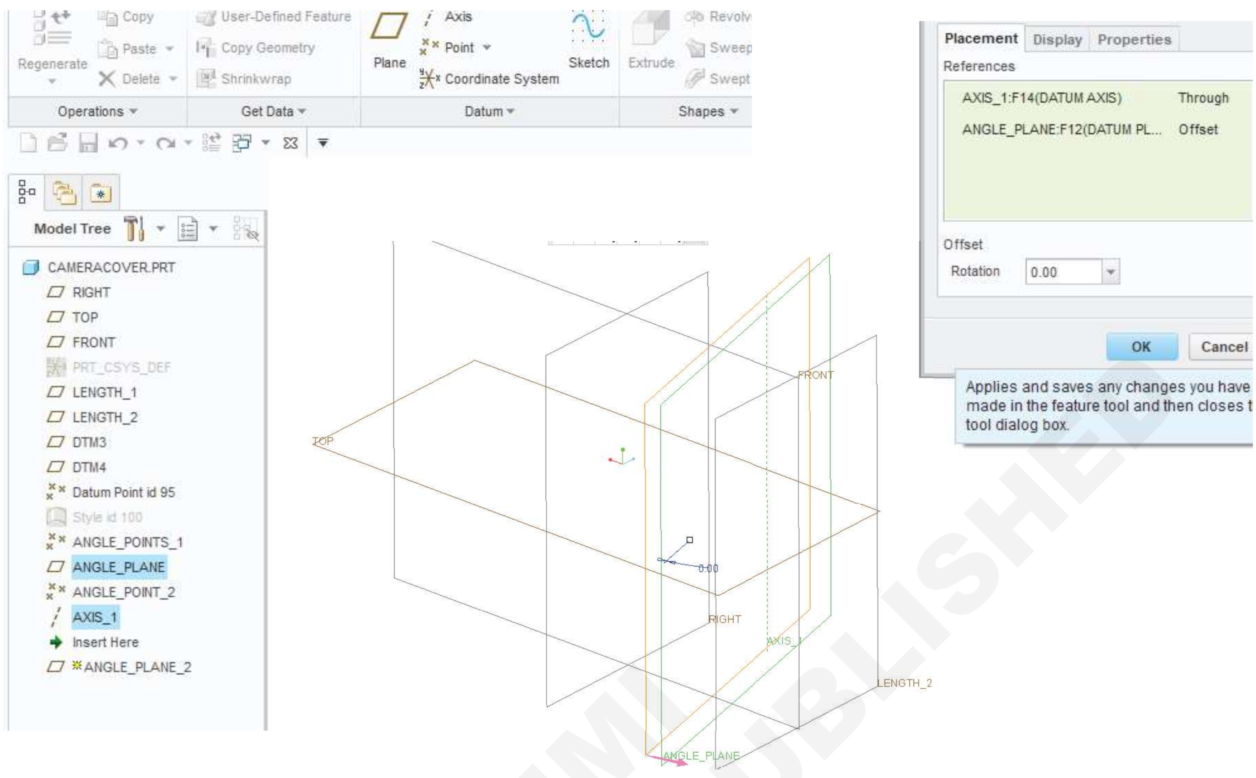
Step 18: Creating Datum axis with created angle point & top plane as a references (Fig 14)

Fig 14



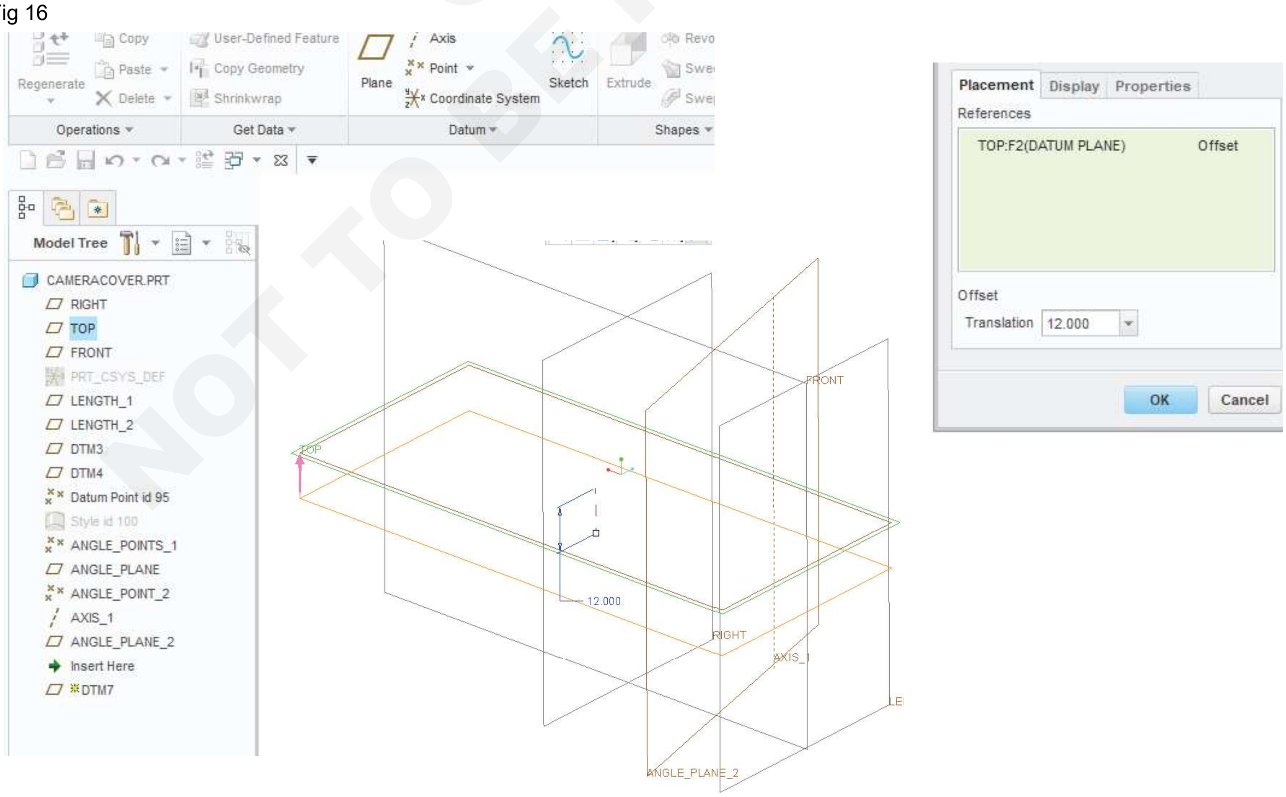
Step 19: Create another Datum plane / angle plane_2 with axis_1 & angle plane as placement references with rotation angle value as 0. (Fig 15)

Fig 15



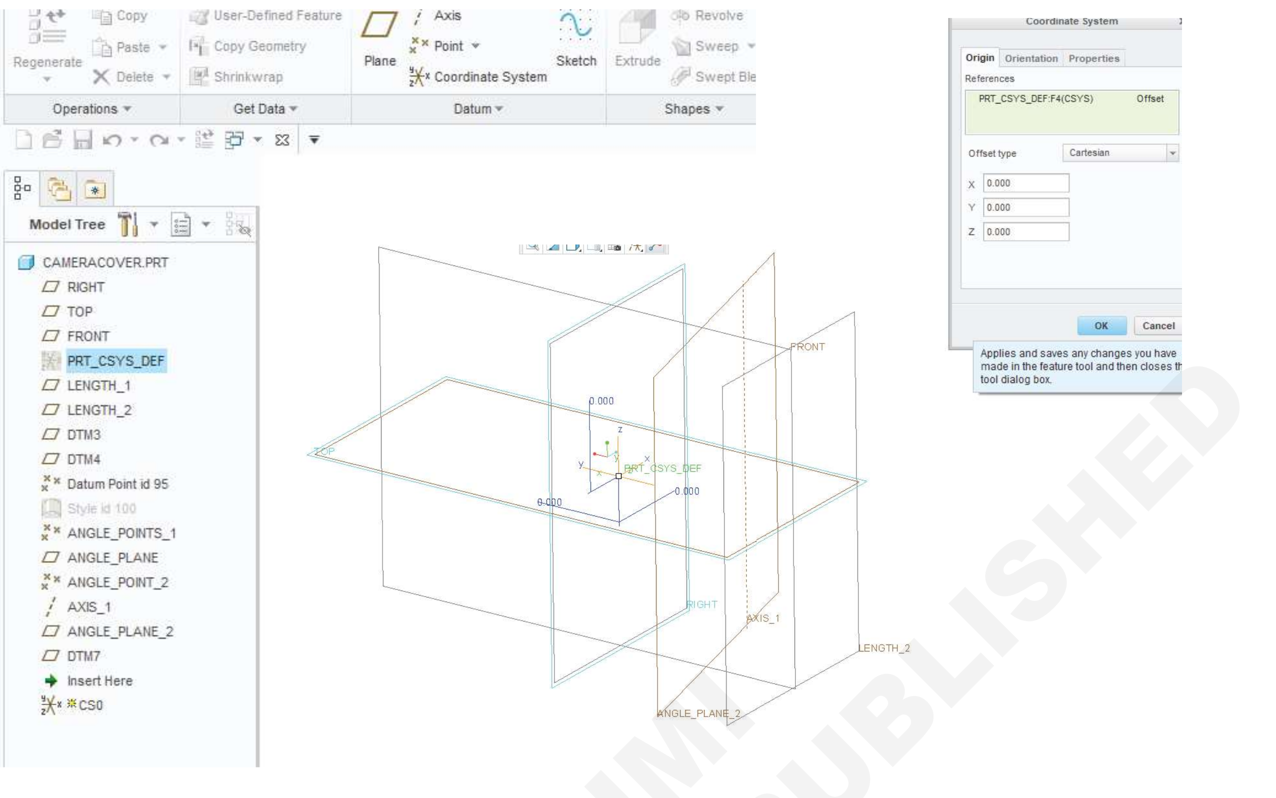
Step 19: Another datum plane created with Top plane as reference with offset translation distance 12.00 (Fig 16)

Fig 16



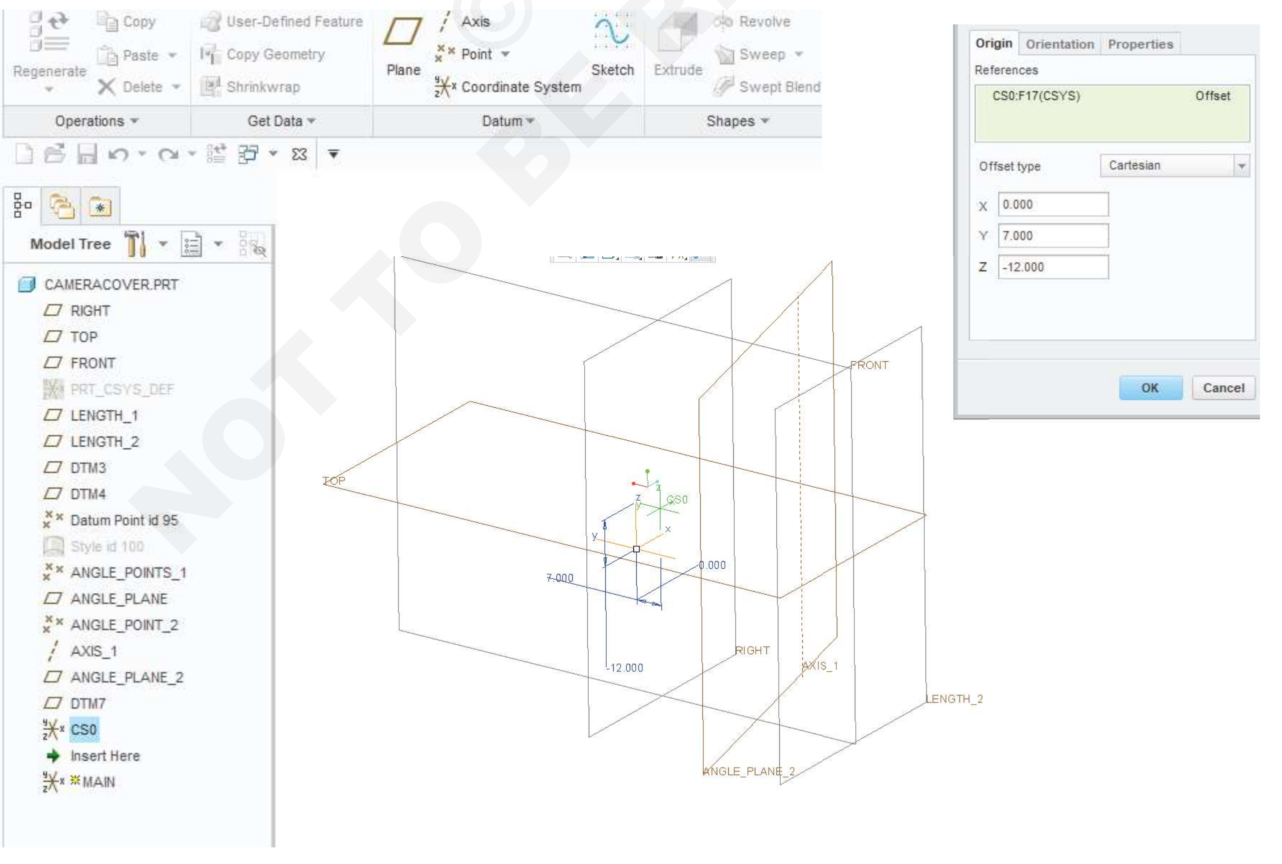
Step 20: Create co-ordinate system with origin references PRT_CSYS_Def F4(CSYS), with offset type Cartesian X=0, Y=0, Z=0 (Fig 17)

Fig 17



Step 21: Create another co-ordinate system with origin references as CSO: F17 (CSYS) which is created in last step 20 with offset distance as X=0.00, Y=7.00, Z= -12.00 and click ok button. (Fig 18)

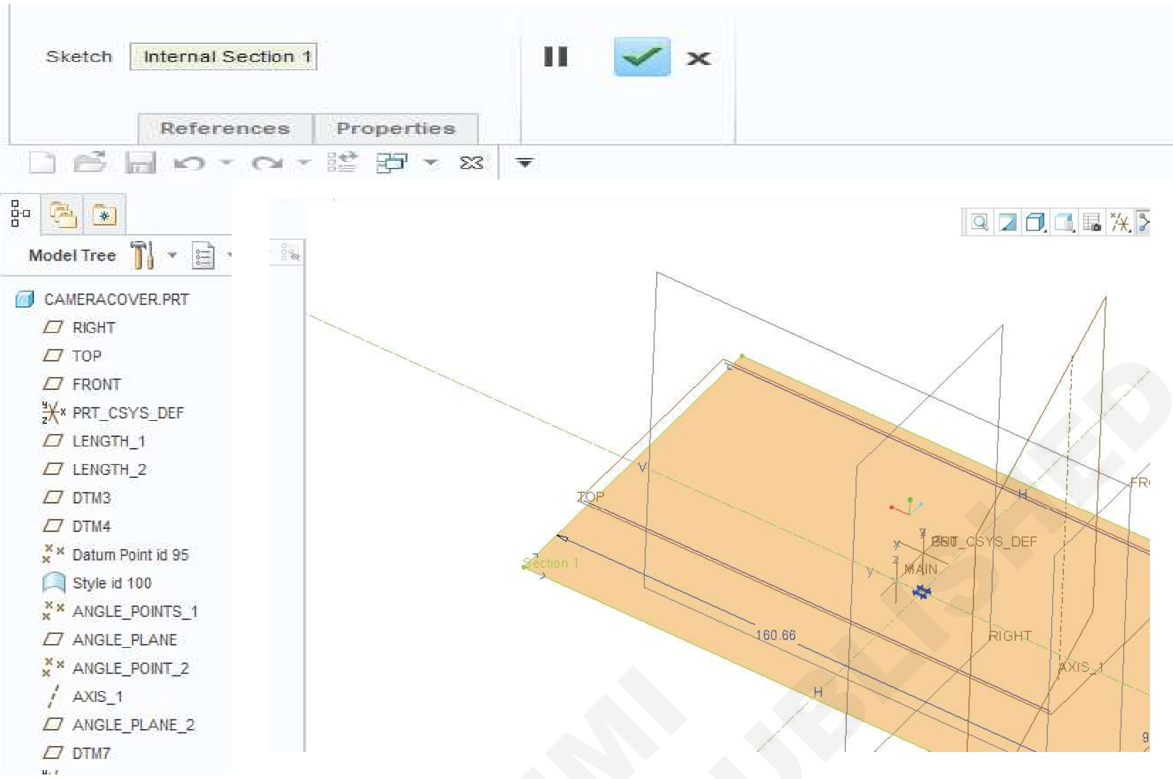
Fig 18



TASK 2: **Reference surface creation**

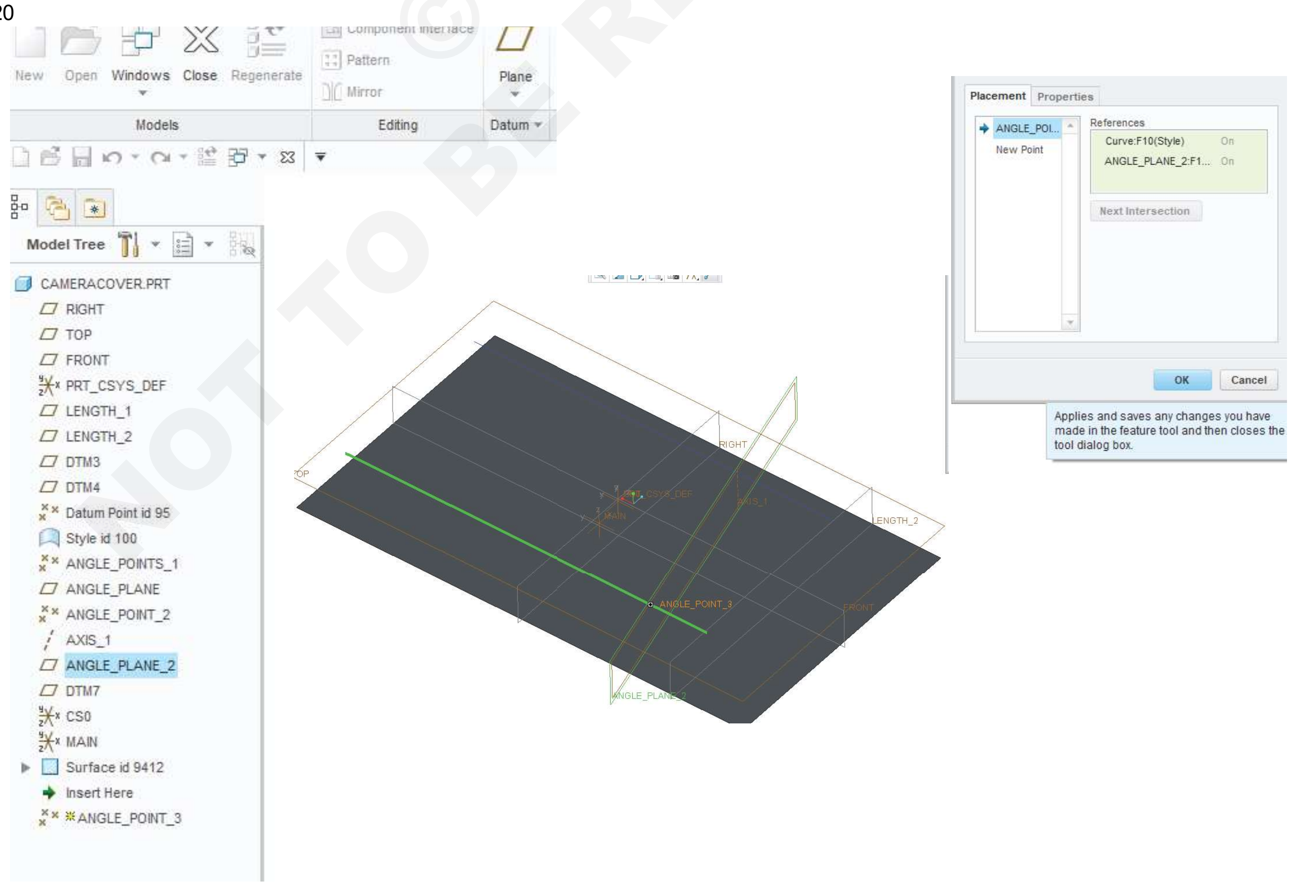
Step 22: Select Fill option from surfaces- Then select DTM7 plane – Draw the rectangular profile as shown in (Fig 19) by selecting center rectangle from – Sketcher option, finally click ok button.

Fig 19



Step 23: Create another angle point with curve F10 and angle plane as references & click ok button. (Fig 20)

Fig 20



Step 24: Select style option in surfaces create four curve separately as shown in (Fig 21) with each curve on separate set of reference points as follows.

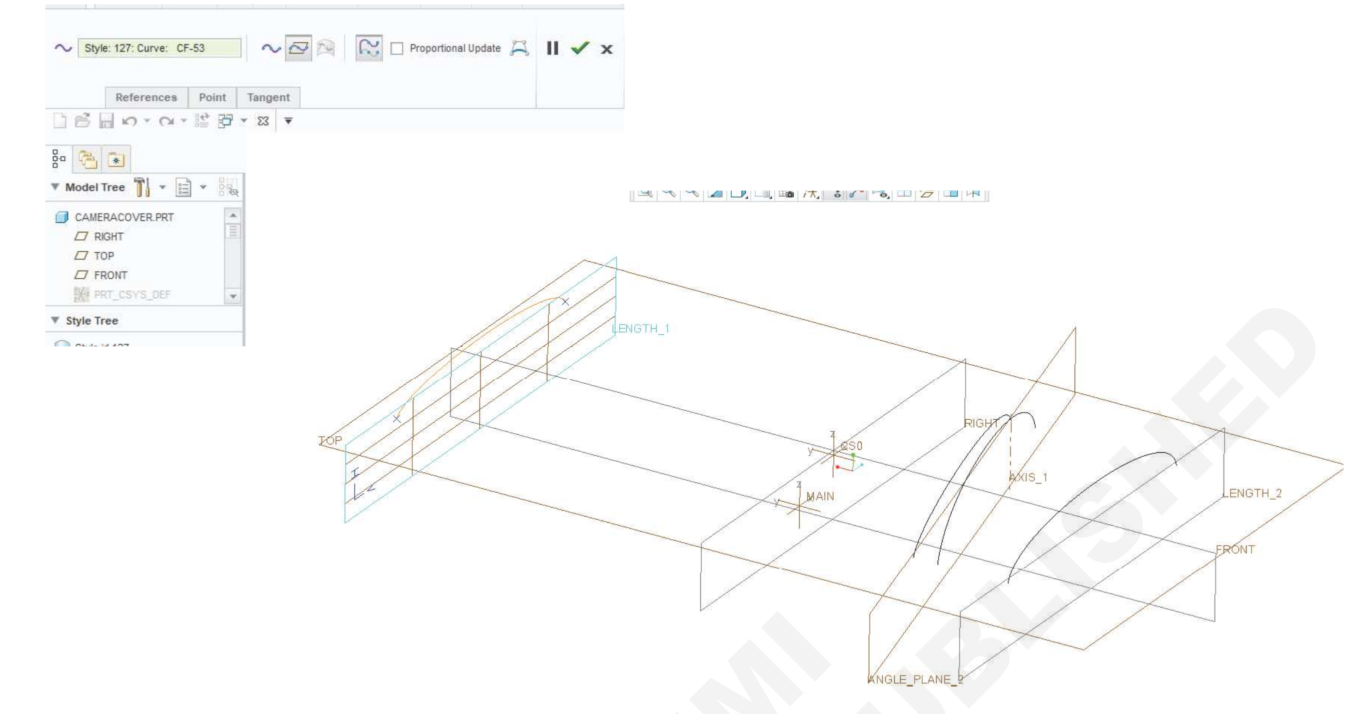
CF-50 in Ref. Plane select Length_2 F6 (Datum plane)

CF – 51 – Angle plane

CF – 52 – Angle plane _2

CF – 53 – Length_1

Fig 21



Step 25: After drawing the curves, select style surface option create surfaces by selection of chain of curves one by one to make three segments or surfaces as shown in following. (Fig 22 & 23)

Fig 22

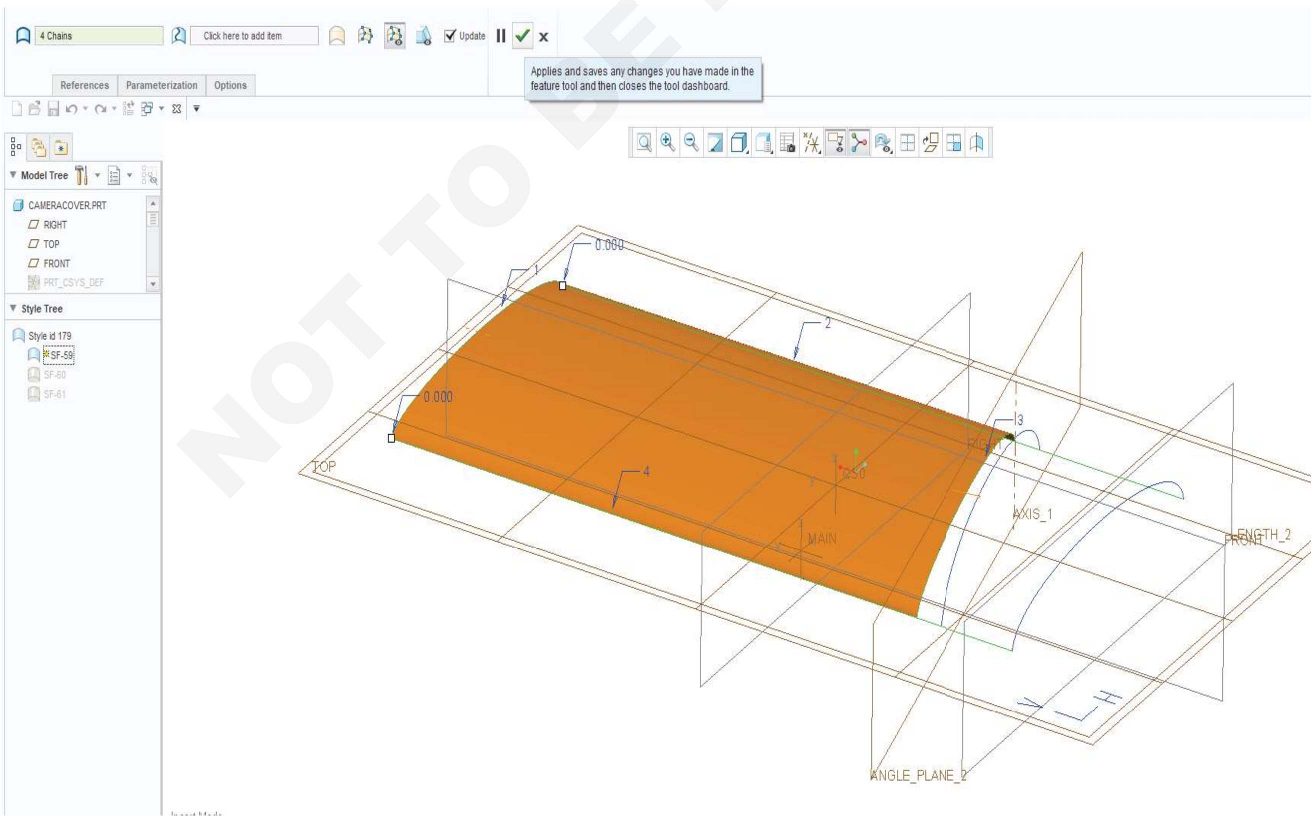
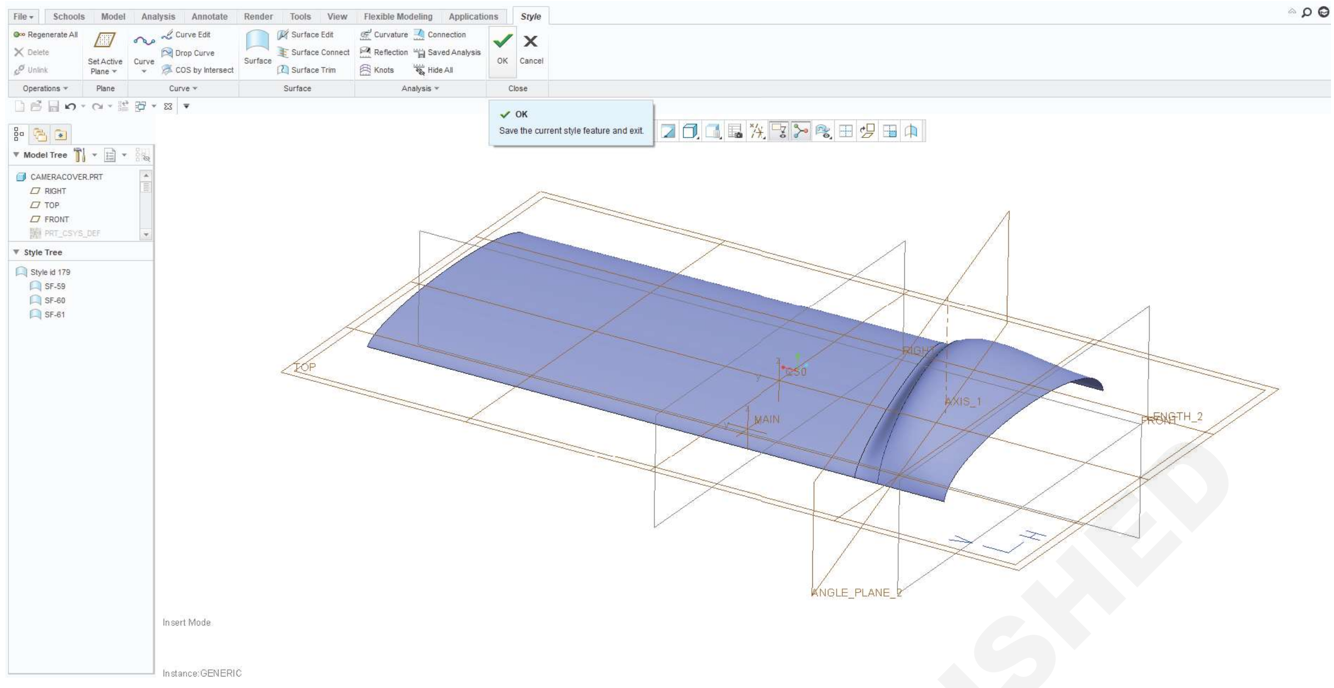
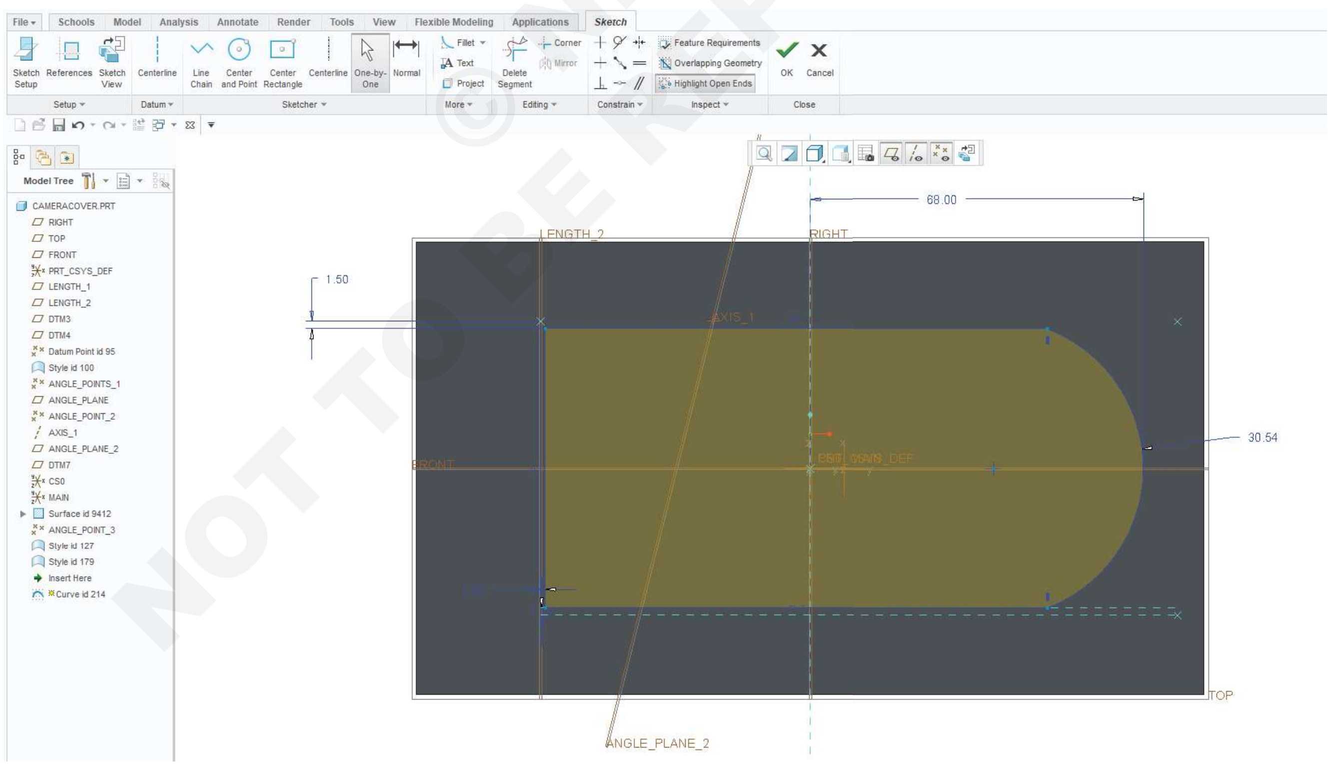


Fig 23



Step 26: In the face of rectangular surface created previously, create a sketch as per the given dimension in (Fig 24) (or) as with rough dimension.

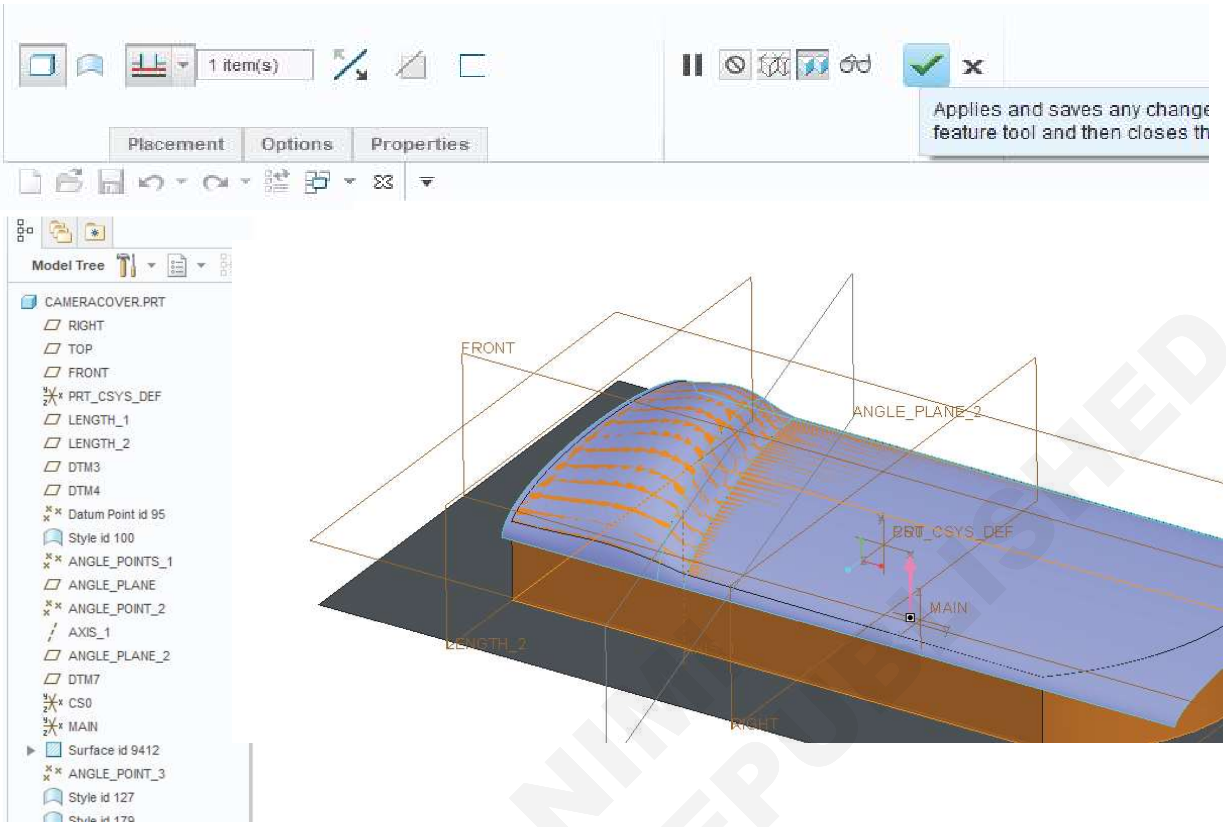
Fig 24



TASK 3: **Development of model with above references**

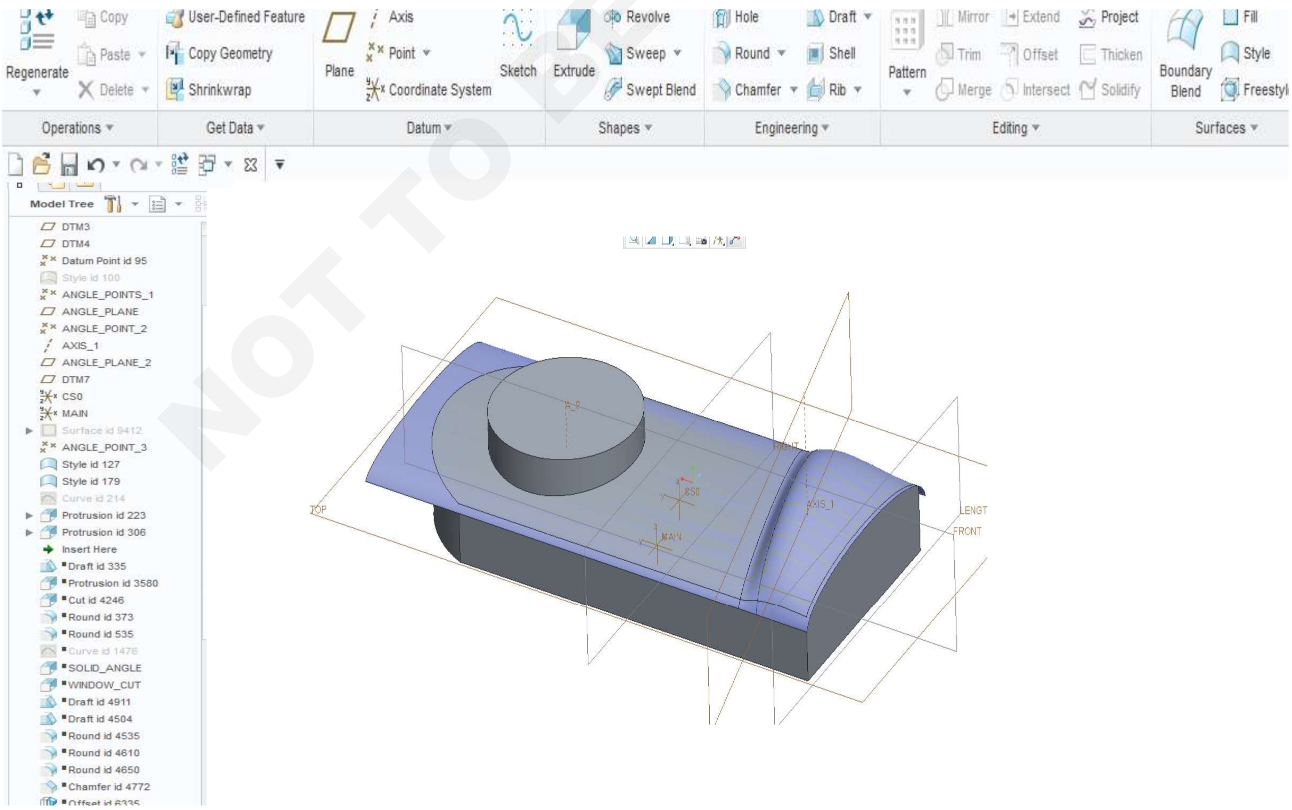
Step 27: Extrude the sketch up to the reference surface (by selecting up to the surface option) as shown in (Fig 25).

Fig 25



Step 28: Draw the circle with ø 40 mm sketch on the top plane. Extrude the sketch to about 12mm extrude from sketch plane by a specified depth value option. (Fig 26)

Fig 26



Step 29: In model tab select draft option select all the four surface of the part & give draft angle as 4°. (Fig 27, 28)

Fig 27

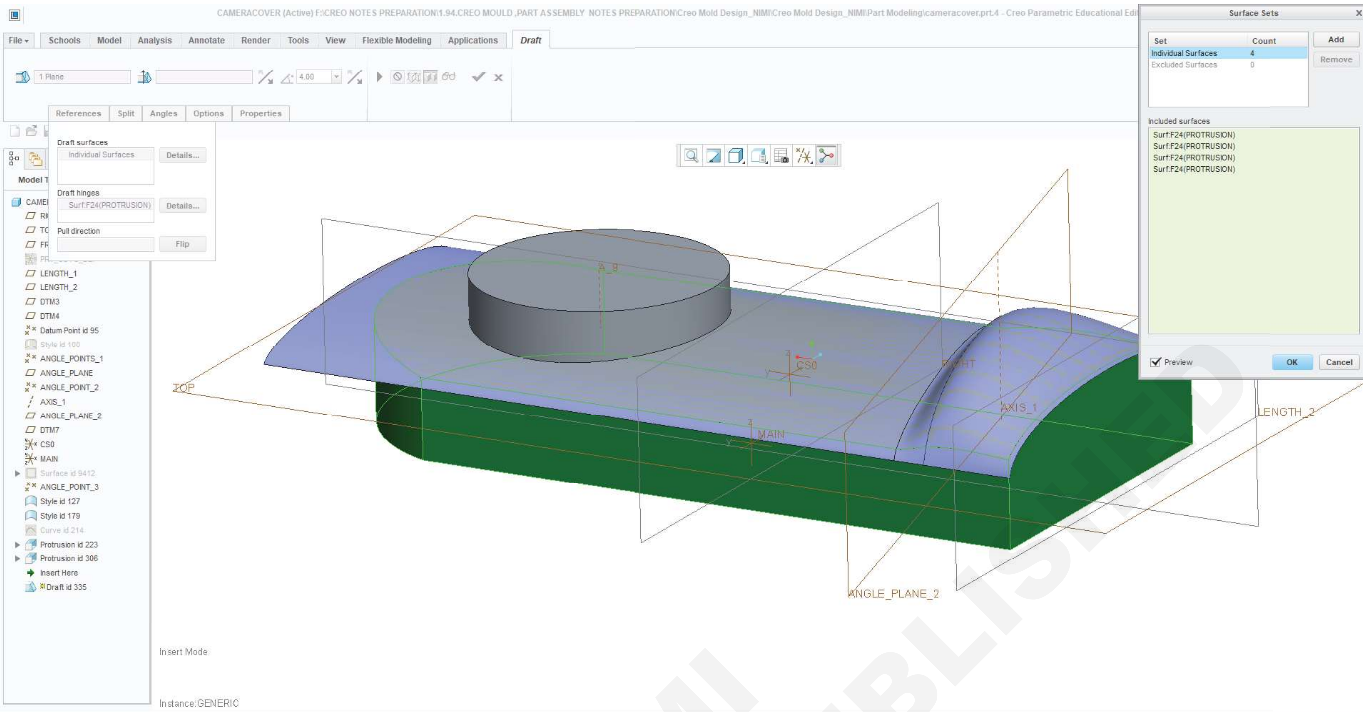
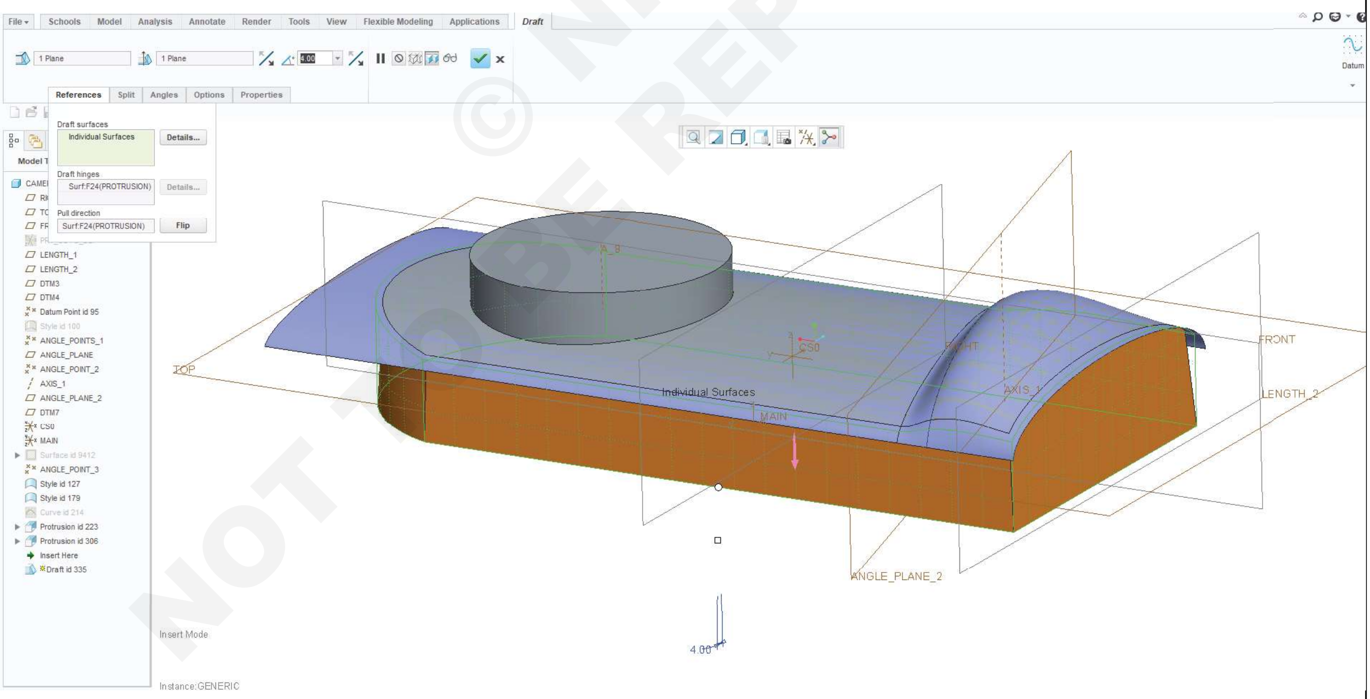
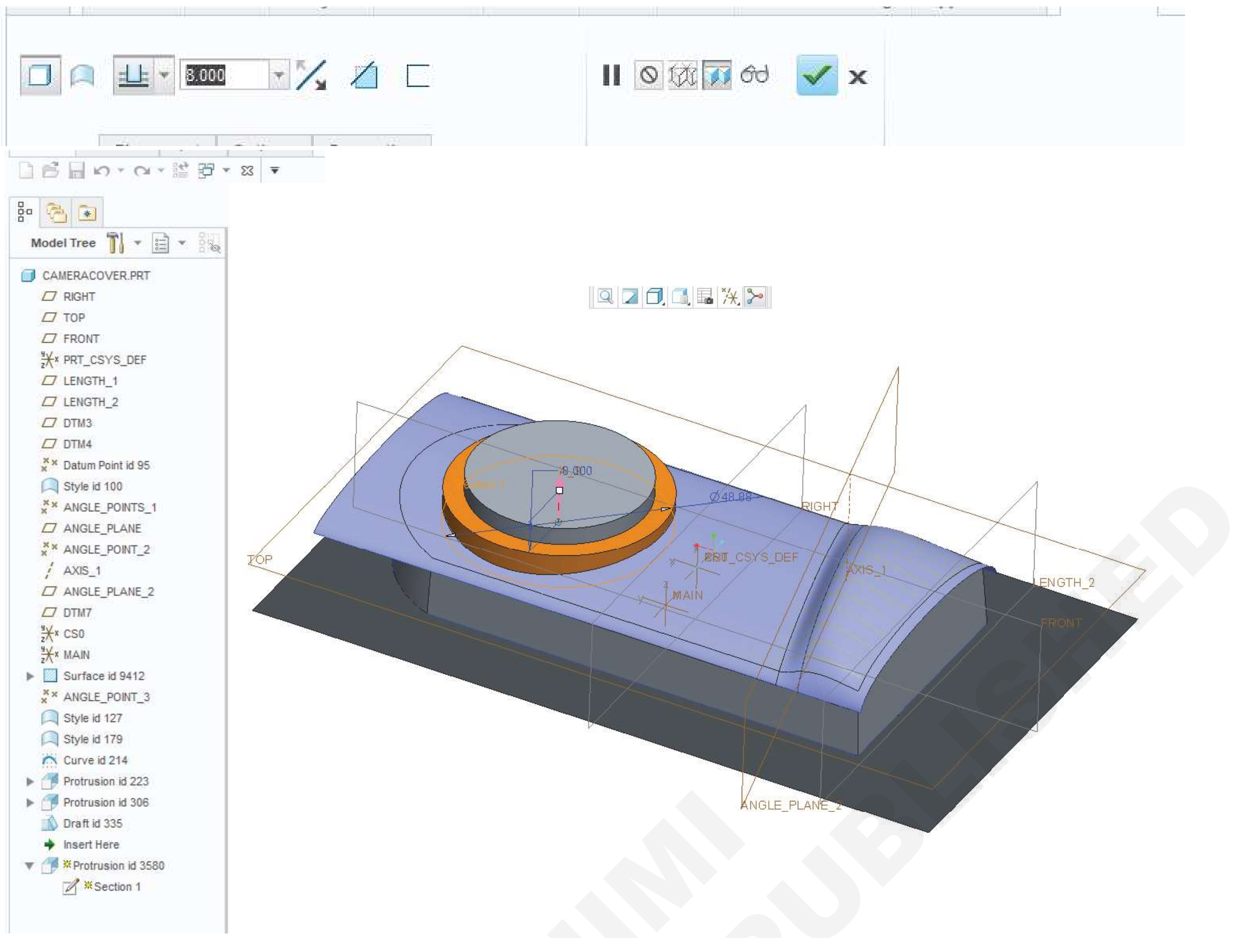


Fig 28



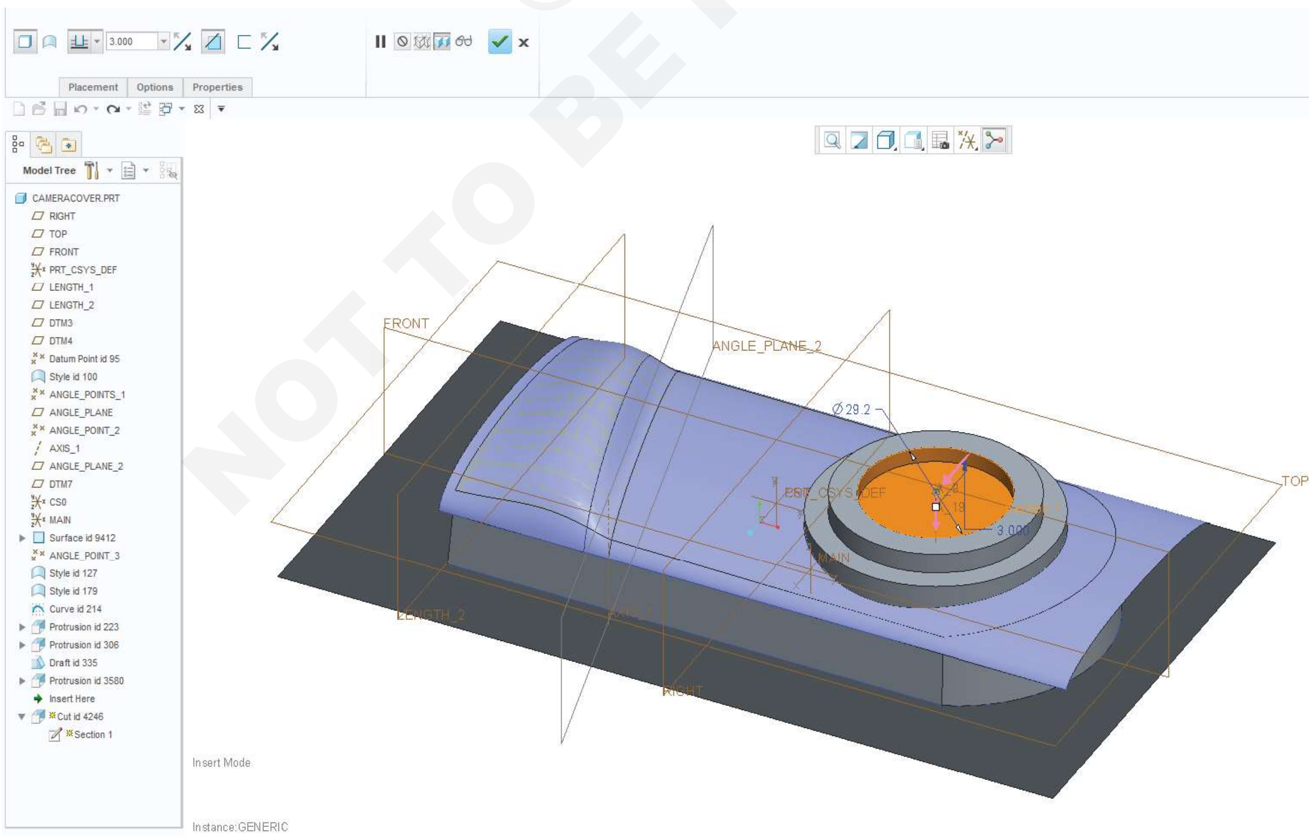
Step 30: Draw another circle on the top plane with ø 48.88 & extrude the sketch to about 8mm, place by a specified depth value option. (Fig 29)

Fig 29



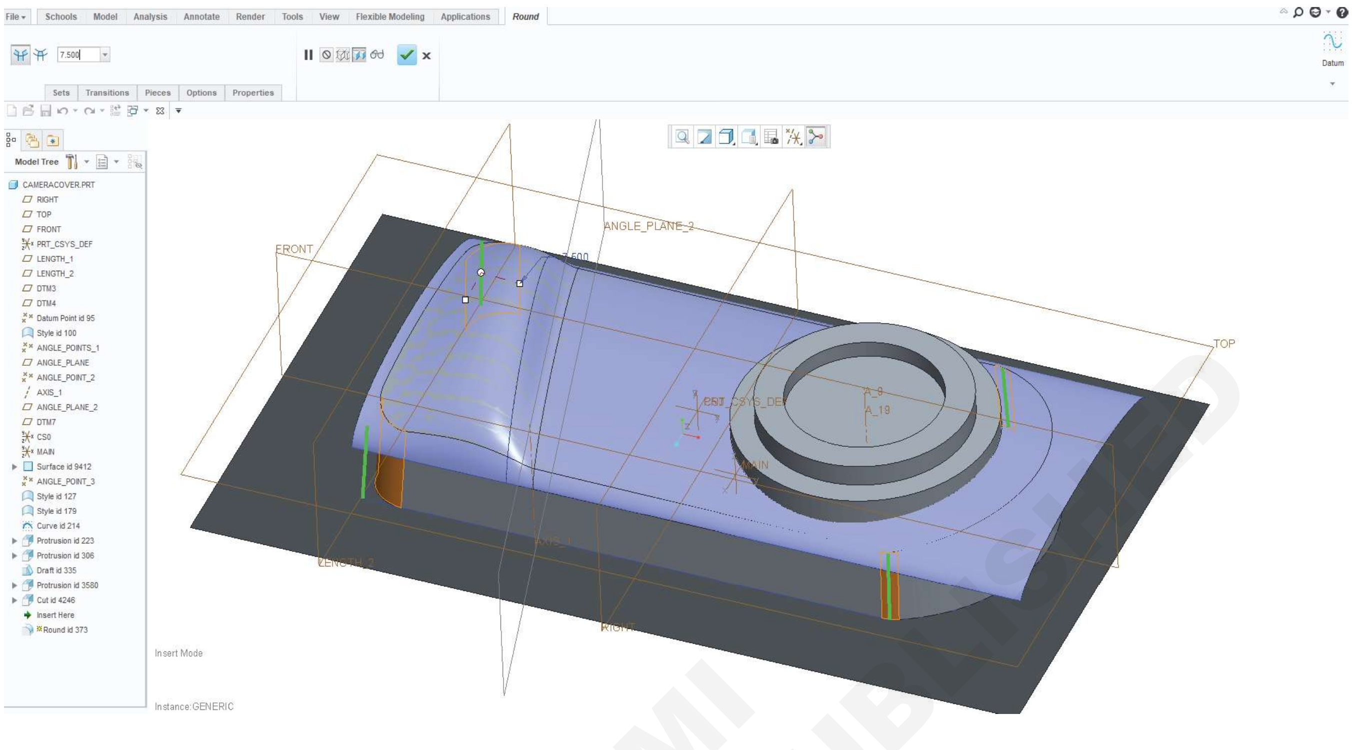
Step 31: Draw another circle on the last extruded face & give extrude command but in direction to the material & select the remove material  command with the value as 3mm. (Fig 30)

Fig 30



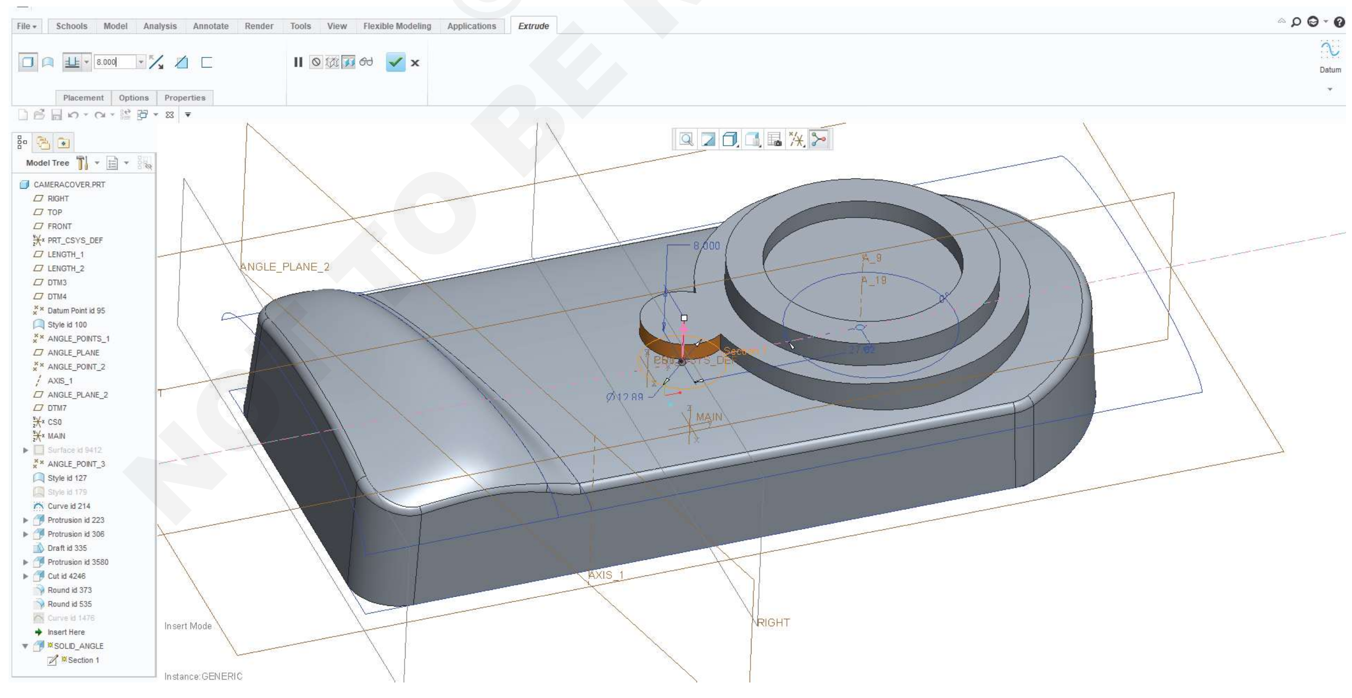
Step 32: Select round option to fillet the sharp edges, give the value of radius as 7.5 select the four sharp edge corners fillet the above shown edges with value as 1.5 with round option as shown in (Fig 31)

Fig 31



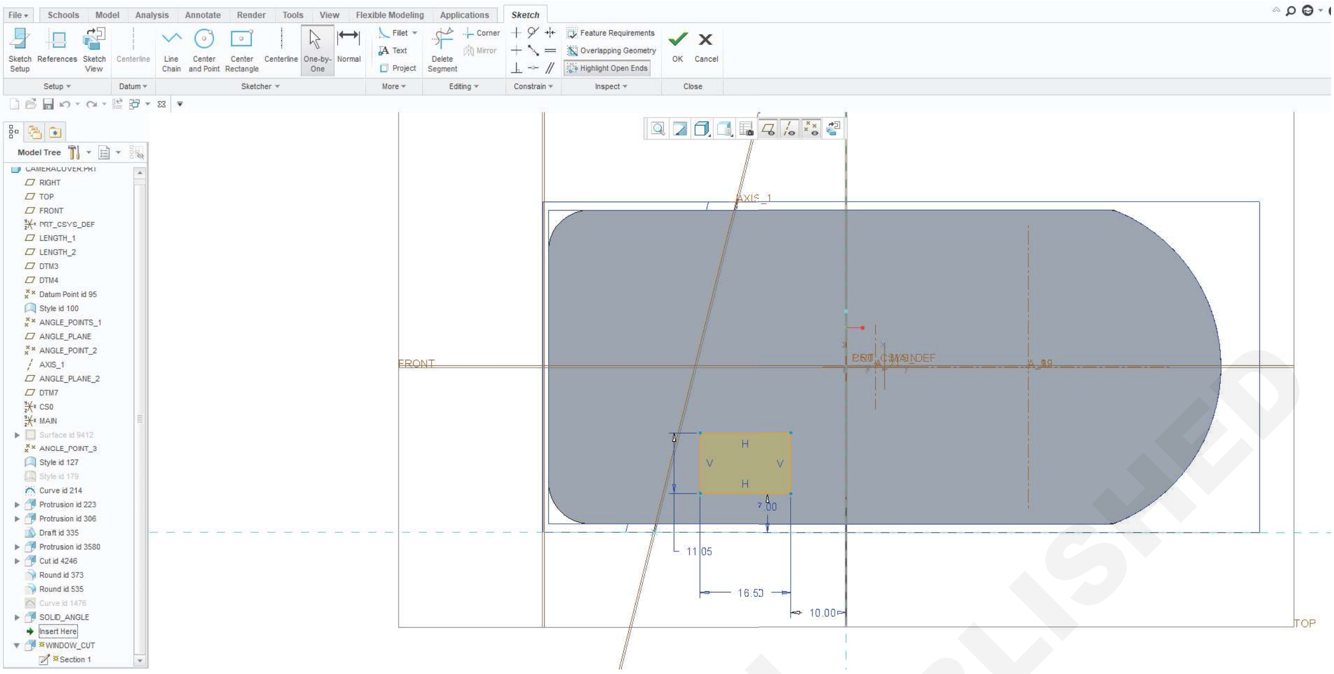
Step 33: Select the top plane draw circle with dia 12.89 from certain distance from center of created extrude. (Fig 32)

Fig 32



Step 34: In top plane draw the rectangular profile with certain distance from the right plane (Fig 33). Then select the extrude command activate the remove material option  with value.

Fig 33



Step 35: Create the draft angle to the rectangle, extrude cut feature by selecting the bottom face (Fig 34, 35). In hinge feature pull direction tab select all four side faces with draft angles as 9°.

Fig 34

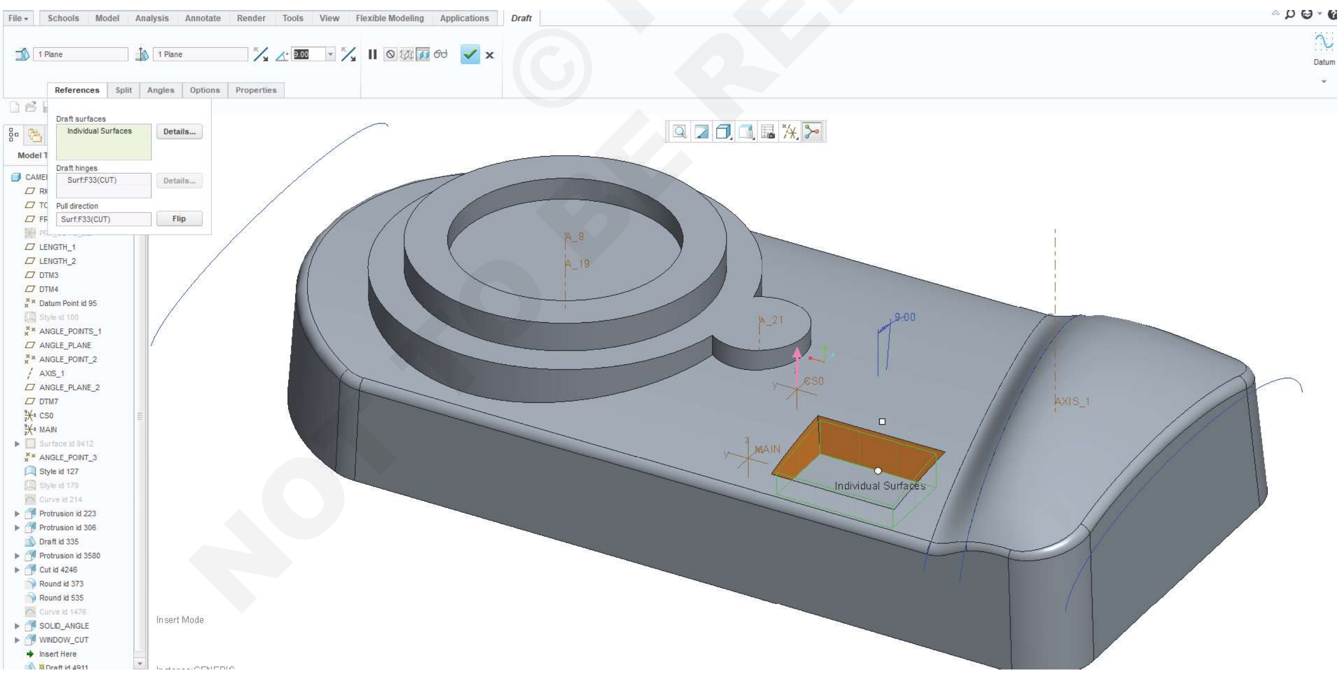
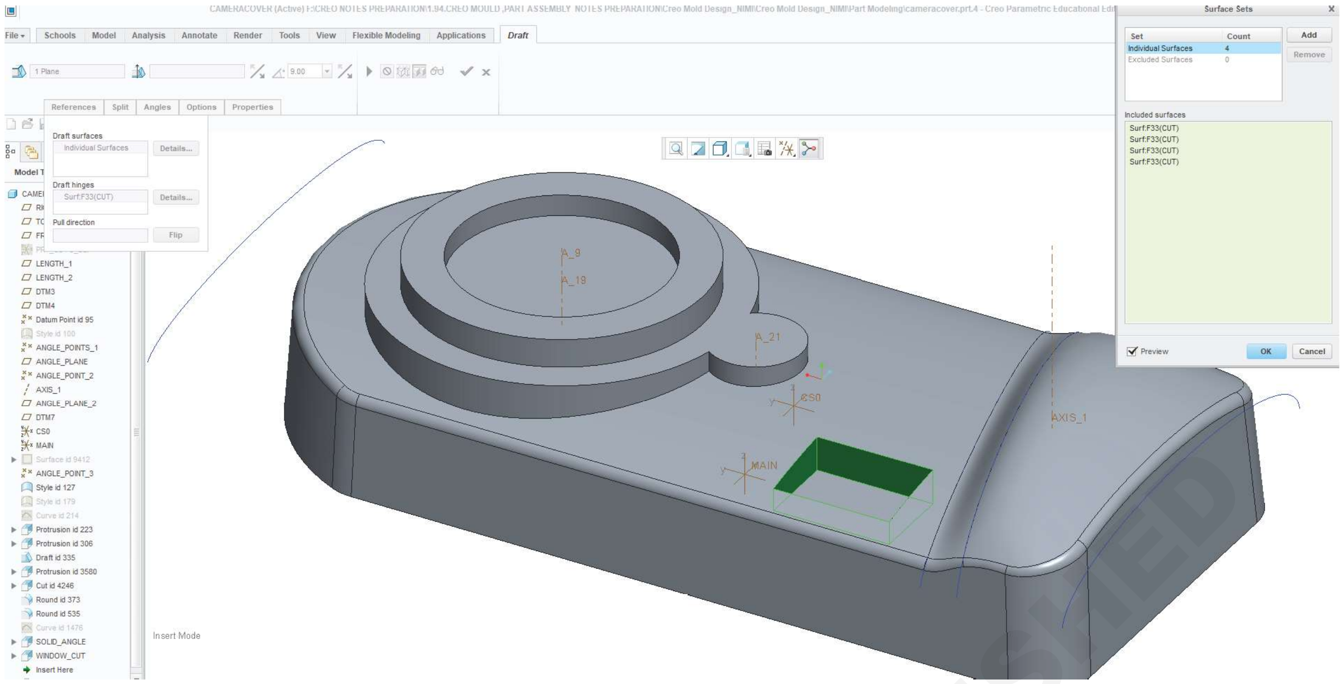
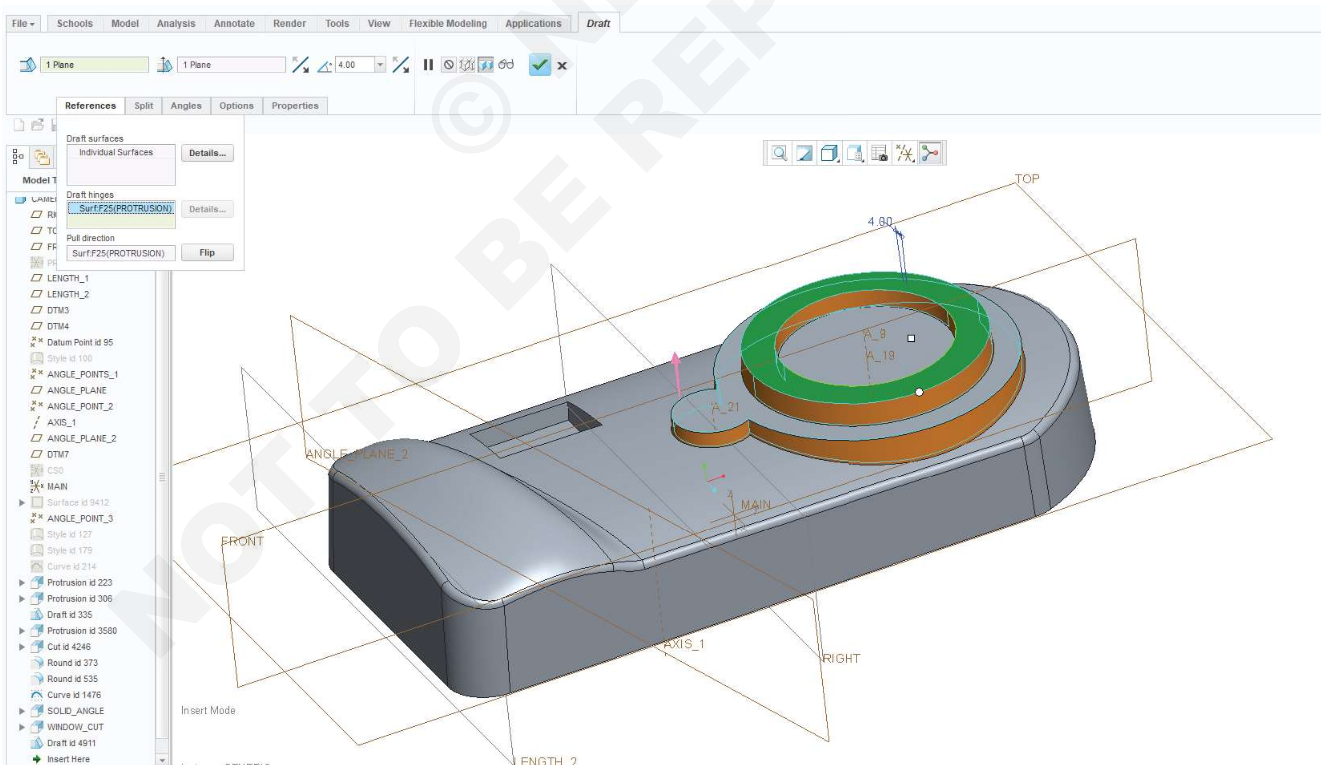


Fig 35



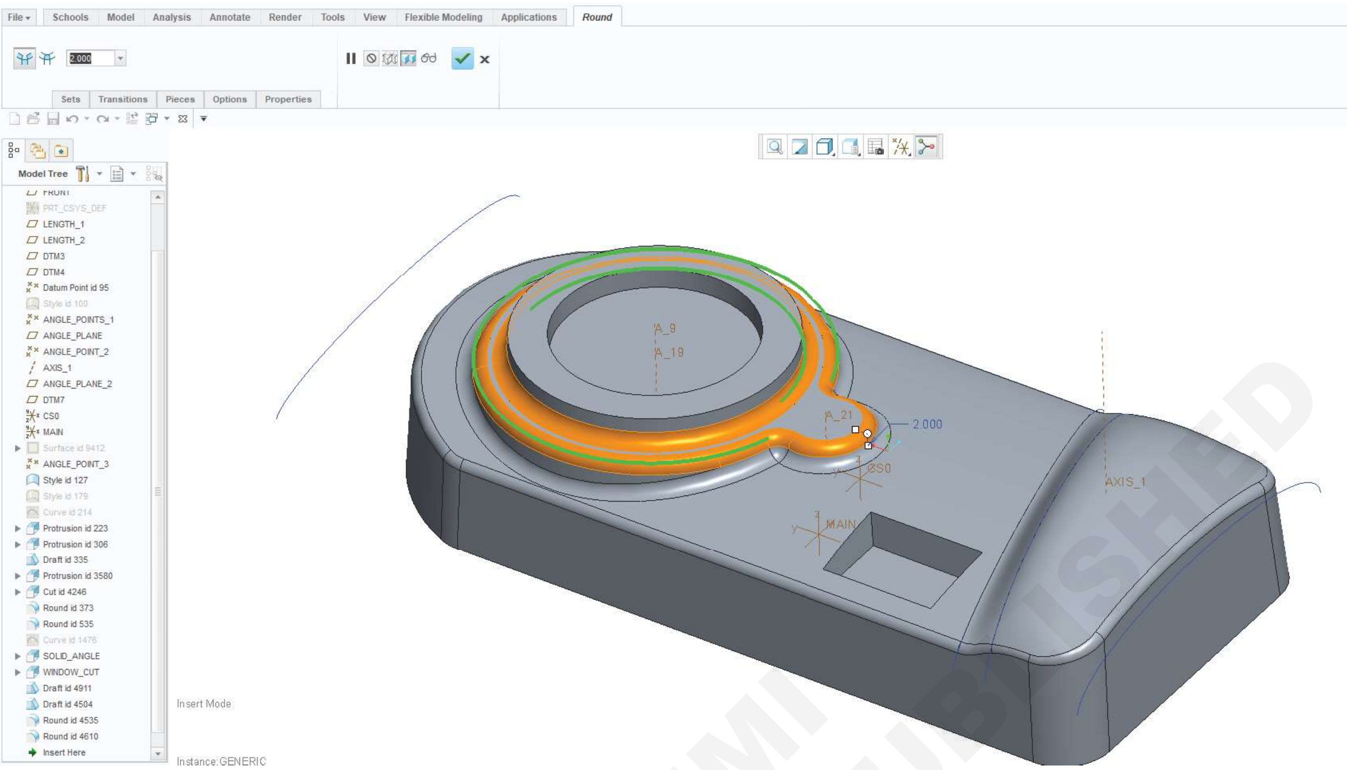
Step 36: As the above steps select the extruded feature face. In reference tab under draft surface details – Select faces as shown in Fig 36 under draft hinges select top & pull direction. Select top surfaces flip direction as draft outward for angle of 4°.

Fig 36



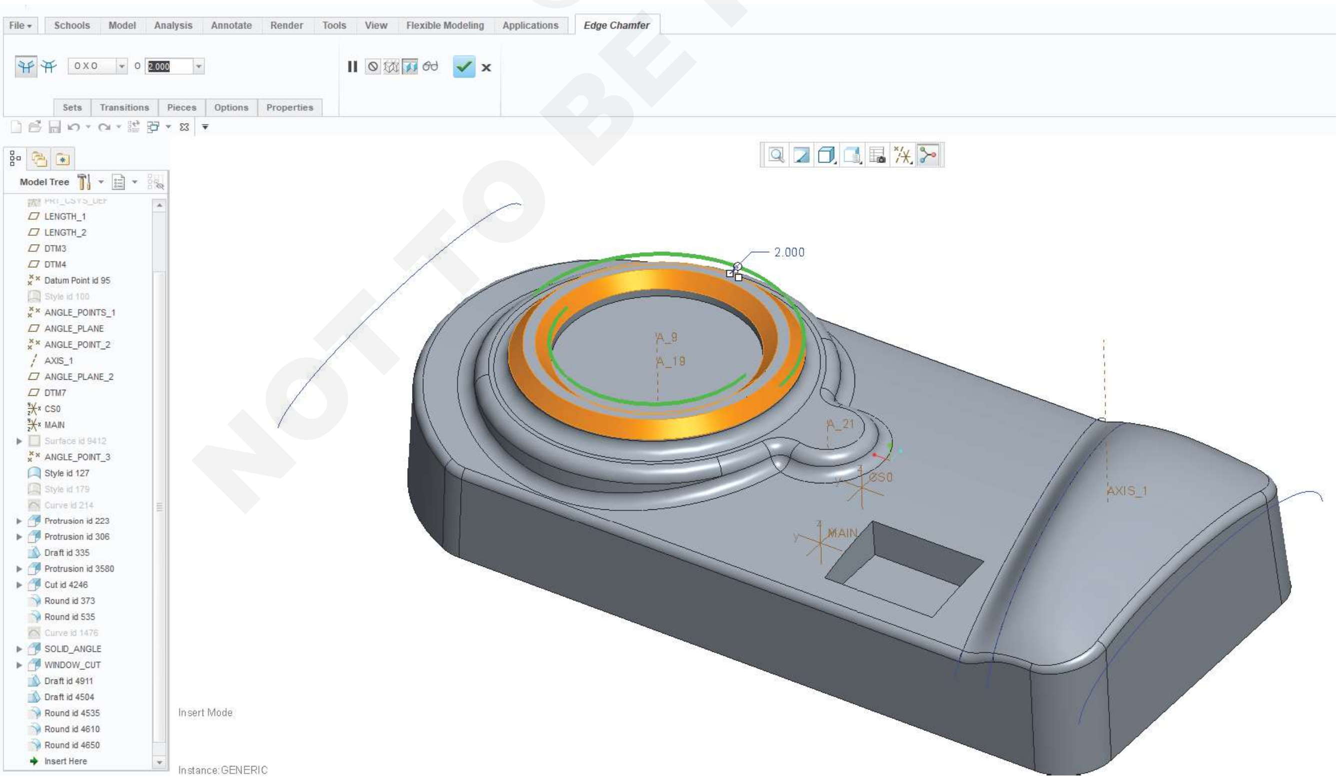
Step 37: Select the round option give the radius value as 2 select the edges (Round id 4650) (Fig 37)

Fig 37



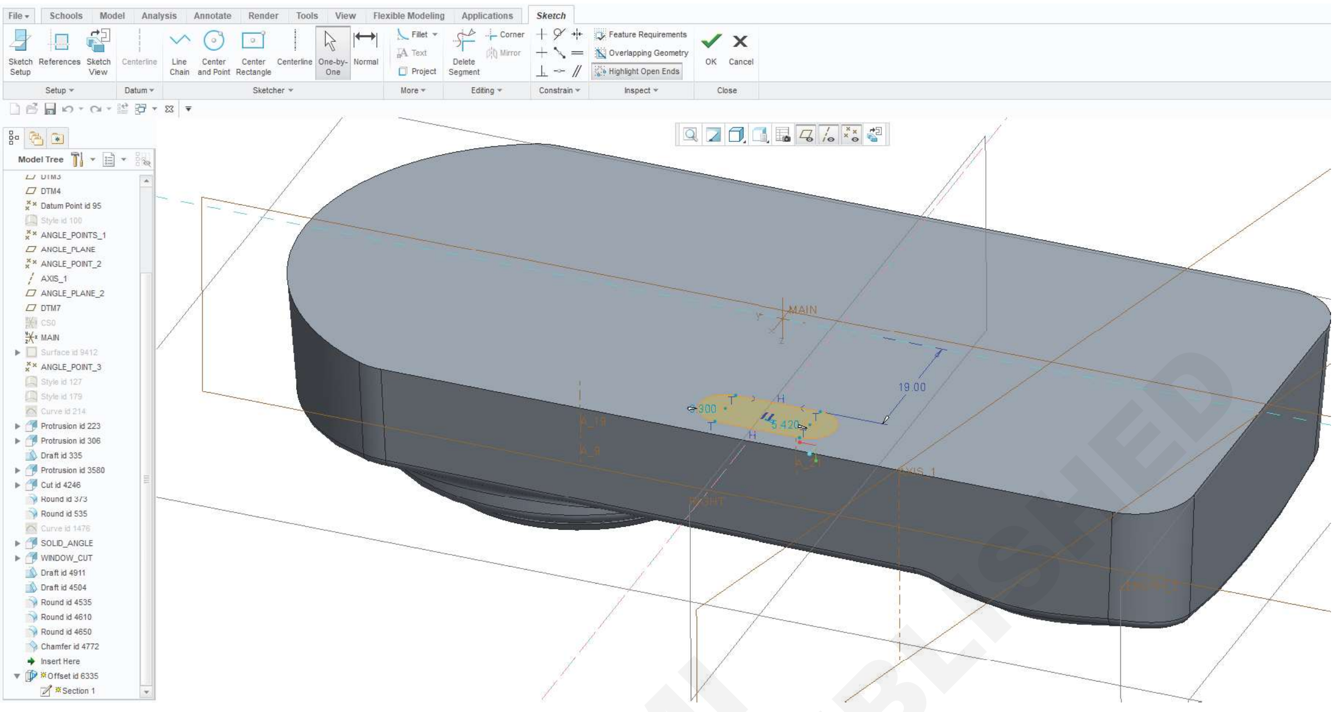
Step 38: Select the chamfer option, under sets select 0x0, 0- 2.00 as the value & then select the sharp edges. (Fig 38)

Fig 38



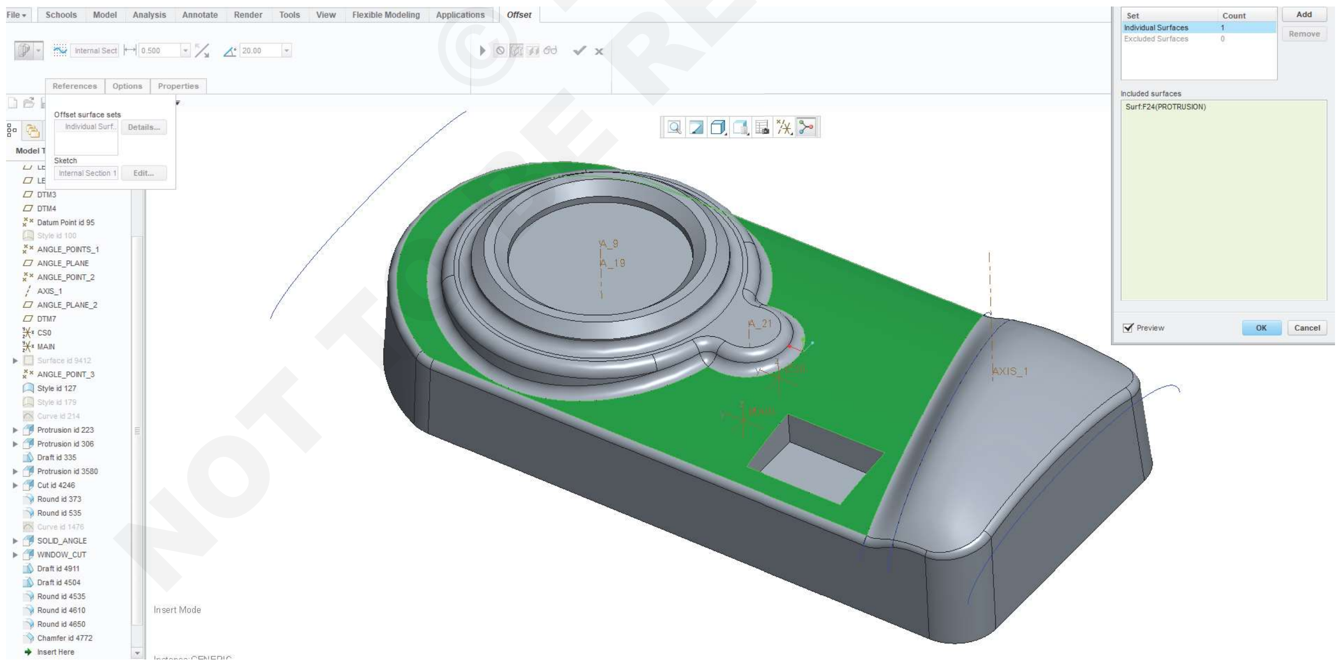
Step 39: Draw the profile sketch in the bottom face (Fig 39) with 19mm from the front plane. Select offset option with draft feature.

Fig 39



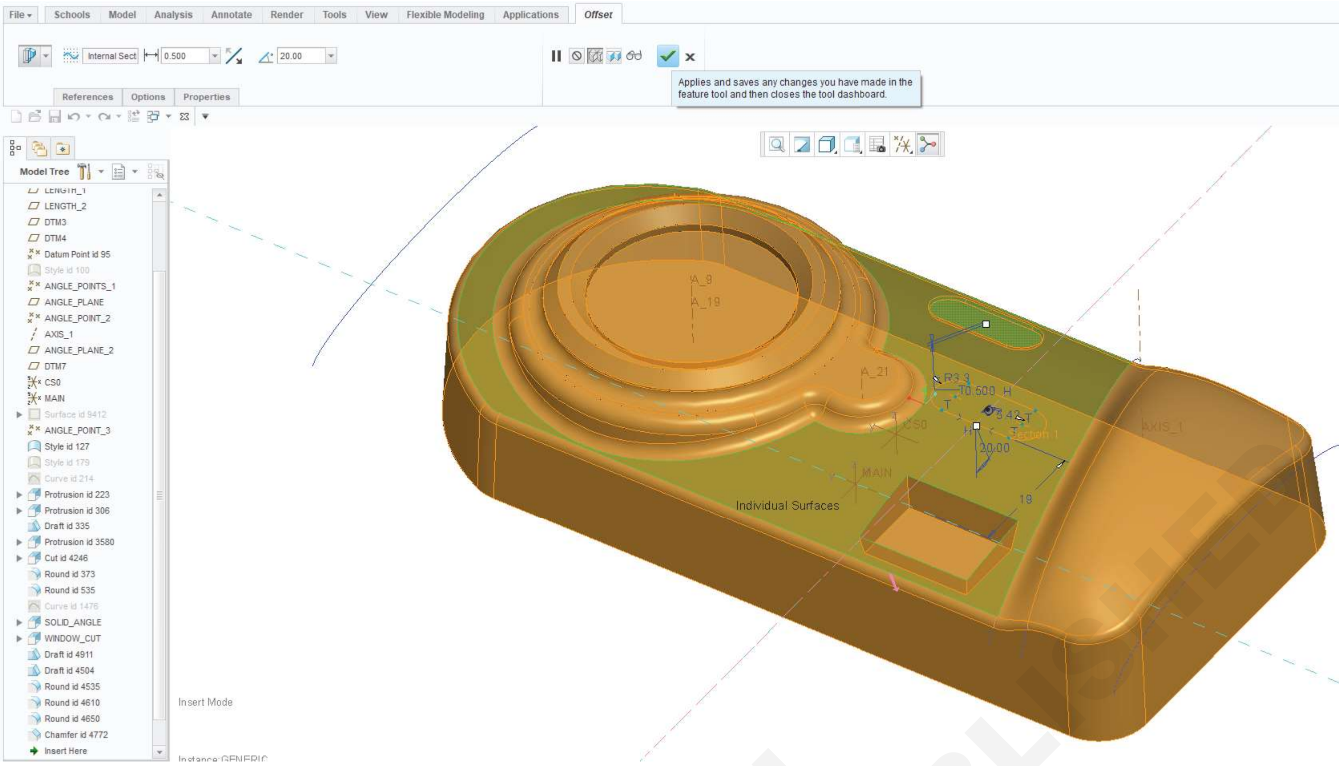
Step 40: In offset surface sets Details ⟶ select the top face (surf F24) under included surface. (Fig 40)

Fig 40



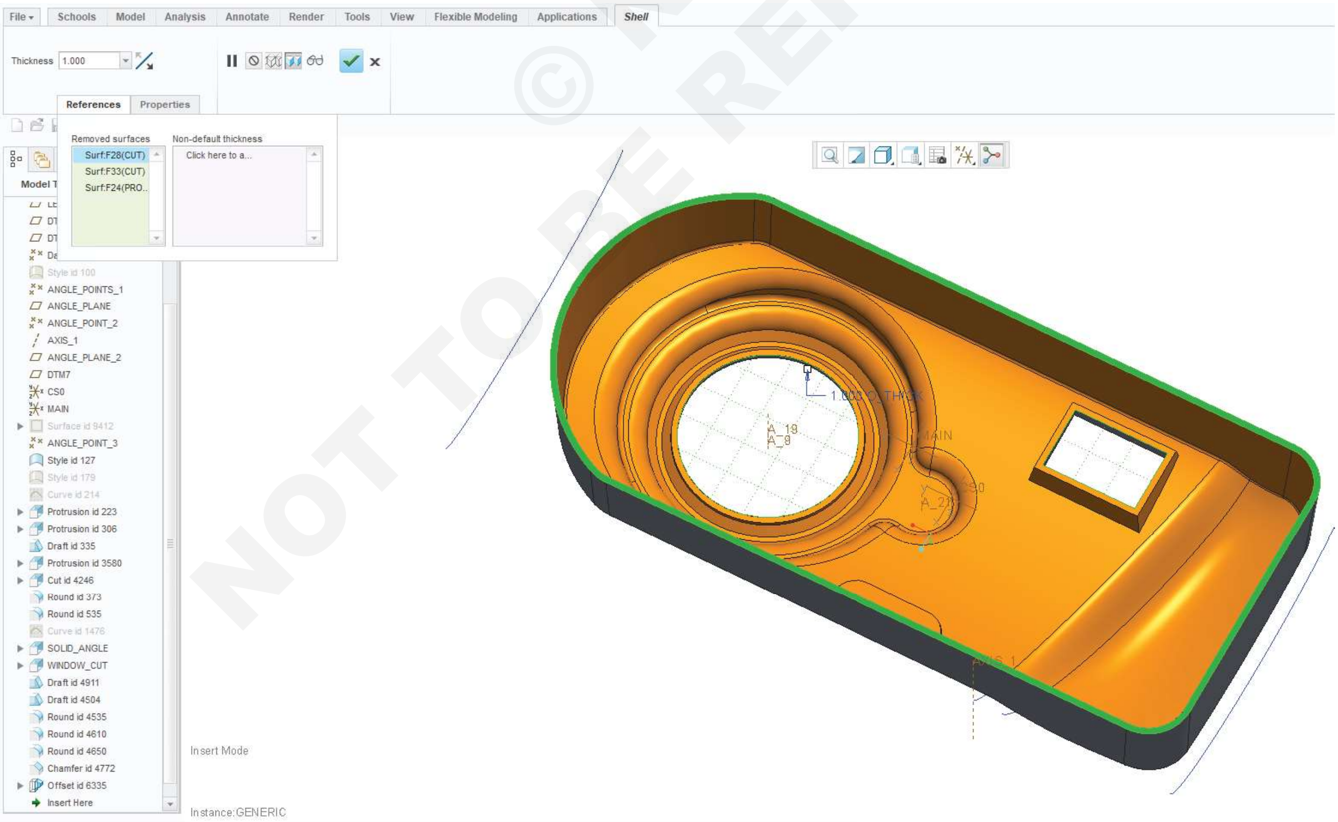
Step 41: In options tab select normal to surface Side surface profile ⟶ straight. Provide offset value as 0.500 give the draft angle value as 20.00 finally select ok option. (as shown in Fig 41)

Fig 41



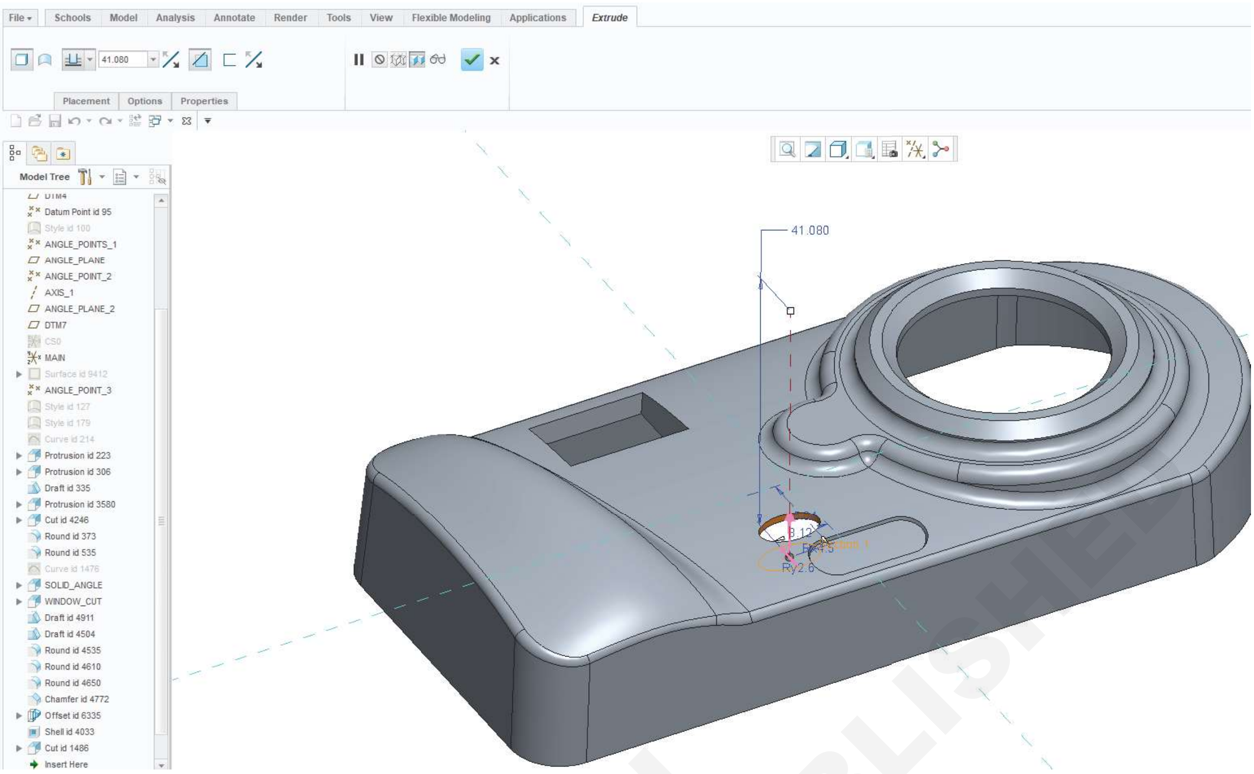
Step 42: Select the shell option under references tab select the removed surface surf 24, surface 33, surface 25 with 1mm thickness. (Fig 42)

Fig 42



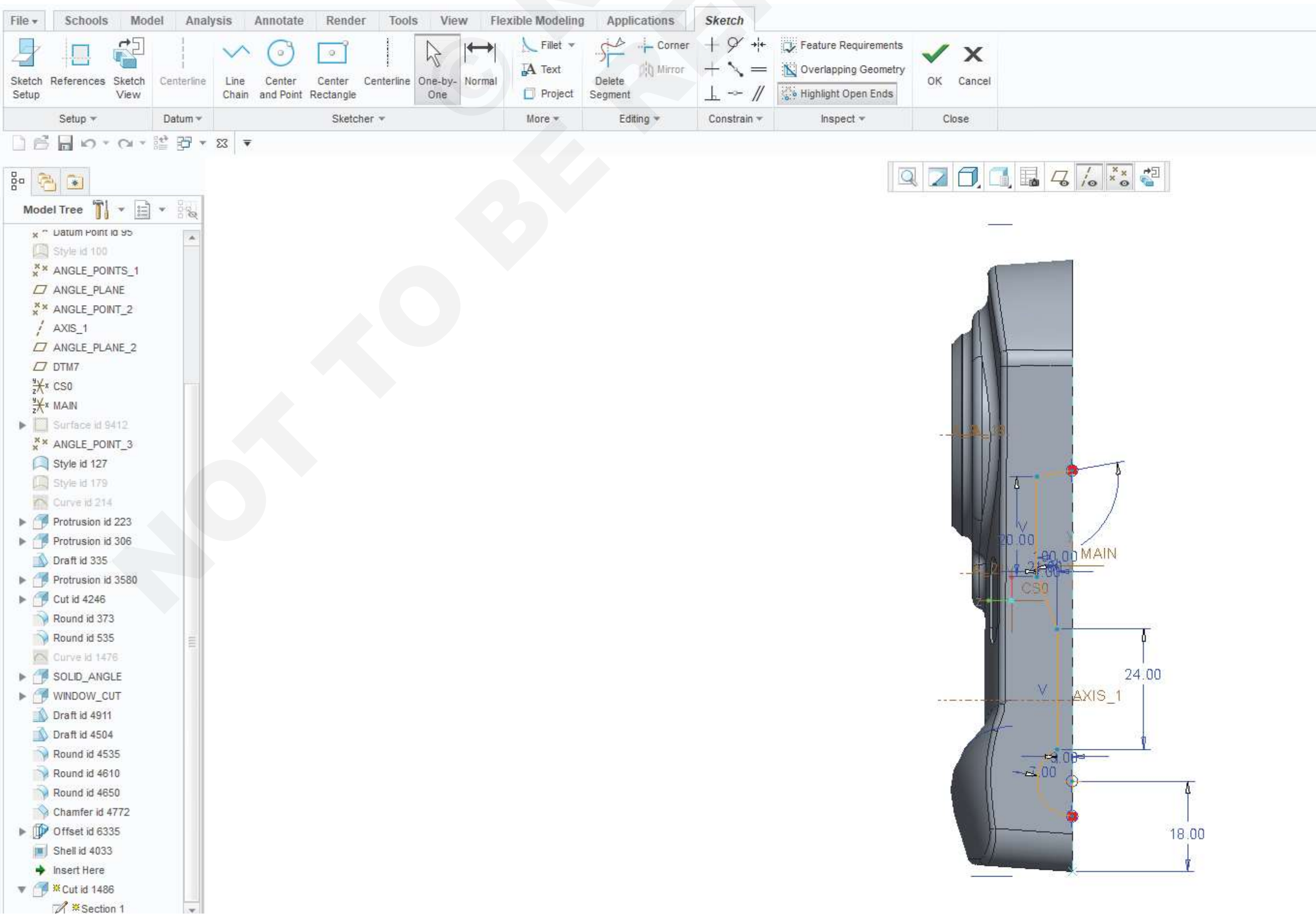
Step 43: Select the top plane, draw the profile (Fig 43).
Select the extrude option to remove material.

Fig 43



Step 44: Select the front plane, draw the profile (Fig 44). Select the extrude option to remove material.

Fig 44

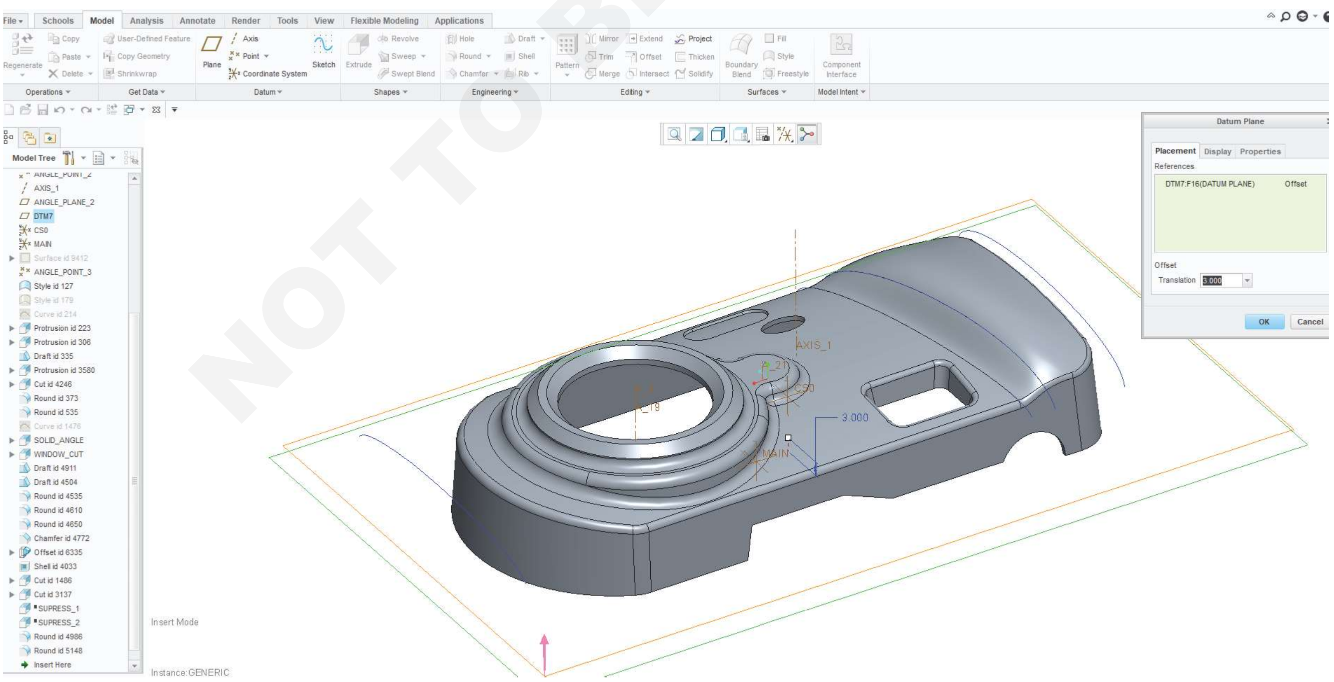


Step 45: Select the sharp edges, give the fillet/Round value as 2 for interior edges & value as 1 for exterior edges. (Fig 45)

Fig 45

Step 46: From DTM7 plane create another plane to the offset translation as 3.000. (Fig 46)

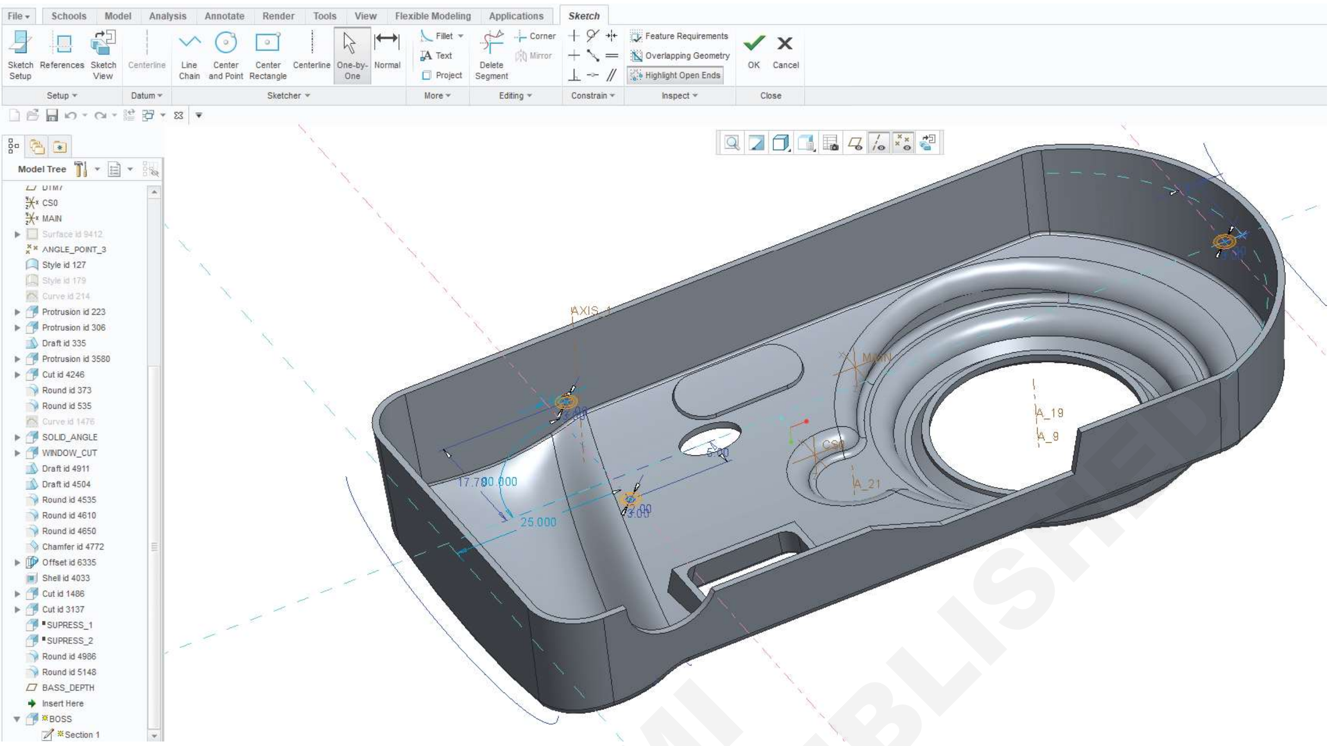
Fig 46



Step 47: In DTM7 plane draw / create the circular sketch with rough dimension as shown in Fig 47.

Extrude the profile up to the next surface.

Fig 47

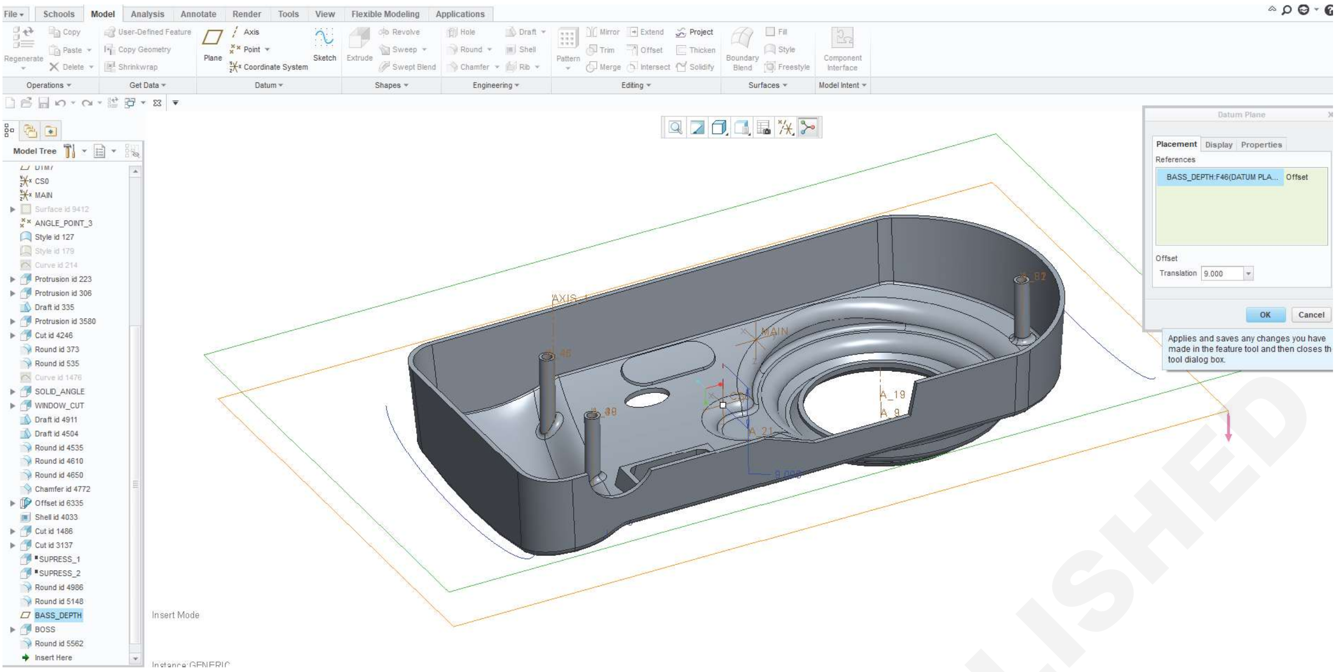


Step 48: Give the round value as 1 to the edge of intersection of boss extruded feature. (Fig 48)

Fig 48

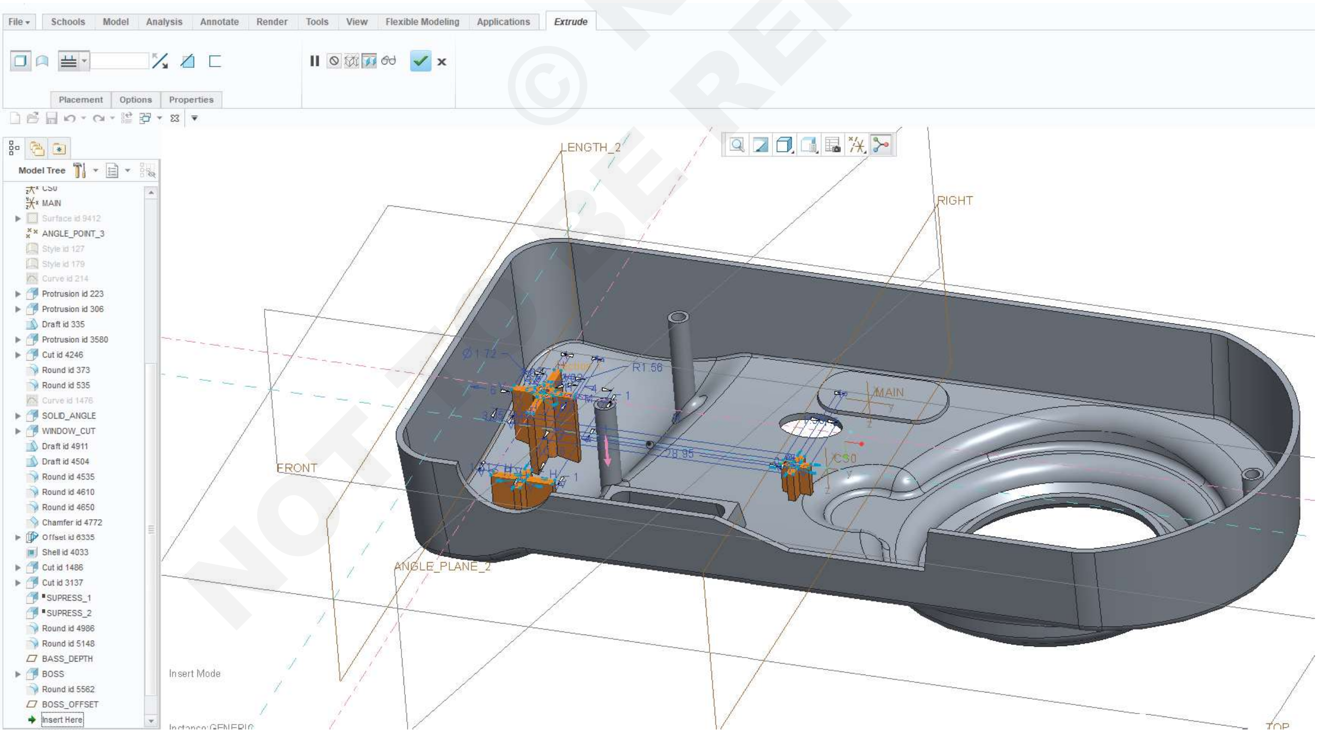
Step 49: Create new plane from top face of boss extrude with offset translation value as 9.00. (Fig 49)

Fig 49



Step 50: Create the profile / Sketch for Ribs (Fig 50) extrude the profile upto the next surface.

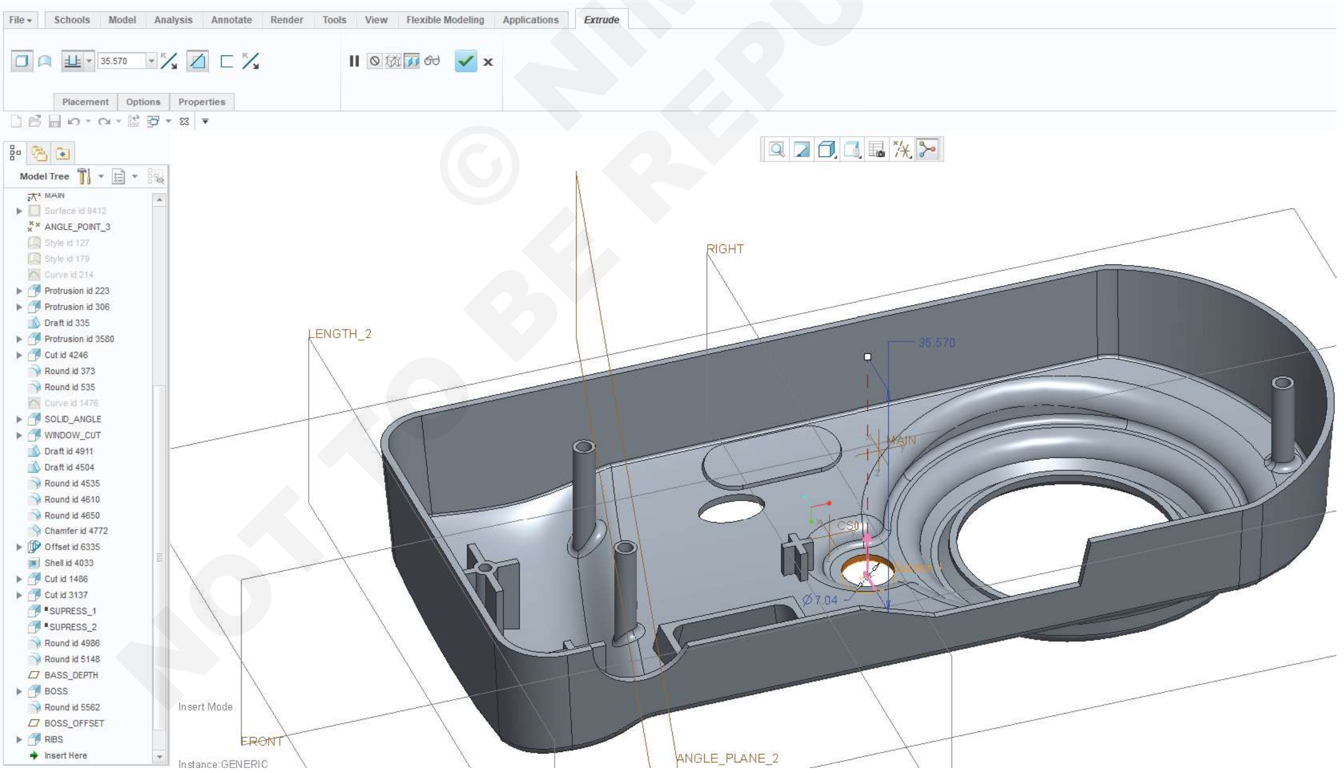
Fig 50



Step 51: Select the top face of the component, draw the circle (Fig 51, 52) with specified depth value of 35.53 to remove the material.

Fig 51

Fig 52



Step 52: Select the top plane, place the datum point at the distance of 14.89 and 5mm with right plane and front plane respectively. (Fig 53 & 54)

Fig 53

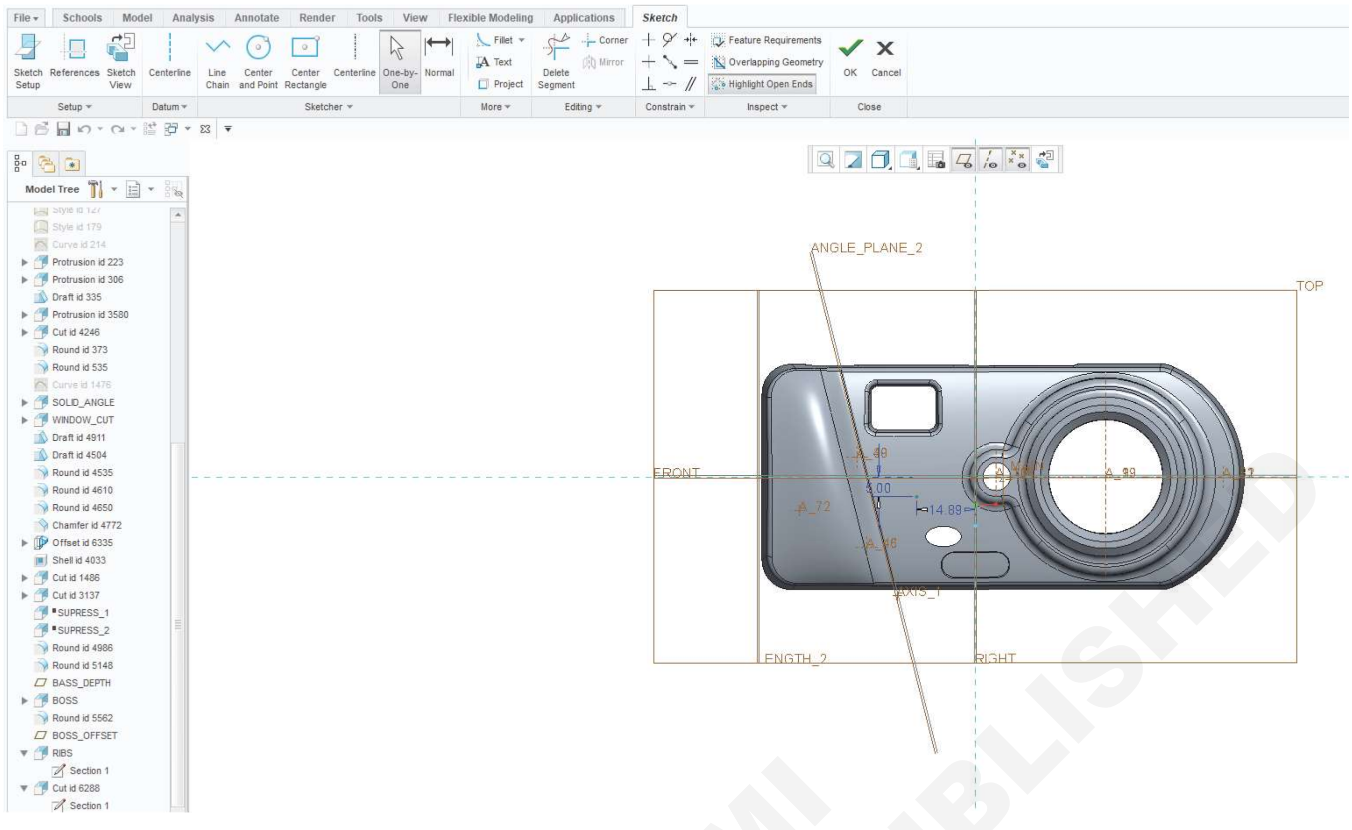
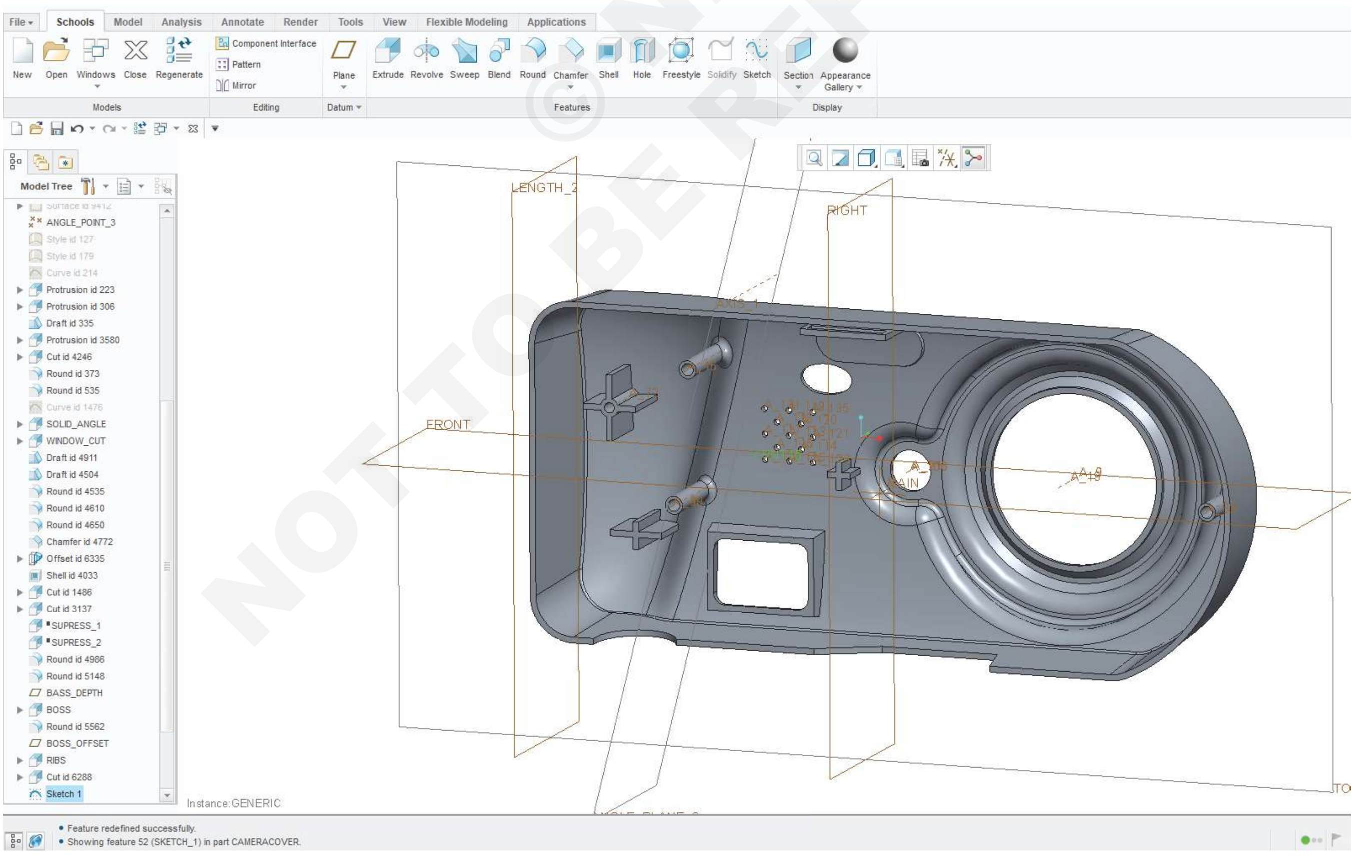
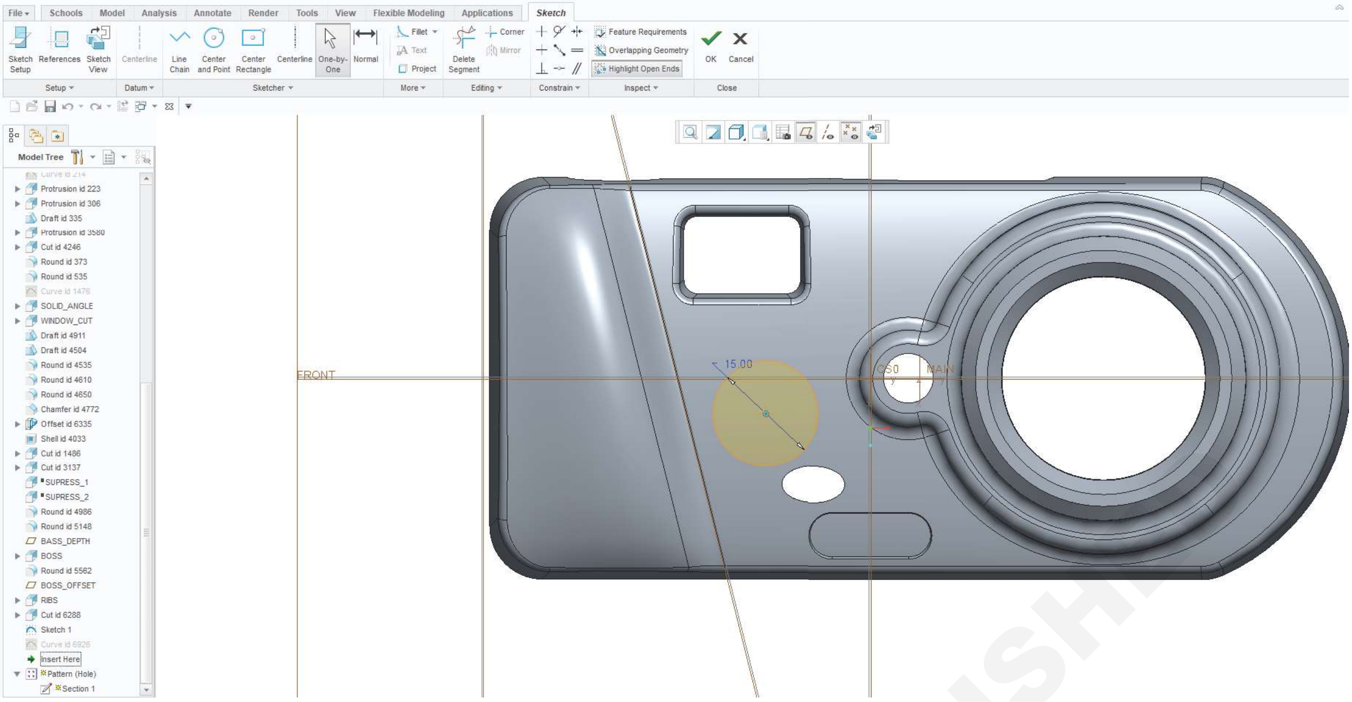


Fig 54



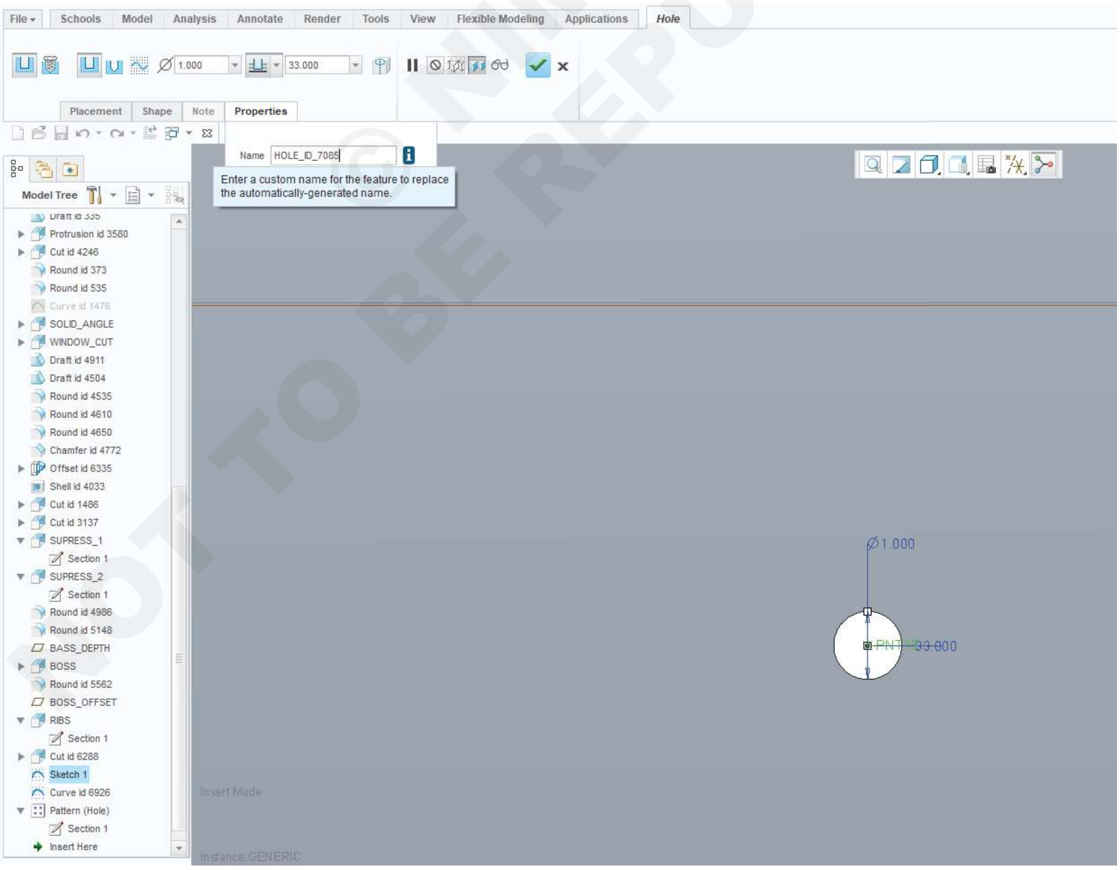
Step 53: With the same plane draw the circle. (Fig 55)

Fig 55



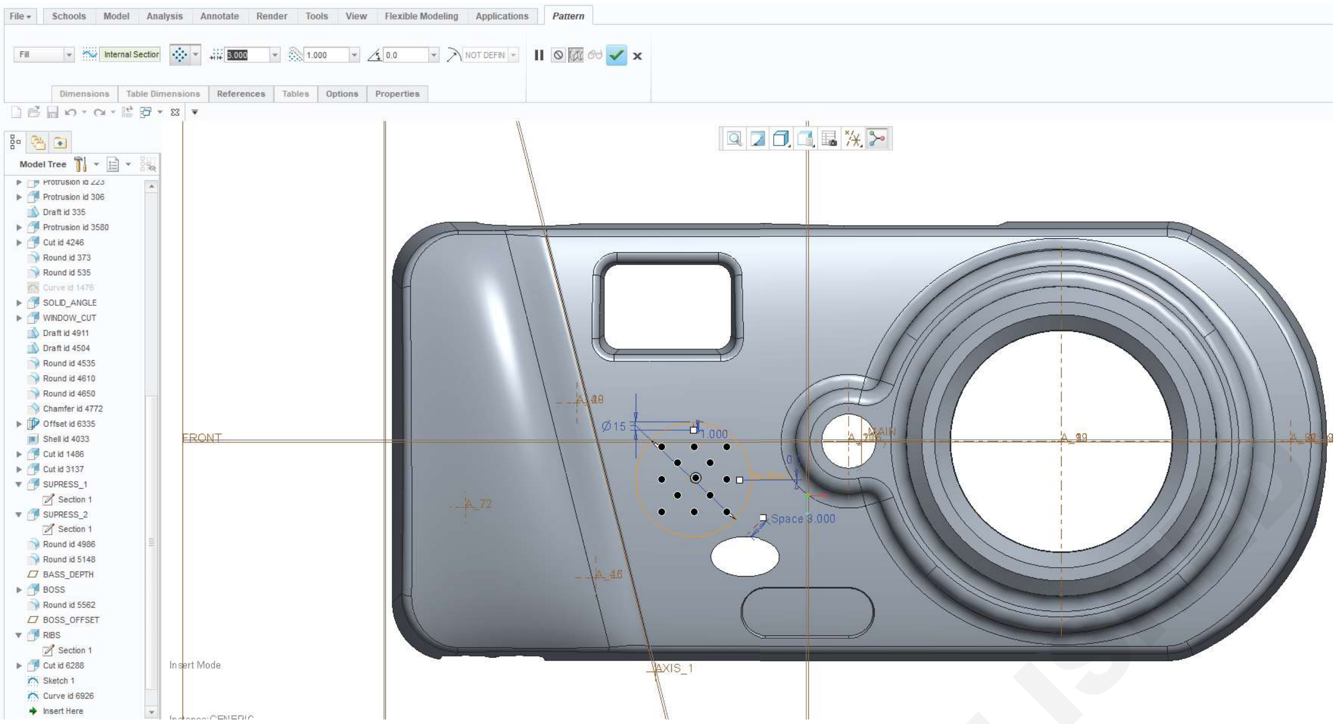
Select create simple hole use predefined circle as drill hole profile with ϕ1 drill from placement ref. by a specified depth value as 33. (Fig 56)

Fig 56



Step 54: Fill the sketched area with pattern member, space the member in the diamond pattern with value as 3mm (Set the distance any pattern members center can be from the sketch boundaries) Select ok option finally. (Fig 57)

Fig 57



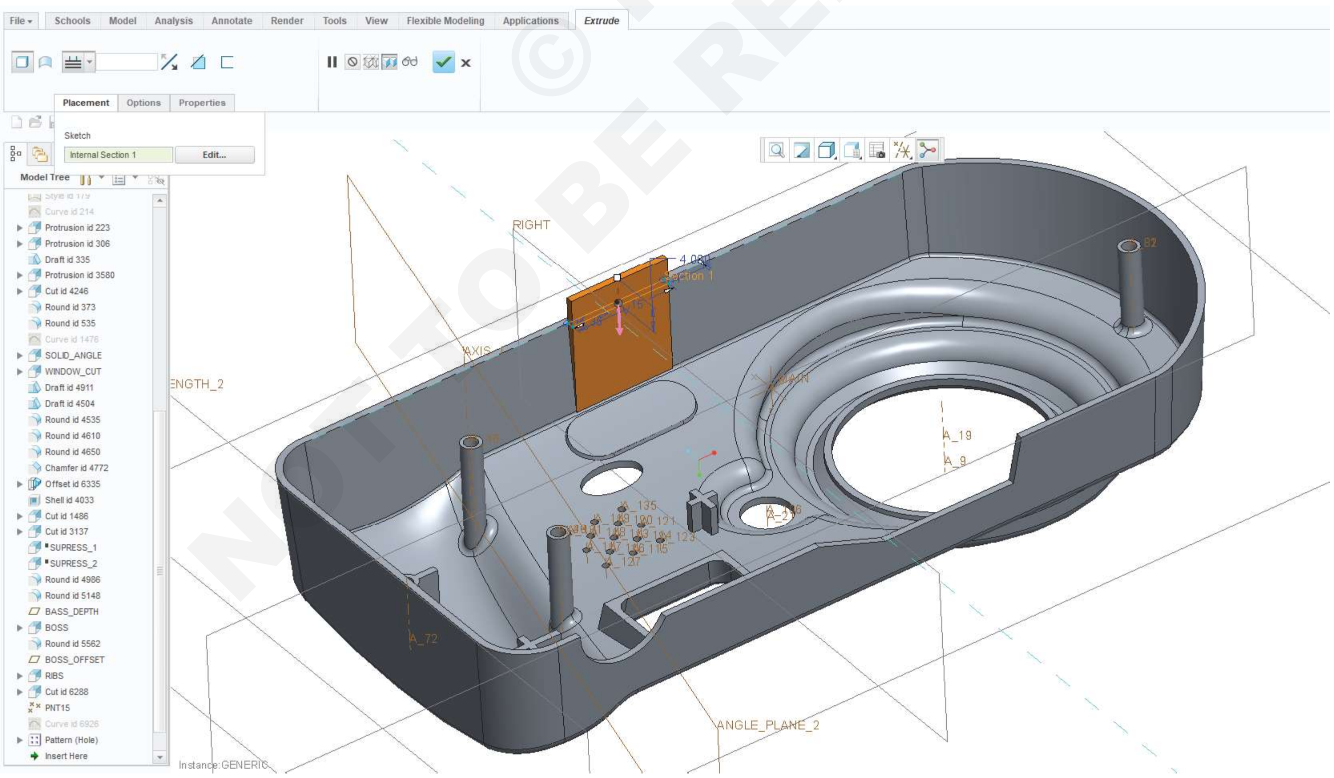
Step 55: Draw the sketch on the bottom face as shown in Fig 58 and extrude the profile placement.

Sketch - Depth

Side - to next

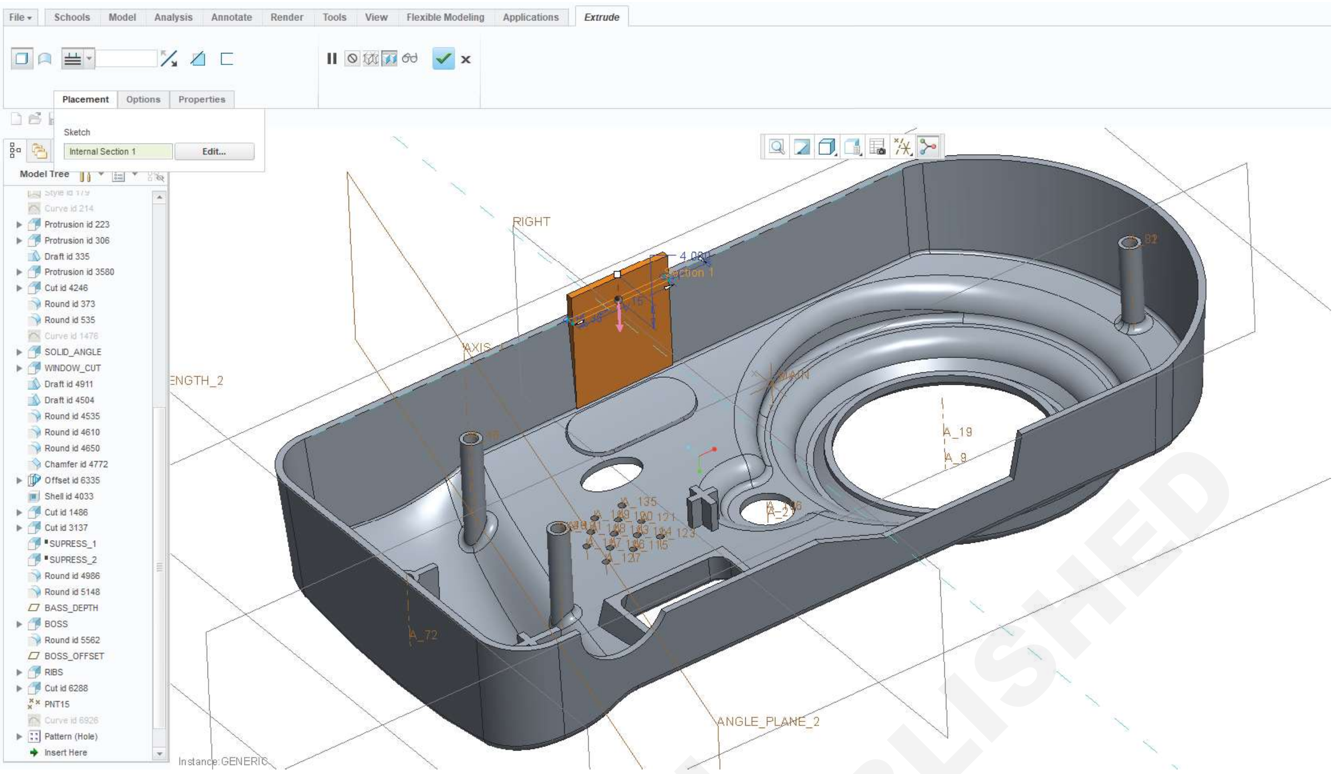
Side 2 – Blind – 4.00

Fig 58



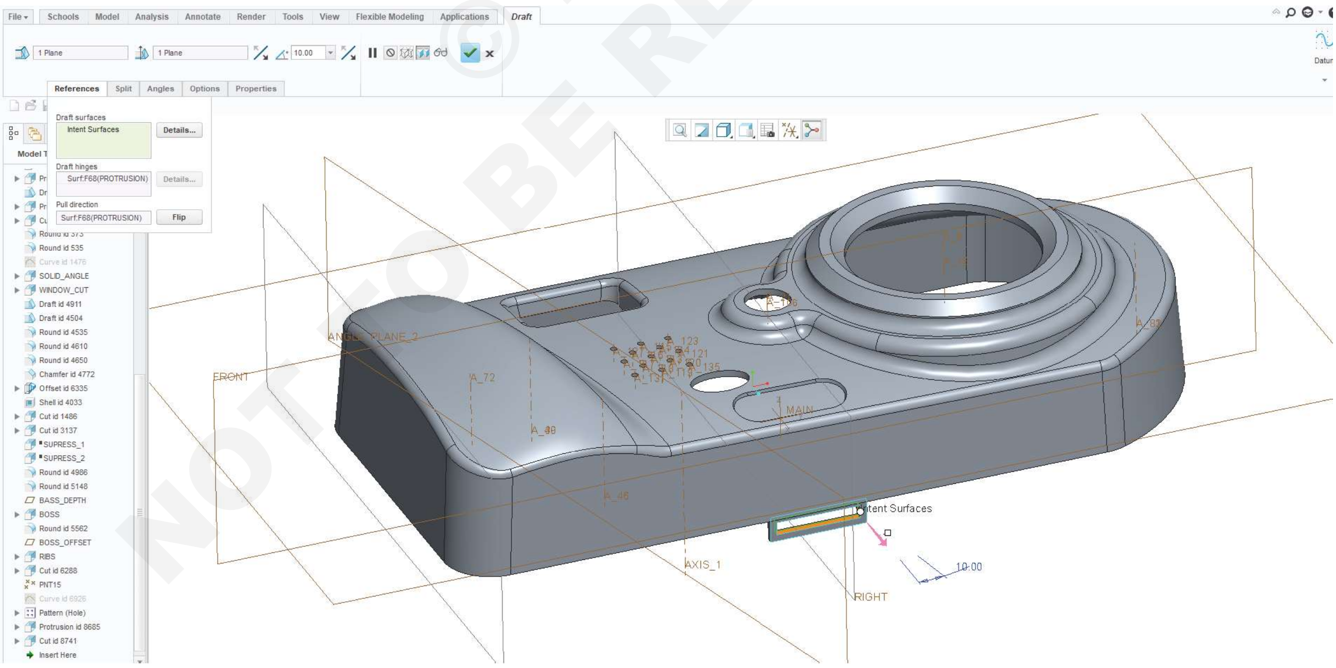
Step 56: Sketch the profile on the side face of the above extruded feature, then select the extrude command to remove material. (Fig 59)

Fig 58



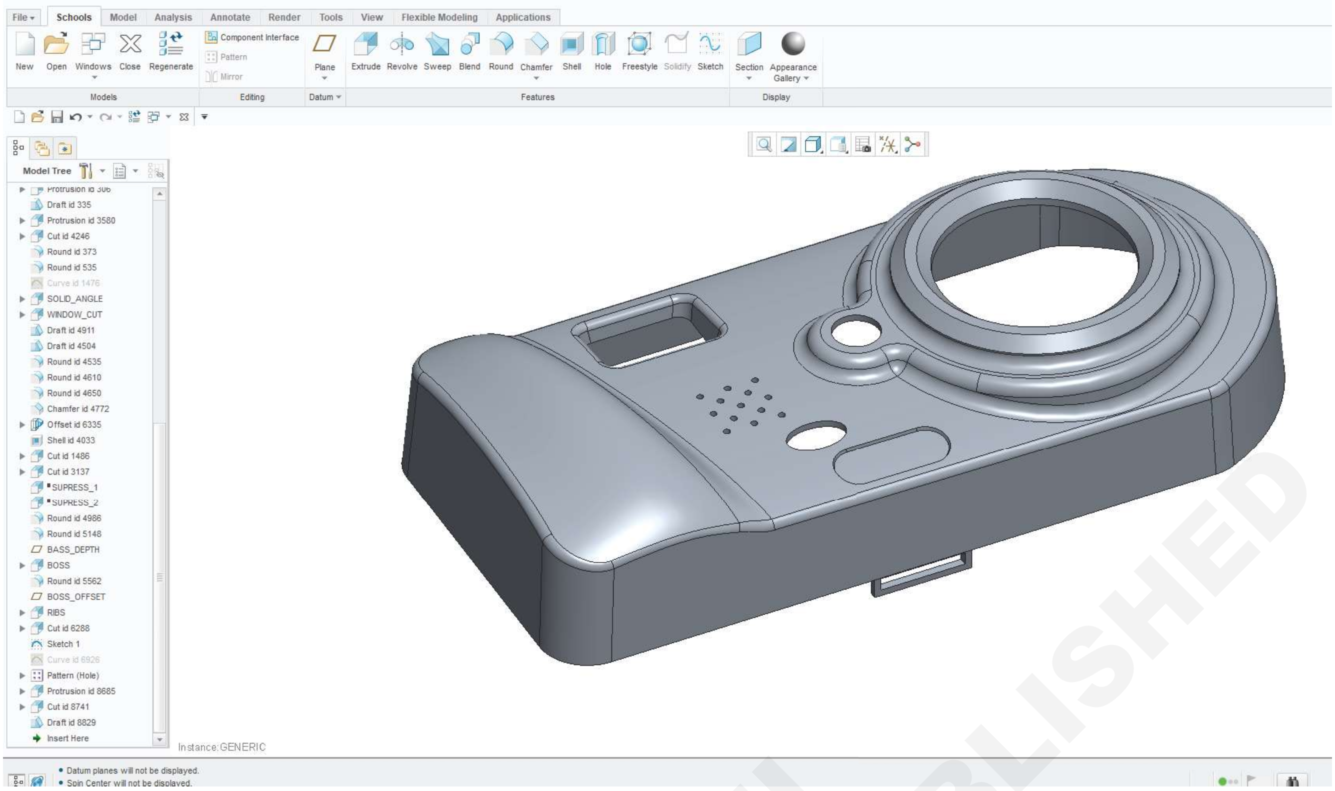
Step 57: Select intent surface i.e (4 faces) (as draft surface), In Pull direction select the top surfaces & give the angle as 10. (Fig 60)

Fig 60



Step 58: Finally save the part fully (Fig 61)

Fig 61



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TASK 4: **Mould assembly creation**

Step 1: Select new option from home TAB.

Step 2: The dialog box opens select manufacturing → select mold CAVITY from sub type.

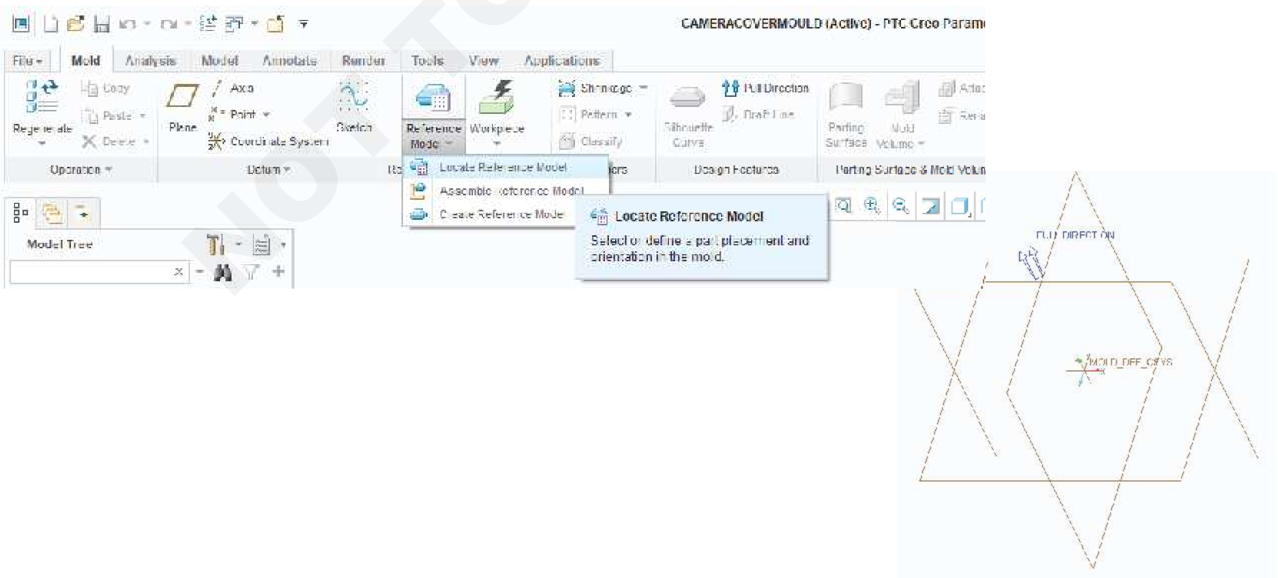
Step 3: In name box enter a name for the model as mold design.

Step 4: Unselect – use default template, then select ok option.

Step 5: Next dialog box appears, select mmns – mfg-mold (or required unit as per user) select ok option to move to the sketch area.

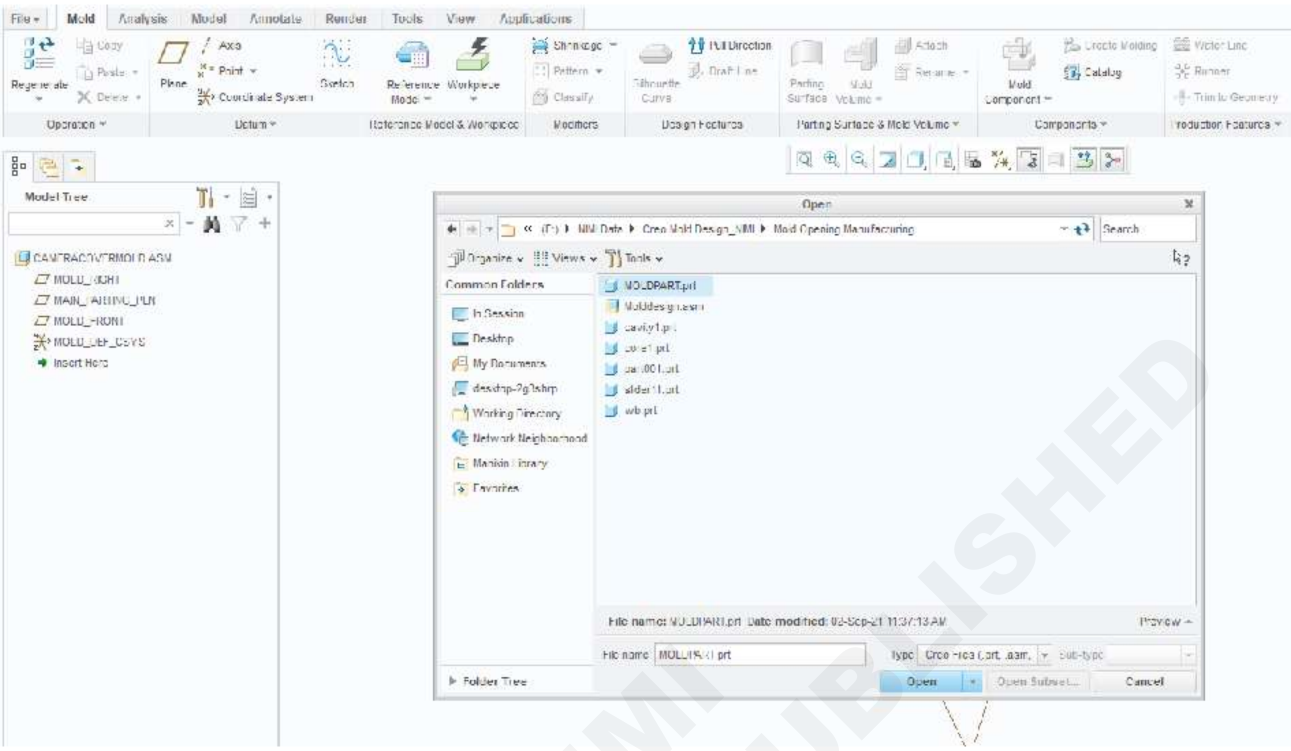
Step 6: Select the reference model icon → select assemble reference model. (Fig 1)

Fig 1



Step 7: Open dialog box appears then select the required reference part from the destination folder and the click open button. (Fig 2)

Fig 2



Step 8: In component placement select default location option, once it is done the status changes to fully constrained from not fully constrained and then click ok button. (Fig 3 & 4)

Fig 3

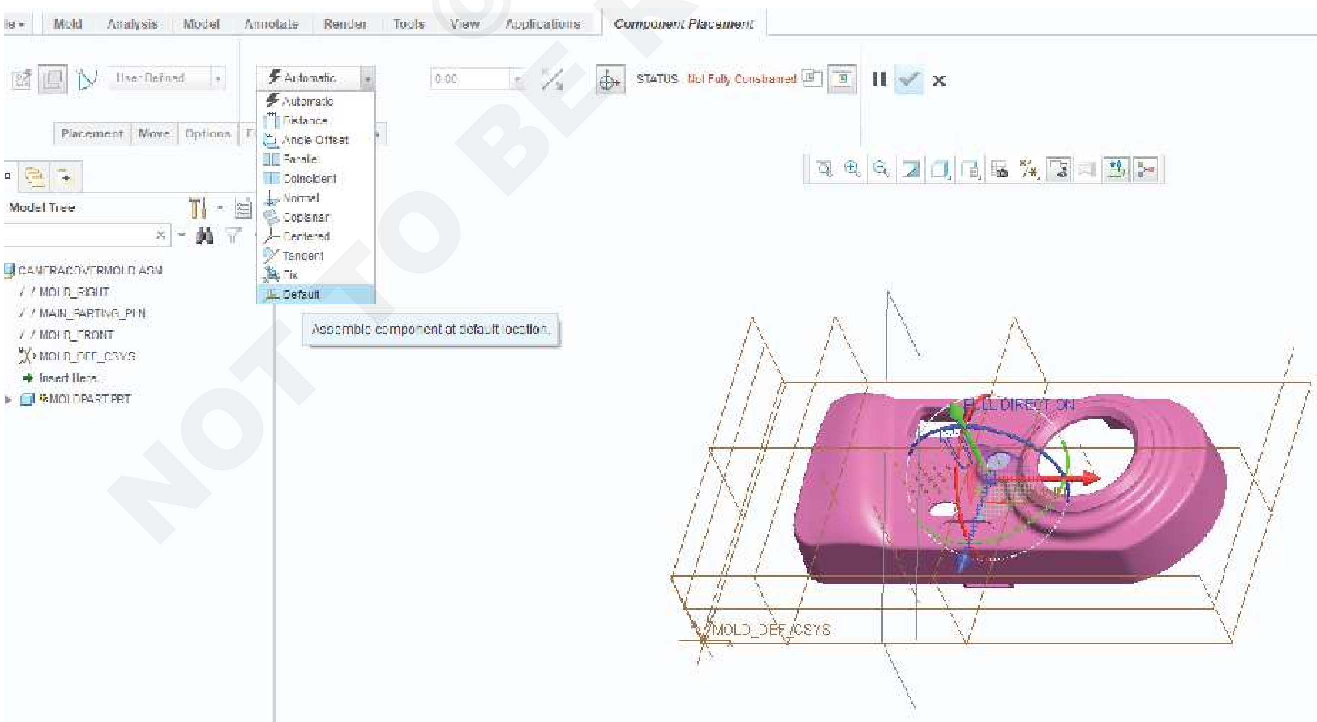
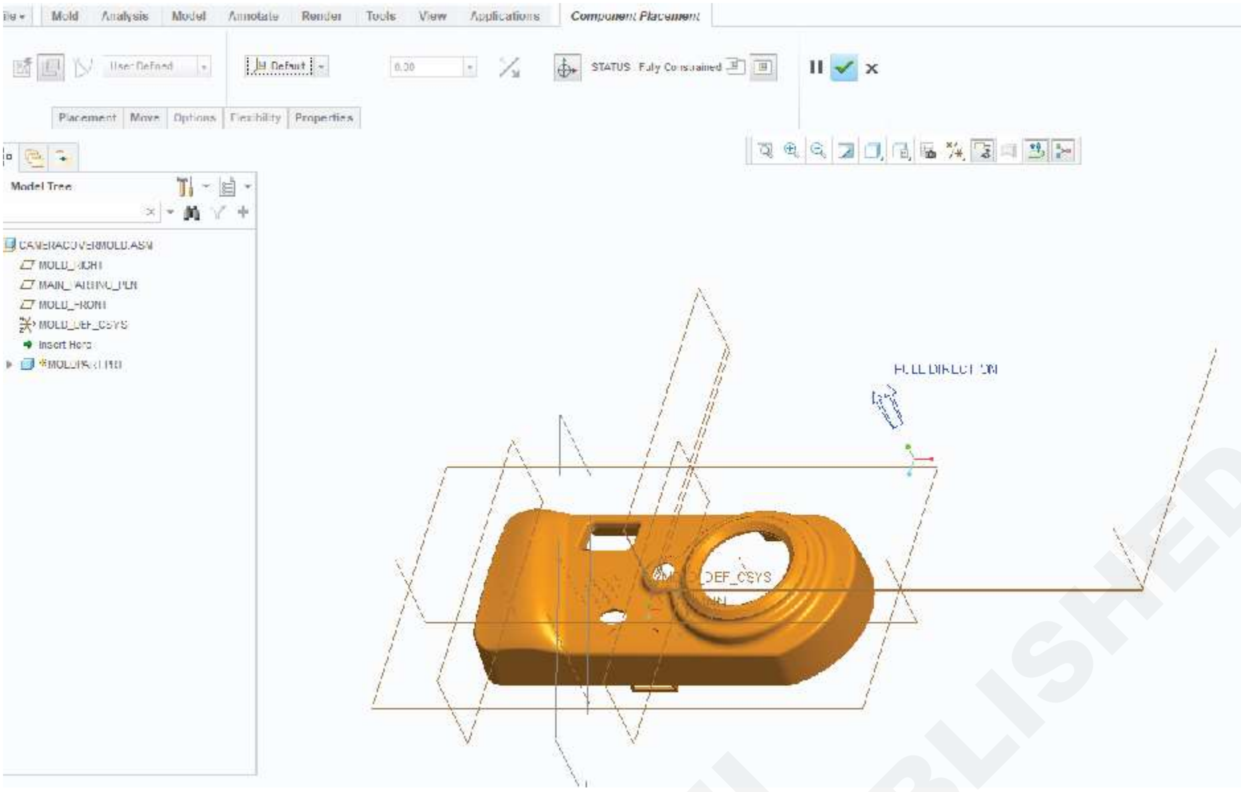
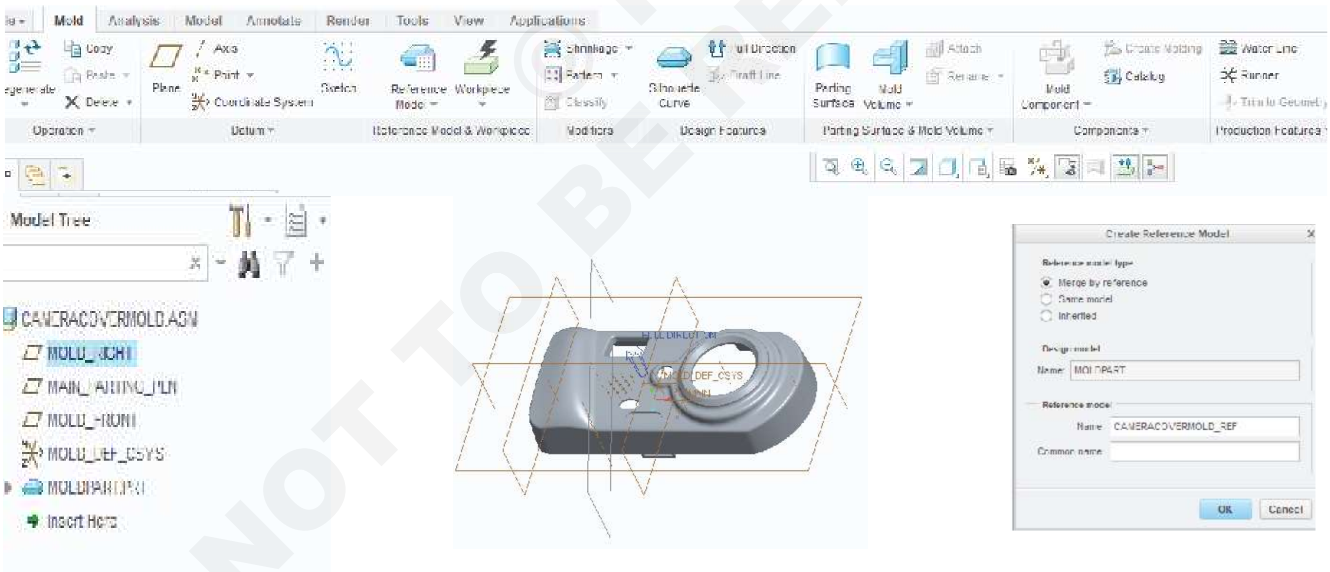


Fig 4



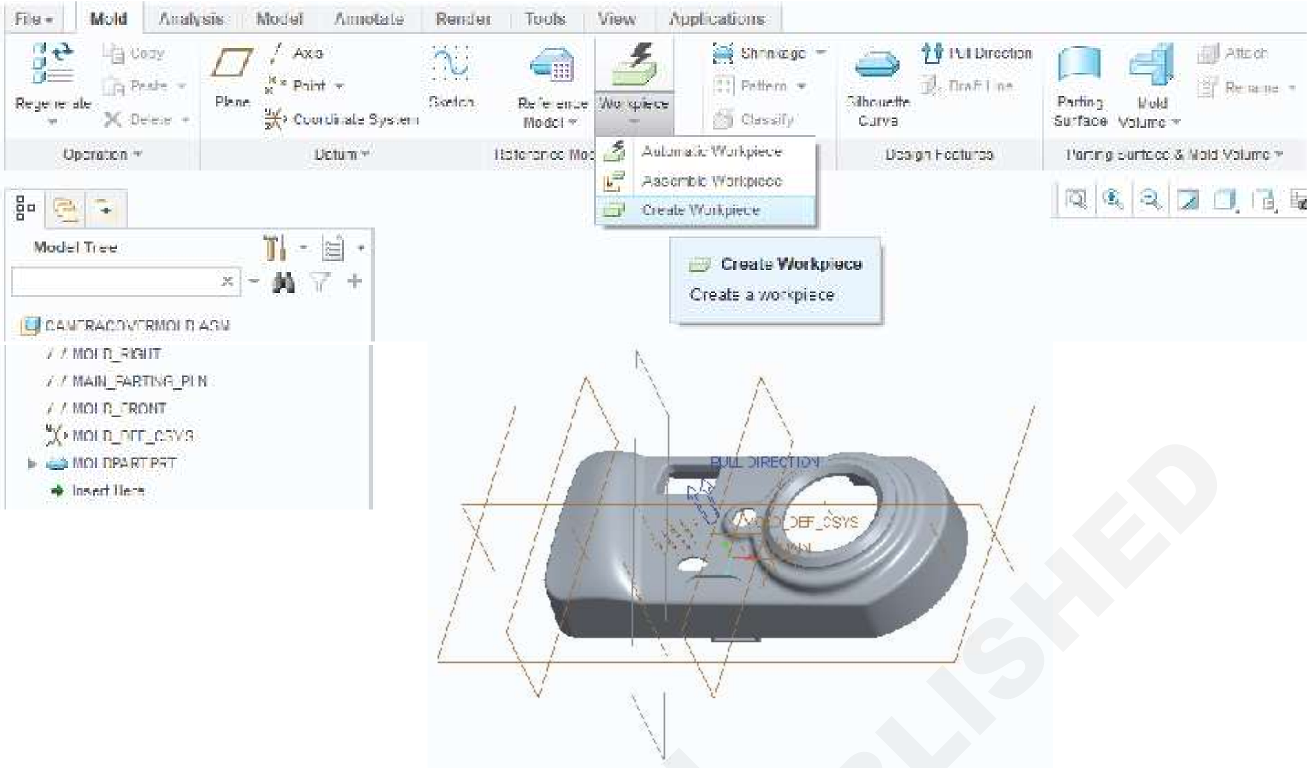
Step 9: Create Reference model dialog box appears, select same model and click ok button. (Fig 5)

Fig 5



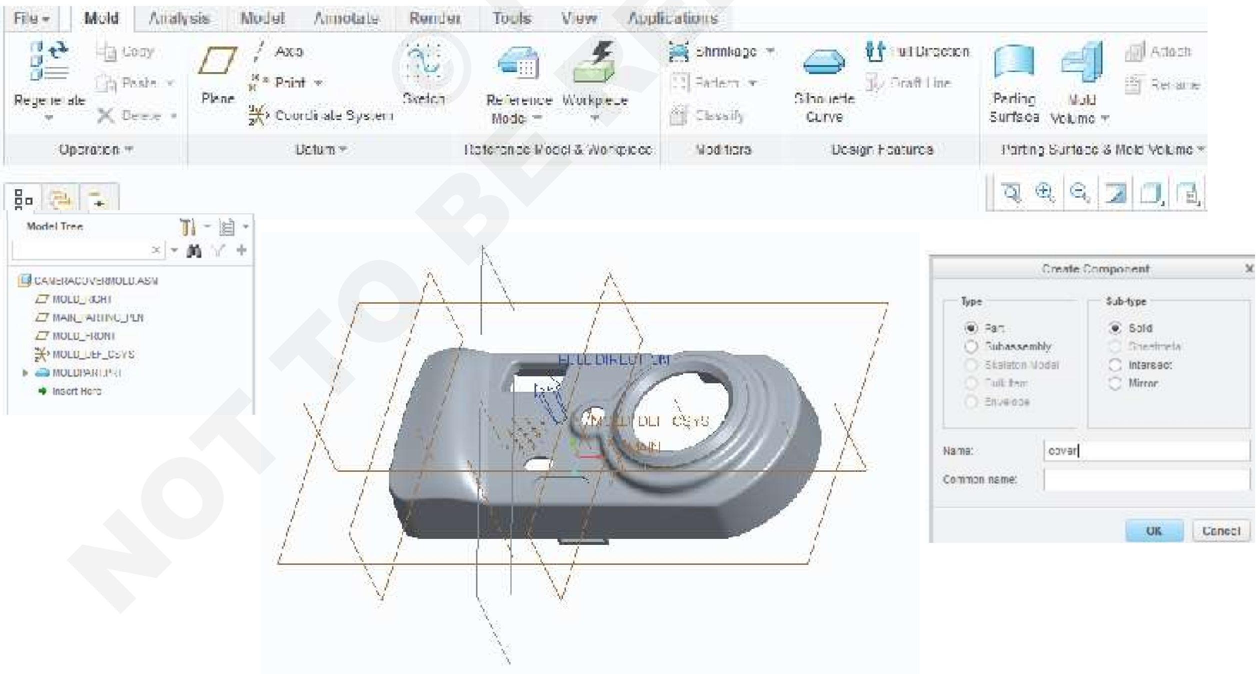
Step 10: SELECT WORPIECE → create work piece create component dialog box appears. (Fig 6)

Fig 6



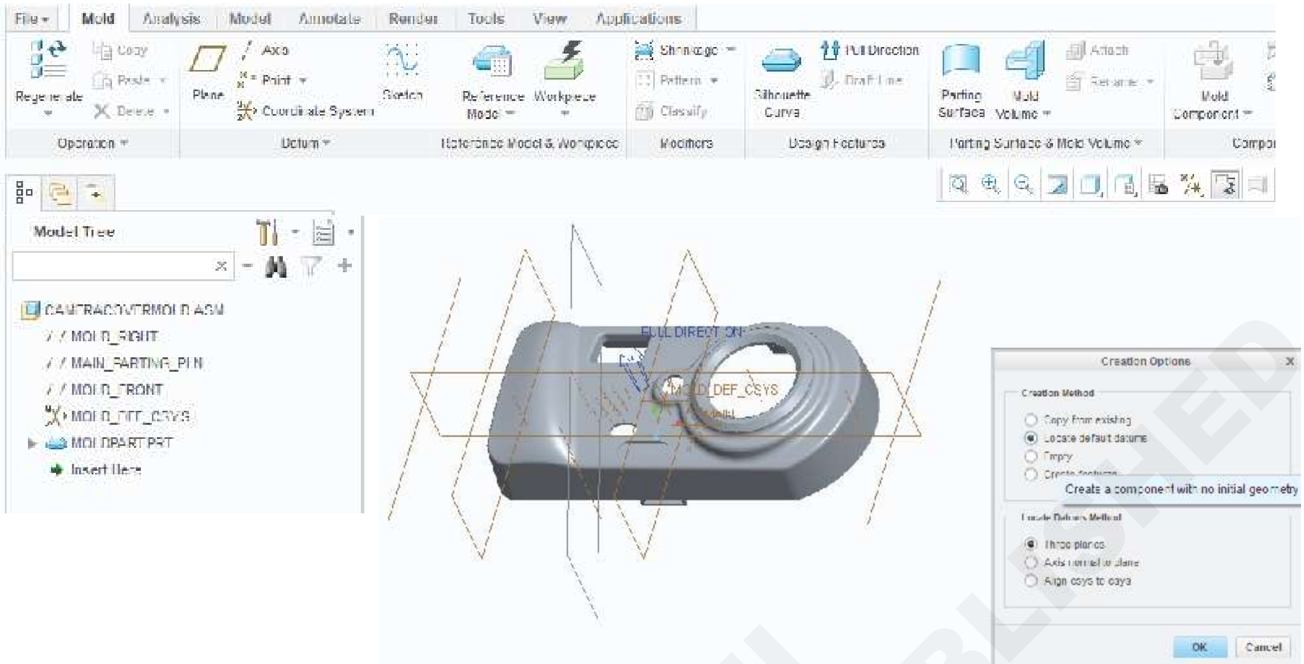
Step 11: In name box enter the name for the component as cover → ok button. (Fig 7)

Fig 7



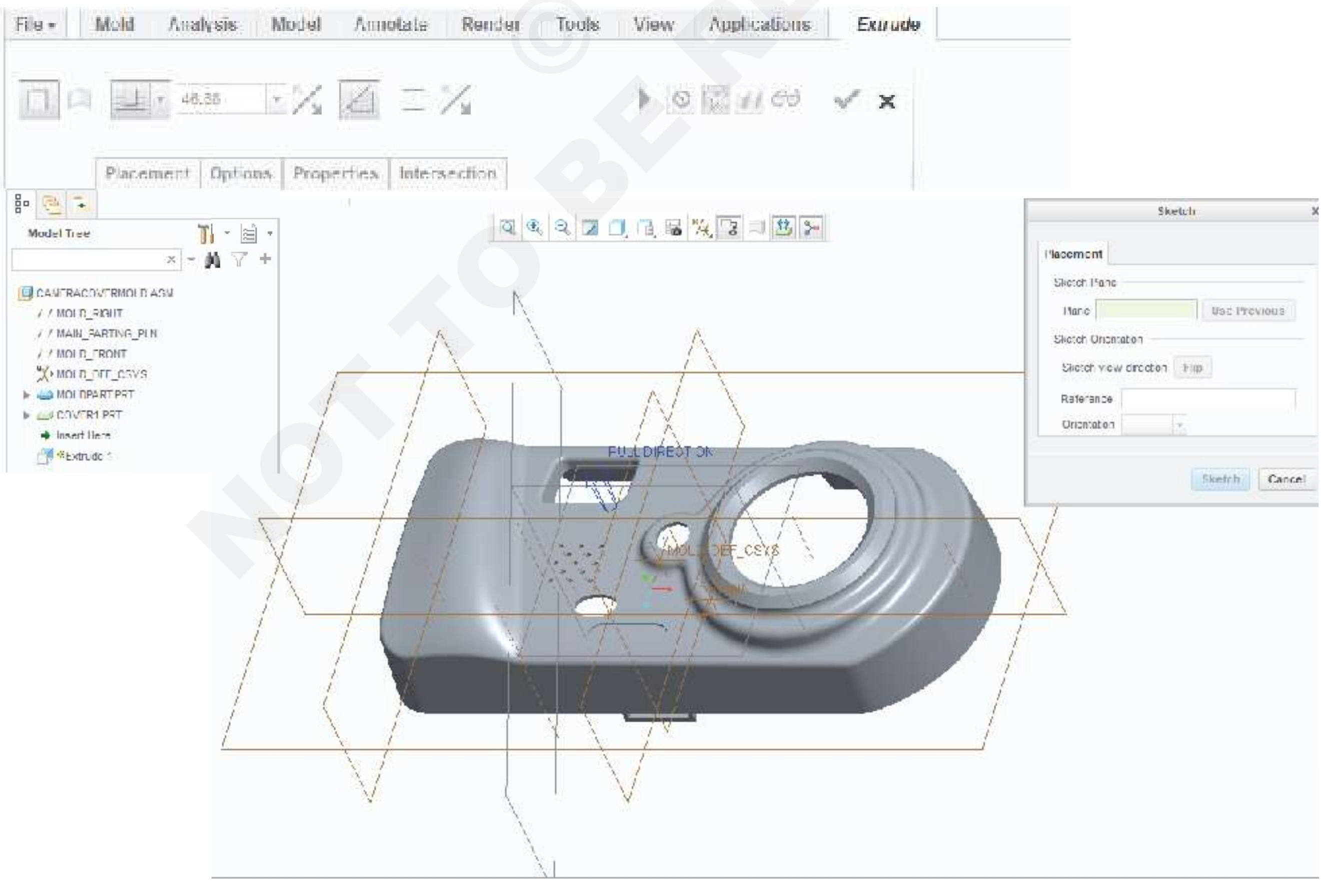
Step 12: Creation options dialogue box appears, in creation method select locate default. (Fig 8). In locate Datums method → three planes and then click ok button.

Fig 8



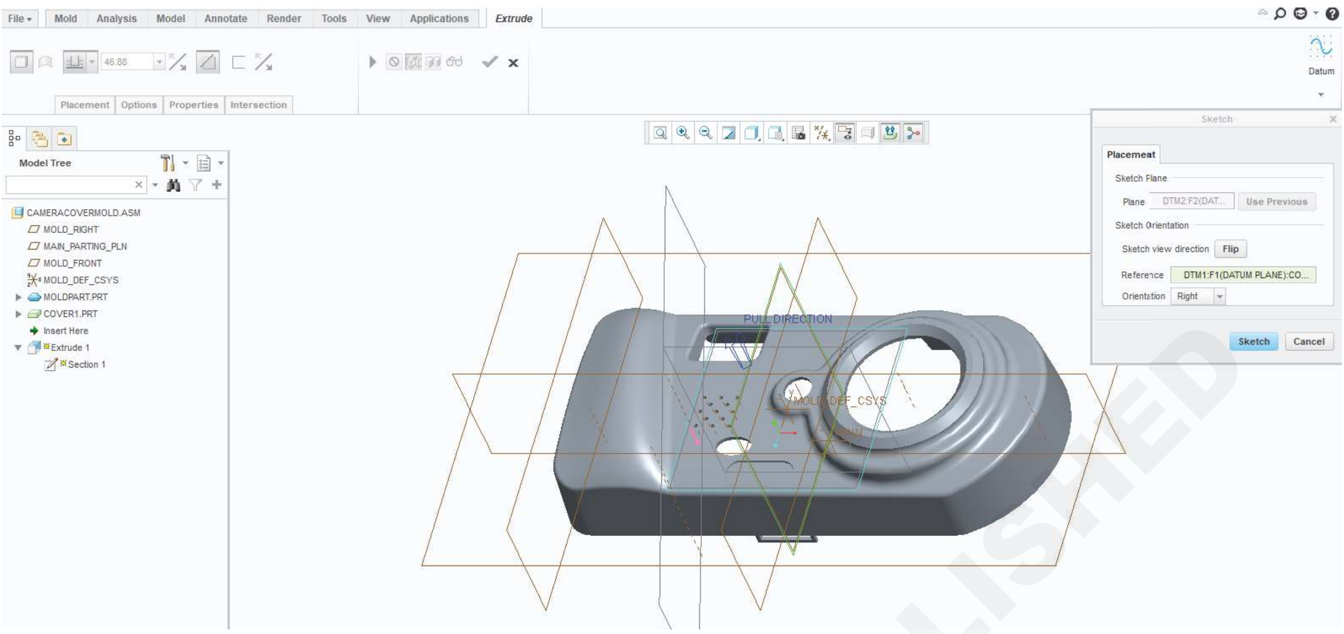
Step 13: Select Extrude from model tab and then select define in the placement tab, sketch dialog box appears. (Fig 9)

Fig 9



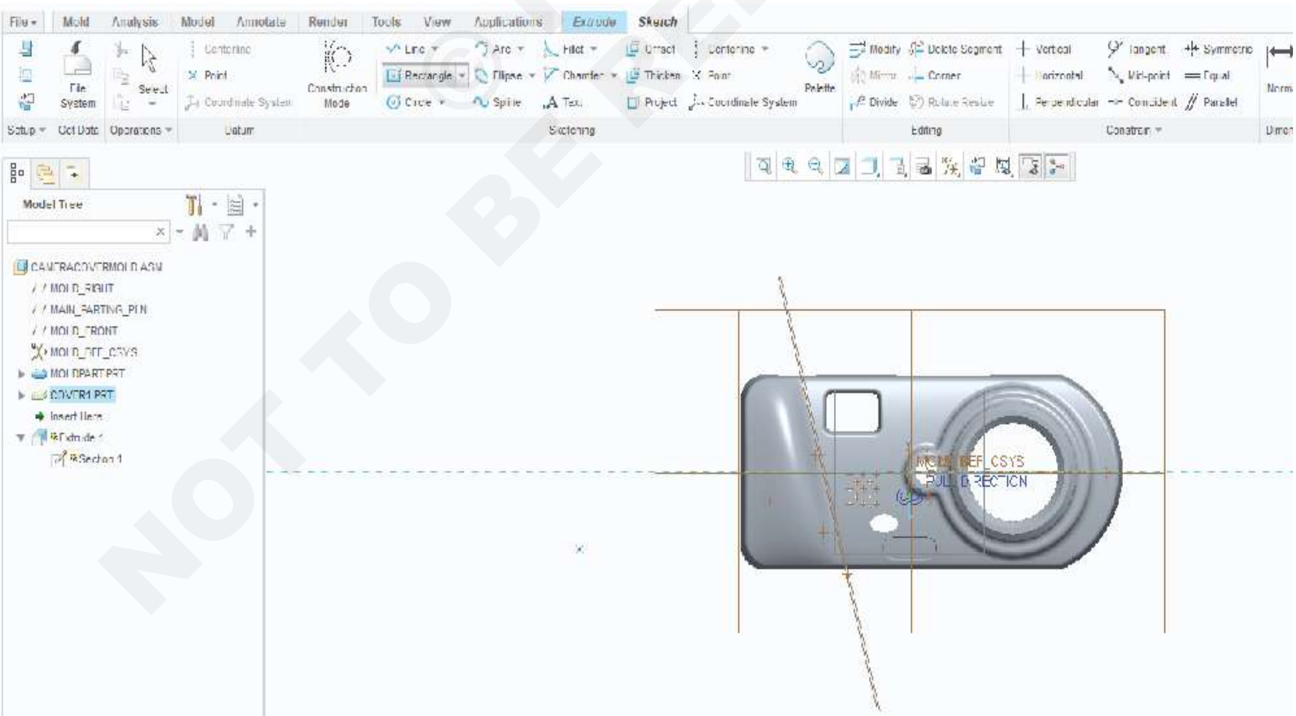
Step 14: Select the plane in which the sketch should be drawn, select it directly by clicking the plane and then select sketch. (Fig 10)

Fig 10



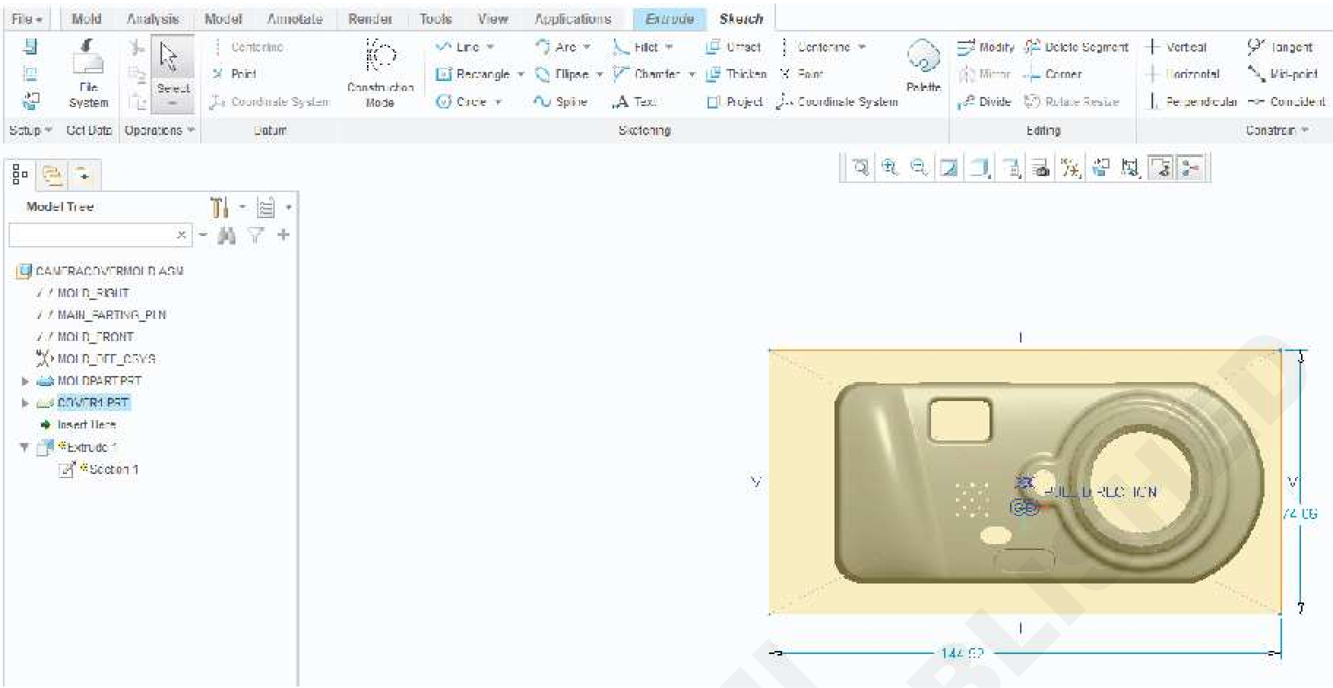
Step 15: Here the plane is selected. The plane is shown in straight view in the screen. (Fig 11)

Fig 11



Step 16: Roughly draw the rectangle using center rectangle command but it totally covers the part as shown in Fig 12 and then click ok button.

Fig 12



Step 17: Extrude tab appears on that select symmetric option shown in (Fig 13) and gives rough value so that it covers the part fully and then click symbol ✓ (Fig 13)

Fig 13

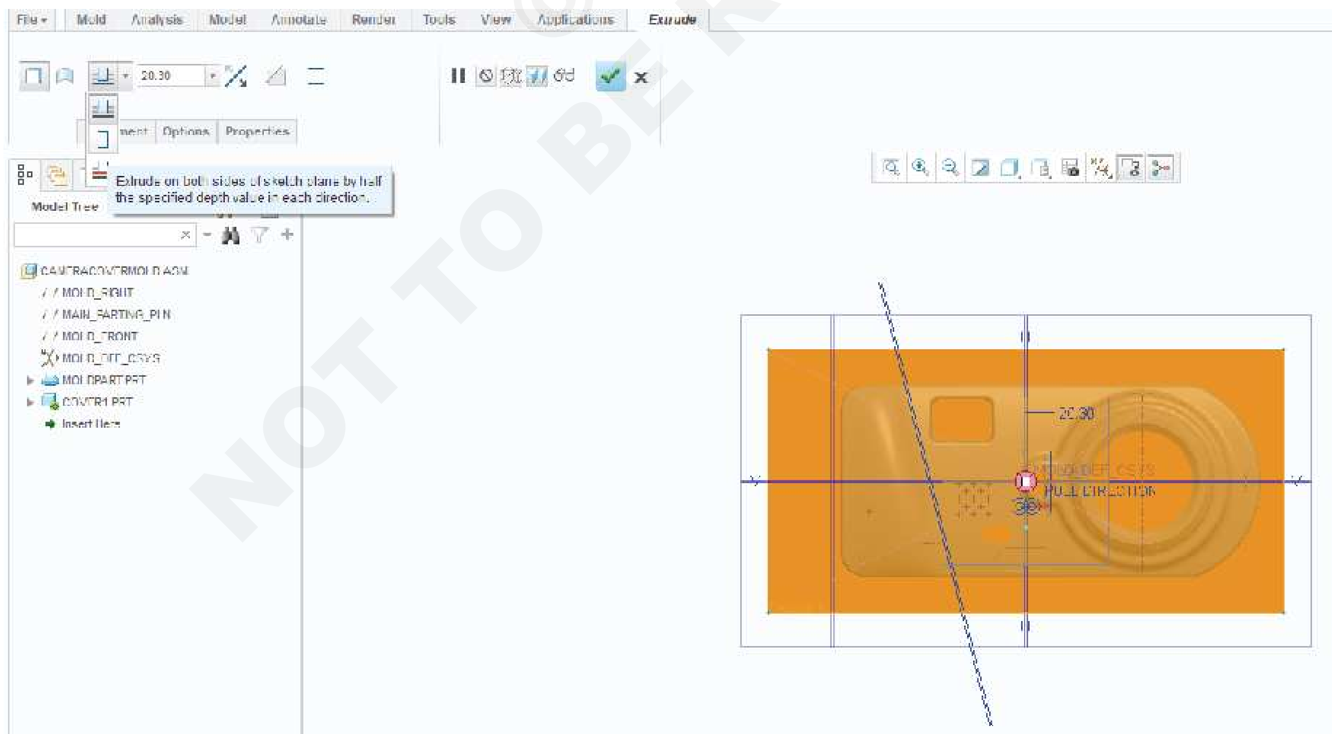
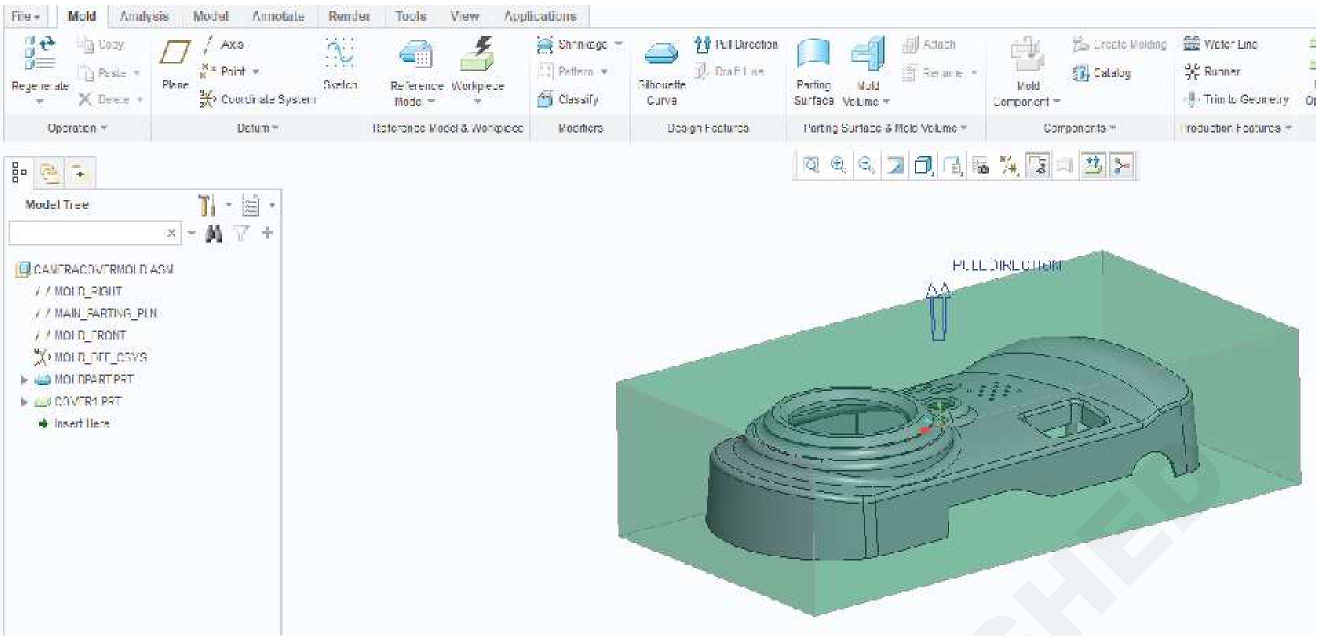


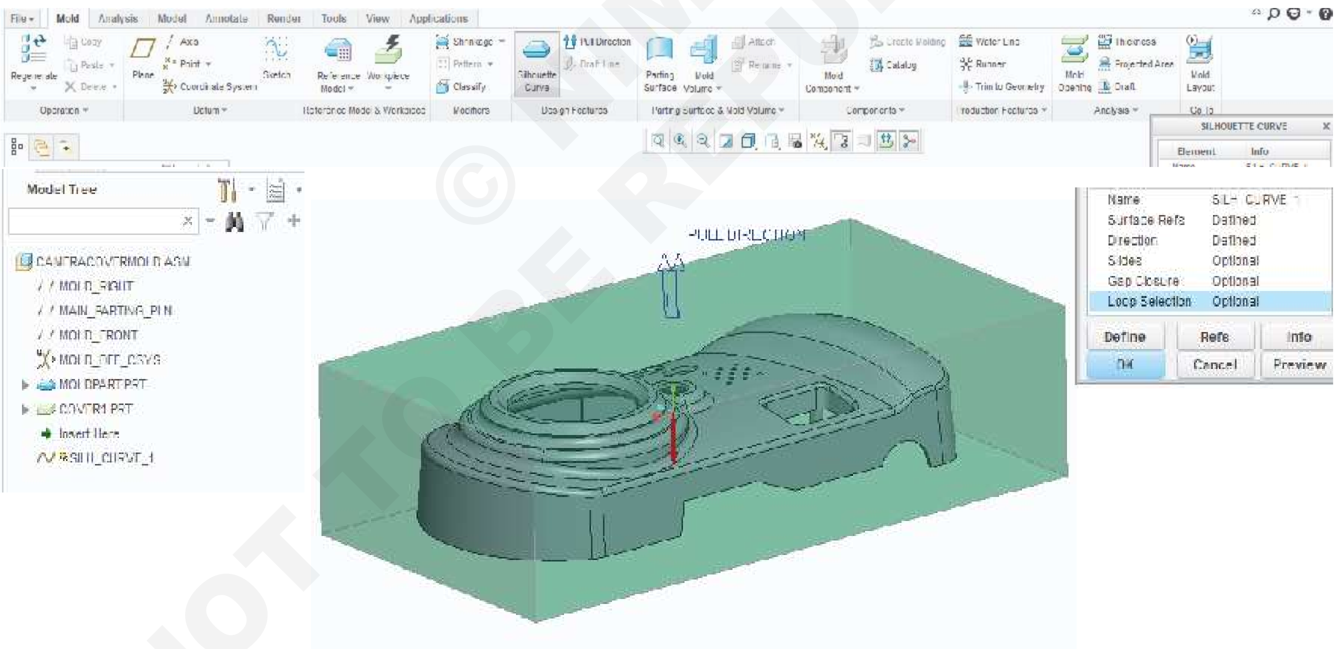
Fig 14



Step 18: Select SILHOUETTE CURVE from the mold TAB.

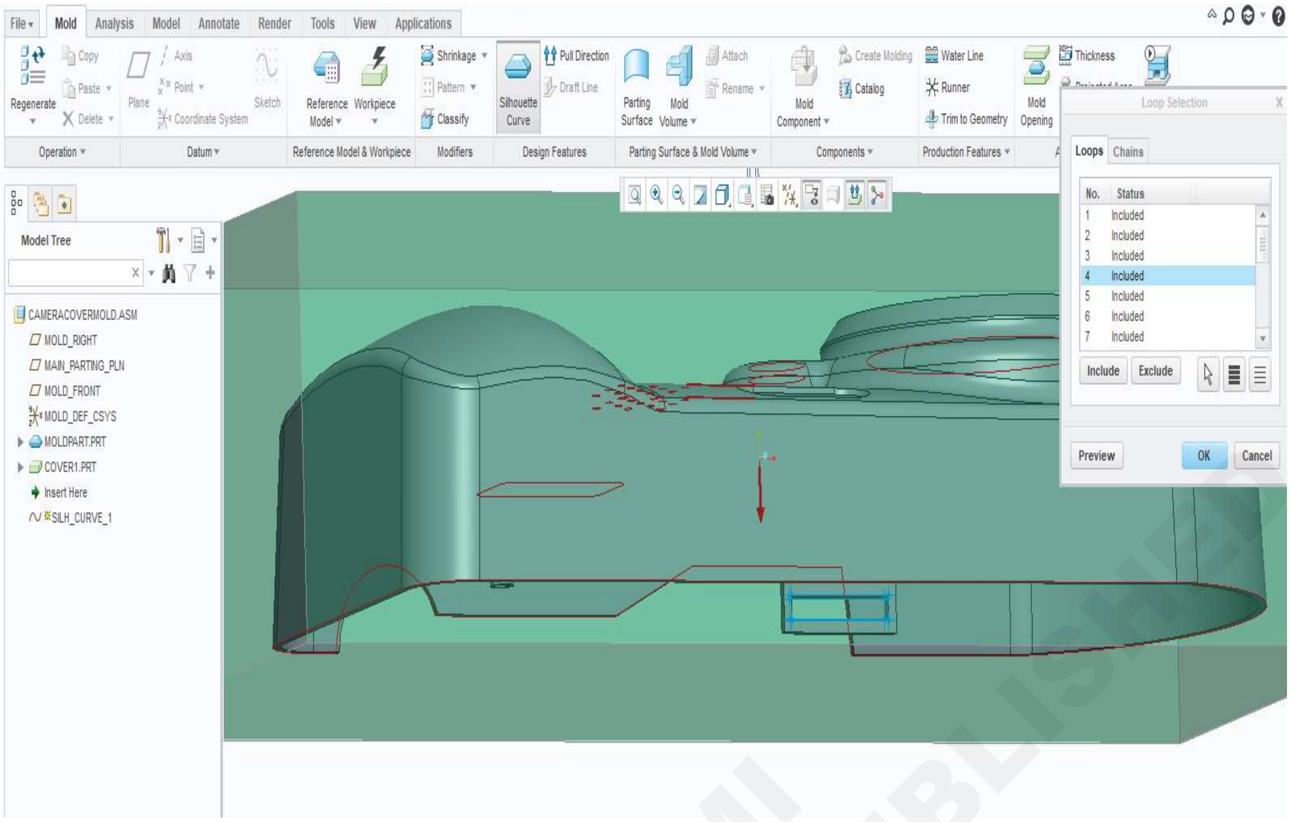
Step 19: SILHOUETTE CURVE dialog box appears, then select loop selection → define (Fig 15)

Fig 15



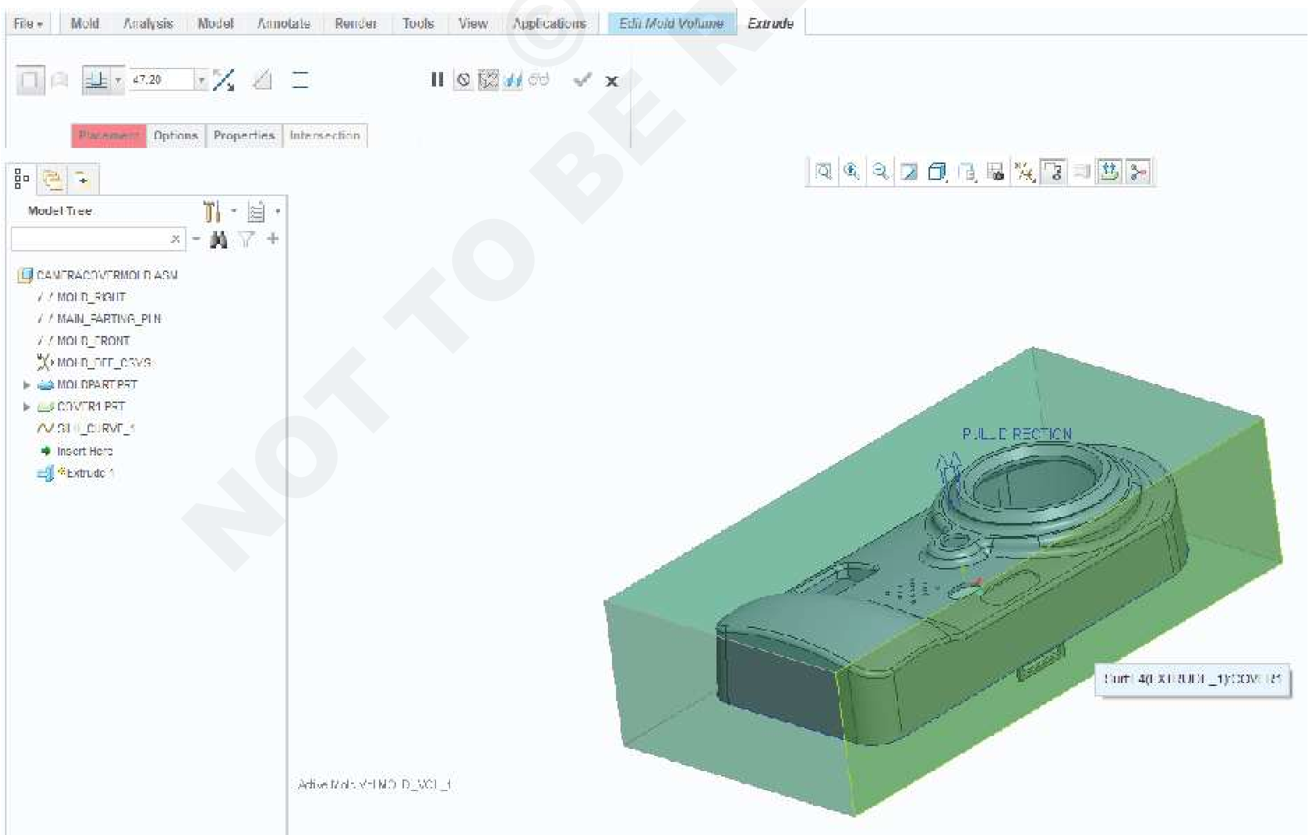
Step 20: Pick the loops one by one for selecting the slider pin fit feature as shown in Fig 16 and then click Exclude → ok → ok.

Fig 16



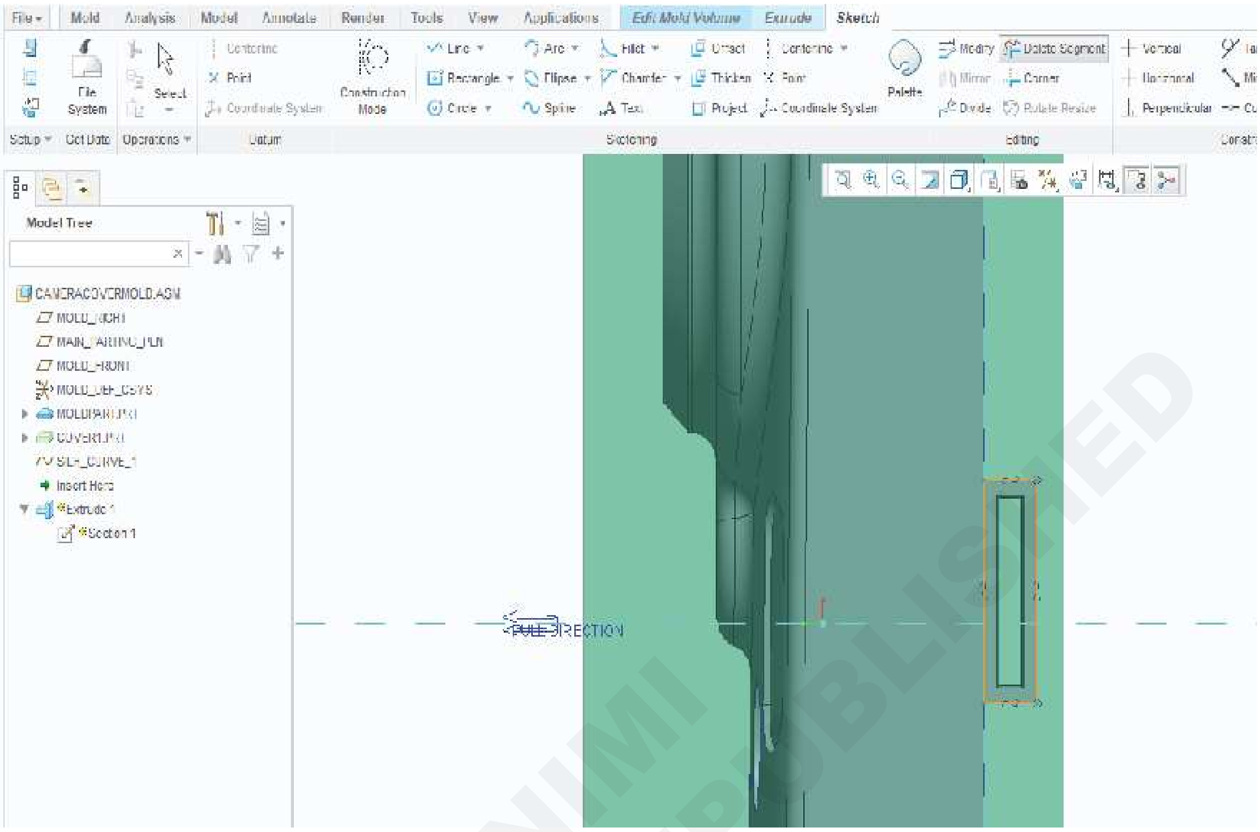
Step 21: Select Mold volume → Mold volume then select Extrude → in placement tab select define, sketch dialog box appears select the corresponding face as shown in Fig 17.

Fig 17



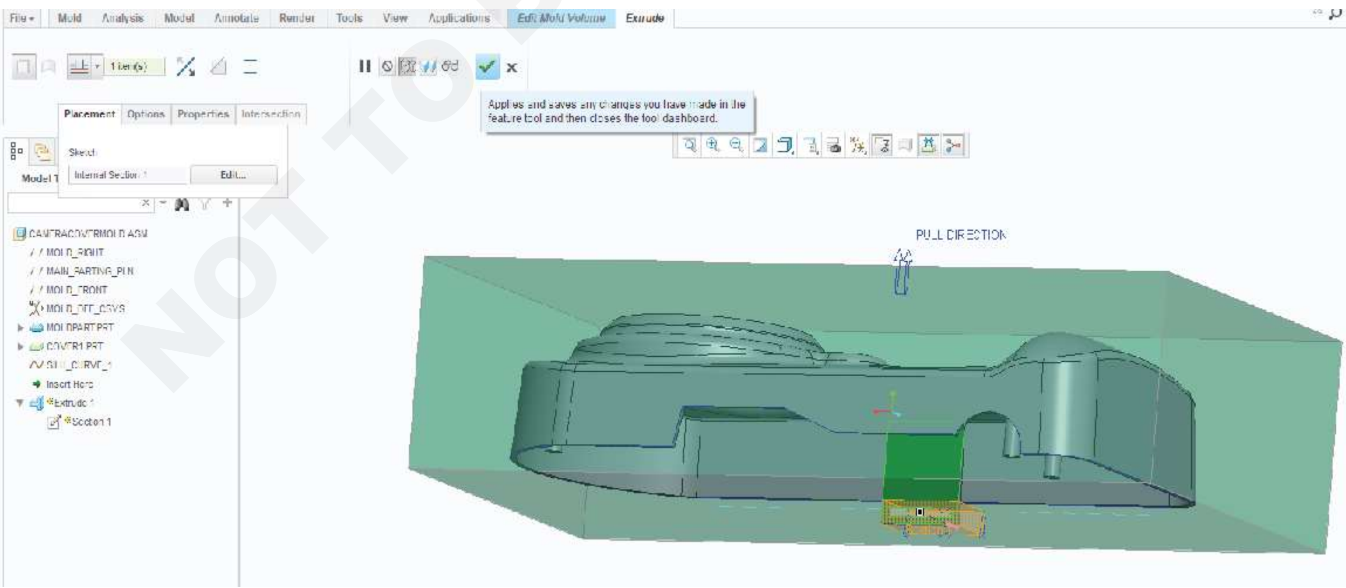
Step 22: By using project command select the outline of the slider pin fit extrude feature and trim the excess line as shown in Fig 18.

Fig 18



Step 23: Extrude tab appears on that select upto surface option and select the surface as shown in Fig 19 and click ✓ button.

Fig 19



Step 24: In Edit mold volume Tab → Reference part cut out and then unwanted surfaces are removed as shown in Fig 20, 21 and click button.

Fig 20

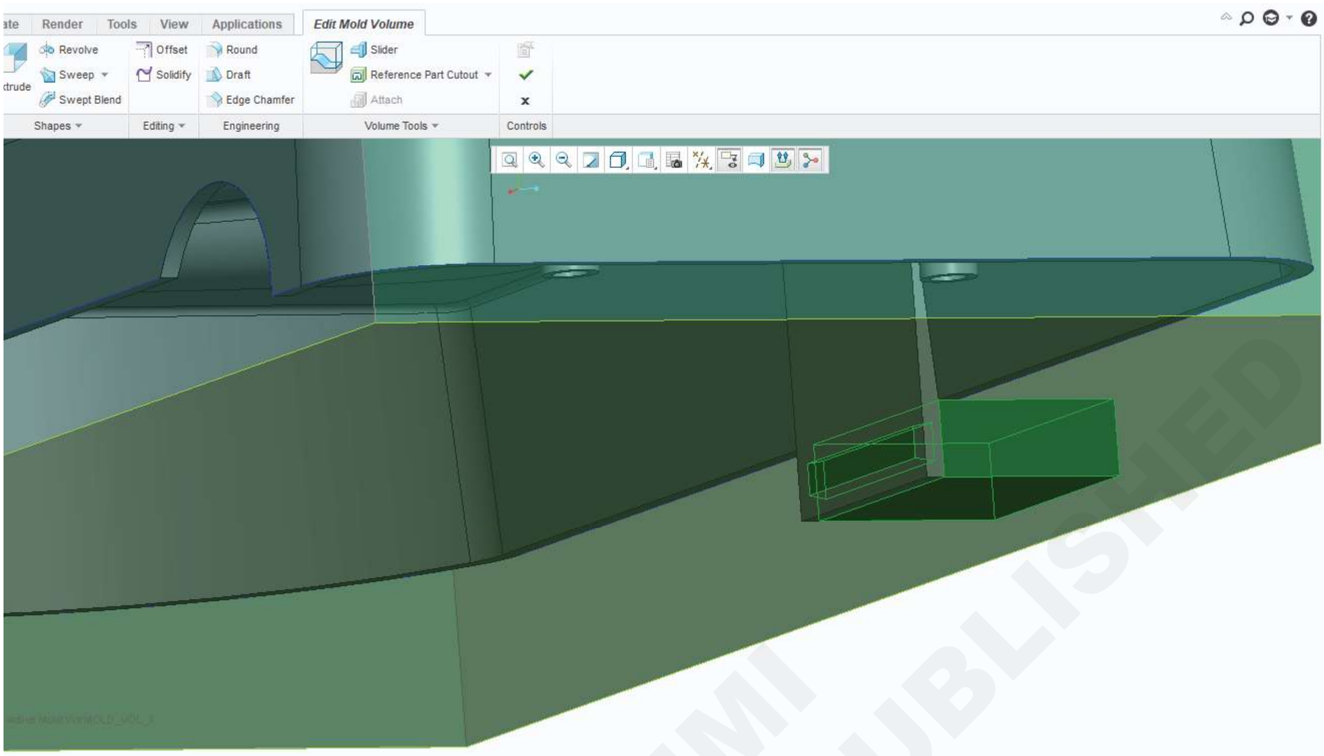
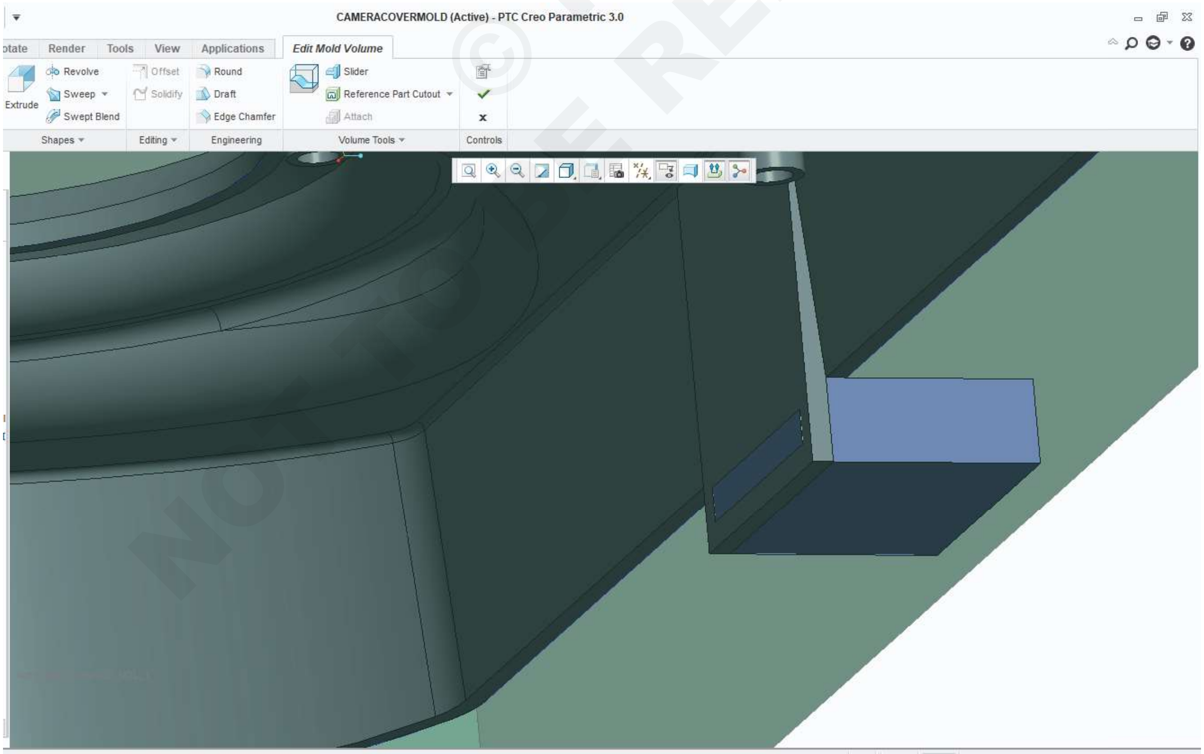


Fig 21



Step 25: Select parting surface → SKIRT surface, SKIRT surface dialog box appears on that select curves then click define button, Menu Manager dialog box opens in that select Feat curves and then select done option, the curves is defined. (Fig 22 & 23)

Fig 22

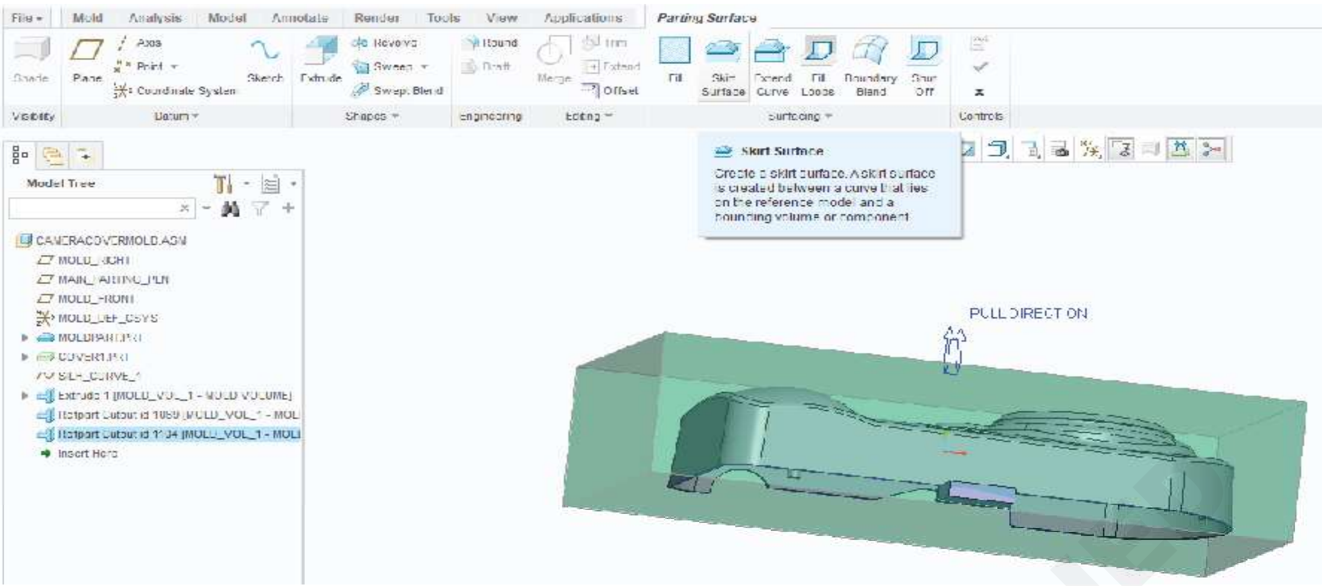
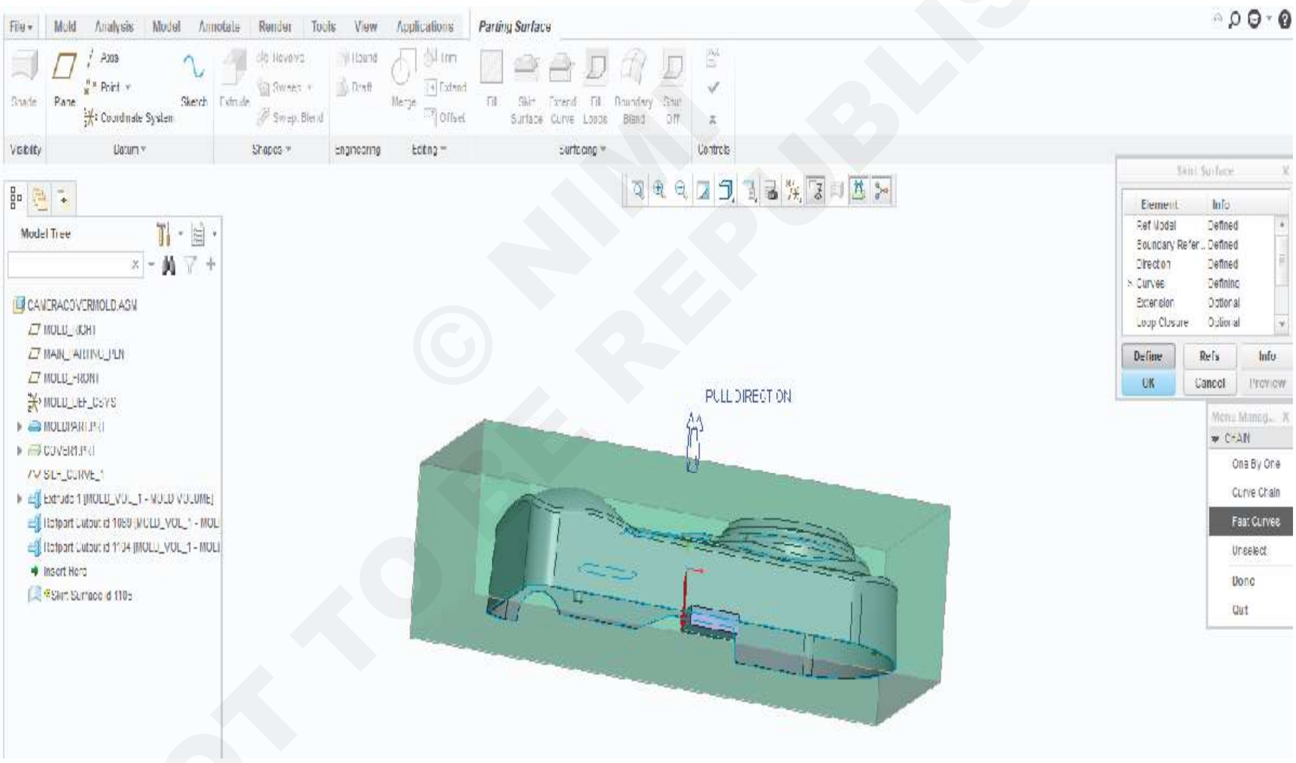


Fig 23



Step 26: Select Mold volume → Volume split, Menu Manager dialog box appears on that select all work piece and then click done. (Fig 24 & 25)

Fig 24

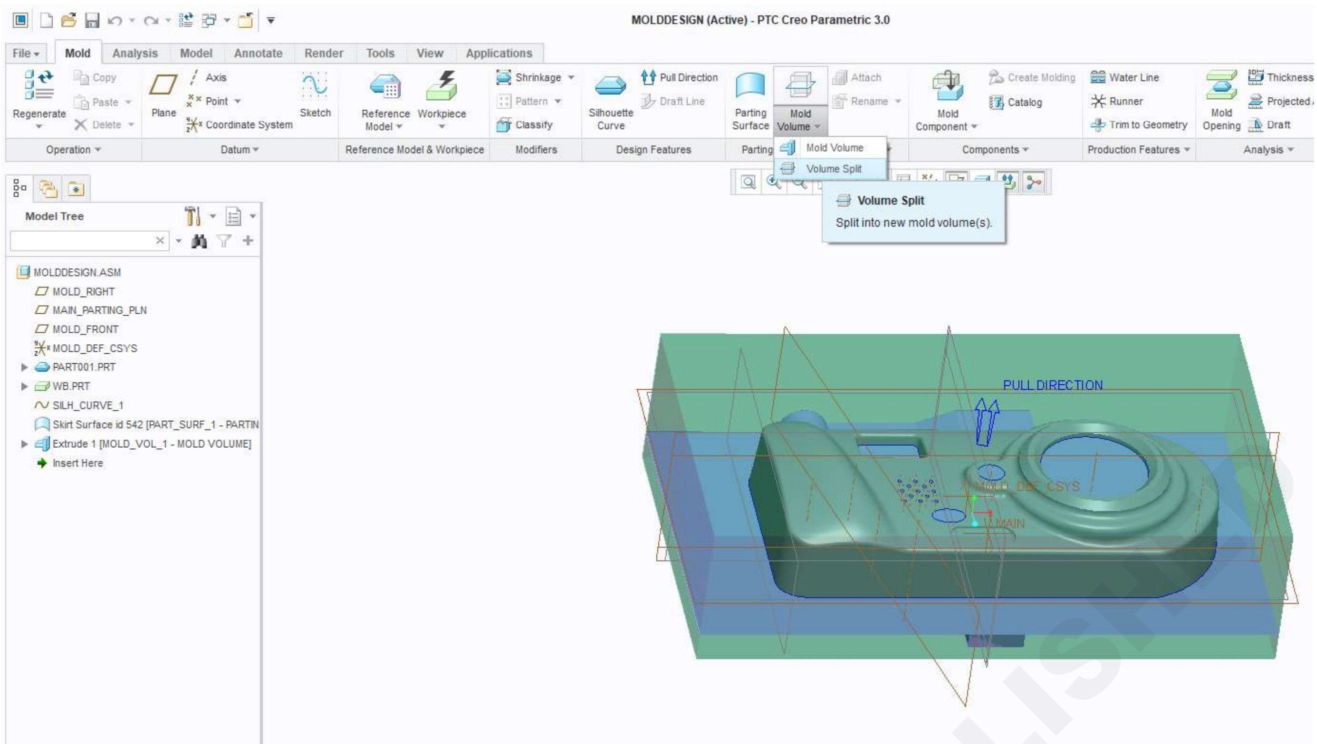
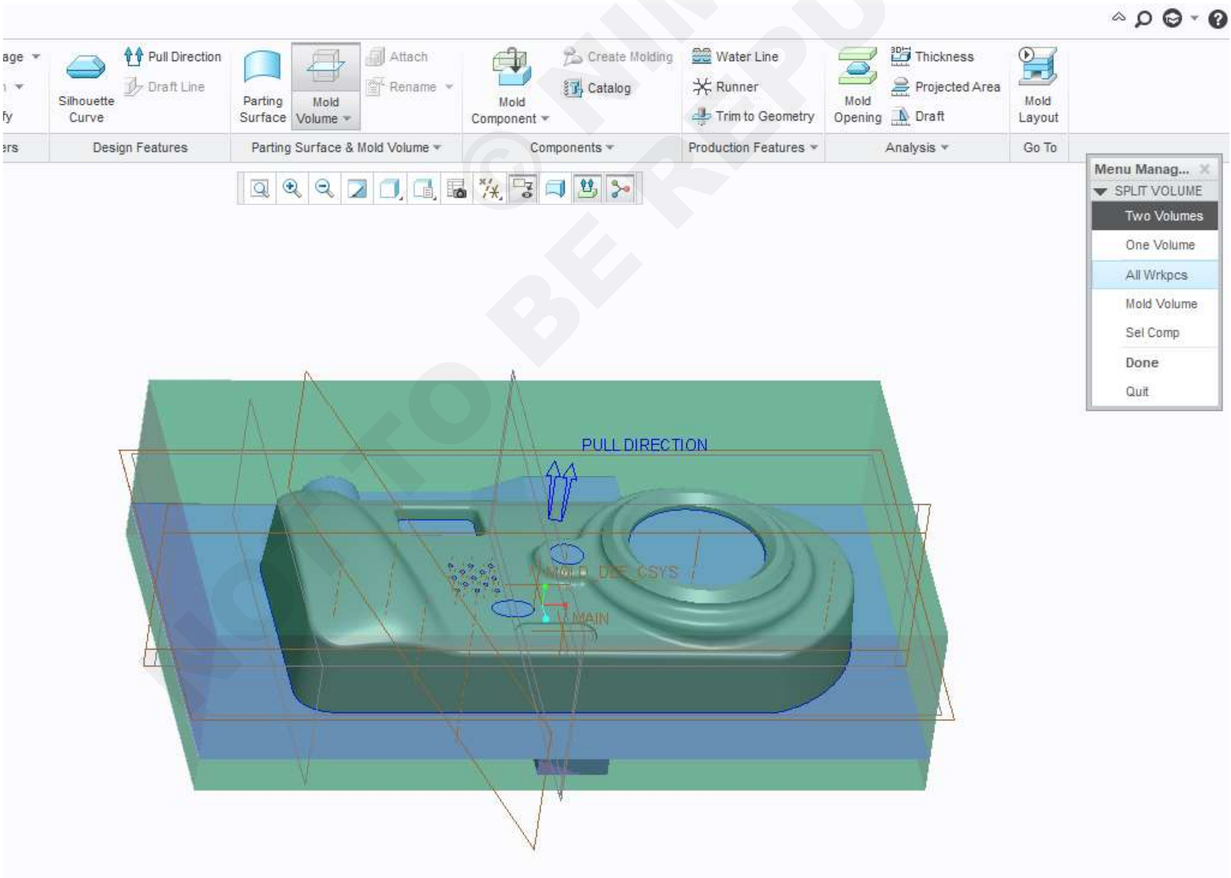
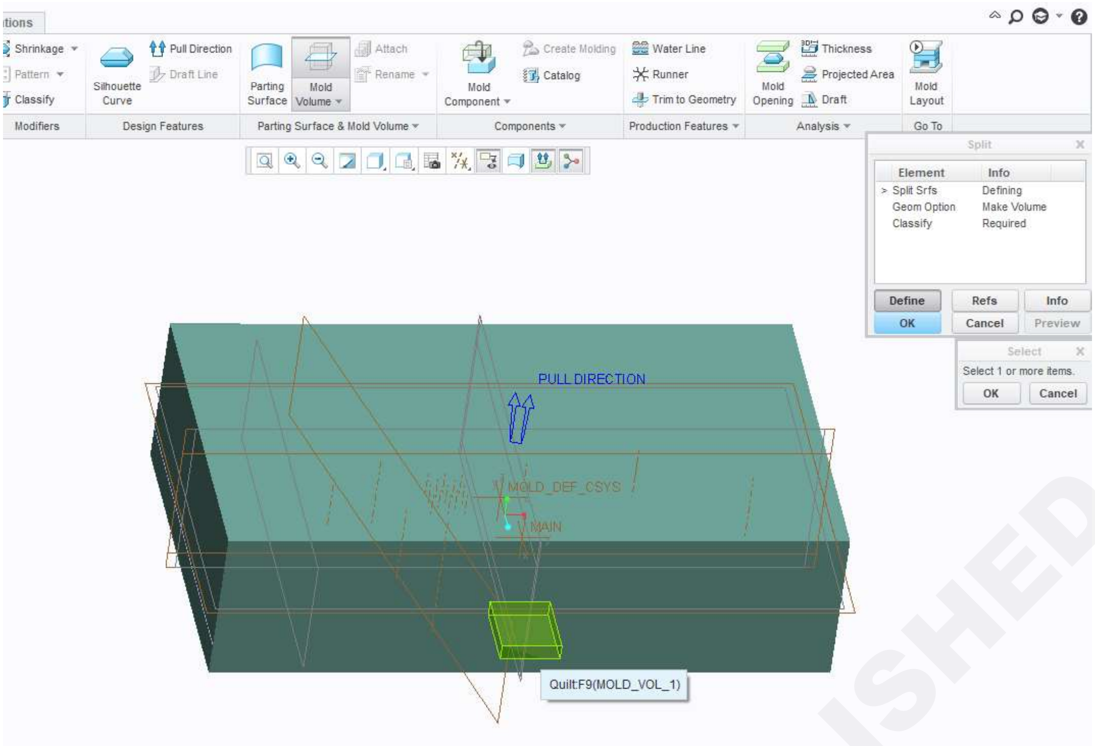


Fig 25



Step 27: Split dialog box appears on that select split surfaces and click define then select the slider and click ok button. (Fig 26)

Fig 26



Step 28: First dialog box appears, click ok button and second dialog box appears change name as slider1 and click ok button. (Fig 27 & 28)

Fig 27

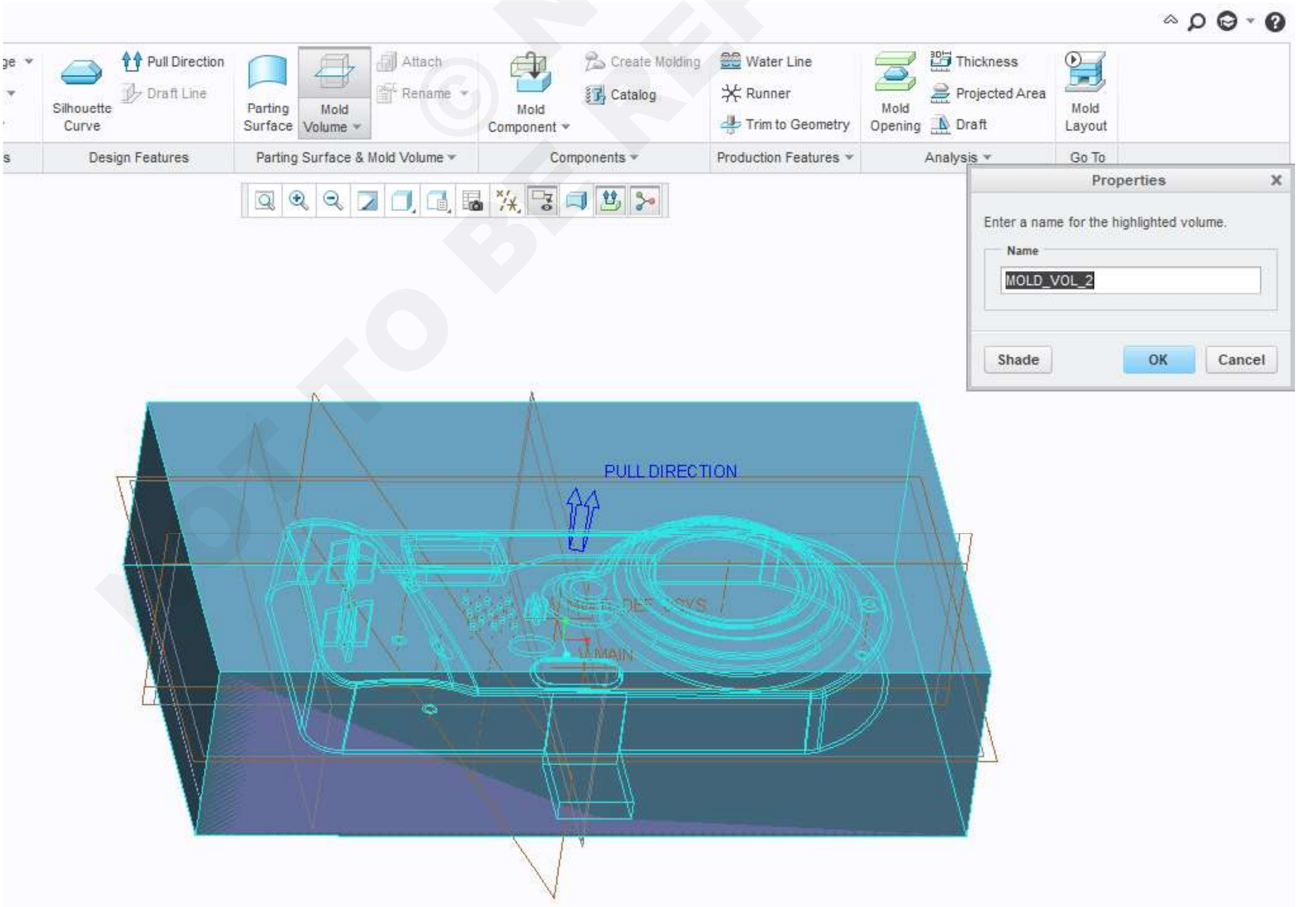
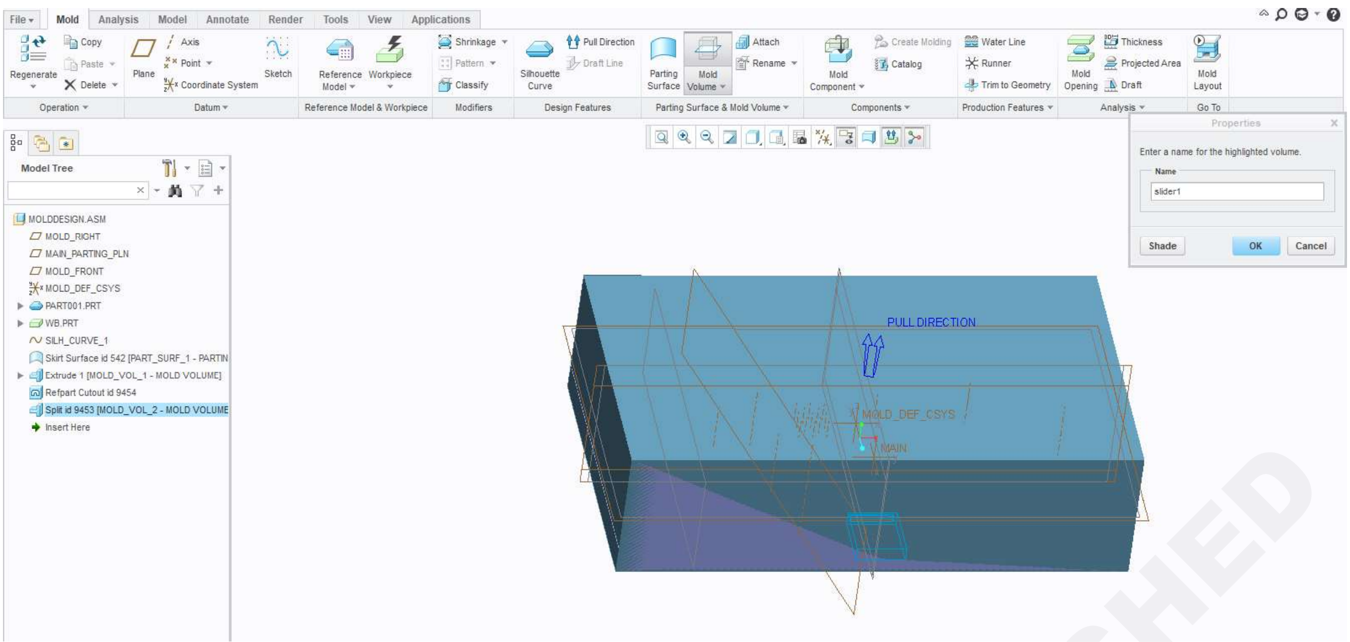


Fig 28



Step 29: Select mold display on view tab, blank and unblank dialog box appears Select the WB part,click the blank button as shown in Fig 29, 30 & 31 and click ok button.

Fig 29

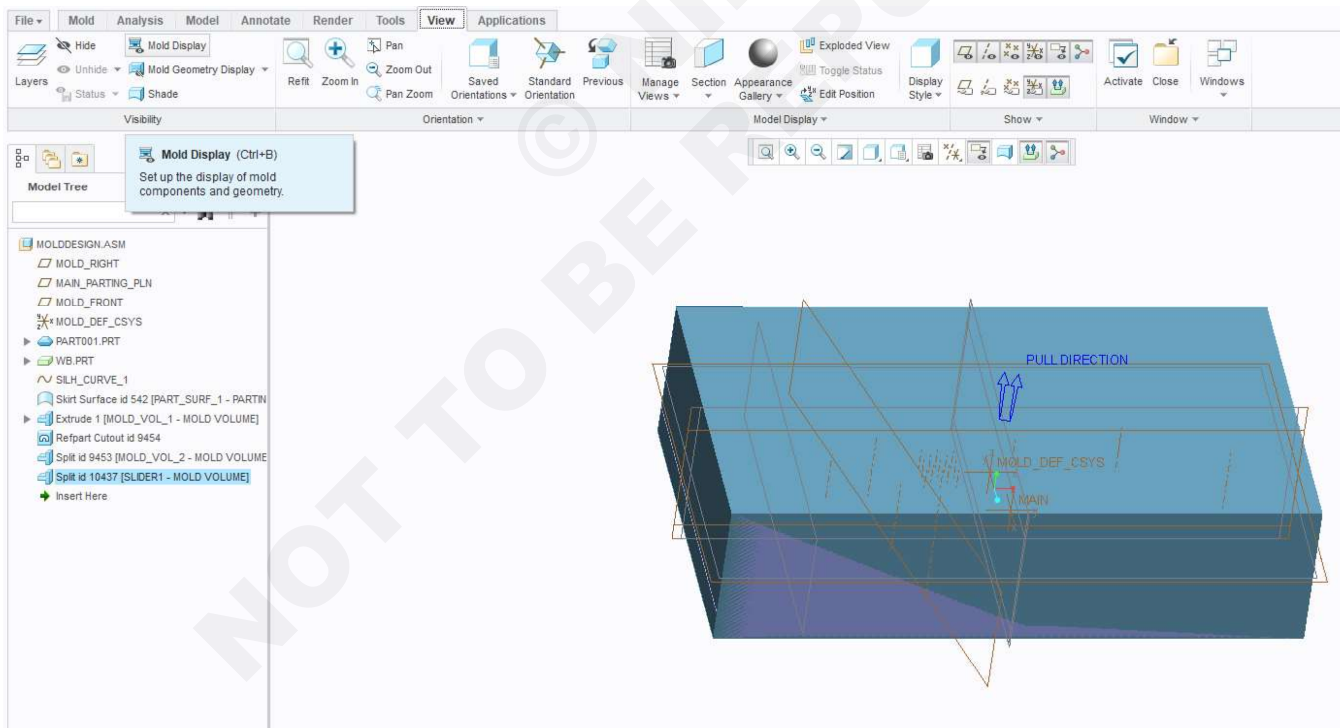


Fig 30

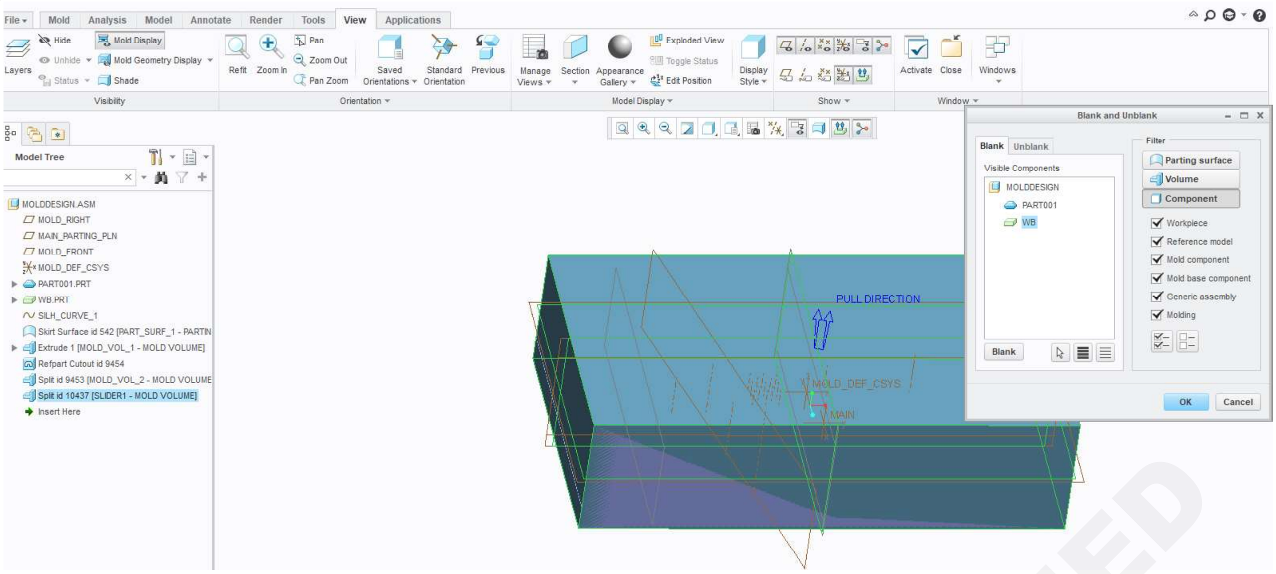
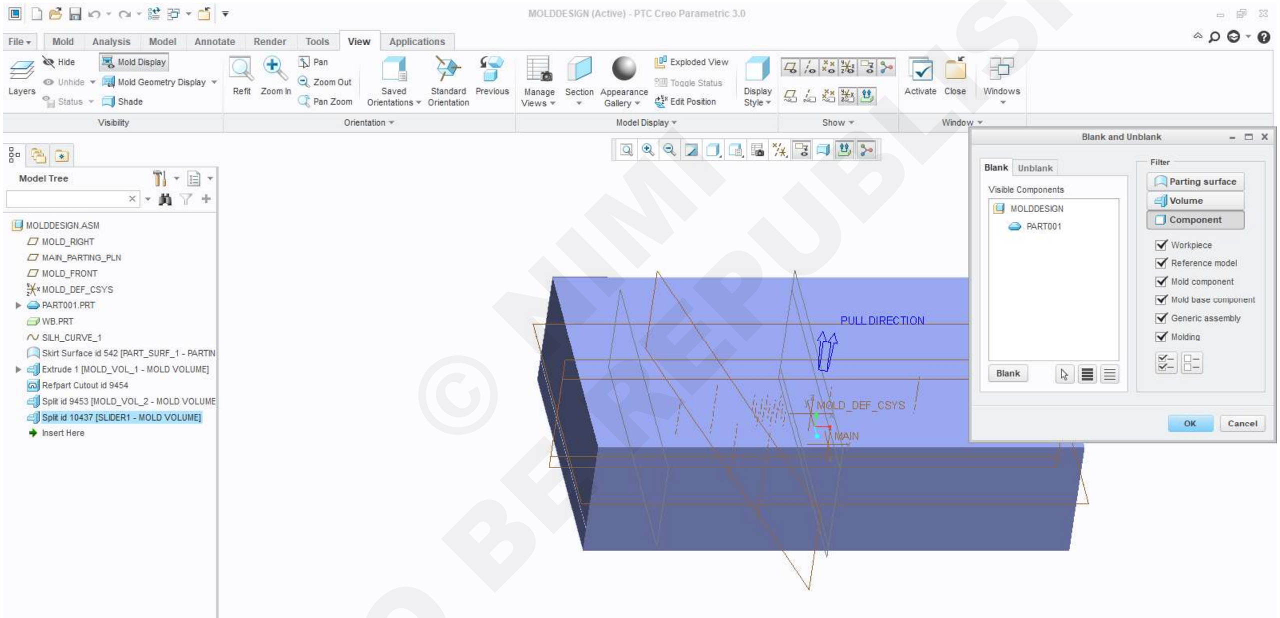
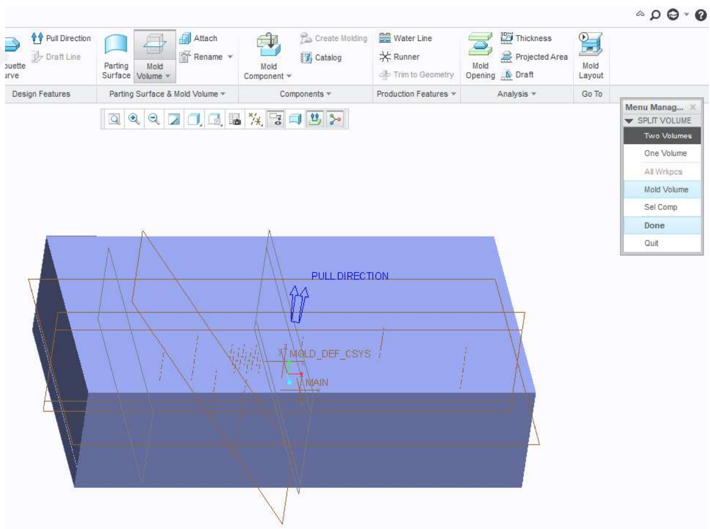


Fig 31



Step 30: Select mold volume on mold tab, Menu Manager opens in that select mold volume and then select done. (Fig 32)

Fig 32



Step 31: Search tool dialog box appears on that click Quilt: F11/Mold-Vol-2) as shown in Fig 33, 34 by clicking the middle arrow button it moves from left to right and then click close.

Fig 33

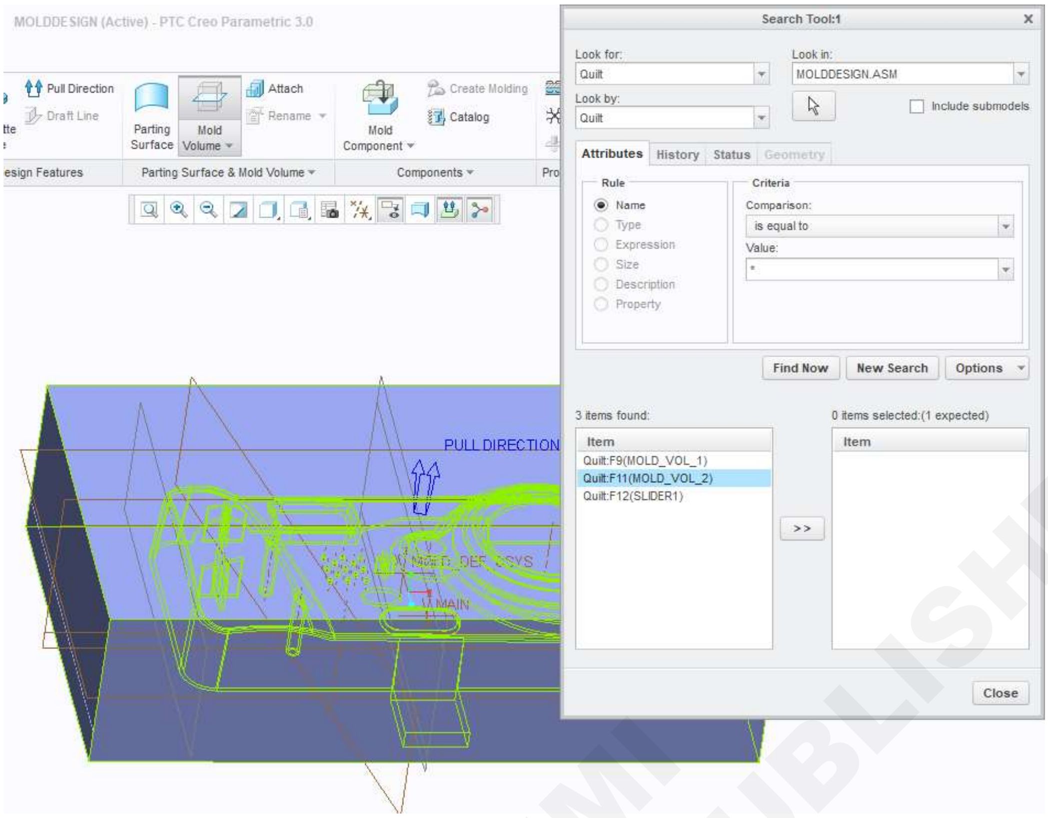
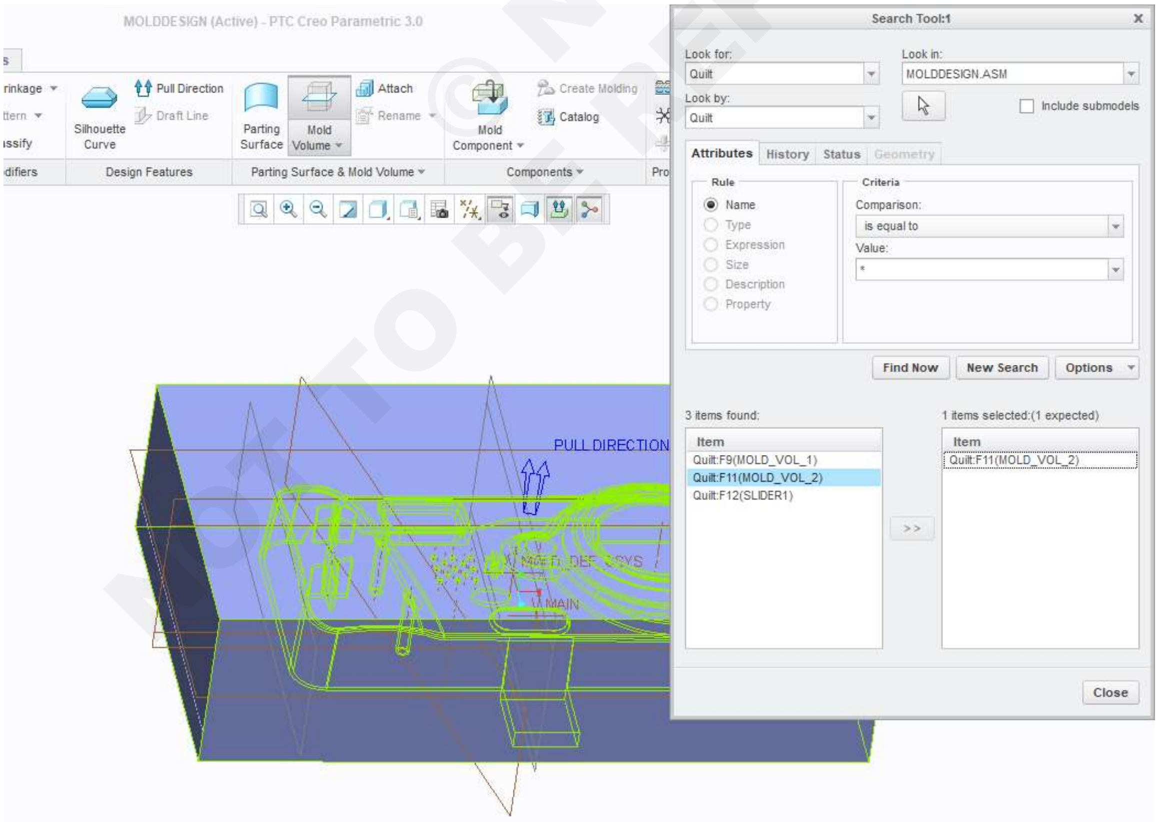


Fig 34



Step 32: In Mold volume option select volume split, menu dialog box appears and click done button then split dialog box appears on that select split srfs and click define then select the surfaces as shown in Fig 35, 36 click ok button.

Fig 35

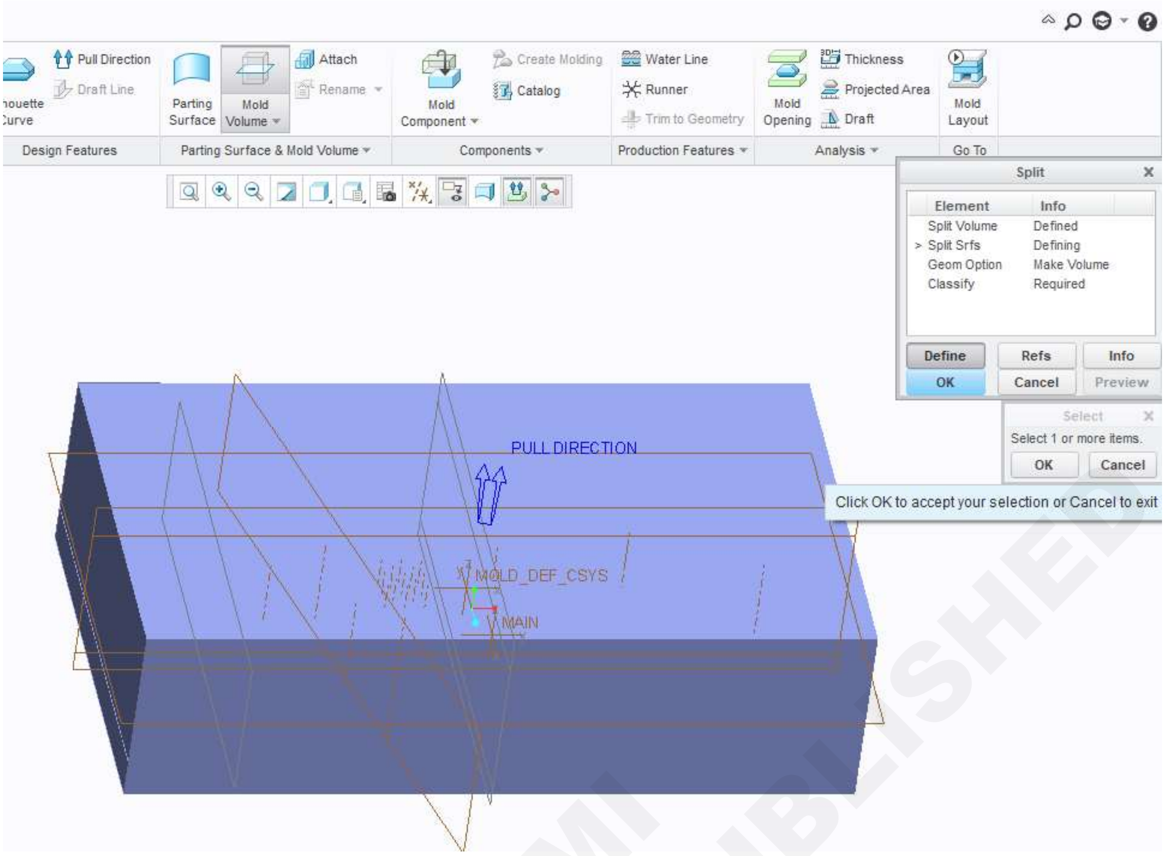
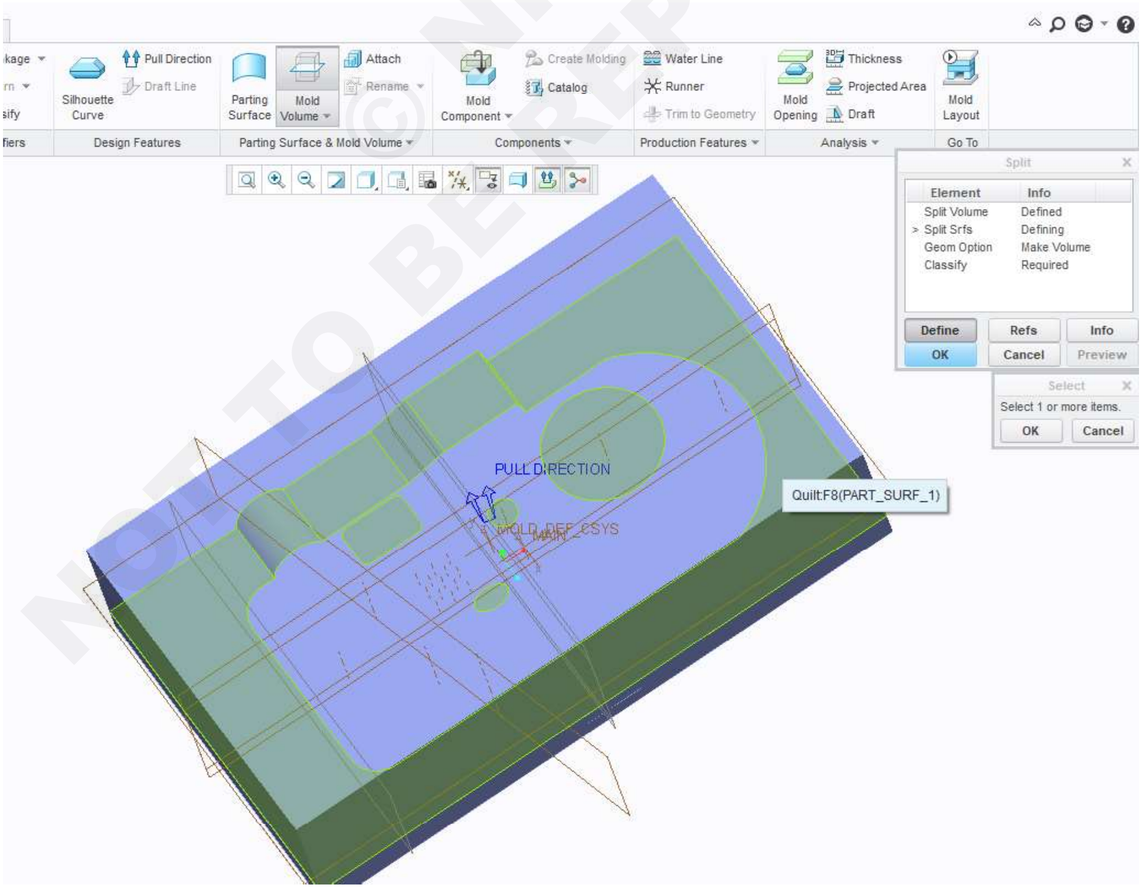


Fig 36



Step 33: As same as step 28 and change name as cavity. (Figs 37 & 38)

Step 34: Third dialog box appears, change name as core and ok button. (Fig 39)

Fig 37

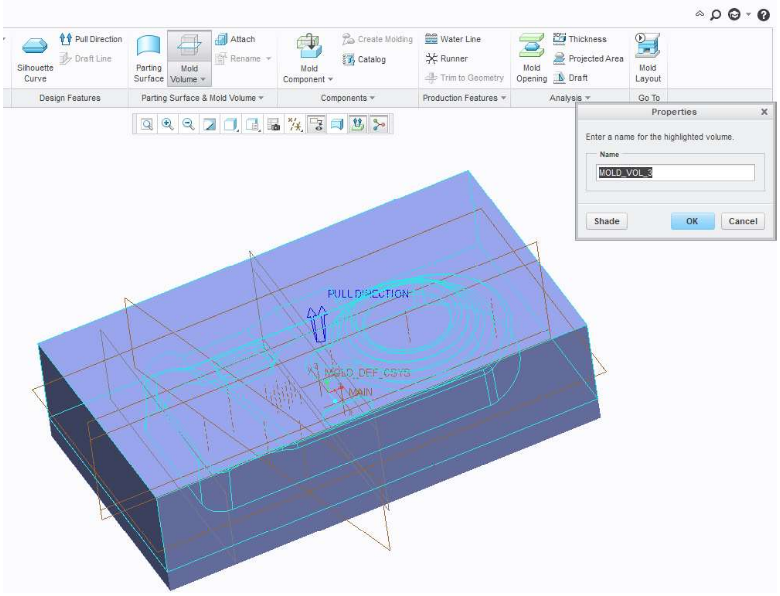


Fig 38

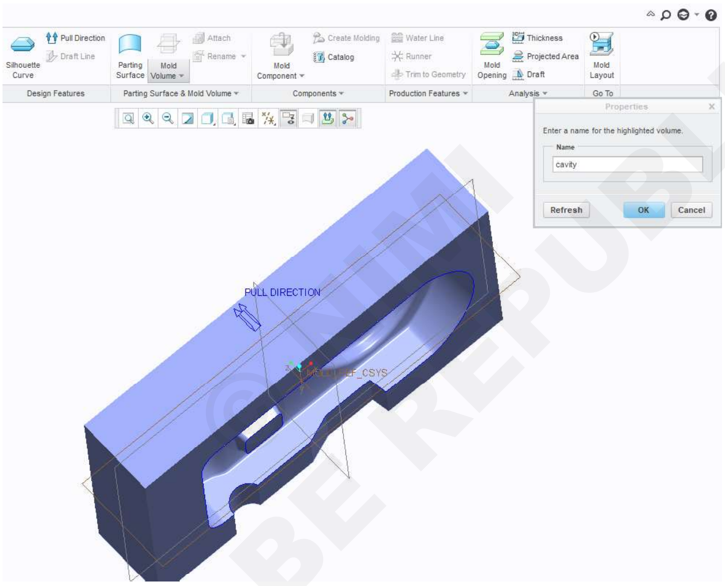
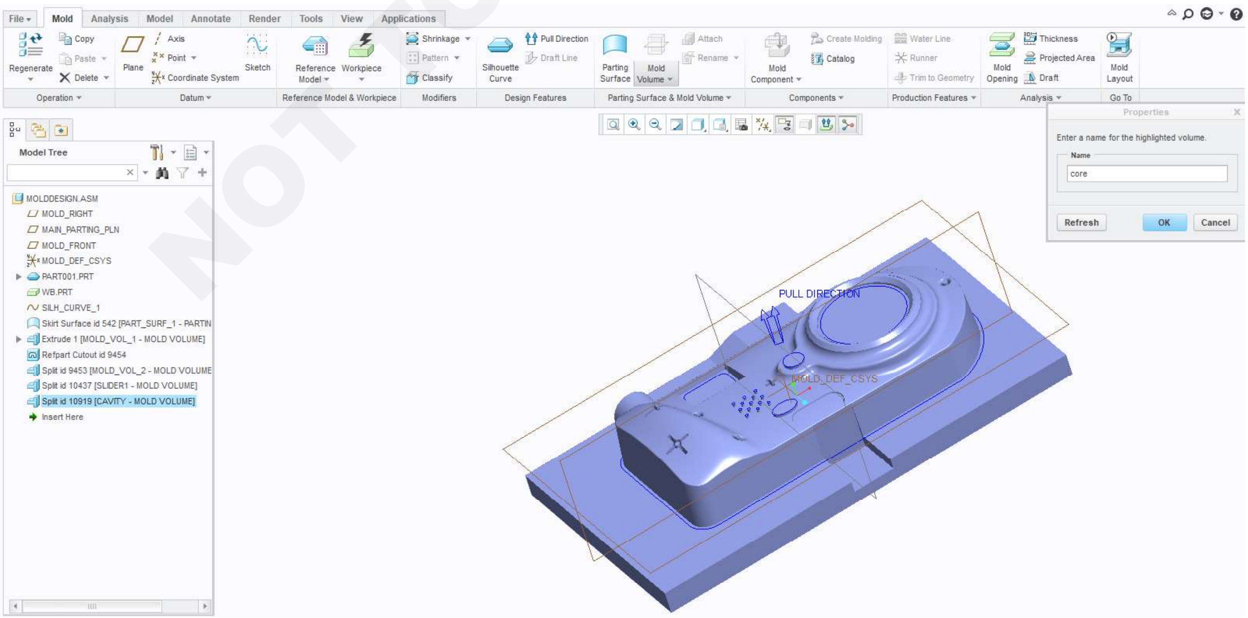
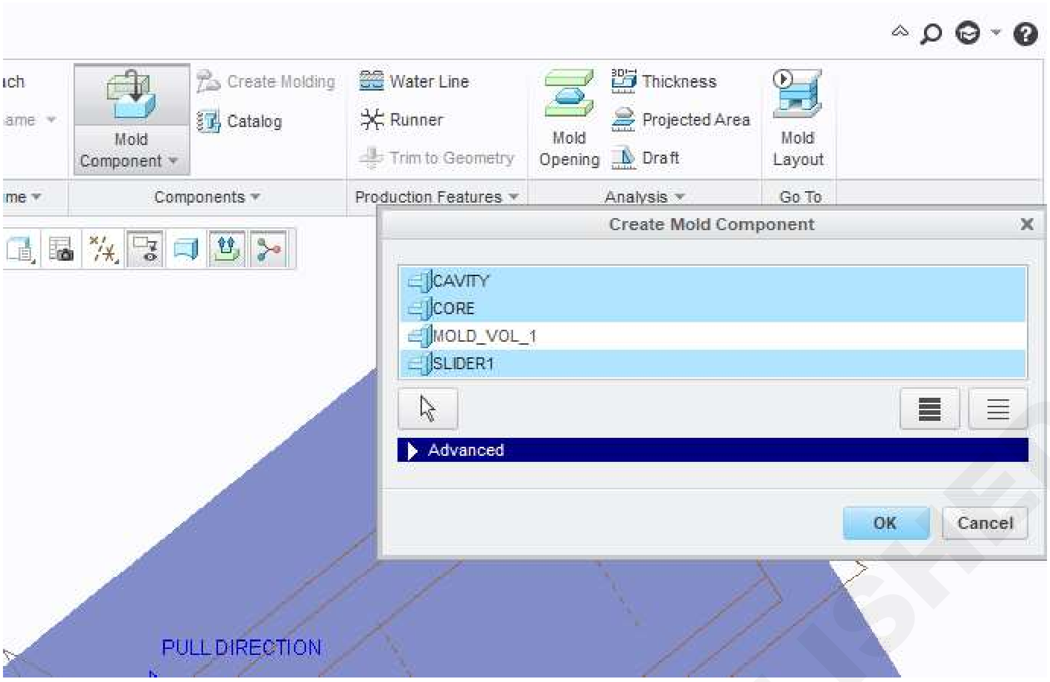


Fig 39



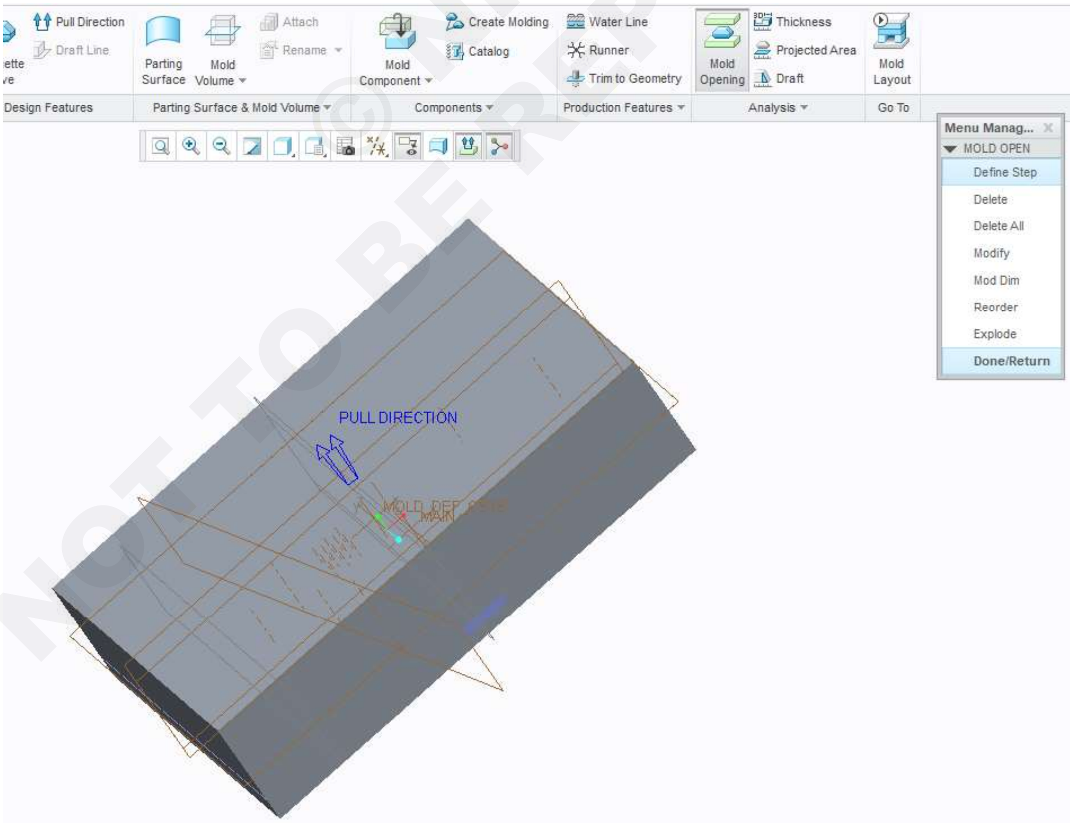
Step 35: Select Mold component → Create mold component, the dialog box opens on that select cavity, core and slider and then click ok button.(Fig 40)

Fig 40



Step 36: Select mold opening, the Menu Manager opens on that select define step and click Done/Return (Fig 41)

Fig 41



Step 37: In define step, select define move and enter the value -500 and select the corner edge as shown in Fig 42 to move the cavity (Fig 43).

Fig 42

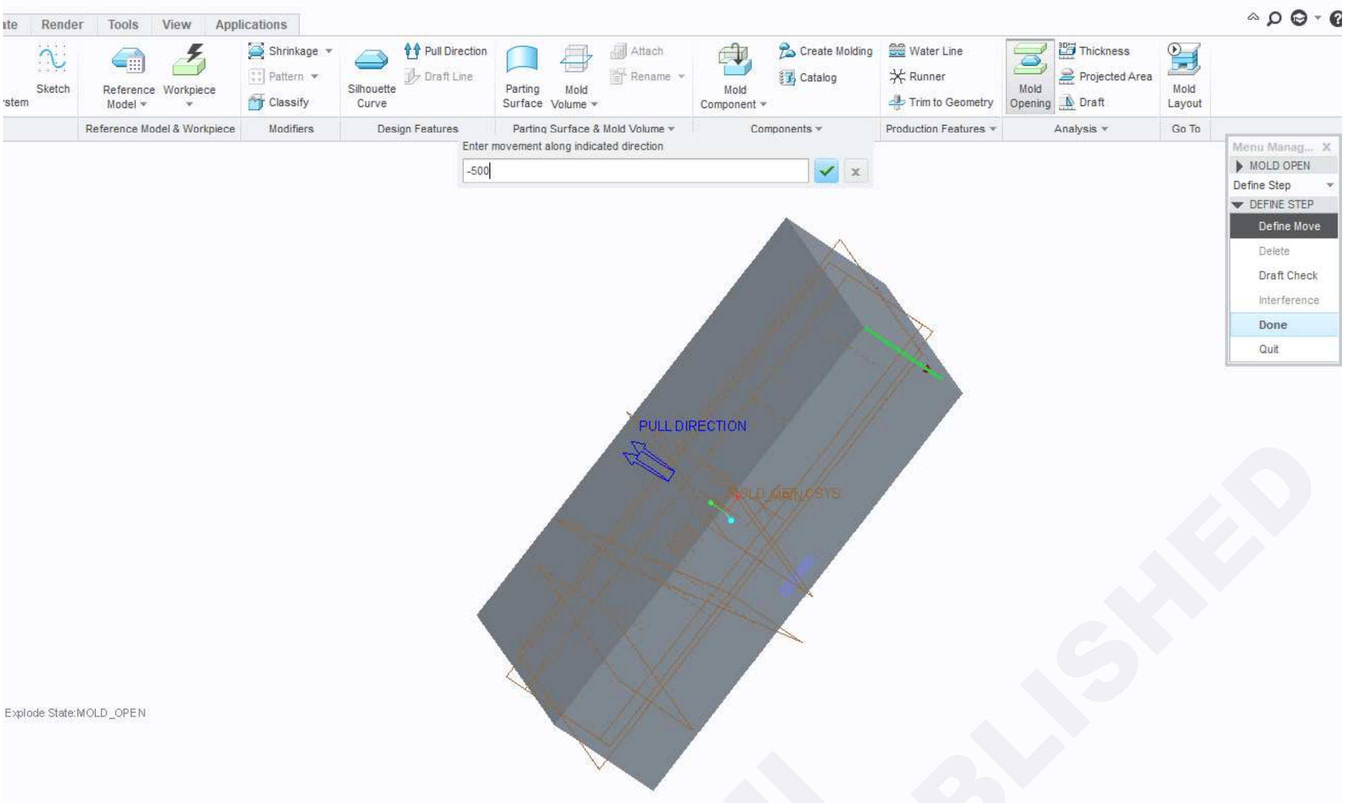
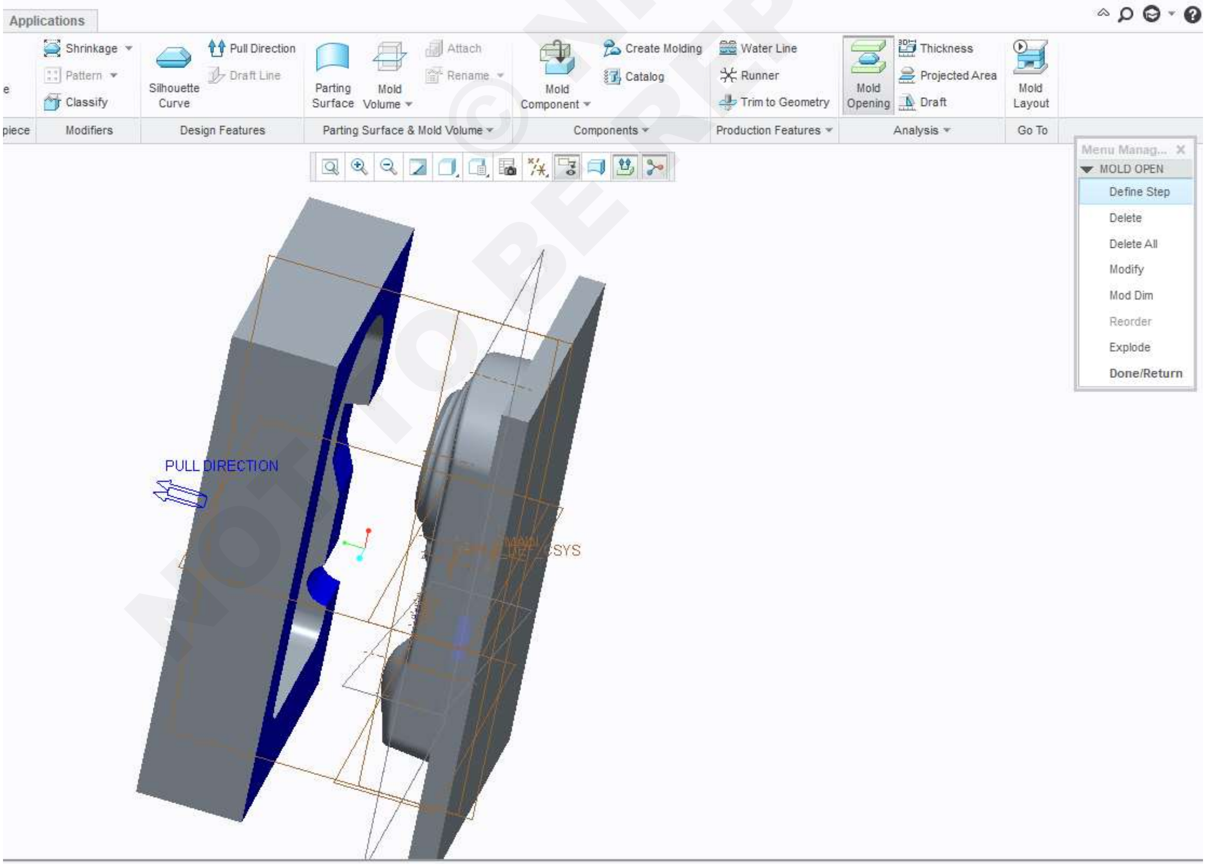


Fig 43



Step 38: Repeat the same process for core & slider by their corresponding direction. (Fig 44, 45,46,47)

Fig 44

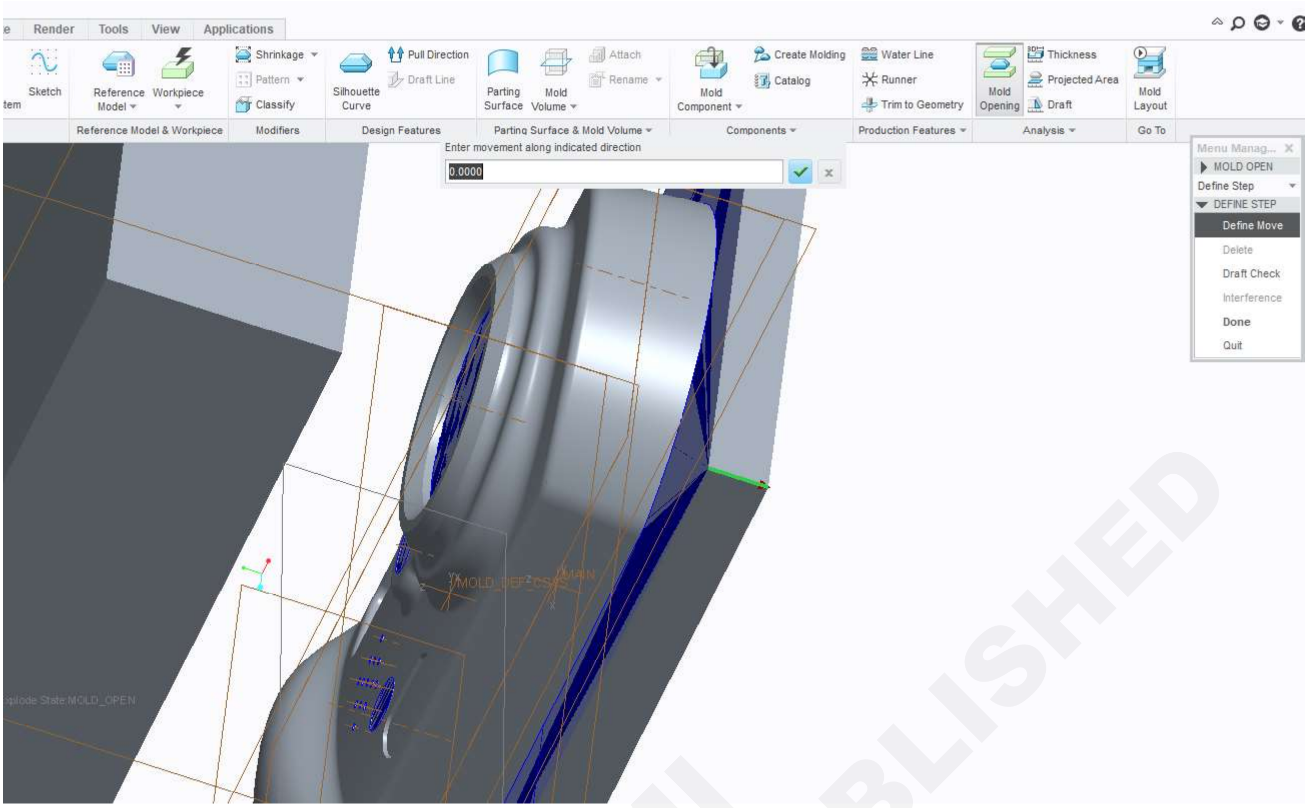

Render
Tools
View
Applications
Sketch
Reference Model
Workpiece
Shrinkage
Pattern
Classify
Silhouette Curve
Pull Direction
Draft Line
Parting Surface
Mold Volume
Attach
Rename
Mold Component
Create Molding
Catalog
Water Line
Runner
Trim to Geometry
Mold Opening
Thickness
Projected Area
Draft
Mold Layout
Reference Model & Workpiece
Modifiers
Design Features
Parting Surface & Mold Volume
Components
Production Features
Analysis
Go To
Enter movement along indicated direction
0.0000
Menu Manag...
MOLD OPEN
Define Step
DEFINE STEP
Define Move
Delete
Draft Check
Interference
Done
Quit

Fig 45

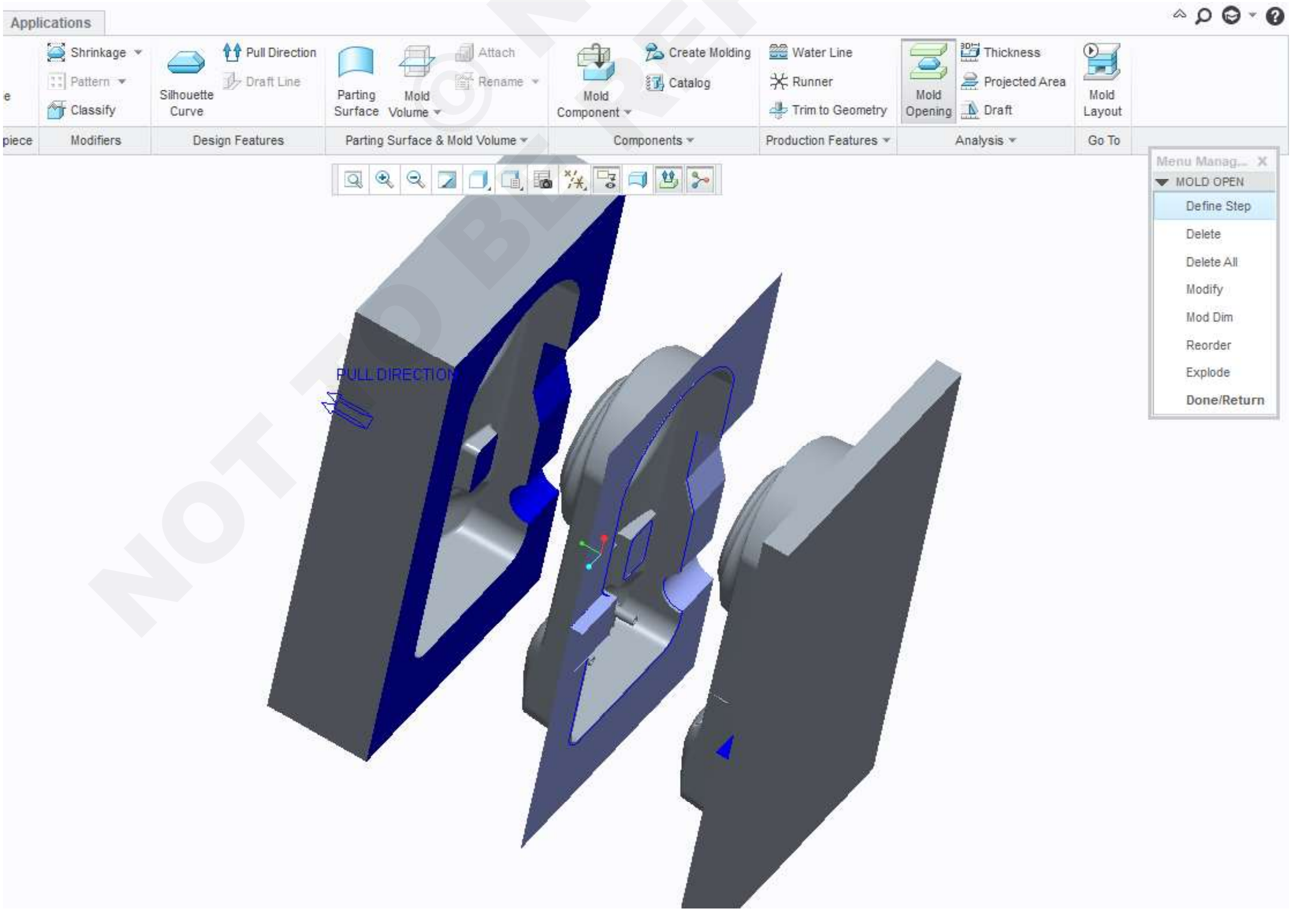

Applications
Shrinkage
Pattern
Classify
Silhouette Curve
Pull Direction
Draft Line
Parting Surface
Mold Volume
Attach
Rename
Mold Component
Create Molding
Catalog
Water Line
Runner
Trim to Geometry
Mold Opening
Thickness
Projected Area
Draft
Mold Layout
Modifiers
Design Features
Parting Surface & Mold Volume
Components
Production Features
Analysis
Go To
PULL DIRECTION
Menu Manag...
MOLD OPEN
Define Step
Delete
Delete All
Modify
Mod Dim
Reorder
Explode
Done/Return

Fig 46

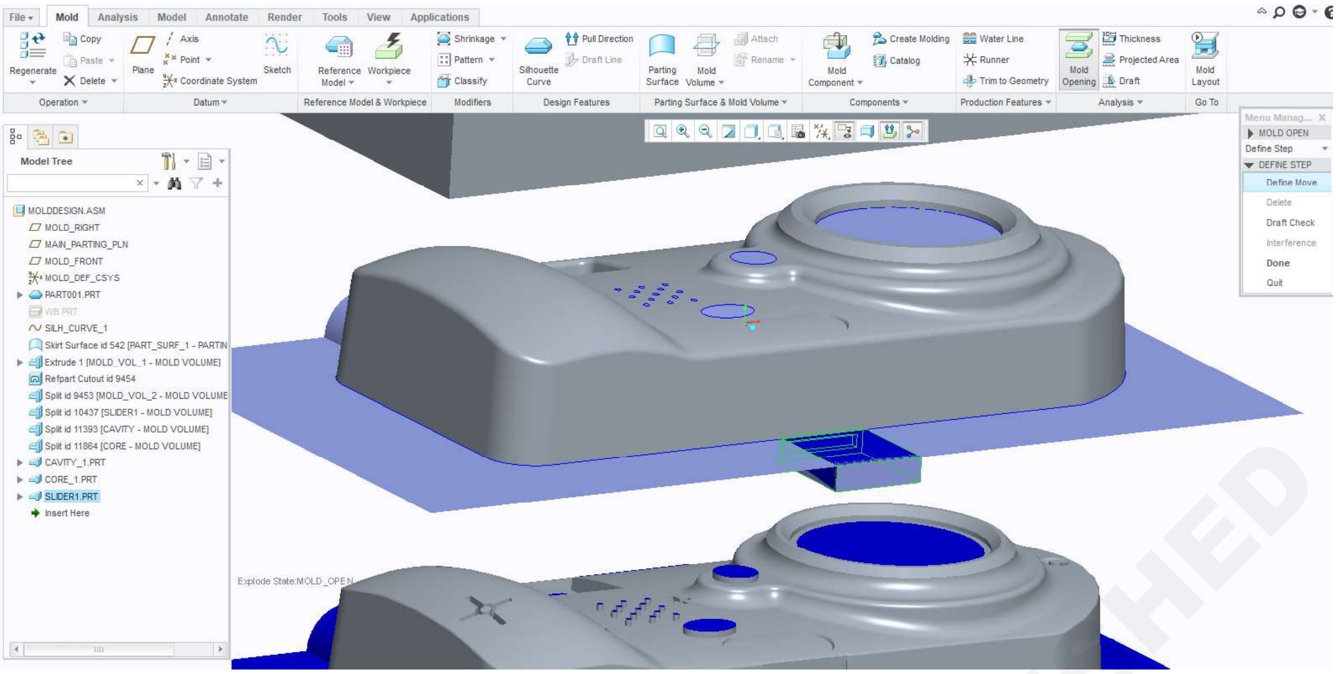
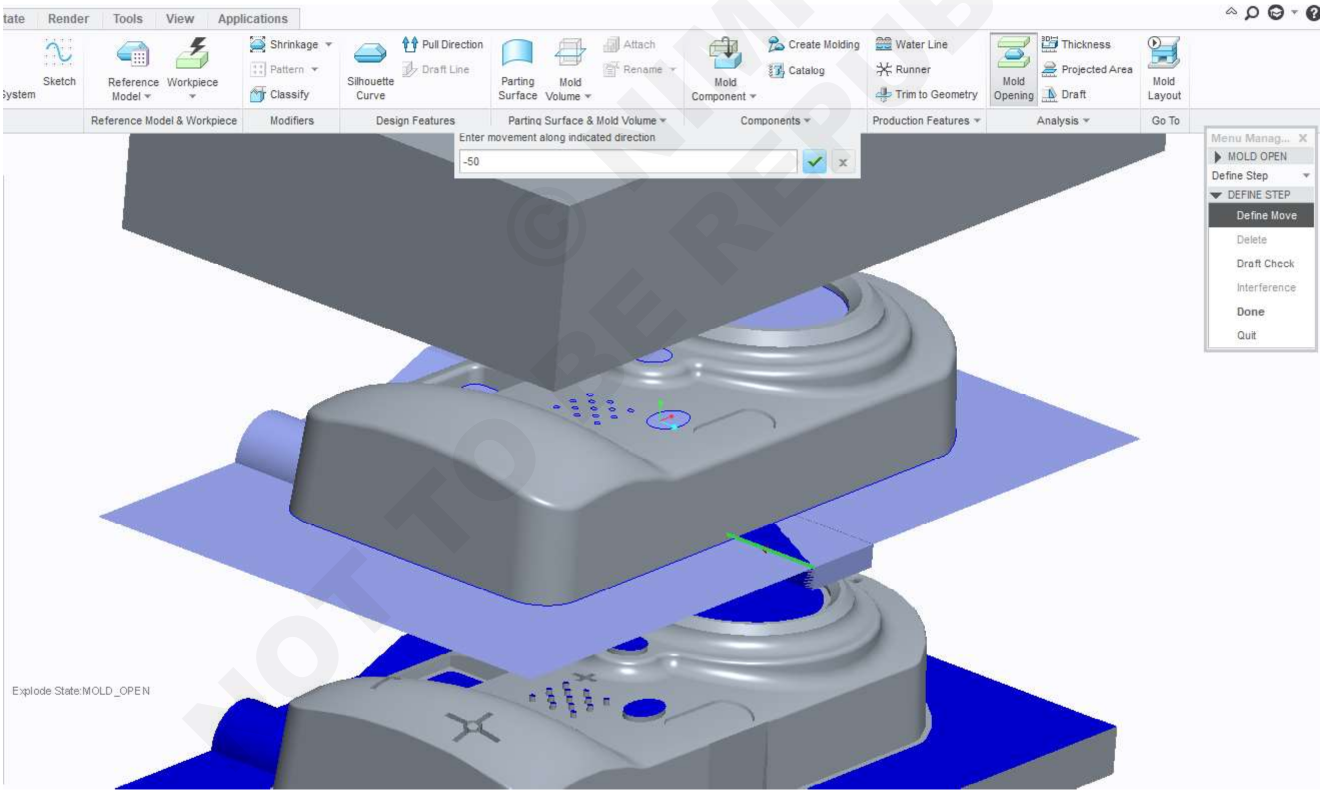
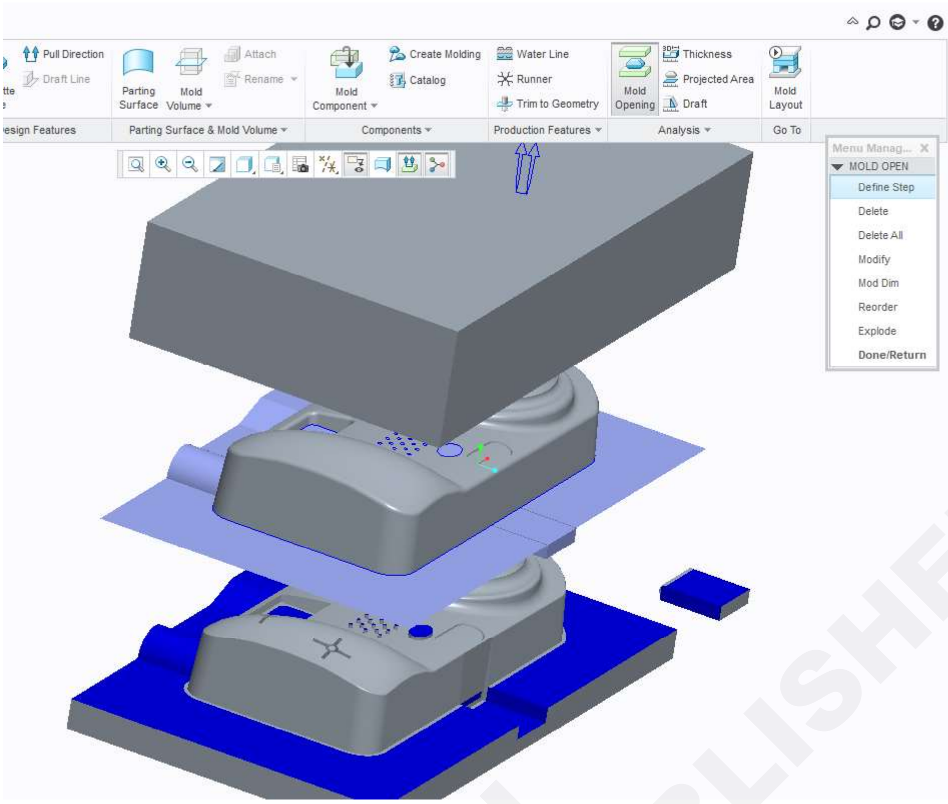


Fig 47



Step 39: All the parts are moved, then click Done/ Return. (Fig 48)

Fig 48



Step 40: Once again click the mold opening,the parts are moved as per the given direction by us (Fig 49,50&51).

Fig 49

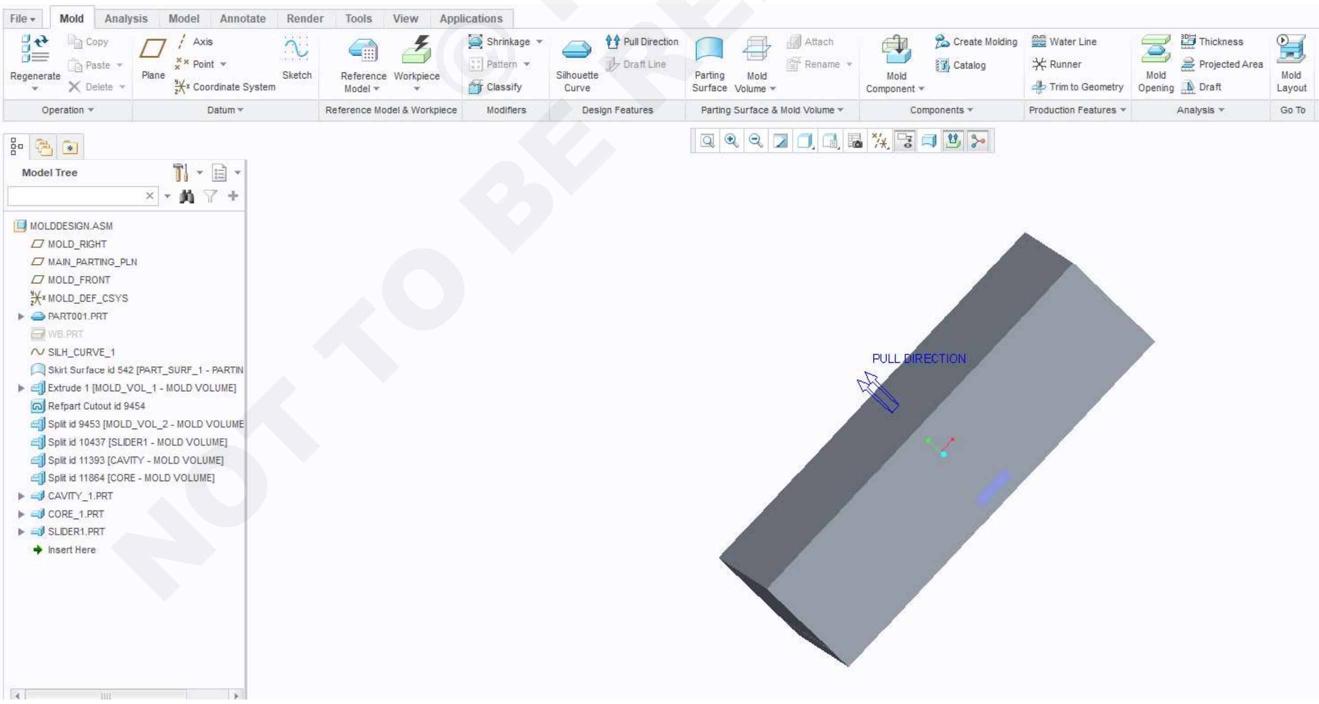


Fig 50

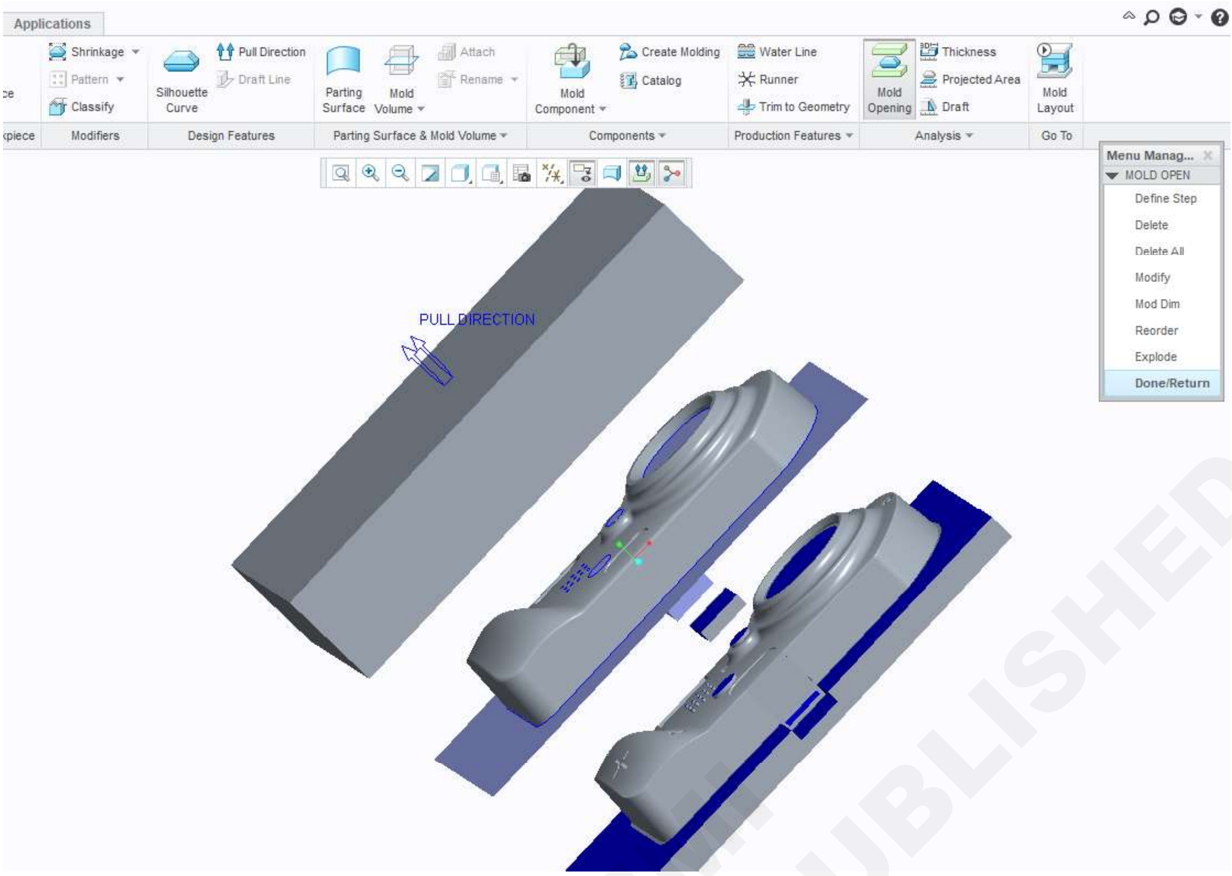
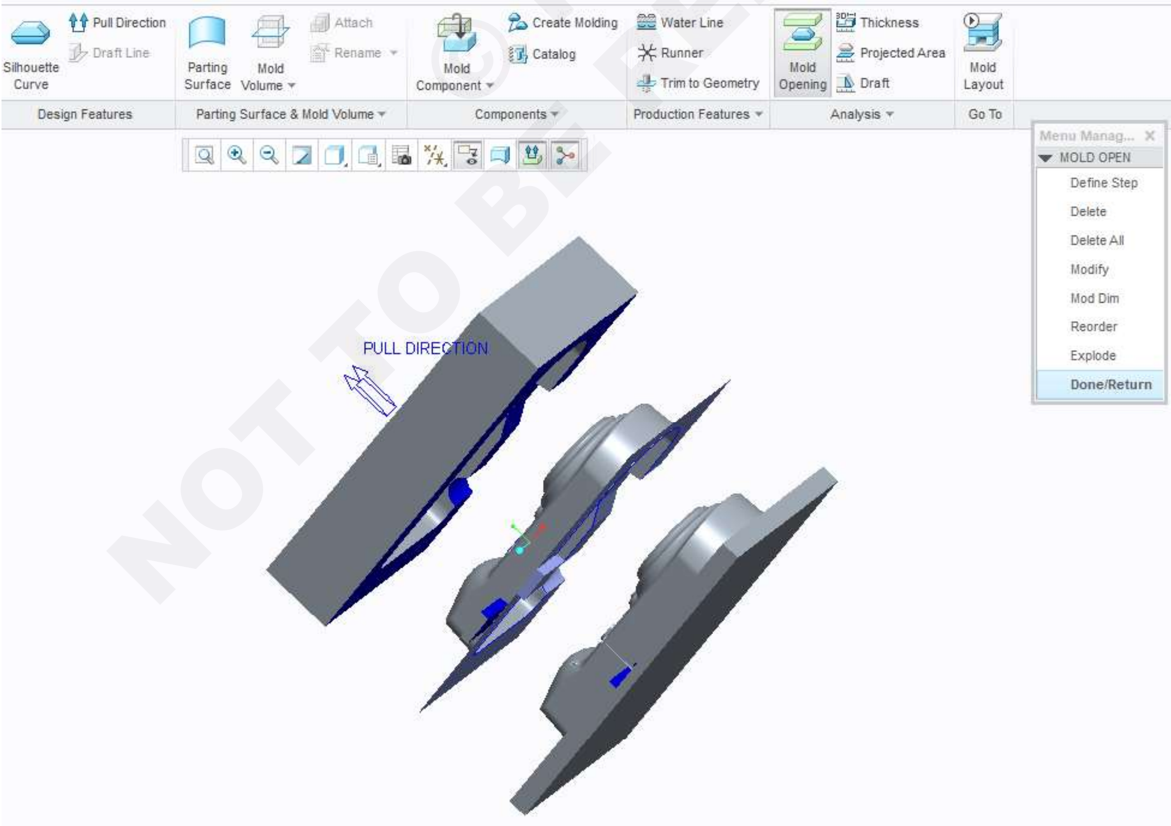

Applications
Shrinkage
Pattern
Classify
Silhouette Curve
Pull Direction
Draft Line
Parting Surface
Mold Volume
Attach
Rename
Mold Component
Create Molding
Catalog
Water Line
Runner
Trim to Geometry
Mold Opening
Thickness
Projected Area
Draft
Mold Layout
Modifiers
Design Features
Parting Surface & Mold Volume
Components
Production Features
Analysis
Go To
Menu Manag...
MOLD OPEN
Define Step
Delete
Delete All
Modify
Mod Dim
Reorder
Explode
Done/Return
PULL DIRECTION

Fig 51

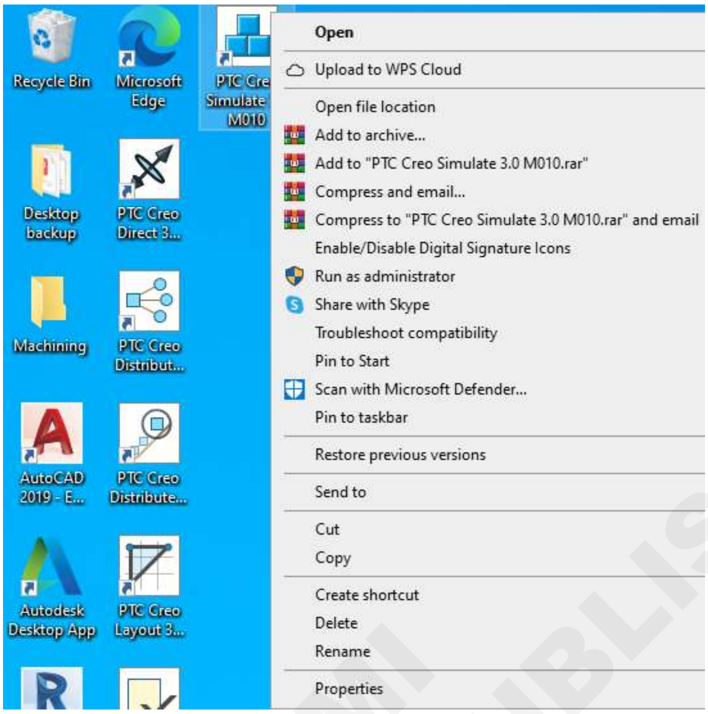

Silhouette Curve
Pull Direction
Draft Line
Parting Surface
Mold Volume
Attach
Rename
Mold Component
Create Molding
Catalog
Water Line
Runner
Trim to Geometry
Mold Opening
Thickness
Projected Area
Draft
Mold Layout
Design Features
Parting Surface & Mold Volume
Components
Production Features
Analysis
Go To
Menu Manag...
MOLD OPEN
Define Step
Delete
Delete All
Modify
Mod Dim
Reorder
Explode
Done/Return
PULL DIRECTION

— — — — — — — —

TASK 5: **CREO Simulate**

- To open Creo simulate double click / right click, the mouse button select open option of PTC creo simulate icon as shown in Fig 1.

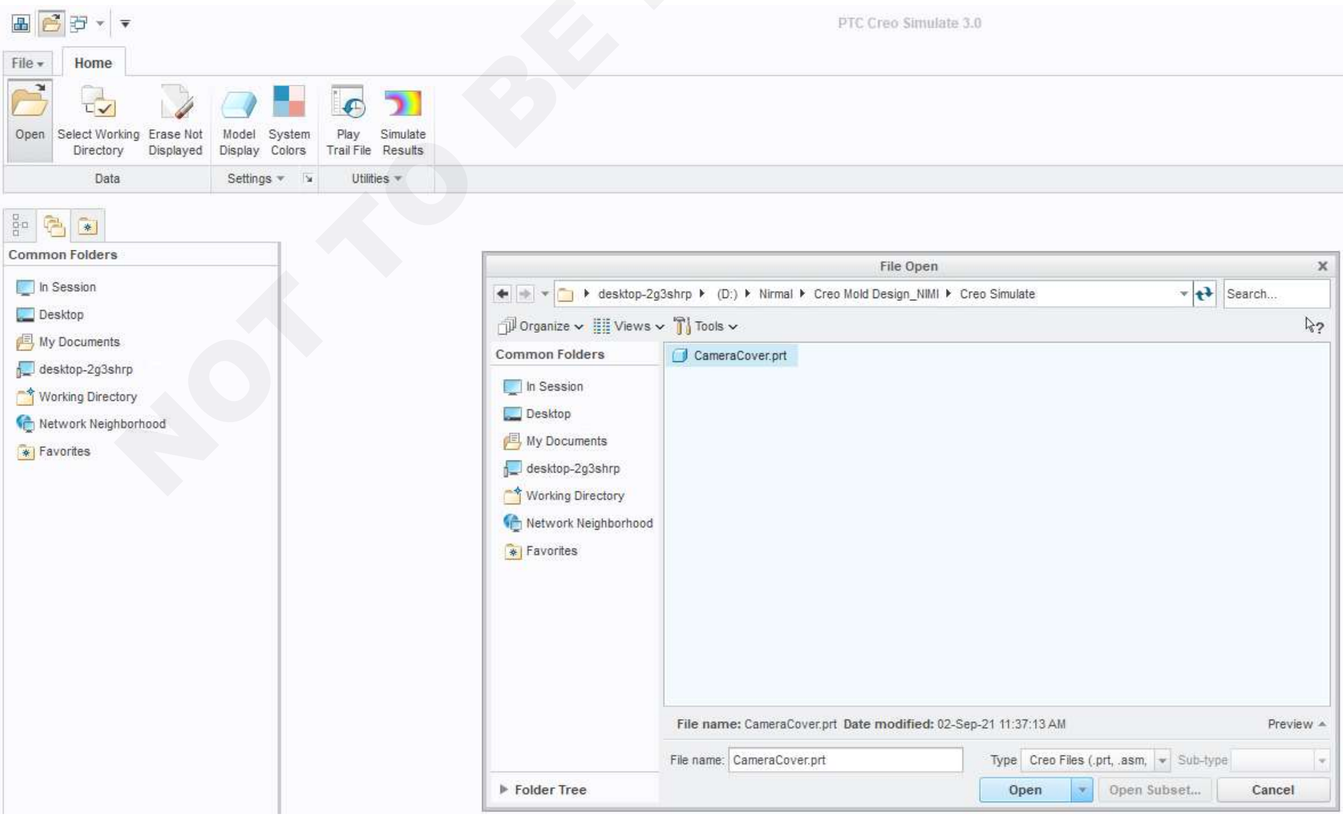
Fig 1



Close the resource centre dialog box.

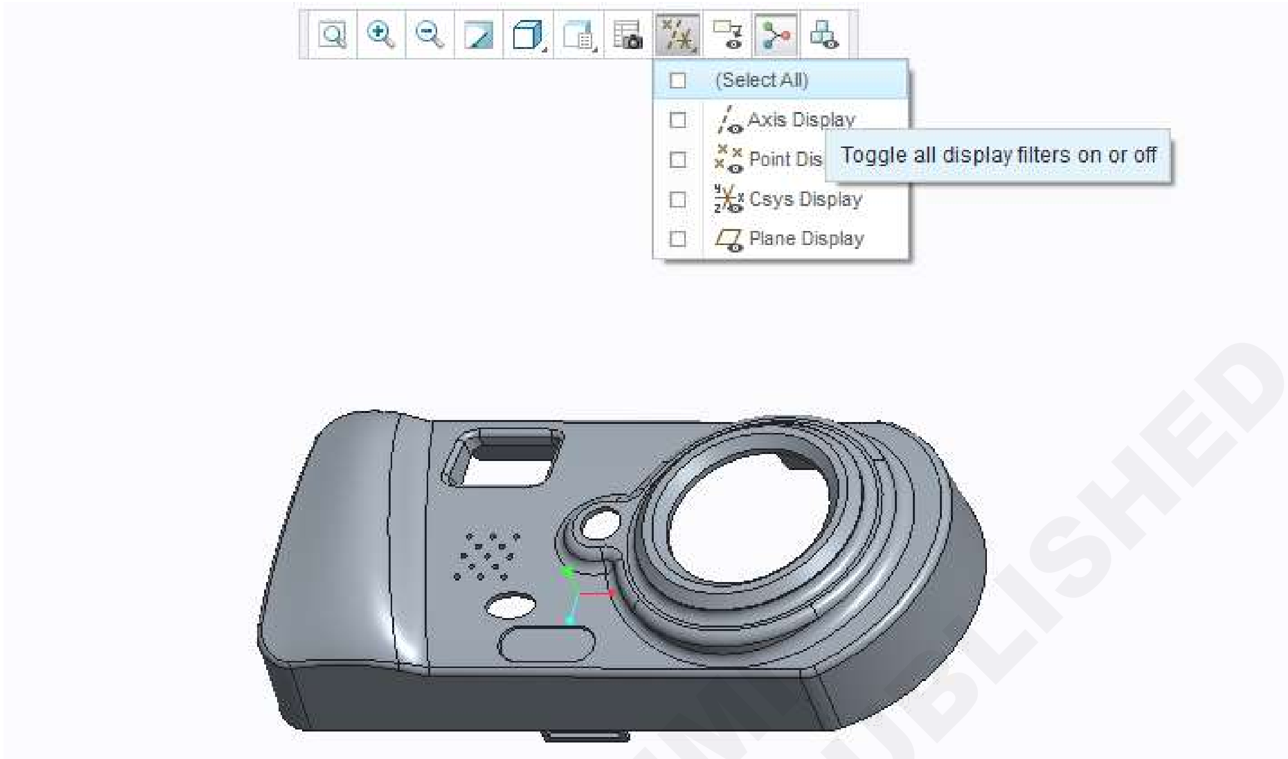
- Select open option from home tab. The directory file opens in which the part to be analysed (simulated) is selected (Camera cover). (Fig 2)

Fig 2



Note: Toggle all display filters ON/OFF for clear view of model. (Fig 3)

Fig 3



- In materials tab select materials then material directory dialog box opens as shown in Fig 4 and Fig 5. Then Select the material (here steel) and press right arrow key  and select ok option.

Fig 4

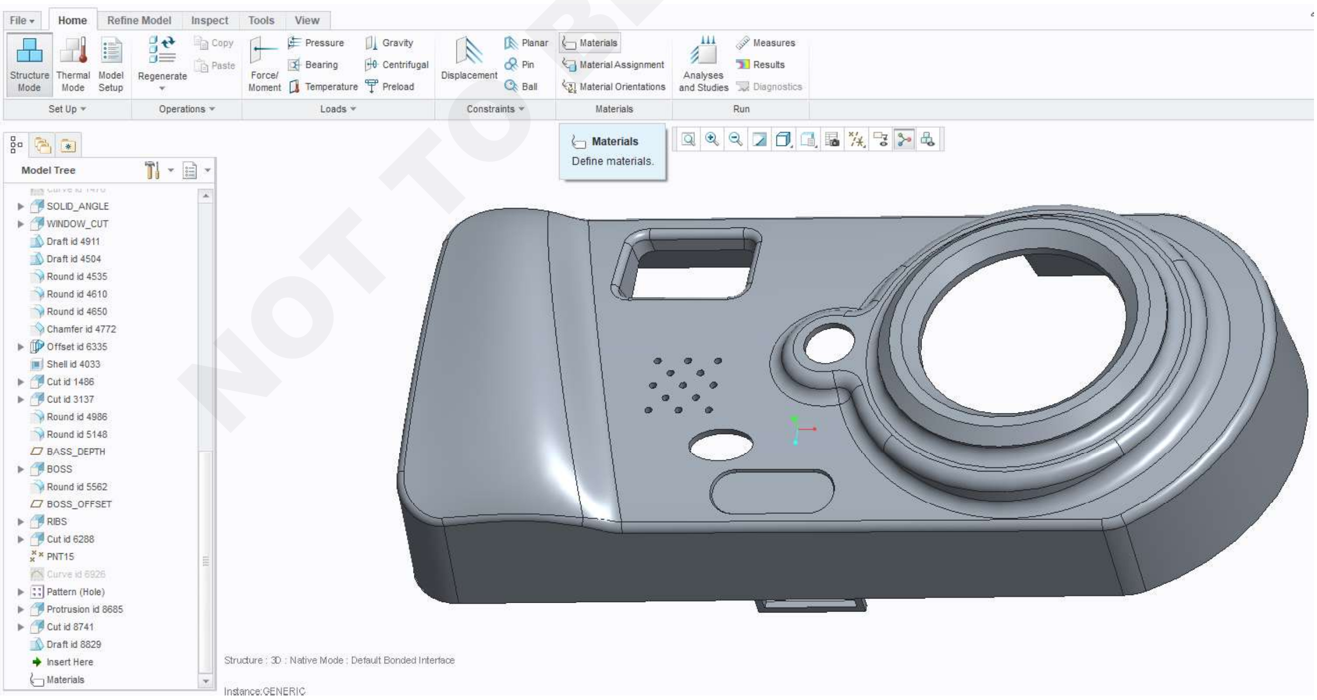
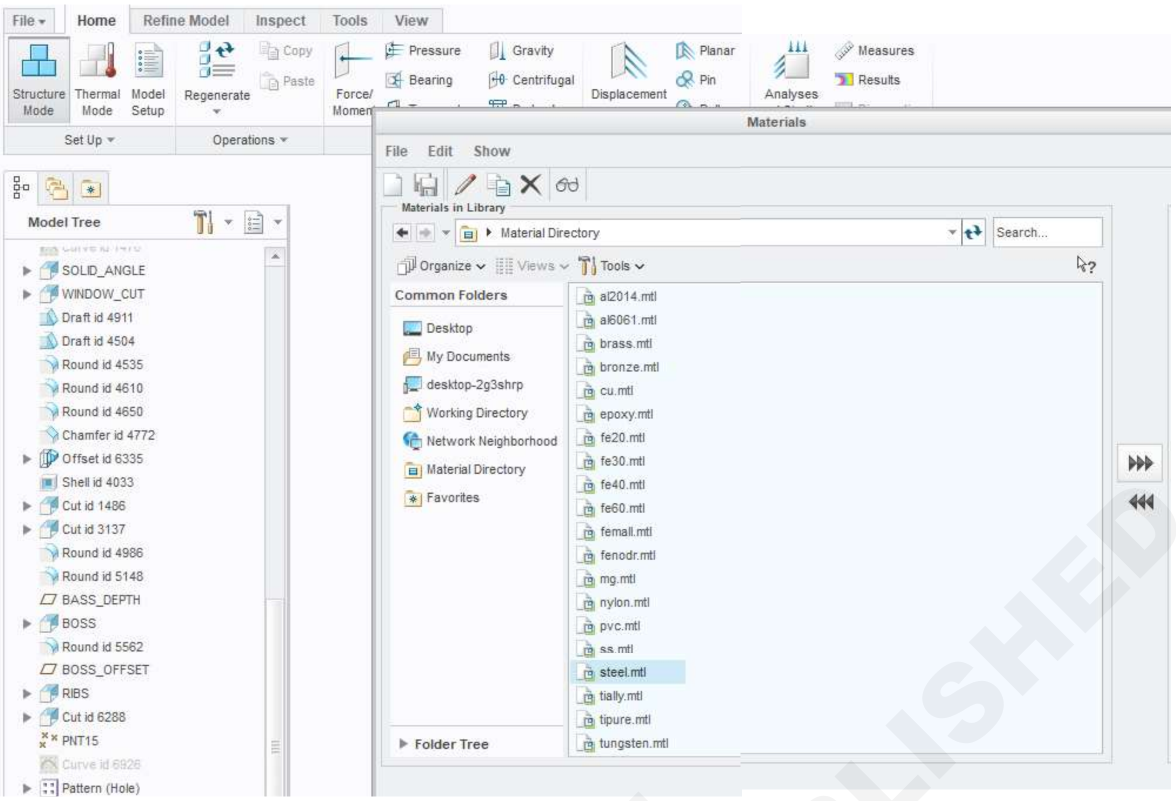


Fig 4



- In constraints tab select displacement, (Fig 6) constraint dialog box opens, under references surface, select the surfaces of camera cover part as shown in Fig 7 and finally select OK option (Fig 8)

Fig 6

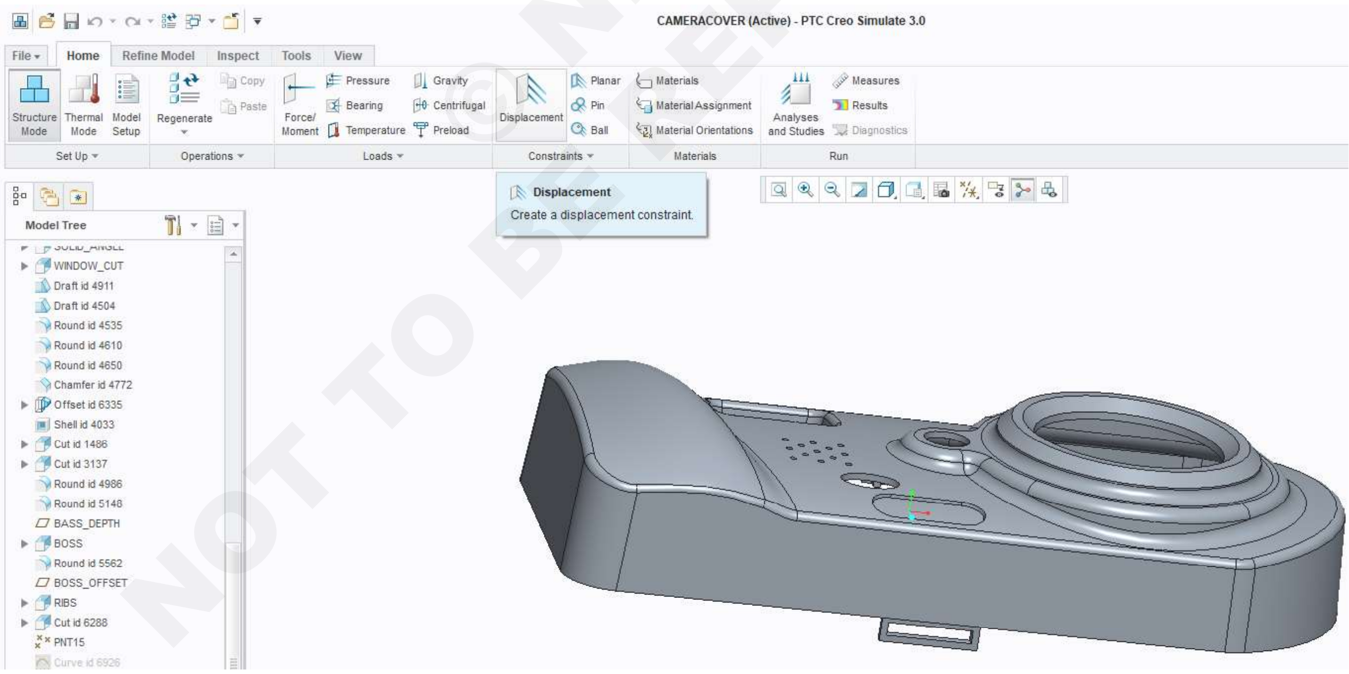


Fig 7

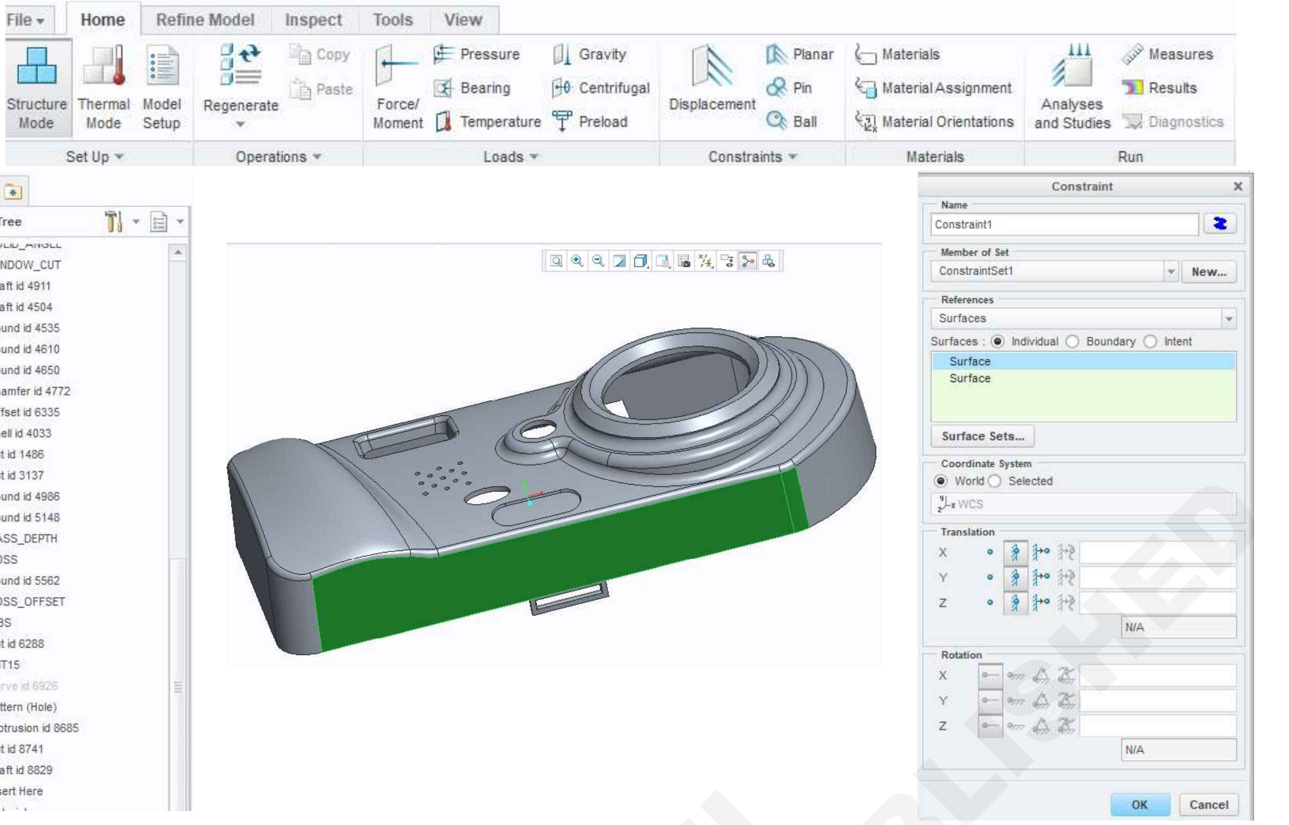
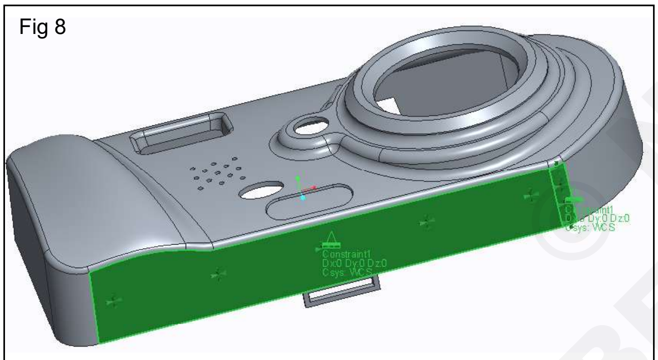
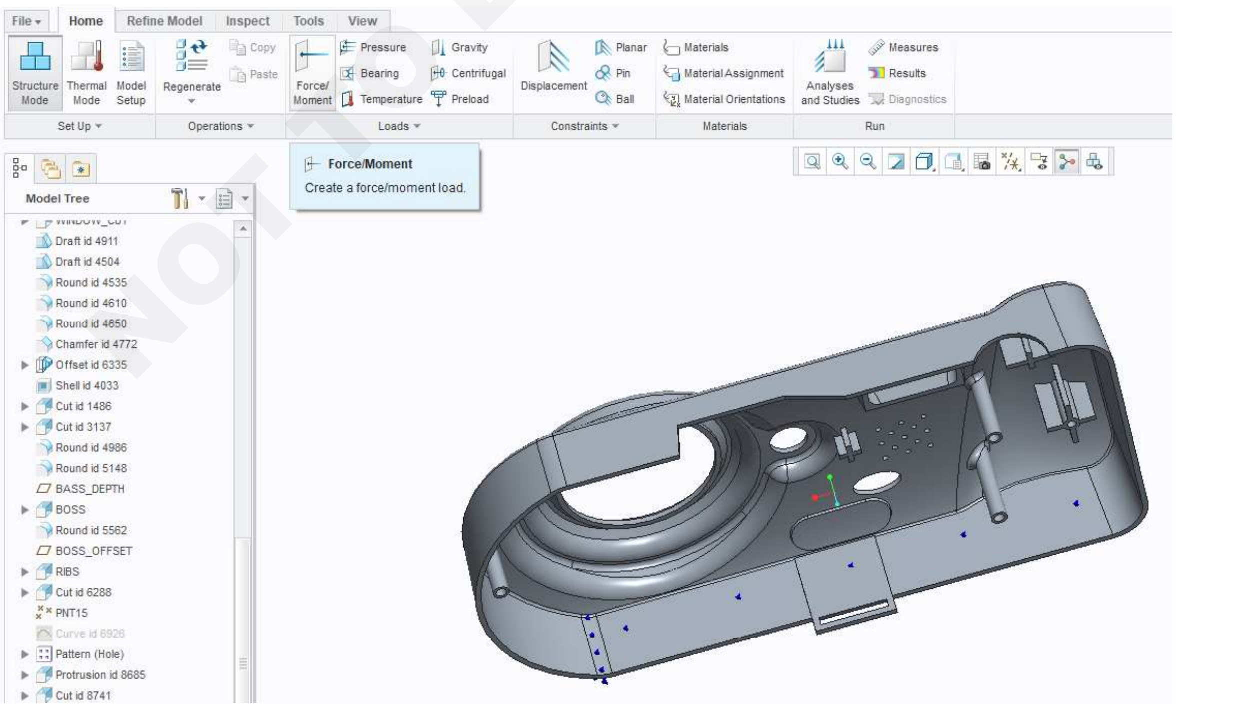


Fig 8



- Next under loads select Force/ moment. (Fig 9)

Fig 9



- Force/moment dialog box appears, under surfaces select the surfaces of the part as shown in Fig 10 Then under force, enter only the 'Z' direction value as

X=0

Y=b

Z=10 Mkg/sec & press preview & finally select OK option. Fig.10,11,12

Fig 10

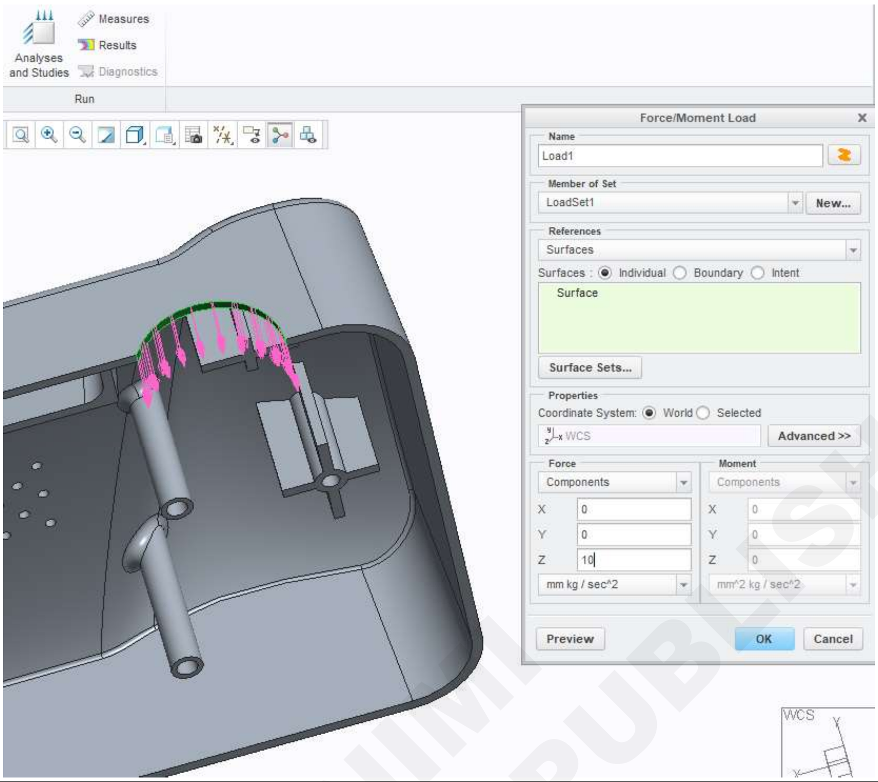


Fig 11

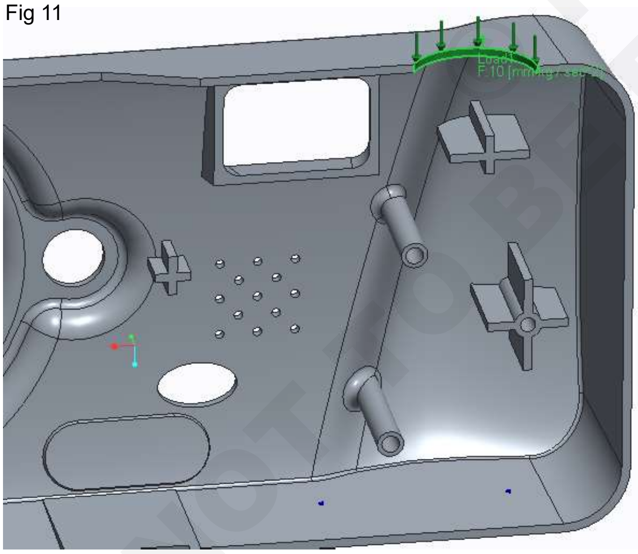
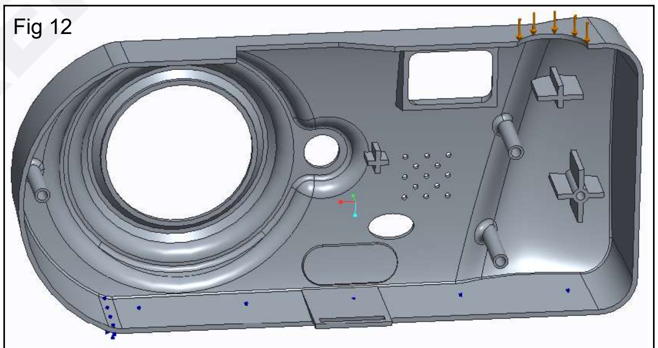


Fig 12



- Next select Home → Loads → Temperature (Fig 13)
- The structure temperature load dialog box appears under surface, select the three surfaces as shown in figure give the value under entity temperature as 10 spatial variations as uniform & click preview to see temperature distribution & click OK button. (Fig 14, 15, 16)

Fig 13

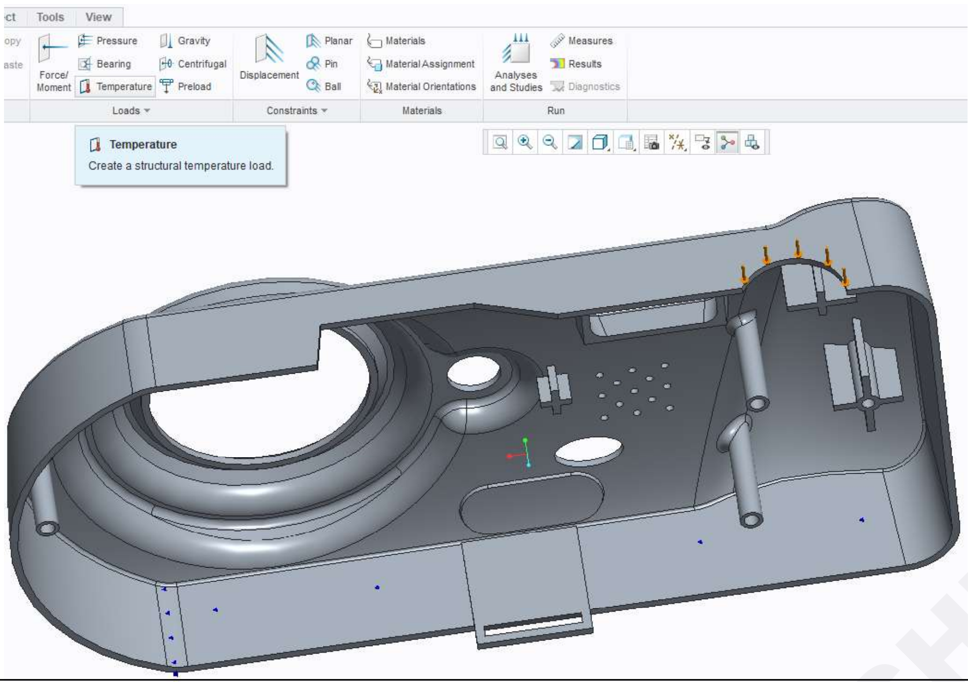


Fig 14

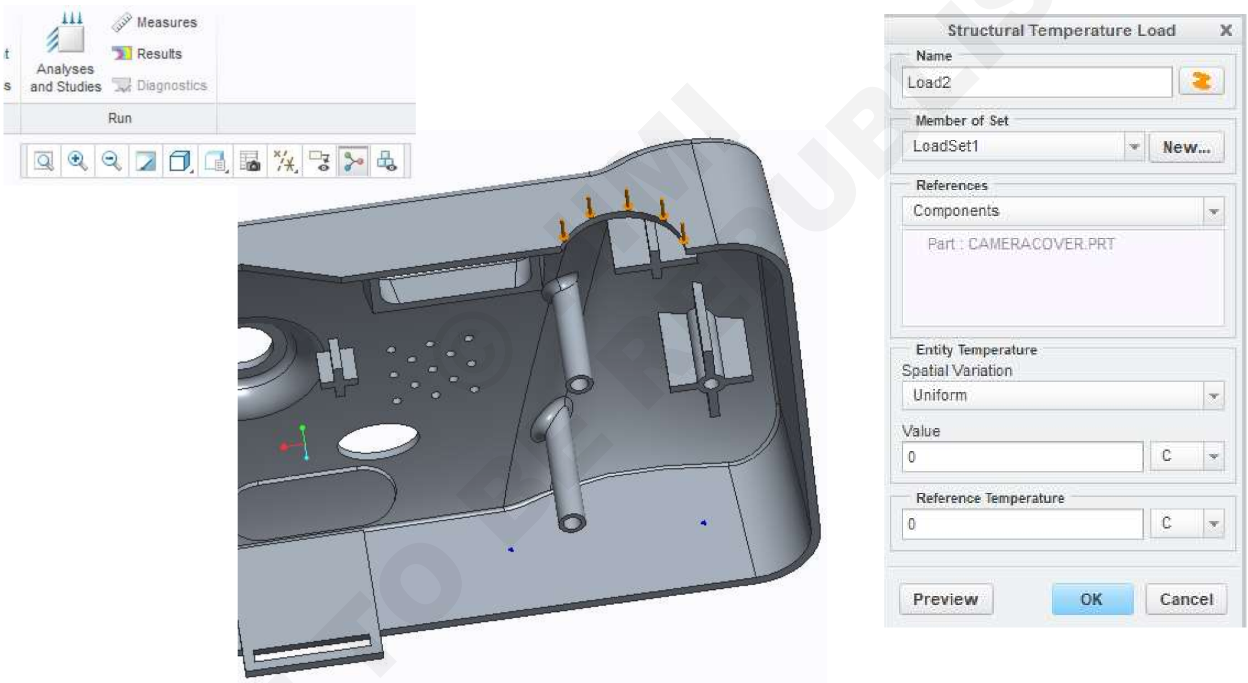


Fig 15

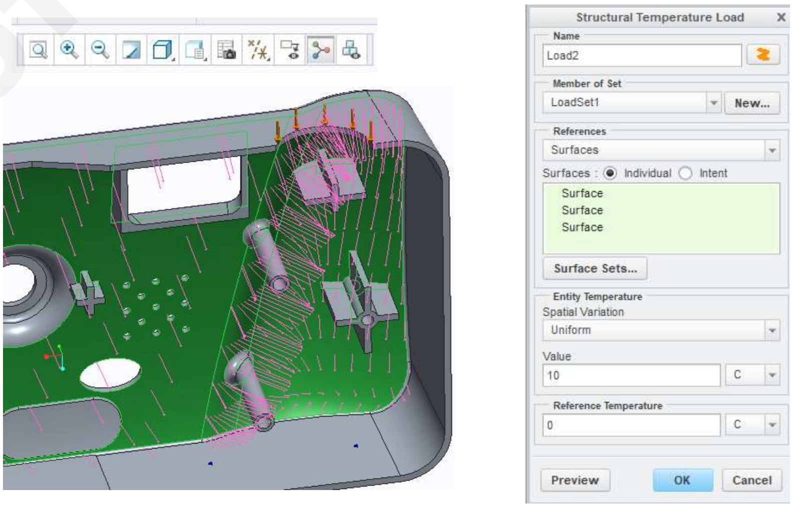
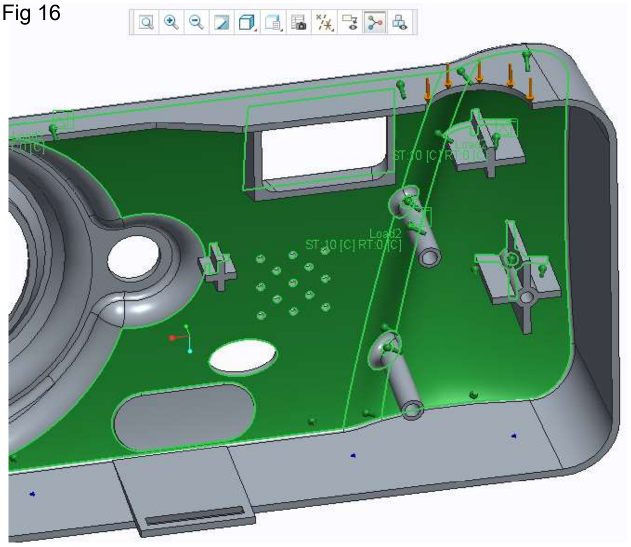


Fig 16



- Now select material assignment in materials tab, material for individual volume and assign steel as material. (Fig 17, 18)

Fig 18

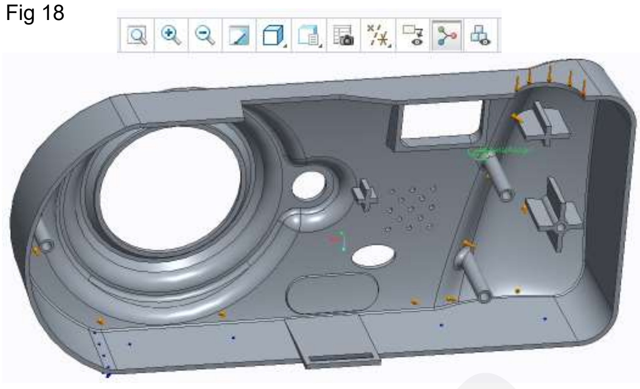
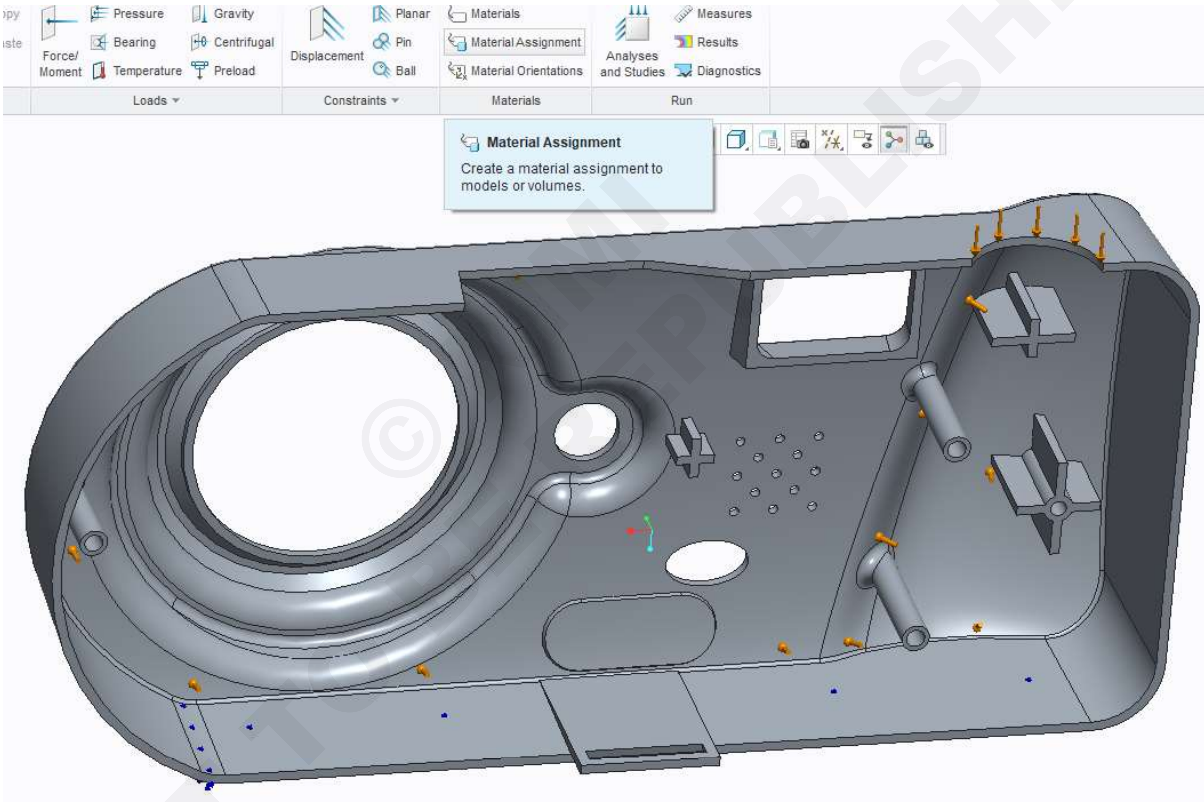


Fig 17



- Select the entire component, go to the refine model in the pallet under AutoGEM tab -> control -> maximum element size control. Fig 19 & 20

- Select the maximum element size control dialog box appears -> Assign mesh element size enter the value as 10 and press ok (Fig 21 & 22)

Fig 19

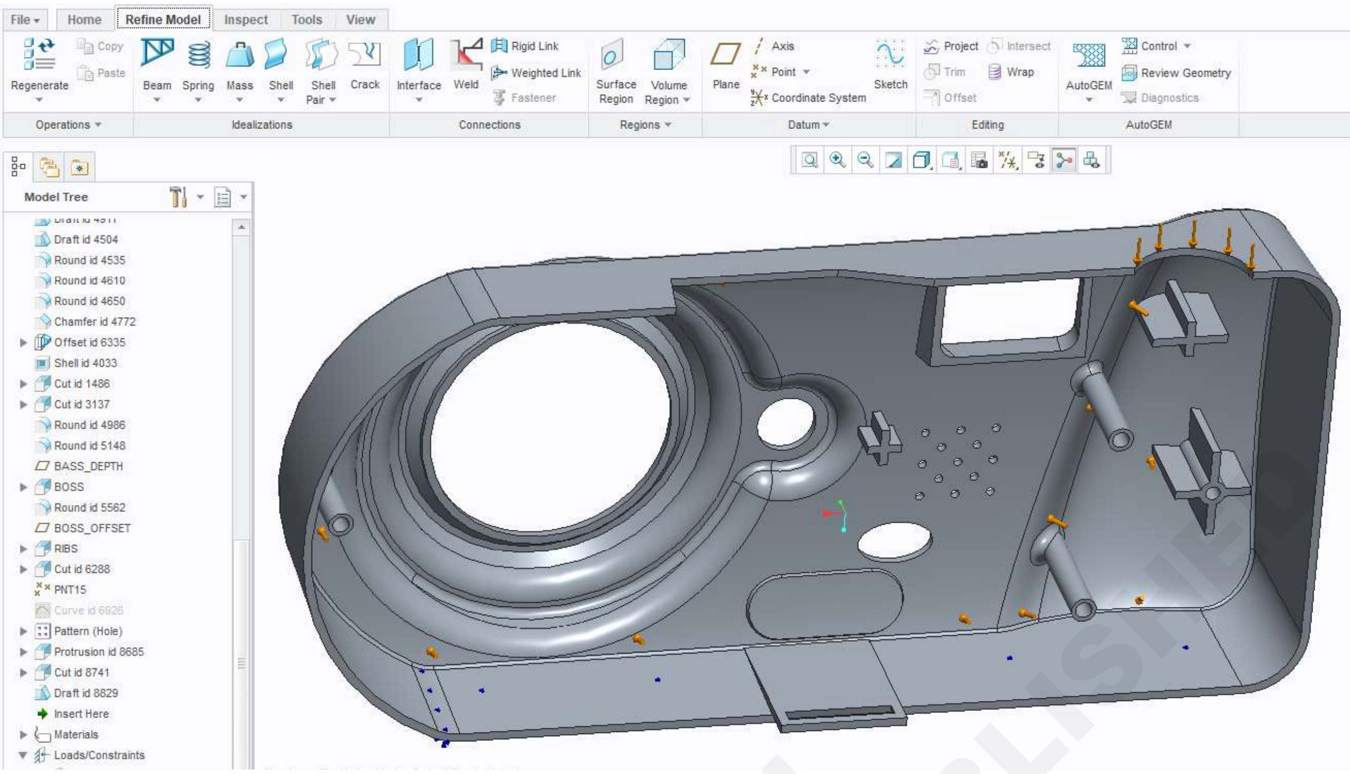

File
Home
Refine Model
Inspect
Tools
View
Regenerate
Copy
Paste
Beam
Spring
Mass
Shell
Shell Pair
Crack
Interface
Weld
Rigid Link
Weighted Link
Fastener
Surface Region
Volume Region
Plane
Axis
Point
Coordinate System
Sketch
Project
Intersect
Trim
Wrap
Offset
AutoGEM
Control
Review Geometry
Diagnostics
Operations
Idealizations
Connections
Regions
Datum
Editing
AutoGEM
Model Tree
Draft id 4504
Round id 4535
Round id 4610
Round id 4650
Chamfer id 4772
Offset id 6335
Shell id 4033
Cut id 1486
Cut id 3137
Round id 4986
Round id 5148
BASS_DEPTH
BOSS
Round id 5562
BOSS_OFFSET
RIBS
Cut id 6288
PNT15
Curve id 6926
Pattern (Hole)
Protrusion id 8685
Cut id 8741
Draft id 8829
Insert Here
Materials
Loads/Constraints

Fig 20

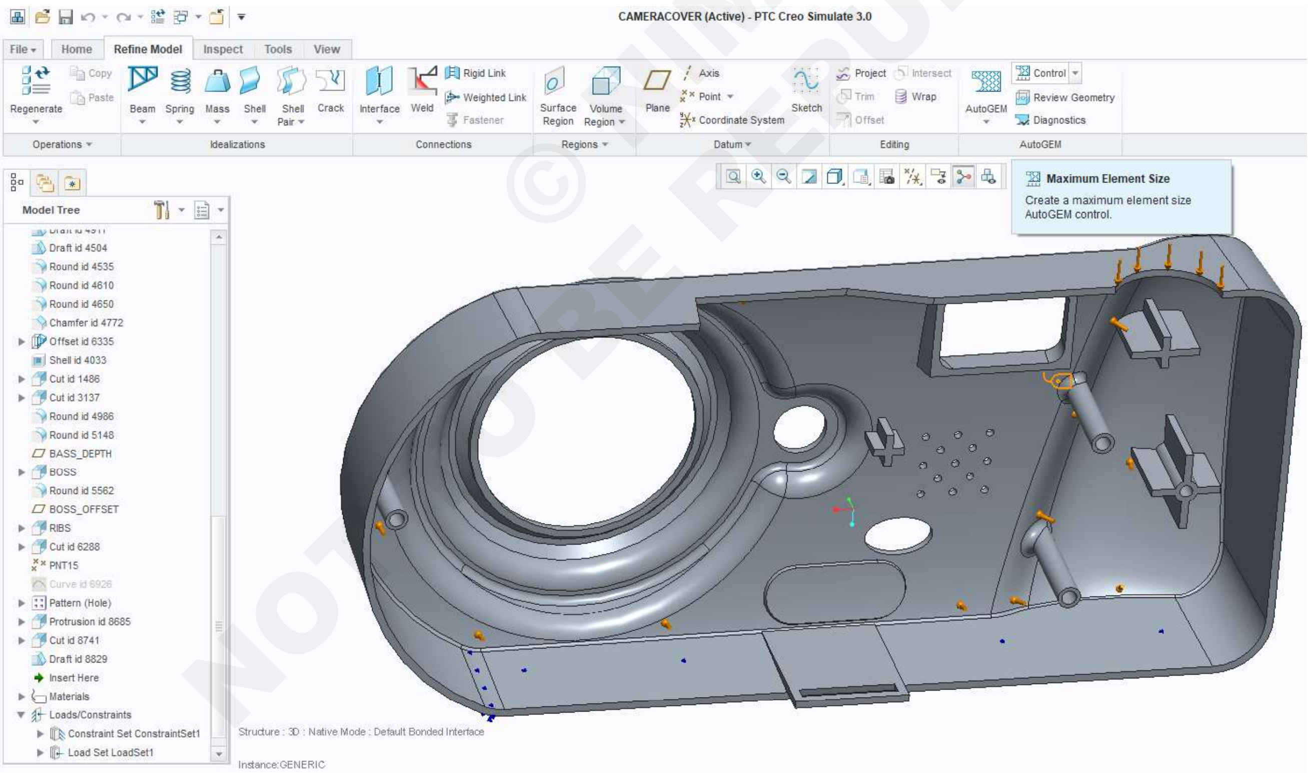

CAMERACOVER (Active) - PTC Creo Simulate 3.0
File
Home
Refine Model
Inspect
Tools
View
Regenerate
Copy
Paste
Beam
Spring
Mass
Shell
Shell Pair
Crack
Interface
Weld
Rigid Link
Weighted Link
Fastener
Surface Region
Volume Region
Plane
Axis
Point
Coordinate System
Sketch
Project
Intersect
Trim
Wrap
Offset
AutoGEM
Control
Review Geometry
Diagnostics
Operations
Idealizations
Connections
Regions
Datum
Editing
AutoGEM
Maximum Element Size
Create a maximum element size AutoGEM control.
Model Tree
Draft id 4504
Round id 4535
Round id 4610
Round id 4650
Chamfer id 4772
Offset id 6335
Shell id 4033
Cut id 1486
Cut id 3137
Round id 4986
Round id 5148
BASS_DEPTH
BOSS
Round id 5562
BOSS_OFFSET
RIBS
Cut id 6288
PNT15
Curve id 6926
Pattern (Hole)
Protrusion id 8685
Cut id 8741
Draft id 8829
Insert Here
Materials
Loads/Constraints
Constraint Set ConstraintSet1
Load Set LoadSet1
Structure : 3D : Native Mode : Default Bonded Interface
Instance:GENERIC

Fig 21

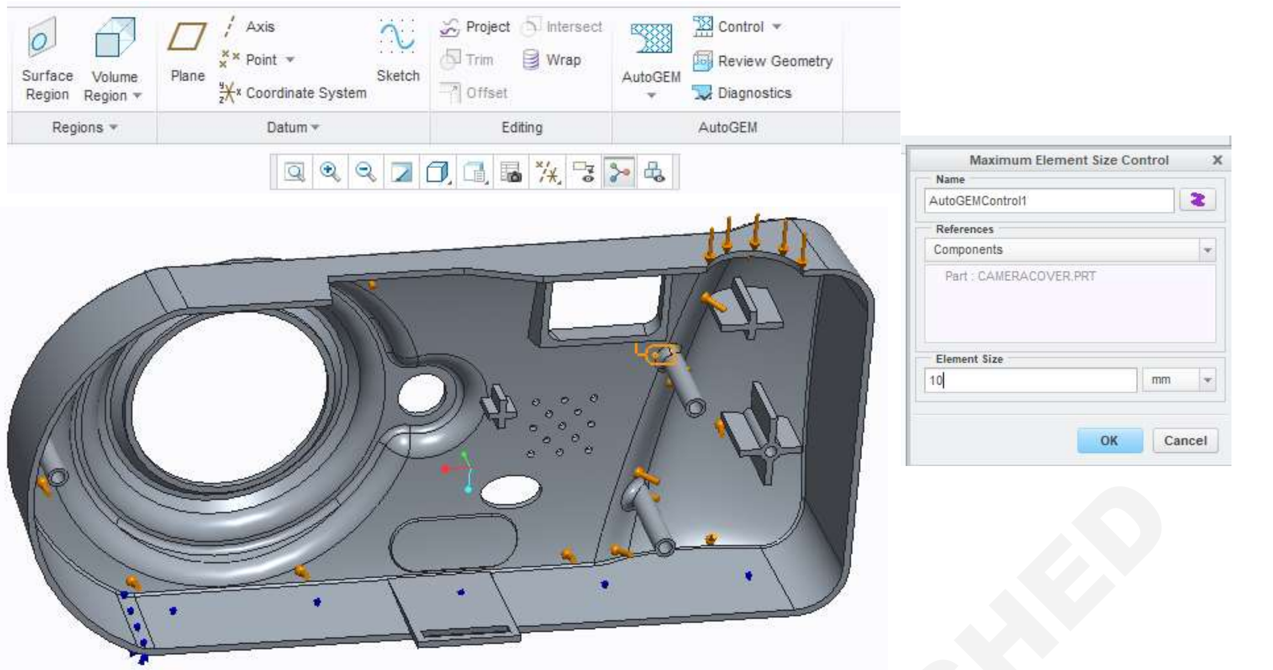
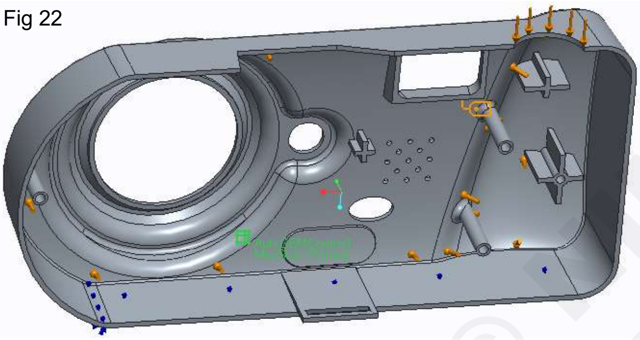


Fig 22



- Go to AutoGEM, in AutoGEM dialog box under AutoGEM References select All with properties -> create -> Entire component is shown with mesh elements) -> Auto Gem summary dialog box appears. Select close option. (Fig 23, 24, 25, 26)

Fig 23

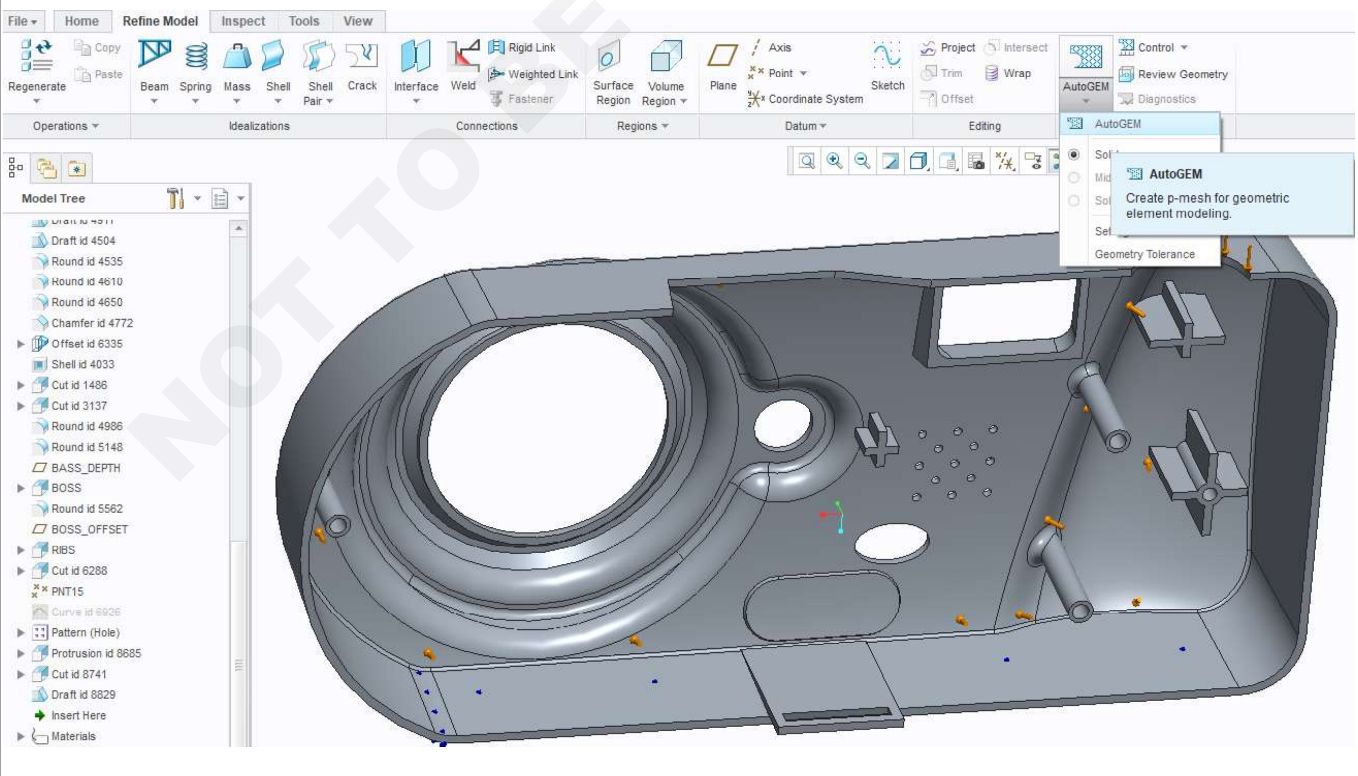


Fig 24

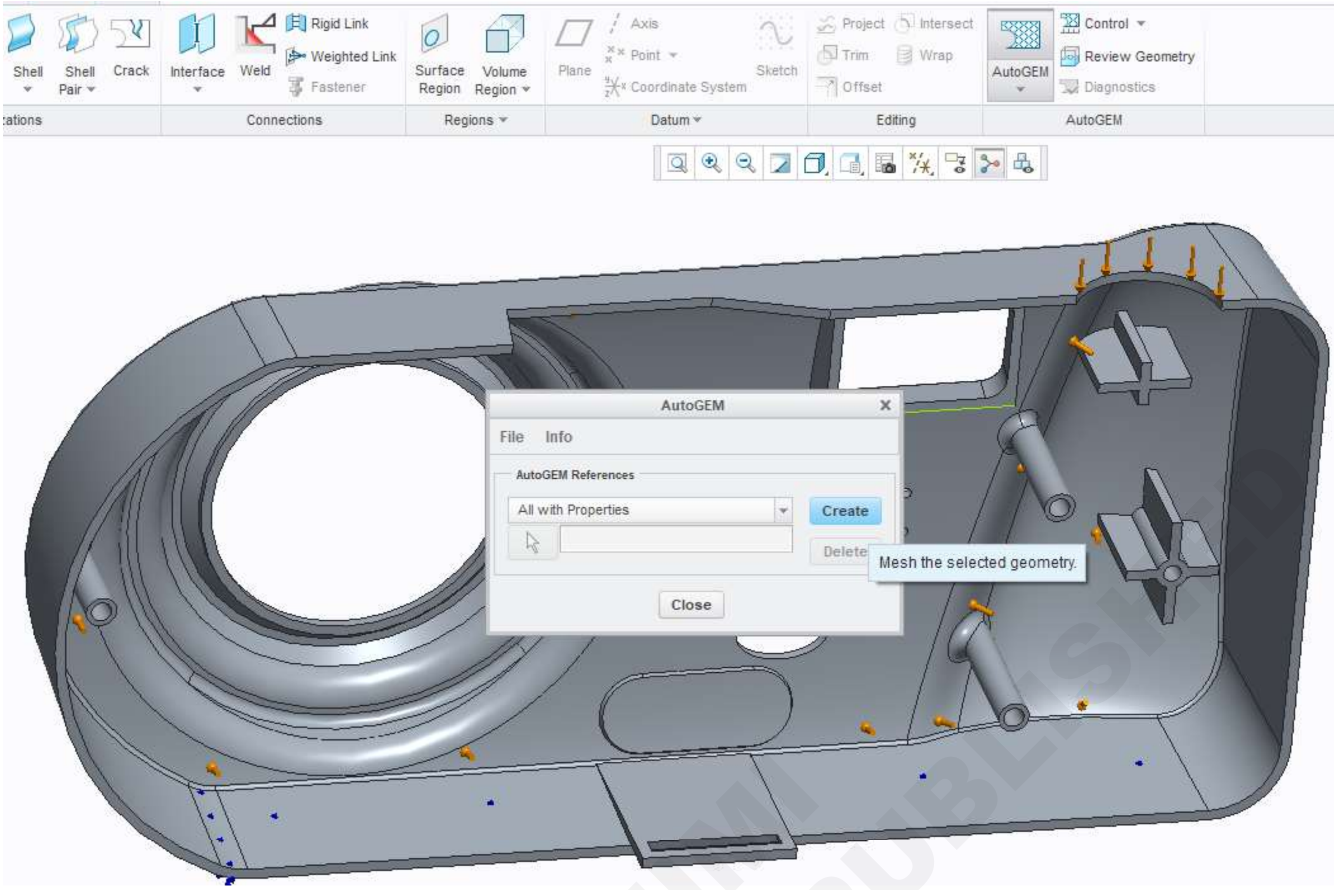
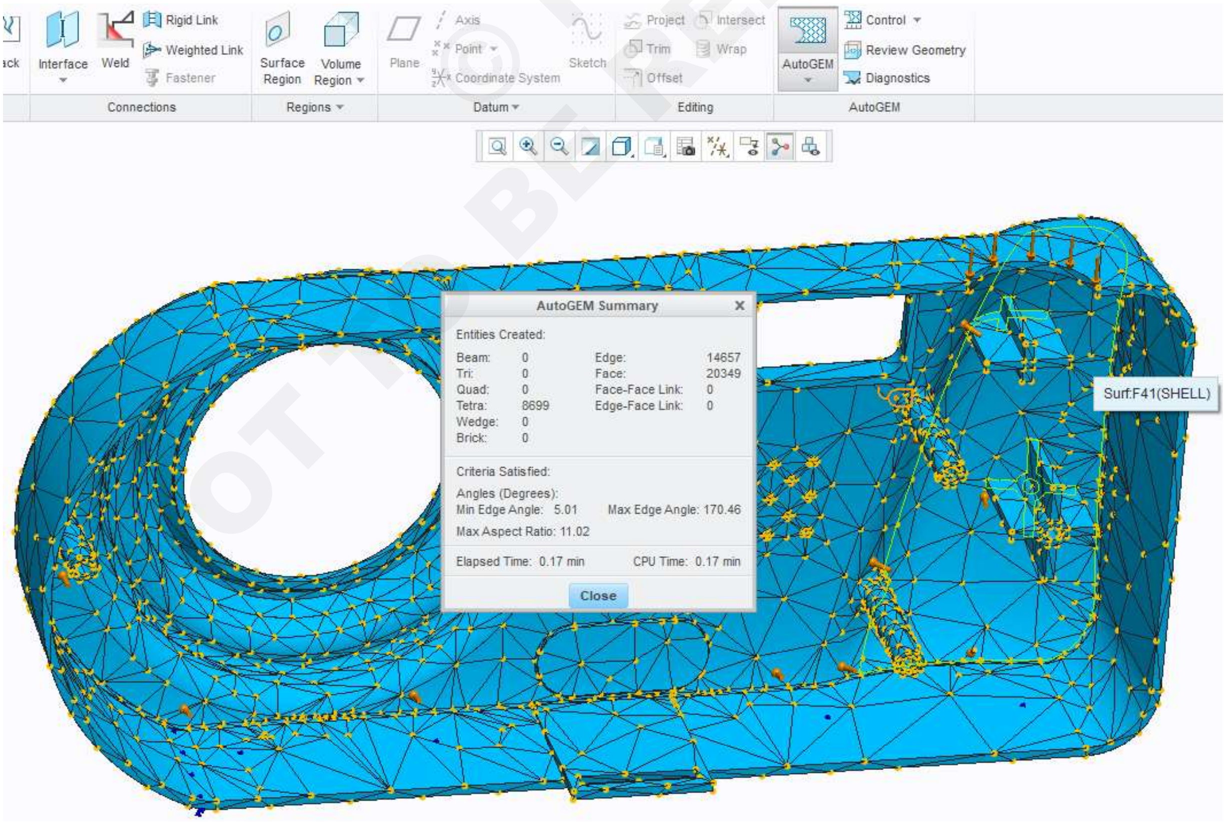

Shell
Shell Pair
Crack
Interface
Weld
Rigid Link
Weighted Link
Fastener
Surface Region
Volume Region
Plane
Axis
Point
Coordinate System
Sketch
Project
Intersect
Trim
Wrap
Offset
AutoGEM
Control
Review Geometry
Diagnostics
Connections
Regions
Datum
Editing
AutoGEM
AutoGEM
File
Info
AutoGEM References
All with Properties
Create
Delete
Mesh the selected geometry.
Close

Fig 25


Interface
Weld
Rigid Link
Weighted Link
Fastener
Surface Region
Volume Region
Plane
Axis
Point
Coordinate System
Sketch
Project
Intersect
Trim
Wrap
Offset
AutoGEM
Control
Review Geometry
Diagnostics
Connections
Regions
Datum
Editing
AutoGEM
AutoGEM Summary
Entities Created:
Beam: 0
Tri: 0
Quad: 0
Tetra: 8699
Wedge: 0
Brick: 0
Edge: 14657
Face: 20349
Face-Face Link: 0
Edge-Face Link: 0
Criteria Satisfied:
Angles (Degrees):
Min Edge Angle: 5.01
Max Edge Angle: 170.46
Max Aspect Ratio: 11.02
Elapsed Time: 0.17 min
CPU Time: 0.17 min
Close
Surf:F41(SHELL)

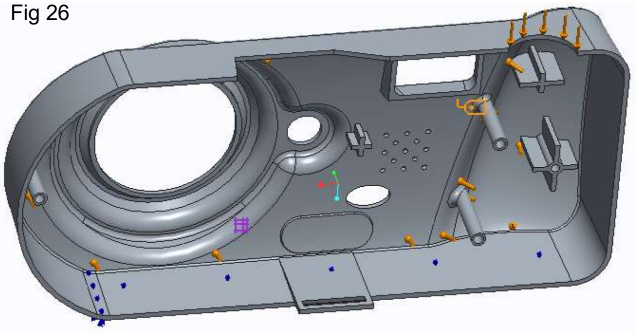


Fig 26

- Go to home in Pallet and select Analysis and studies. Analysis and design studies dialog box appears.
- In analysis & Design studies select file -> New static analysis static analysis definition -> give names as analysis 1 -> Tick constraint set 1/ Camera cover & load set 1/ Camera cover & select OK option. (Fig 27, 28)

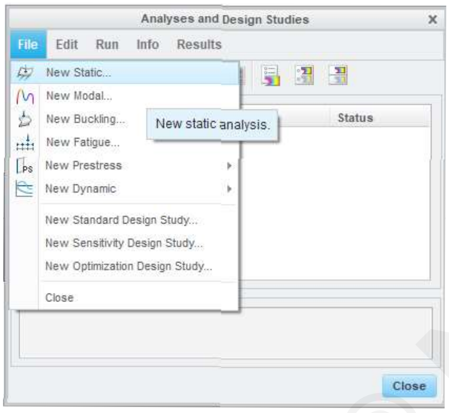


Fig 27

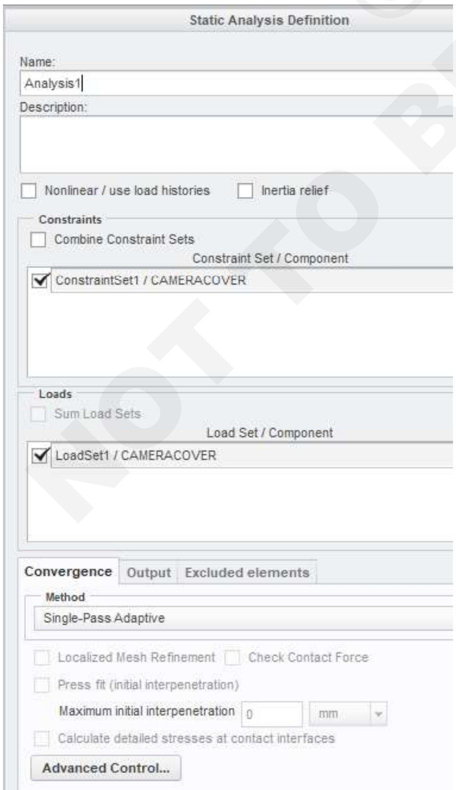


Fig 28

- Once again it comes back to analysis & design studies in that select start run (Green colour flag) icon wait for the status to complete. (Fig 29)

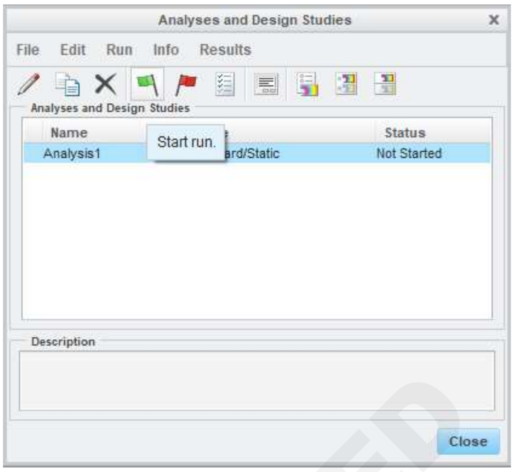


Fig 29

- Check the diagnostics & press close. (Fig 30, 31, 32)

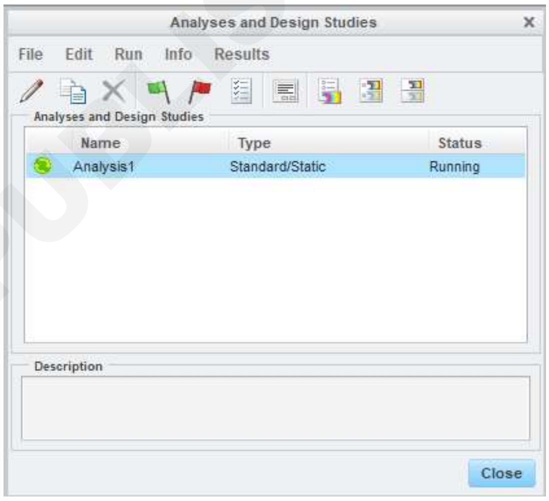


Fig 30

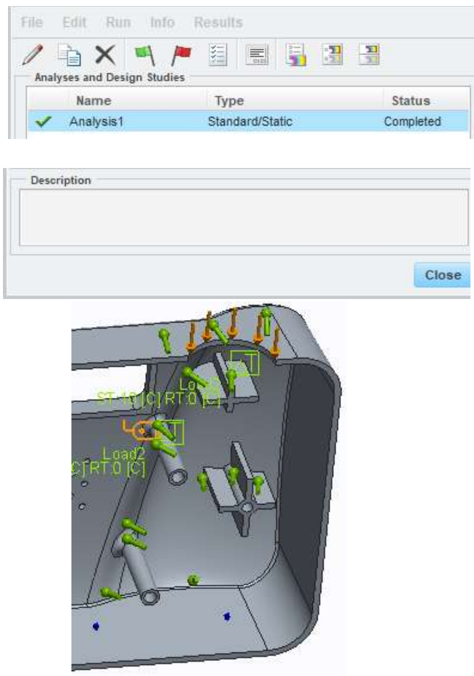
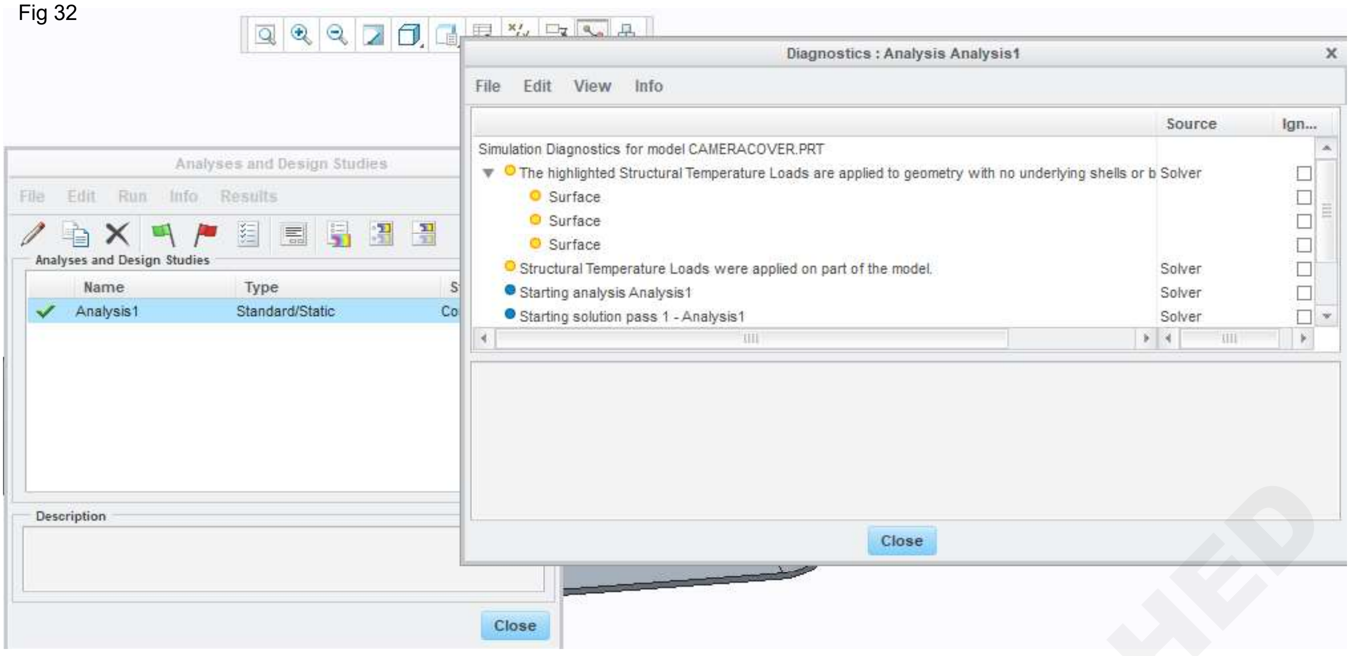


Fig 31

Fig 32



- Once the meshing and analysis in done, go to review result for the given FEA model shown in Fig 33
- Result window definition dialog box appears name it as window1.

Display type as fringe, quantity as stress kpa.

Component – Von mises click (OK and show) button. (Fig 34)

Fig 33

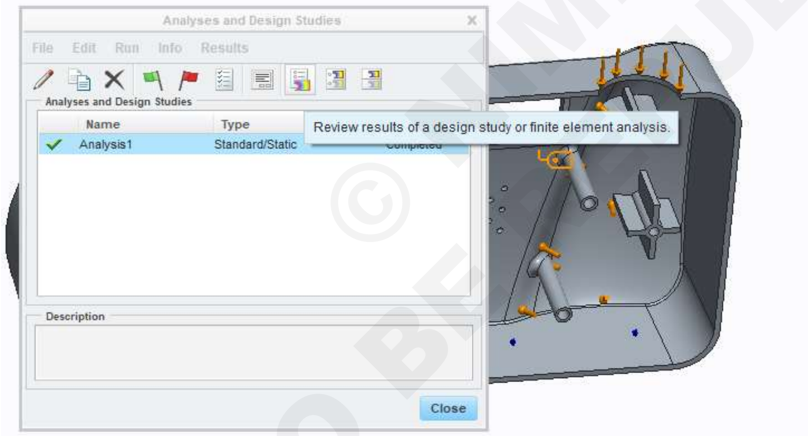
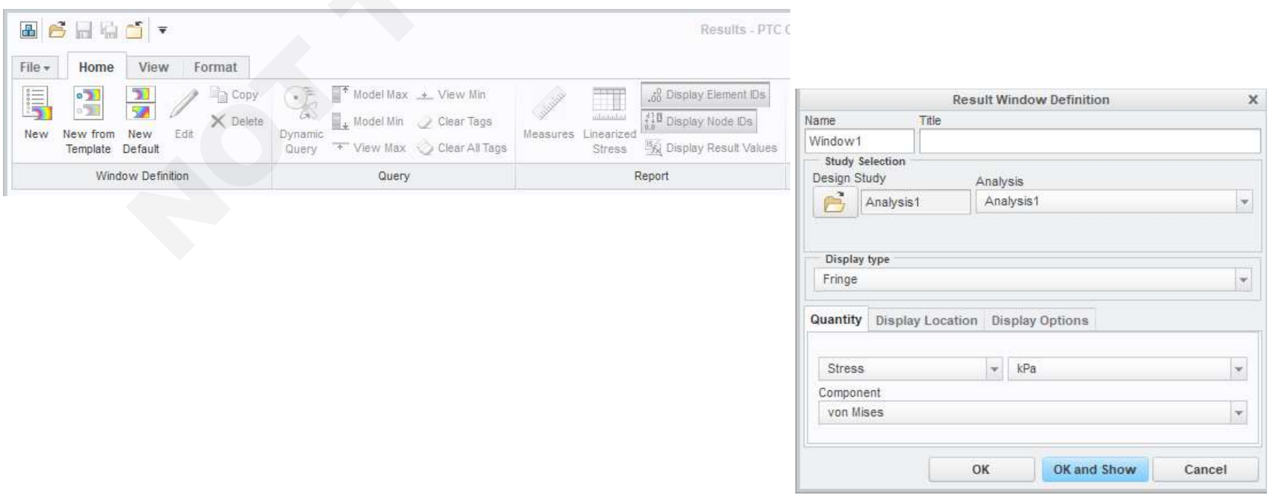


Fig 34



- New window called Results – PTC creo simulate opens. (Fig 35). In that following analyse result charts are shown.
- Select analyse result for -> Stress -> Von mises (WCS) the chart is displayed in the window. (Fig 36)

Fig 35

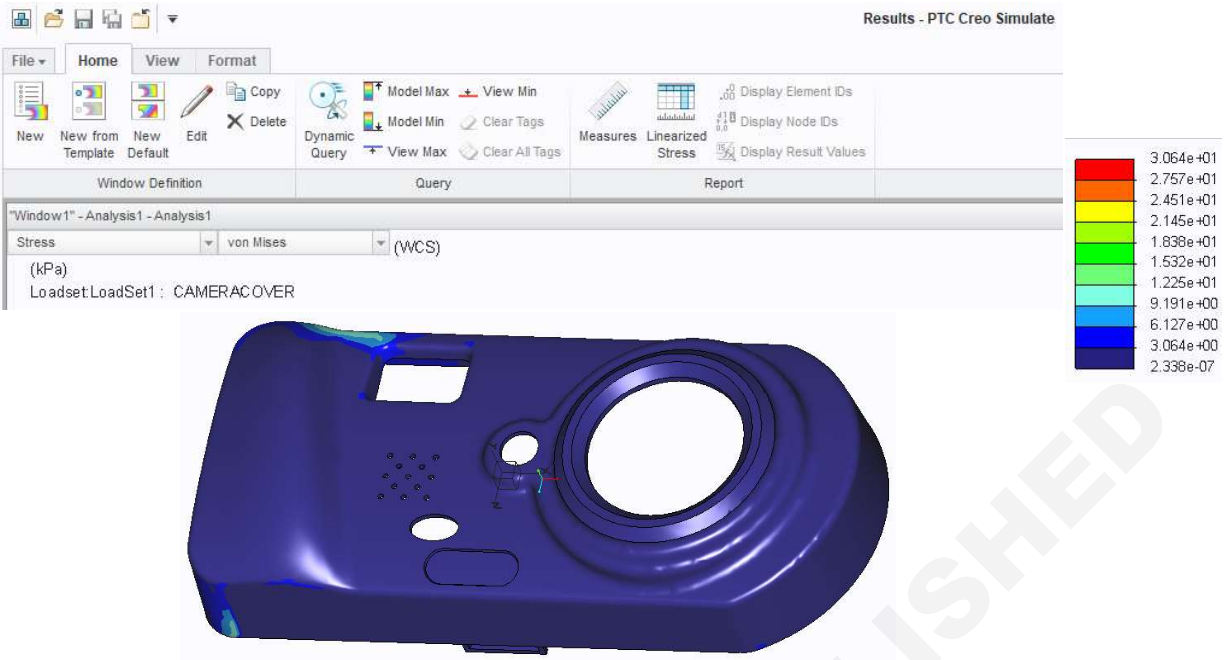
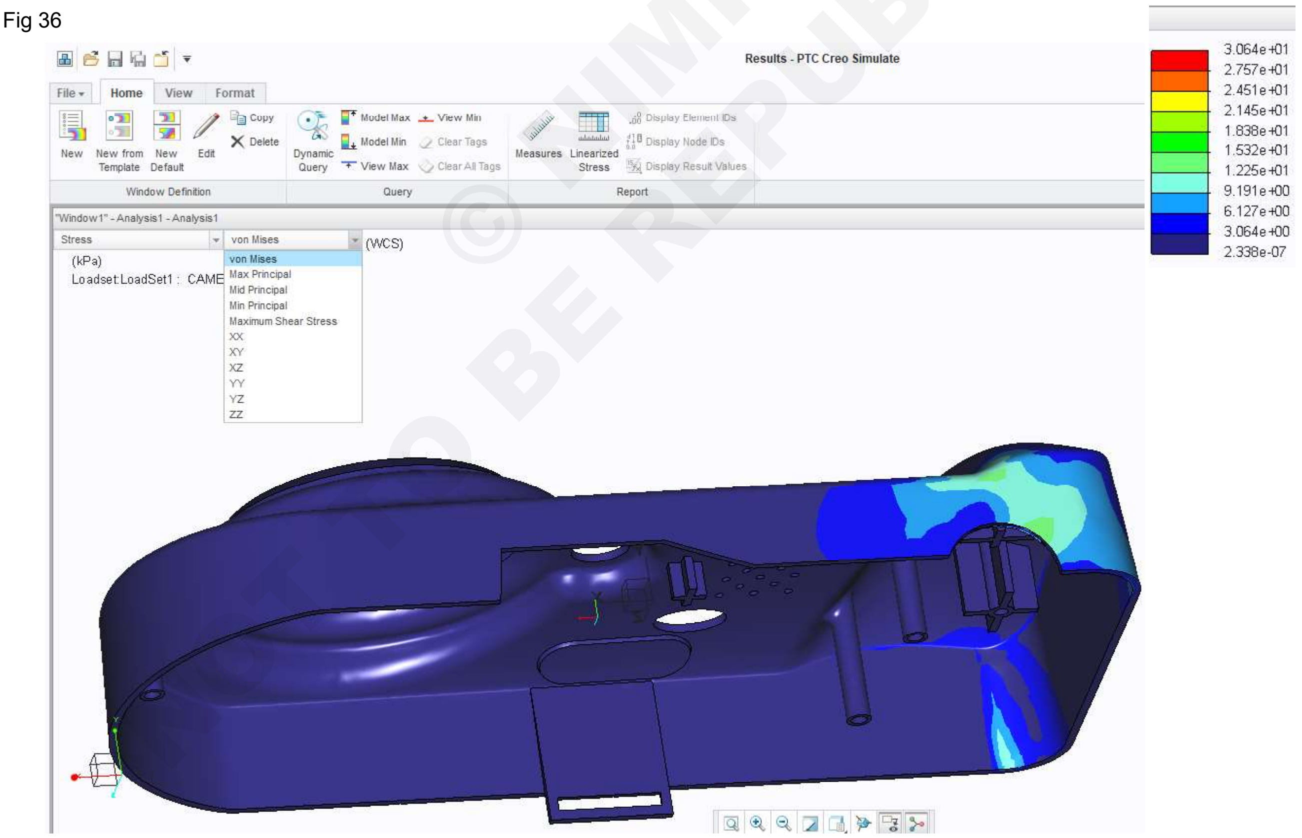
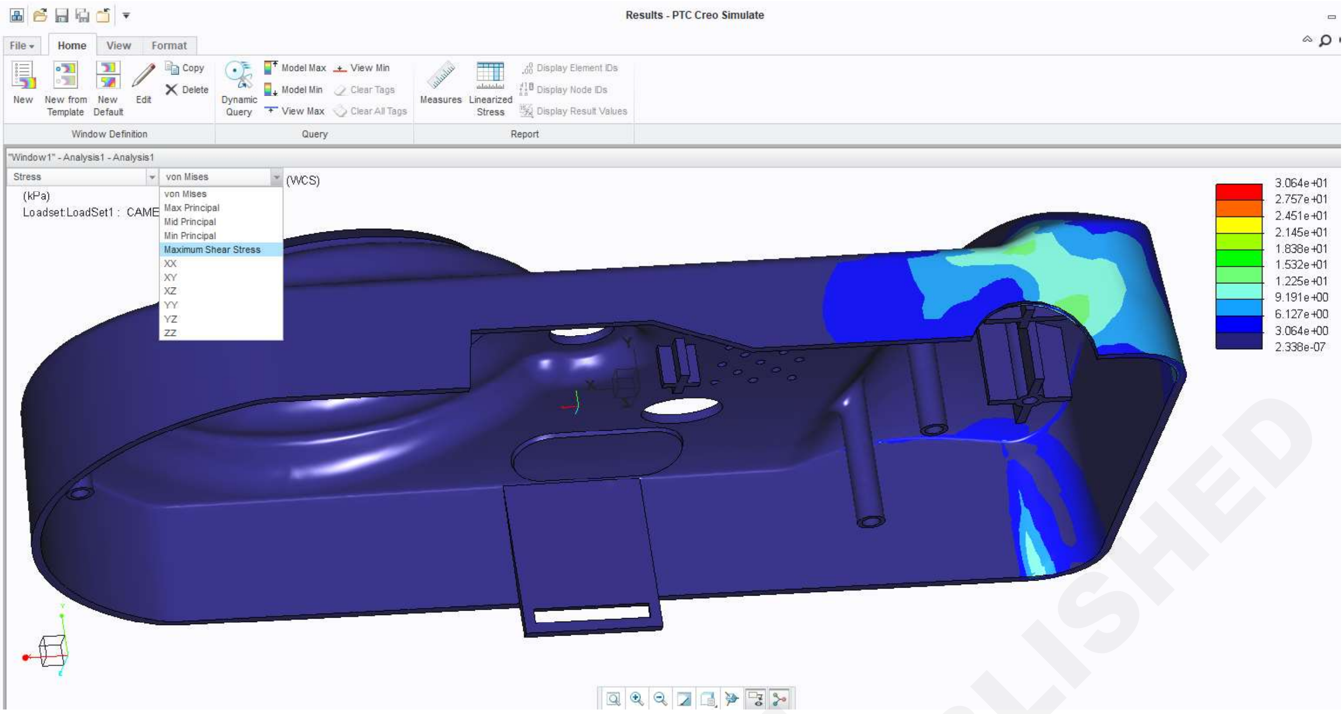


Fig 36



- Maximum shear stress chart. (Fig 37)

Fig 37



- Mid principle chart is shown in Fig 38 & 39.

Fig 38

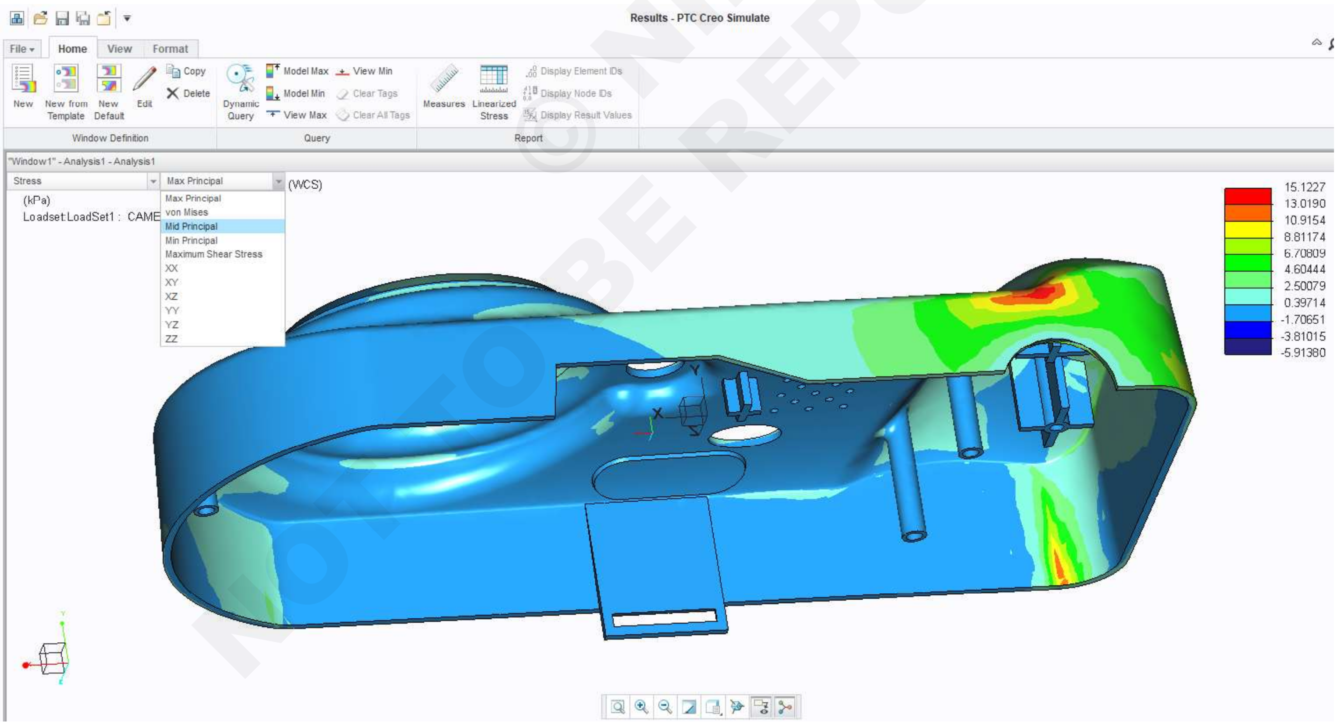
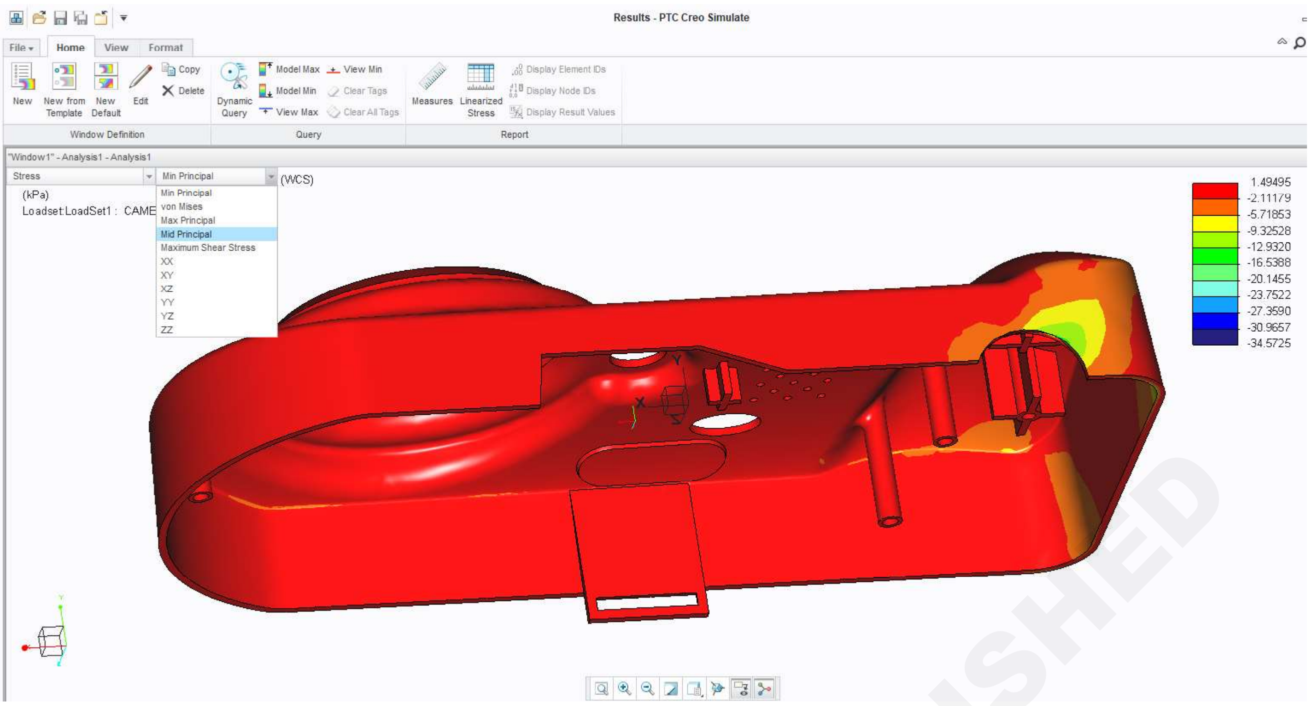


Fig 39



- Displacement -> Magnitude chart is shown in Fig 40, 41, 42, 43.

Fig 40

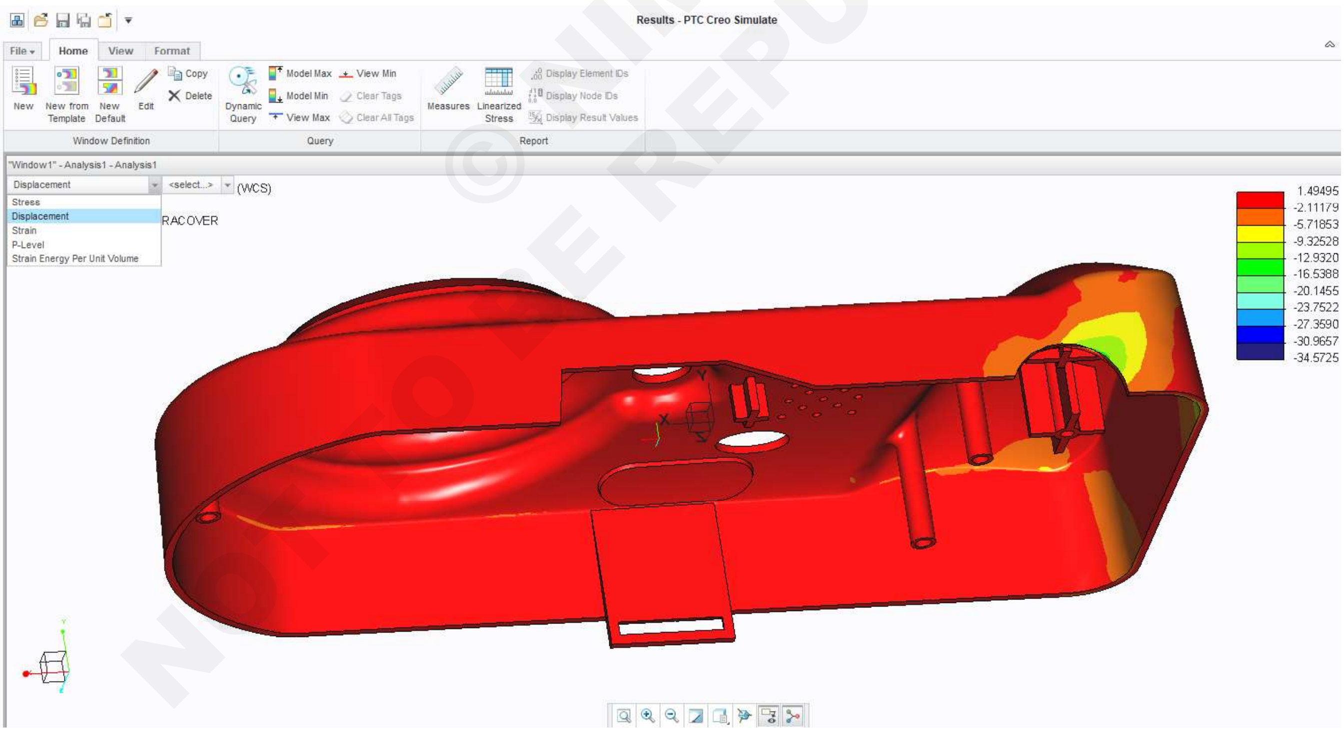
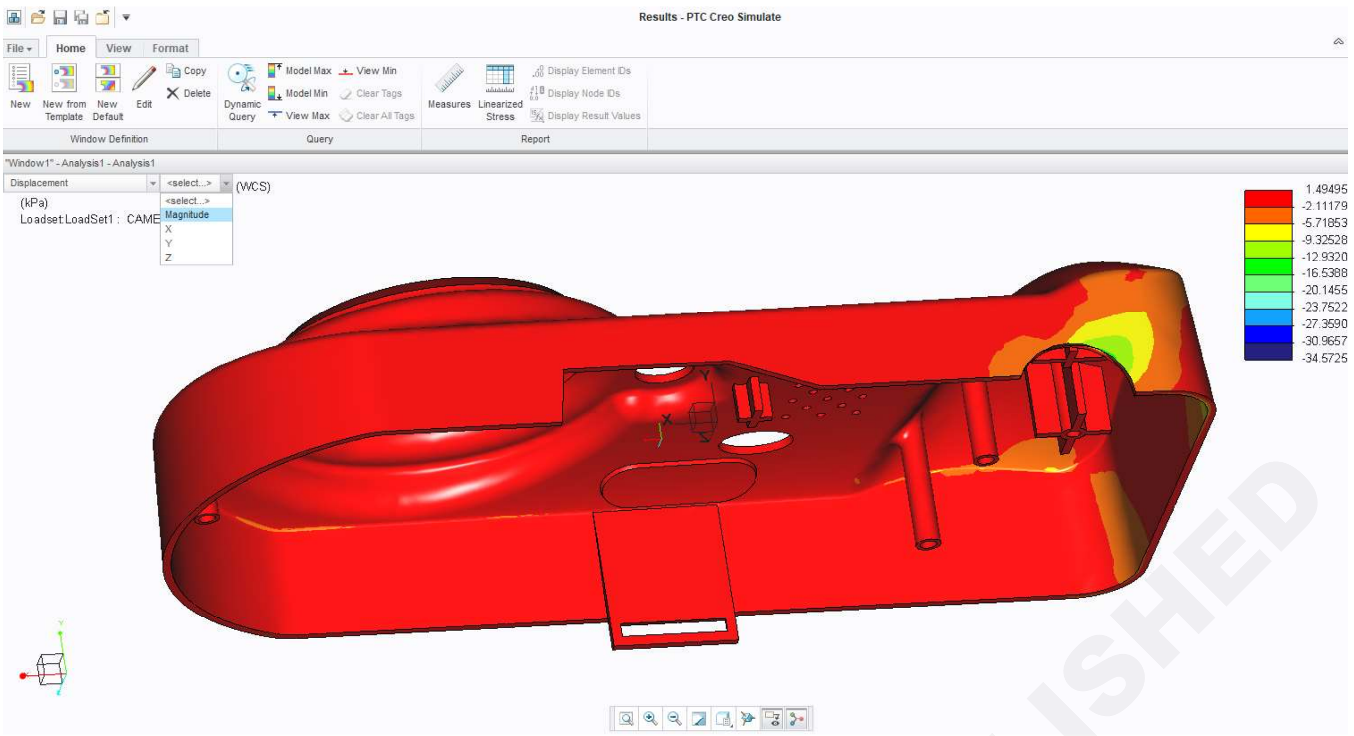
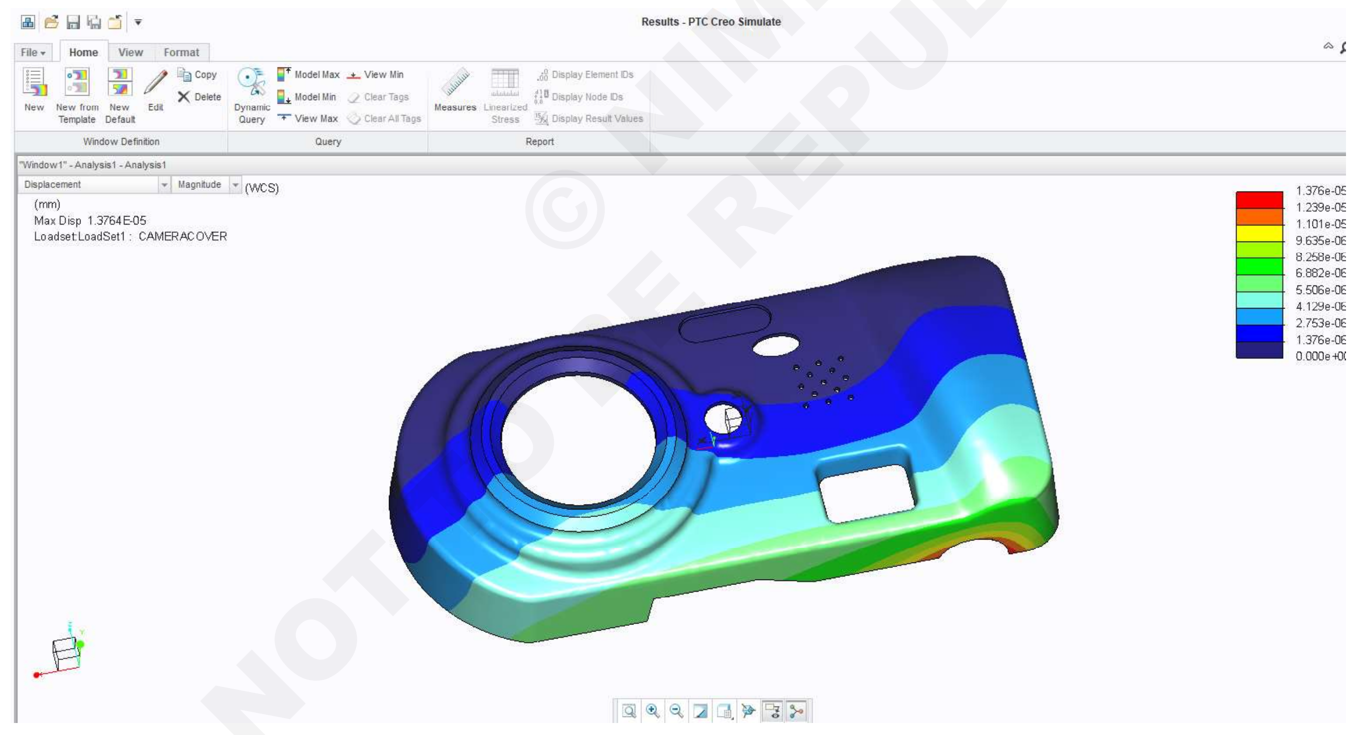


Fig 41



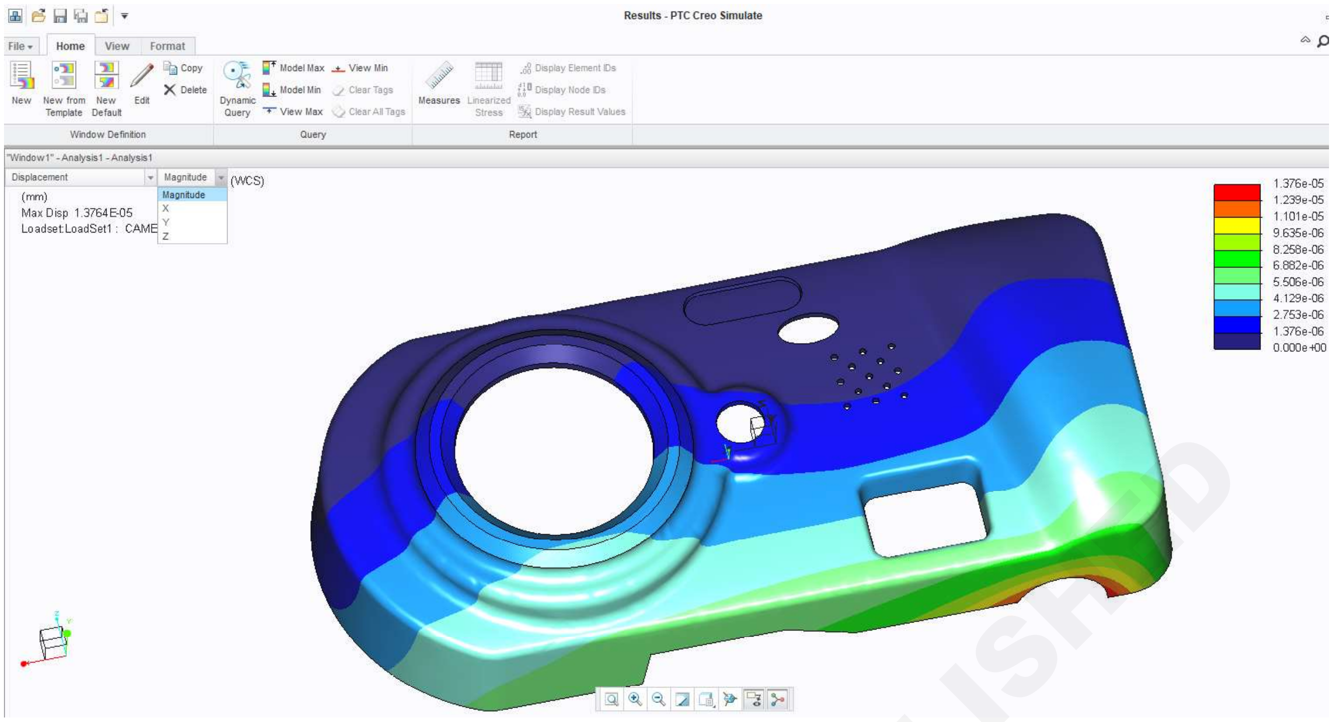
Results - PTC Creo Simulate
File
Home
View
Format
New
New from Template
New Default
Edit
Copy
Delete
Dynamic Query
Model Max
Model Min
View Max
View Min
Clear Tags
Clear All Tags
Measures
Linearized Stress
Display Element IDs
Display Node IDs
Display Result Values
Window Definition
Query
Report
"Window1" - Analysis1 - Analysis1
Displacement
<select...>
(WCS)
(kPa)
Loadset:LoadSet1 : CAME
Magnitude
X
Y
Z
1.49495
-2.11179
-5.71853
-9.32528
-12.9320
-16.5388
-20.1455
-23.7522
-27.3590
-30.9657
-34.5725

Fig 42



Results - PTC Creo Simulate
File
Home
View
Format
New
New from Template
New Default
Edit
Copy
Delete
Dynamic Query
Model Max
Model Min
View Max
View Min
Clear Tags
Clear All Tags
Measures
Linearized Stress
Display Element IDs
Display Node IDs
Display Result Values
Window Definition
Query
Report
"Window1" - Analysis1 - Analysis1
Displacement
Magnitude
(WCS)
(mm)
Max Disp 1.3764E-05
Loadset:LoadSet1 : CAMERACOVER
1.376e-05
1.239e-05
1.101e-05
9.635e-06
8.258e-06
6.882e-06
5.506e-06
4.129e-06
2.753e-06
1.376e-06
0.000e+00

Fig 43



- Strain -> Max principal chart is shown in Fig 44 & 45.

Fig 44

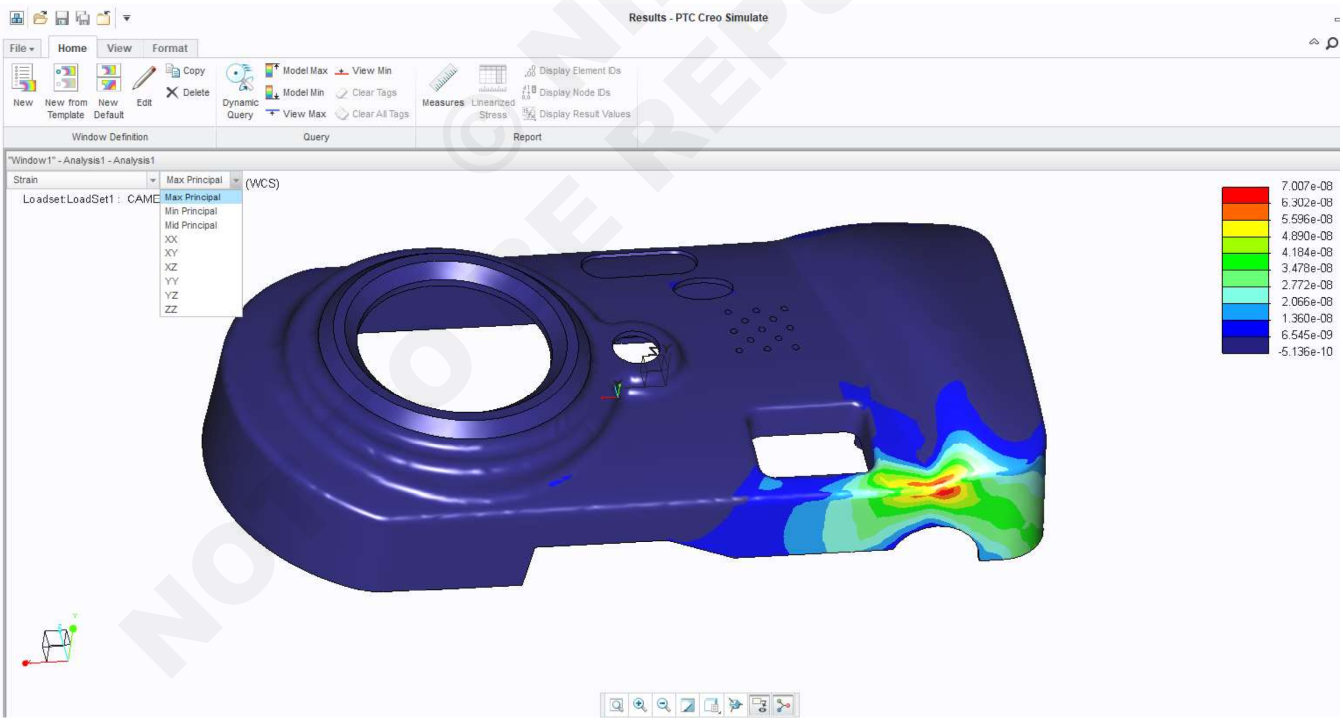
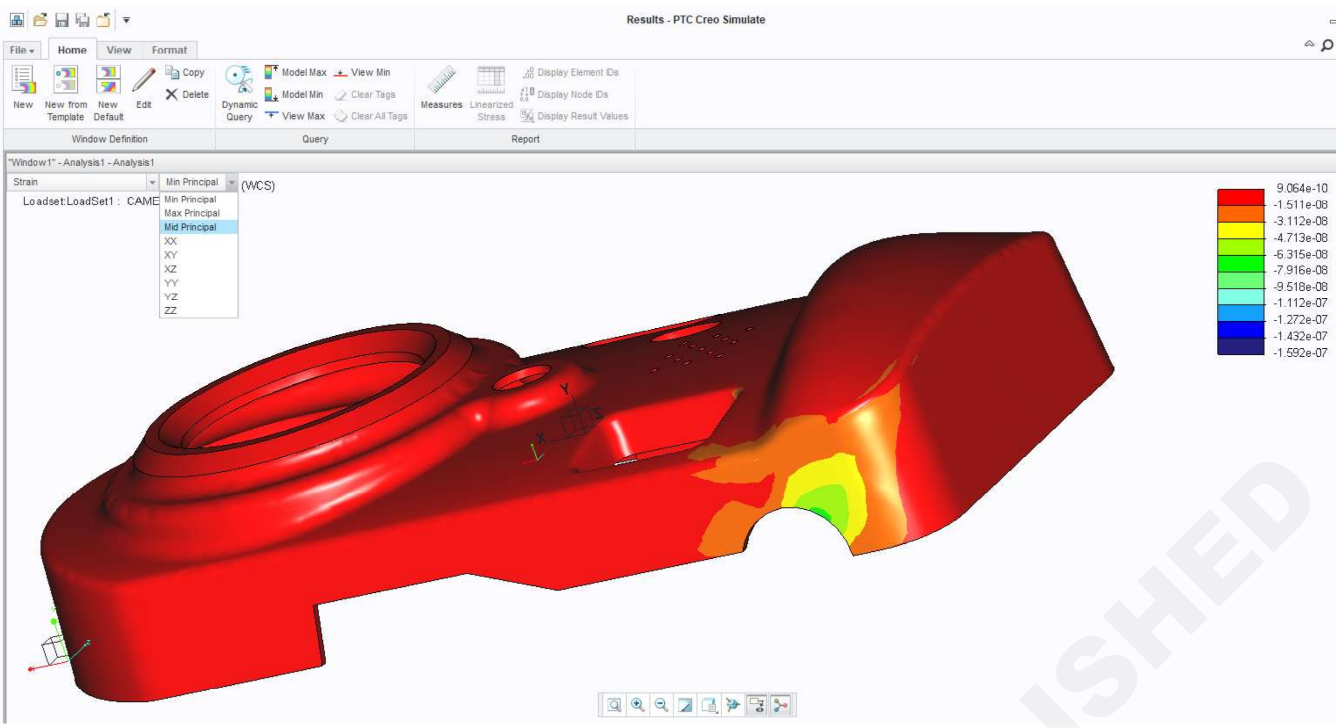
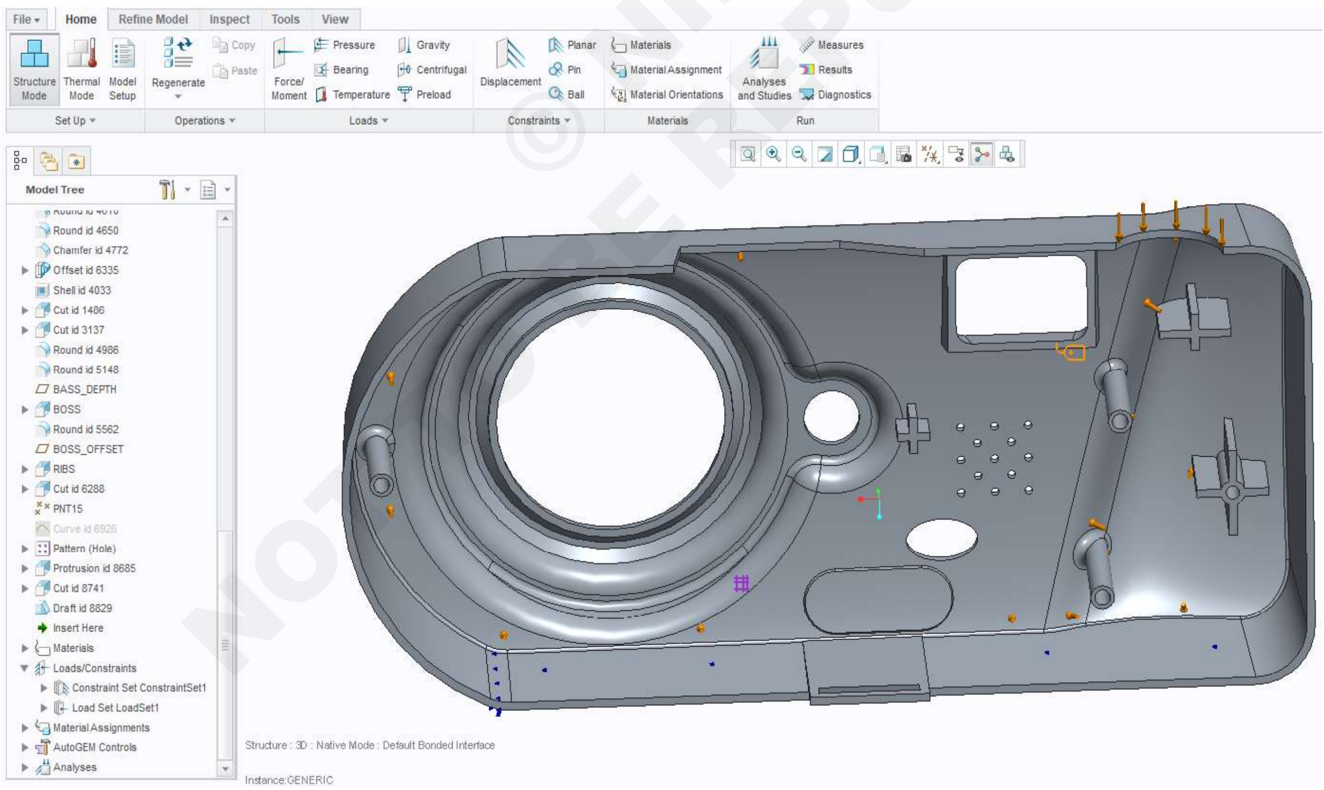


Fig 45



• Atlast required simulation chart is obtained as per our(user) requirement. (Fig 46)

Fig 46



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Creating (NC assembly and mould cavity) drawing

Objectives: At the end of this exercise you shall be able to
- **import part for NC code creation in creo software**
- **set three face coordinates axes for creating NC code**
- **set and select tool to perform milling operations**
- **create NC code for machining the part.**

- Select new option from home -> New dialoge box appears (Fig 1) in that under

  Type -> Manufacturing

  Subtype -> NC assembly – name it as, Camera_NC Code (as per user)

  Disable use default template – Select mmks – mfg – nc select OK option.

- The datum plane (Front top right) plane appears.
- Select Reference model in components task. The working directory opens, select reference mold to be imported (Cavity1), (Fig 2) select open option.

Fig 1

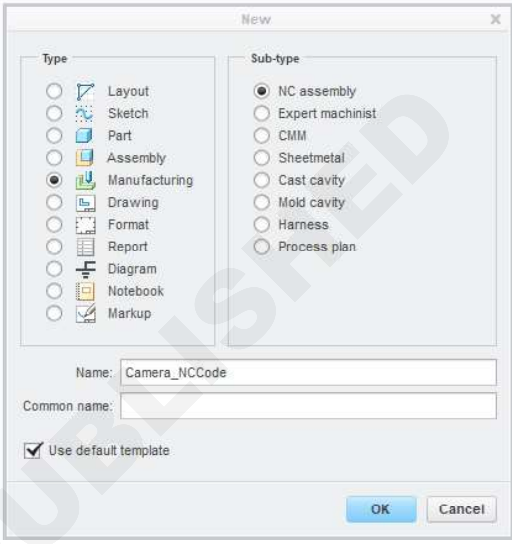
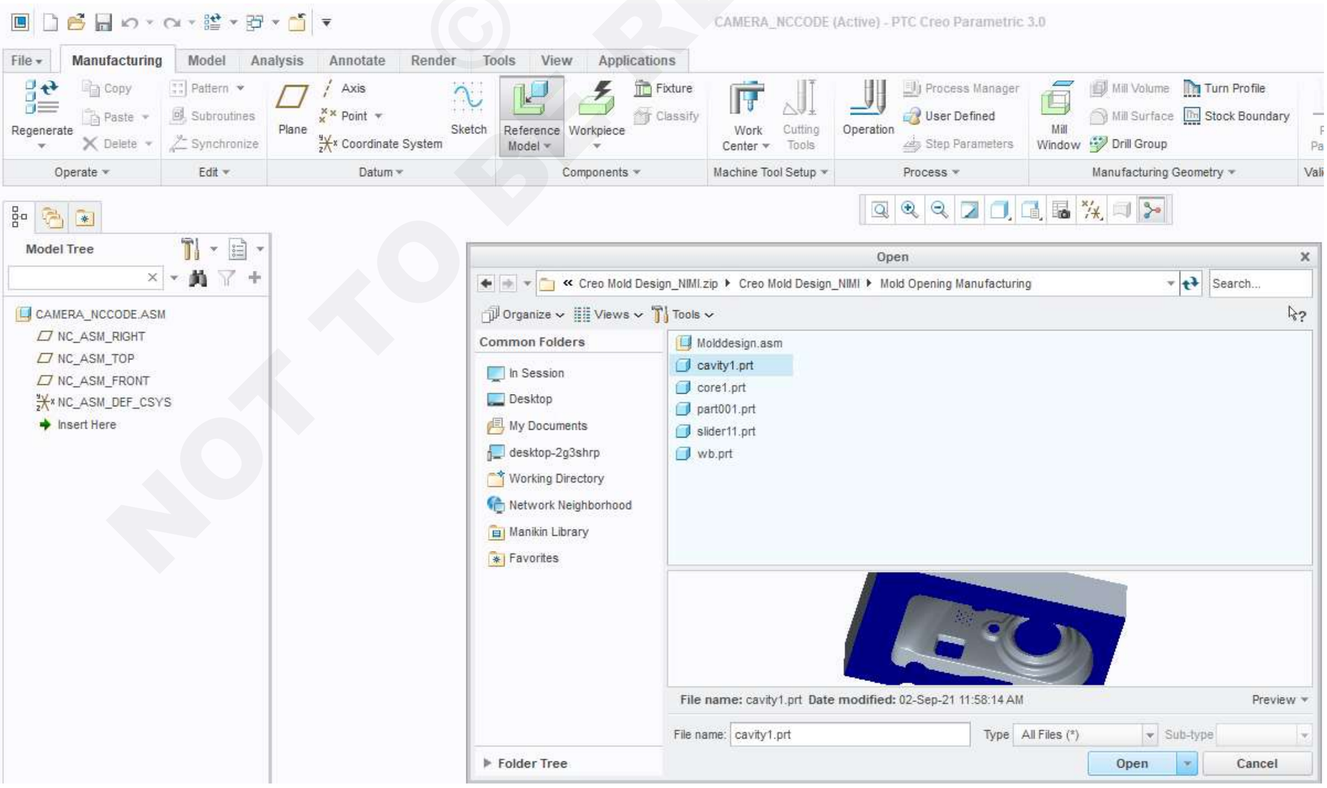


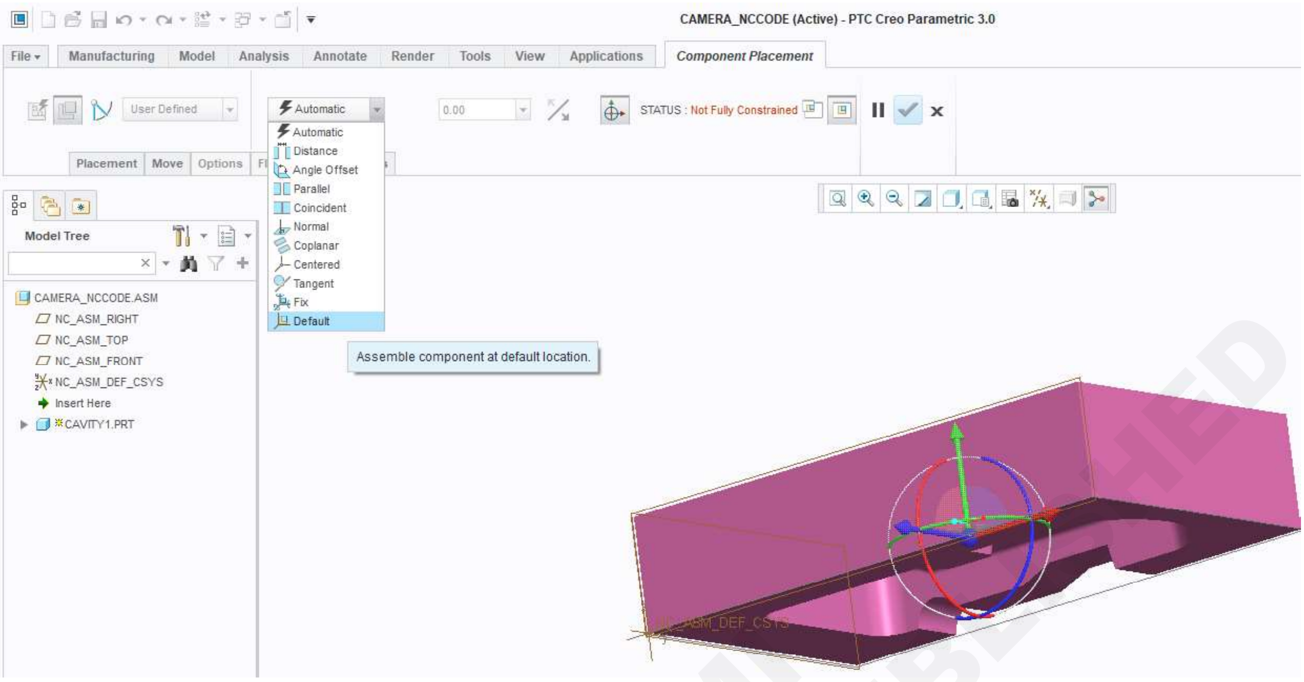
Fig 2



- Click work piece option icon & select automatic work piece.

- The auto(matic) workpiece creation tab opens, in placement tab under coordinate system select default coordinate system (Fig 3) and then select reference model as cavity 1.PRT (click OK option).

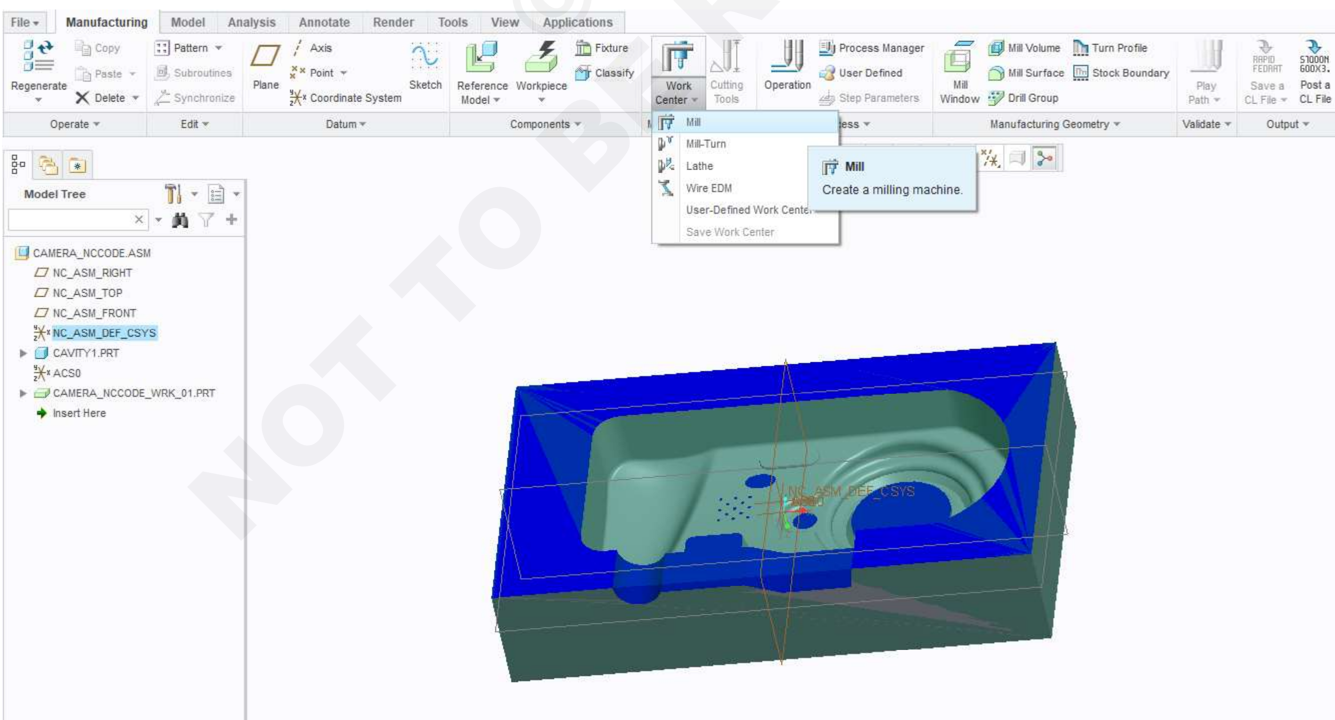
Fig 3



- The imported cavity is created as work piece also indicated as CAMERA_NCCODE_ WRK_01 PRT in model tree.

- Click the workcentre option in Machine tool setup select Mill option. (Fig 4)

Fig 4



- The work centre dialog box appear Then select OK option (If required select output options the select tools tab, change the tools accordingly as per the requirement). (Fig 5)
- Select Operation tab to create new operation. Operation tab appears – MILL01 – in coordinate system selection create new coordinate system by selecting Datum coordinate system located on right side top corner of screen. Datum coordinate system, dialog box appears in Reference select 3 faces as shown in (Fig 6) (Coordinate axis is created on 3 faces that meets on the corner).

Note: Press ctrl + side/faces box for more than one selection.

Fig 5

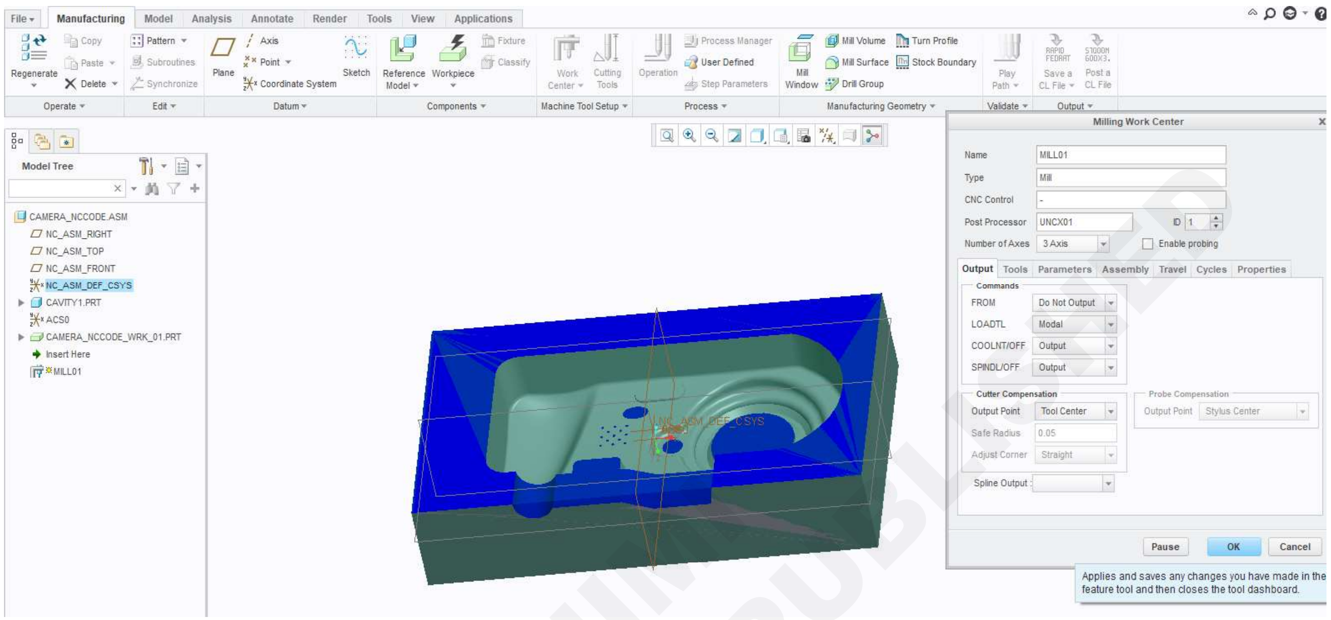
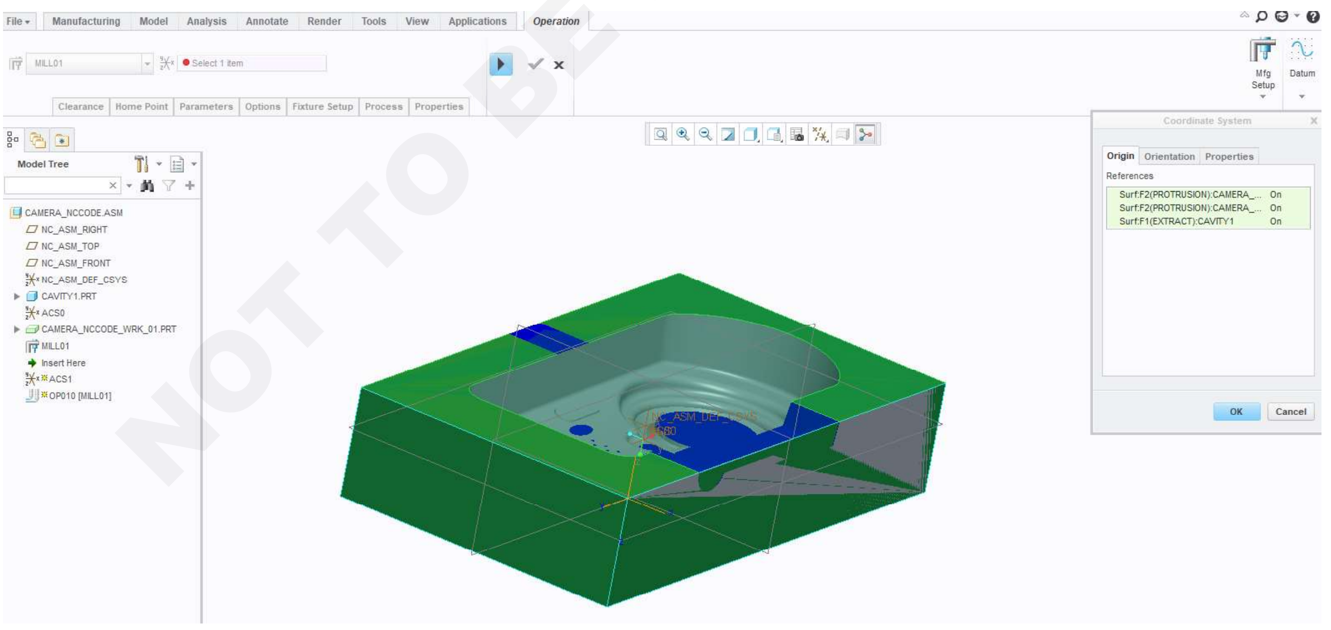


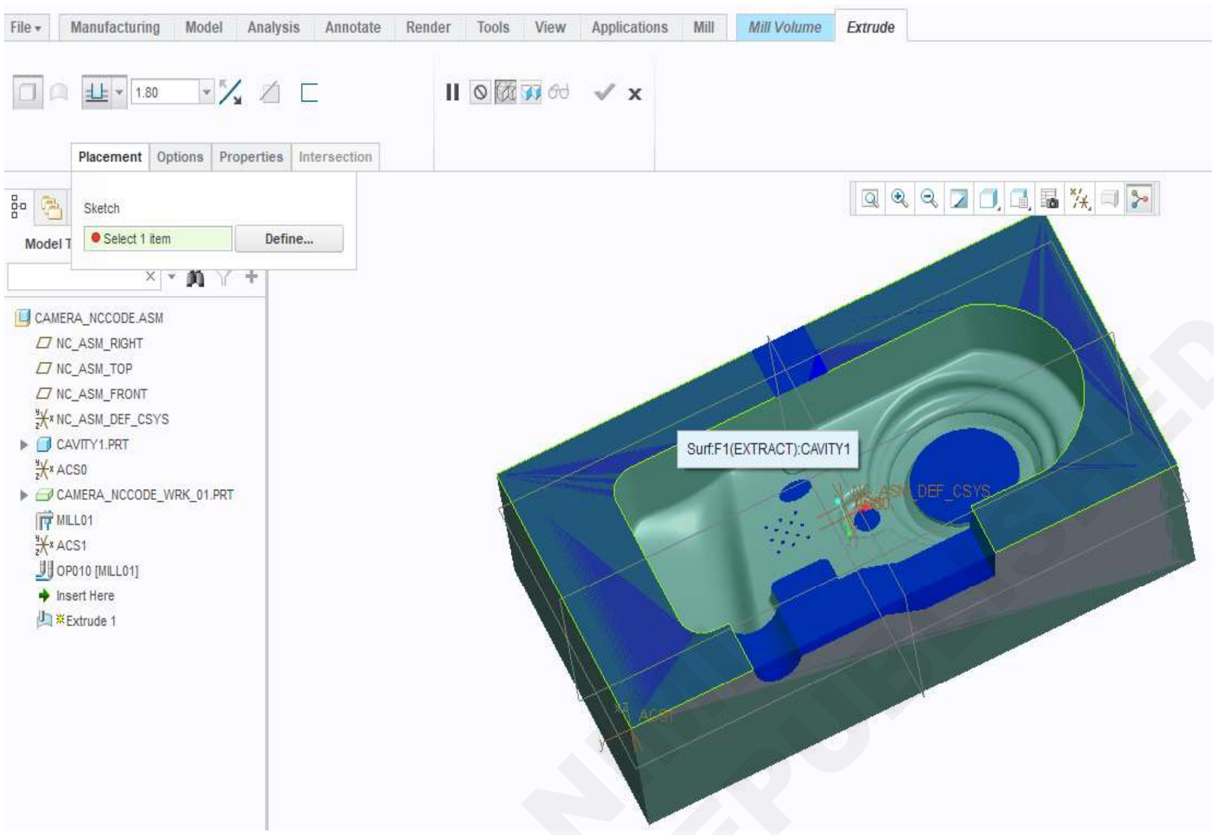
Fig 6



- In orientation tab select orient by References selection, flip direction of the coordinate system axis according to the tool path, then select OK option.).Reference coordinate system got placed and finally click ✓ option.

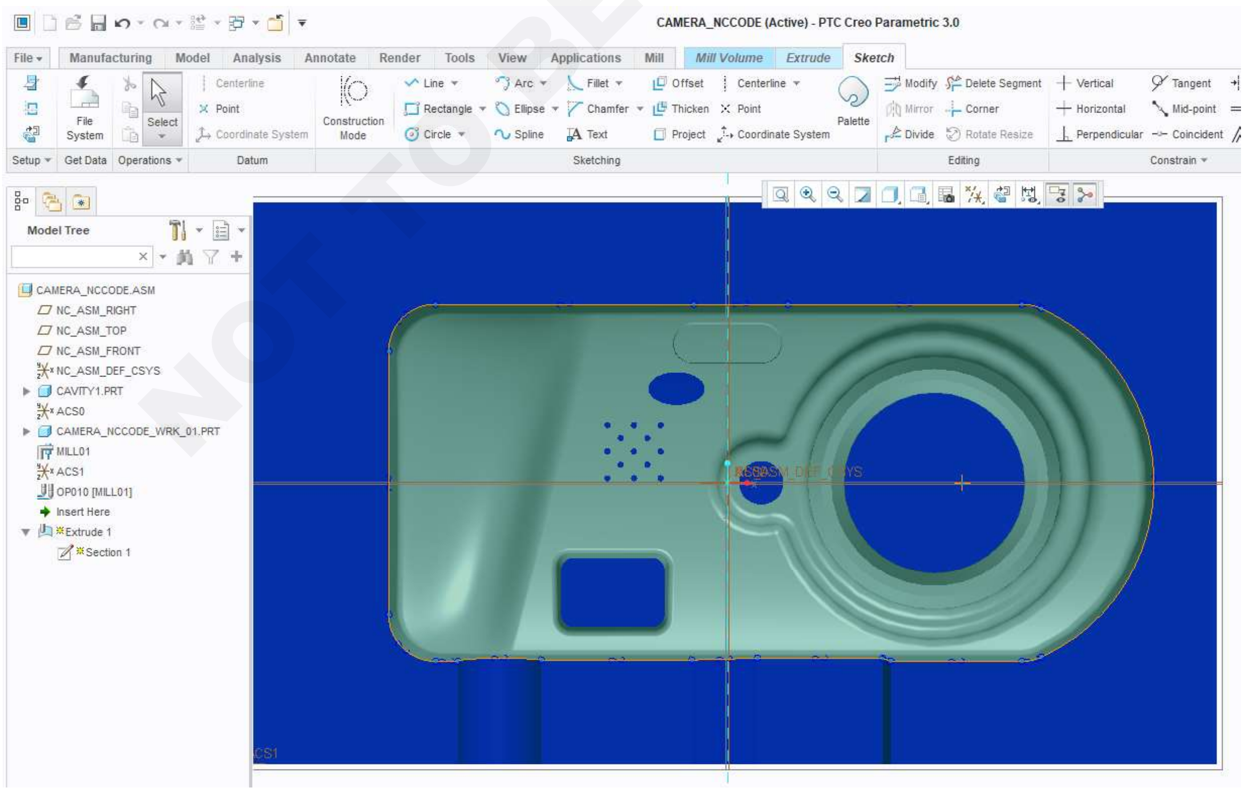
- Once again The mill pallet tab opens in that select mill volume -> Extrude Select Top face as shown in Fig 7.

Fig 7



- The sketch of graphics tool bar opens, Select Project option in sketching tab and pick the edges of cavity to create sketch and select OK option. (Fig 8)

Fig 8



- In extrude tab select extrude to selected curve/ plane/ surface, select till the bottom face of the cavity & click Ok button. (Fig 9)
- Select Mil -> Roughing -> Volume rough
- Under volume milling tab select Edit tools and coordinate axis is already defined
- Tool setup dialog box opens, In Type select End mill (select required tool for the operation) click apply button. (Fig 10)

Fig 9

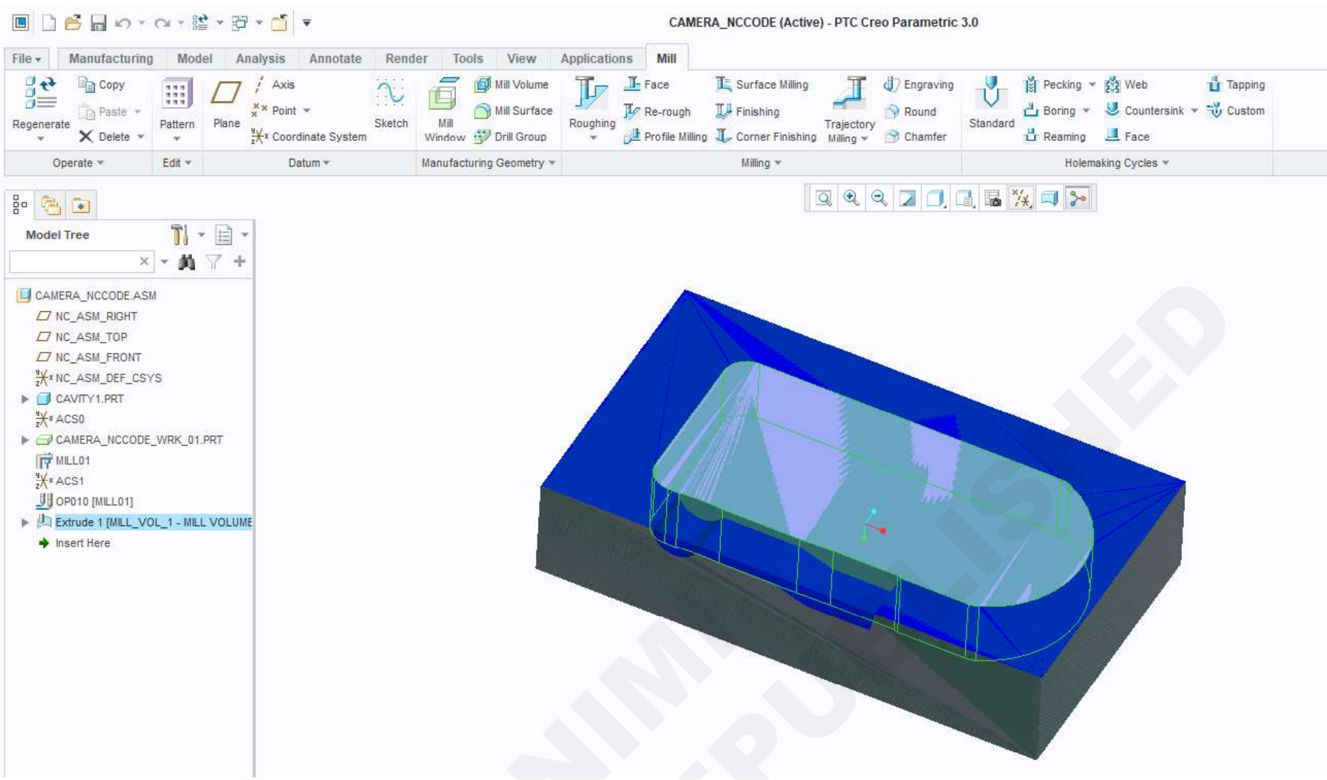
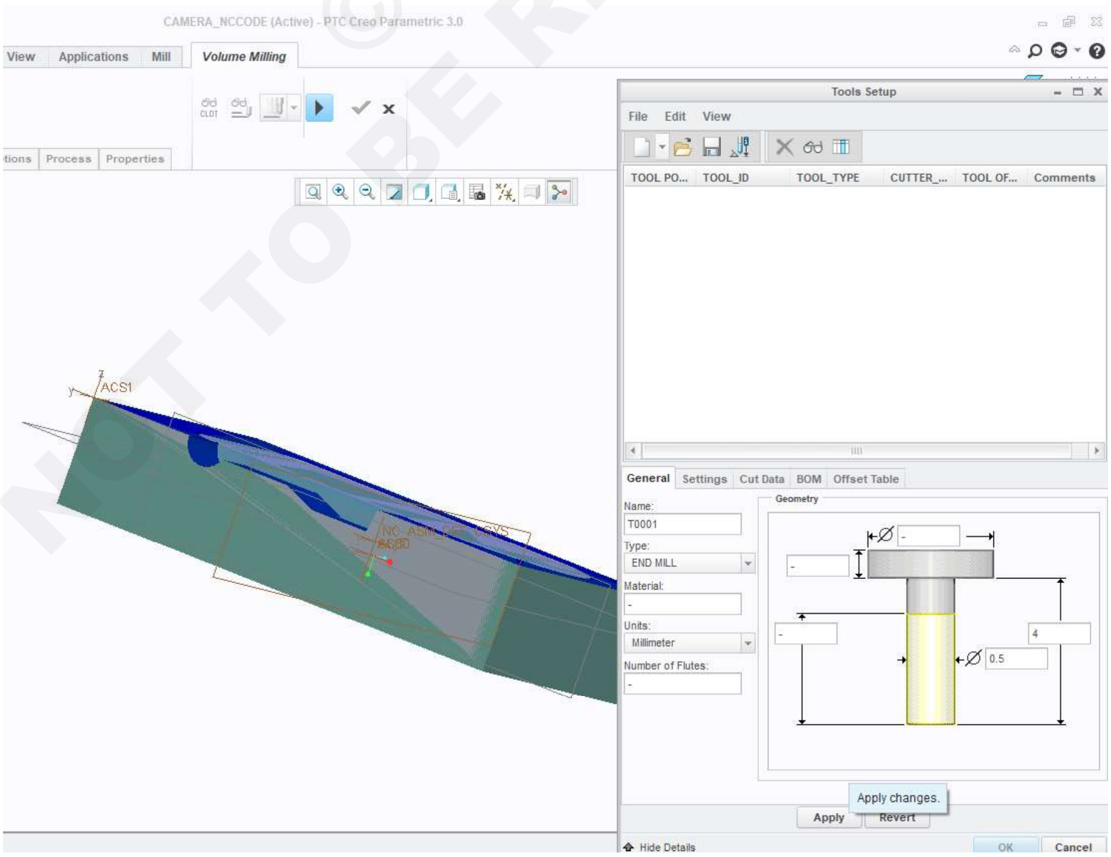


Fig 10



- The selected tool appears in the tool list and select OK option.

  once again it comes back again to Volume milling in that under Reference tab select Top surface select (mill volume) in matching reference.

- Under parameters give the values as displayed (or) the required values as per the operation. (Fig 11)
- Under clearance references select top surfaces (indicated in blue colour). The ref. plane appears give the clearance distance value of 0.5. Click OK button. (Fig 12)

Fig 11

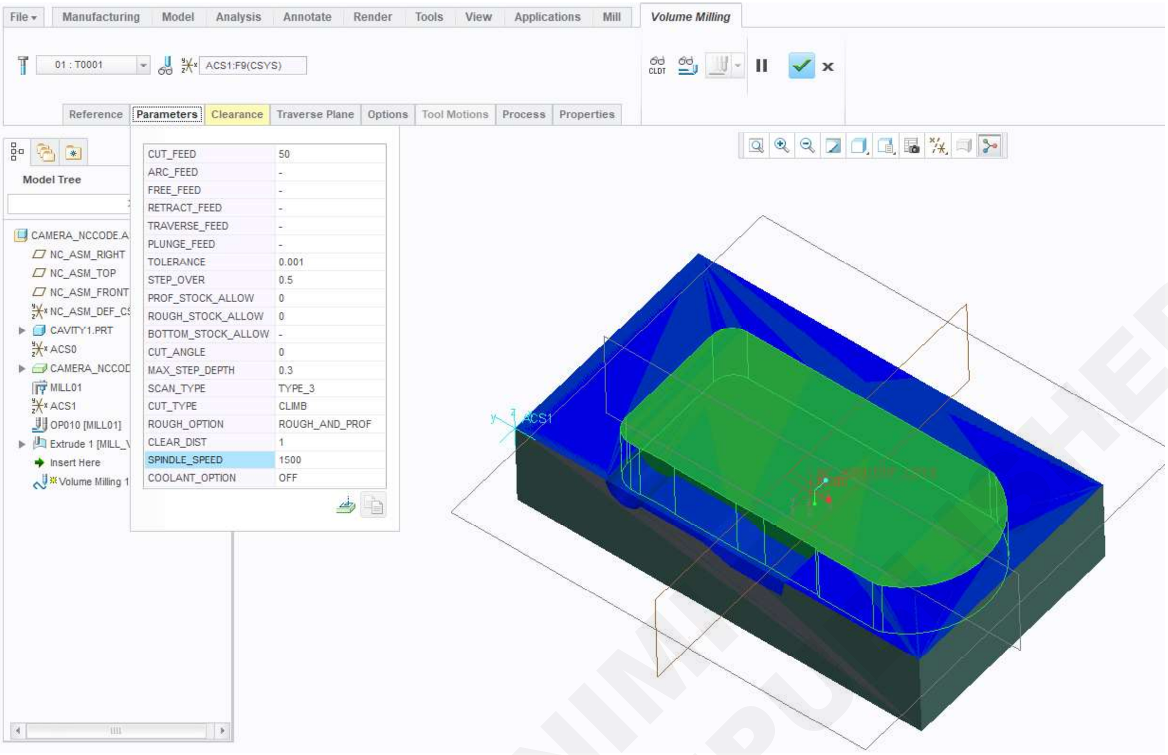
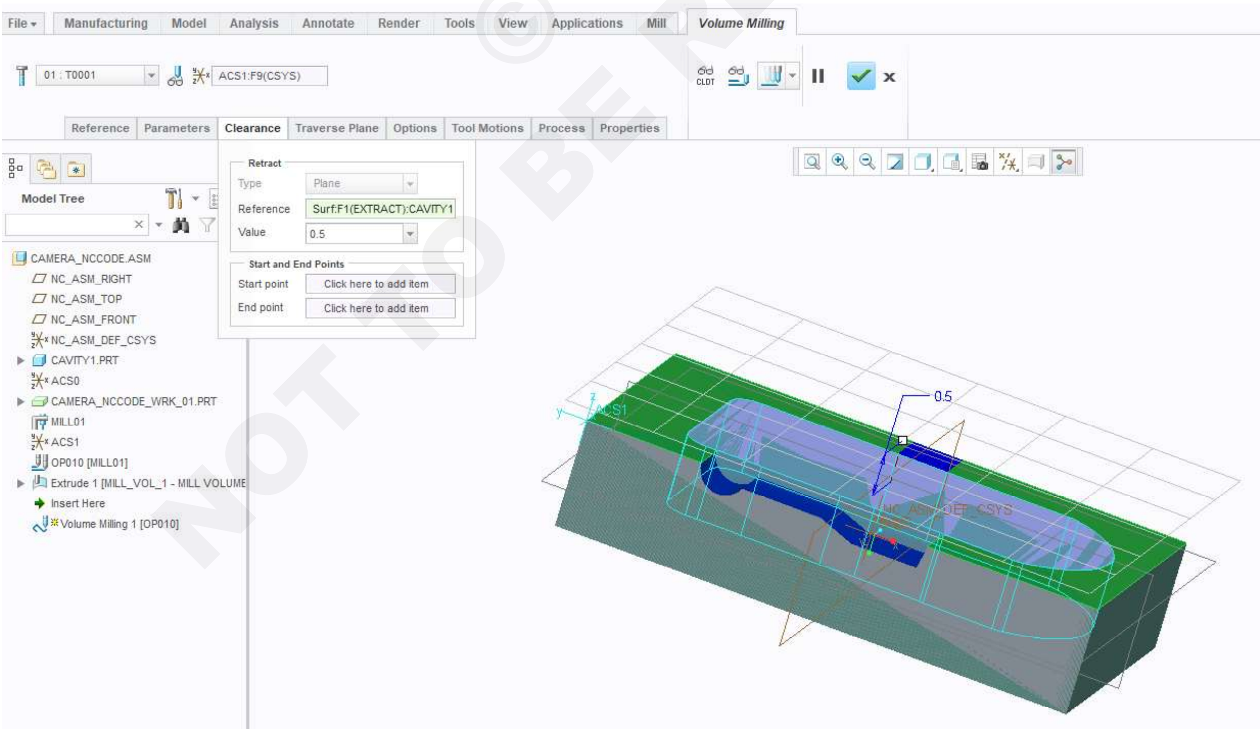


Fig 12



Note: In order to view machinery process in cavity we are hiding work piece & mill volume.

- Now right click volume milling option in model tree then select play path.
- Once the play path selected the play path dialog box appears also the tool appear.

Note: We can change the display style in quick access tool bar to wire frame style for further understanding. (Fig 13)

- Select play button in the play path tab to start tracing the path begins with our given depth value. (Fig 14,15, &16)

Fig 13

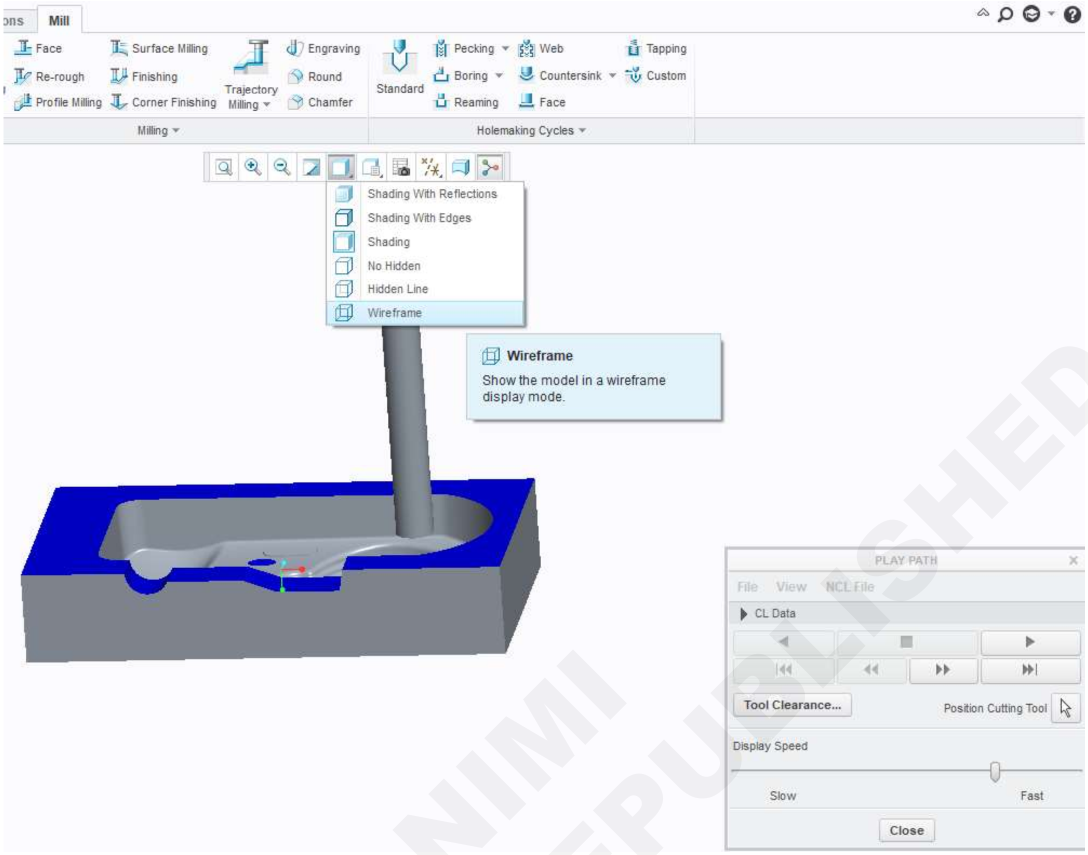


Fig 14

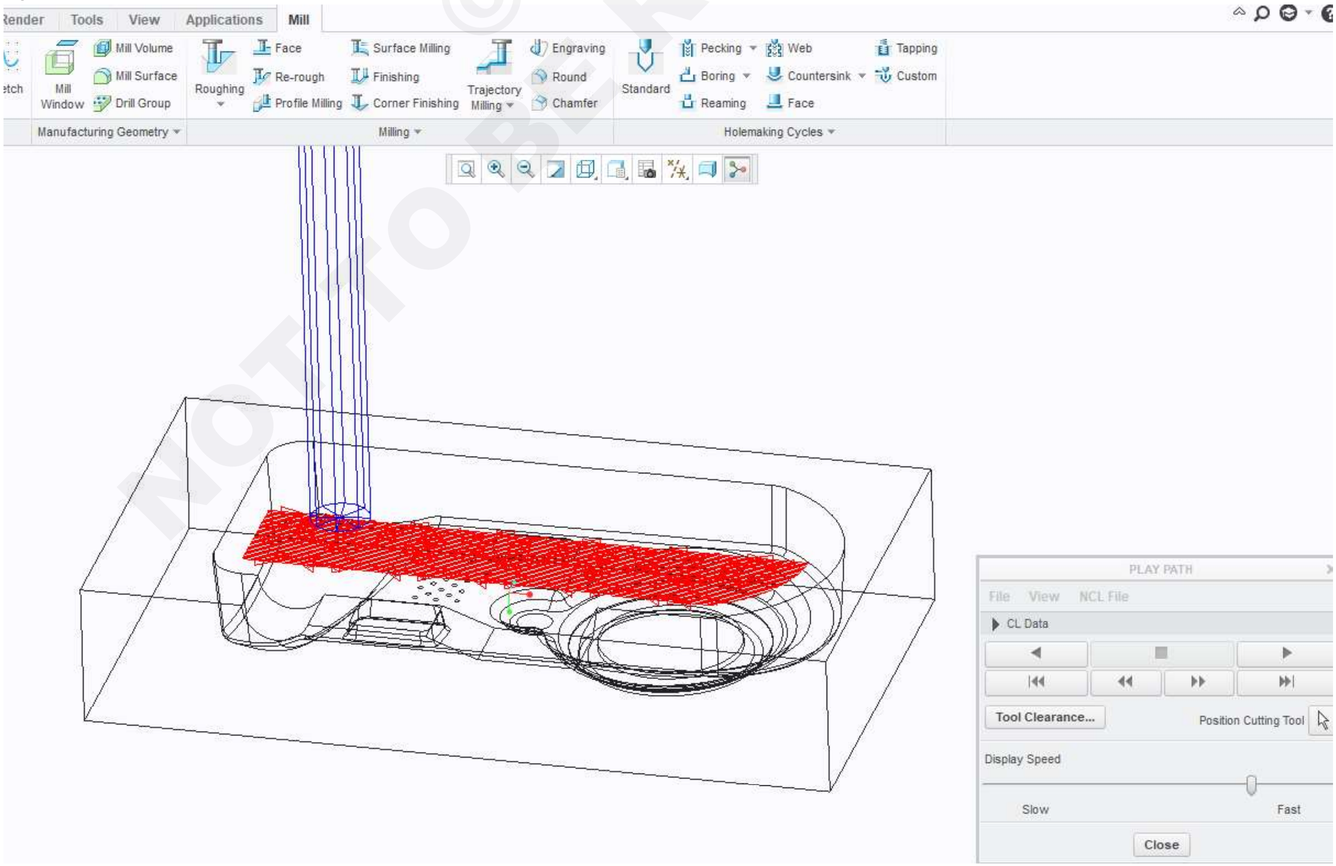


Fig 15

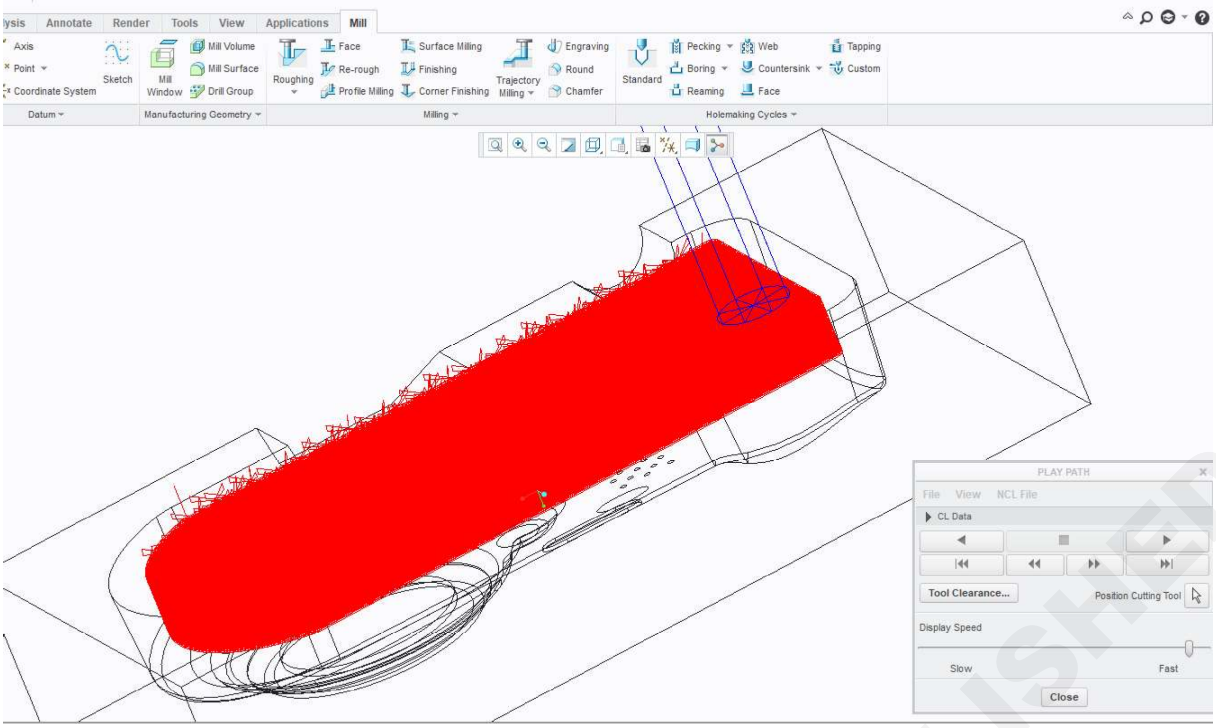
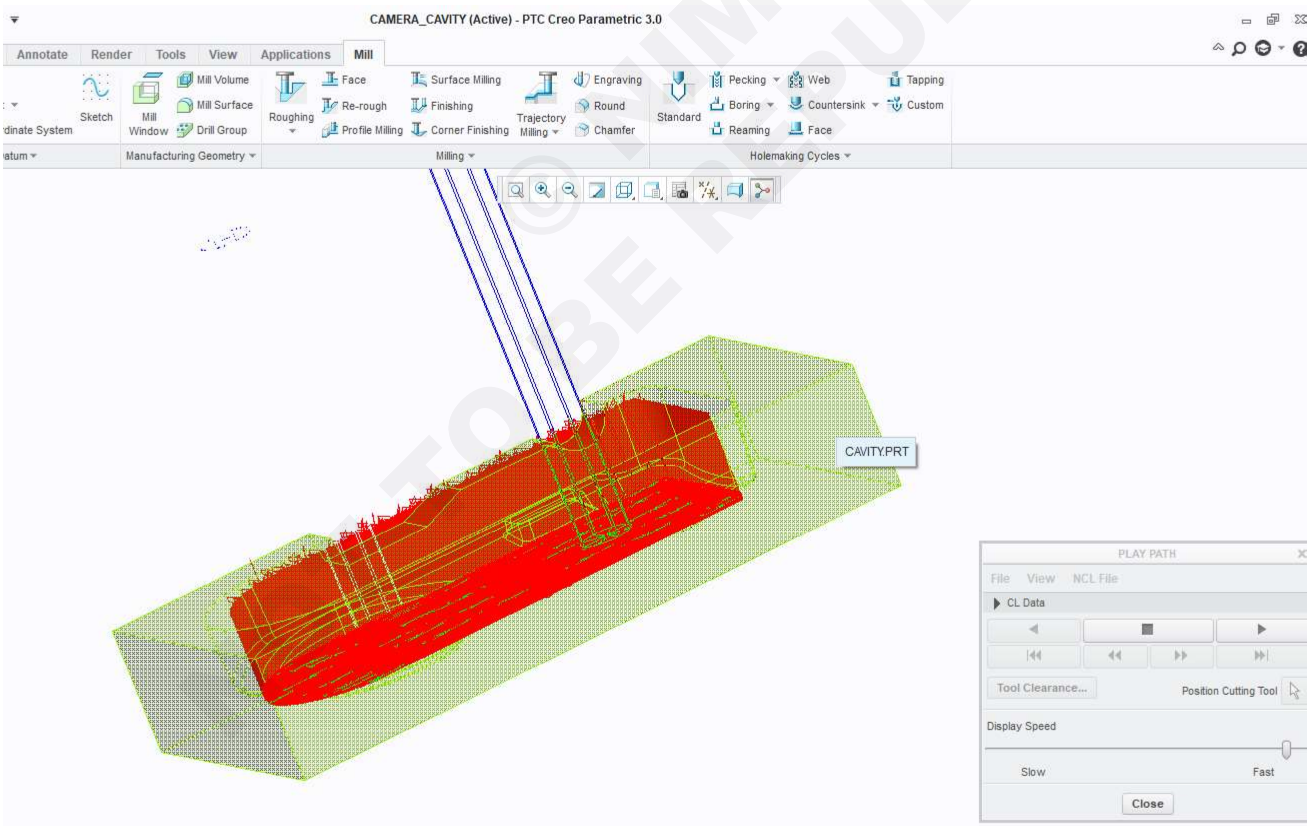


Fig 16



- To generate NC code, select save a CL file under manufacturing (Fig 17), menu manager appears select feat NC sequence -> NC sequence list volume milling option select done. (Fig 18)

Fig 17

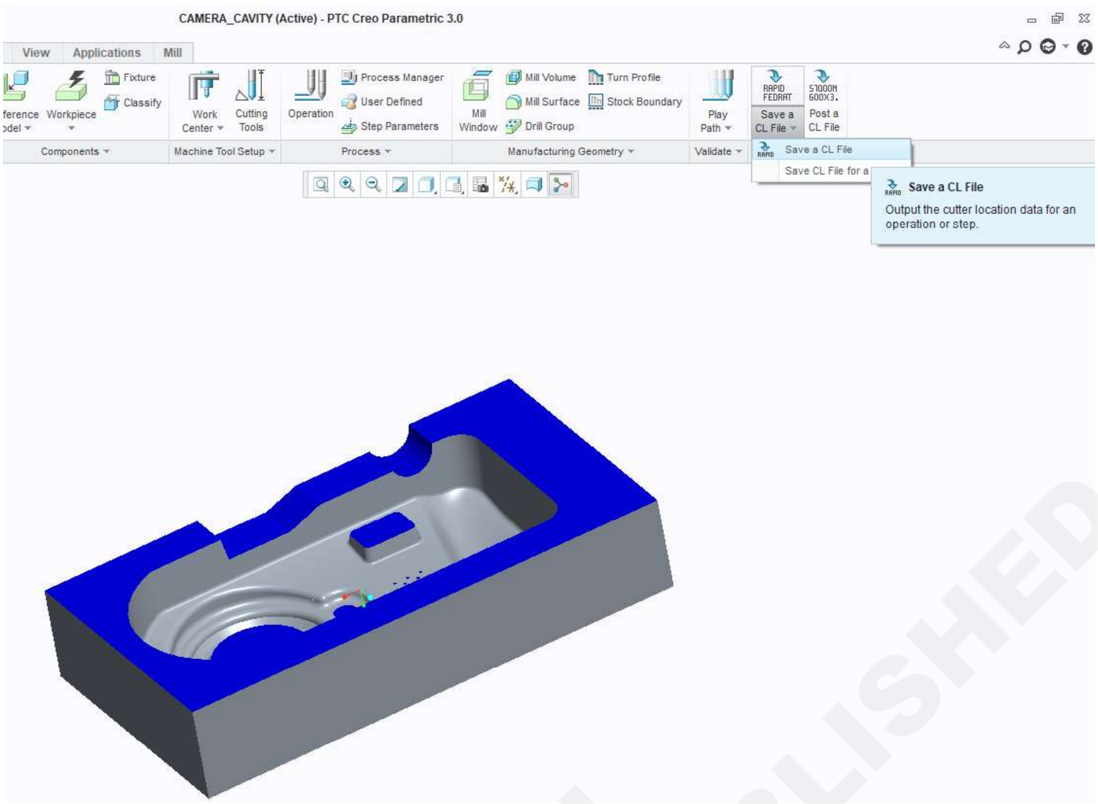
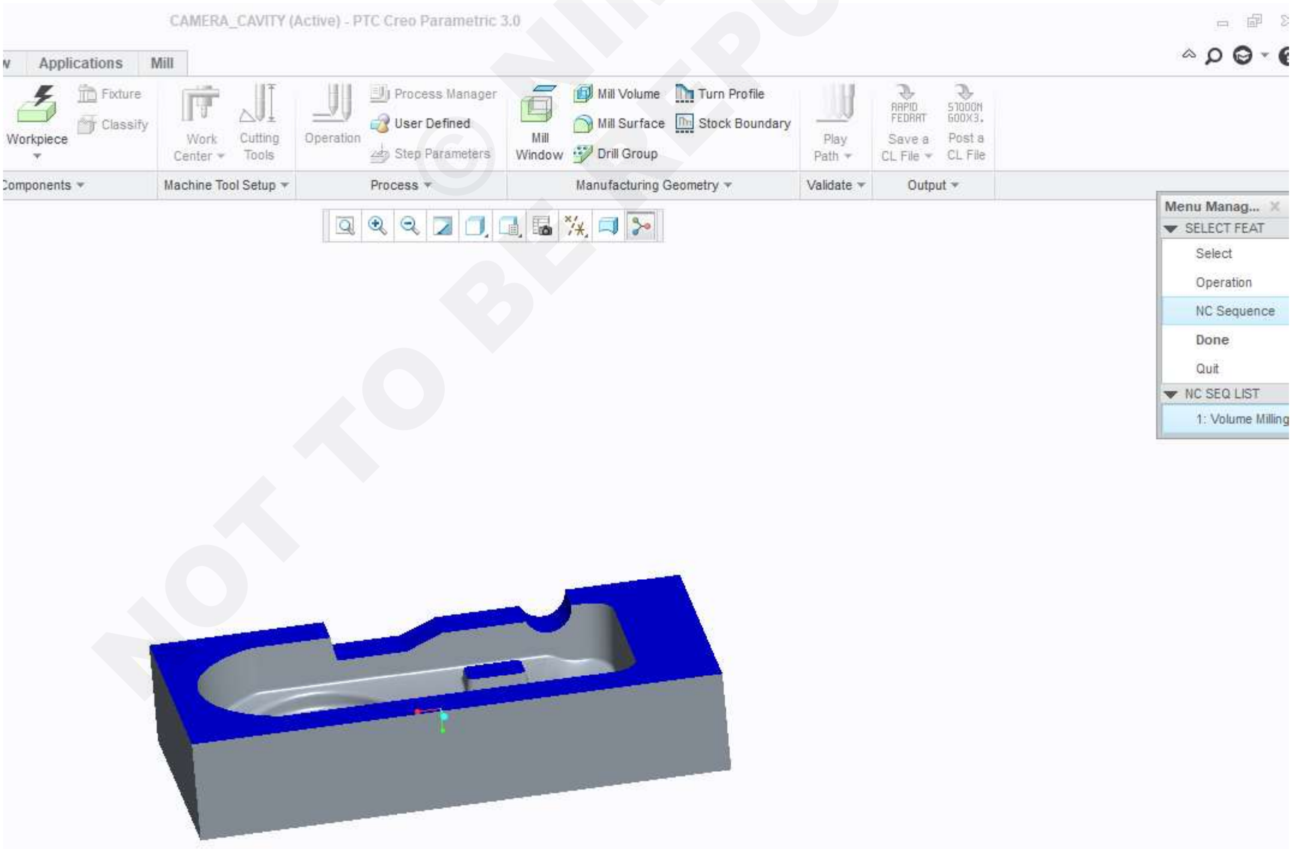


Fig 18



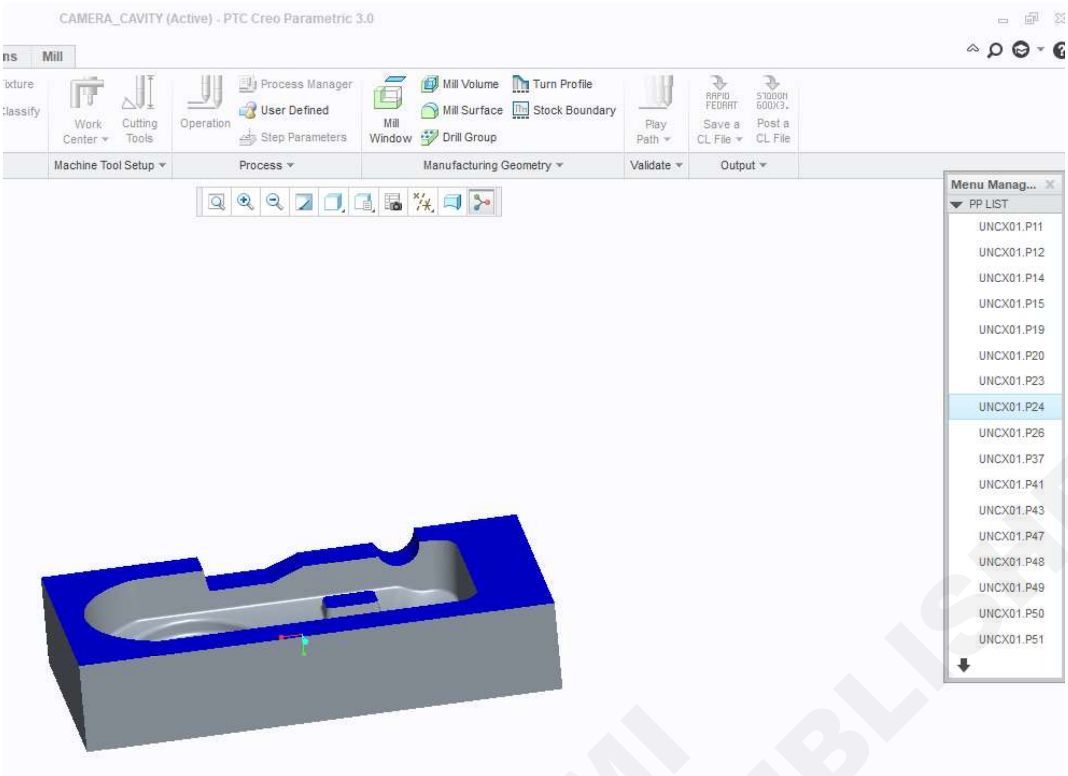
- Once again Menu manager appears enable computer CL under play path &select done

- To open generated NC code, select post a CL file, open dialog box appears specify a file name (select the working directory to post a computed file, click open button.

- Menu manager dialog box appears PP option enable vertex & Trace. select done option.

Then PP list appears select the UNCx01p24 CPHILIPS CNC 432-5 aces machine (Fig 19)

Fig 19



- The information window dialog box appears (Fig 20). Then posted coding file open select the TAP. extension file to open in notepad. (Fig 21)

Fig 20

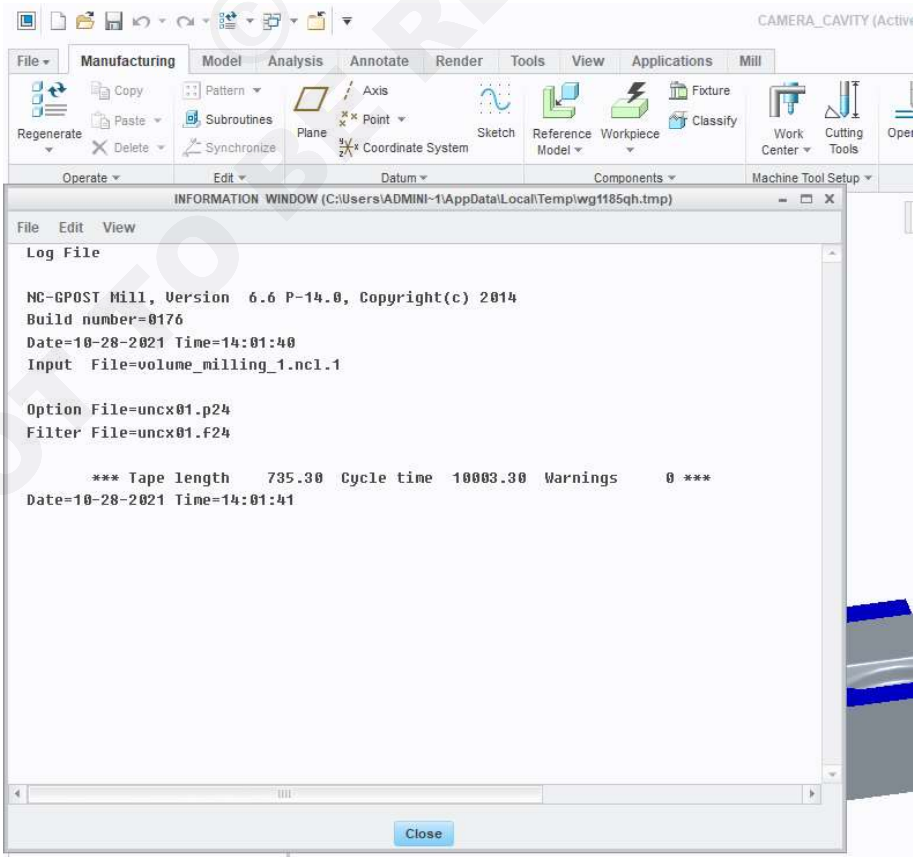
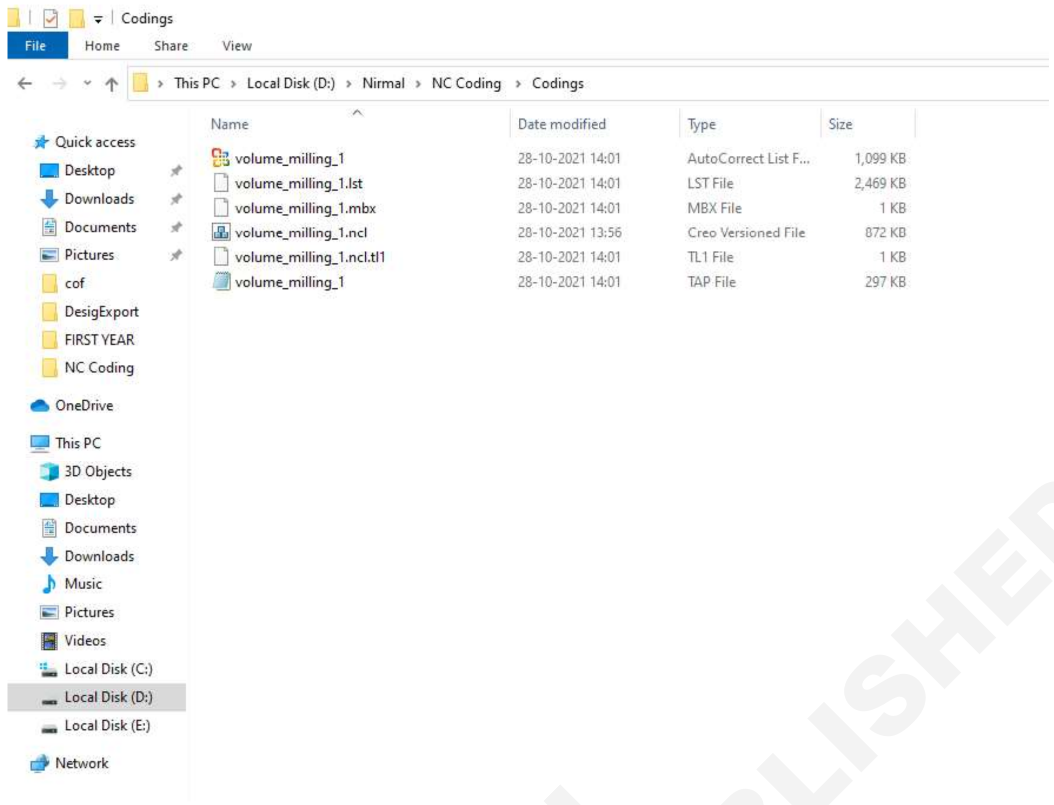


Fig 21



- The NC codes are generated can now be viewed in notepad. (Fig 22,23,24 & 25)

Fig 22

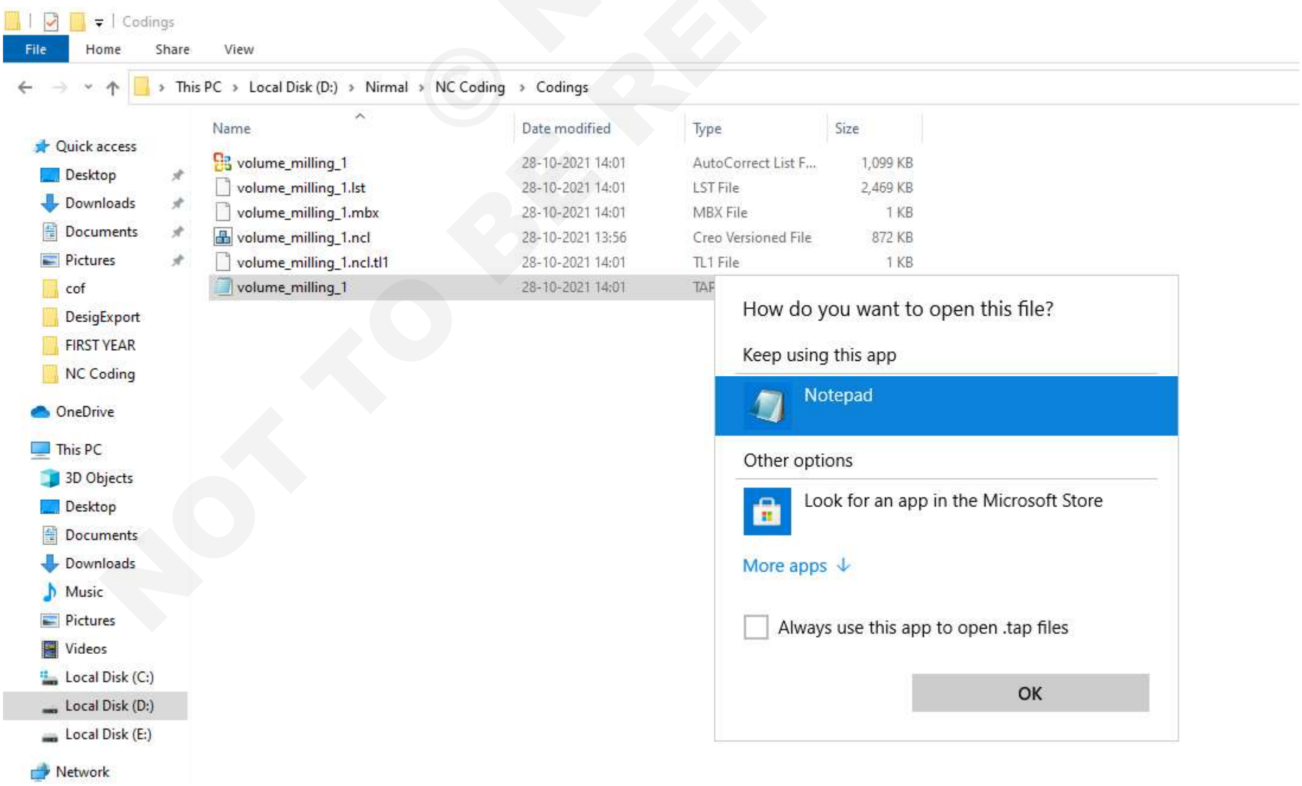
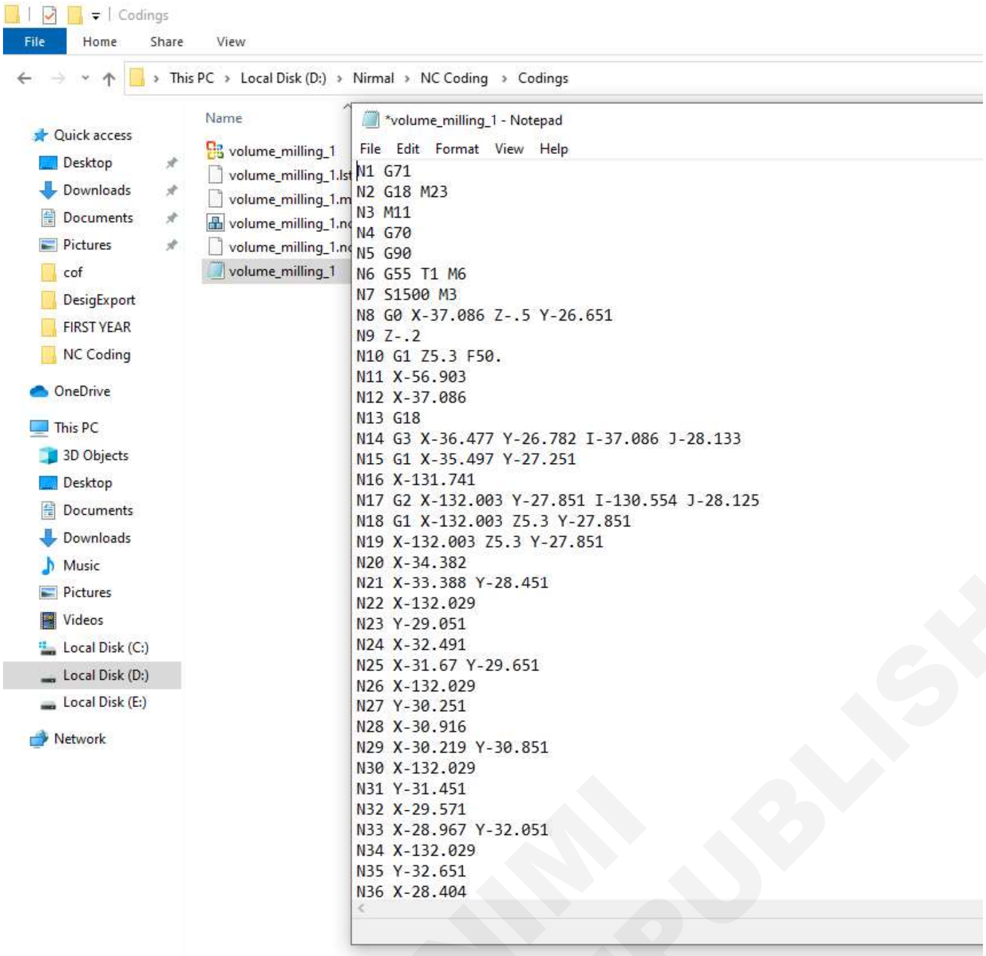


Fig 23



Codings
File
Home
Share
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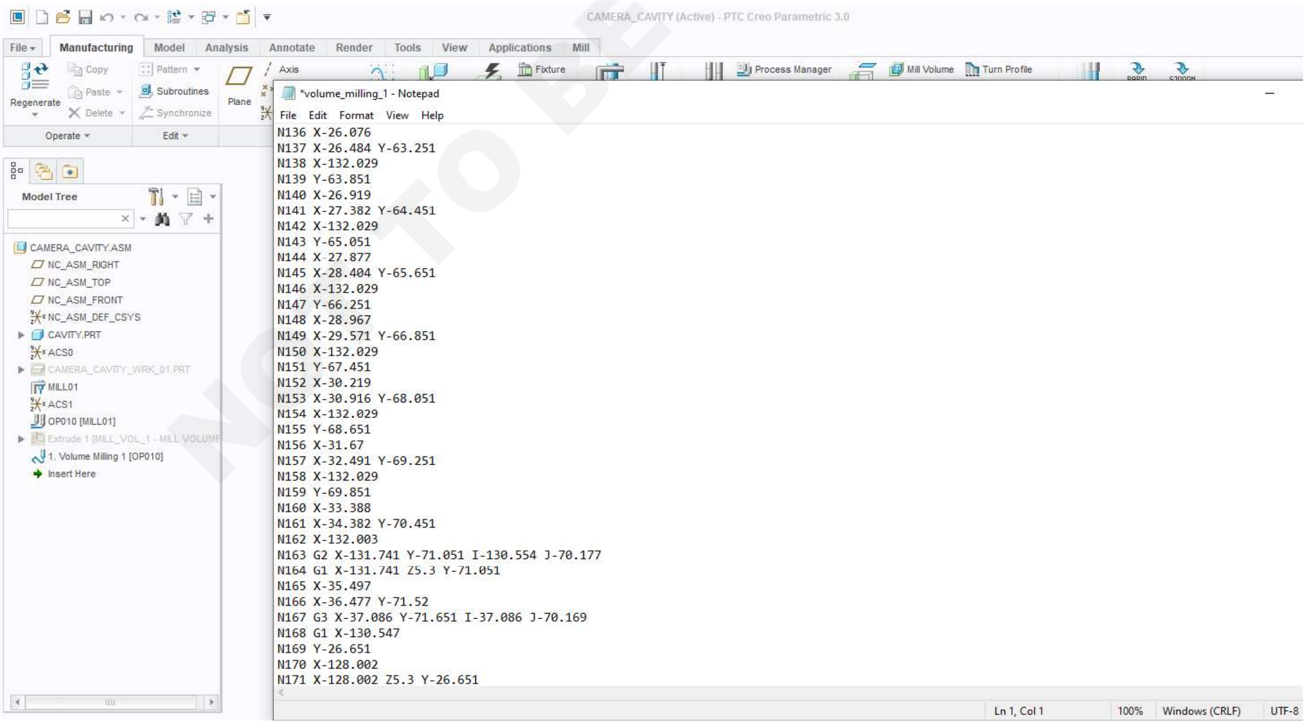
This PC > Local Disk (D:) > Nirmal > NC Coding > Codings
Quick access
Desktop
Downloads
Documents
Pictures
cof
DesigExport
FIRST YEAR
NC Coding
OneDrive
This PC
3D Objects
Desktop
Documents
Downloads
Music
Pictures
Videos
Local Disk (C:)
Local Disk (D:)
Local Disk (E:)
Network
Name
volume_milling_1
*volume_milling_1 - Notepad
File Edit Format View Help
N1 G71
N2 G18 M23
N3 M11
N4 G70
N5 G90
N6 G55 T1 M6
N7 S1500 M3
N8 G0 X-37.086 Z-.5 Y-26.651
N9 Z-.2
N10 G1 Z5.3 F50.
N11 X-56.903
N12 X-37.086
N13 G18
N14 G3 X-36.477 Y-26.782 I-37.086 J-28.133
N15 G1 X-35.497 Y-27.251
N16 X-131.741
N17 G2 X-132.003 Y-27.851 I-130.554 J-28.125
N18 G1 X-132.003 Z5.3 Y-27.851
N19 X-132.003 Z5.3 Y-27.851
N20 X-34.382
N21 X-33.388 Y-28.451
N22 X-132.029
N23 Y-29.051
N24 X-32.491
N25 X-31.67 Y-29.651
N26 X-132.029
N27 Y-30.251
N28 X-30.916
N29 X-30.219 Y-30.851
N30 X-132.029
N31 Y-31.451
N32 X-29.571
N33 X-28.967 Y-32.051
N34 X-132.029
N35 Y-32.651
N36 X-28.404

Fig 24



CAMERA_CAVITY (Active) - PTC Creo Parametric 3.0
File
Manufacturing
Model
Analysis
Annotate
Render
Tools
View
Applications
Mill
Process Manager
Mill Volume
Turn Profile
Fixture
Model Tree
CAMERA_CAVITY.ASM
NC_ASM_RIGHT
NC_ASM_TOP
NC_ASM_FRONT
NC_ASM_DEF_CSYS
CAVITY.PRT
ACS0
CAMERA_CAVITY_WRK_01.PRT
MILL01
ACS1
OP010 [MILL01]
1. Volume Milling 1 [OP010]
Insert Here
*volume_milling_1 - Notepad
File Edit Format View Help
N136 X-26.076
N137 X-26.484 Y-63.251
N138 X-132.029
N139 Y-63.851
N140 X-26.919
N141 X-27.382 Y-64.451
N142 X-132.029
N143 Y-65.051
N144 X-27.877
N145 X-28.404 Y-65.651
N146 X-132.029
N147 Y-66.251
N148 X-28.967
N149 X-29.571 Y-66.851
N150 X-132.029
N151 Y-67.451
N152 X-30.219
N153 X-30.916 Y-68.051
N154 X-132.029
N155 Y-68.651
N156 X-31.67
N157 X-32.491 Y-69.251
N158 X-132.029
N159 Y-69.851
N160 X-33.388
N161 X-34.382 Y-70.451
N162 X-132.003
N163 G2 X-131.741 Y-71.051 I-130.554 J-70.177
N164 G1 X-131.741 Z5.3 Y-71.051
N165 X-35.497
N166 X-36.477 Y-71.52
N167 G3 X-37.086 Y-71.651 I-37.086 J-70.169
N168 G1 X-130.547
N169 Y-26.651
N170 X-128.002
N171 X-128.002 Z5.3 Y-26.651
Ln 1, Col 1
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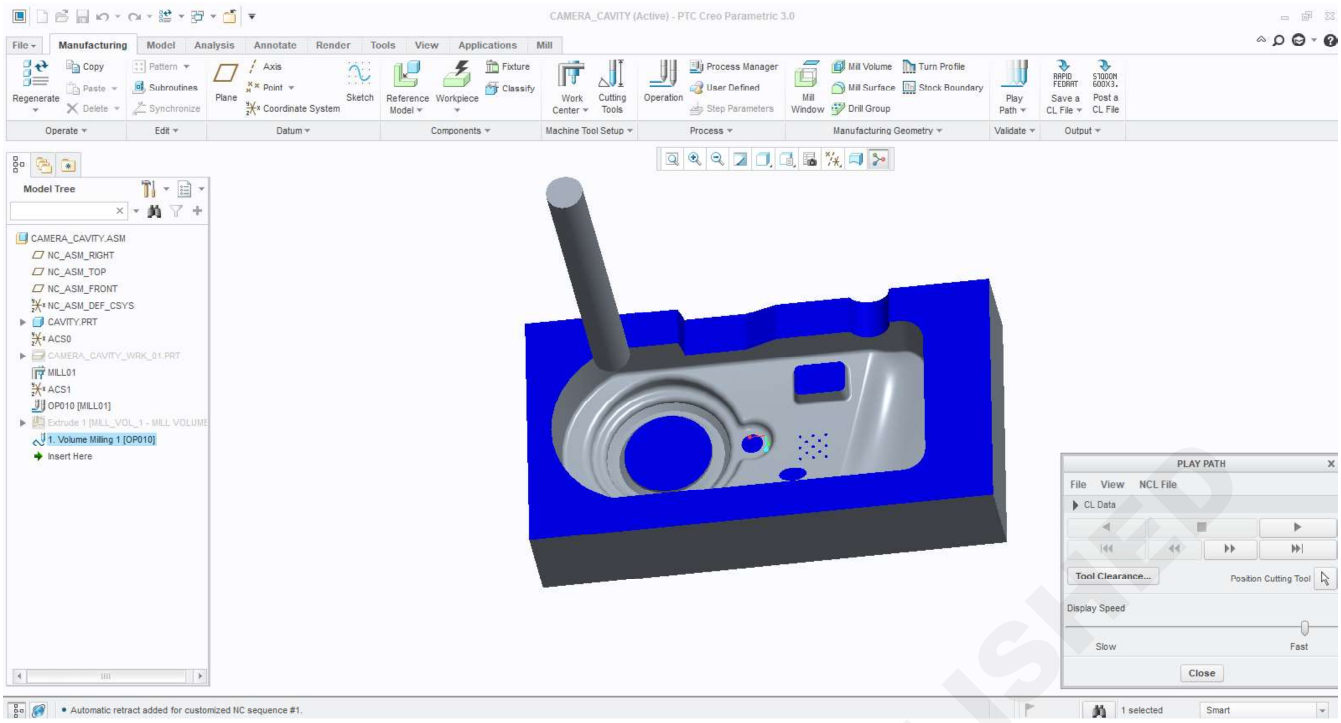
Windows (CRLF)
UTF-8

Fig 25


CAMERA_CAVITY (Active) - PTC Creo Parametric 3.0
File
Manufacturing
Model
Analysis
Annotate
Render
Tools
View
Applications
Mill
Regenerate
Copy
Paste
Delete
Pattern
Subroutines
Synchronize
Plane
Axis
Point
Coordinate System
Sketch
Reference Model
Workpiece
Fixture
Classify
Work Center
Cutting Tools
Operation
Process Manager
User Defined
Step Parameters
Mill Window
Mill Volume
Mill Surface
Drill Group
Turn Profile
Stock Boundary
Play Path
Save a CL File
Post a CL File
Operate
Edit
Datum
Components
Machine Tool Setup
Process
Manufacturing Geometry
Validate
Output
Model Tree
CAMERA_CAVITY.ASM
NC_ASM_RIGHT
NC_ASM_TOP
NC_ASM_FRONT
NC_ASM_DEF_CSYS
CAVITY.PRT
ACS0
CAMERA_CAVITY_WRK_01.PRT
MILL01
ACS1
OP010 [MILL01]
Extrude 1 [MILL_VOL_1 - MILL VOLUME
1. Volume Milling 1 [OP010]
Insert Here
PLAY PATH
File
View
NCL File
CL Data
Tool Clearance...
Position Cutting Tool
Display Speed
Slow
Fast
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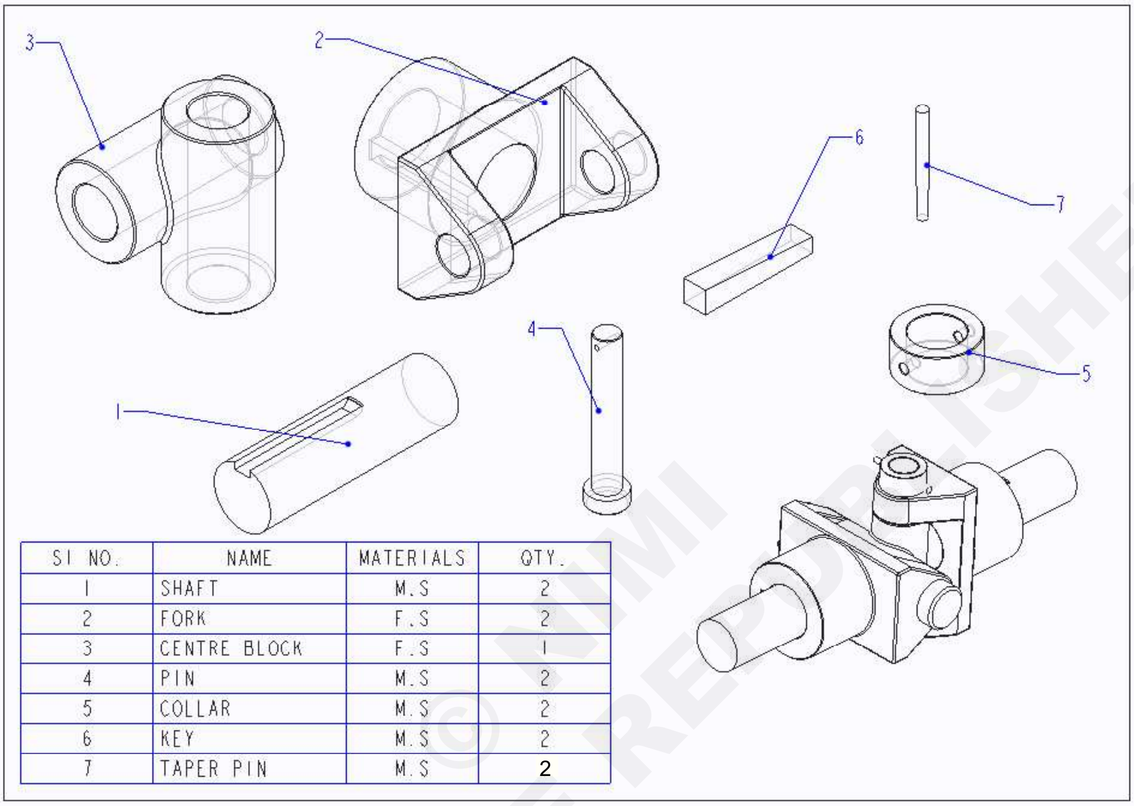
Automatic retract added for customized NC sequence #1.
1 selected
Smart

Capital Goods and Manufacturing — Exercise 1.6.83
Tool and Die Maker (Dies and Moulds) - Auto CAD & Pro - E

Universal coupling

Objectives: At the end of this lesson you shall be able to
- **create all the part drawing of universal coupling using CREO/Pro - E**
- **assemble the universal coupling denoting with colour combination technique.**



SI NO.	NAME	MATERIALS	QTY.
1	SHAFT	M.S	2
2	FORK	F.S	2
3	CENTRE BLOCK	F.S	1
4	PIN	M.S	2
5	COLLAR	M.S	2
6	KEY	M.S	2
7	TAPER PIN	M.S	2

TASK 1: **Centre block (Fig 1)**

- Open creo software selects part type as solid and name the model as 'centre block'

- Select the front plane draw solid as shown in Fig 2 using rectangle shape and revolve command value as 360°, after selecting ✓ ok option draw the circle as shown in Fig 3 in same front plane.

Fig 1

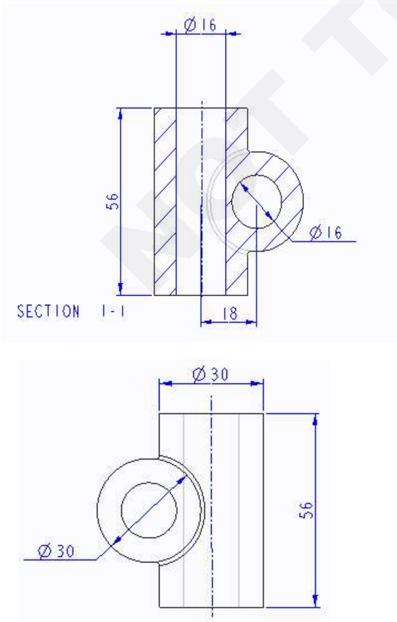


Fig 2

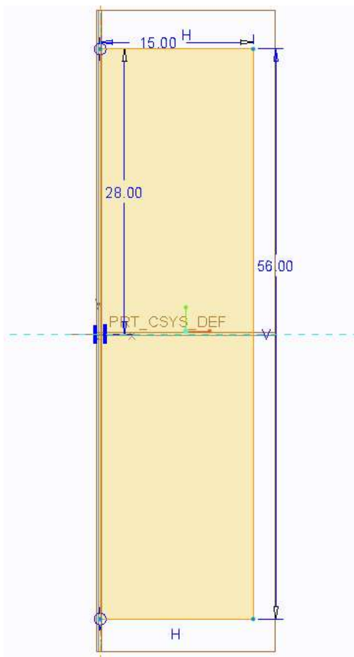
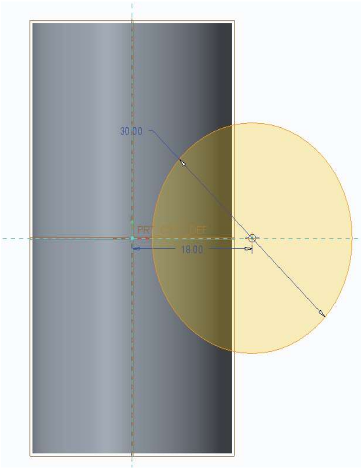
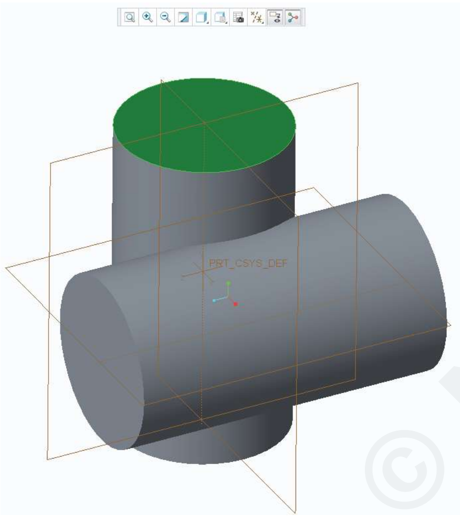


Fig 3



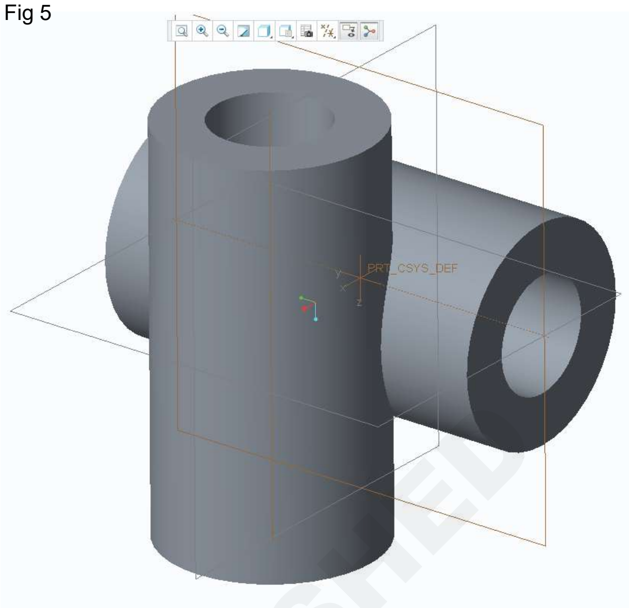
- Extrude the solid as shown in Fig 4 with command value as 56 mm.

Fig 4



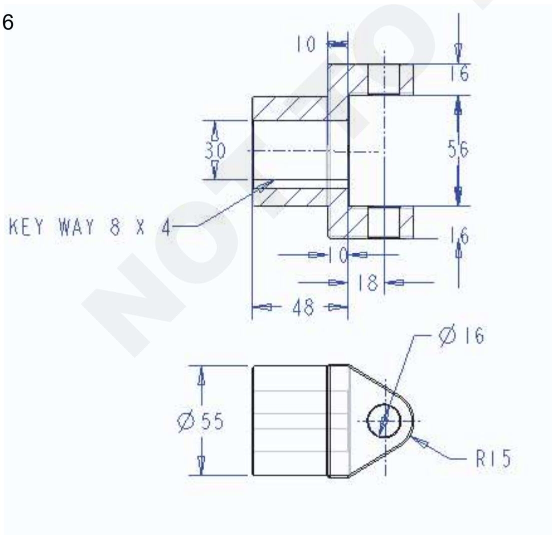
- Draw circle with dia. of 16 mm on the faces of extrude to create circular holes as shown in Fig 5.

Fig 5



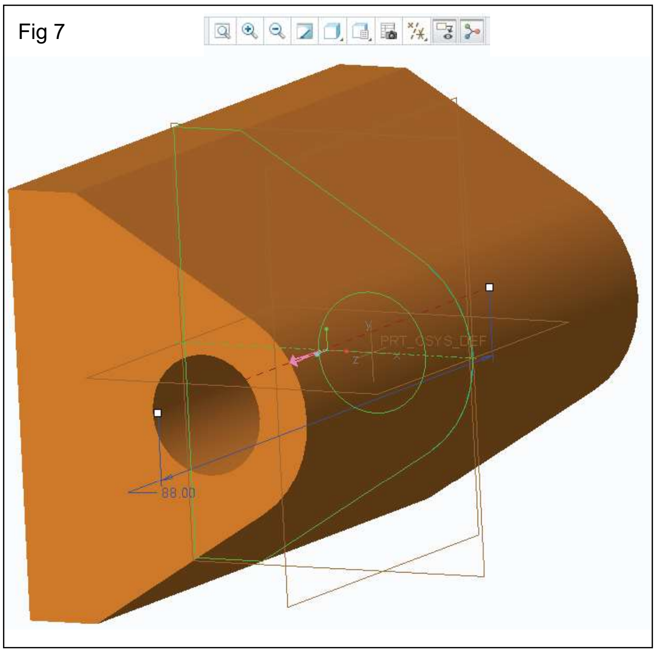
TASK 2: **Fork (Fig 6)**

Fig 6



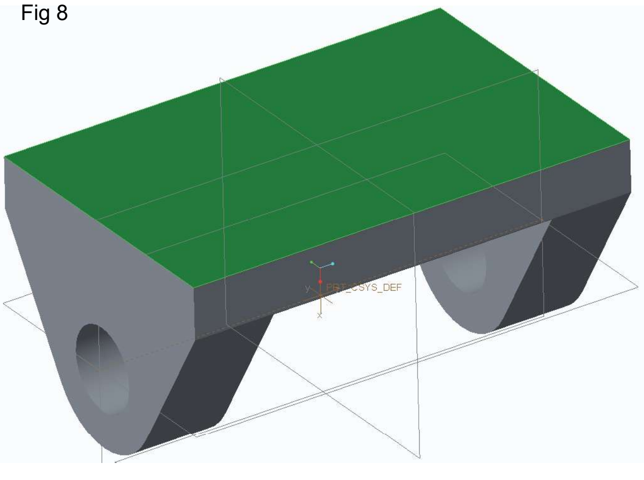
- Draw the solid as shown in Fig 7.

Fig 7



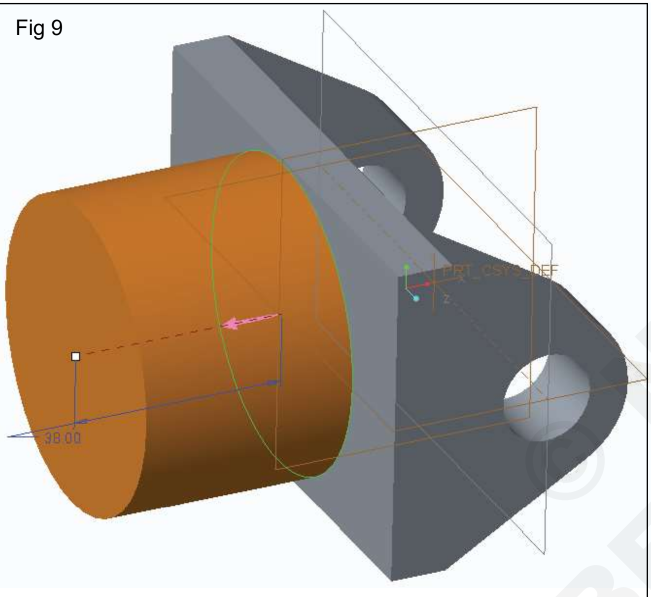
- Extrude cut the part as shown in Fig 8.

Fig 8



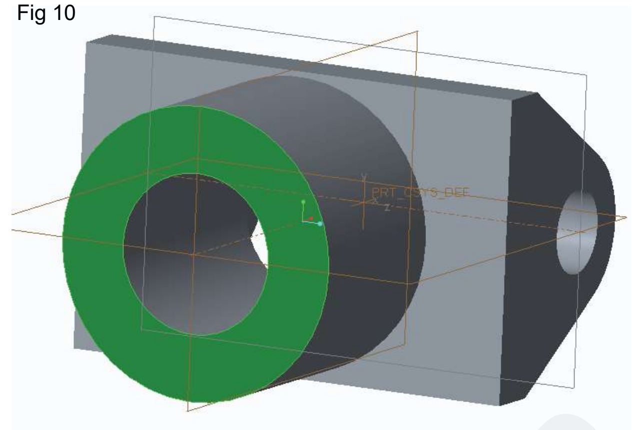
- Draw the solid as shown in Fig 9.

Fig 9



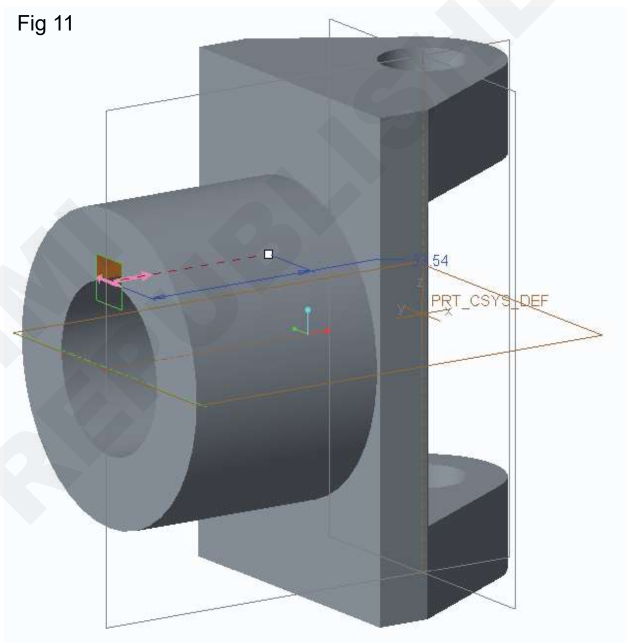
- Extrude the sketch (remove material) as shown in Fig 10.

Fig 10



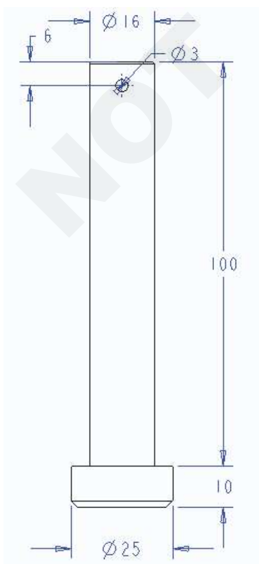
- Draw the key way as shown in Fig 11 and complete the centre block and save it.

Fig 11



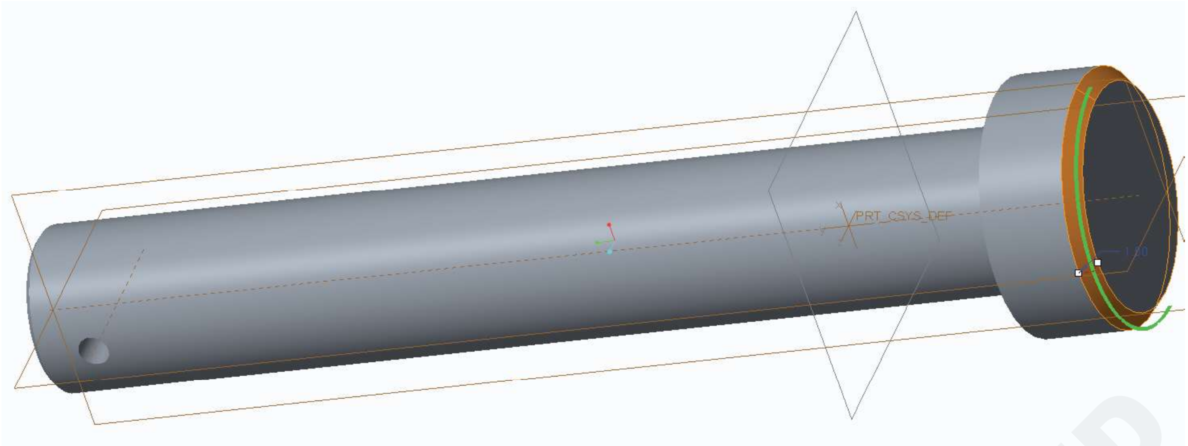
TASK 3: **PIN (Fig 12)**

Fig 12



- Sketch and do revolve the drawn sketch for the pin part as shown in Fig 13.

Fig 13



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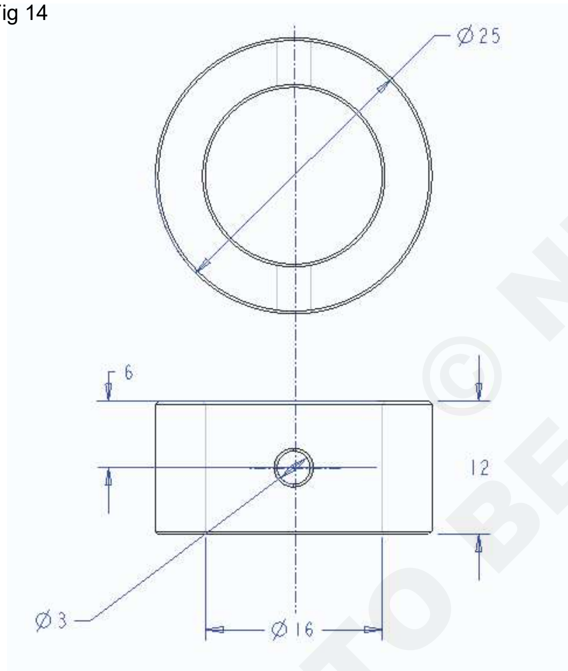
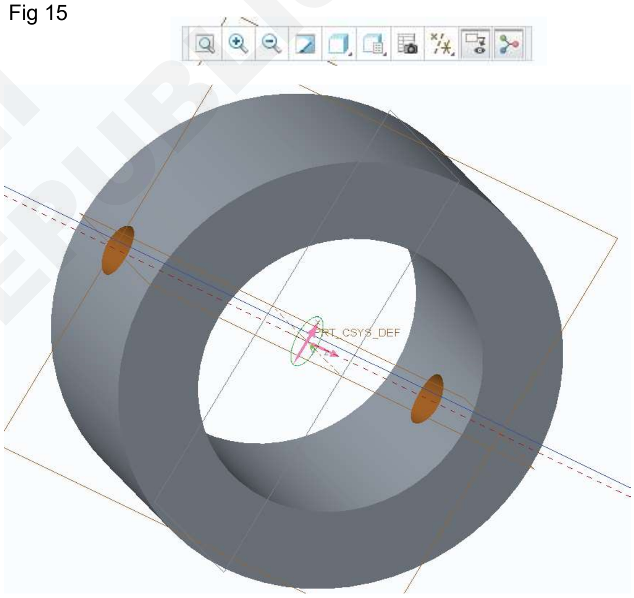
TASK 4: **Collar (Fig 14)**

Fig 14



- Sketch the solid as shown in Fig 15.

Fig 15



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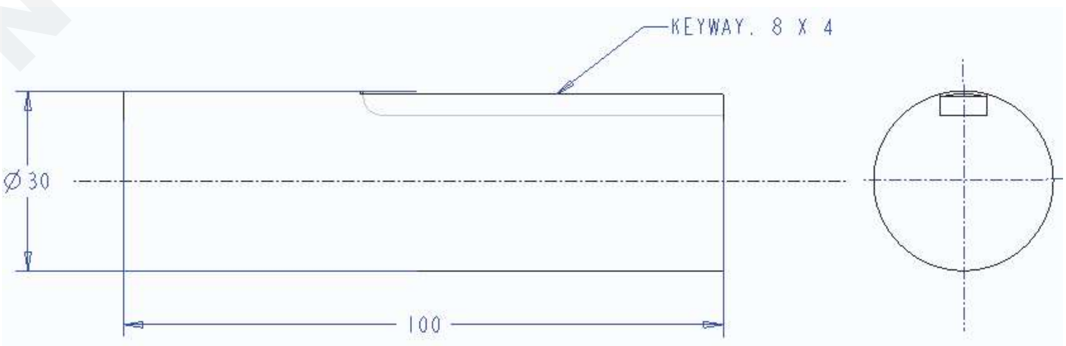
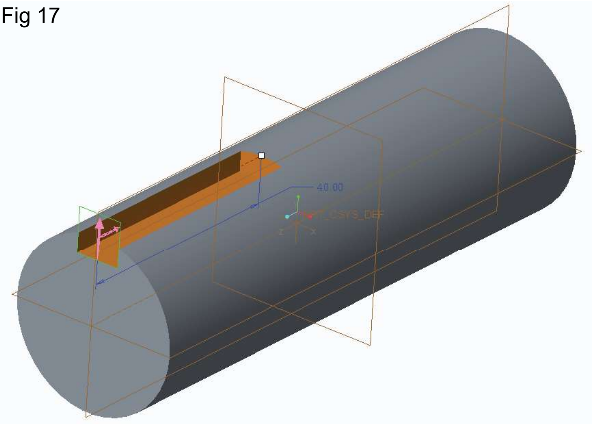
TASK 5: **Shaft (Fig 16)**

Fig 16



- Sketch the solid shaft with keyway as shown in Fig 17.

Fig 17



TASK 6: **Taper PIN (Fig 18)**

Fig 18

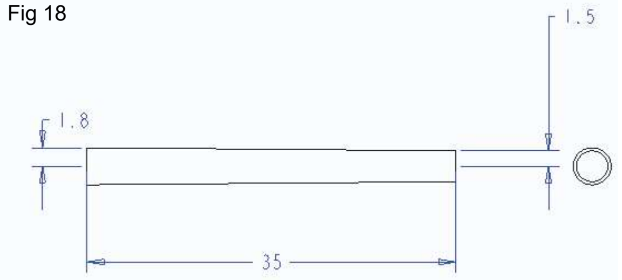
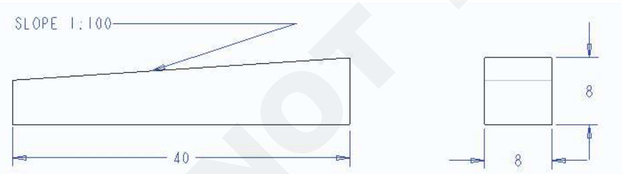


Fig 19

- Sketch the taper pin (solid) as shown in Fig 19 (use revolve/ blend).

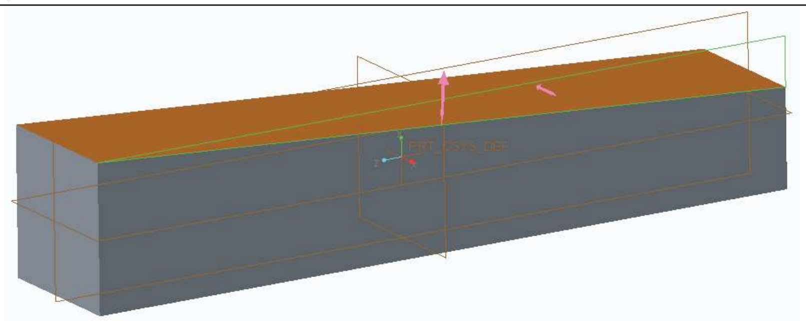
TASK 7: **KEY (Fig 20)**

Fig 20



- Sketch the solid as shown in Fig 21.

Fig 21



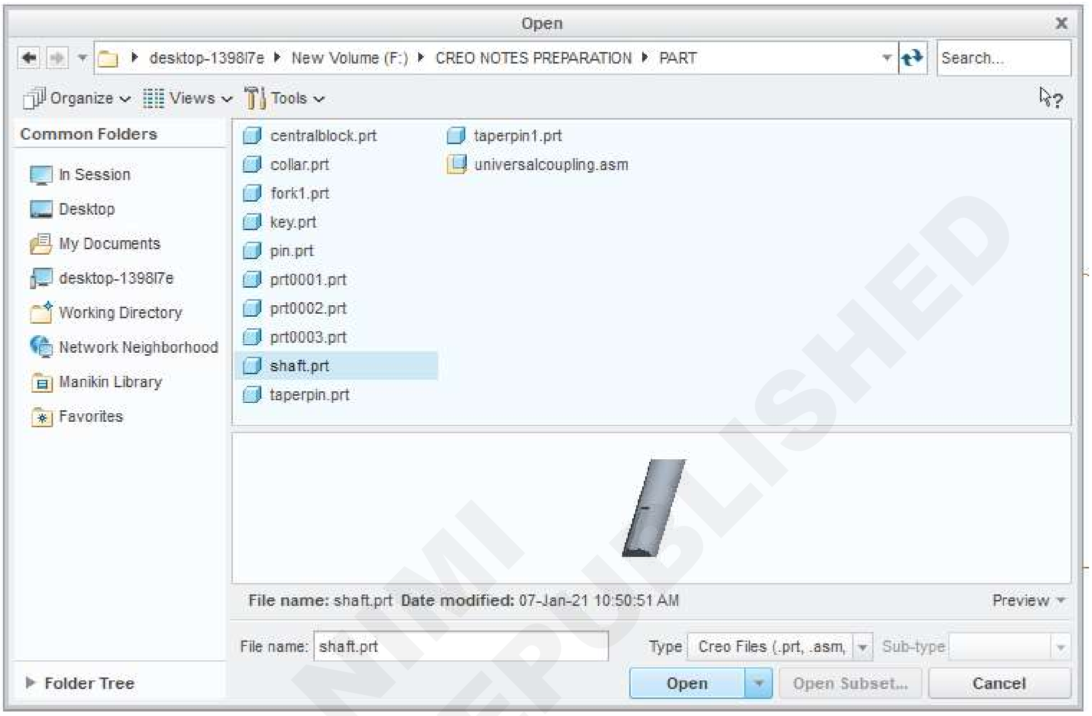
TASK 8: ASSEMBLY:

Step 1: To create a new assembly, select the new option dialog box appears, select assembly in type and Design in sub type, Give the name as universal coupling unselect the use default template and select ok

Step 2: New file option dialog box open select desired template mostly mmns-assmm-design select ok option.

Step 3: Select Assemble option in the component dialog box in ribbon The open dialog box appears choose the directory in which the part components are saved select the shaft file Select ok. (Fig 22)

Fig 22



Step 4: First import the shaft file into the assembly area use 3D dragger to move or rotate the components use constraints to define constraint set let the shaft be constrained as user defined. In component reference shaft be automatic to the assembly reference. (Fig 23)

Step 5: Next repeat the step 3 to open the next component fork. In component reference select the coincide option. This is done by selecting the cylindrical face of shaft & cylindrical face of hole in the fork. (Fig 24)

Fig 23

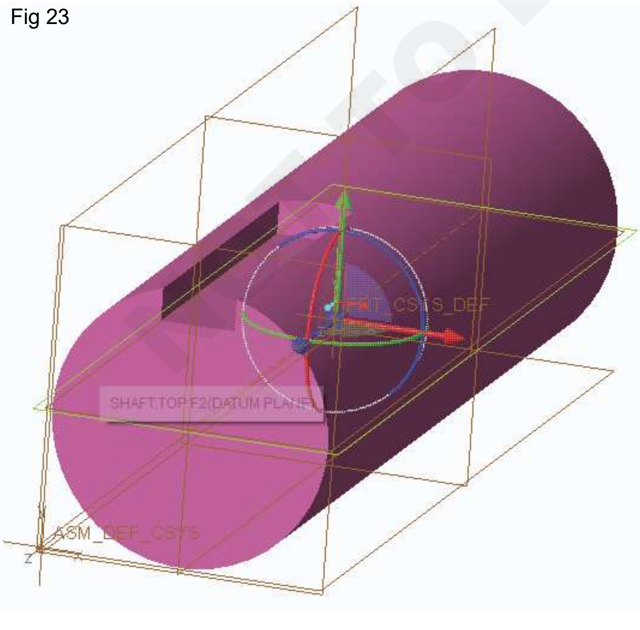
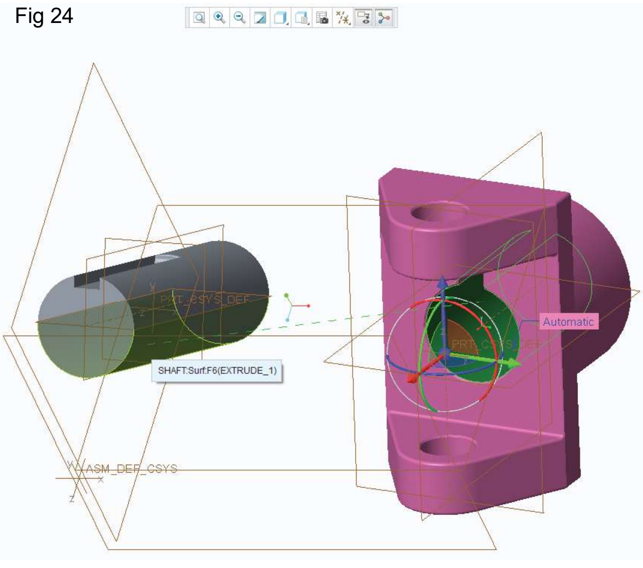


Fig 24



Step 6: Flip constraint options are used if the components needs to be flipped as per our required direction.

Step 7: Continuously select the constraints for the assembly process select the flat face of the shaft (Turns green) and select face of the fork. (Figs 25 & 26)

Fig 25

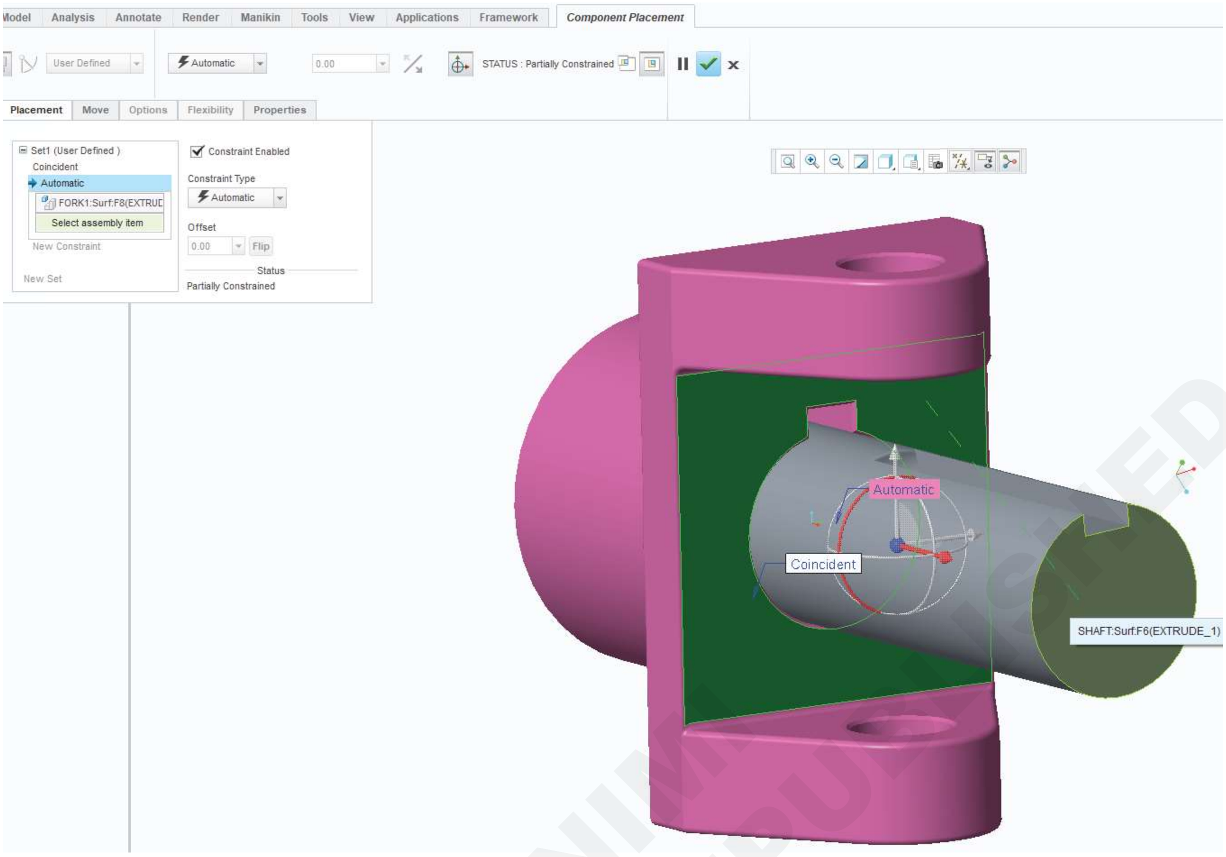
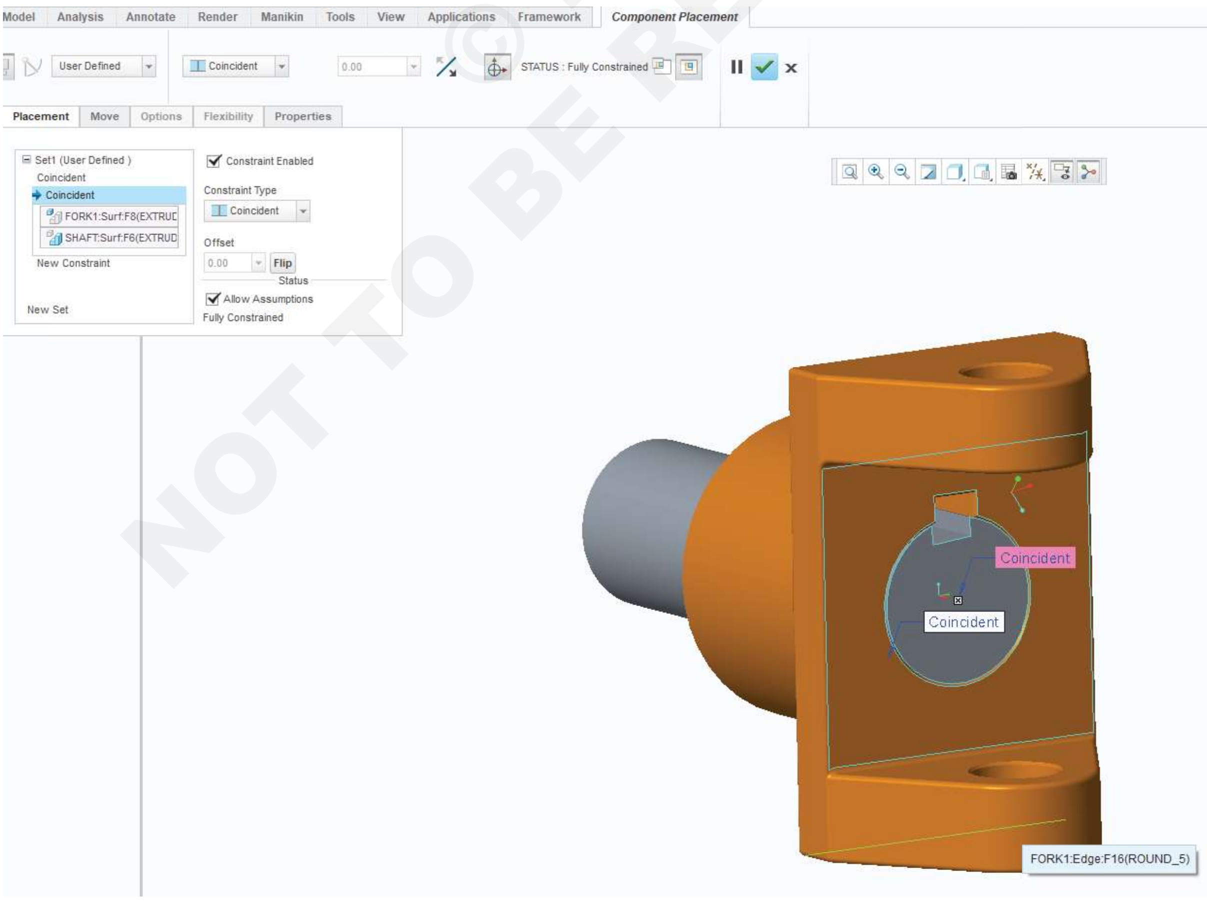
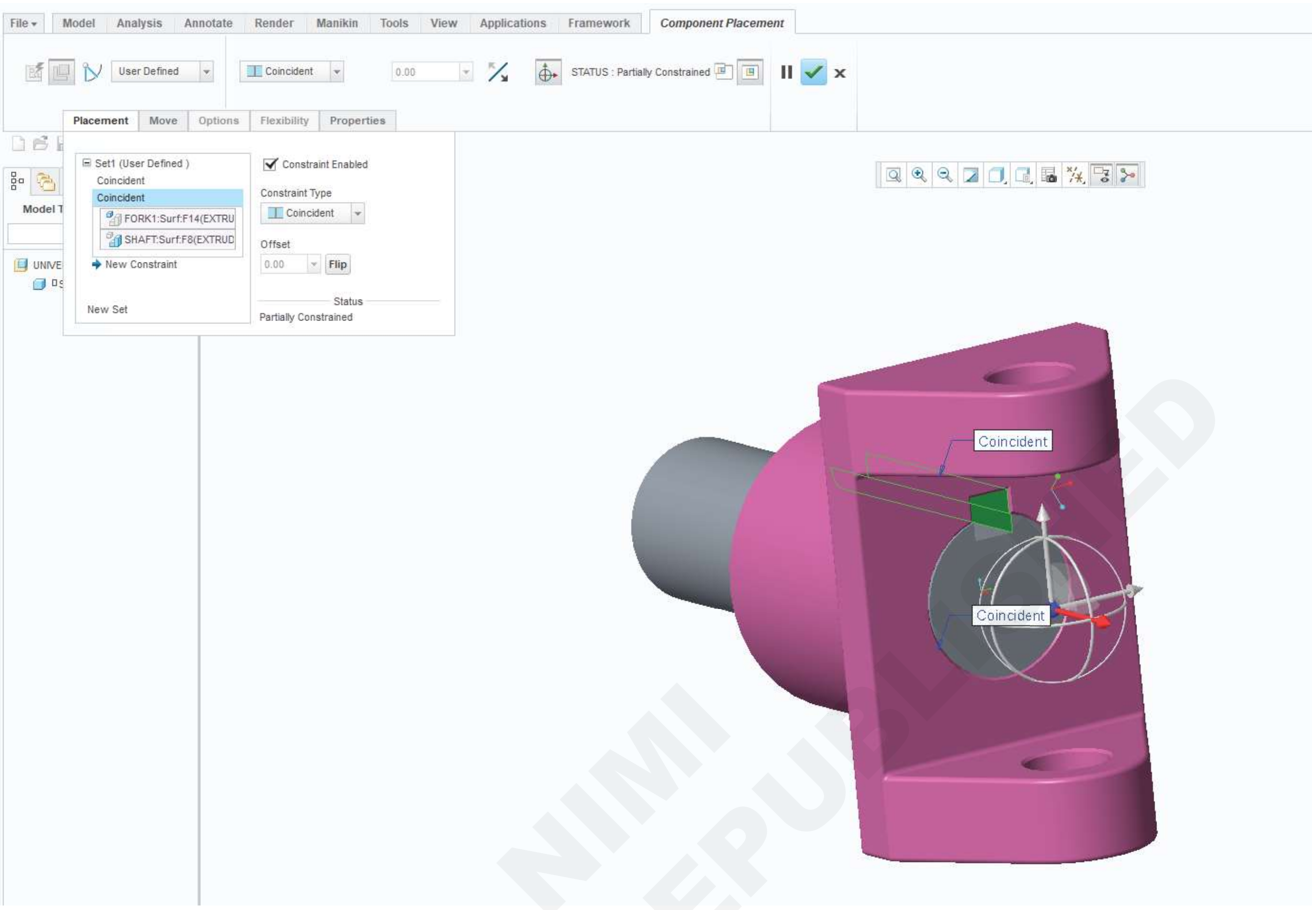


Fig 26



Step 8: The component reference for mating displayed as Distance select coincide The two components get mated. Give the constraint as such the key way of shaft & fork are in line. (Fig 27)

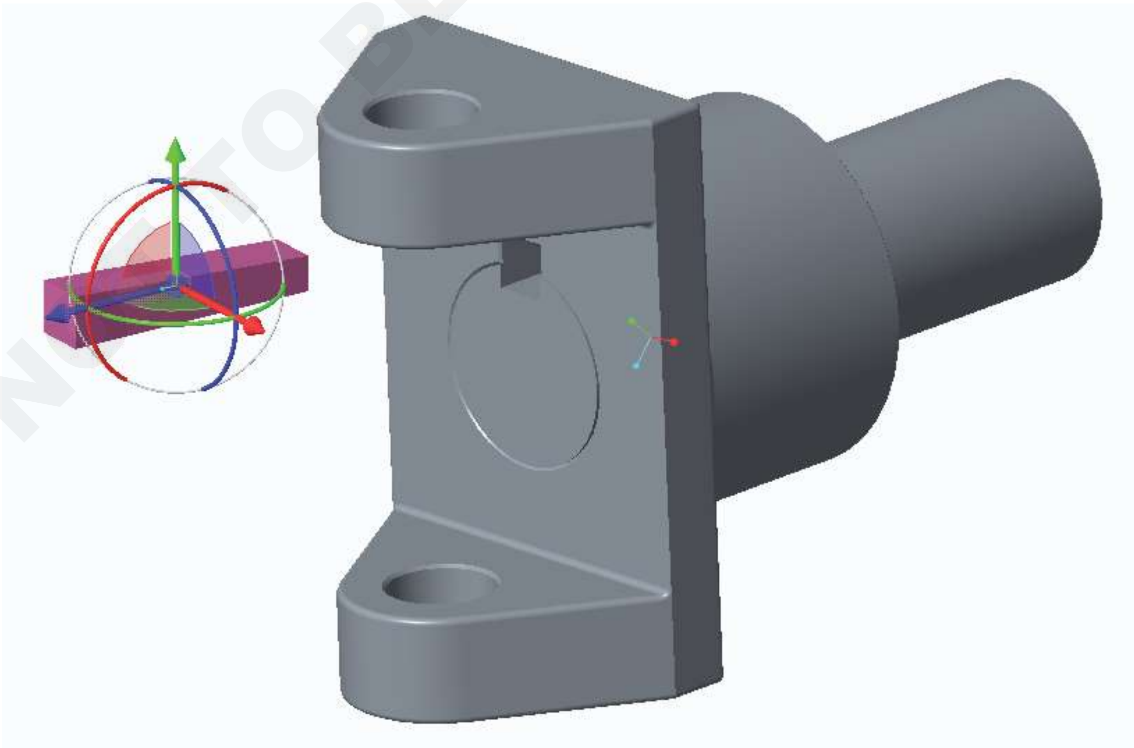
Fig 27



Step 9: Finally select ok option.

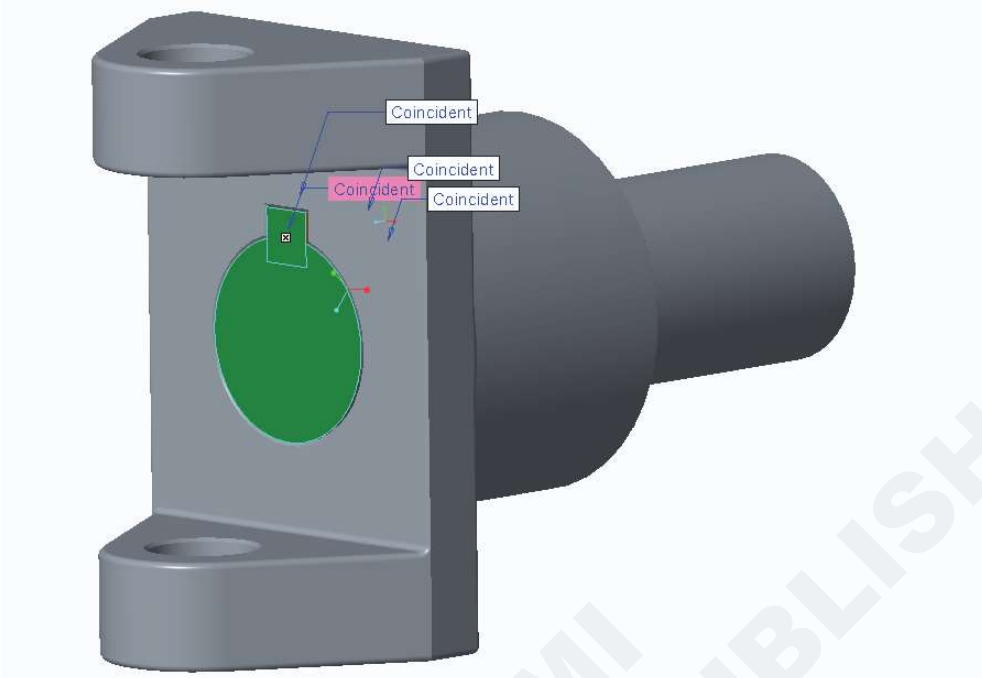
Step 10: Repeat step 3 to import taper key component to the assembly area. (Fig 28)

Fig 28



Step 11: Select the front face of the shaft / fork & front face of taper key to coincide, & side face of taper key with side face of key way hole of fork to coincide, & bottom edge of (parallel face side) taper key to bottom edge of key way in shaft to coincide. (Fig 29)

Fig 29



Step 12: The mating of components can be edited by selecting the edit definition option in model tree by right click.

Step 13: Save this as a separate assembly.

Step 14: Import centre block by repeating step 3 (Figs 30&31)

Fig 30

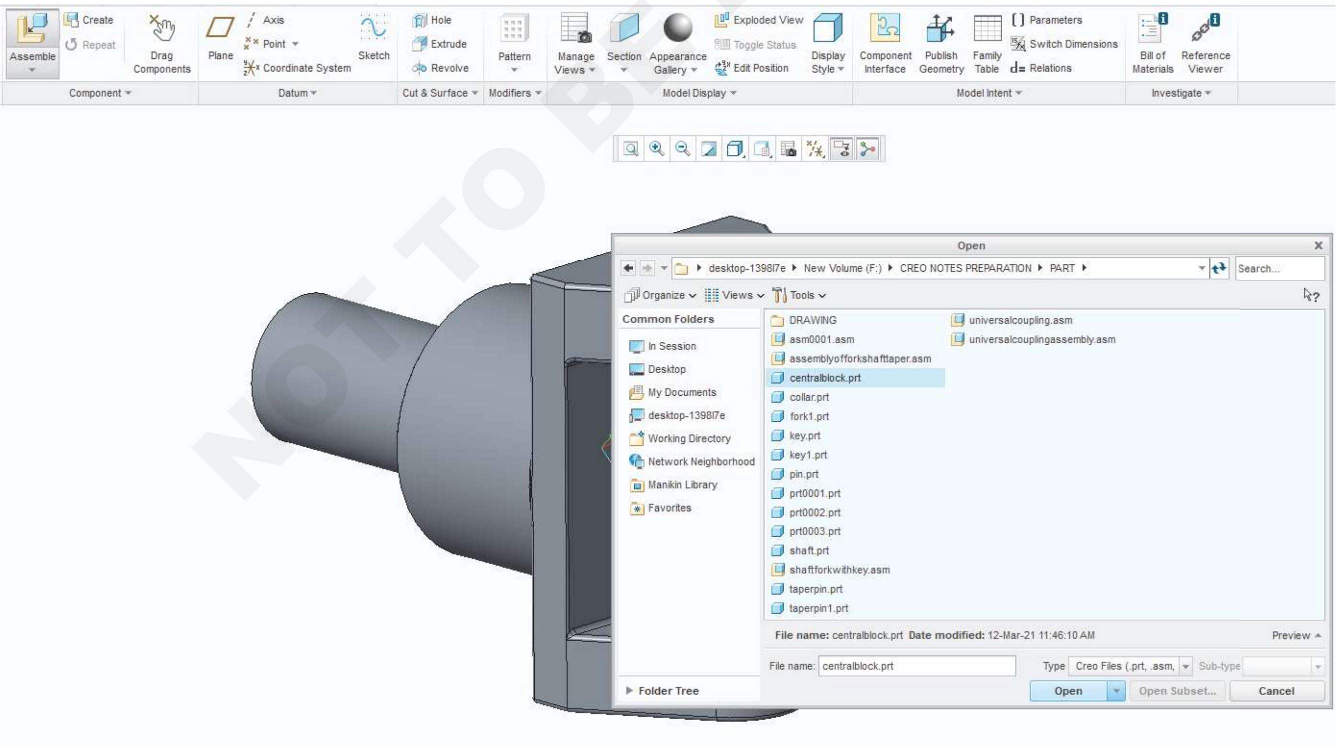
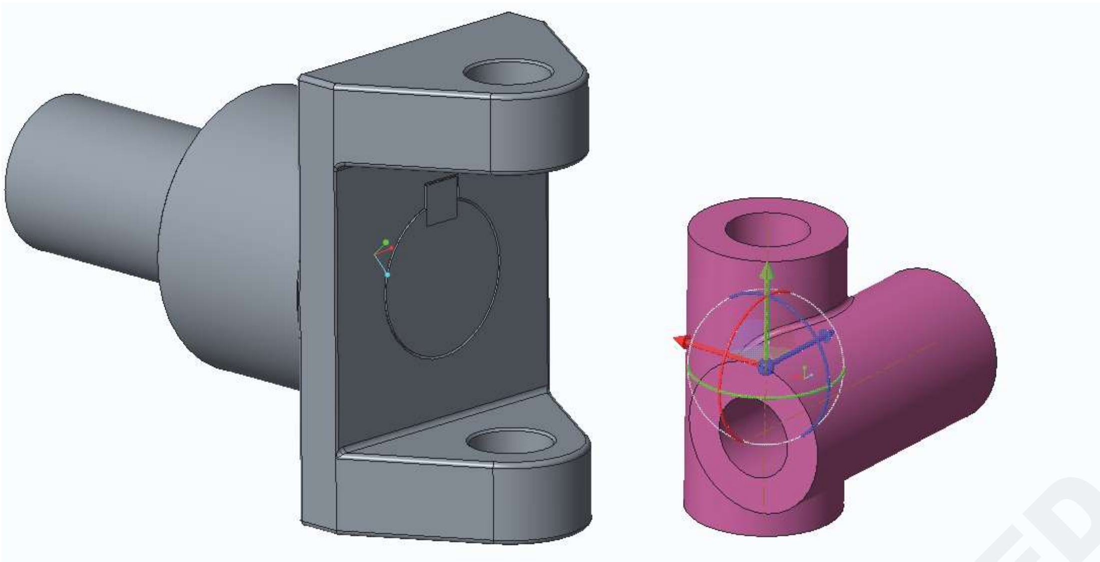


Fig 31



Step 15: Select the interior hole face of centre block and fork hole cylindrical face to coincide and then select side face of the centre block & fork to coincide. (Figs 32&33)

Fig 32

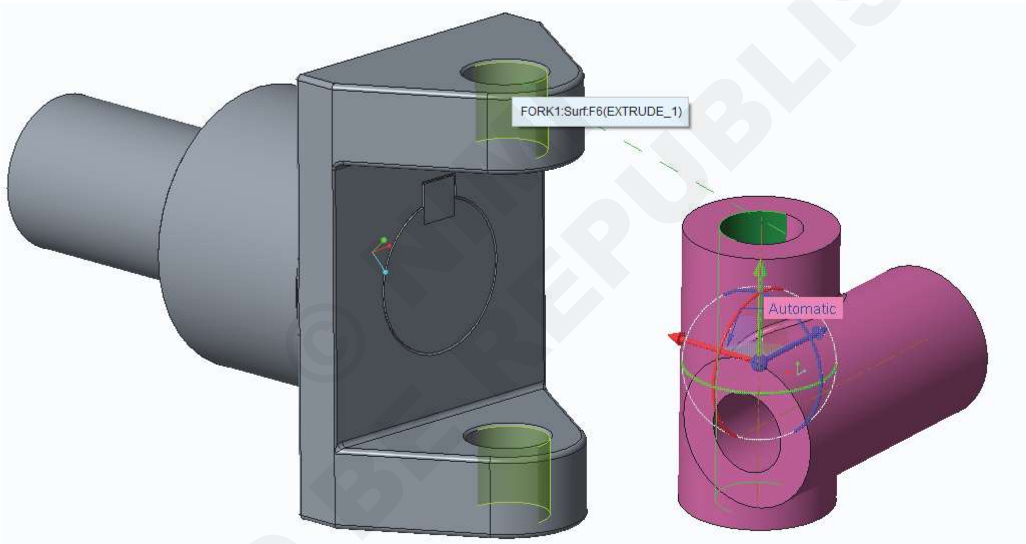
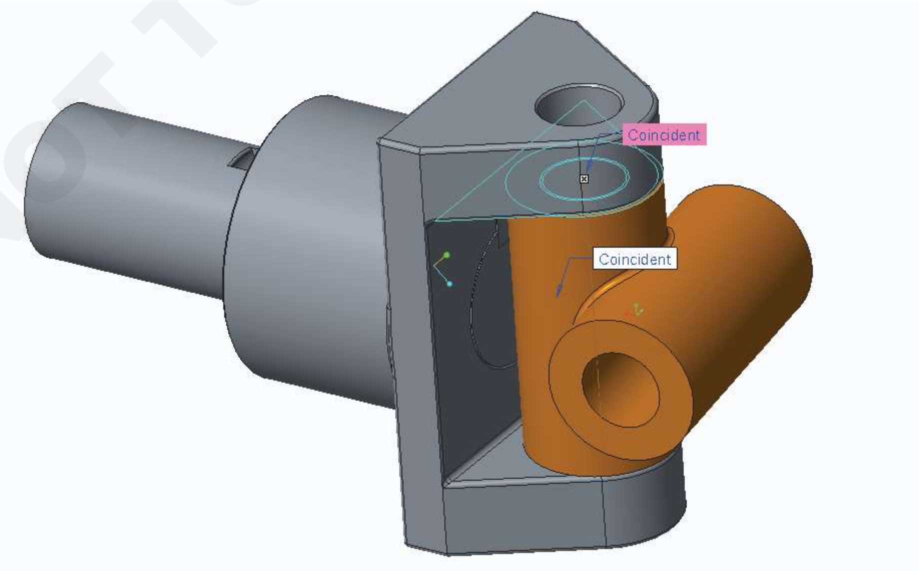
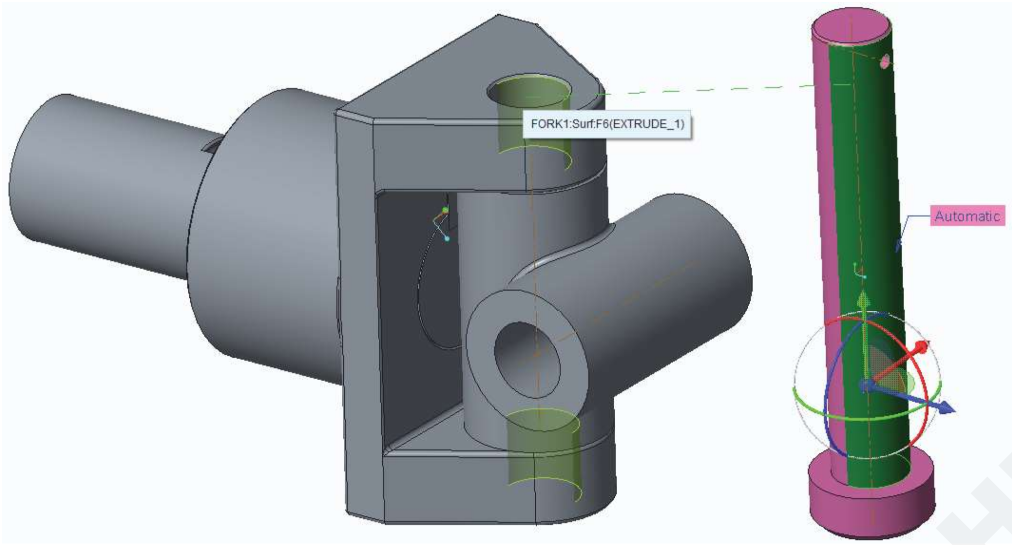


Fig 33



Step 16: Next repeat the step 3 to open the next component Pin. In component reference select the coincide option. This is done by selecting the cylindrical face of pin & cylindrical face of hole in, the fork center block. (Fig 34)

Fig 34



Step 17: Select the outside face of holding arm of fork & pin head bottom face to coincide constrain in component reference. (Figs 35,36&37)

Fig 35

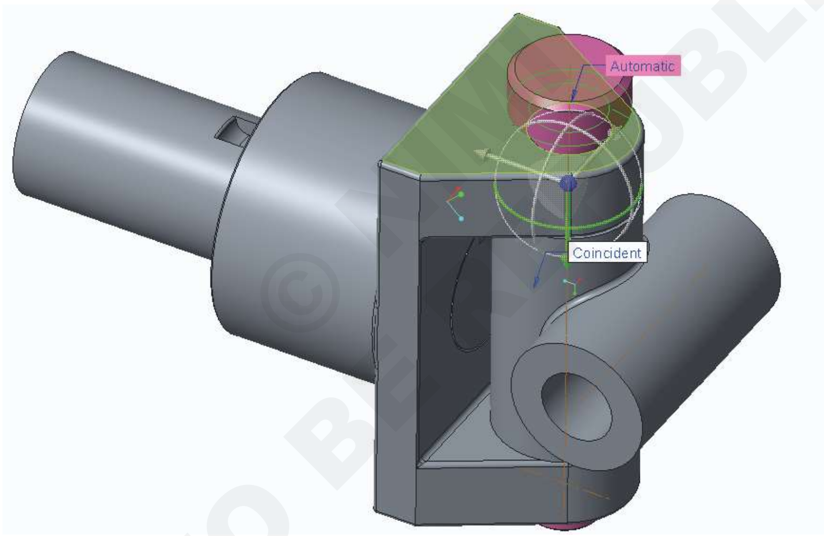


Fig 36

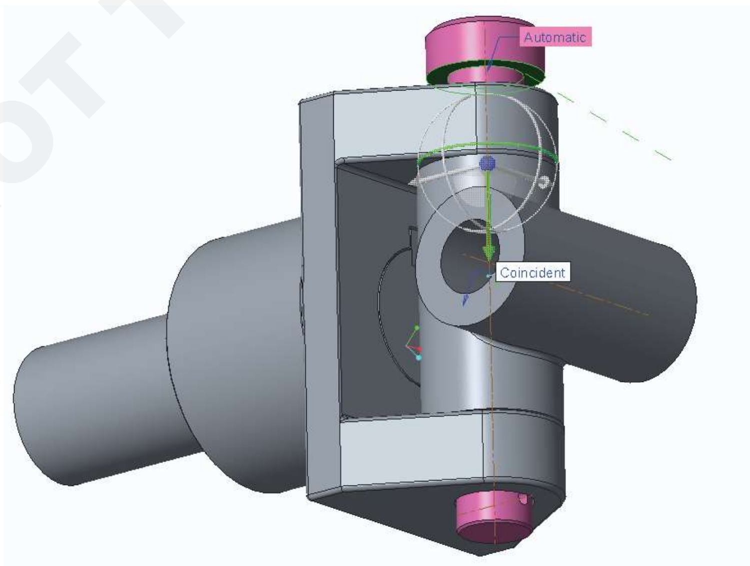
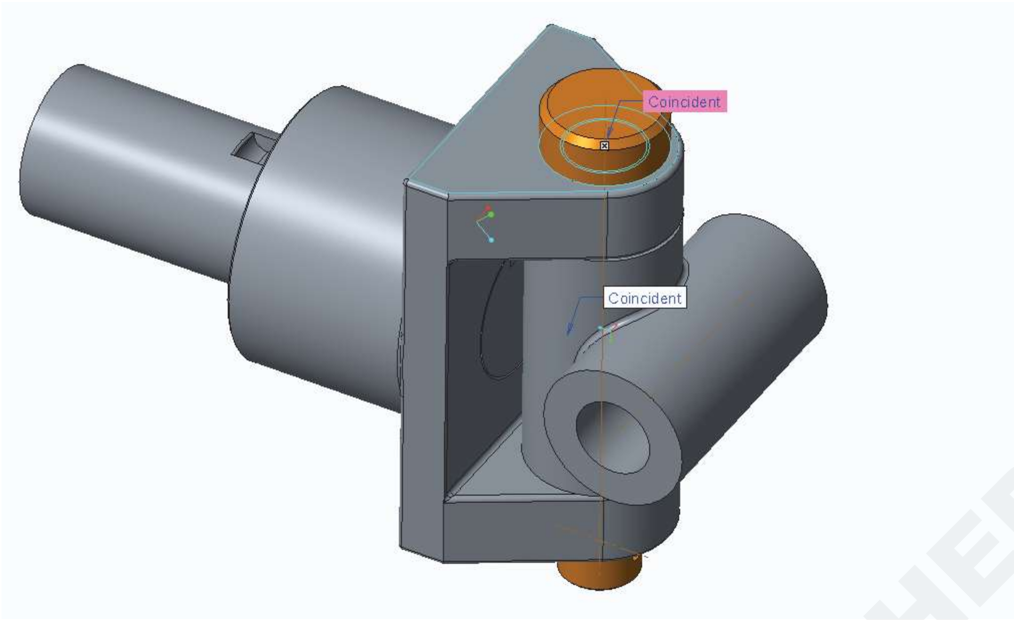
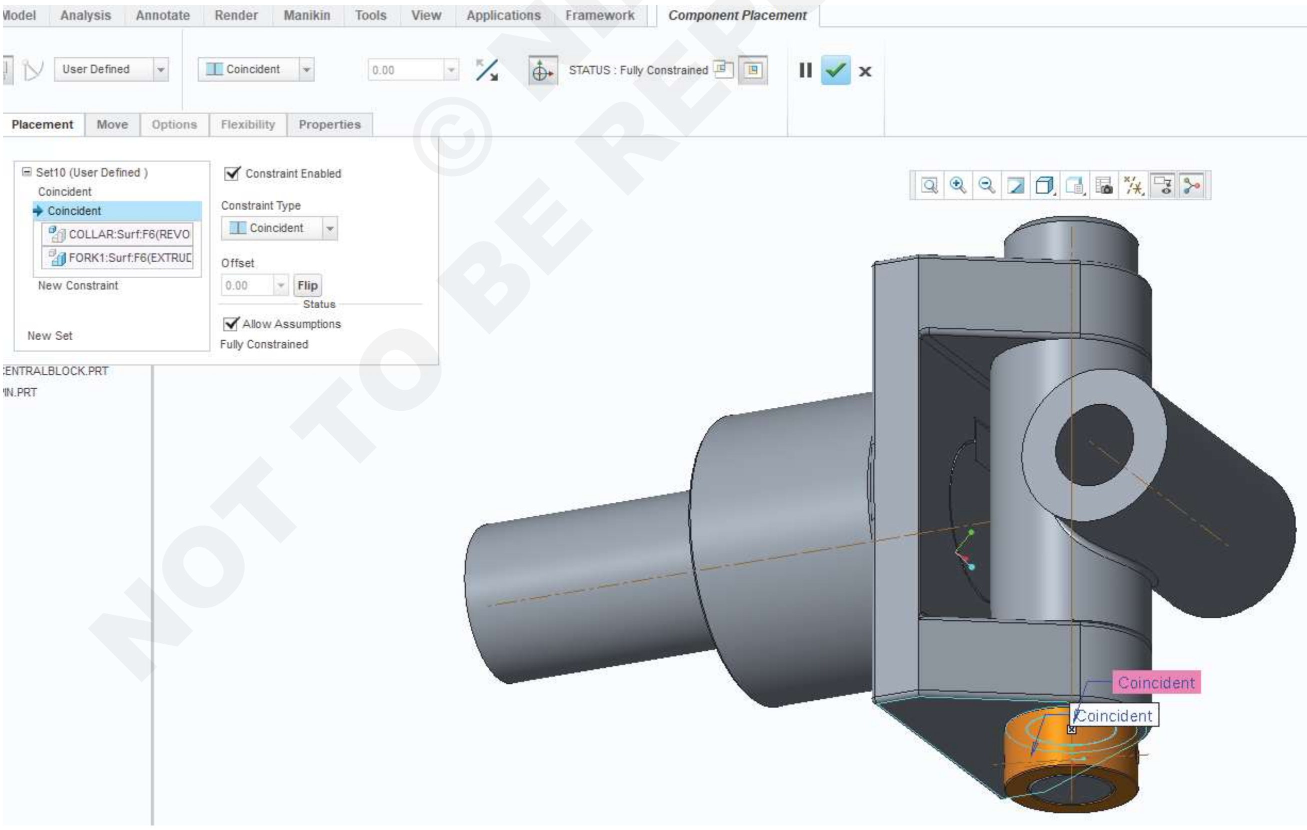


Fig 37



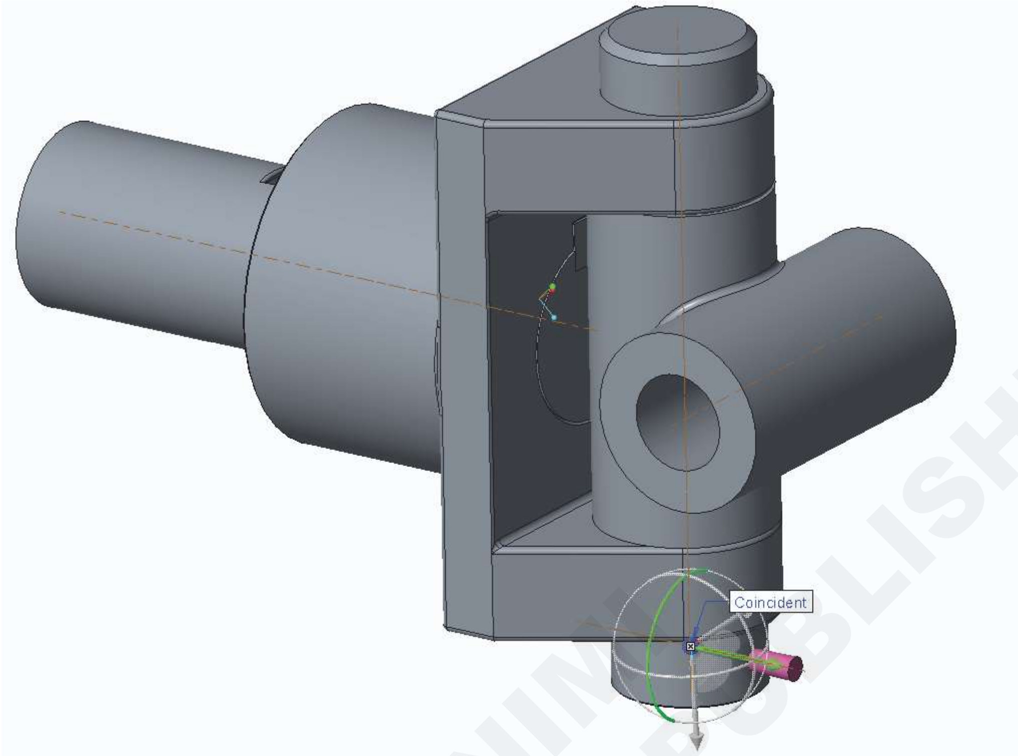
Step 18: Select / Insert collar by repeating the step 3 Select the cylindrical face of collar and cylindrical face of pin-select coincide as component mate reference and select coincide of axis for collar taper pin hole to pin-taper pin hole. (Fig 38). Click ✓ ok option.

Fig 38



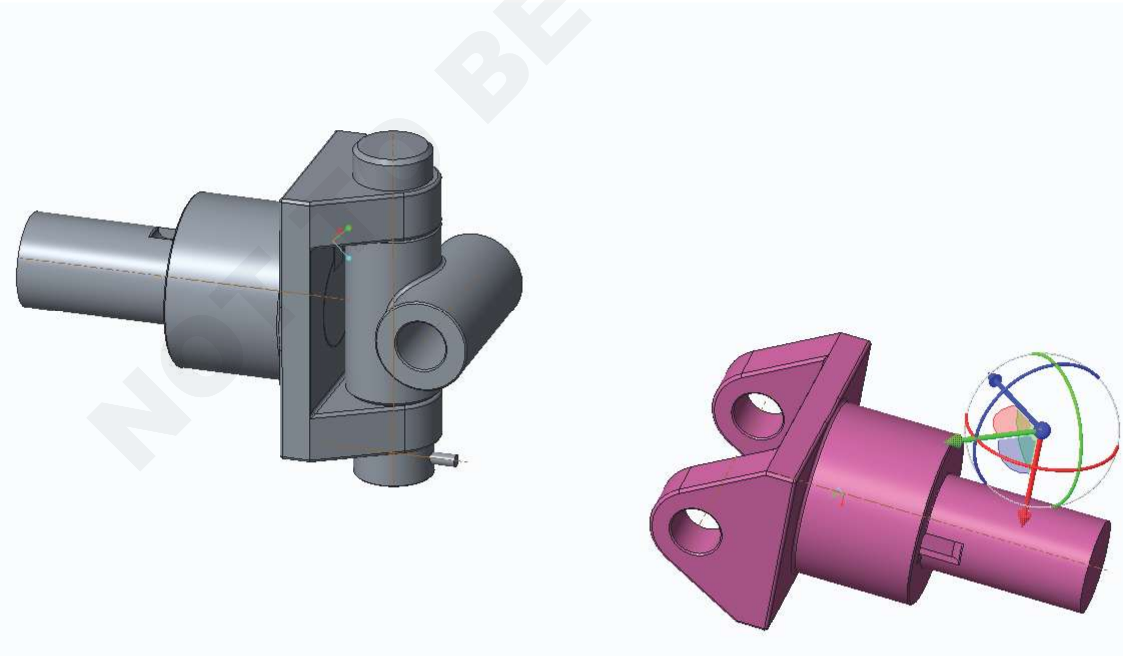
Step 19: Open taper pin by selecting assemble.In component ref. Select axis of taper pin & collar axis coincide - move pin vertically by using 3D dragger- accordingly to match the correct fit. Select ok option. (Fig 39)

Fig 39



Step 20: By selecting assemble option insert assembly saved in step 13. (Fig 40)

Fig 40



Step 21: In component reference select internal cylindrical pin hole face of fork with centre block, hole as coincide & select internal face of holding arm of fork with centre block face as coincide. (Fig 41)

Step 22: Select ok option, Repeat the step 16 to 19 for another arm of centre block for final assembly. (Fig 42)

Step 23: Save the assembly [universal coupling]. (Fig 43)

Fig 41

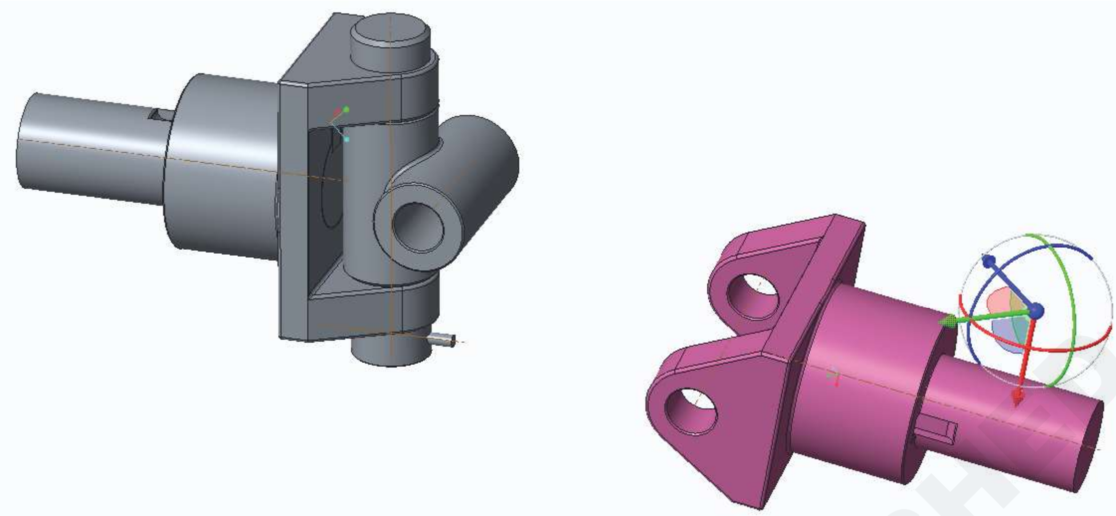


Fig 42

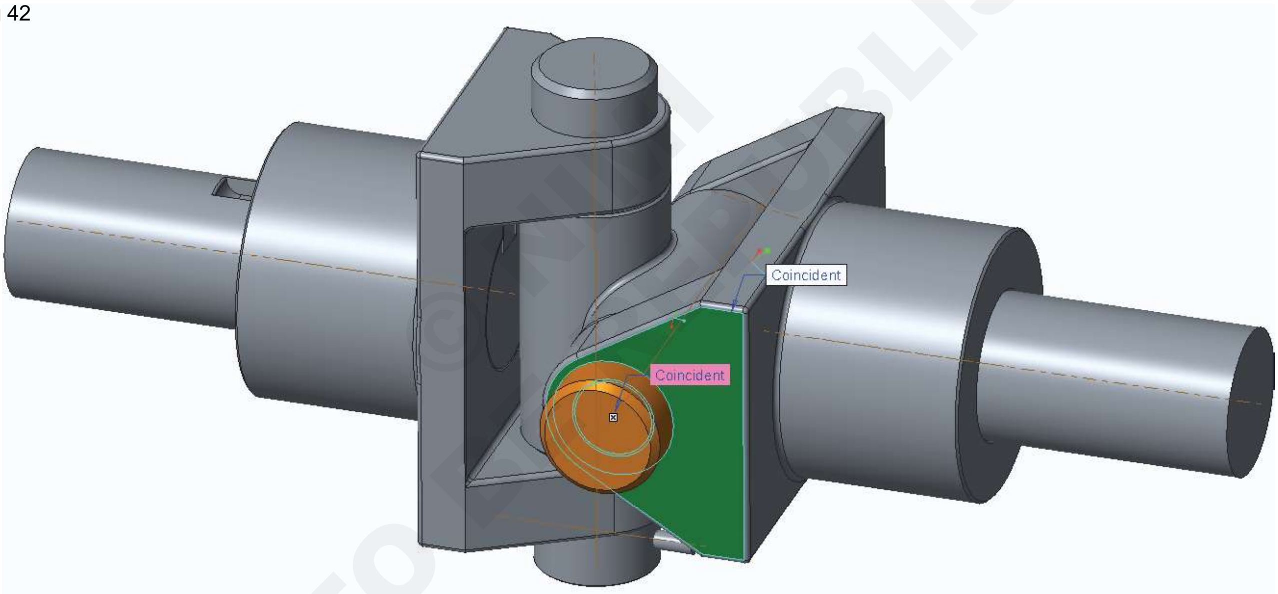
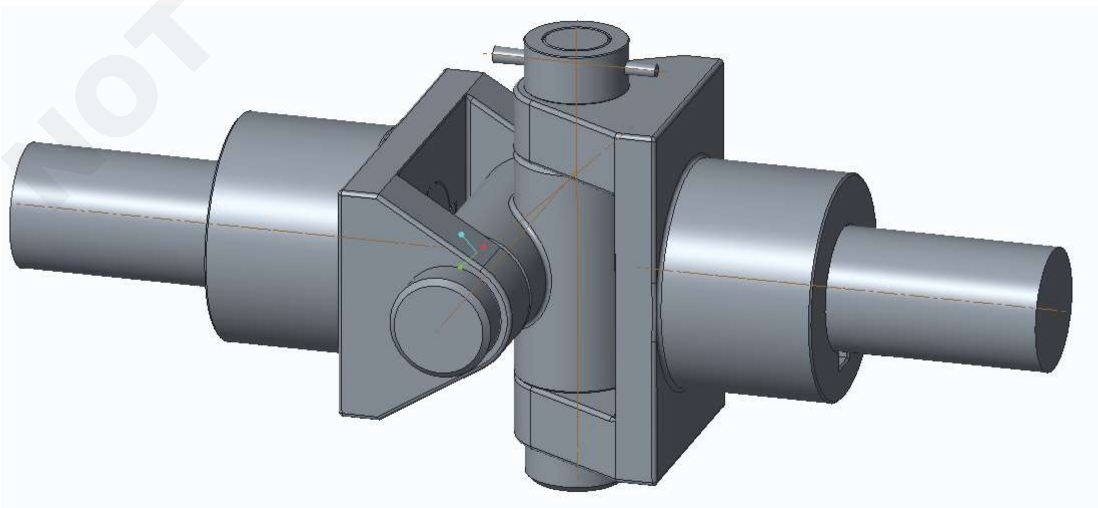


Fig 43



Step 24: To give appearance for the assembly - select appearance gallery in model display (Fig 44), Select the required appearance of colour from my appearance, select the colour with right click of mouse button- Brush symbol appears select the component,Give/select ok option or click the middle scroll button of the mouse (Figs 45&46). Repeat the step to give different appearance for all the components in the assembly(Figs 47&48).

Fig 44

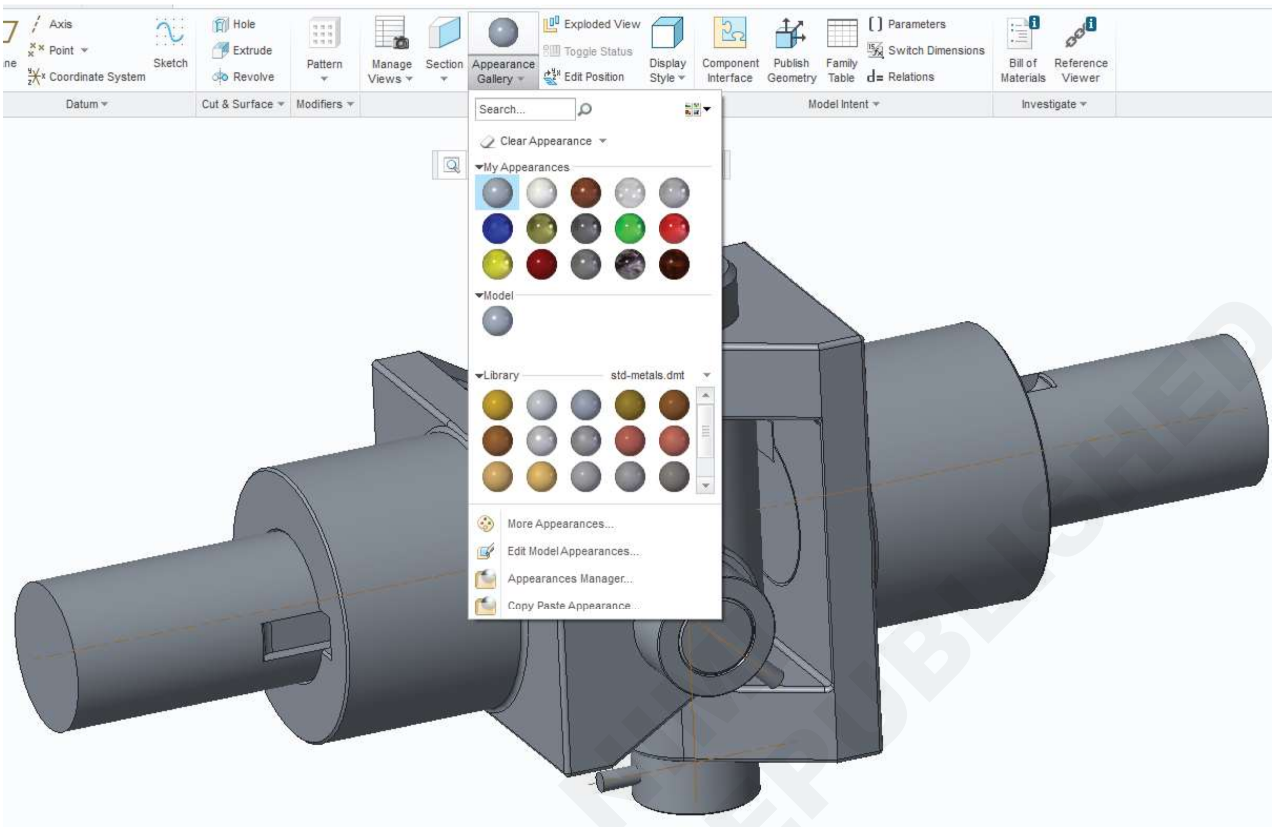


Fig 45

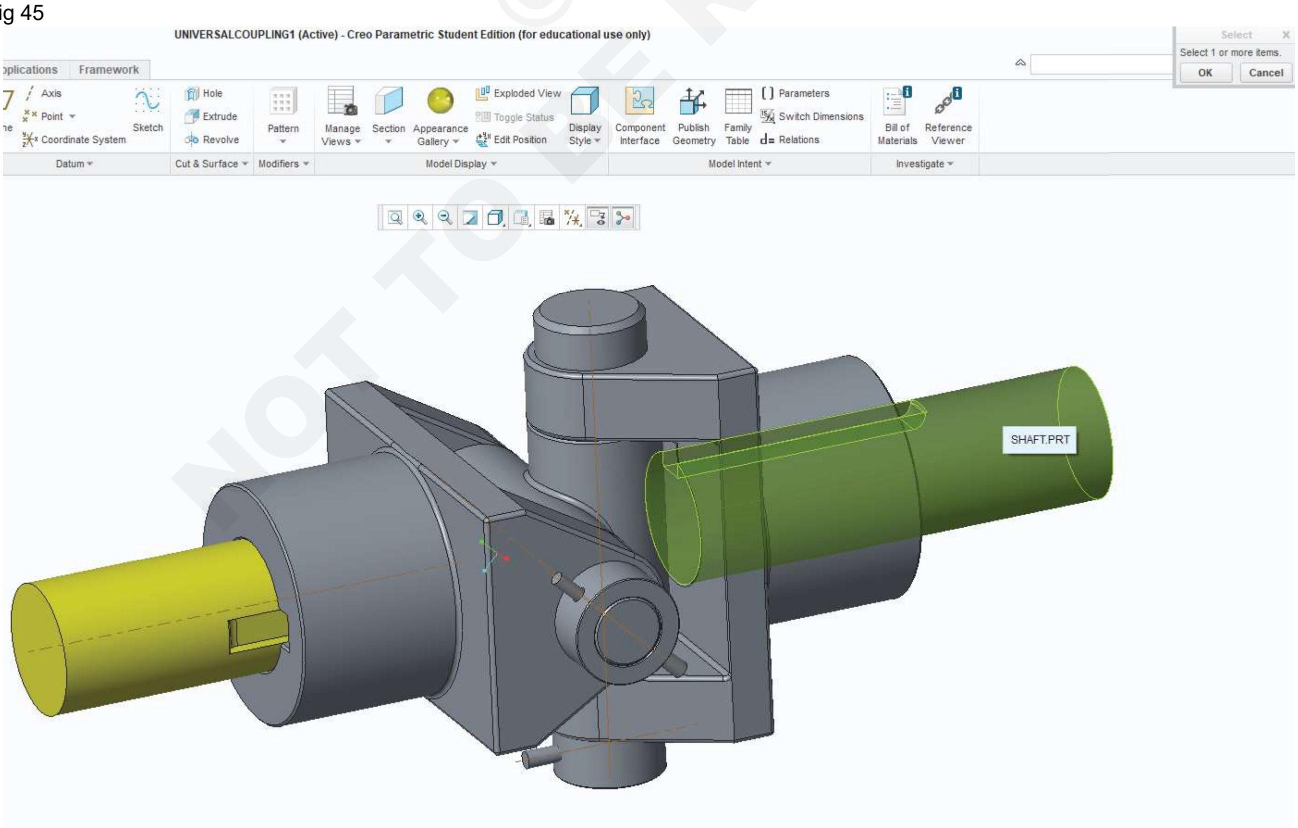
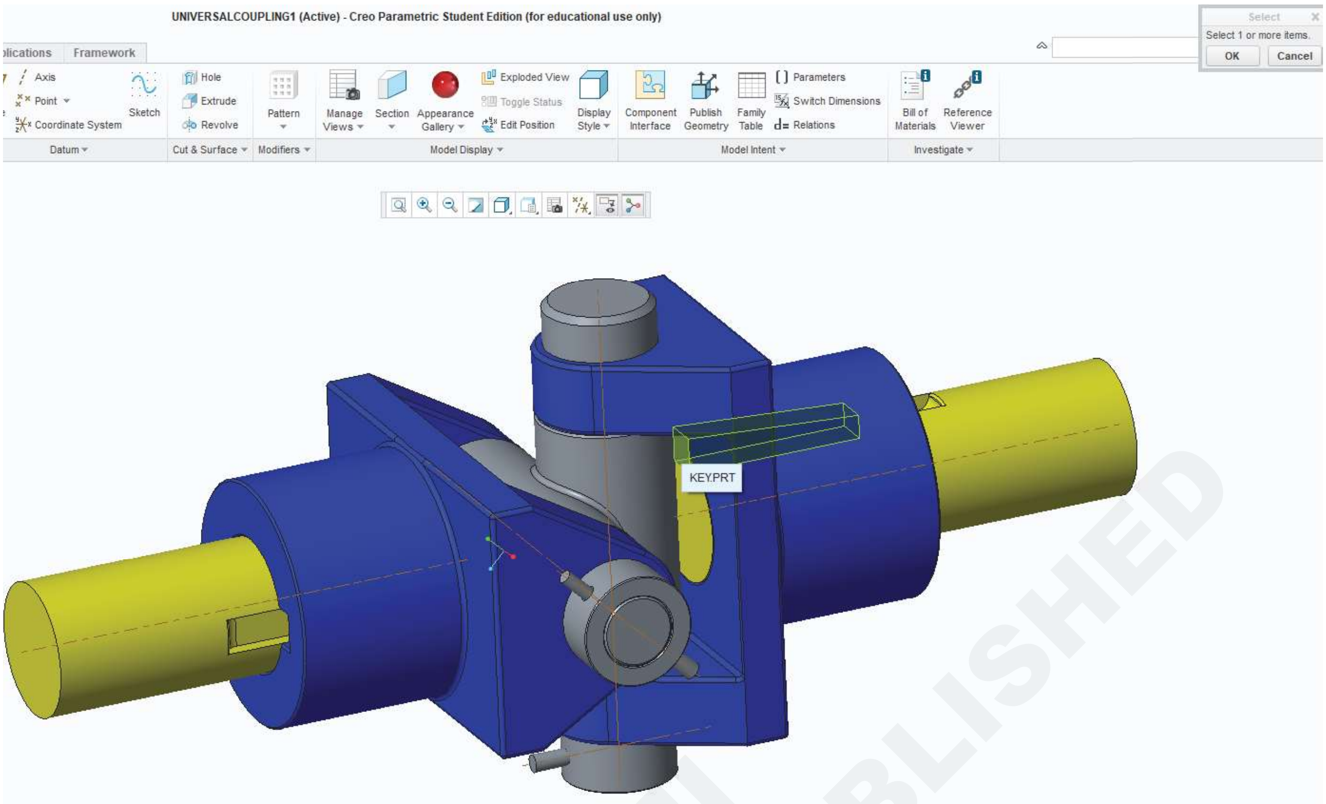


Fig 46


UNIVERSALCOUPLING1 (Active) - Creo Parametric Student Edition (for educational use only)
Framework
Axis
Point
Coordinate System
Sketch
Hole
Extrude
Revolve
Pattern
Manage Views
Section
Appearance Gallery
Exploded View
Toggle Status
Edit Position
Display Style
Component Interface
Publish Geometry
Family Table
Parameters
Switch Dimensions
Relations
Bill of Materials
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OK
Cancel
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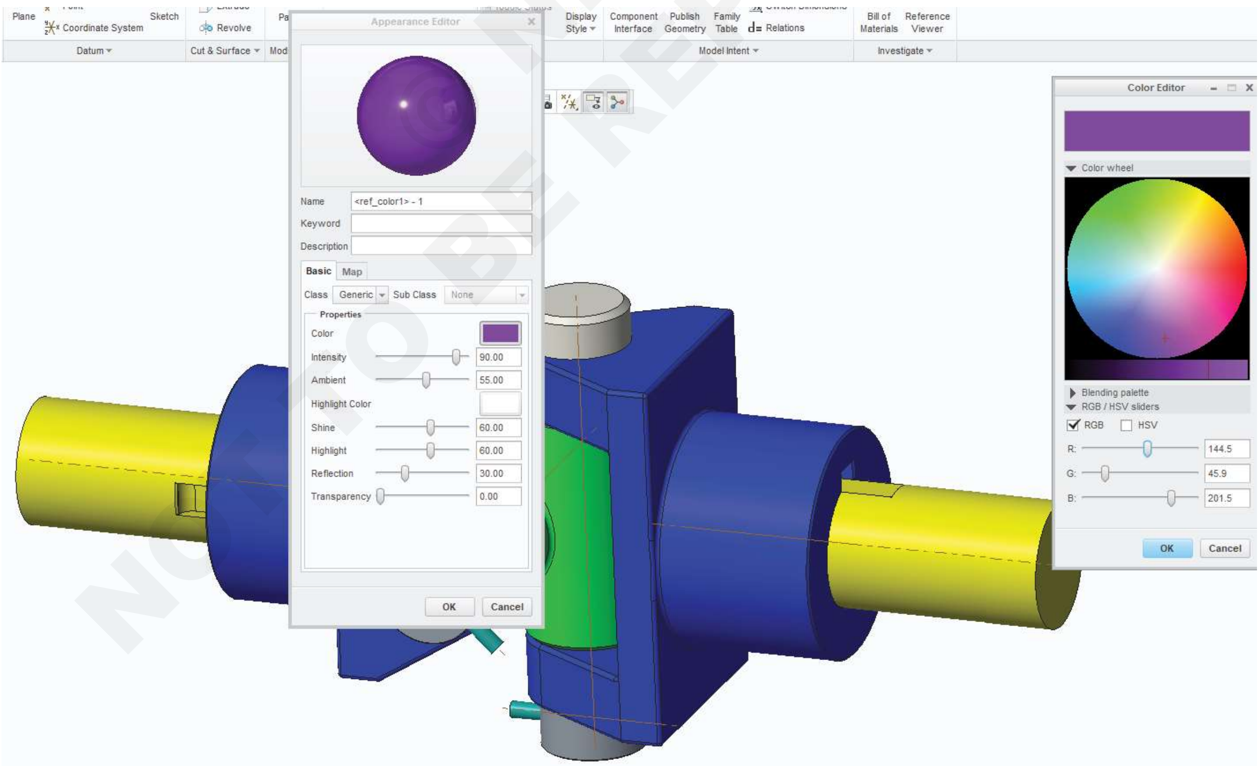
Fig 47


Appearance Editor
Name
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Sub Class
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Transparency
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OK
Cancel
Color Editor
Color wheel
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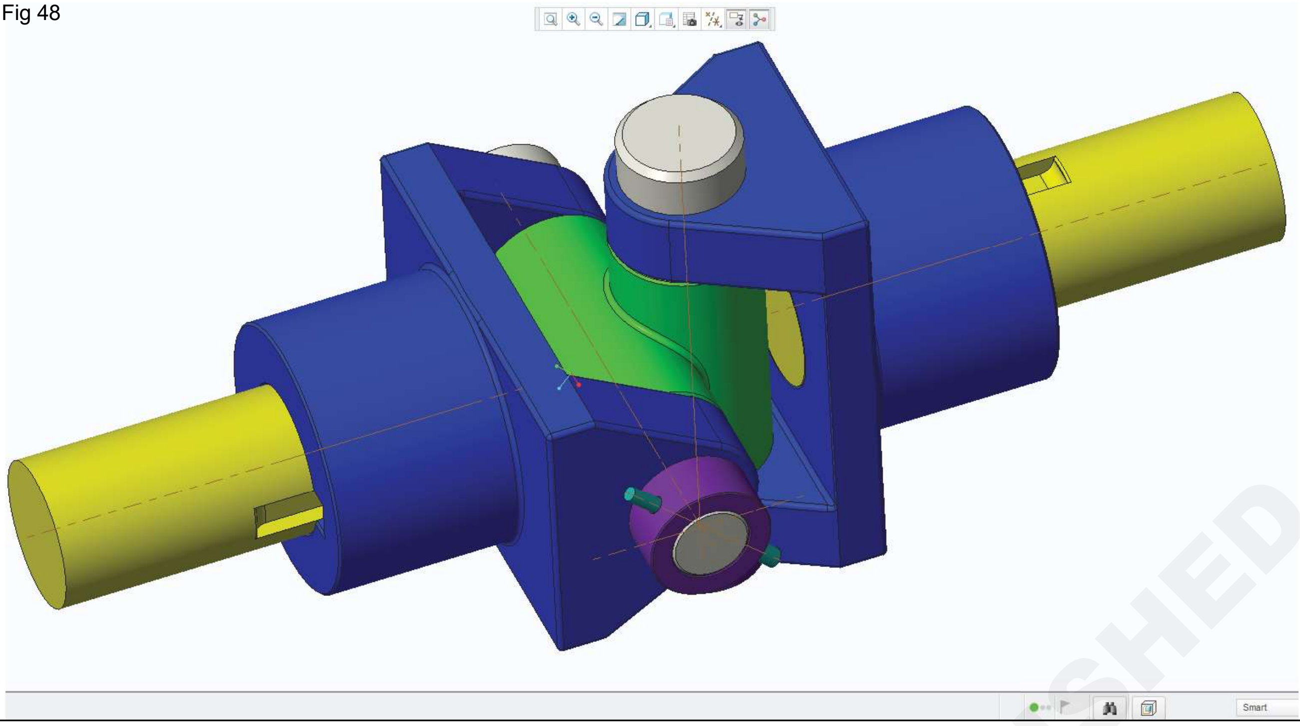
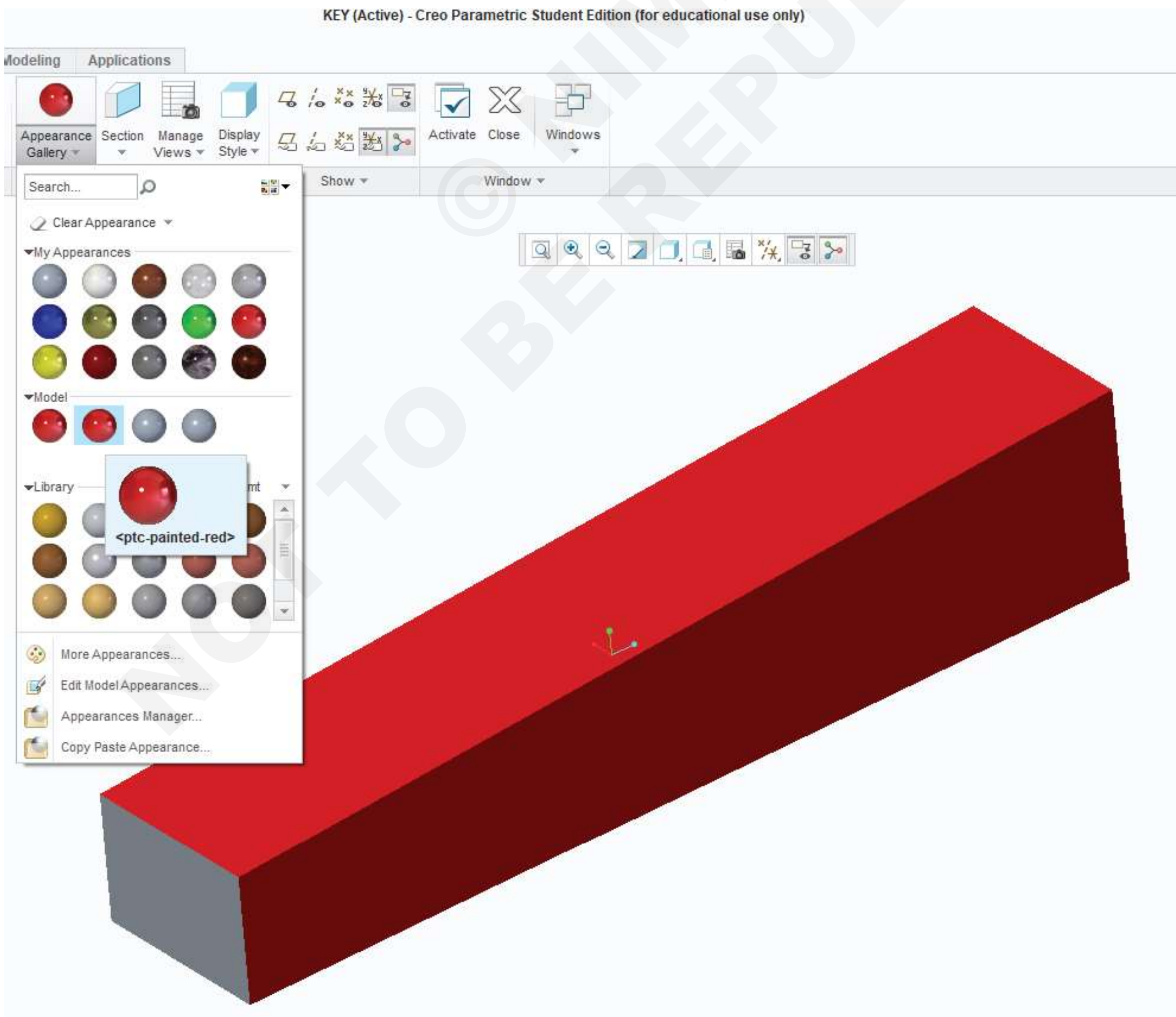
Fig 48



Step 25: Appearance can also be given for each parts individually apart from the assembly, in part window select view - tab ⟶ Appearance gallery. (Fig 49)

Fig 49



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