WORKSHOP CALCULATION & SCIENCE

(NSQF)

2nd YEAR

(As per Revised Syllabus July 2022)

Mechanical Agricultural Machinery

Directorate General of Training

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

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

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Workshop Calculation & Science

Mechanical Agricultural Machinery - 2nd Year NSQF

As per Revised Syllabus July 2022

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FOREWORD

The Government of India has set an ambitious target of imparting skills one out of every four Indians, to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of comprising various stakeholder's 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 **Workshop Calculation & Science - Mechanical Agricultural Machinery 2nd Year** NSQF (Revised 2022) under CTS 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 trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

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

Jai Hind

ATUL KUMAR TIWARI, I.A.S.

Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

November 2023
New Delhi - 110 001

PREFACE

The National Instructional Media Institute(NIMI) was set up at Chennai, by the Directorate General of Training, Ministry of skill Development and Entrepreneurship, Government of India, with the technical assistance from the Govt of the Federal Republic of Germany with the prime objective of developing and disseminating instructional Material for various trades as per prescribed syllabus and Craftsman Training Programme(CTS) under NSQF levels.

The Instructional materials are developed and produced in the form of Instructional Media Packages (IMPs), consisting of Trade Theory, Trade Practical, Test and Assignment Book, Instructor Guide and Wall charts. The above material will enable to achieve overall improvement in the standard of training in ITIs.

A national multi-skill programme called SKILL INDIA, was launched by the Government of India, through a Gazette Notification from the Ministry of Finance (Dept of Economic Affairs), Govt of India, dated 27th December 2013, with a view to create opportunities, space and scope for the development of talents of Indian Youth, and to develop those sectors under Skill Development.

The emphasis is to skill the Youth in such a manner to enable them to get employment and also improve Entrepreneurship by providing training, support and guidance for all occupation that were of traditional types. The training programme would be in the lines of International level, so that youths of our Country can get employed within the Country or Overseas employment. The **National Skill Qualification Framework (NSQF)**, anchored at the National Skill Development Agency(NSDA), is a Nationally Integrated Education and competency-based framework, to organize all qualifications according to a series of **levels of Knowledge, Skill and Aptitude.** Under NSQF the learner can acquire the Certification for Competency needed at any level through formal, non-formal or informal learning.

The **Workshop Calculation & Science -** Mechanical Agricultural Machinery 2nd Year NSQF (Revised 2022) under CTS is one of the book developed by the core group members as per the NSQF syllabus.

The **Workshop Calculation & Science -** Mechanical Agricultural Machinery 2nd Year NSQF (Revised 2022) under CTS as per NSQF is the outcome of the collective efforts of experts from Field Institutes of DGT, Champion ITI's for each of the Sectors, and also Media Development Committee **(MDC)** members and Staff of **NIMI.** NIMI wishes that the above material will fulfill to satisfy the long needs of the trainees and instructors and shall help the trainees for their Employability in Vocational Training.

NIMI would like to take this opportunity to convey sincere thanks to all the Members and Media Development Committee (MDC) members.

Chennai - 600 032 **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

The National Instructional Media Institute (NIMI) sincerely acknowledge with thanks the co-operation and contribution of the following Media Developers to bring this IMP for **Workshop Calculation & Science - Mechanical Agricultural Machinery 2nd Year** as per NSQF Revised 2022.

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Shri. G. Michael Johny	-	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 IMP.

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

INTRODUCTION

The material has been divided into independent learning units, each consisting of a summary of the topic and an assignment part. The summary explains in a clear and easily understandable fashion the essence of the mathematical and scientific principles. This must not be treated as a replacment for the instructor's explanatory information to be imparted to the trainees in the classroom, which certainly will be more elaborate. The book should enable the trainees in grasping the essentials from the elaboration made by the instructor and will help them to solve independently the assignments of the respective chapters. It will also help them to solve the various problems, they may come across on the shop floor while doing their practical exercises.

The assignments are presented through 'Graphics' to ensure communications amongst the trainees. It also assists the trainees to determine the right approach to solve the problems. The required relevent data to solve the problems are provided adjacent to the graphics either by means of symbols or by means of words. The description of the symbols indicated in the problems has its reference in the relevant summaries.

At the end of the exercise wherever necessary assignments, problems are included for further practice.

Time allotment - 2nd Year : 16 Hrs

Time allotment for each title of exercises has been given below. **Workshop Calculation & Science - Mechanical Agricultural Machinery** 2nd Year NSQF Revised Syllabus 2022.

S.No	Title	Exercise No.	Time in Hrs
1	Friction	2.1.01 & 2.1.02	4
2	Estimation and Costing	2.2.03 - 2.2.13	12
		Total	**16 Hrs**

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

- **Demonstrate basic mathematical concept and principles to perform practical operations.**
- **Understand and explain basic science in the field of study.**

CONTENTS

SYLLABUS

2nd Year

Workshop Calculation & Science - Mechanical Agricultural Machinery
Revised syllabus July 2022 under CTS

S.no.	Syllabus	Time in Hrs
I	**Friction** 1 Advantages and disadvantages, Laws of friction, co- efficient of friction, angle of friction, simple problems related to friction 2 Friction – Lubrication	4
II	**Estimation and Costing** 1 Simple estimation of the requirement of material etc., as applicable to the trade 2 Problems on estimation and costing	12
	Total	16

Friction - Advantages and disadvantages, Laws of friction, co-efficient of friction, angle of friction, simple problems related to friction

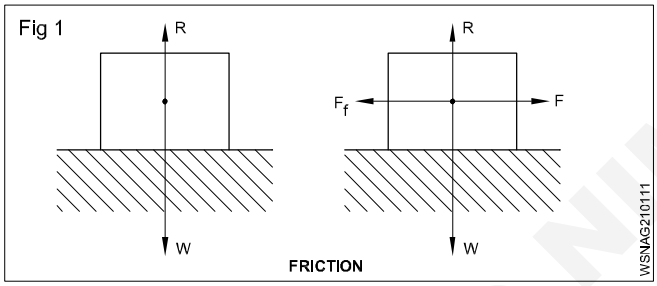
Introduction

When on a solid surface, another solid is rubbed a force is created between the two solids which acts in the opposite direction of motion or tries to obstruct the motion of the object, this force is called frictional force. This phenomenon is called friction. This happens due to roughness of the two surfaces.

In other words, It is the force of resistance offered to motion, experienced by bodies which are in contact. It depends upon the normal reaction between the contacting surfaces and the nature of the surfaces. No surface is absolutely friction less.

Friction plays an important role in our daily life. It would not be possible to walk without friction between our foot and floor. Vehicles are able to run on roads because of the friction between the wheels and road.

Fig 1



Types of friction

1 Static friction

2 Dynamic friction

1 Static friction

The friction between two solid objects when at rest is called static friction.

Eg. Static friction can prevent an object from sliding down on a sloped surface.

Limiting friction

When the frictional force (F) is equal to the applied pulling force (P) then the friction between two surfaces is known as limiting friction. (i.e F=P)

2 Dynamic friction

It is the friction between two objects, when are in motion is called dynamic friction. It is also called kinetic friction.

Sliding friction

It is the friction experienced by an object when its slides over another object. Sliding friction is always less than limiting friction.

Rolling friction

It is the friction that occurs when a circular object such as a ball or roller rolls on a flat surface. Rolling friction is less than sliding friction. (ball or roller bearing)

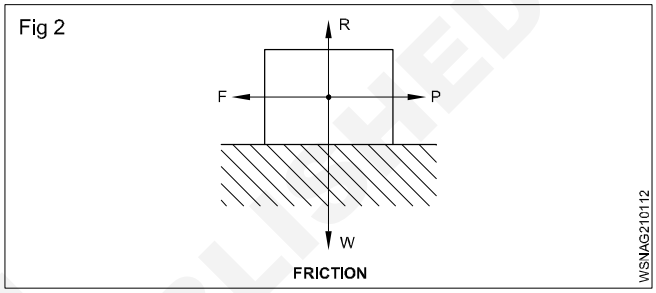
Forces acting on a body when a pulling force is applied to move (Fig 2)

- Weight of the block acting vertically downward (W)
- The normal reaction which acts upwards (R)
- The applied pulling force (F)
- The frictional force (F_f)

When the body is about to move W=R, F=P

When pulling force is increased the body starts to move.

Fig 2



Advantages of friction

1 Helps us to walk without slipping.

2 Used to stop vehicles when brakes are applied.

3 Movement of vehicles due to friction between revolving wheels with tyres and the road.

4 Power transmission using gear drive or belt pulley drive.

5 Using friction we can sharp any object and also to hold it.

6 Nails and screws are held in wood by friction.

7 Heat is produced when two rough surfaces are rubbed against each other.

Disadvantages of friction

1 It causes wear and tear of the machine parts.

2 It produces heat and may cause melting of machine parts. To avoid production of heat using of coolant is necessary.

3 It reduces efficiency of a machine.

4 It reduces speed of the moving object. eg. spindle, shaft, piston etc.

Friction can be reduced

1 By using suitable lubricants (oil, grease) between the moving parts.

2 By polishing the surface to make them smooth.

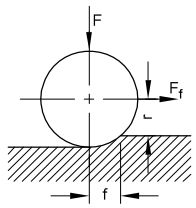
3 By using ball bearings and roller bearings.

4 By the use of wheel.

Laws of friction (Fig 3 & 4)

- Frictional force is directly proportional to the normal reaction between contacting surfaces.
- Frictional force acts opposite to the direction of motion.
- Frictional force depends on the nature of contacting surfaces.
- Frictional force is independent over the area and shape of contacting surfaces.

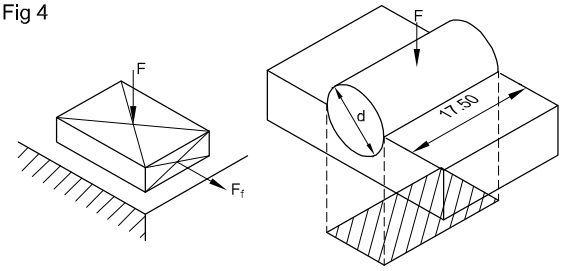
Fig 3



FRICTION

WSNAG210113

Fig 4



FRICTION

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Coefficient of friction

The ratio between the limiting friction force and the normal reactions is called the co-efficient of friction.

Suppose, by applying a force P kg, the object is just fit to move, then limiting friction force will be produced in between the two surfaces. The limiting friction force will be equal to external force applied and will work in the opposite direction.

$\therefore$ $F = P$ kg

According to the second law of limiting friction force, the friction force will be proportional to normal reaction.

$F \propto R$ ($\propto$ sign is proportional to)

$F = R \times$ constant

or $\frac{F}{R} =$ constant

This constant between objects is called Co-efficient of Friction. This is represented by μ.

$$\mu = \frac{F}{R} \text{ or } F = \mu.R$$

$$\text{Co-efficient of Friction} = \frac{\text{Limiting friction force}}{\text{Normal reaction}}$$

Co-efficient of friction is always constant for any two objects and it has no units.

Angle of friction (Fig 5)

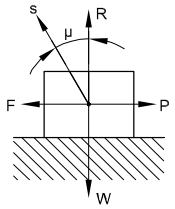
The forces acting on a body when it is just about to move by the application of a pulling force are W, R, P and F. The forces 'R' and 'F' are compounded and we get the resultant force 'S'. The angle formed by 'S' with 'R' is the angle of friction.

Therefore

$$\tan\theta = \frac{F}{W}$$

$$\tan\theta = \mu$$

Fig 5



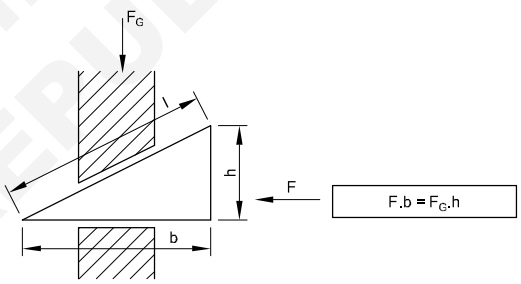
FRICTION

WSNAG210115

Angle of repose (Fig 6)

A body placed on an inclined surface remains at rest till the angle of inclination equals the angle of friction. When it exceeds the body starts sliding down. This is known as angle of repose.

Fig 6



ANGLE OF REPOSE

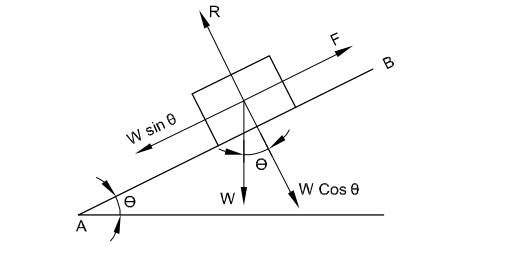
WSNAG210116

Inclined Plane (Fig 7)

According to the figure, given below plane AB is inclined $\theta°$ to the horizontal. On this, the vertical line working at W kg weight will make an angle with normal line of the inclined plane equal to the degree of inclination of the base at the horizontal.

The first component of weight 'W' of the object acts on the normal line and is equal to W cos $\theta°$. The second component acts parallel to base and downward and is equal to sin $\theta°$.

Fig 7



WSNAG210117

$\therefore$ Normal Reaction 'R' = W cos θ°

Limiting Friction Force 'F' = W sin θ°

$\therefore$ Co-efficient of friction 'μ' $= \frac{F}{R}$

$= \frac{W \sin\theta}{W \cos\theta}$

$= \tan\theta$

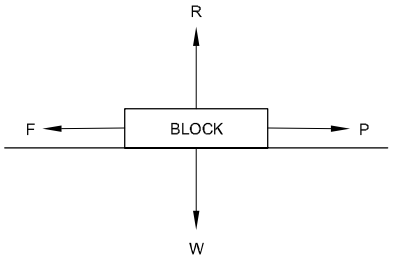
$\therefore$ $\mu = \tan\theta$

It may also be mentioned as:

In an inclined plane, some object without any external force applied only due to W sin 0 is about to come right downwards, then the plane makes an angle equal to the angle of friction with the horizontal.

Force of Friction When the Force is Horizontal (Fig 8)

Fig 8



Let,

P = Force required to pull the block

F = Force of friction

R = Normal reaction

W = Weight of block

μ = Co-efficient of friction between block and surface.

As per observation from the figure 8:

The block will move forward, if it has been overcome by the force of friction.

$\therefore$ P = F (it is horizontal)

Normal reaction of block is opposite to the direction of weight. $\therefore$ R= W

$\therefore$ Force of friction = μ . R

$\therefore$ Force required to move the block = μ . R

Force of Friction When the Force is Inclined at an Angle θ with the Horizontal (Fig 9)

Let,

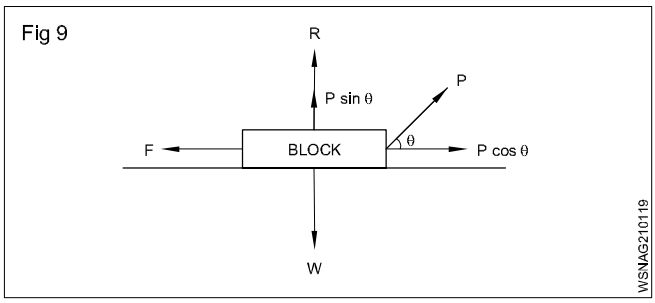
θ = Angle of pull 'P' to move the block with the horizontal

W = Weight of block

R = Normal reaction

P = Pull at an angle 'θ' with the horizontal

Fig 9



As per observations: from the geometry of figure 9, it is obvious:

Horizontal component of 'P' = P cos θ

Vertical component of 'P' = P sin θ

The horizontal component P cosθ will be the effective pull, while the vertical component P sinθ will go on for reducing the normal reaction.

As per condition of equilibrium :

Algebraic sum of horizontal components = 0

$F - P \cos\theta = 0$

$F = P \cos\theta$

Algebraic sum of vertical components = 0

$R + P \sin\theta - W = 0$

$R = W - P \sin\theta$

We know $F = \mu . R$

$P \cos\theta = \mu [W - P . \sin\theta]$

$= \mu . W - \mu . P . \sin\theta$

$P \cos\theta = \mu . W + \mu . P . \sin\theta = 0$

$P [\cos\theta + \mu . \sin\theta] = \mu . W$

$$P = \frac{\mu . W}{\cos\theta + \mu . \sin\theta}$$

Force of pull required at an angle of θ with the horizontal is given by:

$$P = \frac{\mu . W}{\cos\theta + \mu . \sin\theta}$$

Example

1 A force of 40 kg is required to pull a weight of 400 kg on a horizontal plane. Determine the coefficient of friction.

$$\text{Coefficient of friction} = \frac{\text{Force}}{\text{Weight}} = \frac{F}{W}$$

But F = P and R = W

$$\mu = \frac{F}{W} = \frac{F_f}{R} = \frac{40}{400}$$

μ = 0.1

2 A force for 30N is required to move a body of mass 35 kg on a flat surface horizontally at a constant velocity. Find the coefficient of friction.

Mass of the body = 35 kg. = W (By taking
The weight force=35 x 10 = 350 N 1kg = 10N)

(By taking g = 10 metre/sec^2)

$$\therefore \mu = \frac{F}{W} = \frac{F_f}{R} = \frac{30}{350} = \frac{3}{35} = 0.086$$

μ = 0.09

3 A solid weights 20 kg. This is placed on a solid surface. How much force does it require to come in motion when co-efficient of friction is 0.24.

Co-efficient of friction (μ) = 0.24
Weight (W) = 20 kg
Force required (F) = ?

$$\mu = \frac{F}{W}$$

$$0.24 = \frac{F}{20}$$

$$F = 20 \times 0.24$$

F = 4.8 kg

4 A tanker with loaded weight of 14500 kg is running on the road. If the co-efficient friction between tyres and road surface is 0.28. Find out its force of friction.

Co-efficient of friction (μ) = 0.28
Weight (W) = 14500 kg
Force friction (F) = ?

$$\mu = \frac{F}{W}$$

$$0.28 = \frac{F}{14500}$$

$$F = 0.28 \times 14500$$

F = 4060 kg.

5 A force of 800 gram weight is needed to pull a block weighing 3200 gram. What is the co-efficient of friction.

Force (F) = 800 gm
Weight (W) = 3200 gm
Co-efficient of friction (μ) = ?

$$\text{Co-efficient of friction } (\mu) = \frac{F}{W}$$

$$= \frac{800}{3200}$$

μ = 0.25

6 A force of 40 kg is required to move a mass of 80 kg on a flat surface horizontally at a constant velocity. Calculate its co-efficient of friction?

Force (F) = 40 kg
Weight (W) = 80 kg
Co-efficient of friction (μ) = ?

$$\text{Co-efficient of friction } (\mu) = \frac{F}{W}$$

$$\mu = \frac{40}{80}$$

μ = 0.5

7 A weight of 10 kg is resting on a horizontal table and can just moved by a force of 2 kg. Find the co-efficient of friction?

Weight (W) = 10 kg
Force (F) = 2 kg
Co-efficient of friction (μ) = ?

$$\text{Co-efficient of friction } (\mu) = \frac{F}{W}$$

$$= \frac{2}{10}$$

μ = 0.2

8 A body weighing 100kg is resting on a table. Find the co-efficient of friction if a force of 30 kg makes its just to move?

Weight (W) = 100 kg
Force (F) = 30 kg
Co-efficient of friction (μ) = ?

$$\text{Co-efficient of friction } (\mu) = \frac{F}{W}$$

$$= \frac{30}{100}$$

μ = 0.3

9 A metal block weighing 10 kg rests on a horizontal table. A horizontal force of 2.5 kg can just slide the block. Find the normal reaction, limiting friction and co-efficient of friction?

Weight (W) = 10 kg
Force (F) = 2.5 kg
R = ?
Normal reaction = W
Limiting friction = ?
μ = ?
Normal reaction (R) = 10 kg

Limiting friction (F) = 2.5 kg

$$\mu = \frac{F}{W}$$

$$= \frac{2.5}{10}$$

$$\mu = \mathbf{0.25}$$

10 A wooden block weights 100 kg. If the co-efficient of friction is 0.3, find out force required to move the block.

Weight (W) = 10 kg

Co-efficient of friction (μ) = 0.3

Force (F) = ?

$$\mu = \frac{F}{W}$$

$$0.3 = \frac{F}{100}$$

$$F = 100 \times 0.3$$

$$\mathbf{F = 30\ kg}$$

11 Calculate the angle of inclination, if a weight of 150 kg is in equilibrium, co-efficient of friction is 0.25. Calculate the force of normal reaction also.

Work done (W) = 150 kg

Co-efficient of friction (μ) = 0.25

θ = ?

Force F = ?

$\mu = \tan\theta = 0.25$

$= 14^\circ\ 2'\ 20''$

$$\mu = \frac{F}{W}$$

$$0.25 = \frac{F}{150}$$

$$F = 0.25 \times 150$$

$$\mathbf{F = 37.5\ Kg.}$$

12 A body of mass 60kg rests on a horizontal plane. The value of co-efficient of friction between it and the plane being 0.2. Find the work done in moving the body through a distance of 5 meters along the plane.

Co-efficient of friction (μ) = 0.2

Weight (W) = 60 kg

Distance (S) = 5 m

Work done (W) = ?

$$\mu = \frac{F}{W}$$

$$0.2 = \frac{F}{60}$$

$$F = 60 \times 0.2$$

$$= 12\ kg$$

Work done = Force x distance = F x S

$= 12 \times 5$

$= 60$ Kg.m

(ie) Work done (or) Applied force = 60 Kg.m

13 If a force of 30N is required to move a mass of 35kg on a flat surface horizontally at constant velocity, what will be the co-efficient of friction?

Force (F) = 30 N

Weight (W) = 35 kg

1 kg = 9.8 N

35 Kg = 9.8 x 35 = 343 N

Co-efficient of friction = $\mu = \frac{F}{W}$

$$= \frac{30\ N}{35\ kg}$$

$$= \frac{30\ N}{35 \times 9.8\ N}$$

$$\mu = \mathbf{0.087}$$

14 A block of ice weighing one quintal rests in equilibrium on a wooden plank inclined at 30º. Find the coefficient of friction between the ice and wood.

W = 1 quintal = 100 kg = Weight

$\theta = 30^\circ$ $\qquad \frac{F}{W} = \mu = \tan\theta$

$\mu = \tan\theta = \tan 30^\circ$

μ **= 0.5774**

15 Calculate the force that is required to slide a mass of 980 kg on a guide, when the coefficient of friction between the surfaces is 0.09.

Weight (W) = 980 kg

Co-efficient of friction (μ) = 0.09

Force (F) = ?

Co-efficient of friction = $\mu = \frac{F}{W}$

$$0.09 = \frac{F}{980\ kg}$$

$$F = 0.09 \times 980\ kg$$

Required force(F) = 88.2 kg

16 A metal block weighing 10kg rests on a horizontal board and the coefficient of friction between the surfaces is 0.22. Find (a) the horizontal force which will just move the block and (b) the force acting at an angle of 30° with the horizontal, which will just move the block.

Weight (W) = 10 kg

Co-efficient of friction (μ) = 0.22

(a) F = ?

(b) Force acting at an angle of 30º with the horizontal?

(a) $\mu = \frac{F}{W}$

$0.22 = \frac{F}{10\ kg}$

F = 2.2 Kg.

(b) Force acting at an angle of 30º $= \frac{F}{\cos \theta}$

= 2.2/cos 30º

= 2.2/0.8660

Force acting at an angle of 30º **= 2.54 kg**

17 Calculate the angle of inclination, if a weight of 250 kg is in equilibrium. Coefficient of friction is 0.36. Calculate the force of normal reaction also.

Angle of inclination (θ) = ?

Weight (W) = 250kg

μ = 0.36

Force (F) = ?

$\tan \theta = \mu$

$\tan \theta = 0.36$

$\theta = 19º\ 48'$

$\mu = \frac{F}{W}$

$0.36 = \frac{F}{250\ kg}$

F = 0.36 x 250 kg

F = 90 kg.

18 A body of mass 10 kg rests on a horizontal plane. The co-efficient of friction between the body and plane is 0.15. Find the work done in moving the body through a distance of 10 metre.

Weight (W) = 10kg

Co-efficient of friction (μ) = 0.15

Distance (S) = 10 metre

Work done (W) = ?

$\mu = \frac{F}{W}$

$0.15 = \frac{F}{10\ Kg}$

F = 0.15 x 10 kg

F = 1.5 kg

Work done = W = F x S

= 1.5 kg x 10 m

Work done **= 15 kg.m**

Assignment A

1 A force 50N is required to move a mass of 40kg on a flat surface horizontally at a constant velocity. Find the coefficient of friction. (9.8N = 1kg)

2 A vehicle having a weight of 800kg is moving on the road. If the coefficient of friction between the tyres and road surface is 0.3, then calculate the force of friction.

3 A solid weighing 50kg is placed on a solid surface. How much force is required to move the block when coefficient of friction is 0.25 between the block and the surface.

4 A railway wagon weighs 1250 tonnes. If the coefficient of friction between it and the rails is 0.003, find the force required to move the wagon.

5 A body of mass 100kg rests on a horizontal plane. The angle of friction between the body and the plane being 0.025. Find the work done in moving the body through a distance of 16m along the plane.

6 A body of mass 20kg rests on a horizontal plane, the co-efficient of friction between the body and plane is 0.3. Find the work done in moving the body through a distance of 10 metres.

7 A body of mass 2000 kg moves a distance of 10 meters in 5 sec. If the co-efficient of friction between the body and floor is 0.3 find the horizontal force required to move the body and horsepower absorbed against friction.

8 A vehicle is moving at 50kmph and the load on the vehicle is 5000 kg. Find the H.P. required to move the vehicle if $\mu = 0.2$.

9 Find out the power lost due to friction by a planer under the following conditions.

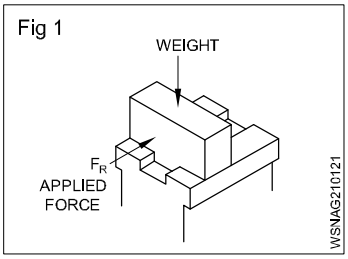
Mass of the planer table = 3500 kg

Rate of moment of the table=0.5 m/sec

Co-efficient of friction between the table and the ways=0.06

10 A truck having weight 12000 kg is moving on the road. If the co-efficient of friction between the tyres and the road surface is 0.3, then calculate the force of friction.

Assignment B

1 

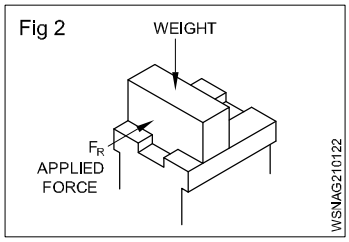
F = 1800 N

μ (static) = 0.16

μ (dynamic) = 0.012

F_R to overcome static friction = _____ N

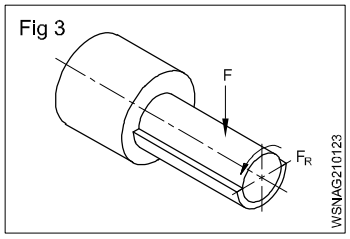
F_R to overcome dynamic friction = _____ N

2 

mass = 250 kg

F_R = 160 N

μ = _____

3 

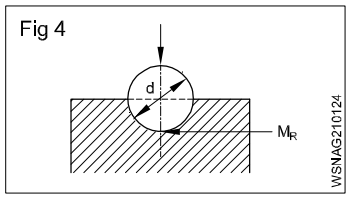
F = 5000 N

μ (dry) = 0.03

μ (fluid friction) = 0.01

F_R when dry = _____ N

F_R when lubricated = _____ N

4 

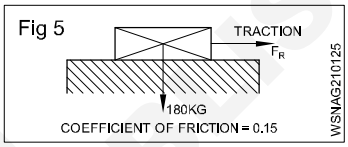
F = 1.2 kN

d = 60 mm

μ = 0.03

Frictional torque M_R = _____ Nm

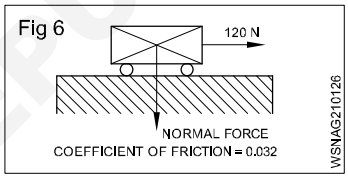
(Frictional torque = Frictional force x radius)

5 

mass = 180 kg

μ = 0.15

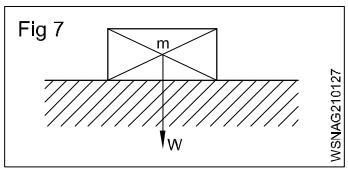
F_R = _____ N

6 

F_R = 120 N

μ = 0.032

Normal force F = _____ N

7 

m = 1000 kg

μ = 0.4

Force required to move F_R = _____ N

C MCQ

1 Which one of the following is useful friction

A Rings in cylinders B Crankshaft bearings

C Brake shoe linings D Wheel hole bearings

2 Which is in between the wheels and road, if vehicles are able to run on roads.

A erosion B motion

C corrosion D friction

3 Which direction of motion frictional force acts.

A equal B opposite

C inclined D forward

4 What is the formula of angle of friction, if 'F' is the frictional force, R is the normal reaction and θ is the angle of friction.

A $\text{Tan } \theta = \frac{F}{R}$ B $\text{Cot } \theta = \frac{F}{R}$

C $\text{Sin } \theta = \frac{F}{R}$ D $\text{Cos } \theta = \frac{F}{R}$

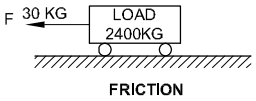
5 What is the formula for Co-efficient of friction (m).

A $\mu = \frac{R}{F}$ B $\mu = \frac{F}{R}$

C $\mu = F \times R$ D $\mu = F + R$

6 A loaded truck weighs 2400 kg and it can be moved by a force of 30 kg. Determine the co-efficient of rolling friction

Fig 1



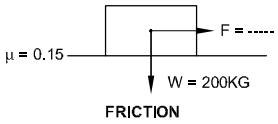
WSNAG210131

A 0.0215 B 0.0152

C 0.0125 D 0.0251

7 Calculate the pulling force required for the figure shown.

Fig 2



WSNAG210132

A 27 Kg B 28 Kg

C 29 Kg D 30 Kg

8 Determine the co-efficient of friction (μ) between brass and steel when a brass slider was placed on the horizontal steel surface until it is just moving, if brass slides (W) = 3 Kgf and required force is 0.7 Kgf.

Brass slides (W) = 3 Kgf

Force (F) required = 0.7 kgf

A 0.033 B 0.133

C 0.233 D 0.333

9 Which is necessary to avoid production of heat.

A sand B coolant

C lubricant D salt

10 Which is used to reduce the friction.

A lubricants B sand

C coal D coolant

Friction - Lubrication

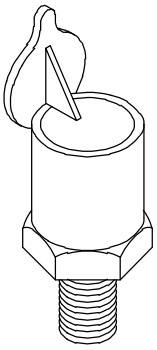
There are 3 systems of lubrication.

- Gravity feed system
- Force feed system
- Splash feed system

Gravity feed

The gravity feed principle is employed in oil holes, oil cups and wick feed lubricators provided on the machines. (Figs 1 & 2)

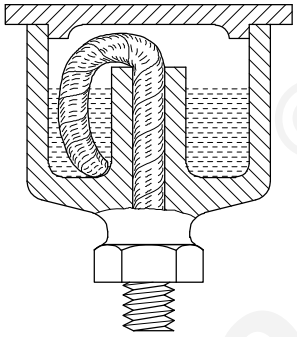
Fig 1



OIL CUP

WSNAG210211

Fig 2



WICK FEED

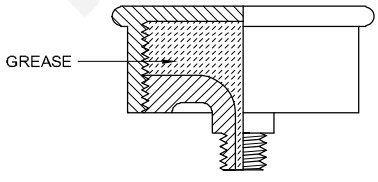
WSNAG210212

Force feed/Pressure feed

Oil, grease gun and grease cups

The oil hole or grease point leading to each bearing is fitted with a nipple, and by pressing the nose of the gun against this, the lubricant is forced to the bearing. Greases are also force fed using grease cup. (Fig 3)

Fig 3

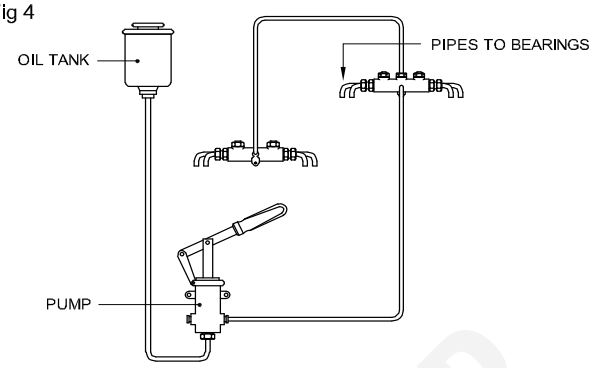


MANUAL SCREW DOWN GREASER

WSNAG210213

Oil is also pressure fed by hand pump and a charge of oil is delivered to each bearing at intervals once or twice a day by operating a lever provided with some machines. (Fig 4) This is also known as shot lubricator.

Fig 4



HAND PRESSURE FEED (SHOT LUBRICATED)

WSNAG210214

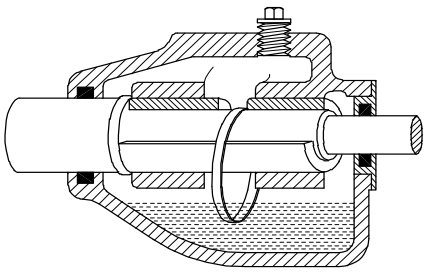
Oil pump method

In this method an oil pump driven by the machine delivers oil to the bearings continuously, and the oil afterwards drains from the bearings to a sump from which it is drawn by the pump again for lubrication.

Splash lubrication

In this method a ring oiler is attached to the shaft and it dips into the oil and a stream of lubricant continuously splashes around the parts, as the shaft rotates. The rotation of the shaft causes the ring to turn and the oil adhering to it is brought up and fed into the bearing, and the oil is then led back into the reservoir. (Fig 5) This is also known as ring oiling.

Fig 5

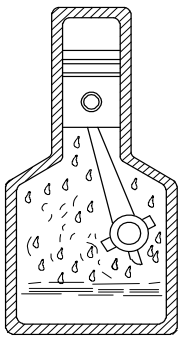


RING OILING

WSNAG210215

In other systems one of the rotating elements comes in contact with that of the oil level and splash the whole system with lubricating oil while working. (Fig 6) Such systems can be found in the headstock of a lathe machine and oil engine cylinder.

Fig 6



SPLASH-LUBRICATING SYSTEM

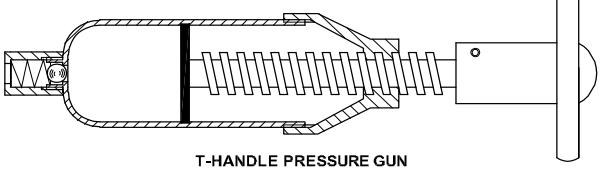
WSNAG210216

Types of grease guns

The following types of grease guns are used for lubricating machines.

- 'T' handle pressure gun (Fig 7)

Fig 7

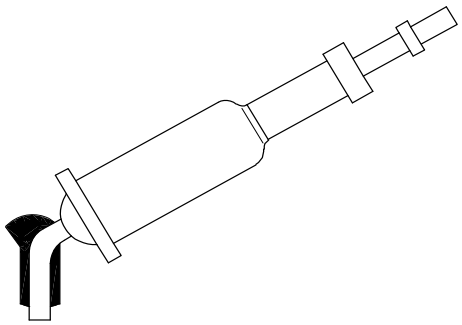


T-HANDLE PRESSURE GUN

WSNAG210217

- Automatic and hydraulic type pressure gun (Fig 8)

Fig 8

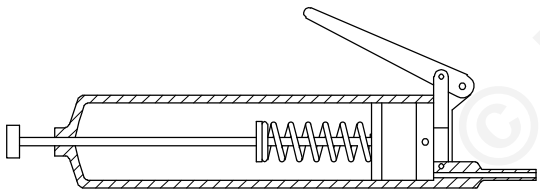


AUTOMATIC HYDRAULIC-TYPE PRESSURE GUN

WSNAG210218

- Lever-type pressure gun (Fig 9)

Fig 9



PRESSURE GREASE GUN

WSNAG210219

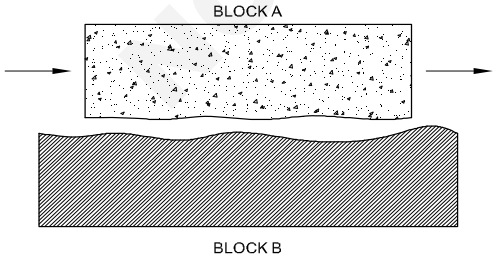
Lubrication to exposed slideways

The moving parts experience some kind of resistance even when the surface of the parts seems to be very smooth.

The resistance is caused by irregularities which cannot be detected by the naked eyes.

Without a lubricant the irregularities grip each other as shown in the diagram. (Fig 10)

Fig 10



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With a lubricant the gap between the irregularities fills up and a film of lubricant is formed in between the mating components which eases the movement. (Fig 11)

The slideways are lubricated frequently by an oilcan. (Fig 12)

Fig 11

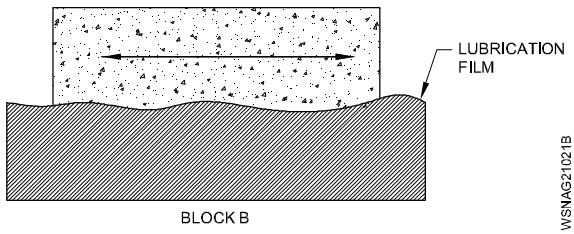

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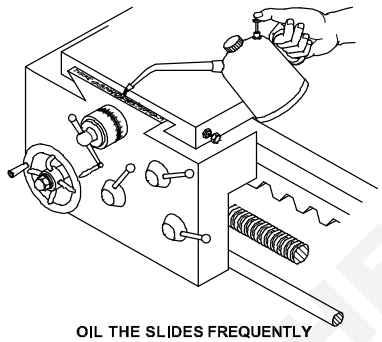
Fig 12

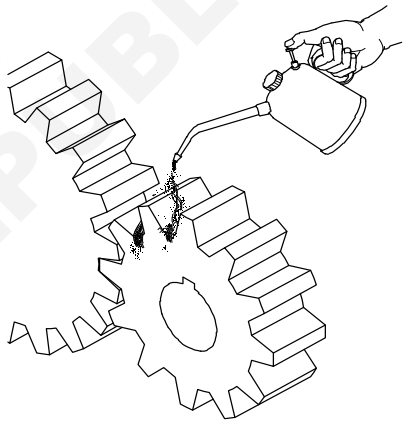


OIL THE SLIDES FREQUENTLY

WSNAG21021C

After cleaning the open gears, oil them and repeat lubrication regularly. (Fig 13)

Fig 13



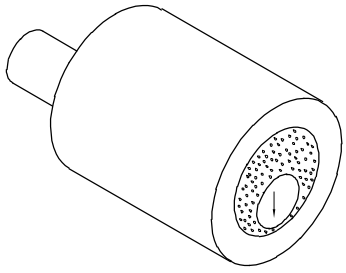
WSNAG21021D

Lubricate bearings

A shaft moving in a bearing is also subjected to frictional resistance. The shaft rotates in a bush bearing or in ball/ roller bearing, experiencing friction.

When the shaft is at rest on the bottom of the bush bearing, there is hardly any lubricant between the shaft and the bush. (Fig 14)

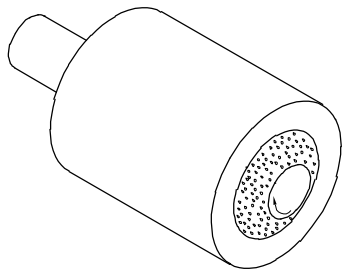
Fig 14



WSNAG21021E

When the shaft starts rotating the lubricant maintains a film between the shaft and the bush and an uneven ring of lubricant builds up. (Fig 15)

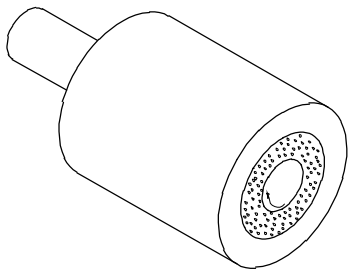
Fig 15



WSNAG21021F

When the shaft is rotating at full speed a full ring of lubricating film surrounds the shaft (Fig 16) which is known as hydro dynamic lubrication.

Fig 16

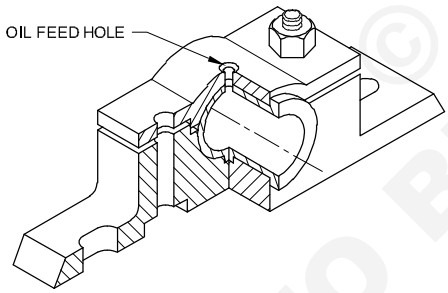


WSNAG21021G

This lubrication ring decreases the frictional resistance very much and at the same time protects the mating members against wear and changes.

Some bush bearings have oil feeding holes over which the oil or grease cup is mounted and the lubricant is fed through the holes into the bearing by gravity feed system.(Fig 17)

Fig 17



WSNAG21021H

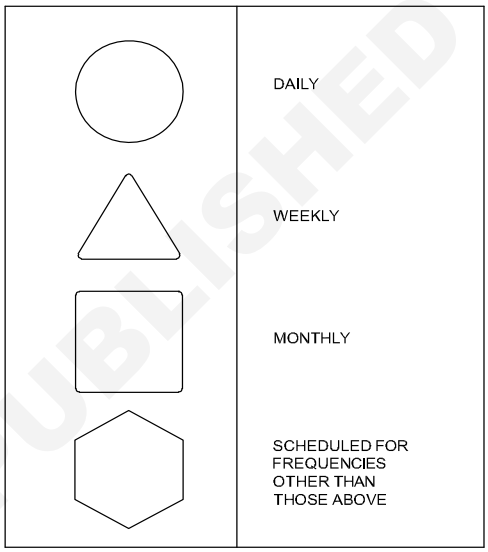
Hints for lubricating machines:

- identify the oiling and greasing points
- select the right lubricants and lubricating devices
- apply the lubricants.

The manufacturer's manual contains all the necessary details for lubrication of parts in machine tools. Lubricants are to be applied daily, weekly, monthly or at regular intervals at different points or parts as stipulated in the manufacturer's manual.

These places are indicated in the maintenance manuals with symbols as shown in Fig 18.

Fig 18 FREQUENCY CLASSIFICATION SYMBOLS



WSNAG21021I

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Rectify the feed pump of tractor

Introduction

Estimation is the method of calculating the various quantities and the expenditure to be incurred on a particular job or process.

Estimate is the method used to measure or quantify the different quantities and the expected expenditure to be incurred on a particular work or project.

We know that the estimation is a long procedure, and it is totally depends upon the projects,

In case the funds available are less than the estimated cost the work is done in part or by reducing it or specifications are altered,

The following essential details are required for preparing an estimate.

Drawings like plan, elevation and sections of important parts.

Detailed specifications about workmanship & properties of materials, etc.

Standard schedule of rates of the current year.

Estimating is the process of preparing an approximation of quantities which is a value used as input data and it is derived from the best information available.

An estimate that turns out to be incorrect will be an overestimate if the estimate exceeded the actual result, and an underestimate if the estimate fell short of the actual result.

A cost estimate contains approximate cost of a product process or operation. The cost estimate has a single total value and it is inclusive of identifiable component values.

Purpose of Estimating and Costing

1 Estimates provide a rough idea of the cost of the job and therefore its feasibility can be calculated, i.e. whether or not the project would be included in the funds available.

2 Estimate gives an idea of the time needed to complete the work.

3 Estimates are required to invite tenders and quotations and to arrange the contracts.

4 Estimates are also required to control expenditure during the execution of the work.

5 Estimates decide whether or not proposed plan matches the funds available.

Estimation Methods

Estimate involves the following operations

- Preparing detailed Estimate.
- Calculating the rate of each unit of work.
- Preparing abstract of estimate.

Estimation is the process of calculating or evaluating a quantity by estimation, that is, without reference to specific measurements. Estimating is a fundamental process in all engineering.

This is usually done before purchase or construction begins or during preliminary planning stages. Estimating is usually more accurate, but there are a few limitations - namely that if your estimate relies on labour costs, you'll need to know how many man-hours will take to complete the project.

Estimates are developed from observations and knowledge of past experience. The accuracy of an estimate often depends on the level of detail available and the amount of time for which data are available for analysis.

Costing is the process of estimating the cost of a project before it's completed. It can be done with an itemized list, or through estimation using a construction cost calculator.

Costing includes three steps: estimating, bidding, and finalizing. It helps predict how much money will be required to construct the project.

A "costing" typically refers to how much it will cost someone to produce a single unit.

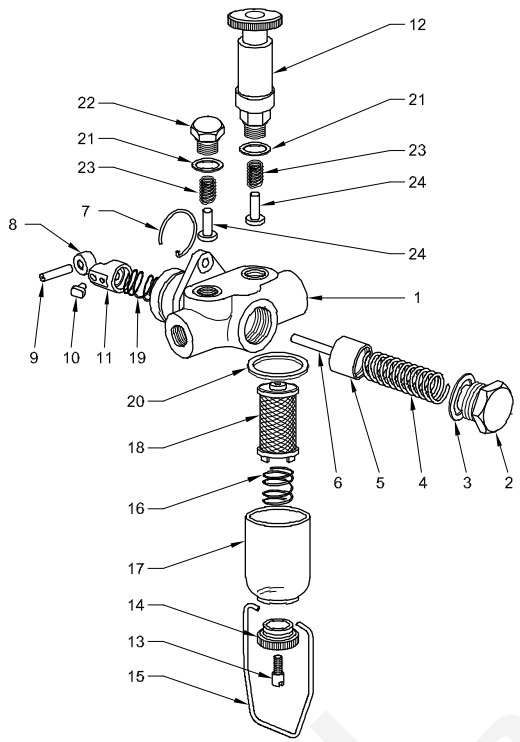
There are two types of costings

Independent costing - this is the cost of direct material and labour costs. This type of costing only takes into account the cost of a single-phase, so it's not representative of the overall project cost.

Cumulative Costing - this type of costing looks at the total cost for all phases of work, but it can be difficult to ensure that estimates are accurate.

Exercise: Rectify the Feed pump of tractor (Fig 1)

Fig 1



1 Remove feed pump assembly from fuel injection pump.

2 Remove filter housing, remove snap ring and take out roller tappet assembly of the pump.

3 Clean all the parts of fuel feed pump with kerosene or diesel.

4 Check visually all parts for wear and replace required parts.

5 Check tension of all the springs and replace necessary parts.

6 Check valve seats and washer.

Replace Components

1 Springs (16), (4)

2 Filter (18)

3 Snap ring (7)

4 Washer (3), (20), (21)

Replace Oil

1 Lubrication oil

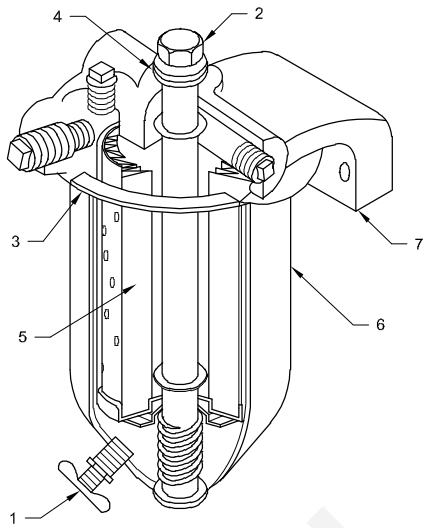
2 Diesel

1	Cost of Replaced components	=	Rs.3000
2	Cost of Lubrication oil	=	Rs.1500
3	Diesel cost	=	Rs. 500
	Total cost	**=**	**Rs.5000**

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Dismantling and replacing the fuel filters

Dismantling and replacing the fuel filters (Fig 1)

Fig 1



1 Drain fuel, dirt and water from the filter housing by opening the drain plug

2 Remove the top cover and remove the used elements from the filter housing, discard the element

3 Wipe the inside of the filter housing. Cleaning fuel residue and other deposits, use kerosene/diesel for cleaning the housing

1 Material cost of Gaskets (3), (4)
2 Material cost of Drain plug (1) } **= Rs. 1000**

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Refitting alternator on tractor and testing

Refitting alternator on tractor and testing (Fig 1)

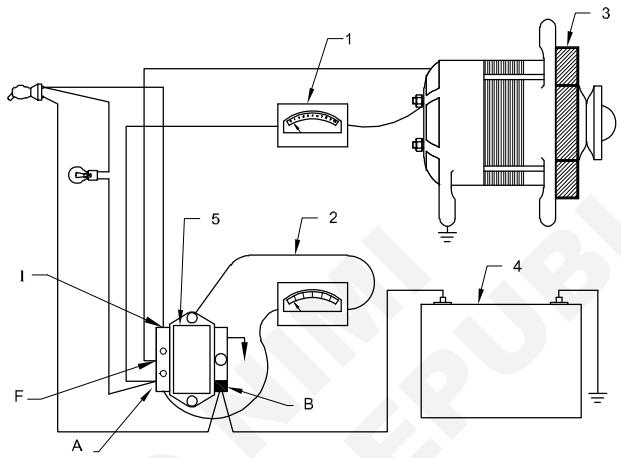
Tools/Instruments - Service persons owns

- Test lamp - 1 No.
- Soldering Iron - 1 No.

Materials/Components

- Tray - 1 No.
- Kerosene oil - as reqd.
- Distilled water - as reqd.
- Fine emery paper - as reqd.
- Carbon brush - as reqd.
- Cotton waste - as reqd.

Fig 1



Refitting alternator to the vehicle

1 Place and secure the alternator in its bracket using bolts & nuts.

2 Connect all the wires of the alternator which you disconnected earlier. Connect the battery cables to the circuit.

3 Check the fan belt for overstretched or damaged condition.

4 Check the fan belt for proper tension. If the fan belt tension is low/high adjust by removing the alternator to the appropriate side.

5 Check if all the ends of the battery cables are clean. check all the wire connections for loose, dirty or broken connections.

6 Disconnect the battery earth cable. Connect the ammeter (1) in series. Connect the voltmeter (2) parallel to the alternator terminal and earth. Connect a wire across the field output terminal in the alternator (3). Connect the battery cable and put on the starting switch. Note the ammeter reading.

7 Run the engine at medium speed. Switch on the lights and other electrical appliances.

8 If the voltmeter (2) and ammeter (1) read low, the regulator (5) needs replacement.

Cost of Alternator = Rs.19,800

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Repair and servicing clutch wire

Repair and servicing clutch wire (Fig 1)

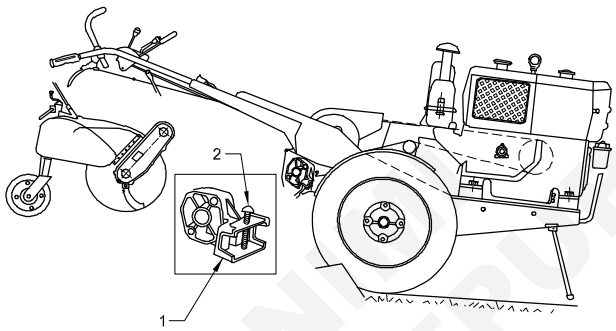
Tools/Instruments - Service persons owns

- Spring loaded cultivator - 1 No.
- Disc plough - 1 No.
- Tractor ridger - 1 No.
- Tractor rotavator - 1 No.
- Jack - 1 No.

Materials/Components

- Cotton cloth - 1 No.
- Lock pin - as reqd.
- Hitch pin - as reqd.
- Oil - as reqd.
- Wooden block - as reqd.
- Tray - as reqd.
- Solvent - as reqd.
- Transmission oil - as reqd.
- 'O' ring - as reqd.

Fig 1



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1 Replace the clutch wire and sleeve if found damaged. In case of wires are to be replaced ensure free movement of wire in the sleeves

2 Replace all worn out pivots of side clutch break levers pins 'O' rings and bolts and ensure free movement

3 Change the side clutch if found worn out (or) cracked. Replace the bushes if excessive play between shaft and side clutch is observed

4 Change the springs if cracked and deformed

5 Change bushes in the front mission cover if excessive play is observed

6 Replace bearing if worn out

7 Replace the yoke if it is bent or worn out or damaged

8 Change the covers if they are cracked (or) bearing seat is worn out replace the new one.

1	Cost of Clutch wire and sleeve	=	Rs.1500
2	Cost of pivots	=	Rs. 500
3	Cost of Bushes	=	Rs. 500
4	Cost of Bearings	=	Rs.2000
	Total cost	=	**Rs.4500**

Estimation and Costing - Simple estimation of the requirement of material etc., as applicable to the trade - Check spring loaded cultivator

Check spring loaded cultivator (Fig 1)

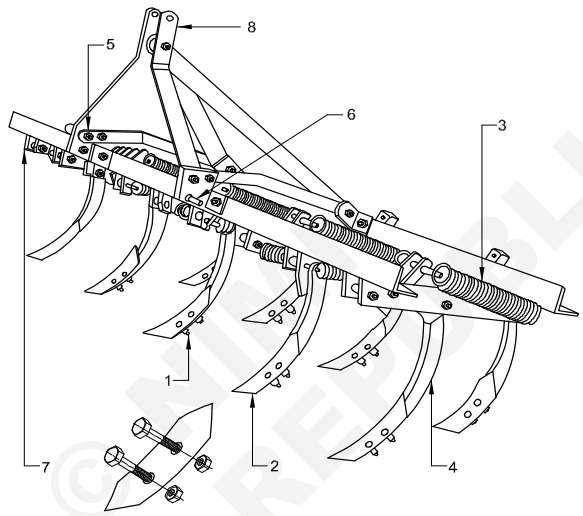
Tools/Instruments - Service persons owns

- Spring loaded cultivator - 1 No.
- Disc plough - 1 No.
- Tractor ridger - 1 No.
- Tractor rotavator - 1 No.
- Jack - 1 No.

Materials/Components

- Cotton cloth - 1 No.
- Lock pin - as reqd.
- Hitch pin - as reqd.
- Oil - as reqd.
- Wooden block - as reqd.
- Tray - as reqd.
- Solvent - as reqd.
- Transmission oil - as reqd.
- 'O' ring - as reqd.

Fig 1



WSNAG220711

1 Check fastening bolts (1) of shovels (2) fitted to the spring loaded (3) cultivator tynes (4) of front and rear assemblies.

2 Tighten the bolts if loose.

3 Replace them if worn out.

4 Check side struts bolts (5) for tightness.

5 Check lower hitch pin (6) for tightness and damage to the hitch pin holes. Replace them with new ones if found defective.

6 Ensure pin (6) diameter is matching with the sockets (balls) of side links of the tractor.

7 Check sharpness and shape of the shovels (2) to ensure for effective tilling.

8 Reverse the shovel if found wornout.

9 Replace if both points have become unserviceable.

10 Check straightness of the tynes (4). Replace the tynes if found unserviceable or beyond repair.

11 Turn the cultivator upside down and check the spring (3) tension fitted to the tynes by means of pipe socket bar lever.

12 The pipe socket bar is locally prepared to sleeve the shovel. Each shovel is pulled against the line of travel to a certain spring tension.

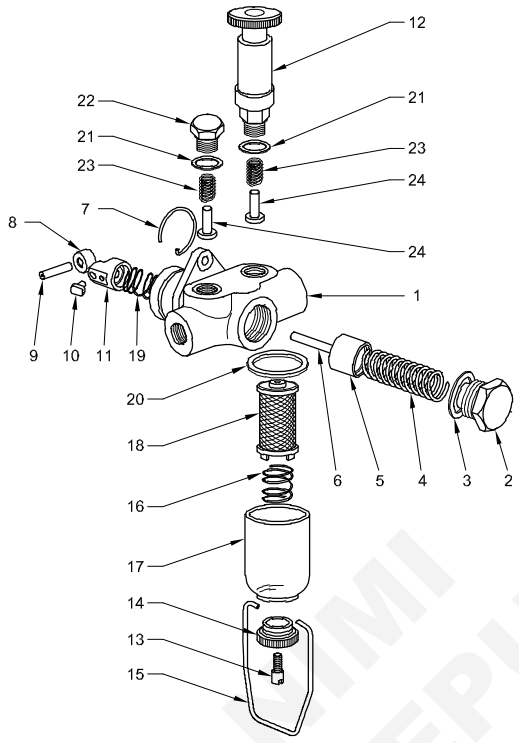
13 Change the spring if found loose and broken.

1	Cost of Shovel - 5 Nos.	=	Rs.1000
2	Cost of Springs - 2 Nos.	=	Rs; 500
3	Cost of Bolts & nuts	=	Rs. 200
	Total cost	=	**Rs.1700**

Estimation and Costing - Problems on estimation and costing - Servicing feed pump of tractor

Servicing Feed pump of tractor (Fig 1)

Fig 1



1 Remove feed pump assembly from fuel injection pump

2 Remove filter housing, remove snap ring and take out roller tappet assembly of the pump

3 Remove screw plug, washer take out plunger spindle with return spring

4 Remove hand priming pump and washer, screw plug, washer and remove valves along with springs

5 Remove roller pin, roller, slider, tappet and spring

6 Clean all the parts of fuel feed pump with kerosene or diesel.

7 Check visually all parts for wear and replace required parts

8 Check tension of all the springs and replace necessary parts

9 Check valve seats and washer

10 Assemble roller tapper asembly in housing and secure it.

11 Assemble spindle plunger assembly and tighten screw plug

12 Place valves on its seat along with springs, tighten hand priming pump and screw plug

13 Fit the filter assembly, rotate FIP's camshaft, fit feed pump on FIP.

14 Tighten feed pump connect all the fuel lines

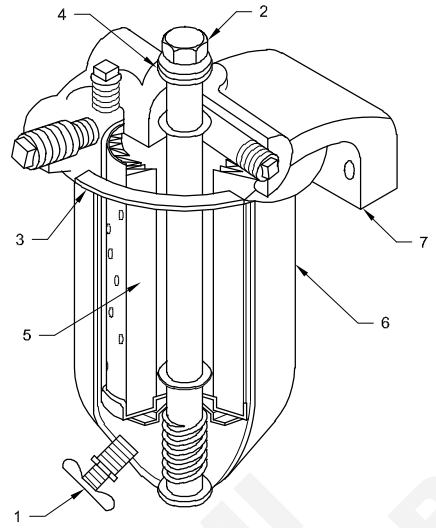
15 Operate the fuel pump and check fuel pump delivery pressure as per specification

Cost of Components & Oil	= Rs.5000
Service charge for 4 hours Feed pump of tractor	= Rs.1000
Total cost	**= Rs.6000**

Estimation and Costing - Problems on estimation and costing - Servicing and replacing the fuel filters

Servicing and replacing the fuel filters (Fig 1)

Fig 1



1 Drain fuel, dirt and water from the filter housing by opening the drain plug.

2 Remove the top cover and remove the used elements from the filter housing, discard the element.

3 Wipe the inside of the filter housing. Cleaning fuel residue and other deposits, use kerosene/diesel for cleaning the housing.

4 Place a new gasket on the centre stud bolt, place a new gasket in the filter cover assembly and new fuel filter element in the filter housing.

5 Assemble the housing with cover and tighten the centre bolt.

6 Fit the drain plug in the filter housing and connect fuel lines.

7 Loosen the bleeding screw for air to escape through the hole.

8 Pump the fuel by hand priming pump till fuel flows through bleeding screw without air.

9 Tighten the bleeding screw again.

Material cost (Gaskets & Drain plug)	=	Rs.1000
Service charge for 4 hours Dismantling and replacing the fuel filters	=	Rs.1000
Total cost	=	**Rs.2000**

Estimation and Costing - Problems on estimation and costing - Rectify problems in alternator circuit

Rectify problems in Alternator circuit (Fig 1)

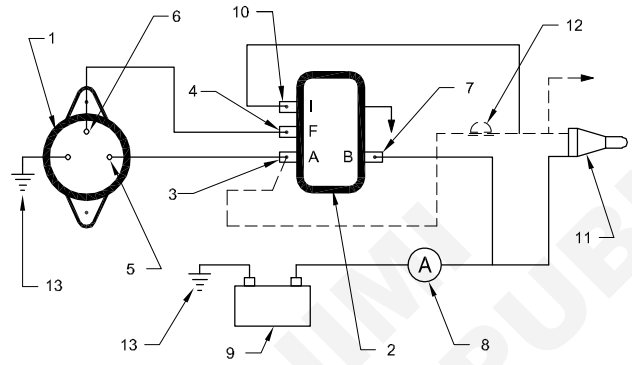
Tools/Instruments - Service persons owns

- Test lamp - 1 No.
- Soldering Iron - 1 No.

Materials/Components

- Tray - 1 No.
- Kerosene oil - as reqd.
- Distilled water - as reqd.
- Fine emery paper - as reqd.
- Carbon brush - as reqd.
- Cotton waste - as reqd.

Fig 1



1 Locate the circuit from the alternator's (1) output terminal (5) to the voltage regulator's (2) terminal A (3).

2 Locate the feedback circuit from the voltage regulator's (2) 'F' terminal (4) to the alternator's (1) field terminal (6).

3 Locate the circuit from the voltage regulator's (2) 'B' terminal (7) to the ammeter (8).

4 Locate the circuit from the ammeter (8) to the battery (9).

5 Locate the circuit from the voltage regulator's (2) 'A' terminal (3) to the indicator lamp (12).

6 Locate the circuit from the indicator lamp (12) to the ignition starting switch (11).

7 Locate the ground connection (13).

8 Locate the circuit from the ammeter (8) to the ignition starting switch (11).

9 Disconnect the earth cable of the battery.

10 Disconnect the wires from the alternator.

11 Loosen the bolts which secure the alternator with the bracket.

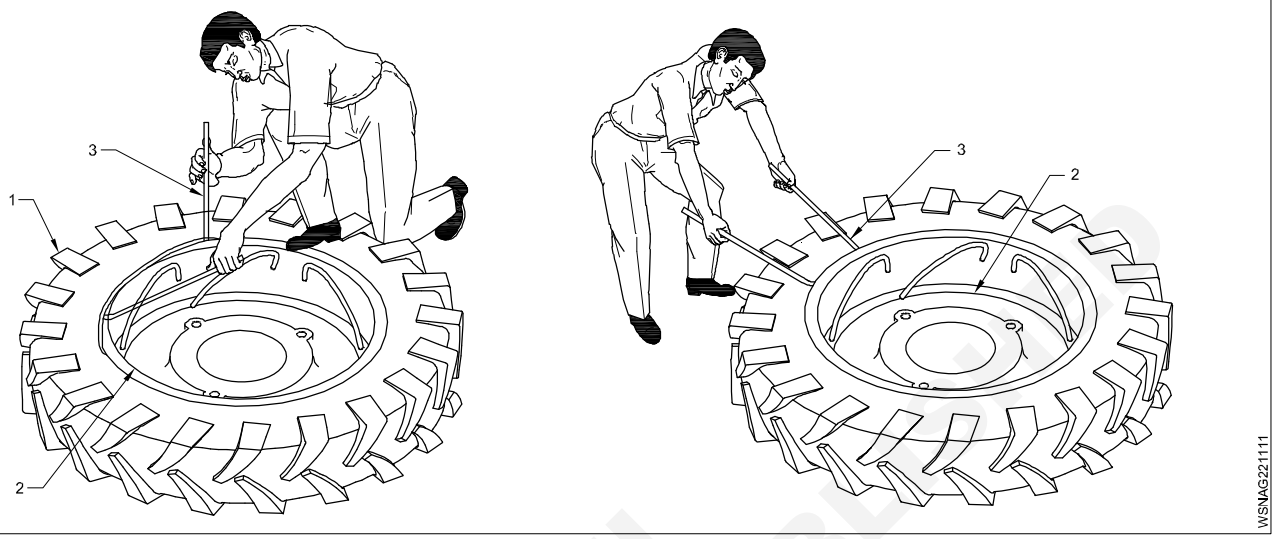
12 Take out the alternator.

Inspection charge for 4 hours = Rs.1000

Estimation and Costing - Problems on estimation and costing - Repairing puncture in the tube of tractor wheel

Repairing puncture in the tube of Tractor wheel (Fig 1)

Fig 1



1 Insert the tyre lever into the rim in the place where the valve is located below the edge of the tyre.

2 Remove the tube from the tyre, if there is any bulge on the tube then replace the tube.

3 Dip the inflated tube in the water tub. At the punctured area air bubbles will come out. Mark the puncture area.

4 Remove the valve core and clean the puncture area by cloth.

5 Clean the puncture with woodruff file. Apply vulcanizing cement on the puncture portion.

6 Place a piece of vulcanizing raw rubber on the punctured area.

7 Clamp the puncture area on vulcanising machine and switch ON.

8 After 15 minutes switch OFF and allow 5 minutes to cool the tube.

9 Unclamp remove the tube and fix the valve core on the tube.

10 Inflate the tube with low pressure 5 to 10 lbs/sq.inch.

11 Dip the repaired tube in the water tub and recheck for any leakage.

Service Charge for 1 hour = Rs.500

Estimation and Costing - Problems on estimation and costing - Checking and repair a mechanical steering system

Checking and repair a mechanical steering system (Fig 1)

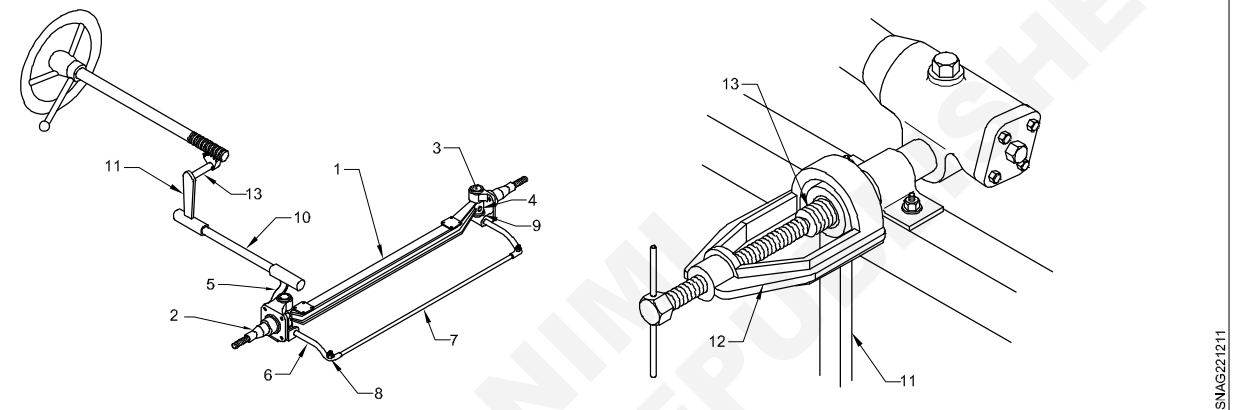
Tools/Instruments - Service persons owns

- Hammer - 1 No.
- Puller - 1 No.
- Wrench - 1 No.
- Tractor - 1 No.
- Trolley Jack/ Screw Jack - 1 No.

Materials/Components

- Tray - 1 No.
- Grease - as reqd.
- Kerosene oil - as reqd.
- Cotton waste - as reqd.

Fig 1



1 Check the front wheels jack up the vehicle and place horses under the front axle. Remove the front wheel.

2 Remove the split pin and loosen the nut of the steering arm at both the ends.

3 Give support underneath the steering arm.

4 By using special tool (or) wooden block and hammer hit the nut and remove the ball joints from the tie rod ends.

5 Loosen the drag link nut connected to the steering arm and remove the same.

6 Loosen the drag link nut from the drop arm on the lower side and take out the drag link.

7 Mark the position of the drop arm with respect to the steering rocker shaft. This mark should be aligned while refitting the drop arm on the steering rocker shaft.

8 Remove the drop arm's nut on the top.

9 Pullout the drop arm from the steering rocker shaft by using use a special puller.

10 Clean all the steering dismantled parts in kerosene.

11 Check visually all the parts for wear, replace if found worn out.

12 assemble all the steering dismantled parts. Lubricate all the parts with recommended grease, tighten all ball pin nuts at the recommended torque

Service charge for 4 hours = Rs.2000

Estimation and Costing - Problems on estimation and costing - Overhauling the main clutch of power tiller

Overhauling the main clutch of power tiller (Fig 1)

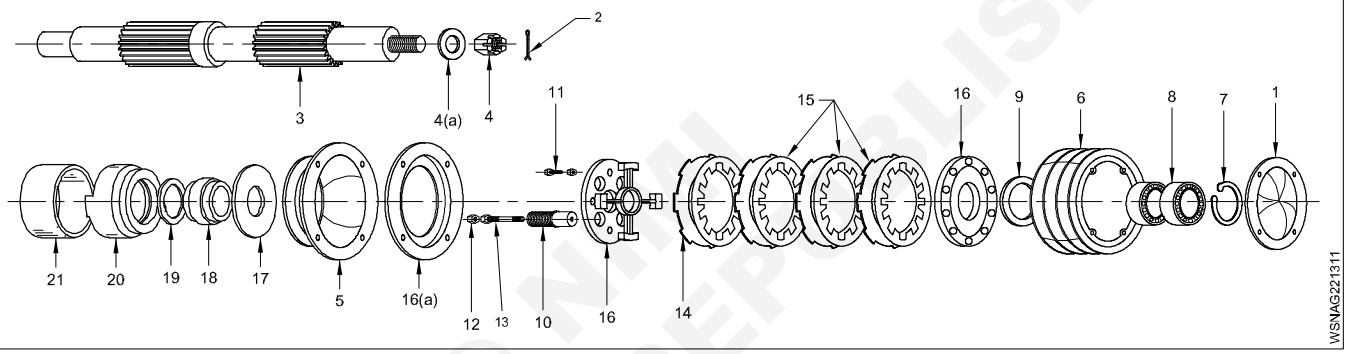
Tools/Instruments - Service persons owns

- Spring loaded cultivator - 1 No.
- Disc plough - 1 No.
- Tractor ridger - 1 No.
- Tractor rotavator - 1 No.
- Jack - 1 No.

Materials/Components

- Cotton cloth - 1 No.
- Lock pin - as reqd.
- Hitch pin - as reqd.
- Oil - as reqd.
- Wooden block - as reqd.
- Tray - as reqd.
- Solvent - as reqd.
- Transmission oil - as reqd.
- 'O' ring - as reqd.

Fig 1



1 Opening of the main clutch assembly

2 Wash all metal parts with recommended solvent

3 Check tensioner bearing, 'V' belt, surface for damaged and cracks. Check threads are exposed

4 Check operating lever rod, pivot pin, bearing. 'V' pulley of the main clutch assembly

5 Clean compression plate, facings with recommended fluid and check for their serviceability

6 Check compression plate, pressure plate, clutch springs for cracks, squareness and tension

7 Check all the studs & bolts, screws and nuts for corrosion and damage of threads

8 Check the face of clutch shifter for uneveness and check internal spline ridges

9 Check cluch release bearing and clutch cams for wear out

10 Repair and service change all the worn out pivot pins bolts split pins, 'V' belts, bearings, clutch release bearing, clutch facing, clutch driver metal plate replaces and Replace broken and corroded springs also.

Service Charge for 4 hours = Rs.3000