Subject :- Advanced Construction

1 CONTRIBUTION AND IMPORTANCE OF CONSTRUCTION EQUIPMENTS : [G.T.U., May/June 2012]

→ In case of major construction projects, the speed of work and the timely completion of work is very important. Due to this reason, the mechanisation of most of the construction work is required, in which the construction equipments play the most important role. The proper use of the appropriate equipment contributes to economy, quality, safety, speedy and timely completion of the project.

→ The cost of construction is a major factor in all projects. The factors that influence construction costs mainly are materials, labour, construction equipment, Overhead and profit.

The costs of construction equipment for civil engineering construction projects ranges from 25% to 40% of the total project cost.

The amount which is invested in the purchase of a construction equipment should be recovered during the useful period of such equipment.

If it is found that the purchase price of a particular construction equipment is far less than the estimated profit to the contractor due to its use on the project, the contractor should purchase the same without considering its further use or salvage value.

→ The construction equipments are deployed on the construction projects for the various reasons, such as

(i) Larger output

(ii) Cost–effective implementation

(iii) For execution of work that is not feasible by manual efforts or when deployment of construction equipment may help in doing the work more cost efficiently.

(iv) Large output can be maintained, even if there is a shortage of skilled and semi–skilled manpower.

(v) Precision of implementation is done by using modern construction equipment equipped with software controls.

→ The construction equipment and machineries of very high capacities are available now and very large outputs are possible due to mechanization, adhering to the construction schedules.

→ Thus, the deployment of construction equipment on the construction projects is of vital importance in completing the work at an optimum cost within stipulated time.

11.2 CLASSIFICATION OF EQUIPMENTS :

The construction equipments are classified as below:

(a) **The equipments are classified according to the type of work, it performs :**

(i) Intermittent type:

→ This type of equipments have the intermittent cycles of work. They can be operated on series of work cycles and each cycles completes in itself.

→ Power shovels, draglines, scrappers, bulldozers, concrete mixers, etc. are the examples of intermittent type equipments.

(ii) Continuous flow type:

→ This type of equipments have a continuous flow of work turned out.

→ Belt conveyors, pipelines, air compressors, etc. are the examples of continuous flow type equipments.

(iii) Mixed type

→ This type of equipments have characteristics of both, intermittent as well as continuous flow type equipments.

→ They are continuously operated over a defined surface area. After completion of a particular sweep, it requires operation cease and readjustment of its position to resume production on another area.

→ Motor graders, bulldozers, scrapers, etc are the examples of mixed type equipments.

(b) **The construction machineries or equipments can be easily classified into following types:**

(i) Earth excavating and transporting equipments

(ii) Hoisting equipments

(iii) Conveying equipments

(iv) Drilling equipments

(v) Pumping equipments

(vi) Compacting equipments

(vii) Pile–driving equipments

(c) **Depending upon their availability, on the basis of specifications, the equipments can be classified into types:**

(i) Standard equipments

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(i) **Standard equipments :**

→ The standard equipments are commonly manufactured and are easily available to the prospective purchasers.

→ They can be used for a variety of construction operations without any difficulty and they are available in standard commercial sizes.

The initial investment is less as compared to a special equipment..

→ The delivery of standard equipment is very quick, as it is readily available in the market.

→ The repair parts for standard equipment can be obtained more quickly and economically and the repairs of such equipment can be carried out quickly in short period.

→ If the contractor no longer needs a unit of standard equipment, he can usually dispose of it more easily and at a more favourable price than a piece of special equipment.

(ii) **Special equipments :**

→ The special equipments are those equipments which are manufactured for a specific project or which does not have readily accessible spare parts.

→ The selection of special equipment should be made carefully after proper financial analysis.

→ The initial investment in case of special equipment is very high and there is risk of change in design, it cannot be used economically on the other project.

→ A special order is to be given to the manufacturer of special equipment and a special price is to be given and therefore the delivery of special equipment can be obtained after a long period.

→ Examples of special equipment include tunnel-boring machines, large hauling units and very large shovels, such as a 70 to 80 cum. shovel used to strip-mine coal.

1.3 SELECTION OF CONSTRUCTION EQUIPMENTS

[G.T.U., Nov. 2011, May/June 2012]

GENERAL :

→ Any contractor, who plans to construct a project, he frequently faces the problem of selection of most suitable equipments.

→ He should consider the money spent for equipment as an in-

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→ A contractor does not pay for construction equipment, but the equipment must pay for itself by earning, for the contractor more money than it costs.

SELECTION (FACTORS AFFECTING) :

→ The various factors to be considered, while selecting the construction equipment are as follows:

(i) **Standard type of equipment:**

→ The contractor should confine their purchases to standard equipment unless a project definitely justifies the purchase of special equipment.

→ Delivery of standard equipment may be obtained more quickly.

→ Standard equipment can be used economically on more than one project.

→ Repair parts for standard equipment may be obtained more quickly and economically than for special equipment.

→ If a contractor no longer needs a unit of standard equipment, he can usually dispose of it more easily and at a more favourable price than a piece of special equipment.

(ii) **Replacement of parts:**

→ Prior to purchasing equipment, the buyer should determine where spare parts are obtainable.

→ If parts are not obtainable quickly, it may be wise to purchase other equipment, for which the parts are quickly available, even though the latter seems less desirable.

(iii) **Operating costs:**

→ The most efficient and therefore the most economical equipment is one whose operating cost is the minimum. This is a fulproof measure for selection of the equipment.

(iv) **Utilization of the equipment :**

→ The maximum utilization of the existing machine should be done to reduce the cost of production of various items of the project.

(v) **Availability of equipment :**

→ Sometimes the selection of equipment has to be made from the available equipment held with the manufacturers or dealers.

→ In the case of big projects, however, the specifications are laid

) Sources of equipment

→ Contractor and other users of construction equipment frequently are concerned with a decision as to whether to purchase or rent (lease) equipment.

→ Under certain conditions, it is financially advantageous to purchase, whereas under other conditions it is more economical and satisfactory to rent it.

i) Country of Origin :

→ As far as possible, indigenous equipment should be used. This encourages the industry of the country and saves foreign exchange. When imports have to be resorted to, they should be preferably restricted to soft currency area.

ii) Operating facility:

→ The equipment chosen for project should be such that the trained operators for the machine are available.

) Suitability of equipment for future:

→ While selecting an equipment, the useful life of the equipment should be compared with the duration of the project.

→ If the life of the equipment is longer, it should be possible to use the equipment for other projects.

4 FINANCIAL ASPECTS RELATED TO CONSTRUCTION EQUIPMENTS :

[G.T.U., Nov. 2011]

→ The financial aspects of the construction equipments is a very important matter for a construction contractor. Unless the department or the owner of the contract understands the problem, they will not be able to assist, advice and take proper decisions in approving the plans.

v to arrange finance :

→ When the contractor place the equipment purchase order to the manufacturers, the majority of the manufacturers demand 10 to 30% advance with orders, without any commitment of delivery period.

→ The arrangement of finance can be done from the advances given by the project authorities or from the advances given to the contractors on equipment purchase.

→ In some cases, even foreign exchange is made available in contracts for import of equipment and spares.

→ The finance can also be arranged from Industrial Development Banks and leasing companies.

Whether to Buy or hire :

→ A piece of equipment may be employed on a project, in one of the following two ways:

1. Direct purchase
2. Hiring.

1. Direct Purchase:

→ If the equipments are to be used frequently for many types of jobs and for a long duration of time on the project, it will be economical for the contractor to purchase the equipment.

→ The purchasing of construction equipment and machineries would be advantageous for the following reasons :

(i) The construction equipment would be available at all times for deployment.

(ii) These equipments could be used in other projects as required according to the conceived programme.

(iii) The cost of such equipments could be apportioned among different contracts.

(iv) It always economically operated and can be maintained properly.

→ The disadvanges of direct purchase are as follows:

(i) If the equipment purchased by the contractor becomes obsolete or if another equipment is available with superior performance, the contractor cannot take advantage of such situation.

(ii) The sum invested for purchase of equipment will be blocked and can not be available for other purposes.

(iii) The disposal of equipment after the project completion becomes difficult due to modernization of machinery.

(iv) The owned equipment may be utilized by the contractor beyond its economic life, thereby reducing his profit.

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2. Hiring :

→ If the project is small and if the equipment is to be used for a short duration of time on the project, it will be economical for the contractor to get it by hiring or by renting from other agencies.

→ The various advantages are as follows :

(i) The equipment could be rented as and when required for a calculated period of time.

(ii) The hiring agencies are responsible for repair, replacements and even operation depending on the contractual terms.

(iii) On completion of the hiring period, the executing agency would be liability-free of the rented items.

(iv) The sum to be invested for the purchase of equipment can be diverted to the other projects.

(v) There is no fear of obsolescence of equipment and full advantage of rented equipment can be taken by the contractor.

→ But, the rented items of equipment should not be left idle for a long period, otherwise it will be uneconomical to use.

→ Sometimes, the combined method of partly purchasing and partly renting the selected equipment may be advantageous.

→ For instance, the equipment may be hired initially and then subsequently, if found useful, it can be purchased, considering the various aspects of the project, works on hand, future prospects of getting works, available funds, storage space for equipment, loss due to non–availability of equipment, hiring charges, etc.

imple–11.1 (purchase / hire) :

The original cost of a power shovel is Rs. 7, 50,000/– and its salvage value is 8% of the original cost. The power shovel is used for 1500 hours per year and its life is 5 years.

The hiring charges for the power shovel including ma'ntenance and repairs is Rs. 30,000/– per month. Suggest whether the power shovel should be purchased or hired.

ution :

Original cost of power shovel = Rs. 7, 50,000/–

Salvage value of power shovel = 0.08 × 7.50.000/–

Utilization per year is of 1500 hours.

∴ For 5 years of useful life,

Utilization hours = 5 × 1500 = 7500 hours

Depreciated value = Original cost– salvage value

= 7,50,000/– 60,000/–

= Rs. 6,90,000/–

$$\text{Cost of depreciation per hour} = \frac{6,90,000}{7500}$$

= Rs. 92/–

Assuming Owning and operating cost as Rs. 68/- per hour

Then, total cost = Rs. 92 + Rs. 68

= Rs. 160/– per hour ...(i)

Hire :

Hiring charges including maintenance & repairs per year = 12 × 30,000

= 3, 60,000/–

$$\text{Hiring cost per hour} = \frac{3,60,000}{1500}$$

= Rs. 240 ...(ii)

∴ From the results (i) and (ii), it will be clear that it is better to purchase the power shovel in preference to hire it.

Example–11.2 : A concrete dam is proposed to be constructed. It will require 2.20 million tonnes of stone aggregates. The estimate for constructing a temporary road is Rs. 52 lacs. The hauling charges of stone aggregates is Rs. 22/– per tonne for truck.

The original cost of belt conveyor is Rs. 82 lacs. Its salvage value is 20% of the original cost of belt conveyor. The maintenance and repair charges are 30% of depreciated value and electric power consumption is 60% of original cost.

Which is the best alternative for hauling of stone aggregates-truck or belt conveyor?

Solution :

For trucks :

Estimated cost of temporary road = 52 lacs.

Hauling charge for truck = Rs. 22/– per tonne

∴ Total hauling charge = Rs. $(2.2 \times 10^5 \times 22)$

The net present worth of second hand equipment is :

$$NPW_{old} = -30,00,000 + 6,00,000\ [P/A, i, n]$$

$$= -30,00,000 + 6,00,000 \left[\frac{(1+0.18)^4 - 1}{0.18(1+0.18)^4}\right]$$

$$= -30,00,000 + 6,00,000 \left(\frac{0.939}{0.349}\right)$$

$$= -30,00,000 + 6,00,000\ (2.691)$$

$$= -30,00,000 + 16,14,327$$

$$= -13,85,673/-$$

The suggestion to purchase the new equipment is better.

11.10 ECONOMIC LIFE OF EQUIPMENT (FACTORS AFFECTING) :

→ The Economic life is defined as the life in which the annua worth is maximized.

→ If no income is generated, the economic life is the life for which the annual costs are minimized.

→ When a new equipment starts working there are practically n breakdowns and the plant equipment gives excellent output With the lapse of time normal wear and tear takes place; as result of which the output decreases and due to diminished performance the cost of POL (Fuel and Lubricants) and fiel repairs increases.

→ Gradually a stage reaches at which cost of operation is mor than the output and it is better to dispose off the equipment fo what ever salvage value it may fetch and purchase a nev equipment.

→ To arrive at such a decision, the owner has to consider th following factors:

(a) Depreciation and replacement

(b) Investment

(c) Maintenance and repairs

(d) Downtime

(e) Obsolescence

→ An analysis of the above parameters, which may affect th working of the equipment, will indicate the time at whic replacement of the equipment is justified.

(a) **Depreciation and replacement :**

→ Depreciation is defined as the loss in the value of a piece of equipment due to use, life, wear and tear, decay and obsolescence, etc.

→ Whenever an equipment performs useful work, its wear and tear is bound to occur. This can be minimised by proper maintenance.

→ Its efficiency also reduces with the lapse of time and at one time, it becomes uneconomical to be used further and needs replacement by new one.

→ For this, some amount must be set aside every year from the profits, so that the accumulated sinking fund will be equal to the replacement cost of a equipment, at the end of useful life.

(b) **Investment cost :**

→ The money spent on the purchase of the equipment, if invested in the bank, it would have earned an interest.

→ Now, this amount of interest should be recovered from the equipment.

→ Therefore, the investment includes the interest on the money invested to purchase the equipment. Also, the amount spent for taxes, insurance and storage, etc. have to be recovered as interest on the money from which equipment is purchased.

→ Generally, it may be taken as 10 to 15% of the average investment. The average investment is considered because the capital cost does not remain the same due to depreciation.

(c) **Maintenance and repairs:**

→ The cost of maintenance and repairs may depends upon the nature of work on which equipment is used and the manner in which the operation is carried out.

→ If proper maintenance and repairs are carried out regularly, the useful life of the equipment can be increased.

→ The annual cost of maintenance and repair should be sufficient to cover the cost of owing and operation and usually taken to be 100% of the annual depreciation.

(d) **Down time cost:**

→ The duration for which an equipment is not available for work is known as down time'

→ The equipment may be undergoing for major or minor repairs or it may be under servicing.

→ If the equipment is down time for 10% of the time, its availability reduces to 90%

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→ Thus, the increase in downtime, decreases the productivity. This is equivalent to an increase in the cost per hour for use of the equipment.

(e) **Obsolescence cost:**

→ If the manufacturer of construction equipment introduces a new equipment, which involves less operating cost and decreases production cost by say 10% , the equipment in use is placed at a disadvantageous position.

→ This type of loss, when the existing equipment has to be replaced by a new one, even though it had not completed its useful life, is termed as obsolescence loss.

✦ QUESTIONS ✦

1. Discuss the contribution and importance of construction equipments in construction industry. **[G.T.U., May/June 2012]**
2. Classify the construction equipment, giving brief description of each.
3. Discuss in brief, the factors affecting the selection of construction equipments. **[G.T.U., Nov. 2011, May/June 2012]**
4. Explain the different financial aspects of procuring construction plant and equipment. **[G.T.U., May/June 2012]**
5. From the following data for a power shovel, find out hourly rental cost for hiring it out to others:

Prime cost	= Rs. 12,50,000/–
Estimated useful life	= 6 years
Salvage value	= 10% of original cost
Investment cost	= 15% of average value
Maintenance & repair cost	= 30% of annual depreciation
Annual overhead	= Rs. 10,500/–
No of hours used per day	= 18 hours
Operating factor	= 0.60
Daily Operating cost	= Rs. 2200/–

Use straight line method of depreciation.

6. What is the use of present worth analysis in engineering economic studies? **[G.T.U., Nov. 2011]**

Derive the expression for (i) Revenue–dominated cash flow diagram

7. An engineer has two bids for an elevator to be installed in a new building. The details of the bids for the elevators are as follows:

Bid	Engineer's estimates		
	Initial cost (Rs.)	Service life (years)	Annual operation & maintenance cost (Rs.)
Trio Elevators	5,20,000	15	30,000
Otis Elevators	6,50,000	15	33,500

Determine which bid should be accepted, based on the present worth method of comparison assuming 15% interest rate, compounded annually.

8. What is meant by depreciation ? Derive the expression for depreciation and book value.
9. Derive the expression for depreciation and book value using sinking fund method.
10. A company has purchased a bus for its officers for Rs. 12,00,000. The expected life of the bus is 8 years. The salvage value of the bus at the end of its life is Rs. 1,60,000. Find the following using the sinking fund method of depreciation.

(i) Depreciation at the end of 3rd and 5th year

(ii) Book value at the end of 2nd and 6th year.

11. Discuss the costs to be considered for arriving at the cost of owning and operating equipment.
12. What are the factors affecting the cost of owning and operating equipment?
13. Estimate hourly owning and operating cost of a mobile heavy duty crane unit with following data :

Prime cost	= Rs. 42,50,000
Estimated useful life	= 15 years
Salvage value	= 10% of prime cost
Maintenance & Repair cost	= 15% of annual depreciation
Annual Overhead cost	= Rs. 22,000
Daily operating cost	= Rs. 2400
Annual operating hours	= 3300 hours = 11 hrs/day

14. Under what circumstances, should the equipment be replaced?

✦ QUESTIONS ✦

1. Describe with illustration, the following soil fundamentals
   (i) Material properties [G.T.U., Nov. 2011]
   (ii) Soil weight – volume relatioushps
   (iii) Volumetric measure
2. What meant by Rolling resistance of a haul road? What are the factors affecting the rolling resistance? [G.T.U., May/June 2012]
3. Discuss the effect of grade or slope of a haul road on the tractive effort.
4. Write a note on efficient of Traction
5. Discuss the effect of altitude above sea level on the performance of I.C. Engines, giving example.
6. Discuss the effect of pressure and temperature on the performance of I.C. Engines. [G.T.U., May/June 2012]
7. Discuss the Drawbar of a tractor on a load towed by it, giving example.
8. Discuss the effect of rimpull on the driving wheels, giving example.

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CHAPTER 13

07

TRACTORS AND RELATED EQUIPEMENTS

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13.1 TRACTORS

(i) GENERAL

→ Tractors are the machines that converts engine energy into tractive energy

→ The primary purpose of the tractor is to pull or push the loads. However, by making various modifications and by joining various attachments to the basic unit, they can be used for other purposes also.

(ii) TYPES

→ They may be divided into two major types:

(1) Crawler type tractors

(2) Wheel type tractors

(a) Two wheel type tractors

(b) Four wheel type tractors

(iii) SELECTION (Factors affecting)

→ For any particular job, what type of tractor may be required, is decided on the basis of some important factors:

(i) The size required for a given job

(ii) The kind of job for which it will be used e.g. bulldozing, pulling a scraper, pulling a wagon, ripping etc.

(iii) The type of footing over which it will travel or it requires high tractive or low tractive efficiency.

(iv) The firmness of the haul road.

(v) The smoothness of the haul road.

(vi) The slope of the haul road.

(vii) The length of haul

(viii) Type of work to be done after this job is completed.

(iv) CRAWLER TRACTORS: [G.T.U., Nov. 201

→ Crawler tractor is the most basic and a versatile machine in the construction industry.

→ They are more compact and powerful and can handle heavier jobs of hauling and digging.

→ They are more costly due to their expensive track system and large number of track parts subject to wear, increase the operating cost of crawler tractors,

transportation of crawler tractor over long distances usually done on trailors.

→ It serves a multitude of purposes, such as

- a primemover for pulling or pushing loads,
- a power unit for winches and hoists, and
- a moving mount for bull dozer blades, side booms and front end bucket loaders.

(v) WHEEL TRACTORS : [G.T.U., Nov. 2011]

→ Wheel tractors equipped with pneumatic tyres, have been used as primemovers since 1938

→ They have a speed of about 50 kmph, therefore they can travel faster than crawler tractors and they can be self driven over long distances.

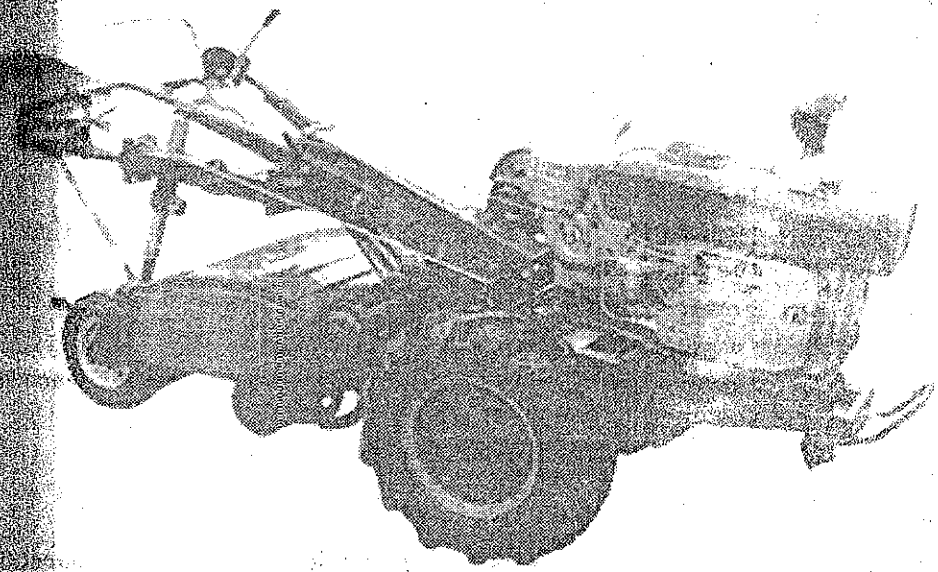
→ There are two types of wheel tractors:

(i) Two wheel type tractors

(ii) Four wheel type tractors

→ Two wheel type drives and steers with the same wheels.

→ Because of the weight concentration on the driving wheels, it may be able to develop more rimpul than a four wheel unit having the same engine power.



→ The front wheels of a four wheel unit are used primarily for steering purposes.

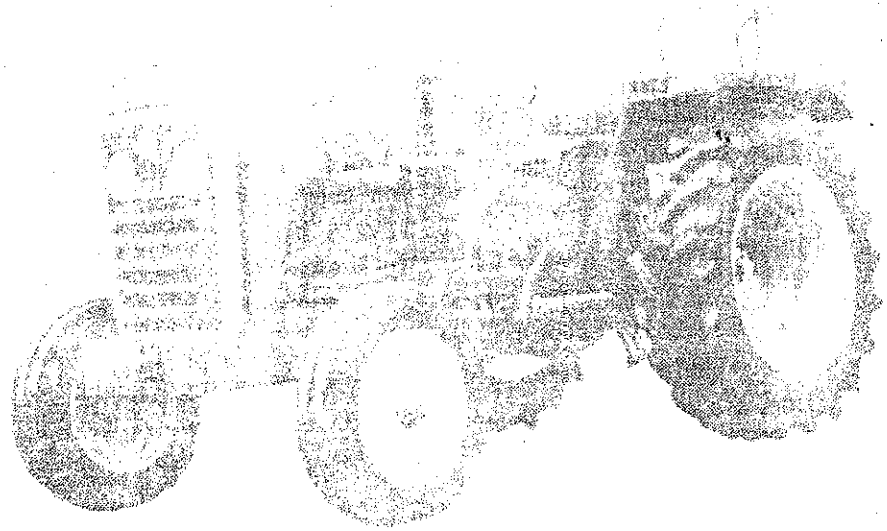


Fig. 13.2 Four Wheel Tractor

(i) Increased maneuverability.

(ii) Increased traction for driving axle.

(iii) Decreased rolling resistance because of the elimination of the extra axle.

(iv) Fewer tyres to provide and maintain.

(i) Better steering properties. This gives better confidence to the operator of the machine.

(ii) Less tendancy to bounce on rough haul roads.

(iii) Greater speed specially on rough roads, because of (i) and (ii) above

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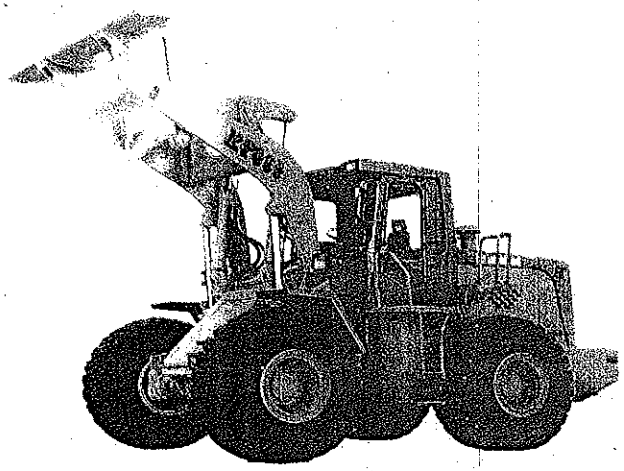
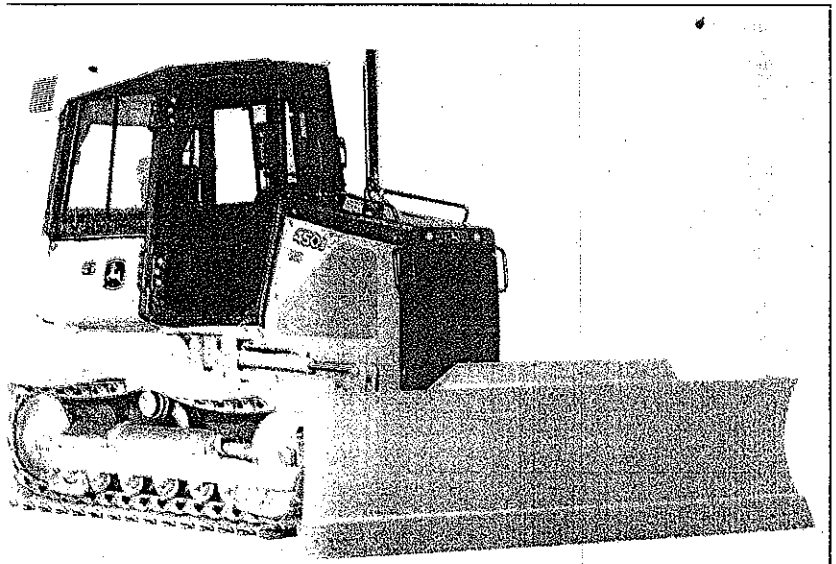


Wheel Mounted Bulldozer



Crawler Mounted Bulldozer

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13.2 BULLDOZER

(i) GENERAL :

→ A bulldozer is a tractor unit which has a blade attached to its front. The blade is used to push (ધકેલવું), shear (કાપવું/વાઢવું), cut (કાપવું) and roll (ફેરવવું) the material ahead of the tractor.

→ A bulldozer is a very useful equipment and can be used on the construction work for the following purposes:

(i) To clear the site

(ii) Opening up temporary roads through difficult areas i.e. mountains and rock terrain, thick forests. etc.

(iii) Moving earth for haul distance up to about 100 metres.

(iv) In helping load tractor- pulled scrapers.

(v) Levelling earth fills, i.e. To spread and level the earth embankments.

(vi) Back filling trenches.

(vii) Clearing the construction sites, i.e. old buildings, structures are demolished.

(viii) Clearing the floors of borrow pits.

(ix) Maintaining haul roads.

(ii) CLASSIFICATION:

The bulldozers may be classified as follows:

(1) **According to direction of blades:**

(a) Machines mounted with blades perpendicular to the direction of travel are known as Bulldozers. It pushes the earth forward.

(b) Machines mounted with blades set at an angle with the direction of travel are called Angledozers. It pushes the earth forward and to one side.

(2) **On the basis of mountings :**

(a) Crawler – tractor- mounted bulldozer

(b) Wheel – tractor mounted bulldozer

(3) **Based on method of control for raising & lowering blades:**

(a) Cable control

(b) Hydraulic control

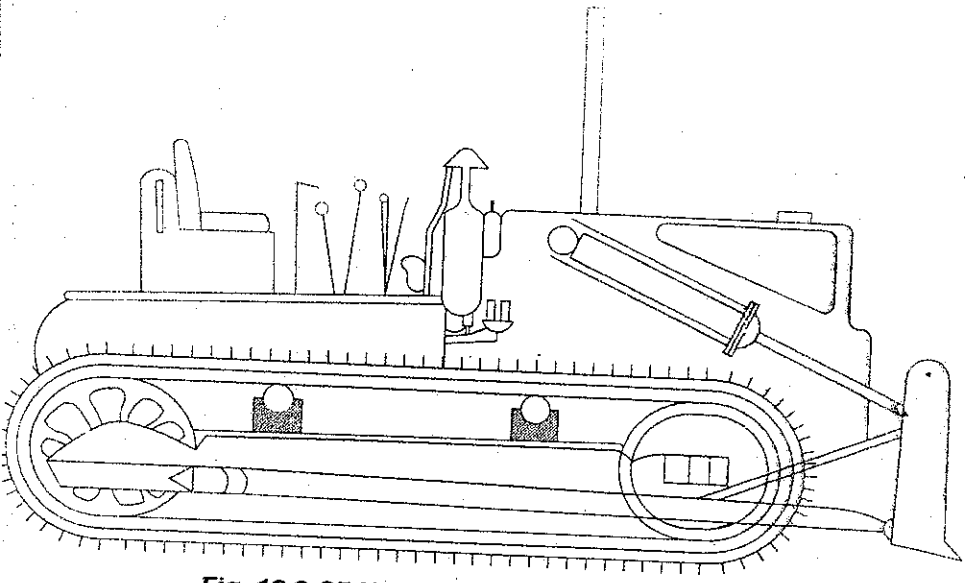

Fig. 13.3 CRAWLER MOUNTED BULLDOZER

ii) COMPARISION : (Advantages):

(a) Cable control verses Hydraulic control :

→ The cable controlled operation has the following advantages.

(i) It is simple in installation (ફીટ કરવું) and operation (ચલાવવું)

(ii) It is easier (પ્રમાણમાં સહેલું) to repair the controls (રિપેરાવવો).

(iii) There is less chance of damaging the machine, as the blade can move up and ride over a rigid obstruction such as big boulders.

→ The hydraulic controlled operation has the following advantages:

(i) It can produce high down pressure on the blades.

(ii) More precise (ચોકસ) setting of the blades can be maintained.

(b) Crawler mounted Verses Wheel mounted :

→ The crawler mounted dozer has the following advantages:

(i) It can deliver greater tractive effort even in operating on soft footings, such as loose or muddy soil.

(ii) It can travel over muddy surfaces.

(iii) It is able to operate in rocky formations, where rubber tyres might be seriously damaged.

(iv) Greater floatation because of the lower pressures under the trackes.

(v) It can travel over rough surfaces, which may reduce the cost of maintain haul roads.

(vi) Various jobs can be performed by it.

→ The wheel mounted dozers have the following advantages:

(i) It has high travel speeds on the job.

(ii) Greater out put is received when considerable travelling is necessary.

(iii) The operator has less fatigue (થાક લાગવો) with this machine.

(iv) No hauling equipment is required for transporting the dozer from one job to the other.

(v) It can travel over paved highway without damaging the surfaces.

(iv) CLEARING LAND WITH BULLDOZER:

→ If small trees are to be removed, the dozer blade is lowered below the surface of ground and when the machine moves forward, the bushes and the trees are pushed a head of it.

→ For moderately large trees, leverage is increased sufficiently by raising the blade to the full height and the trees are pushed down.

→ When any large trees are to be removed, a wire rope of 25 to 50 mm. diameter is taken and then it is wound round the tree and its two ends are tide with two bulldozers moving in one direction at suitable space ultimately pulls down the trees.

(v) BULLDOZER BLADES :

→ The blade attached to the tractor to convert it into a bulldozer must be matched to the expected work task.

→ Basic earth-moving blades are curved in the vertical plane in the shape of a "C". Along the bottom length of the blade, hard steel plates are bolted. These plates make up the cutting edge of the blade.

→ The blade is lowered or raised by cable system or by hydraulic system.

(vi) BLADE ADJUSTMENTS :

There are three possible blade adjustments, such as tilt, pitch and angle.

(a) Tilting : The vertical movement of a blade end is known as tilt. This movement is within the vertical plane of the blade.

Tilting permits concentration of tractor driving power on a limited length of the blade

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(b) Pitching : The control which allows the operator to varry the angle of attack to the blade's cutting edge with the ground is pitch.

- It is the movement of the top of the blade toward or away from the tractor. This is a pivotal movement about the point of connection between the tractor and the blade.
- When the top of the blade is pitched forward, the bottom edge moves back; this increases the angle of the cutting edge attack.

(c) Angling : Turning the blade so that it is not perpendicular to the direction of the tractor's travel is angling.

- This causes the pushed material to roll off the trailing end of the blade.
- The procedure of rolling material off one of the blade is called side casting.

(vii) TYPES OF BLADES :

The various types of the blades available for bulldozer along with their specific usage and possible movement for maneuvering are as follows :

(a) Straight "S" blade
(b) Angle "A" blade
(c) Universal "U" blade
(d) Cushion "C" blade

(a) Straight "S" blade :

→ These are the blades used primarily for excavation work. They have no curvature in their length.

→ The blade is normally heavy duty and can be titled, thus facilitating penetration into hard materials.

→ It may be equipped to pitch. The ability to pitch means that the operator an set the cutting edge to dig hard-materials or to move the edge's plane of attack to ease the drifting of light materials.

(b) Angle blades "A" :

→ An angle blade is wider by 30 to 60 cm. than an S blade.

→ The angle blade can be operated straight or angled up to a maximum of 25° left or right of the normal position (perpendicular to the tractor).

→ The blade can be tilted. Because of the angle blade is attached to the tractor by a C frame mount, it cannot be pitched. It is

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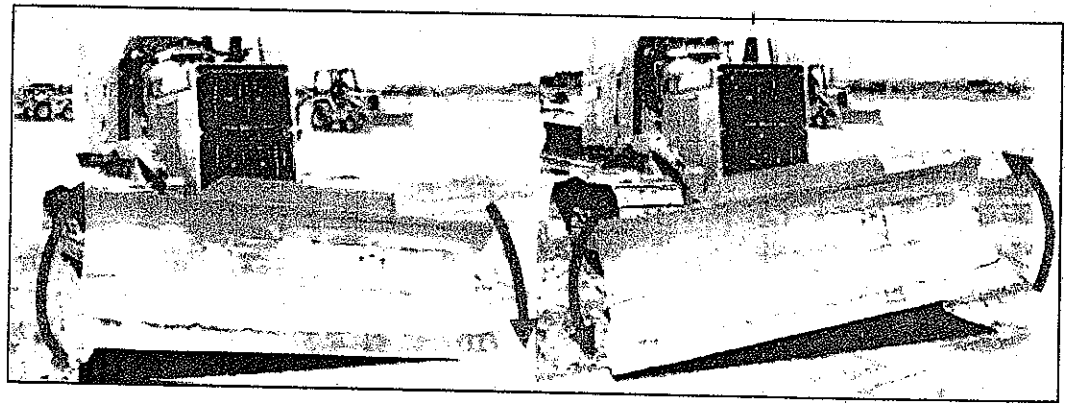

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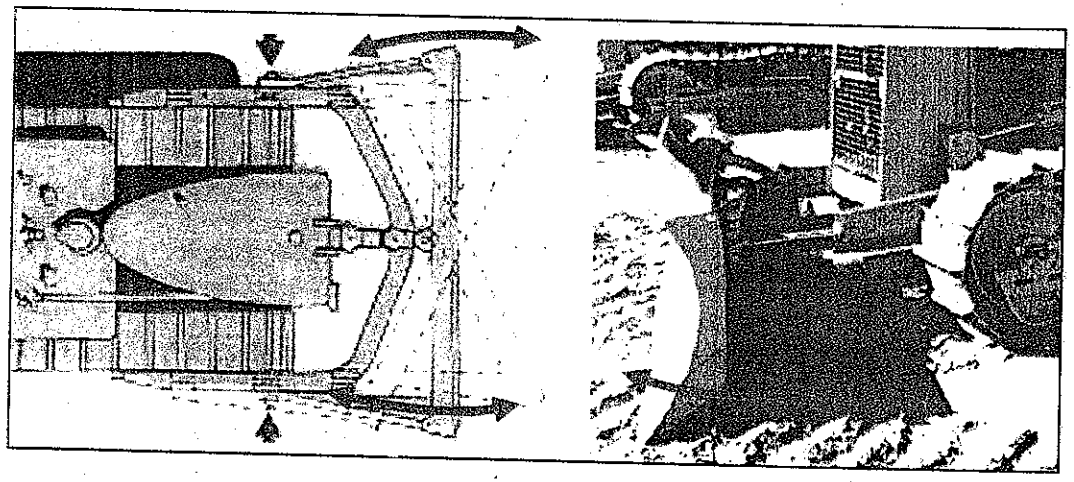

ANGLELING

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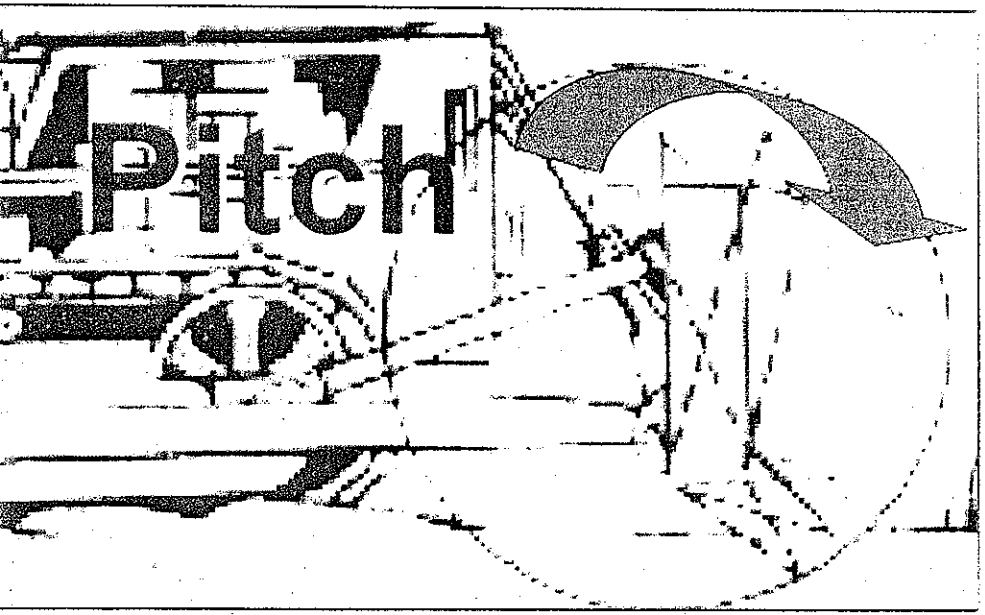
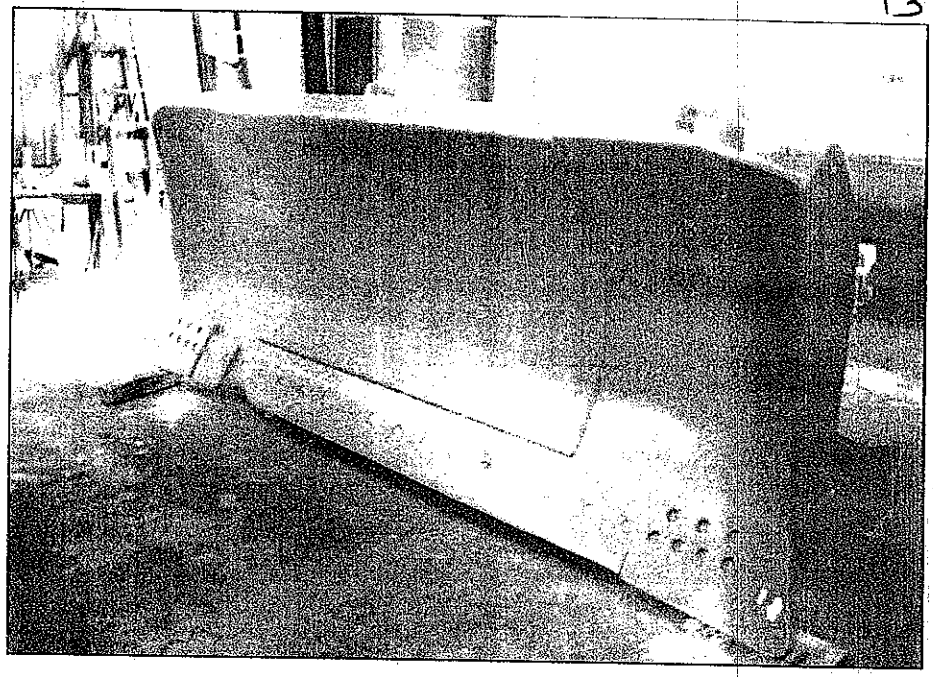
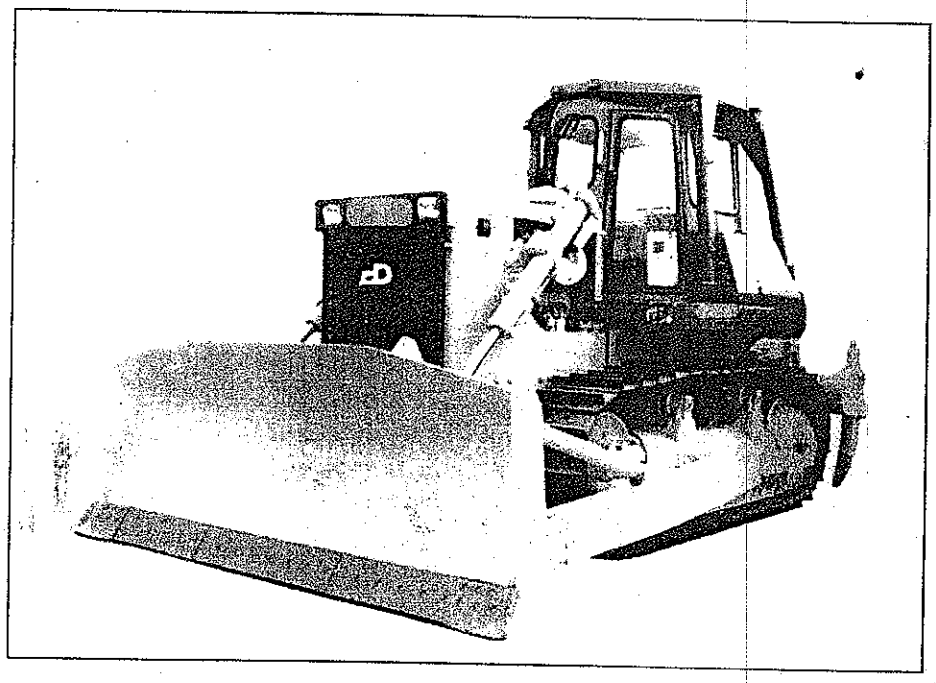


PITCHING



CUSHION BLADE-BULLDOZER



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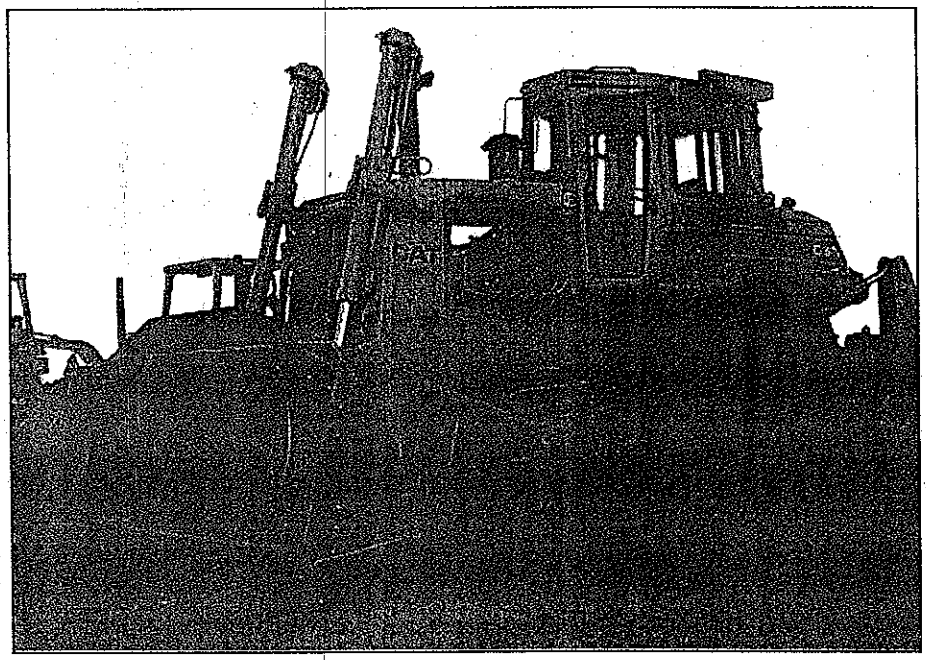
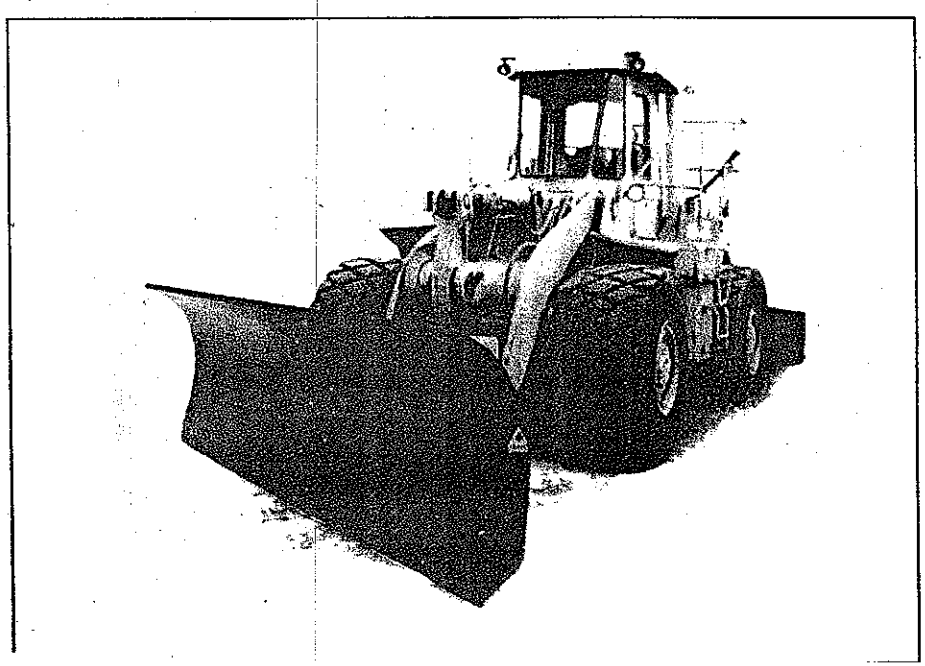


UNIVERSAL BLADE BULLDOZER



(c) Universal blades "U" :

→ This blade is wider than a straight blade and the outside edges are canted forward about 25°. This canting of the edges reduces the spillage of loose material making the U blade efficient for moving big loads overlong distances.

→ The hp/ft ratio is lower for the U-blade than for the S-blade mounted on a similar tractor.

→ The penetration is not a primar objective of the U-blade, as this ratio relationship indicates.

The U-blades hp/lcy ratio is lower than that of an S-blade. This denotes that the blade is best suited for lighter materials.

Typical usages are working stockpiles and drifting loose or non-cohesive materials.

(d) Cushion blades 'C' :

→ The cushion blades are mounted on large tractors, which are used primarily for push-loading scrapers.

→ The C-blade is shorter than the S-blade, to avoid pushing the blade into and cutting the rear tires of the scraper while push-loading.

→ The shorter length facilitates maneuvering into position behind the scrapers.

→ The rubber cushions and spring in the mounting allow the dozer to absorb the impact of contracting the scraper push block.

→ By using a cushion blade instead of a "pusher block" to push scrapers, the dozer can clean up the cut area and increase the total fleet production.

→ The cushion blade has limited utility in pushing material and should not be used for production bulldozing. It cannot be titled, pitched or angled.

(viii) BULLDOZER OUTPUT (PRODUCTION RATES) :

The factors affecting the output or production rates of bulldozers are as follows :

(a) Blade type :

→ The production rate or output of a bulldozer may depends upon the characteristics of various types of blades.

→ The straight blade roll material in front of the blade, whereas universal blades control side spilage, thus holding the material within the blade. Because the universal blade forces the material

→ The U-blade's quantity of loose material will be greater than that of the S-blade. But the ratio of this difference is not the same, when considering bank yards. This is because the factor to convert loose cubic yards to bank cubic yards for the universal blade is not the same as that for a straight blade. The difference is caused by the U-blade's bolting effect.

→ The same type of blade comes in different sizes to fit different size tractors. Blade capacity then is a function of blade type and physical size.

(b) **Type and condition of material :**

→ The shape of the pushed mass in front of the blade is affected by the type and condition of the material being handled.

→ The cohesive materials (clays) will 'boil' and heap.

→ The materials which exhibit a slippery quality or those which have a high mica content will ride over the ground and swell out.

→ The cohesion less materials (sands) are known as "dead" materials because they do not exhibit heap or swell properties.

(c) **Cycle time :**

→ The sum of the time required to push, backtrack and maneuver into position to push represents the complete dozer cycle.

→ The time required to push and backtrack can be calculated for each dozing situation from the travel distance and the machines performance chart. However, dozing is generally performed at slow speed, 1.5 to 2.0 kmph.

→ The return speed is usually the maximum that can be attained in the distance available.

When using performance charts to determine possible speeds, rember the chart identifies instantaneous speeds.

→ In calculating durations, the estimator must use an average speed which takes into account the time required to accelerate to the attainable speed as indicated by the chart.

→ Usually for distances less than 100 ft. or 30 m., the operator can not get the machine past the second gear.

If the distance is greater than 100 ft. or 30 m and the ground conditions are relatively smooth and level, maximum machine speed may be obtained. Maneuver time for power shift tractors is about 0.05 minutes

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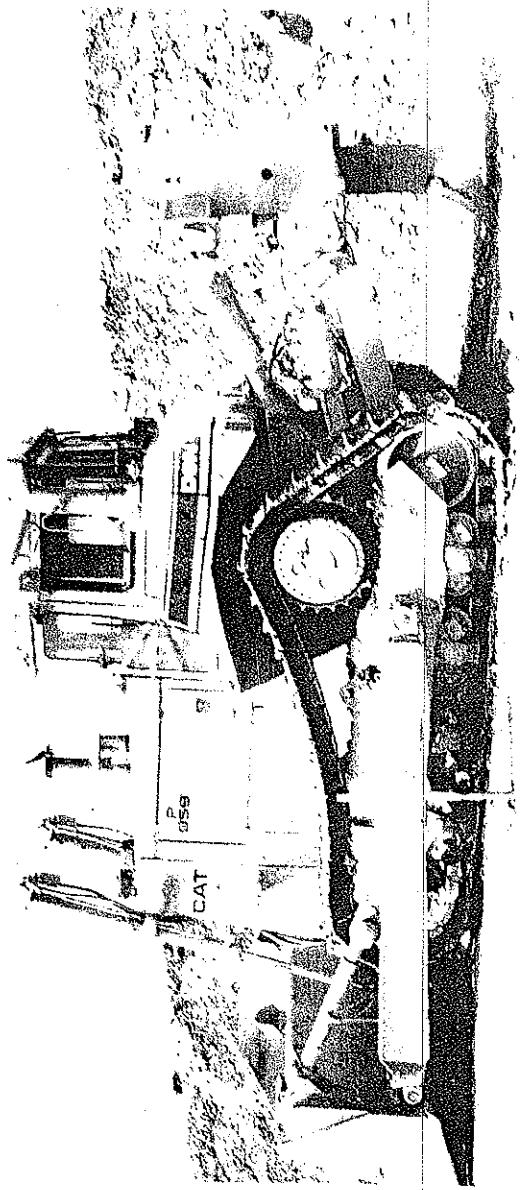

Ripper

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13.3 RIPPERS

(i) GENERAL :

→ The rippers are used to tear and split hard ground, weak rocks or old pavements and bases.

→ The heavy ripping can be done with crawler tractors, because of the power and tractive force available from such machines.

→ The ripping of weak rocks, etc. can be done with relative ease and at reduced costs including ripping and hauling with scrapers which may be about half the cost of drilling, blasting, loading with loaders and hauling with trucks.

(ii) FACTORS AFFECTING THE INCREASE IN UTILIZATION OF RIPPERS:

(i) Heavier and more powerful tractors.

(ii) Improvements in the sizes and performance of rippers to include development of impact rippers.

(iii) Better instruments for determining the rippability of rocks.

(iv) Improved techniques in using instruments and equipments.

(iii) DETERMINING THE RIPPABILITY OF ROCK:

→ Before selecting the method of excavating and hauling rock, it is desirable to determine the rippability of rock and necessity of drilling and blasting.

→ The rippability of most of the rocks is related to the speed of the sound waves through the rock.

→ The rocks which propagate sound waves at low velocities are rippable, while the rocks which propagate waves in high velocities are not rippable.

→ The rocks having intermediate velocities are classified as marginal

→ The rippability of rock is determined by using multi or single shank rippers mounted on a crawler tractor.

(i) TYPES : (Ripper Attachments)

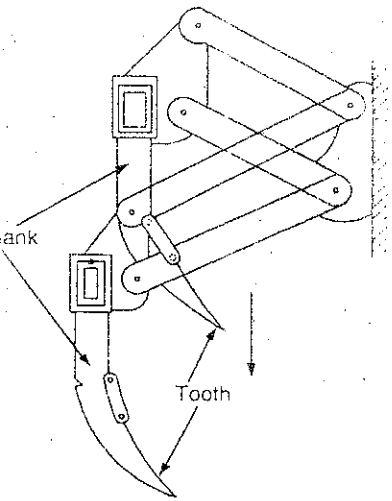

Fig. 13.4(a) Parallel

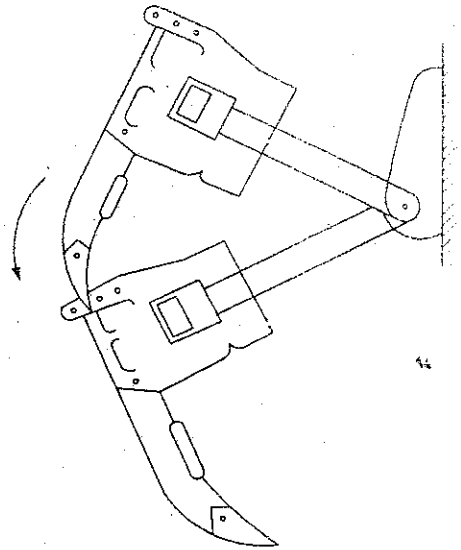

Fig. 13.4(b) Radial

→ The ripper attachments for tractors are generally rear mounted.

→ The mounting may be either radial, hinged type or a parallelogram arrangement.

→ The vertical piece, which may be forced down into the material to be ripped is known as shank.

→ At the lower cutting end of the shank, a tooth is mounted. The tooth is detachable for easy replacement, as it is the high wear surface of the ripper.

→ There are both straight and curved shanks available.

→ The straight shanks are used for massive or blocky formations.

→ The curved shanks are for bedded or laminated rocks or for pavements where a lifting action will help to shatter the material.

→ The number of shanks used depends upon the size of the tractor, the depth of penetration desired, the resistance of the material being ripped and the degree of material breakage desired.

→ It the material to be excavated by scrapers, it should be broken into particles that can be loaded into scrapers, usually not more than 60 to 75 cm maximum sizes.

→ In cash of radial-type mounting, the beam of the ripper pivots on the link arms of the tractor, therefore, the angle of the tooth

→ In case of parallelogram type rippers, the shank is maintained in a vertical position and the tooth is kept at a constant angle.

→ Heavy duty rippers have one to three shanks. The shanks are pinned into position on the ripper frame.

(v) ECONOMY IN RIPPING ROCK:

→ The cost of excavating rock by ripping and scraper loading is considerably higher than for earth, which requires no ripping.

→ How ever, it may by much less expensive than using an alternative method, such as drilling, blasting, excavator loading and truck hauling.

→ The actual operational costs in respect of removal of such type of hard rock, which could be removed both by ripping as well as drilling and blasting shows that the cost of removal by ripping is only 50 to 70% of the cost involved by drilling and blasting.

13.4 SCRAPERS

(i) GENERAL

→ Tractor- pulled scrapers are used to scrap load, haul and dump loose material.

→ They can be used in a wide range of material types, including shot rocks and are economical over a wide range of haul lengths and haul conditions.

→ They are not dependent on the other equipment and they can be self loaded.

(ii) TYPES :

They are available in various types, such as

1. Push loaded scrapers
   (a) Single-power axle (b) Tandem- power axle.
2. Push-pull, tandem-power axle
3. Elevating scraper

Push-loaded scrapers:

→ The wheel-type tractor scraper has the high travel speeds up to 45 kmph on favourable haul roads, when fully loaded.

(a) For the single-power axle scrapers only 50 to 55% of the total loaded weight, comes on the driving wheels. Also, in most materials, the coefficient of traction for rubber tyres is less than that for track system.

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→ Therefore, it is necessary to supplement loading power of the scrapers by a crawler tractor pusher.

→ The loading costs are still relatively low, because both the scraper and the pusher share the total power required to obtain full load.

(b) The tandem-powered units have an initial cost 25% more than single-powered axle scrapers, therefore they are considered as a specialized unit for opening up a job. working in extremely adverse grades or working in soft ground conditions.

2. Push-Pull scrapers:

→ These are basically tandem-powered axle units having a cushioned push block and bail on the front and a hook on the rear above the usual push block.

→ Due to this, two scrapers may assist one another during loading operation, by hooking together.

→ The trailing scraper pushes the lead scraper as it loads.

→ Then the lead scraper pulls the trailing scraper to assist it in loading.

→ Thus, two scrapers can work without assistance from a push tractor.

3. Elevating Scrapers:

→ This is a completely self-contained loading and hauling scraper.

→ The elevating scraper is equiped with horizontal flights, which are operated by two and less elevator chains to which the ends of the flights are connected.

→ As the scraper moves forward with its cutting edge digging into the earth, the flights rake the material upward into the bowl.

Advantages :

(i) Such scrapers are economical in short-haul situations.

(ii) They are very good in small quantity situations.

(iii) No pusher is required, so there is never a mismatch between the pusher and the number or scrapers.

Disadvantages:

(i) The weight of the elevator-loading assembly is dead weight during the haul cycle.

(ii) Because of the elevator mechanism, they cannot handle rock or material containing rocks.

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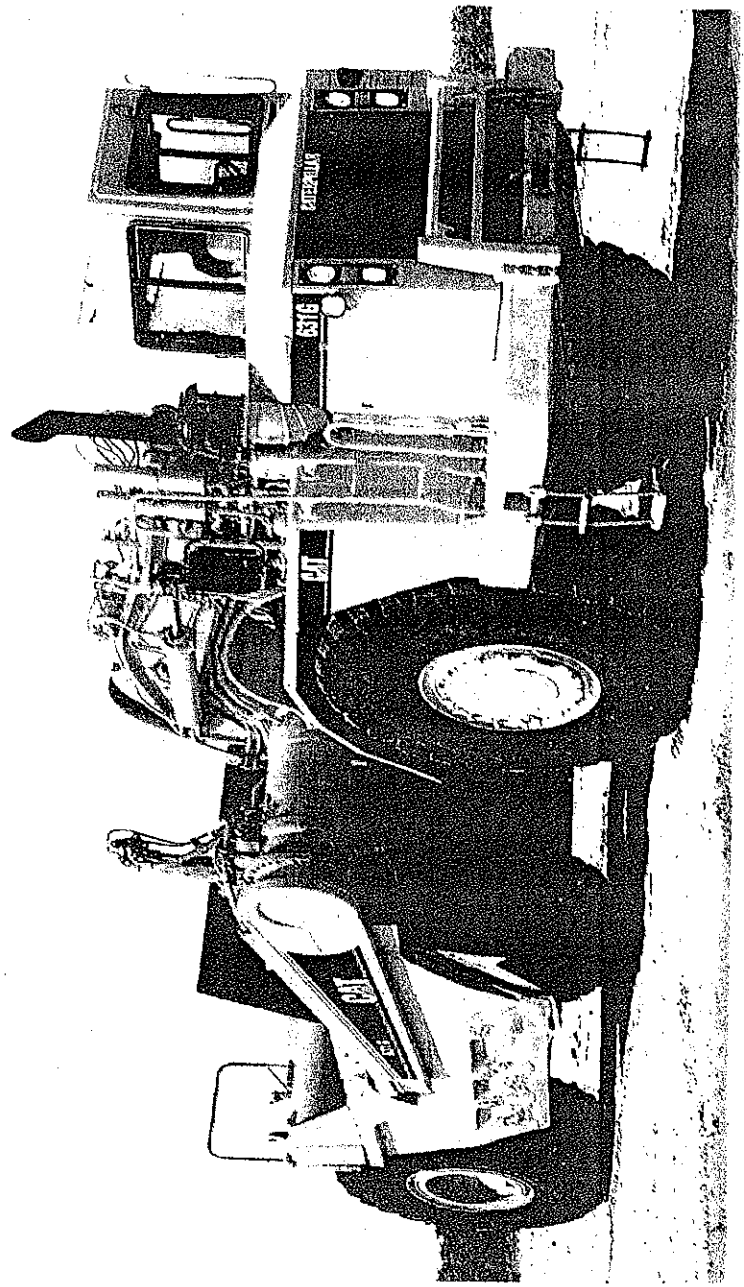

Scraper

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(iii) SCRAPER OPERATION

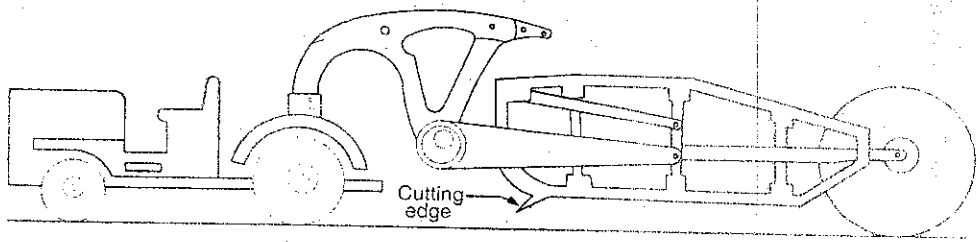

Fig. 13.5 Scraper

The scraper operation can be described in following stages:

(a) **Loading :**

→ A scraper is loaded by lowering the front end of the bowl until the cutting edge enters the ground surface.

→ At the same time, the front apron is raised to provide an open slot through which the earth can flow into the bowl.

→ As the scraper moves forward a horizontal strip of material is forced in to the bowl.

→ When the bowl is filled, the cutting edge is raised and the apron is lowered to prevent spillage during the haul.

(b) **Hauling :**

→ The loaded scraper unit is hauled to a place, where the material is to be dumped.

(c) **Dumping :**

→ The dumping operation consists of lowering the cutting edge, raising the apron and then forcing the material out by means of movable ejector mounted at the rear of the bowl.

→ Then the empty scraper is again moved or hauled to the digging place and the cycle is repeated in the same manner.

(iv) OPERATING EFFICIENCY:

→ The actual production in terms of an average number of minutes per hour that the machine is working.

→ A machine working for 50 minutes per hour is said to have an efficiency factor of $\frac{50}{60} = 0.83$.

(v) PUSH-TRACTORS REQUIRED

→ To attain their maximum volumetric capacities, the tractor-pulled scrapers need the assistance/help of a push tractor during the loading operation.

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→ When using push tractors, we should match the number of pushers with the number of scrapers available at a given time.

→ If either the pusher or the scraper is required to wait for the other, the operating efficiency will be decreased and the production costs will be increased.

) INCREASING SCRAPER PRODUCTION :

→ The following methods are adopted to obtain maximum production at the lowest cost:

(i) Ripping :

→ If the ripping of the hard soil is done, ahead of the scraper, the loading can be done faster.

→ Also, the delays due to equipment repairs will be reduced substantially as the scraper will not be operated under the much strain.

→ If the value of the increased production due to ripping is more than the ripping cost, the material should be ripped.

(ii) Pre-wetting the soil :

→ If pre-wetting of the soil is done in conjuction with ripping or ahead of scraper loading, the soils can be loaded more easily.

(iii) Loading down-grade :

→ If it is possible, the scrapers should be loaded down grade and in the direction of haul.

→ The down grade loading results in faster loading, while loading in the direction of haul may shortens the length of the haul.

→ Each 1% of favourabe grade will increase the loading force by 9 kg. per tonme of gross weight of the push tractor and the scraper unit.

(v) Supervision :

→ The full time supervisory control during the working hours will result in more efficient operation of the equipment, due to the elimination of confusion and the traffic congestion.

✦ QUESTIONS ✦

What are the functions of a tractors? What are the various types of tractors?

Discuss the factors affecting the selection of tractors for a particular job

Write notes on (i) Crawler Tractors (ii) Wheel Tractors.

[G.T.U., May/June 2012]

4. **Differentiate between** the advantages of two-wheel and four-wheel **type tractors.**

5. **What** are the purposes of a bulldozers on the construction work?

6. **Give** the classification of bulldozers.

7. Differentiate between:
   (i) Cable control verses Hydraulic control
   (ii) Crawler mounted verses wheel mounted dozers.

8. Describe the clearing of land with bulldozer and out put of a bulldozer.

9. What are the functions of rippers? What are the factors affecting the increase in utilization of rippers?

10. How the rippability of rock can be determined?

11. Describe the various types of riper attatchments with neat sketches

12. How the economy can be achieved in ripping rock?

13. What are the uses of scrapers? Classify the scrapers.

14. Describe various types of scrapers.

15. Explain the scraper operation, giving a neat sketch .

16. What is meant by operating efficiency? How the numbers of push tractors required can be decided?

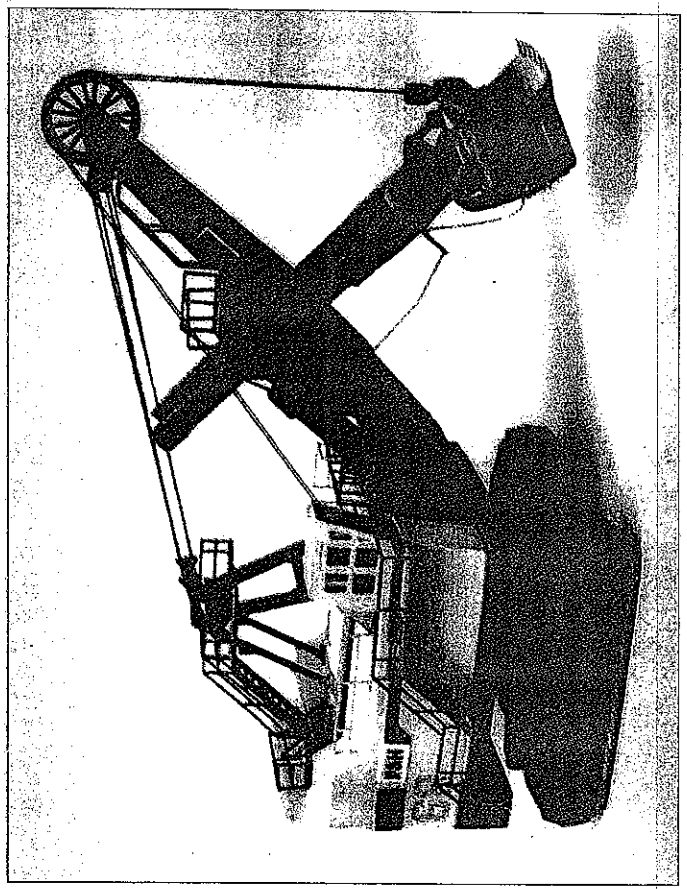
17. Discuss the various methods adopted to increase the scraper production.

❖ ❖ ❖

CHAPTER

14

EXCAVATING EQUIPMENTS



POWER SHOVEL

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14.1 POWER SHOVELS

[G.T.U., Nov. 2011]

(i) GENERAL :

→ Power shovels are used to excavate the earth and load it into the trucks or tractor- pulled wagons or on to conveyor belts.

→ They are capable of excavating all classes of earth, except solid rock, without prior loosening.

→ They may be mounted on crawler tracks, which have very low travel speed, but can be operated on soft ground.

→ They may be mounted on rubber- tyred wheels, which have higher travel speeds than the crawler mounted units and are useful for the jobs, where considerable travelling is necessary and where the road surface and ground are firm.

(ii) BASIC PARTS & OPERATION:

→ The basic parts of a power shovel include the mountings, cab, boom, dipper stick, dipper and hoistline.

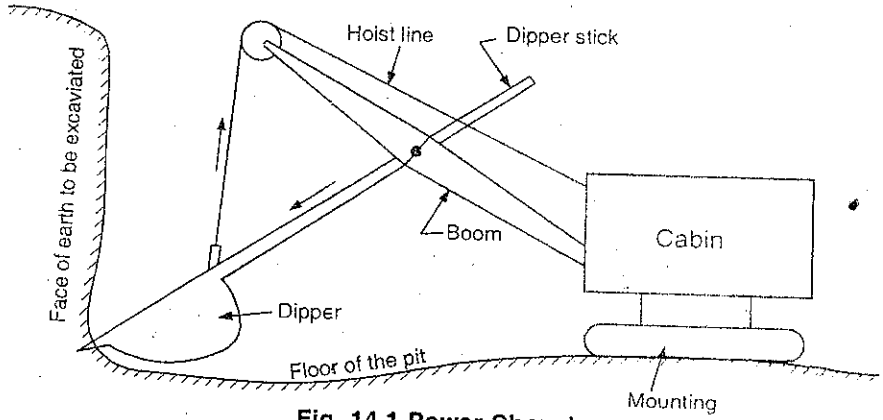

Fig. 14.1 Power Shovel

→ A shovel is placed in the correct position, near the face of the earth to be excavated.

→ The dipper is lowered to the floor of the pit, with the teeth pointing into the face.

→ A crowding force is applied through the shipper shaft and at the same time tension is applied to the hosting line to pull the dipper up the face of the pit.

→ If the depth of the face is just right, the dipper will be filled as it reaches the top of the face.

→ If the depth of the face is too shallow, it will not be possible to fill the dipper completely without excessive

tension. This gives the excessive strain to the equipment and reduce the output of the unit.

→ If the depth of the face is greater than the required to fill the dipper, it will be necessary to reduce the depth of penetration of the dipper into the face.

(iii) SELECTION (TYPE & SIZE) (Factors affecting)

→ The various factors affecting the selection of particular type and size of powershovel are as follows:

1. In selecting the type of shovel :

→ If there will be number of small jobs in different locations, the mobility of the rubber-tyre mounted shovel will be a distinct advantage.

→ If the work will be concentrate in large jobs, the mobility will be of less importance and the crawler mounted shovel will be more desirable.

2. In selecting the size of a shovel :

(i) Cost per cum factor (ii) Job conditions factor

(i) Cost per cum-factor :

→ The size of a job, as a larger job may justify the higher cost of a large shovel.

→ The cost of transporting a large shovel will be higher than the small one.

→ The depreciation rate for a large shovel may be higher than the small one.

→ If it is to be sold at the end of a job, greater difficulty of selling large shovel.

→ The cost of downtime for repairs for a large shovel may be higher than the small one.

→ The combined cost of drilling, blasting and excavating rock for a large shovel may be less than the small one.

→ The cost of wages per cum for a large shovel will be less than the small one.

(ii) Job conditions factor :

→ High lifts to deposit earth from a basement or trench into the trucks at natural ground level will require the long reach of a large shovel.

If blasted rock is to be excavated, the large size dipper will

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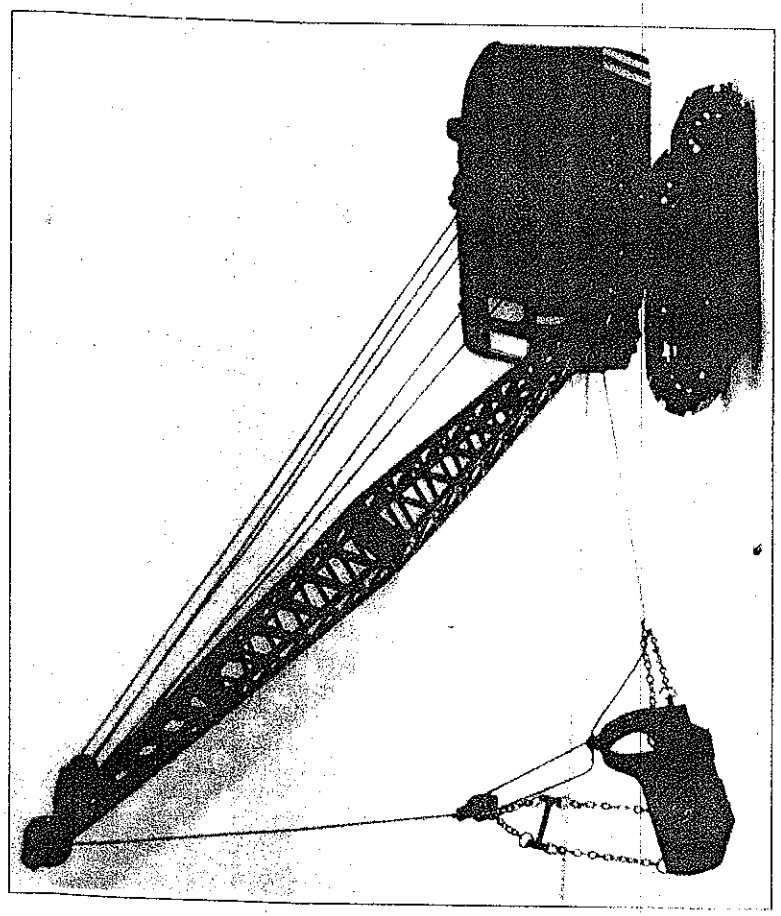

DRAGLINE

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→ If the material to be excavated is hard and tough, the dipper of the large shovel will handle the material more easily.

→ The size of hauling units available : If the small hauling unit is available with contractor, the small size shovel should be selected and if the large hauling units are available, a large shovel should be selected.

→ The weight limitations for hauling on high ways may restrict the size of a shovel, if it is to be hauled over state highways.

→ Also, the clearance of bridges and underpasses may restrict the size of the shovel.

14.2 DRAGLINES

(i) GENERAL :

→ Draglines are used to excavate earth and load it into the hauling units, such as trucks or tractor pulled wagons, or to deposit it in levees, dams and spoil banks near the pits from which it is excavated.

→ In general, a power shovel up to a capacity of 2.0 cum can be converted into a dragline by replacing the boom of the shovel with a crane boom and substituting a dragline bucket for the shovel dipper.

(ii) ADVANTAGES AND DISADVANTAGES

Advantages (Deployment Situations)

→ The draglines are employed or deployed in the following situations:

(i) It is useful when earth is to be removed from a ditch or canal or pit containing water, as it can be operated from natural ground level, without going into the pit.

(ii) If the earth is to be hauled with trucks, they do not have to go into the pit and contend with mud.

(iii) Dragline with long booms are helpful, when earth is to be deposited directly on the banks or dams, eliminating need of hauling unit.

(iv) Draglines are excellent units for excavating trenches, without shoring.

Disadvantages :

→ One dis advantages in using a dragline, compared with a power shovel, is the reduced out put of a dragline.

iii) TYPES AND SIZE OF DRAGLINES :

Types :

Draglines may be divided into four types, as follows:

1. Crawler – mounted
2. Wheel- mounted, self propelled
3. Truck- mounted
4. Walking

Size of a Dragline :

→ The size of dragline is indicated by the size of the bucket, as expressed in cum

→ However, most of the draglines may handle more than one size bucket depending upon the length of the boom and the class of material excavated.

iv) BASIC PARTS AND OPERATION :

→ The basic parts of a dragline includes a mounting, a cab, a crane boom, a bucket, hoist cable, hoist chain, drag cable and a drag chain, etc.

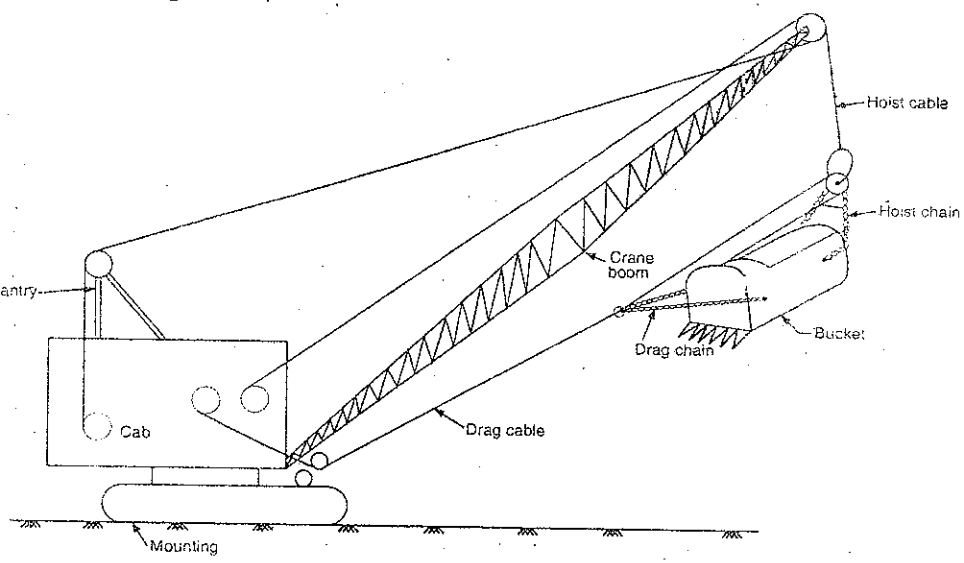

Fig. 14.2 DRAGLINE

→ Excavation is started by swinging the empty bucket to the digging position and at the same time slacking off the drag and hoist cables.

→ Excavation is accomplished by pulling the bucket towards the

→ When the bucket is filled, the operator takes in on the hoist line, while playing out the drag cable for hoisting (lifting up) the loaded bucket and then swinging it to the dumping position, which may be over a spoil bank or a dam or a truck.

→ Then the dumping is accomplished by releasing the drag cable.

→ The whole cycle is then repeated in the same manner.

(v) FACTORS AFFECTING THE OUTPUT OF A DRAGLINE

[G.T.U., May/June 2012]

Output :

The various factors affecting the output of a dragline are as follows:

(i) **Class of material:**

→ The class of material has the effect on the cost per cubic metre, when excavating with draglines.

→ If the material to be excavated is soft, the output of a dragline will be more and if the material is hard and tough, the output will less.

(ii) **Depth of cut:**

→ The dragline will produce its greatest output, when the excavation is done at the optimum depth of cut, with a swing angle of 90°.

→ The optimum depth is defined as the depth at which the output in terms of quantity of earth excavated and dumped would be maximum.

→ The factors that affect the optimum depth are the class of material and various sizes of buckets.

(iii) **Angle of swing:**

→ The angle of swing is the horizontal angle between the position of the bucket when it is excavating and the position when it is discharging the load.

→ The total cycle time includes- digging, hoisting and then swinging to the dumping position and then dumping and returning to the digging position .

→ If the angle of swing is increased, the cycle time will be increased and the output will be decreased, whereas if the angle of swing is decreased. the cycle time will be decreased and the output will be increased.

→ The ideal production of a dragline is based on operating at a 90° swing and the Optimum depth of cut.

→ If a dragline is excavating at optimum depth and if the angle of

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(iv) Size and type of bucket:

→ In order to obtain the maximum output, the proper size and type of bucket should be selected.

→ The buckets are generally available in three types: light duty, medium duty and heavy duty.

→ The light duty buckets are used for excavating materials, which can be easily dug, such as sandy loam, sandy clay or sand.

→ The medium duty buckets are used for excavating clay, soft shale or loose gravel.

→ The heavy duty buckets are used for mine stripping, handling blasted rock and excavating hard pan and highly abrasive materials.

→ Also, for increasing the output, it is desirable to use the largest size bucket, but the combined weight of the load and the bucket does not exceed the recommended safe load for the dragline.

(v) Length of Boom:

→ It is generally desirable to have a dragline with a fairly long boom.

→ Due to the increased length of the boom, it is possible to dispose off the earth in one operation, thereby saving the cost and time required for employing a hauling unit.

→ The ratio of the output obtained from the use of a 70'ft long boom and 2.0 cum. bucket, compared with a 1½ cum. bucket, will be equal to 127%, that means the output is increased by 27%.

(vi) Job conditions:

→ The output of a dragline may depends upon the different job conditions in which the equipment has to work.

→ e.g. when the dragline is working in a large, open quarry situation with a firm and well drained floor, where the trucks can be placed on either side of the machine, which will eliminate the lost time waiting for haul units.

→ Also, the terrain may be having uniformly level ground, so that the height of cut will always be closed to ptimum depth.

→ Fierther, the haul road may not be affected by climatic conditions, such as rains, etc.

→ These are the excellent job conditions in which the output can be increased considerably.

→ On the other hand, another equipment may be excavating

→ The height of cut may vary from zero at the base of the hill to considerably more than the optimum height at the top of the hill.

→ Also, the sides of the cut must be carefully sloped.

→ The cut may be so narrow that a loaded truck must be moved out before an empty truck can be backed into the loading position.

→ As the truck must be placed behind the equipment, the angle of swing will be approximately 180°; which will delay the movement of the trucks.

→ Due to this type of difficult job conditions, the equipment will have a severely reduced output.

(vii) Management Conditions:

→ The advanced planning and foresight of the contractor in controlling the work and organizing the job will affect the output of a dragline.

→ All possible measures should be taken to improve the management conditions, such as proper maintenance of equipment, availability of repair parts, coordinating the hauling units, haul road condition, providing competent supervisors and operators etc.

(viii) Size of hauling units, if used:

→ The hauling units should be made available as and when required in desired sizes, to avoid unnecessary delay, which will increase the output of the equipment.

(ix) Skill of Operator:

→ The better skilled operator should be employed, which will result in more output.

(x) Physical conditions of the machine:

→ If the physical condition of the machine is good, it will handle large size bucket very easily and very quickly, the output will be increased.

→ The new bucket with sharp teaths will result in more output as compared to dull teaths.

4.3 HOES

) GENERAL :

→ The hoes are the excavating machines of a power shovel group.
→ It is given several names, such as – hoe, back hoe, back shovel and pull shovel.
→ A power shovel is converted into hoe by installing a dipper stick and a dipper at the end of the shovel boom.

i) USES

→ The hoes are primarily used to excavate below the natural surface of the ground on which the machine rests.
→ They are used for excavating trenches, pits for basements and for general grading work, which requires precise control of depths.

iii) BASIC PARTS AND OPERATION:

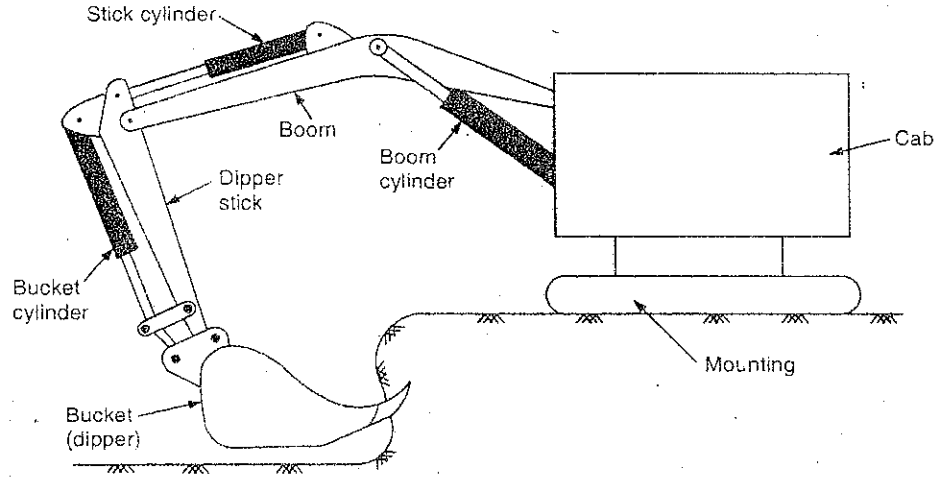

Fig. 14.3 HOE – HYDRAULIC CONTROL

→ The basic parts of a hoe includes a mounting, a cab, a boom, a boom cylinder, a dipper stick, a stick cylinder, a dipper or a bucket and a bucket cylinder etc.
→ The machine is placed in operation by setting the boom at the desired angle with the help of boom cylinder and pulling in on the stick cylinder and the bucket cylinder to move the dipper stick and a dipper out to the desired position.
→ The free end of the boom is lowered by pulling in on the boom cylinder, until the dipper teaths are engaged in digging the material.
→ As the stick cylinder and the bucket cylinder are pulled out, the

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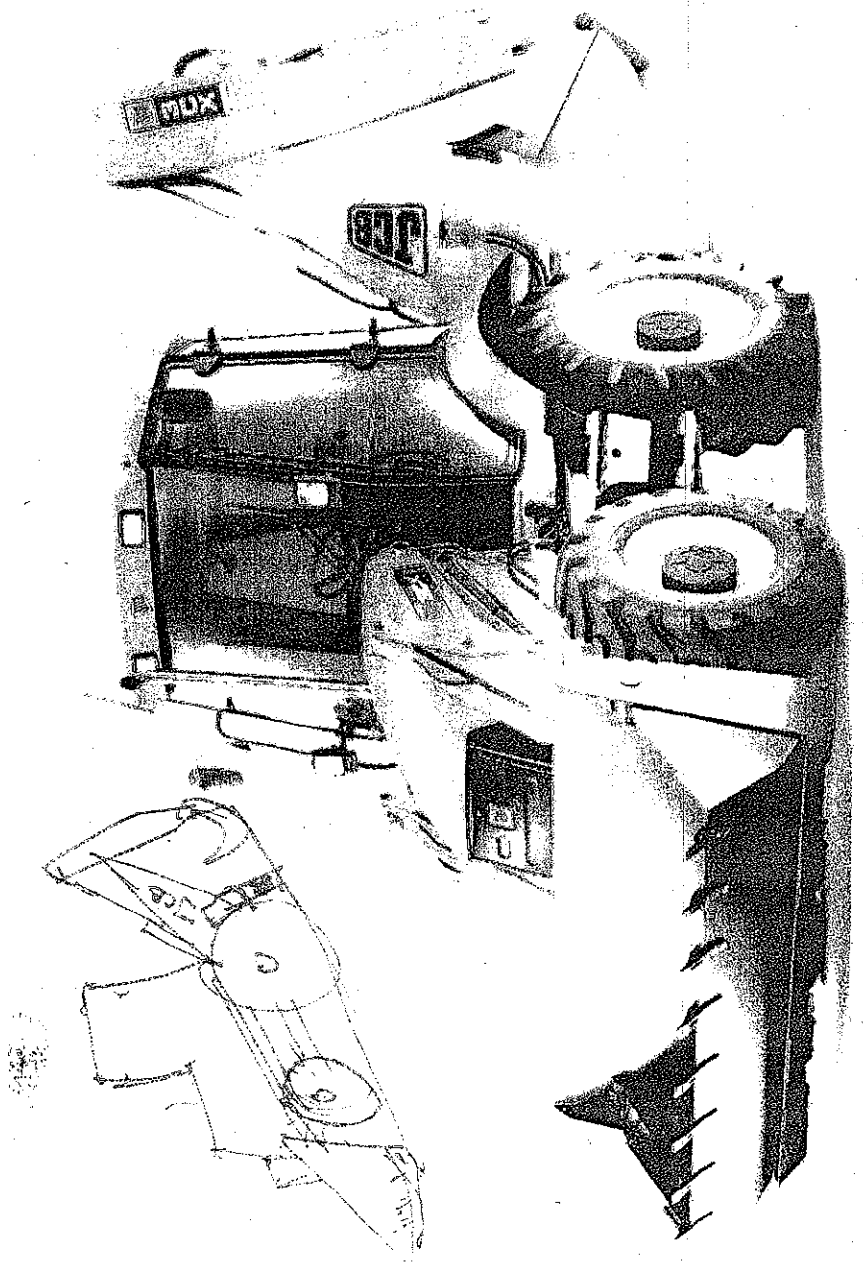

Backhoe

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swinging it to the dumping position, which may be over a spoil bank or a truck.

→ Then the dumping is completed by pulling in on the bucket cylinder.

→ The cycle is repeated in the same manner.

(iv) OUT PUT:

→ For moderate depth of digging, the hoes can give the same output as the power shovel of same size and for same class of material

→ However, as the depth is increased, the output of a hoe will decrease considerably.

→ The most effective digging is done, when the dipper stick is at right angles to the boom.

→ The greatest out put will be obtained, if digging is done near the machine, because of the reduced cycle time and because the material rolls back into the dipper, when the dipper is pulled upward towards the machine.

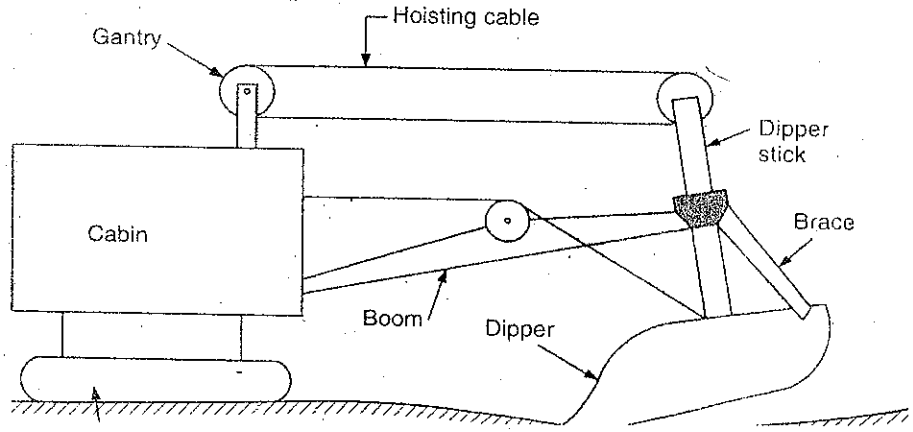
(v) ADVANTAGES:

→ In comparison to the other excavating equipments, the hoes are having the following advantages:

(i) Because of their rigidity, they are superior to draglines in operating on close-range work and dumping into trucks.

(ii) Because of the direct pull on the dipper, hoes may exert greater tooth pressure than the power shovels.

(iii) In some respect, hoes are superior to wheel type trenching machine, especially in digging utility trenches, whose banks may establish natural slopes and for which trench shoring is not required.



Examples-14.1 (HOE) : **[G.T.U., May/June 2012]**

From the following information, determine the cost of production (excavation and hauling) in terms of Rupees per cubic meter.

- Excavating equipment : Hoe with 1.33 m^3 dipper (can handle 1.51 m^3) having cycle time of 16 seconds and operating factor 55 minute per hour.
  Cost Rs. 3500 per hour
- Material : Good common earth will swell of 20% and fill factor 0.85.
- Hauling units : Trucks 8.5 m^3 (b.m.) capacity with operating factor of 50 minutes per hour and having round trip time 22 minutes,
  Cost Rs. 400 per hour

Solution :

(i) **Excavating equipment : HOE :**

Dipper capacity is 1.33 m^3 and can handle 1.51 m^3

$\therefore$ Handling capacity = 1.51 m^3

Cycle time = 16 seconds

Operating factor = 50 minutes per hour

Fill factor of soil = 0.85

$$\therefore \text{Number of cycles/hour} = \frac{50 \text{ min} \times 60 \text{ sec}}{16 \text{ sec}} = 187.5 \text{ cycles/hr.}$$

$\approx$ 188.0 cycles/hr.

Volume = 188 cycles $\times$ 1.51 $\times$ 0.85

= 241.30 m^3/hour

The cost of excavating equipment = Rs. 3500/hr

$\therefore$ Cost per cum of excavating equipment = 3500/241.30

= Rs. 14.50/cum.

(ii) **Hauling unit : Truck :**

Capacity of Truk = 8.50 m^3

Operating factor = 50 minutes per hour

Round trip time (cycle time) = 22 minutes

Swell of dry earth = 20%

Volume of earth excavated per hour = 241.30 m^3

Swell of dry earth = 20%

$\therefore$ Total volume of earth to be handled by truck

= 214.30 $\times$ 1.20

= 257.16 m^3

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Volume of earth handled by truck per hour

= Capacity of truck × Operating factor × Cycle time

$= 8.50\ m^3 \times \frac{50}{22}$

$= 19.32\ m^3/hr.$

Now, Total time taken by truck to handle 257.16 m^3

$= \frac{257.16}{19.32}$

= 13.31 hours

Cost of hauling truck = Rs. 400/hr.

∴ Total cost of hauling 257.16 m^3 of material

= 13.31 × 400

= Rs. 5323.81

∴ Cost per cum. of truck = $\frac{5323.81}{257.16}$

= Rs. 20.70 per hour

∴ The cost of production = Hoe = 14.50

Truck = 20.70

Total = Rs. 35.20 per hour

14.4 CLAMSHELLS

(i) GENERAL

→ The clamshells are primarily used for handling loose materials such as sand, gravel, crushed stone, coal and shells and for removing materials from cofferdams pier foundations, sewer manholes, sheet-lined trenches, etc.

→ They are especially suited for lifting materials vertically from one location to another, as in charging hoppers and overhead bins.

→ The vertical movement capability may be relatively large when clamshells are used with long crane booms.

(ii) BASIC PARTS:

→ The basic parts of a clamshell includes- a mounting, a cab, a crane boom, hoist cable and a clamshell bucket, etc.

→ The bucket may consists of various parts, such as closing line, hoist line, sheaves, brackets, tagline, shell and hinge, etc.

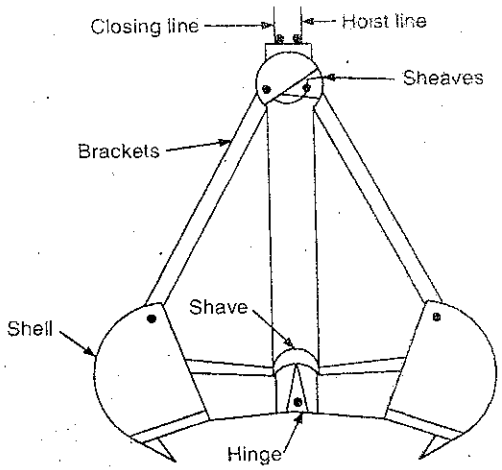

Fig. 14.5 CLAM SHELL

Buckets for Clamshell :

→ The buckets for clamshell care available in various sizes and in heavy duty types for digging, medium weight types for general-purpose work and light weight types for rehandling light materials.

→ The buckets are with teeth or without teeths. The teeths are used for digging herder type material.

→ The capacity of a bucket is usually given in cubic metres.

The capacity of buckets are expressed as:

(i) Water-level capacity is the capacity of a bucket if it was hung level and filled with water.

(ii) Plate-line capacity indicates the capacity of the bucket following a line along the tops of the clams.

(iii) Heaped capacity is the capacity of bucket when it is filled to the maximum angle of repose for the given material. The angle of repose is usually 45° :

(iii) OPERATION:

→ The clamshell bucket is brought over the location where the material is to be dug.

→ The bucket is lowered with the shells open till the edges or teeths of bucket enters the ground.

→ The bucket shells are then closed- in through the closing line. As the two shells close- in, the weight of bucket enables it to dig into the material, thereby filling it.

→ The loaded bucket is then hoisted and swung to the position of dumping and the contents are dumped.

→ The boom is then swung back to the digging position and the same cycle of operations are repeated.

→ The operations are performed by manipulating the cables suitably.

(iii) FACTORS AFFECTING OPERATIONS

There are variable factors affecting the operations of a clamshell, which includes:

(i) the difficulty of loading the bucket

(ii) the size of the load obtainable

(iii) the height of the lift

(iv) the angle of swing

(v) the method of disposing of the load

(vi) the experience of the operator.

14.5 WHEEL-TYPE TRENCHING MACHINES

(i) GENERAL :

→ The wheel-type trenching machines are especially suited to excavating trenches for water, gas and oil pipelines and pipe drains which are placed in relatively shallow trenches.

→ They may be used to excavate trenches for swear pipes up to the maximum digging depths.

→ They are usually crawler-mounted to increase their stability and to distribute the weight over a greater area.

→ These machines are available with maximum cutting depths exceeding 2.50 m with trench widths from 0.30 m to approximately 1.50 m.

(ii) BASIC PARTS & OPERATION:

→ The basic parts of a machine consists of a power driven wheel, on which the number of movable buckets are mounted, which are equipped with cutter teeth.

→ The buckets are available in varying widths to which the side cutters may be attached to increase the width of a trench, if necessary.

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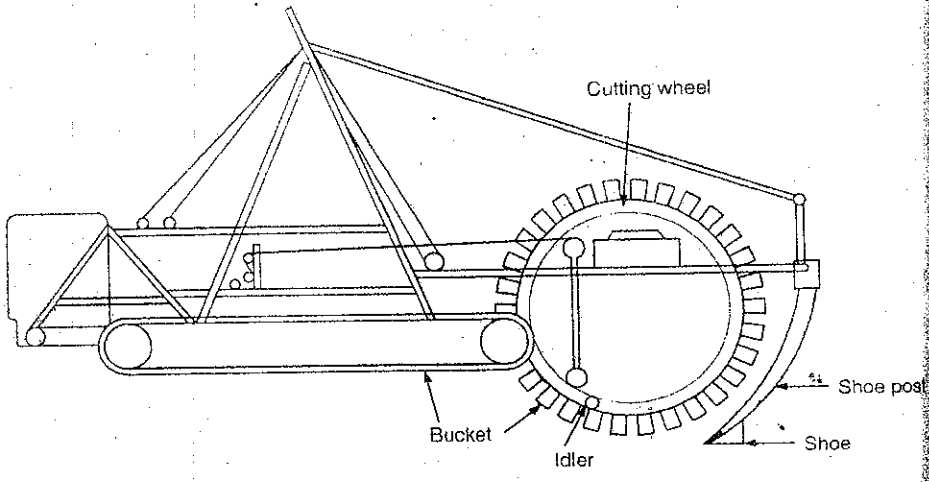

Fig. 14.6 Wheel-type trenching machine.

→ The machine is operated by lowering the rotating wheel to the desired depth, while the unit moves forward slowly.

→ The earth is picked up by the buckets and deposited on to an endless belt conveyor, which can be adjusted to discharge the earth on either side of the trench.

(iii) **SELECTION**

→ The factors affecting the selection of equipment to be used in excavating a trench will depend upon the job conditions, the depth and width of the trench, the class of soil, the extent to which ground water is present, the width of the right of way for disposal of excavated earth and the type of equipment.

(iv) **OUTPUT**

The factors affecting the output of a trenching machines are as below

→ The output or production rates of trenching machine include the class of material or soil, the depth and width of the trench, the extent of shoring required, the topography, climatic conditions, the extent of vegetation such as trees, stumps and roots, physical obstructions such as buried pipes, side walls, paved streets , buildings and the speed with which the pipe can be placed in the trench.

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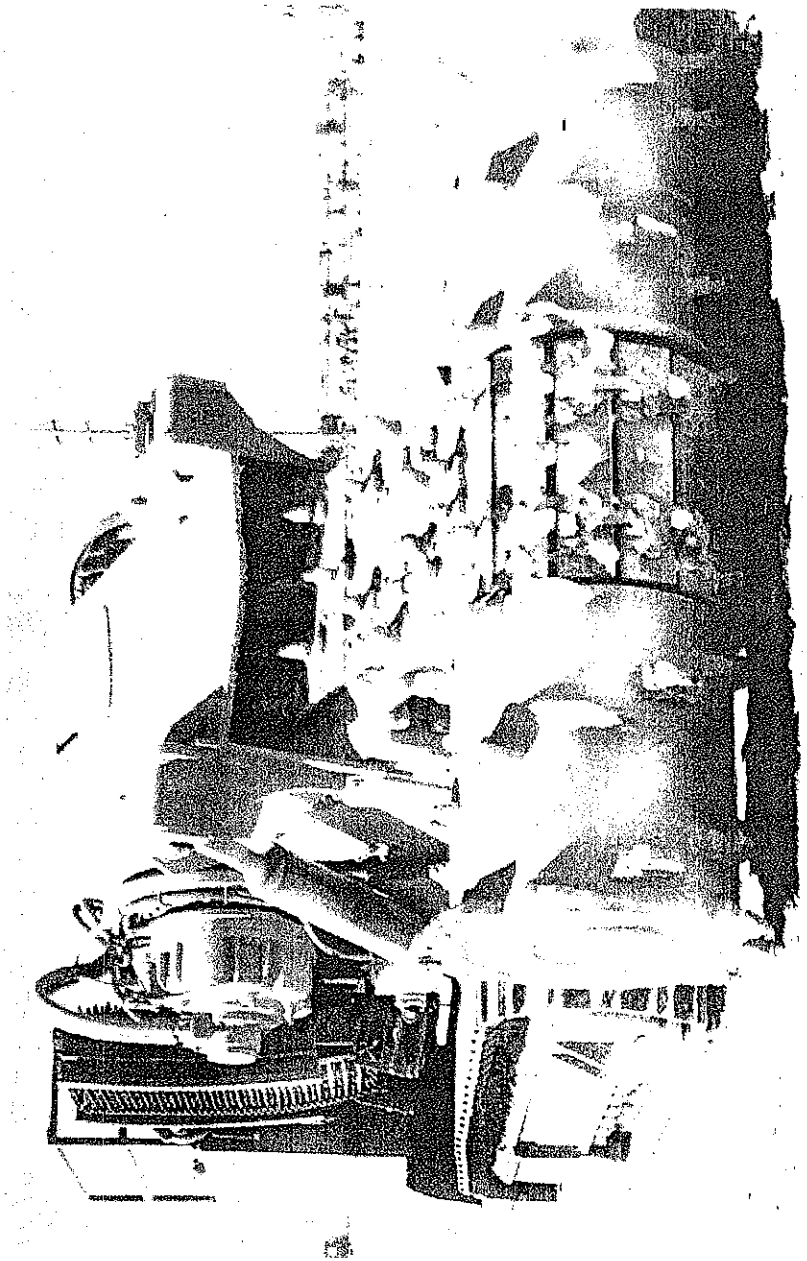

Wheel Type Trencher

QUESTIONS

1. What are the uses of power shovels ? Describe basic parts and operation, giving neat sketch. [G.T.U., Nov. 2011]
2. Discuss the factors affecting the selection of type and size of shovels.
3. What are the uses of draglines? In which situations the draglines are deployed? Write its disadvantages.
4. Write the types and size of draglines.
5. Describe the basic parts and operation of a dragline, giving a neat sketch.
6. Discuss in brief, the factors affecting the output of a dragline.
7. What are the uses of hoes? Describe the basic parts and operation of a hoe, giving a neat sketch.
8. Explain the output and advantages of a hoe in comparison to other excavating equipments.
9. What are the uses of clamshells? Describe its basic parts and operation, giving neat sketch.
10. What are the uses of wheel type trenching machine? Describe its basic parts and operation, giving a neat sketch.
11. Discuss the factors affecting the selection and output of a trenching machine.
12. Briefly explain the inter-relationship amongst material to be excavated, bucket type, bucket size, boom length and boom angle for safe and efficient dragline operations. [G.T.U., May/June 2012]
13. Explain, how output of powershovel can be improved. [G.T.U., May/June 2012]
14. Explain the factors influencing the output of HOE. [G.T.U., May/June 2012]

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16.1 GENERAL

Hauling :

→ Hauling is the transportation of materials by mobile units over high ways or project roads.

Transportation :

→ Transportation includes the movement of materials in air or on land or on water, but hauling is the term confined to the movement over roads only, such as with trucks, trailors or wagons, dump trucks, dumpers, etc

16.2 TRUCKS:

→ The trucks serve the purpose of hauling earth, aggregate, rock, ore, coal and other materials.

→ Because of their high travel speeds, when operating on suitable roads, they provide relatively low hauling costs.

→ They provide a high degree of flexibility, as the number in service can be increased or decreased easily to permit modifications in the total hauling capacity and adjustments for changing haul distances.

→ They may be operated over any haul road, having the surface sufficiently firm and smooth and on which the grades are not excessively steep.

Classifications :

The trucks may be classified according to various factors, as follows:

(a) The Size and type of engine:
  (i) gasoline (ii) diesel
  (iii) butane (iv) propane

(b) The number of gears –

(c) The kind of drive
  (i) Two wheel drive
  (ii) Four wheel drive
  (iii) Six- wheel drive

(d) The number of wheels and axles and arrangement of driving wheels.
  (i) A truck having total four wheels, out of which two wheels are driving wheels, is designated as (4 × 2) truck.
  (ii) For heavy loads on poorly maintained roads with steep gradients (6 × 6) trucks or (4 × 4) trucks are preferred.

(e) The class of material hauled
  (i) Earth (ii) Rock
  (iii) Coal (iv) Ore etc

(f) The capacity, in tones or cubic metres.
  (i) Light trucks (1/2 to 1 tone)
  (ii) Medium trucks (1.5 to 3 tone)
  (iii) Heavy trucks (3.5 to 10 tone)

The truck capacity generally varies from 0.4 cum to 20 cum. the speed may vary from 10 kmph to 100 kmph.

16.3 DUMP TRUCKS:

→ These are the trucks, which are fitted with automatic unloading devices. The loading is normally done by loading shovels or loaders or manually.

→ These trucks have capacities as high as 53 tones.

Classifications :

→ Depending upon the method of dumping the load, they may be classified as follows:
  (a) Rear-dump trucks
  (b) Bottom-dump trucks
  (c) Side-dump trucks.

(a) Rear-dump trucks :

→ Rear-dump trucks are suitable for hauling of many types of materials.

→ The shape of the body, such as the extent of sharp angles, corners and the contour of the rear, through which the materials must flow during dumping, will affect the ease or difficulty of dumping.

→ The bodies of trucks used to haul wet clay and similar materials should be free of sharp angles and corners.

→ Dry sand and gravel will flow easily from any shape of body.

→ If quarry rock is to be hauled, bodies should be shallow with sloping side boards.

→ Factors affecting the selection of Rear-dump-Trucks are as follows:
  (i) The material to be hauled is free flowing or has bulky components.
  (ii) The hauling unit must dump in to restricted locations or over the edge of a bank or fill.

(iii) Maximum maneuverability in the loading or dumping area is required.

→ When hauling rock, the impact loading on the truck body is extremely severe. Continuous use under such conditions will require a heavy duty rock body.

Even with the special body, the loader operator must take care in placing a load in the truck.

(b) Bottom dump trucks :

→ This type of trucks are used to haul materials which can flow easily, such as sand, gravel reasonably dry earth, coal, etc. which reduces the time required to unload the material.

→ There are two types of dump trucks- large off-highly units and highway sized units.

→ They are particularly suitable for use when the materials are to be distributed in layers on a fill or when material is to be discharged though grizzlies into hoppers.

→ This type of units are satisfactorily used on projects, such as earthen dams, levees, highways and airports, where large quantities of materials are to be transported and haul roads can be kept in good conditions.

→ They may be loaded by shovels, draglines or belt loaders.

→ Factors affecting the selection of Bottom-dump trucks are as follows:

(i) The material to be hauled is free-flowing.

(ii) There are unrestricted loading and dump sites.

(iii) The haul route grades are less than 5%, because the unit has limited ability to pull steep grades and there is less weight on the drive wheels of the tractor unit, thereby limiting traction.

(c) Side-dump trucks :

→ These are very popular trucks, specially used, when material is required to be dumped along narrow length on one or both the sides of the road.

→ Heavy large size materials such as boulders, coarse aggregates and bricks can be discharged conveniently.

→ The two sides are hinged to the body and kept in position by means of latches.

→ The material can be discharged on any side by lifting the rams.

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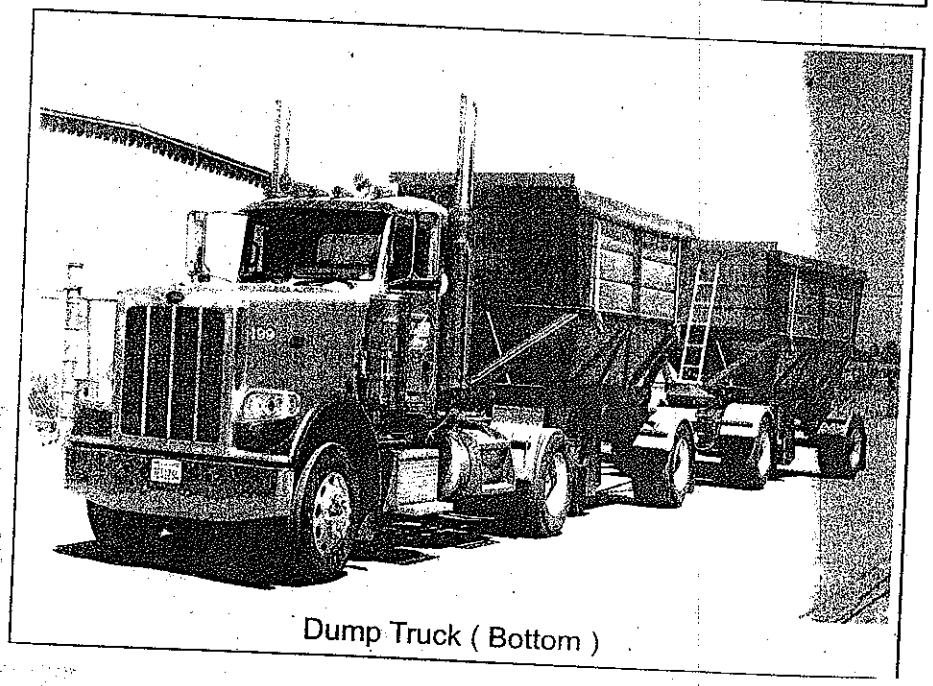
Dump Truck (Rear)



Dump Truck (Bottom)

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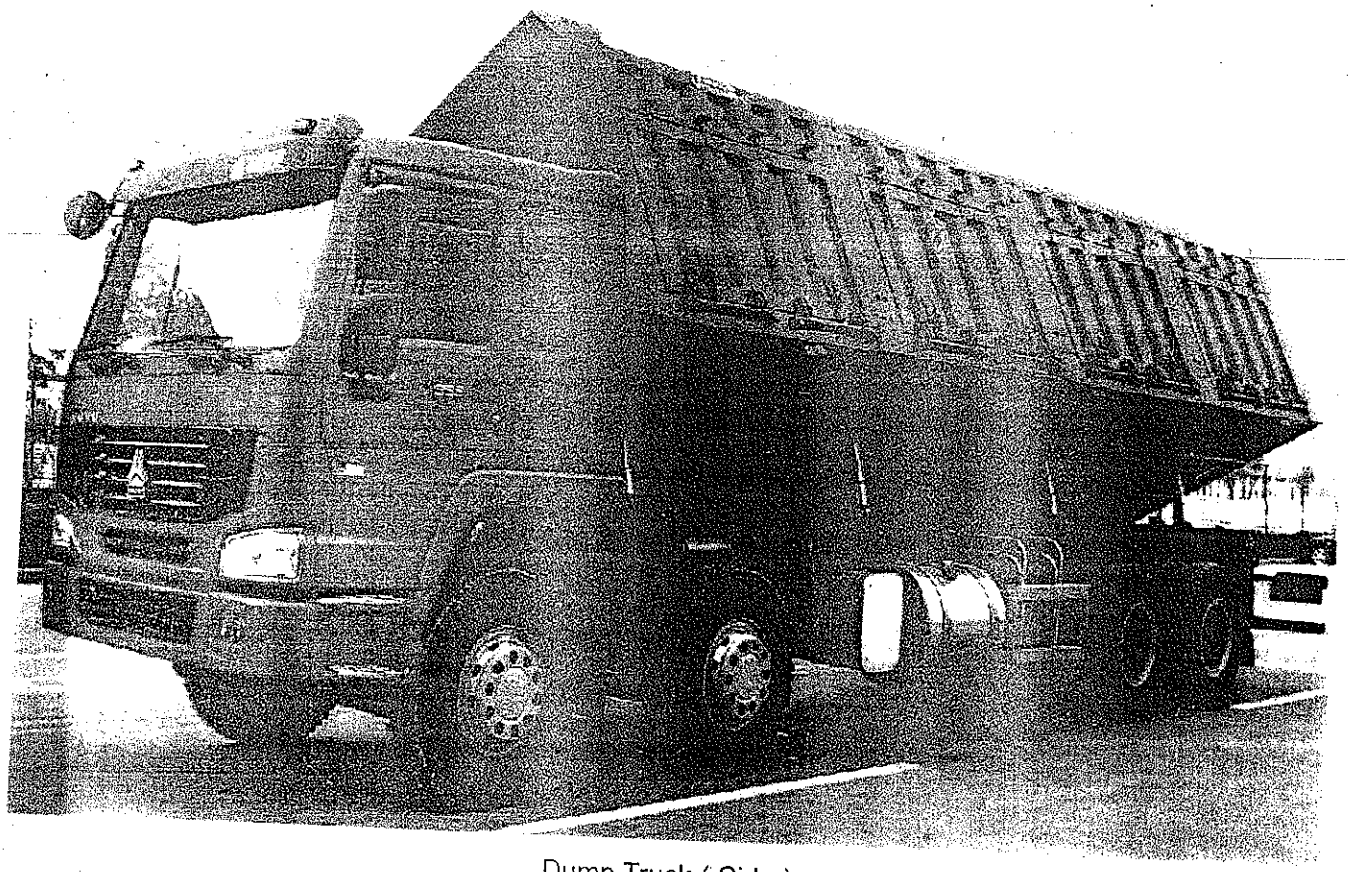
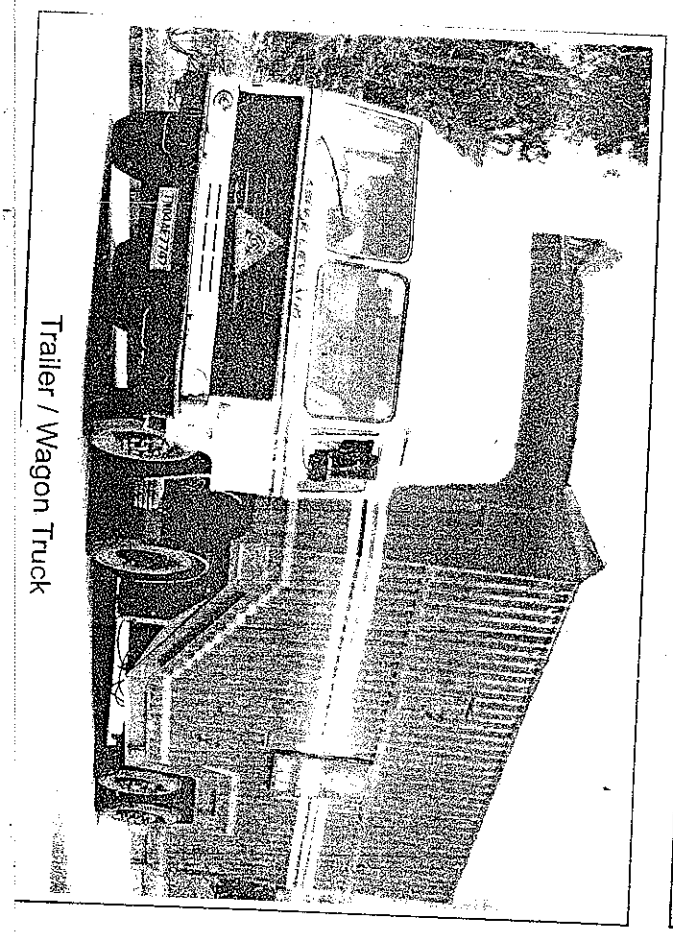
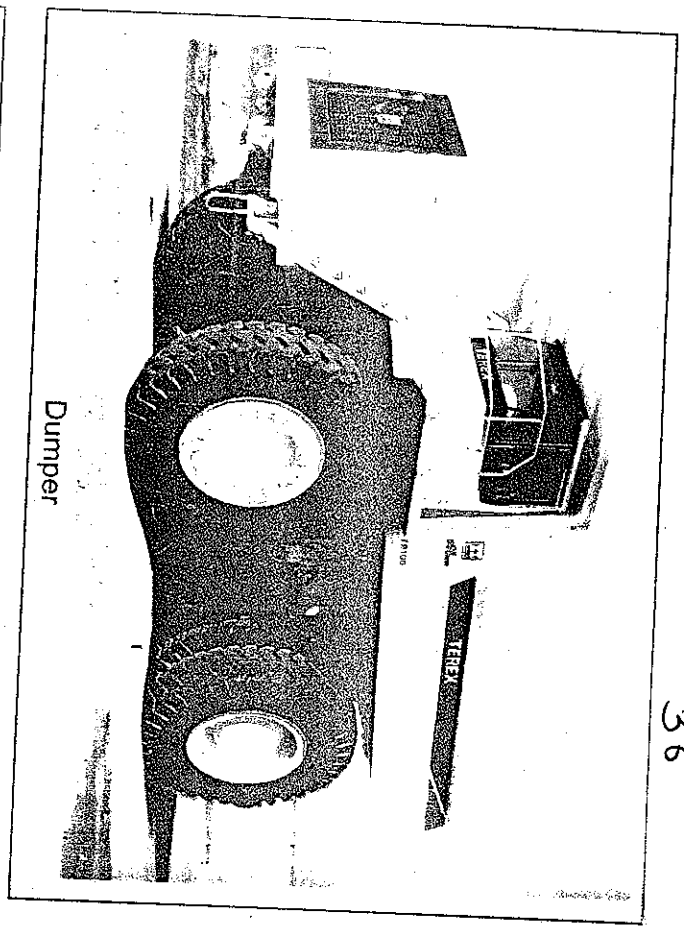


Dump Truck (Side)



Trailer / Wagon Truck



Dumper

16.4 DUMPERS:

[G.T.U., Nov. 2011]

→ These are the most versatile, labour- saving hauling equipment for the horizontal movement of materials such as bricks, aggregates, sanitary fittings, scaffolding and wet concrete.

→ They are usually diesel- powered vehicles requiring only the driver and can transverse the rough terrain on may building sites.

→ They are available in different sizes and varieties giving many options, such as two or four-wheel drive, hydraulic or gravity operated container, side or high level discharge, self loading facilities and specially equipped dumpers for collecting and transporting crane skips.

16.5 TRAILERS OR WAGONS:

[G.T.U., Nov. 2011]

→ These are the carriages hauled by power units like tractors or trucks.

→ They can be of various types, such as

(i) Full trailer or wagons

(ii) Semi-trailers

(iii) Trailers

→ The full trailers are self-supported and connected to the power unit with swivelling axle and drawbar.

→ The semi-trailers are supported in the front by power unit and at rear on their own wheels.

→ Both the trailers have hydraulically operated breaking systems.

→ The lighting system of the trailers is operated from the main units.

✦ QUESTIONS ✦

1. What are the uses of Trucks ? Give classification of it.
2. What are the uses of Dump trucks? Describe various types of dump trucks.
3. What are the uses of Rear-dump truck? What are the factors affecting the selection of Rear-dump trucks?
4. What are the uses of Bottom dump trucks ? What are the factors affecting the selection of Bottom-dump trucks?
5. Write notes on :

(i) Dumpers (ii) Trailors or Wagons [G.T.U., Nov. 2011]

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CHAPTER
17

OVERVIEW OF OTHER CONSTRUCTION EQUIPMENTS

17.1 HOISTING EQUIPMENTS

General :

→ The hoisting is the lifting of material against gravity and may be done with a wide range of equipments from the small, hand operated, simple screw or hydraulic-jack to modern high powered cranes and elevators.

→ The common equipments used are as follows :

1. Pulley and sheave block
2. Chain hoists
3. Derrick cranes
4. Gantry cranes
5. Whirler cranes
6. Mobile cranes
7. Tower cranes

1. PULLEY AND SHEAVE BLOCK :

→ The pulley and sheave blocks are suitable for lifting rough surfaced and heavy loads.

→ For this purpose, the chains and wire ropes are used.

→ The alloy chains are best suited for hoisting operation.

→ The weakest component of this system is the load hook. The hook fails by straightening. Once the book gets elongated or straightened, it should be replaced.

→ A typical sheave and pulley block is shown in fig.

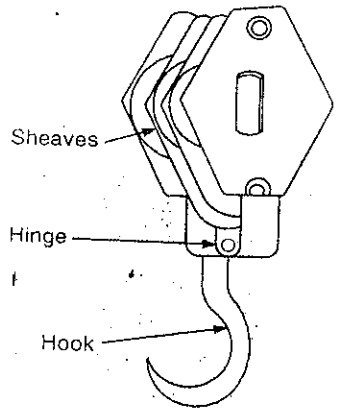

Fig. 17.1 Pulley and Sheave block

2. CHAIN HOISTS

→ The chain hoists are the popular mechanism for lifting loads upto 50 tonnes.

→ The system consists of two sets of chains, namely the hand chain and load chain.

→ The hand chains are particularly useful for the isolated locations, where an electric motor or other types of mechanical equipments are not available.

→ The pull applied through the hand chain is transmitted to the load chain with a multiplication factor of over 20.

→ The load to be lifted is held by a load hook, while

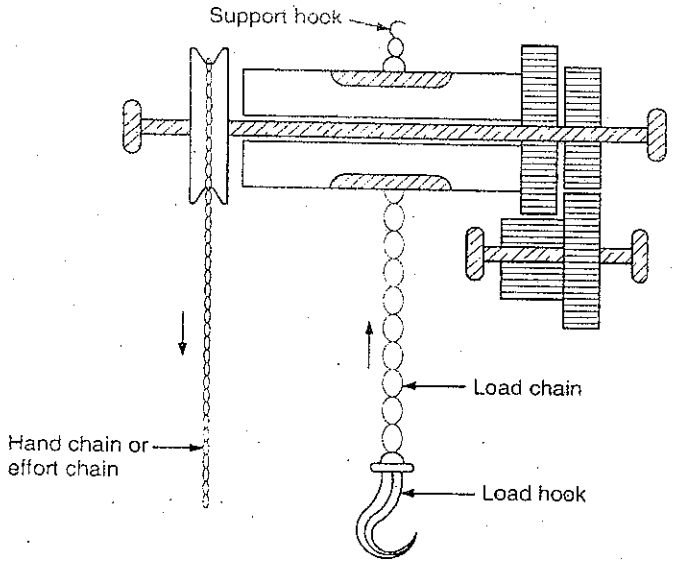

Fig. 17.2 Chain Hoist

→ The two hooks, however, should not be interchanged as the support hook is made much stronger than the load hook.

→ There are four types of hand operated chain hoists are in use :

(i) Differential (iii) Spur geared

(ii) Screw geared (iv) Pull lift

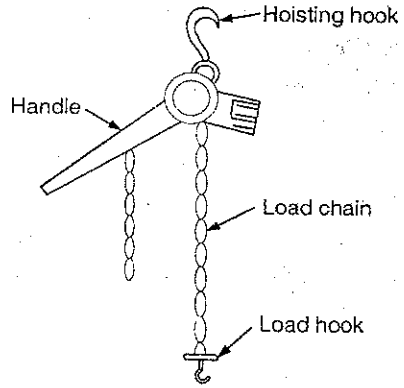

Fig. 17.3 Pull Lift

3. DERRICK CRANES :

→ The derrick cranes are of two types, namely :

(i) Guy derrick and (ii) Stiff-leg derrick

→ The guy derrick consists of a vertical mast. This mast is supported by the number of guys and can revolve through 360°.

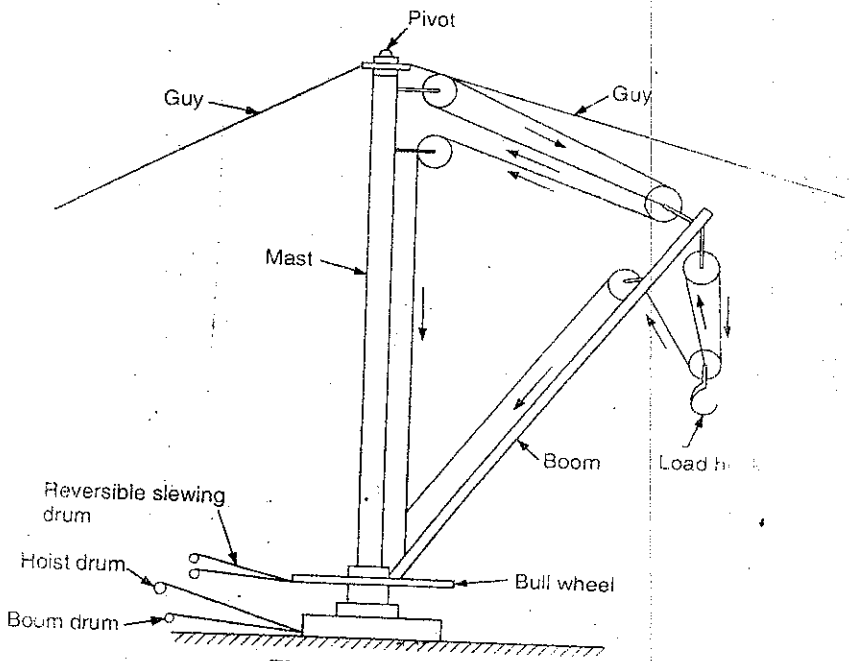

Fig. 17.4 Derrick Cranes

→ While revolving, the radius of revolution should be such that the revolving structure is not obstructed by the guy wires.

→ The power is supplied by a diesel engine or by an electric motor.

→ A typical derrick crane is illustrated in fig.

→ These derricks can be constructed upto 200 tonnes capacity.

→ In stiff-leg type derricks, the guy wires are replaced by trussed structure.

→ This type of derricks are suitable for loads from 10 to 50 tonnes.

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4. GANTRY CRANES

General :

→ The Gantry cranes or overhead cranes are the indispensable machines in factories and workshops.

→ In large workshops, there are separate machines for fabrication or repairs of the machine parts.

→ The machines or the components, which are to be repaired, can be transferred to the place of fabrication or assembly with the help of Gantry cranes.

Basic Parts :

→ The figure shows an overhead crane bridge.

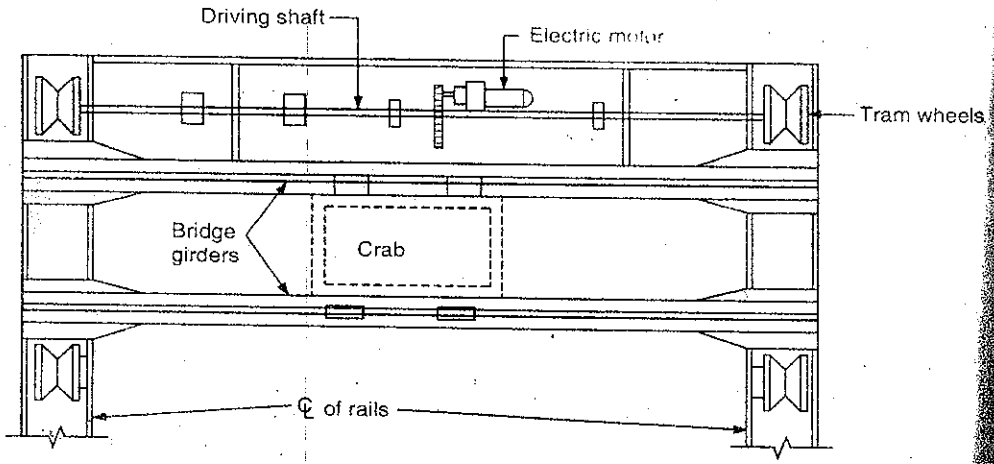

Fig. 17.5 Gantry Crane

5. WHIRLER CRANES

→ This crane is a combination of stationary and mobile unit. This combines the advantage of log boom of derrick crane and mobility of the mobile crane.

The rotating structure has an outer framework.

→ The boom is attached to the front end of this framework. The counter weight is provided at the rear end. On the diagonally opposite corners of the base, two separate motors are provided which give movement to the central shaft.

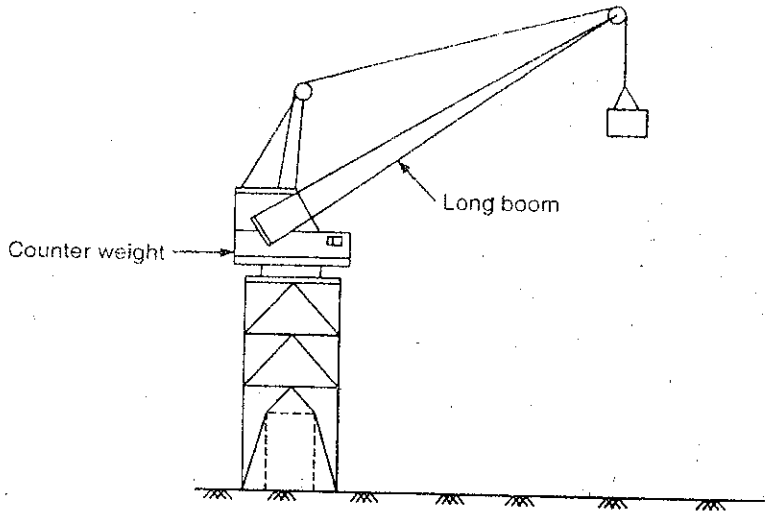

Fig. 17.6 Whirler Crane

6. MOBILE CRANES :

→ These are the cranes mounted on pneumatic tyred trucks or on crawler tractor chassis.

→ On rough terrain, crawler mounted trucks are suitable for operation with a small area. For long distance travel, the machine is stripped and reassembled in the new location.

→ Where electricity is available, an electric drive is preferred to diesel operated units.

→ These cranes are of various designs and capacities, generally with a 360° rotation or slewing circle, a low pivot and lifting jib.

→ These cranes can be classified into following groups :

(i) Self-propelled cranes
(ii) Lorry – mounted cranes
(iii) Truck – mounted cranes
(iv) Tower cranes

7. TOWER CRANES :

→ This type of crane is mainly used for erection of very tall industrial and residential buildings.

→ This crane is also used for loading and unloading very heavy structural members.

→ The main components are :

(i) Four traveling bogies on which are mounted under carriage welded together.

(iii) The chassis.

(iv) Slewing platform placed in the undercarriage.

(v) To provide braking system a double shoe weight brake is placed on the brake drum.

(vi) Truss structure, the pieces of which are bolted to the main tower.

(vii) The jib.

(viii) Horizontal cantilever boom and

(ix) Buffers placed at jib ends to provide cushioning.

→ These cranes are of following types :

1. Self-supporting static tower cranes
2. Supported static tower cranes
3. Travelling tower cranes
4. Climbing cranes

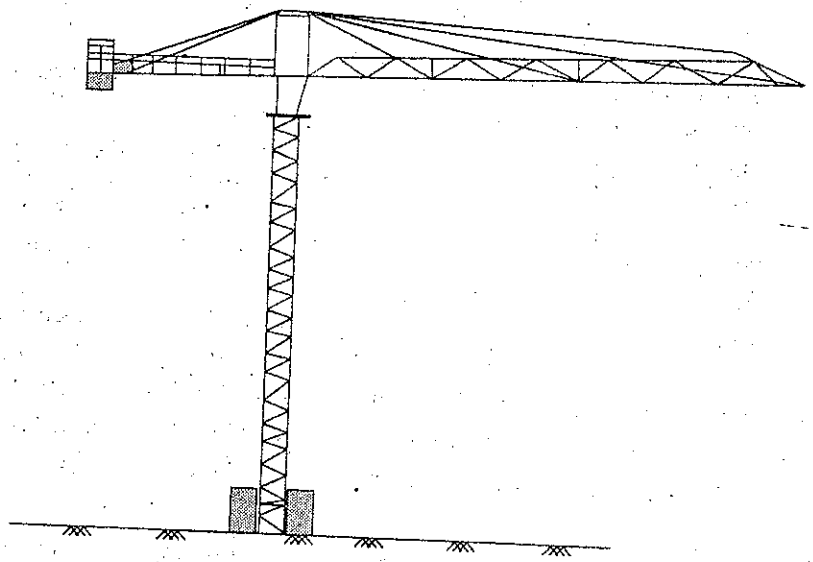

Fig. 17.7 Static Tower Crane

17.2 CONVEYING EQUIPMENTS :

Introduction :

→ Conveying is the movement of material along a stationary structure, the material being generally loose and grannular, such as dug earth, aggregates, sand, concrete, etc.

→ The equipment consists of screw conveyors, bucket conveyors, belt conveyors, pneumatic-conveyors, etc.

→ Conveying may involve horizontal, vertical or inclin movement. When the movement is principally along the horizontal, the equipment is called conveyor and when predominently vertical, it is called an elevator.

1. SCREW CONVEYORS :

General :

→ Screw or spiral conveyors are widely used for handling of pulverised or grannular material.

Advantages :

(i) The quantity of materials carried and distance moved are both moderate, but the cost is much less than for any other type of conveyor.

(ii) The conveyor can be made dust tight by enclosing it from all sides.

Basic Parts and Operation :

→ A screw conveyor consist of helix mounted on bearings at both the ends and also at intermediate points.

→ It is driven by an electric motor from one end.

→ The whole arrangement is enclosed in a trough.

→ The material enters the trough at one end and is carried to the other end by the screwing action of the helix.

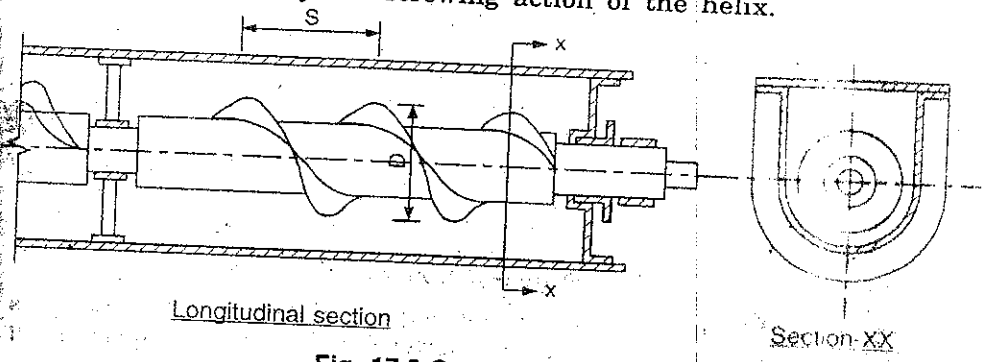

Fig. 17.8 Screw Conveyors

→ For handling abrasive materials the helix and the interior ...

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→ The length of the conveyor is generally limited to about 200 ft. (65 m.) and the inclination with horizontal is limited to 35°. With this inclination, the conveyor capacity is reduced to about 80%.

2. BUCKET CONVEYORS

General :

→ The bucket conveyors are used for horizontal and inclined movements, provided the inclination to the horizontal does not exceed 70°.

Basic Parts and Operation :

→ The bucket conveyor consists of number of buckets or carriers fitted or mounted on the steel chains, which are moving around the wheels provided at both the ends of the conveyor.

→ At the bottom end of the conveyor, the axle of the wheel is attached/ connected to an electric motor for driving the wheels. The conveyor can be enclosed from all sides, to make it dust tight.

→ The carriers may be open top type or V-bucket type.

→ The open top design is like the apron or trays. The trays are being replaced by open top V-buckets, so that they can operate on a steeper inclination upto 70°.

→ The loading may be fed at one point or the bucket may feed itself, as it drags through the load.

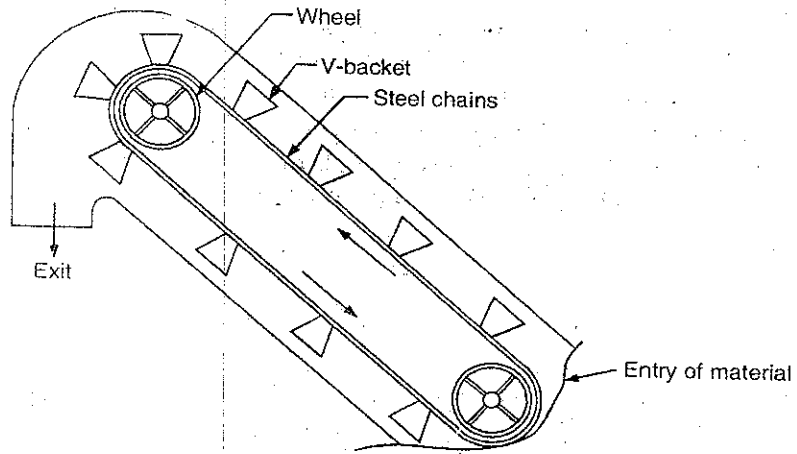


Fig. 17.9 Bucket Conveyors

→ In case of point feed, the conveyor speed can be upto 20 metres per minute, while in case of drag feeding, the conveyor speed limit is 10 metres per minutes.

Limitations :

— ... to the heavy weight of ...

17.3 DRILLING EQUIPMENTS

Introduction :

→ Rock excavation is usually done through the 'drill and shoot' method, in which suitable sized bore holes are first drilled in the rock at proper intervals and then it is loaded with explosive. The explosive is then ignited, with the result that the energy released due to explosion; shutters the rock.

→ The equipment consists of – wagon drill, shot drill, diamond drill, etc.

1. DRILL BITS :

→ The bit is an essential part of a drill, as it is the part which must engage and disintegrate the rock.

→ The success of the drilling operation depends upon the ability of the bit to remain sharp under the impact of the drill.

→ The bits are of two types :

1. Forged bits
2. Detachable bits or Removable bits

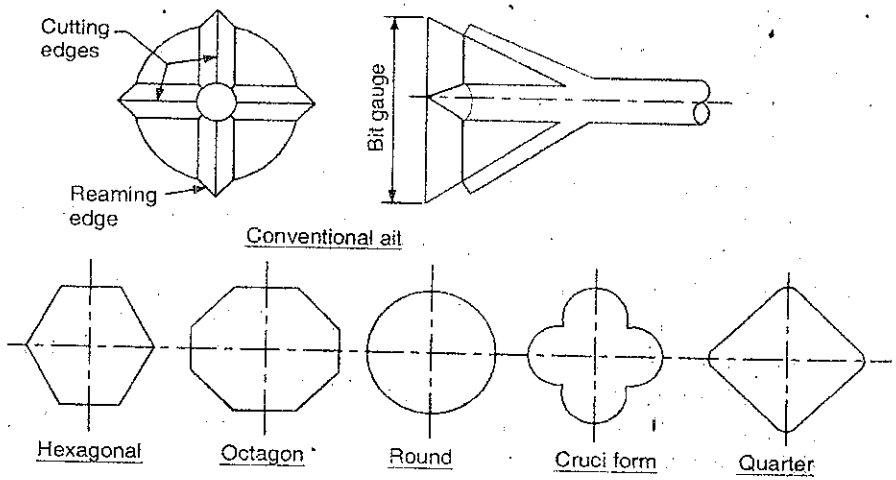


Fig. 17.10 Shapes for Drill Bits

2. JACK HAMMERS :

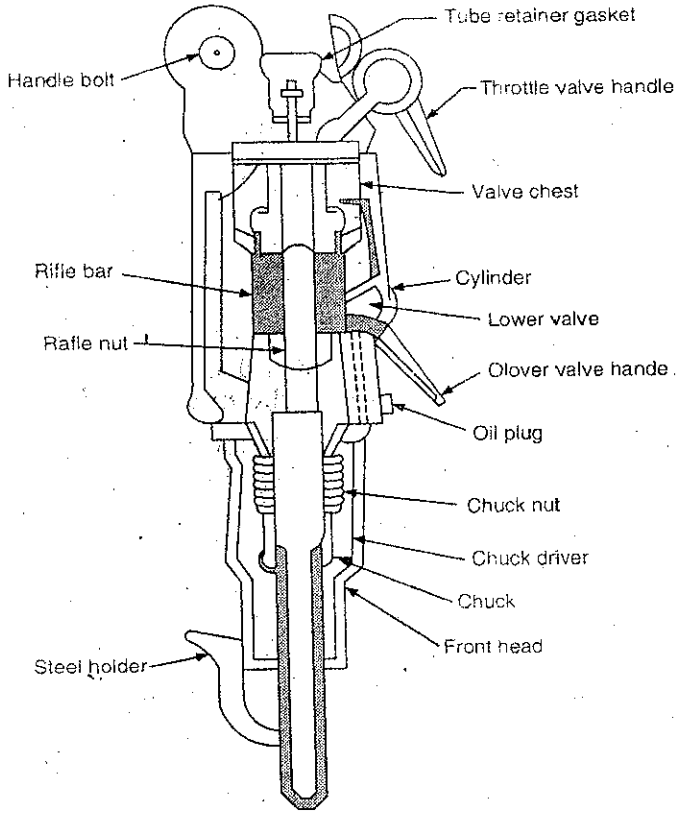


Fig. 17.11 Section through Jack Hammer

→ The jack hammers are hand-held-air operated percussion-type drills, which are used primarily for drilling holes in a down ward direction.

→ For this reason, they are commonly called 'sinkers'.

→ They are classified according to their weight, such as 45 or 55 Lbs. (pound). 1 pound wt. = 0.454 kg.

→ A complete drilling unit consists of a hammer, drill steel (or a drill rod) and a bit.

→ As the compressed air flows through a hammer, it causes a piston to reciprocate at a speed upto 2200 blows per minute, which produces the hammer effect.

→ This energy of the piston is transmitted to a bit through the

3. DRIFTERS :

→ Drifter drills are similar to jack hammers in operation, but they are larger and used as mounted tools for drilling down, horizontal or up holes.

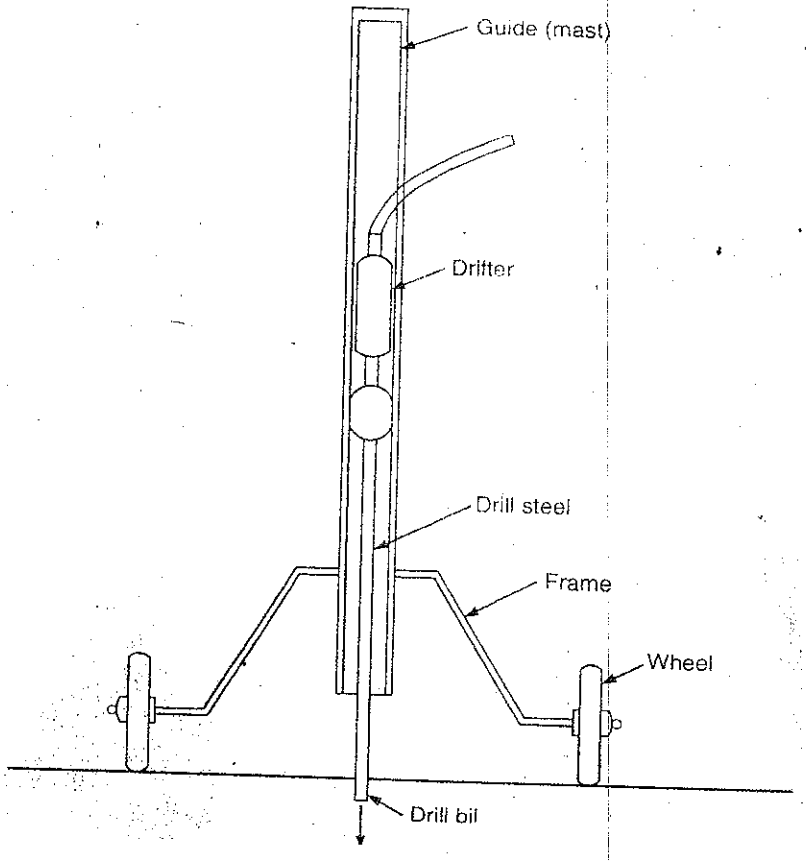
→ They vary in weight from 75 to 260 lbs. and are capable of drilling holes upto 4½ inches in diameter. (110 mm)

→ These tools are used extensively in rock excavation, mining and tunneling. Either air or water may be used to remove the cuttings.

4. WAGON DRILLS :

→ The wagon drills are used on any type of terrain where it is possible for them to operate.

→ They are used extensively to drill holes upto 15 cm. in diameter and 10 m. or more in depth.



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→ They give better performance than the jack hammers.

→ They are used to drill holes at any angle from down to slightly above horizontal.

→ Wagon drills consist of drifters mounted on mast.

→ This mast is supported on the frame. The frame is again mounted on wheels to provide portability.

→ The length of the drill steel may be 2 m, 3 m or 5 m, or more depending upon the length of the feed of the particular wagon drill.

5. SHOT DRILLS :

→ A shot drill is a tool which is based on the abrasive effect of chilled steel shot to penetrate the rock.

→ The essential parts of a shot drill consists of a shot bit, core barrel, sludge barrel, drill rod, water pump and power driven rotation unit.

→ The bit consists of section of steel pipe, with a serrated lower end.

→ As the bit is rotated shots are fed to the lower end through the drill rod.

→ Under the pressure of the bit, these shots erode the rock to form a kerf around the core.

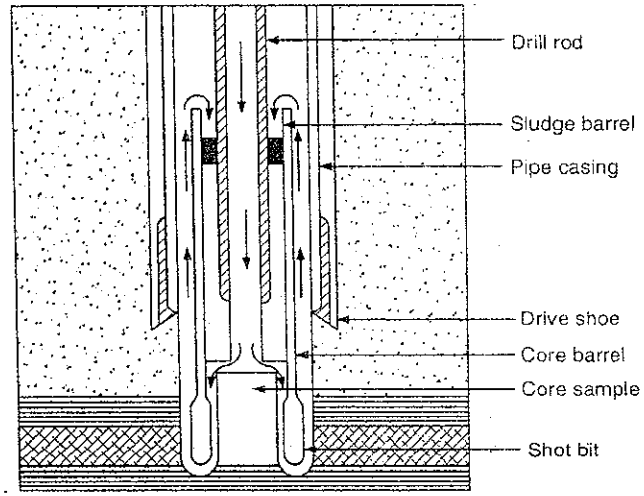

Fig. 17.13 Shot Drills

→ The water is supplied through the drill rod, forces the rock cuttings up around the outside of the drill, where they settle in a sludge barrel, which is to be removed when the entire unit is pulled out from the hole.

→ Periodically the core is broken off and removed from the hole, so that the drilling may proceed further.

→ The shot drills are used extensively and are capable of drilling holes upto 200 m. or more in depth, with diameters varying from 6.5 cm. to 50 cm.

→ The rate of drilling is relatively slow, sometimes less than 30 cm. per hour, depending upon the size of the drill and the hardness of the rock.

6. DIAMOND DRILLS :

→ the diamond drills are used for rock drilling, exploration drilling and mining surveys, where the cores are desired for the purpose of studying the rock structure.

→ The diamond core drills are available in four sizes i.e. 4.0, 5.0, 6.0 and 7.5 cm.

→ A drilling rig consists of diamond bit, a core barrel, a jointed driving tube and a rotary head to supply the driving torque.

→ The diamond drills are capable of drilling to depths of 320 m. The bit speeds may vary from 200 to 1200 rpm.

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