UNIT 5 – CONSTRUCTION EQUIPMENT

2 MARKS

1. **What is meant by dredging? (April/May 2017,Nov/Dec2015**)

   Dredgers are used for excavation from riverbed, lake or sea for purpose of deepening them. Dredging is an important operation in navigation canals, harbours, dams etc.

2. **How to calculate output of scraper (April/May 2017)**

   Scrapers can be very efficient on short hauls where the cut and fill areas are close together and have sufficient length to fill the hopper. The heavier scraper types have two engines ("tandem powered"), one driving the front wheels, one driving the rear wheels, with engines up to 400 kW (536 hp). Multiple scrapers can work together in a push-pull fashion but this requires a long cut area.

3. **List out equipment for earthmoving operations (April/May 2019, April/May 2018)**

   - Excavators
   - Backhoe Loaders
   - Bulldozers
   - Skid-Steer Loaders
   - Trenchers

4. **Define Dredging (April/May 2018, 2019**,**Nov/Dec 2015)**

   Dredgers are used for excavation from riverbed, lake or sea for purpose of deepening them. Dredging is an important operation in navigation canals, harbours, dams etc.

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5. **Difference between single and double acting hammer (Nov/Dec 2015)**

A single-acting steam hammer is raised by the pressure of steam injected into the lower part of a cylinder and drops under gravity when the pressure is released. With the more common double-acting steam hammer, steam is also used to push the ram down, giving a more powerful blow at the die.

6. **What are the factors influencing compaction(Nov/Dec2016)**

- Moisture content.
- Types of soil.
- Amount of compaction.
- Contact Pressure.
- Speed of Rolling.

7. **What are the types of dredgers (Nov/Dec2016)**

- Hydraulic Dredge.
- Hopper Dredge.
- Cutterhead Pipeline Dredge.
- Mechanical Dredge.

8. **What are the points should be considered in mind while selecting equipment? (Nov/Dec 2017)**

    a. Size of the dozer for a given job
    b. The type of work expected from the tractor dozer
    c. Example: bulldozing, ripping, land clearing, pulling a scraper
    d. The type and condition of hauled road
    e. Gradient of the haul road
    f. Distance to be moved

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g. Type of work expected to be taken from the equipment after the present job is completed

9. List various types of vibrators used in compaction process (Nov/Dec 2017)

- Internal or Immersion or Poker or Needle **Type Vibrator**.
- Shutter form or External **Type Vibrator**.
- Surface or Screed or Pan **Type Vibrators**.
- **Vibrating** Tables.

10. State the advantages of using hydraulic machines in construction (Nov/Dec 2018)

1. Ease and accuracy of control
2. Multiplication of force
3. Constant force and torque
4. Simple, safe and economical

11. State the classification of concrete mixers(Nov/Dec 2018)

- Batch mixers. Drum Types Mixer. Tilting drum mixers. Non-tilting drum mixer. Reversing drum mixer. Pan Type Mixer.
- Continuous mixers.

12. Name the equipment used for volume batching in concrete production (April/May 2019)

Measurement boxes or gauge boxes of known volume are used to measure materials. Cement is taken in the form of bags, where volume of one bag of cement (50 kg) is taken

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as 35 liters. Volume of Gauge box used is made equal to the volume of one bag of cement which is 35 liters or multiple thereof.

SIXTEEN MARKS

1. ***Explain the factors must be taken into account during selection of earthwork equipment?*** **(April/May 2019, April/May 2017, Nov/Dec 2015)**

Following are the main points which should be considered in the process of equipment

Selection

1. Suitability for job conditions.

The equipment must meet the requirement of the work, climate and working conditions

2. Size of the equipment

Size of equipment should be such that it must be able to be used with other machine units. If the equipment selected is of large size, that will remain idle for most of the time or shall work on parts loads, which means production cost will be more . on the other side, if the equipment is of smaller size than desired, the equipment will not able to work with the matching equipment and hence other equipment will have to remain idle or to be allowed to work on part loads, which shall again be uneconomical

3. Standardization

It is better to have same type and size of equipment in the project. It means lesser spare parts reserve, more interchangeability of parts if required, easy for the operator to understand it, mechanics will able to maintain and repair better as they become expert by handling one type of equipment.

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4. Availability of spare parts

While selecting a particular type or make of equipment, it should also be ensured that the equipment is of repute and is likely to be continued to be manufactured in future also. This is necessary for future standardization and ensuring spare parts supply. It is easy to dispose off such equipment after completion of project.

5. Availability of spare parts

While selecting a particular type or make equipment, it should be ensured that the spare parts will be available at reasonable price throughout the working life of the equipment .It should also be ensured that the downtime of the equipments for want of spare parts may not be more. This is all the more necessary in case of imported equipments

6. Multipurpose equipment

There are certain types of equipment which are not utillsed fully. Therefore if possible, they must be capable of performing more than one bucket arrangement or with rock breaker attachment.

7. Availability of know-how

The equipment selected should be satisfactory handle by available operators and mechanics. Sophisticated equipment may give excellent performance but it may be difficult to handle and maintain it through available know-how.

8. Use in future projects

When equipment completes only a part of their life in projects, it should be kept in view that the equipment can be used in future projects and may not be come obsolete.

9. The economical aspects

While selecting the equipment it should be considered that the cost of unit production should be minimum.

10. Reliability of the equipment

Equipment selected for project must be reliable one.

11 Service support

Service support should be available in the area of project where the equipment shall be used. Service after sales is a major criteria for selection of equipment.

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12 Operating requirement

The equipment selected should be easy to operate and maintain, acceptable to the operator and should have lesser fuel consumption.

13. Past performance

If the equipment being purchased is of new make and model, it is desirable to enquire about its performance from other users, who are using this make and model.

14 The size and numbers should be such that full life is utilized in the project with very little residuals.

15. Reputation of the manufacturer.

16. Warranty or guarantee offered by the manufacturer

17 Use of standard components in the equipment

2. Explain the working principle of a concrete mixing plant with sketch. **(April/May 2017)**

Concrete batching and mixing plant

As it name suggests the plant has main function of 'batching' and then 'mixing'. Batching means proportioning of ingredients concretive: aggregates, sand, cement and water separately for each batch. Batching and mixing plants used in construction field generally consists of the following main constituents.

(i) Aggregate feeders:

Aggregate feed bins are used for each of the size of the aggregate and sand, and control their quality, weighting system is used for important jobs, since control by volume is not perfect as it varies due to closeness of packing of the material. The aggregate fed bins are loaded by any of the following methods

(a) By shovels directly into the bins

(b) By lorries tipping directly into the bins

(c) Aggregate are stored in bulkhead at ground level

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(ii) Cement silo:

Cement is stored in a silo which is filled from a cement carrier by pumping the cement into silo under pressure. Weigh batching is provided for measuring the quality of cement to be fed for each batch mix. This weighed cement is carried to the mixing unit through the conveyor belts which are totally enclosed to avoid any loss.

During filling under pressure by bulk tanker, cement laden air is vented to atmosphere through a filter. Cement/air filters are generally,"multisock" type having number of easy-to-renew nylon socks giving mixing filtration area. These nylon socks trap cement. Access door allows inspection and cleaning when necessary. Dust from the filters falls back into the silo when the shaker device is operated from ground level controls

Cement enters the silo through a valve provided on an inlet pipe connected either to a screw conveyor either to a screw conveyor or rotary blower pressurizing the pipeline, carrying cement, at about 0.4 bar. These are used to inject the cement received from either of the two sources from a bag splitting hopper, or from standing bulk cement carrier. The bay splitting hopper is of steel construction and is fitted with a bag splitting knife to cut the bag and a grill which allows cement to fall through into hopper whilst trapping the bag and any other destruction.

(iii) Water measuring device:

Concrete production requires exact quantity of water, therefore, a reliable and accurate water measuring device is required in the plants. Measured correct quality of water is fed during the period of charging a batch into the drum of the mixer. Water is filled from a tank into a measuring tank during the period when mixing takes place in the mixer. This water from the measurement tank is delivered to the mixer during the next batch when aggregate, sand and cement is charged into the drum of the mixer. Thus after each charge the measuring tank is filled up from the water tank by the quantity needed for a batch for the supply to the next batch. This water from the measuring tank is supplied to the mixer through the adjustable spray bar so as to achieve homogeneous mix within a shortest time

(iv) Mixing unit:

Mixing unit consists of two parallel shafts made of cast steel provided with adjustable paddle mounted on external supports provided with bearings. The mixer discharges the mix into a hopper for delivering it to the concrete dumpers directly or into bin where the

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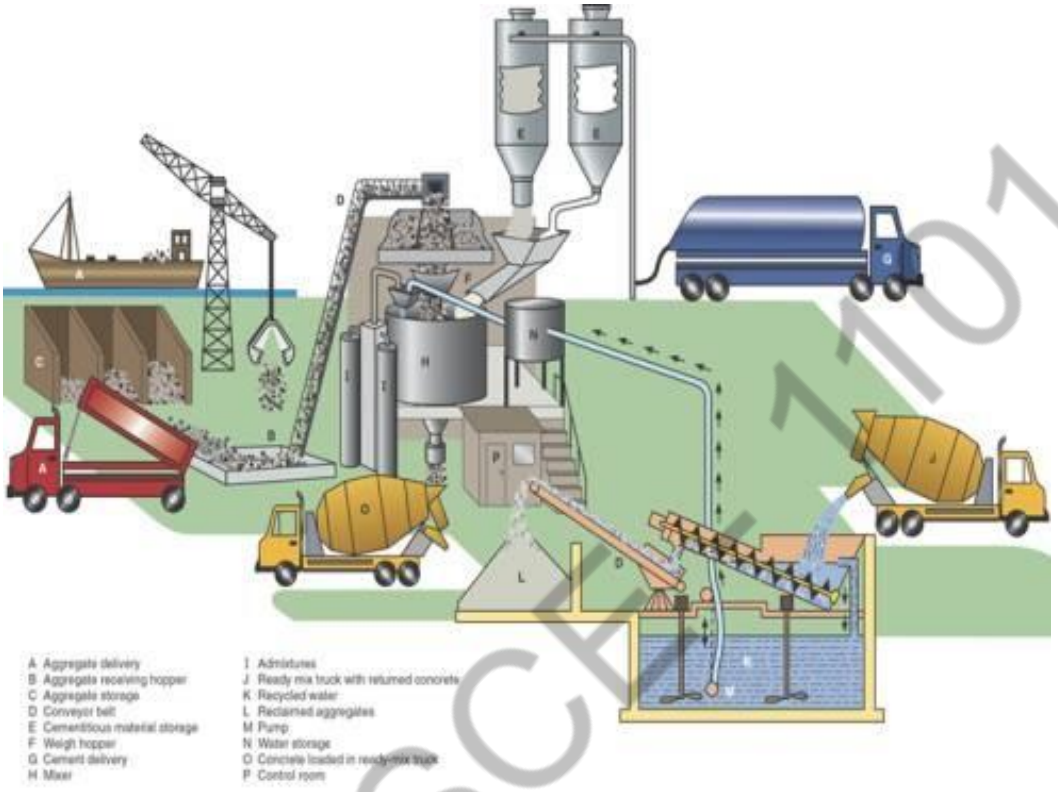
mix is stored temporarily. The mixer is then taken to the construction site. The mixer is then taken to the construction site. The walls of mixing units are made of wear resistant steel.



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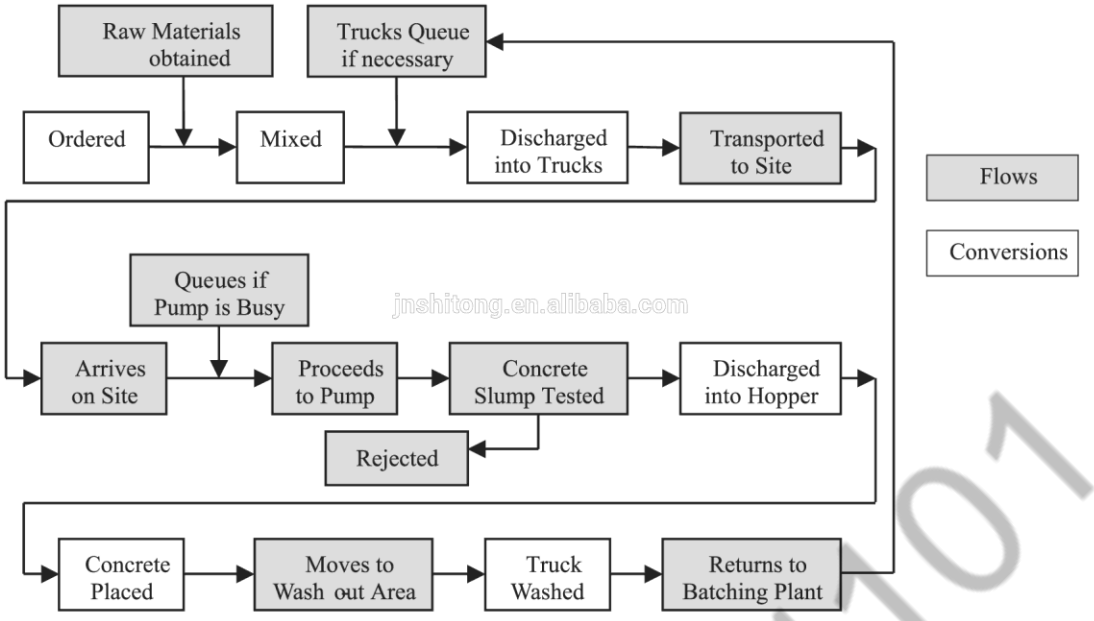

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3. **Explain in detail about earth moving equipment (April/May 2018, Nov/Dec 2017)**

- Excavators
- Backhoe Loaders
- Bulldozers
- Skid-Steer Loaders
- Trenchers

1. Excavators

These heavy machines consist of a base cabin and a long arm with a bucket attachment at its end. They use a hydraulic system to function. The operator controls the excavator from the base cabin which is capable of rotating 3600. The base cabin is placed on a supporting structure with either wheels or tracks. Excavators are widely used in both small as well as large construction sites. Their applications include excavation, demolition, heavy lifting, grading, landscaping, mining, dredging and mor ..

2. Backhoe Loaders

Backhoe loaders or backhoes are tyre mounted machines with a shovel at the front and a bucket attached to a jointed arm at the rear end. They look quite similar to farm tractors and their mobility makes them ideal for use in urban areas. Backhoe loaders are medium-sized machines that can be used for applications such as excavation works, digging trenches, placing pipes, filling up trenches, lifting materials, etc. Some backhoe loaders come with retractable buckets that can either be replaced with equipment used for other construction activities or buckets of varying sizes that can be used for applications such as digging trenches varying in width.

3. Bulldozers

Considered to be one of the most heavy-duty machines that can be spotted at a construction site, one of the most common applications of bulldozers is moving huge amounts of dirt or soil in large and open construction sites. They have a large metal plate in the front which can be moved up, down until a certain depth or in a limited range of angles using two hydraulic pistons attached to it. Apart from moving soil, they can also be used for rough grading, fine grading, crushing or removing rocks, etc.

4. Skid-Steer Loaders

As the name suggests, these are tyre mounted small-sized machines which can skid on their own axis and therefore, are highly applicable in space-constrained construction sites. The tread pattern used in their tyres ensure that they have minimal impact on finished construction sites and that they limit soil compaction. These machines provide a good grip on snow as well as mud. Most skid-steer loaders commonly available in the market can be

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retrofitted with different attachments and can be used for a wide range of applications such as moving mud or snow, excavation works, compacting soil, drilling holes, lifting loads, etc

5.Trenchers

Trenchers are earth moving machines which are used for digging trenches typically to be used for piping, cabling or drainage purposes. The material that has been dug up is deposited besides the trench by the conveyor system of the trencher. Different types of trenchers are available which vary according to their applicability, construction requirement or the sturdiness of the surface to be trenched. Trenchers generally are mounted either on tracks or on wheels.

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ii. Equipment used for concreting work (April/May 2018)

- Trowels. Trowels also help smooth concrete surfaces for their finish coats before being left to dry. ...
- Float Blades and Troweling Blades. ...
- Groove Cutter/Jointer Tool. ...
- Edger. ...
- **Brooms**. ...
- Polishers. ...
- Grinders. ...
- Dust Collection Systems.

4. Material handling equipment (April/May 2018)

The overall objectives of materials handling is to reduce production cost. This general objective can be sub-divided into more specific goals, such as:

1. To increase equipment and space utilization.

2. To reduce costs

3. To increase capacity

4. To improve working conditions.

5. To improve customer service.

Advantages of elevating scraper

Scrapers are the device to scrap the ground and load it simultaneously, transport it over the required distance, dump at desired place and then spread the dumped material over the required area in required thickness level, and return to the pit for the next cycle.

Crawler and Pneumatic type of wheel excavator

The crawler excavator is a tracked vehicle that moves upon crawler tracks. On contrast, wheeled excavator is moved upon wheels. They both can be used in many working conditions, such as digging of the trenches, holes; material handling, forestry work, demolition.

The advantage of a crawler excavator is that it can dig or excavate without much set-up. It can realize 360°free rotation. The crawler crane's dynamic property and trafficability is better than wheeled crane. It is capable of working in mining project or muddy area with stronger gradeability. Wheeled excavator features high flexibility, which can travel rapidly among different jobsites with the speed up to 40-50KM/H. It is suitable for firm ground operation without harm to the road surface. On the other hand, the tyre's low heat resistance and high flexibility undercut its stability and safety.

Therefore, nowadays more and more people prefer crawler excavator. Even though crawler excavator is not good at mobility, the specific transport cart will provide the transport service. Besides, the crawler excavator's comprehensive performance is better than the wheeled crane, which can be used in various jobsites.

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5. **What is tunneling ? Explain the features of the equipment used for tunneling(Nov/Dec 2015)**

Tunnel Boring Machine (TBM)

A TBM is a massive set of complex equipment assembled together to excavate a tunnel, often called as “Mole”. Major components of this Tunnel Boring Machine includes

- Cutter head, with cutting discs/tools and
- Muck buckets to carry and dispose excavated muck
- Power supply Systems
- Cutter head rotation & thrust
- Bracing system for the TBM during mining
- Equipment for ground support installation
- Shielding to protect workers
- Steeling system

The advantages of using a TBM include the following:

- Higher advance rates.
- Continuous operations.
- Less rock damage.
- Less support requirements
- Uniform muck characteristics.
- Greater worker safety.
- Potential for remote, automated operation.

Disadvantages of a TMB are the fixed circular geometry, limited flexibility in response to extremes of geologic conditions, longer mobilization time, and higher capital costs

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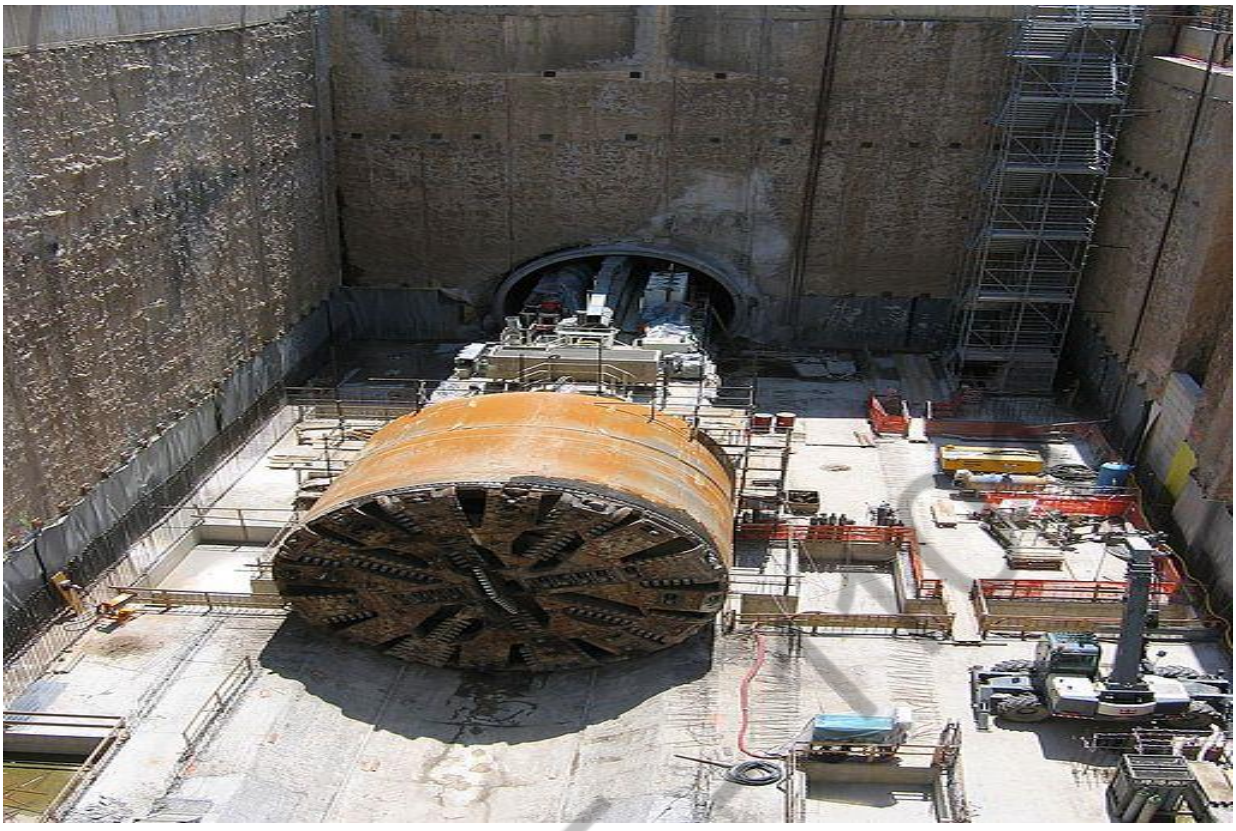

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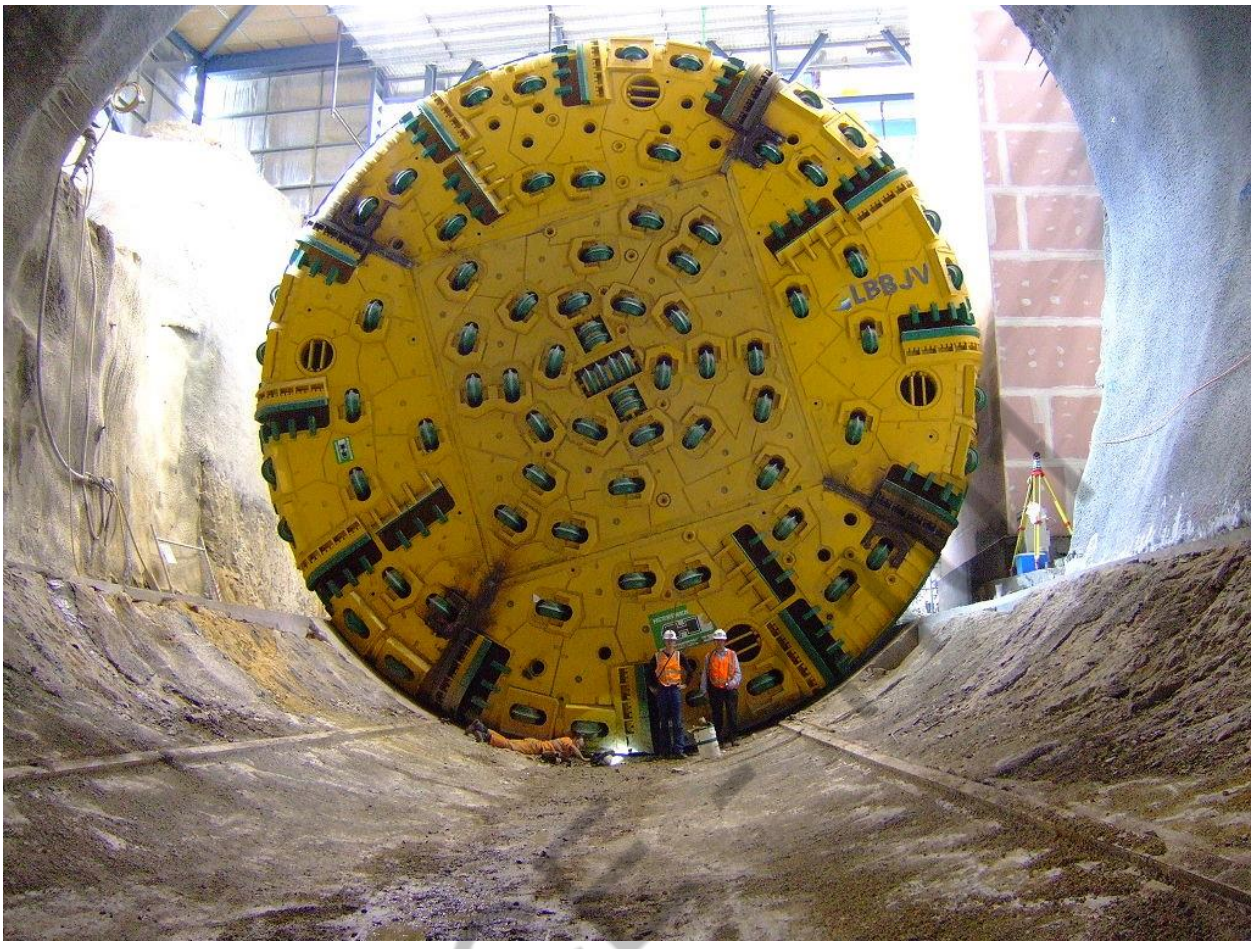


TBM system Design and Operation

A TBM is a system that provides thrust, torque, rotational stability, muck transport, steering, ventilation, and ground support. In most cases, these functions can be accomplished continuously during each mining cycle. Figure shown is a sketch of a typical open or unshielded TBM designed for operation in hard rock. The T BM cutter head is rotated and thrust into the rock surface, causing the cutting disc tools to penetrate and break the rock at the tunnel face. Reaction to applied thrust and torque forces may be developed by anchoring with braces (grippers) extended to the tunnel wall, friction between the cutter head/shield and the tunnel walls, or bracing against support installed behind the TBM.

6. ***Explain various equipment's for pile driving (NOV/DEC 2016)***

Pile Driving Equipment:

Piles are installed by a special pile driving device known as a pile hammer. The hammer may be suspended from the boom of a crawler crane, supported on a large frame called a pile driver or carried on a barge for construction in water.

In all cases, the hammer is guided between two parallel steel members called leads. The leads may be adjusted at various angles for driving vertical and batter piles.

Types of Hammer:

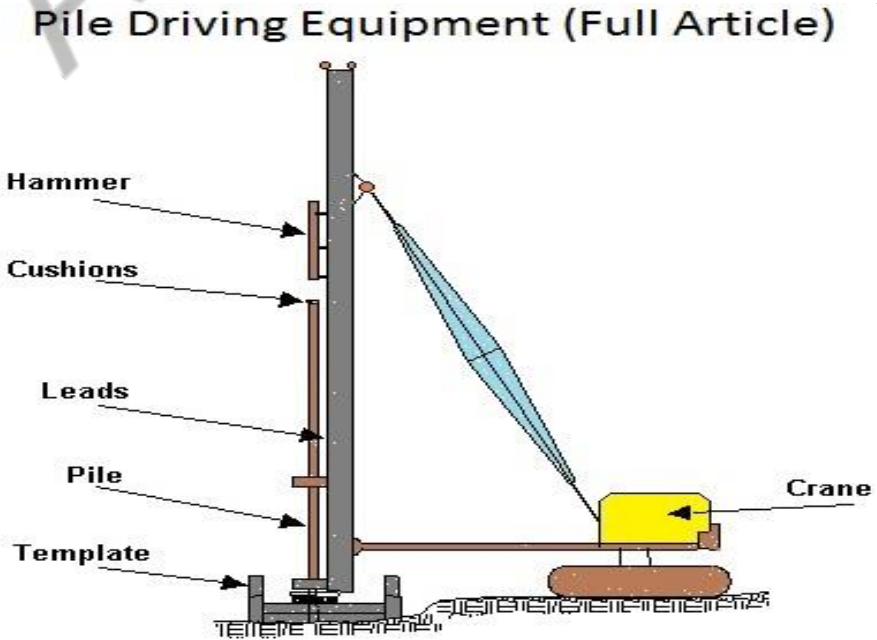
Several types of hammers are in use and each of which are different sizes. The hammer types are:

1. Drop hammer:

The drop hammer in the pile driving equipment consists of a heavy ram in between the leads. The ram is lifted up to a certain height and released to drop on the pile. This type is slow and therefore not in common use. It is used in the cases where only a small number of piles are driven.

2. Single acting hammer:

In a single acting hammer a heavy ram is lifted up by steam or compressed air but dropped by its own weight. The energy of a single acting hammer is equal to the weight of the ram times the height of fall.



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3. Double-acting hammer:

The double-acting hammer employs steam or air for lifting the ram and for accelerating the downward stroke. The energy of a double-acting hammer is equal to the (weight of the ram I mean effective pressure I the effective area of ram) 1 times the height of fall.

4. Diesel hammer:

The diesel hammer is a small, lightweight and highly mobile. They use gasoline for fuel. To start the operation, the ram is raised, and the fuel is injected. As the ram is released, the ram falls and compresses air and fuel. The air and fuel becomes hot because of the compression and the air-fuel mixture is ignited. The resulting explosion

Advances the pile and

Lifts the ram. If the pile advance is very great as in soft soils, the ram is not lifted by the explosion sufficiently to ignite the air-fuel mixture on the next cycic, requiring that the ram be again manually lifted

5. Vibratory hammer:

The principle of the vibratory driver is two counter-rotating eccentric weights. The driving unit vibrates at high frequency and provides two vertical impulses, one up and one down. The downward pulse acts with the pile weight to increase the apparent gravity force. These hummers have reduced driving vibrations, reduced noise, and great speed of penetration.

Hammer Selection:

Generally the size of hammer is more important factor than type of hammer. A heavy pile should be driven by a heavy hammer delivering large energy. Preferably the weight of HKjmcr should beat ^H HB1 the total weight of the pile and the deriving energy should be at Hpiie foot-pound for each pound of pile weight. Each type of hammer has its use under suitable conditions, The advantages and disadvantages of cach type are summarized below:

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Single-acting hammer :

They arc advantageous when driving heavy piles in compact or hard soils; the heavy ram striking at - tow velocity produces least damage due to impact. The disadvantages arc low driving speed and large headroom requirement.

Double-acting hammer:

They are generally used to drive piles of light or moderate weight in soils of average resistance against driving. This type of hammer can drive piles at fast speed, requires less headroom and can be used to extract piles by turning them [i.e. the double-acting hammer] upside down.

Diesel hammer:

They are similar in application as double-acting hammers, but driving may become difficult in extremely soft ground.

Vibratory hammer:

They have fairly good results in silty and clayey deposits. They are used in heavy clays or soils with appreciable numbers of boulders. See above for other advantages.

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Hammer Type	**Efficiency (ηh)**
Single and double acting hammer	0.7 - 0.85
Diesel hammers	0.8 - 0.9
Drop hammers	0.7 - 0.9

7. **Explain various types of compaction equipment** ***(NOV/DEC 2016)***

The different types of compaction equipment used in compaction project depend on the scope of work. The compaction equipment to be used can either be used for some situations or can be a special type which meets the requirements of the particular project.

- Smooth Wheeled Roller
- Sheepfoot Roller
- Pneumatic Roller
- Vibratory Roller
- Rammer
- Vibratory Plate Compactor

Static Smooth Wheeled Rollers.

These are rollers used with or without ballast and may be 3 wheeled or tandem type (two rolls of equal width). These are the conventional rollers used for almost all types of rolling. It is not effective on uniformly graded sand, gravel or silt and on over moist cohesive soil due to poor traction.

Diesel powered rollers with modern technology of hydrostatic transmission rollers have replaced the traditional steam rollers which were first introduced 100 years ago. The dead weight rollers (static rollers are sometimes called by this name) rely on weight alone to compact the material over which they pass. The units of 8 to 10 tonnes imparting pressure of 20 to 40 kg per linear cm are generally used. For light works, lighter rollers of weight upto 1 ton are also available.

Sheep Foot or Pad Foot Rollers.

These may be self driven or tractor driven and are suitable on cohesive soils specially when water content is on the higher side. The inherent dynamic beat developed by these tamping pads or feet in many cases produce a high degree of compaction at a faster rate.

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Pneumatic-Tyred Rollers.

These are used for compaction both the earthwork and bituminous road construction. Because of the oscillating axle layout they produce more even compaction across the rolling width than a wide steel wheel smooth rollers, which sometimes bridge the material leaving uncompacted areas of fill.

On bituminous wear courses, it can eliminate surface cracking and material crushing caused by steel rolls – the tyres fold and knead the material to produce an almost total sealed finish. These rollers are available in weighing range from 6 to 30 tonnes with 500 to 4000 kg per tyre and tyre pressure from 2 to 8 kg/sq.cm.

Vibratory Rollers.

Different types and sizes of vibratory rollers to suit specific conditions are available like :

1. Rollers with large vibrating drum infront with 2 steel or pneumatic tyred rear driving wheels. Pneumatic tyres offer better traction on gradients and in over moist soil. These may be articulated or non articulated type.
2. Roller with tandem smooth wheels, either one wheel vibrating and driven or both wheel vibrating and driven.
3. Single roll pedestrian vibrators rollers weighing nearly 400 kg are used for compacting small areas such as pavements, foundations etc.
4. Towed vibrating rollers weighing 5000 to 11000 kg. are aged for mass earthworks, base constructions embankments, rockfill dams etc.

Vibrations are produced by rotating eccentric weights within the rolls at high speed. These roll thus hitting the material to be compacted at high frequency. The vibration reduces the friction between the particles of material which are brought closer together as air voids are eliminated. Thus binding the material into denser state. Further. compaction results from the dynamic forces applied by vibrating roll onto the material being compacted.

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Vibrating rollers are very effective on free draining type soil and granular base course. These are not effective on uniform graded sand, gravel or silt. Rollers with high amplitude are preferable for soil and granular base course. At high amplitude vibrations the effective pressure on the compacting materials is around twice the static weight of the roller.

Tampers and Vibrating Plates.

Tampers with small vibrating feet are used to tamp footings, trench bottoms, position posts, lay paving slabs etc. These can also be used on small road repair jobs, footpath construction and compacting trench bottoms for pipe laying.

Operational weights fall in range upto approximately 80 kg for tampers and as much as 300 kg for vibrating plates. Although sizes larger than about 120 kg are seldom used. The tampers can deliver front 800 to 4500 blow/min and are generally powered by engines of 2.5 to 12.5 H.P.

8. Explain about various types of dredgers *(NOV/DEC 2018, NOV/DEC 2016)*

Dredgers are used for excavation from riverbed, lake or sea for purpose of deepening them. Dredging is an important operation in navigation canals, harbours, dams etc.

1. Mechanical Dredgers:

These are available in a variety of forms, but each has the same working principle of "hand-packing". These are equipped with a grab or a bucket, which is driven on the loose bed sediments, then material get filled in the bucket and the bucket is then raised to transport it to the req

(i) Bucket Dredgers:

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These are the oldest type of mechanical dredgers. These are fixed on anchors so considered as stationary dredgers but can be moved along the semi-arcs while dredging, with the help of winches

An endless chain of buckets is provided in bucket dredgers, these buckets scrap off and fill the loose dredged material in them and after being completely filled, these buckets can be emptied into barges by turning the bucket upside down over the barges.

(ii) Bucket Ladder Dredgers:

These kind of dredgers are just modification of conventional bucket dredgers, the series of buckets used in these dredgers are mounted on a wheel which mechanically picks up the sediments. They are more efficient and can be used to rip out even powerful and hard corals. The only limitations of these dredgers are their low production, the requirement of more anchor lines and high level of noise, which made them obsolete these days.

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They can be used for a wide variety of materials including soft rock material and are powerful enough to rip out the corals as well. But because of their low production, high level of noise and the need for anchor lines, their use has hugely diminished in recent times.

(iii) Grab Dredgers:

Grab Dredgers (or Clamshells) are also stationary dredgers fastened either on anchors or on spud-poles. The cutting tool, of these dredgers, is a grab which consists of wire operated two half-shells.

These half-shells after filling dredged material in them, load the material in barges. Grab is mounted either on a dragline or hydraulic excavator. These can be of different types such as (top) open grab, (top) closed grabs and watertight grabs.

Grab dredgers can be of different capacity ranging between 1.0 and 20 m^3 whereas the capacity of grab hopper draggers ranges from 100 to about 2,500 m^3. Their capacity largely depends upon the crane power. Grabs are efficient in removing material in corners of dock and basins and also these make excavation closer to quay walls easier.

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A revolving crane, fitted with a grab, placed on a hopper vessel or pontoon is known as a grab dredger. As the name suggests, it picks up the sediments at the seabed with a clam grabbing motion and discharges the contents. Often used for excavating bay mud it also is useful to pick up clays and loose sand.

(iv) Backhoe Dredgers:

These are also referred to as Dipper dredger and are somewhat similar to onshore excavators. These are used for harbour maintenance and shallow dredging. These are hydraulically driven excavators and consist of a half-open shell or a digging bucket which is capable of digging across a wide range of materials.

The shell or bucket is moved toward the machine and when filled, emptied in barges. Bucket capacity ranges between 0.5 and 13 m^3. Care should be taken while dropping this heavy and rigid bucket as it can cause damage to canal lining or quay walls.

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Like some onshore excavators, Backhoe dredgers have a digging bucket attached to it which digs through a wide range of materials and when it is excavated it's brought out and placed on the onboard barges. Although they have few limitations where deep dredging is concerned but with some recent modern dredgers, deeper excavation is made quite easy.

2. Hydraulic Dredgers:

The key feature of hydraulic dredgers is that the material dredged by these type of dredgers is in suspension form and raised through the pumping system and fed to outlet pipes.

These are most suitable for dislodging fine materials because it is easier to hold fine materials in the suspension than heavy gravels.

Gravels and other powerful material can also be removed through hydraulic dredger by using greater power pumps. Some common hydraulic dredgers are as under:

(i) Suction Dredgers:

These are generally employed to remove sand or silt deposits from the seabed. They have a vertical suction pipe, which is pushed vertically inside the sand deposit and dredged material is sucked with or without water jet. The dredged material is laden into barges or can directly to the reclamation area.

These suction dredgers can be of two types viz. profile or plain suction Dredgers and Cutting Suction Dredgers. Rest of the working and design of cutter suction dredger is similar to the plain suction dredger but has the only difference that cutter suction dredger is equipped with a cutting tool which may be swinging arc.

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(ii) Trailing Suction Hopper Dredger:

A Trailing Suction Hopper Dredger is a self-driven dredging vessel. It consists of hoppers or trailers with bottom gates or valves. The material is loaded in hopper hydraulically when this hopper or trailer is filled, the bottom valves or gates are closed and the hopper is raised up with cranes or winches. This dredger is most commonly used in open water: rivers, canals, estuaries and the open sea dredging.

Suitable mostly for harbour maintenance and pipe trenching, a hopper dredger is a self-propelling vessel that holds its load in a large onboard hold knows as the hopper. They can carry the load over large distances and can empty it by opening the bottom doors or by pumping the load offshore. Hopper dredges mostly dredge the soft non-rock soils and because of their high production rates can carry out land reclamation projects easily.

(iii) Water Injection Dredger:

It is a self-driven dredger which excavates sediments with strong water jets. Strong water jet converts the sediments into suspension, as this suspension is heavier than water, it is carried away by water currents and gravity and disposed-off at a specific site. This type of dredger is generally used to dredge mud or fine sand bottoms and are more commonly used for harbour maintenance.

Often used for environmentally sensitive projects, water injection dredgers work by fluidizing the material by pumping water into the bed material. Once it is fluidized it is either moved by a second burst of water or is carried away by the natural current.

3. Other types of dredger:

These are the dredgers which don't fall in the category of hydraulic and mechanical dredgers but are designed for a specific purpose. All these other types of dredgers are operable in shallow waterways such as narrow canals, industrial lagoons and reservoirs. They include:

(i) Jet-lift dredgers and Air-lift dredgers:

Jet-lift dredgers work on the principle of Venturi effect. A high-speed stream is injected, which in turn pushes the adjacent water along with the bed material, into a delivery pipe.

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Air-lift dredgers are similar to jet-lift dredgers with the only difference that high-pressure air is used as the medium for inducing water or material and dispose off through suction pipe. These jet-lift dredgers, as well as air-lift dredgers, cannot be used for powerful and hard material.

(ii) Augur suction dredgers:

These dredgers work on the outline of mechanical cutter suction dredgers, except that these dredgers are equipped with a rotating Archimedean screw for cutting, which is placed perpendicular to the suction pipe. The augur like screw rotates and removes material, after removal the material is served to the centrally placed suction pipe. This dredging method is employed where the material is to be dredged in precise vertical as well as horizontal dimensions.

(iii) Reclamation Dredger:

This type of dredger is generally used for reclamation purpose. These are also referred to as barge unloading dredgers.

(iv) Pneumatic dredgers:

These work on the same principle as a vacuum does. They consist of a chamber with high vacuum pressure inside and the chamber is suspended with the help of a crane. Bed material is pumped in the inlet chamber through vacuum pressure and the chamber is lifted up through crane and emptied at the requisite site. These type of dredgers are opted only for easily flowing material.

(v) Amphibious dredgers:

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These are a result of great technical advancement as these are capable of working in both submerged as well as in raised condition. These are equipped with grabs, buckets or a shovel installation to carry out the dredging.

(vi) Plough or bed leveler:

It is a special type of dredger which has a long cutting blade or bars fixed with a boat. As the dredger move over the bed, it scrapes off the bed level to the requisite depth. It is used for short length direct dredging, as it simply scraps the dredged material with a blade to a certain distance.

9. Explain about hydraulic excavator and factors to be considered in selection ***NOV/DEC 2018***

A hydraulic excavator (digger) is a large vehicle that is designed for excavation and demolition purposes. Hydraulic excavators consist of a chassis, boom, and bucket, and move via tracks or wheels. They range in size and function, an example of which is the similar but smaller "mini excavator." All versions are generally designed for the same purposes. Hydraulic excavators weigh between 3,000 and 2 million pounds and their speed ranges between 19 HP and 4,500 HP.

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Hydraulic excavators are entirely dependent on hydraulic systems. The hydraulic excavator's base/undercarriage consists of a track or wheeled platform and provides transportation for the vehicle while supporting the chassis. The chassis allows the driver to control the hydraulic excavator by using levers to drive the vehicle, raising the boom up and down, and controlling the bucket. Because the chassis is built on top of the undercarriage, it is able to rotate 360 degrees. The boom and bucket are attached to the chassis, work in conjunction to move materials, but are controlled independently.

Applications

Hydraulic excavators are used for a wide variety of applications, the most notable being excavation. They are also capable of being used for demolition purposes, however, as even the smallest models are more than capable of demolishing buildings. Hydraulic excavators are also commonly used for moving large amounts of materials, such as minerals, from one area to another. Hydraulic excavators are usually used in conjunction with bulldozers and loaders for construction purposes.

Advantages

Hydraulic excavators have many advantages that allow them to be used in the ways that they are. For example, they are small enough to work on specific tasks within a project area and can usually be transported from one project to another by either being towed or stored on a large truck. Hydraulic excavators can also take advantage of many different attachments: a mallet for demolition purposes, a blade for scraping, or a grapple for picking up objects. Hydraulic excavators are also widely available and can be purchased new or used.

Disadvantages

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Hydraulic excavators have few disadvantages, most of which are expected in such a vehicle. For example, hydraulic excavators are heavy and cannot simply be driven across large distances or on non-reinforced roads. Likewise, they generally use large amounts of fuel and can be a very expensive investment, the latter being countered by the fact that they can remain operable for decades. Additionally, hydraulic excavators can be difficult to repair due to their large size and many moving parts.

Factors to be considered while selection

- Size of the excavator for a given job
- The type of work expected from the tractor dozer
- Example: bulldozing, ripping, land clearing, pulling a scraper
- The type and condition of hauled road
- Gradient of the haul road
- Distance to be moved
- Type of work expected to be taken from the equipment after the present job is completed

10. ***Write note on Scrapers (APRIL/MAY 2019)***

Scrapers are the device to scrap the ground and load it simultaneously, transport it over the required distance, dump at desired place and then spread the dumped material over the required area in required thickness level, and return to the pit for the next cycle.

The scrapers are of three types

(a) towed type

(b) Self propelled or motorized

(c) Self-loading or elevating scraper

Towed type

Towed scrapers are provided with either cable or hydraulic control. Although these are becoming obsolete but even then some contractors use them because when coupled to a suitably powered crawler tractor; they can operated in extremely adverse conditions

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Self-propelled or motorized

Self-propelled or motorized are most popular now-a-days. These are generally manufactured in ranges from 10-25m^3 .A motorized scraper needs push loading by a crawler mounted or wheeled tractor. Motorized scrapers have more hauling speed and hence are suitable for long distance hauling while crawler-towed scrapers travel at slower speed and can be used for short hauls only. The problem of loading by a pusher is overcome by the third type of scraper known as self-loading or elevating scraper.

Construction: A scraper has following main parts

(i) **Bowl:** The bow is pan to hold the scraper dirt. It is hinged at the rear corners to the rear axle inside the wheels, and is capable of tilting down for digging or ejecting. The bowl size is specified to indicate the size of the scraper.

(ii) **Cutting edge:** The bowl has cutting edge attached at the bottom. The cutting edge is lowered into the dirt to make a shallow cut.

(iii) **Apron:** This is wall in front of the bowl, which opens and closes to regulate the flow of the earth in and out of the bowl. This can be open or closes in carrying position as well

(iv) **Tail gate or ejector:** These are the rear of the pan which is capable of forward ad backward movement inside the bowl. During loading it remains at its rear wall, while moves forward to help in ejecting the load during dumping

Operation

Operation of a scraper is described hereunder for an work application

(ii) **Loading or digging:** Operator moves to the cut the ejector at the rear and the apron raised approximately to 40 mm.The bowl is then lowered to the desired depth of cut, increase engine speed, move forward in first gear keeping optimum depth of cut. When the bowl is full, the apron is closed and the bowl is then raised.

(iii) **Transporting:** The bowl is transported in high gear in raised position to provide sufficient clearance. During transporting position to provide clearance. During transportation, apron should be fully closed to prevent loss of the material and the ejector should remain in the rear position

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(iv) **Unloading:** Unloading in a scraper is also termed as 'dumping and speading'.The bowl should be positioned to spread the material to the desired depth during this operation. A partial opening of the apron during the initial unloading will help in even spreading.For wet and sticky material,te apron should be raised and lowered repeatedly intil the materal behind it is loosened and drops out of the bowl.

For better efficiency in the scraping operations following points should be taken care of

(i) Keep the haul roads maintained

(ii) Pushers should utilize their waiting time in dressing the cut

(iii) Loading operation should be carried out downhill whenever possible

(iv) Excessive turning of a pusher should be avoided and scraper-pusher balance should be maintained.

11. E**xplain in detail about different types of cranes (April/MAY 2019)**

Mobile Cranes

Mobile cranes are mounted on crawlers or tires and offer greater mobility than standard cranes. Some mobile cranes are even able to be driven on the highway. Their ability to navigate around job sites and carry large amounts of weight makes mobile cranes a very popular addition to many projects.

There are several different types of mobile cranes, including:

1. Carry Deck Crane

Carry deck cranes are a relatively new type of crane that evolved from the older pick and carry model that was first introduced in the 1980s. They're small, four-wheeled, can rotate a full 360 degrees, and are more portable than other types of cranes. Carry deck cranes are simple to set up, and their small size easily allows them to navigate around confined and open spaces, making them a staple on many job sites.

2. Crawler Crane

Unlike the wheeled carry deck cranes, crawlers are track vehicles. Instead of wheels, crawlers are built on an undercarriage fitted with a pair of rubber tracks. Though this limits the crawler's turning capacity, the tracks make it possible to use on soft ground and sites with limited improvement without sinking.

Some crawler cranes have an attached telescopic arm that allows it to change its size, making them highly adaptable on many terrains. Unlike carry decks, however, crawlers are best used for long-term projects due to their bulkiness, special set up, and need to be transported from site to site.

3. Floating Crane

Also known as a crane vessel or crane ship, these floating cranes are used for projects at sea, such as ports or oil rigs. These cranes have a rich history—they have been used since the Middle Ages and, with the help of continuous technological advancements, have helped many generations of people.

As of today, there are several types of floating cranes as well, such as the sheerleg and semi-submersible. Nevertheless, the only difference floating cranes have from the other common types is that they're used at sea.

4. Rough Terrain Crane

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As the name implies, these cranes are used for pick and carry operations off-road and on rough terrains. A rough terrain crane is built similarly to a crawler crane, but instead of tracks, the undercarriage is outfitted with four large rubber tires that are typically equipped with four-wheel drive. Rough terrain cranes are also fitted with telescopic booms and outriggers to improve stability and make mobility much more manageable in tight and rough areas.

5. Truck-mounted Crane

Truck-mounted cranes are made up of two parts: the carrier (truck), and the boom (arm). Due to their unique build, they're able to travel easily on the road with no unique set up or transportation equipment.

Truck-mounted cranes are outfitted with counterweights and outriggers for stabilization, allowing them to move slowly while carrying a large load. Different versions of the truck-mounted crane exist; for example, special truck-mounted cranes are used for the inspection, maintenance, and building of bridges.

Fixed Cranes

Fixed cranes are typically fixed in one location or spot, and most need to be brought in and assembled at the site of the project. What fixed cranes lack in mobility, they make up for with the ability to lift heavier loads and reach even greater heights. These crane types are set in place for the duration of a project.

6. Bridge/Overhead Crane

The bridge crane, also known as an overhead crane, are typically found in industrial environments. Its name comes from the fact that it resembles a bridge supported by two steel beams that straddle the workload, with the hoist (lifting mechanism) traveling along the bridge part of the crane.

There are two subtypes of overhead cranes: gantry and jib cranes.

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Gantry

A variant of the overhead crane is the gantry crane, although sometimes the two terms are used interchangeably. The most significant difference between a bridge and gantry crane is that the gantry crane is supported by two a-frame steel legs and is typically built on a track. Gantry cranes are commonly seen at shipping docks and ports, lifting cargo off ships.

Jib Crane

Jib cranes are another version of the bridge crane. These types of cranes are permanently installed over a workstation and typically used for repetitive tasks.

The jib, or arm, is typically mounted on either a wall or floor-mounted pillar with a moveable hoist and may have some additional movement.

7. Bulk-handling Crane

Bulk-handling cranes are used to carry large volumes of heavy materials, like coal or minerals. Instead of a hook at the end, bulk-handling cranes have a specialized hook that utilizes a grabbing mechanism and a bucket to grab, hold, and lift materials.

8. Hammerhead Crane

Hammerhead cranes are some of the most commonly used in construction projects. This crane has a horizontal, swiveling lever resting on a fixed tower. The trolley is held in the forward part of the arm and is counterbalanced with the part of the arm that extends backward.

Hammerhead cranes also offer a feature known as racking, which allows the trolley to move forward and back horizontally along the crane arm. These cranes can be extremely heavy and are assembled on the job site.

9. Stacker Crane

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Stacker cranes are automated machines with a forklift-like mechanism and are primarily designed for warehouse storage. Typically, stacker cranes are used in places with special working conditions, like extremely cold temperatures, making it unnecessary for a human worker to endure extreme working conditions.

10. Telescopic Crane

Telescopic cranes are equipped with a boom (arm) outfitted with a hydraulic cylinder that allows it to change length, like a telescope. Although it's considered a fixed crane, many telescopic cranes are mounted on a truck to transport to and from different worksites.

Due to the unique nature of their boom being able to collapse and compact itself, telescopic cranes are highly adaptable for a variety of situations, such as short-term construction jobs as well as some rescue operations during natural disasters or other emergencies.

11. Tower Crane

Commonly used in the construction of tall buildings, tower cranes offer amazing lifting capabilities. Due to their size, tower cranes are equipped with an operating cab that controls the entire crane. Tower cranes have their jib extending horizontally from the mast (tower part), which itself rests on a concrete base.

A luffing jib is able to move up and down, while the fixed jib has an operating dolly that moves materials horizontally. The engine (called a slewing unit) that controls the rotation of the crane sits on the top of the mast.

Due to their size, tower cranes are built along with the building, growing alongside it; once the building is complete, the process is reversed. With its height, ability to lift heavy materials, and various features, tower cranes are an essential tool when constructing a tall building.

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12. Explain in detail about various aspects of graders (April/MAY 2019)

Motor grader also named as road grader is a self-propelled machine with an adjustable blade. Position of blade is between the front and rear axle. That blade is most commonly used for cutting, spreading and leveling of material.

This machine has also a scarify option which is used for scarifying the underlying layer and then removal of that layer with the help of blade. After that a new layer is made by spreading some other soil or that scarify soil again. Motor graders are classified on the basis of frame structure. Depending on frame arrangement motor grader is classified as;

1. Rigid frame motor grader
2. Articulated frame motor grader

Rigid Frame Motor Grader

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Articulated frame motor grader

Rigid frame motor grader has only one axle. Axle is unable to turn left or right about a point. Articulated frame motor grader has a hinge in between the front and the rare axle. That type of grader is most commonly used where small space is available during turning.

Motor grader is one of the pieces of construction machinery that is used to create a well smooth, wide-ranging, and level surface. Most commonly motor graders are used for the maintenance of road. It spread the soil and then flattens that soil. Before the pavement of asphalt layer motor graders are used for uniformly flat surface so that asphalt distribute uniformly throughout the surface.

Uses Of Motor Grader | Functions

Now a day's grader is used for;

1. Moving of earth from one location to another.
2. Leveling of soil so that next bitumen layer spread uniformly throughout the surface.
3. Scarifying. Scarifying is the removal of complete layer of soil and then spreading of a new layer at that particular location.
4. Mixing of two materials.
5. Spreading of soil, aggregates etc…
6. Trenching
7. Land grading. It is the process in which a certain slope is achieved with the help of motor grader.
8. Ditching
9. And for cutting of bank canals.
10. Motor grader is also used as snow removing machine. Because of speed and normal wheel instead of crawler wheel. This makes motor grader as most suitable machine for this type of operations in areas where snow rate is above the normal conditions.

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