

# construction Equipment



## Introduction

It is a common fact that we find a wide variety of construction machines on every construction sites, which make the construction jobs easy, safe and quicker. Good project management in construction must vigorously pursue the efficient utilization of labor, material and equipment.

The use of new equipment and innovative methods has made possible wholesale changes in construction technologies in recent decades. The selection of the appropriate type and size of construction equipment often affects the required amount of time and effort and thus the job-site productivity of a project.

These act as a backbone in the case of huge construction projects. Proper use of the appropriate equipment contributes to economy, quality, safety, speed and timely completion of a project. Equipments are use for highway projects, irrigation, buildings, power projects etc. Almost 15-30% of total project cost has been accounted towards equipment and machinery.

It is therefore important for site managers and construction planners to be familiar with the characteristics of the major types of equipment most commonly used in construction.

### **Advantages of utilizing the construction equipments:**

- Increase the rate of output through work progress with the best effective and efficient methods.
- Reduce the overall construction costs especially for large contracts.
- Carry out activities which cannot be done manually or to do them more economically and much faster.
- Eliminate the heavy manual work by human thus reducing fatigue and eliminates various other hazards and health issues.
- Maintain the planned rate of production where there is a shortage of skilled or unskilled labor.
- Maintain the high quality standards often required by present-day design and specifications (technical standards).

# **EARTH-MOVING EQUIPMENTS**

## **SELECTION CRITERIA FOR EARTHWORK EQUIPMENTS**

The selection of earthmoving equipment is mainly dependent on the following factors:

- Quantities of material to be moved
- The available time to complete the work the job conditions
- The prevailing soil types, the swell and compaction factors, etc.
- The job conditions include factors such as availability of loading and dumping area, accessibility of site, traffic flows and weather conditions at site.

In order to plan the number of *Earthwork Equipment* needed, the planner first determines the following:

- The suitable class of equipment for earthwork-for example, if the soil to be excavated is loose and marshy, and bulk excavation is involved In the project, one may opt for a dragline.
- The appropriate model of equipment based on different characteristics such as payload of bucket and speeds required. For example, draglines come in different capacities ranging from 0.38 cum to 3.06 cum; scrapers in capacities ranging from 8 cum to 50 cum and so on.
- The number of equipment needed for the project to carry out the given quantity.
- The number of associated equipment required to support the main equipment

## **1. Excavators**

- **Excavators** are heavy construction equipment consisting of a boom, stick, bucket and cab on a rotating platform (known as the "house").
- The house sits atop an undercarriage with tracks or wheels.
- Excavators are also called diggers
- Excavators are used in many ways:
  - a. Digging of trenches, holes, foundations
  - b. Material handling
  - c. Brush cutting with hydraulic attachments
  - d. Forestry work
  - e. Demolition
  - f. General grading/landscaping
  - g. Heavy lift, e.g. lifting and placing of pipes
  - h. Mining, especially, but not only open-pit mining
  - i. River dredging
  - j. Driving piles, in conjunction with a pile driver



## 2. Back hoe

- Backhoes are mainly used to clean up construction areas, to dig holes in the ground, to smooth uneven ground, to make trenches, ditches and to help remove deep roots from trees.
- It can exert high tooth pressures and hence can excavate stiff material which normally cannot be excavated by dragline. Out put of hoe is greatest when the excavation is done near the machine, because cycle time of operation reduces.
- A **backhoe**, also called a **rear actor** or **back actor**, is a piece of excavating equipment or digger consisting of a digging bucket on the end of a two-part articulated arm. They are typically mounted on the back of a tractor or front loader.
- Also known as **hoe**, **back shovel** and **pull shovel**
- It is used to excavate below the natural surface on which it rests.
- Generally used to excavate trenches, pits for basements and also for grading works, which requires precise control of depths.
- The basic parts are boom, Jack boom, Boom foot drum, Boom sheave, Stick sheave, Stick, Bucket and Bucket sheave.





The section of the arm closest to the vehicle is known as the boom, and the section which carries the bucket is known as the **dipper** or dipper stick (the terms "boom" and "dipper" having been used previously on steam shovels). The boom is attached to the vehicle through a pivot known as the kingpost, which allows the arm to slew left and right, usually through a total of around 200 degrees. Modern backhoes are powered by hydraulics.

**Applications:**

- It is the most suitable machine for digging below the machine level, such as, trenches, footings, basements etc.
- It can be efficiently used to dress or trim the surface avoiding the use of manual effort for dressing the excavated the surface.

### 3. Front shovel

- A **front shovel** (also **stripping shovel** or **power shovel** or **electric mining shovel** or **Dipper Shovel's power shovel**) is a bucket-equipped machine, usually electrically powered, used for digging and loading earth or fragmented rock and for mineral extraction.
- They are mounted on crawler tracks.
- To excavate the earth and to load the trucks
- It is used to excavate earth of all classes except hard rock and load it into wagons.
- Size varies from  $0.375\text{m}^3$  to  $5\text{m}^3$ .
- Basics parts of power shovel including the track system, cabin, cables, rack, stick, boom foot-pin, saddle block, boom, boom point sheaves and bucket.
- Power shovels are used principally for excavation and removal of overburden in open-cut mining operations, though it may include loading of minerals, such as coal. They are the modern equivalent of steam shovels, and operate in a similar fashion.
- Front shovel are mainly used for excavation purposes above its own track or wheel level.
- They are suitable for heavy positive cutting in all types of dry soils.





**Old Front Shovel**



**New Front Shovel**

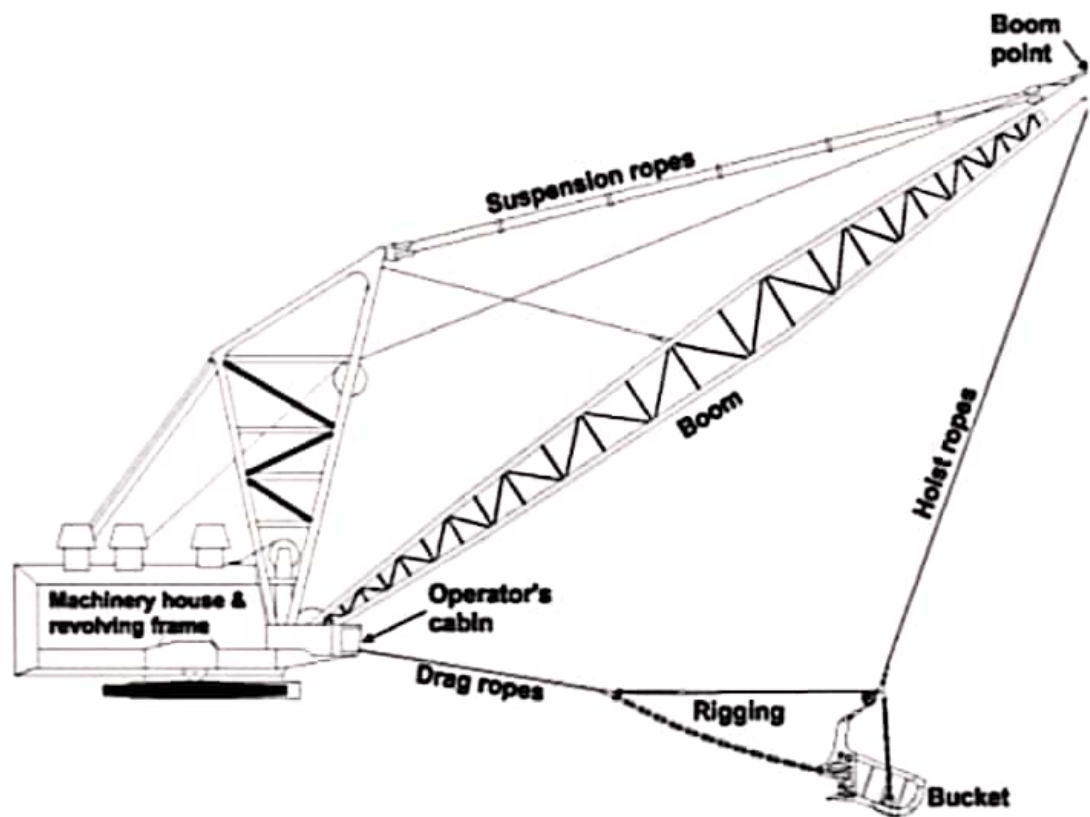
- A shovel's work cycle, or digging cycle, consists of four phases:
  - a. digging
  - b. swinging
  - c. dumping
  - d. returning

#### **4. Dragline**

- They are used to excavate soft earth from below ground and to deposit or to load in wagons. Output of dragline is measured in Cubic Meters per hour.
- They are used for bulk excavation below its track level in loose soils, marshy land and areas containing water.
- The drag line is so name because of its prominent operation of dragging the bucket against the material to be dug.
- Unlike the shovel, it has a long light crane boom and the bucket is loosely attached to the boom through cables.
- Because of this construction, a dragline can dig and dump over larger distances than a shovel can do.
- Drag lines are useful for digging below its track level and handling softer materials.
- The basic parts of a drag line including the boom, hoist cable, drag cable, hoist chain, drag chain and bucket.





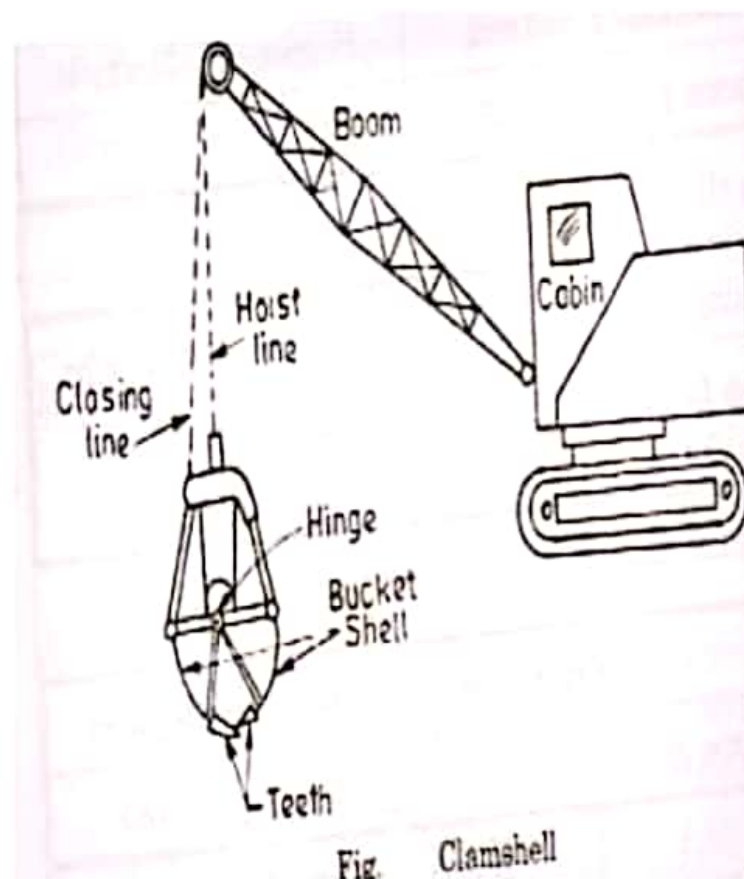


#### Applications of Dragline:

- It is the most suitable machine for dragging softer material and below its track level
- It is very useful for excavating trenches when the sides are permitted to establish their angle of repose without shoring.
- It has long reaches.
- It is mostly used in the excavation for canals and depositing on the embankment without hauling units.

## 5. Clamshell

- It consists of a hydraulically controlled bucket suspended from a lifting arm. It is mainly used for deep confined cutting in pits and trenches.
- It is having bucket of two halves which are hinged together at top. It is used to excavate soft to medium materials and loose materials.
- This is so named due to resemblance of its bucket to a clam which is like a shell-fish with hinged double shell.
- The front end is essentially a crane boom with a specially designed bucket loosely attached at the end through cables as in a drag line.
- The capacity of a clam shell bucket is usually given in cubic meters.
- The basic parts of clam shell bucket are the closing line, hoist line, sheaves, brackets, tagline, shell and hinge.



### Comparison between different types of equipment

Sr.no.	Items of comparison	Power shovel	Back hoe	Drag line	Clam shell
1	Excavation in hard soil or rock	Good	Good	Not good	Poor
2	Excavation in wet soil or mud	Poor	Poor	Moderately good	Moderately good
3	Distance between footing and digging	Small	Small	Long	Long
4	Loading efficiency	Very good	Good	Moderately good	Precise but slow
5	Footing required	Close to work	Close to pit	Fairly away from pit	Fairly away from pit
6	Digging level	Digs at or above footing level	Digs below footing level	Digs below footing level	Digs at or below footing level
7	Cycle time	Short	Shortly more than power shovel	More than power shovel	More than the other equipment

## 6. Bulldozers

- A **bulldozer** is a crawler (continuous tracked tractor) equipped with a substantial metal plate (known as a blade) used to push large quantities of soil, sand, rubble, or other such material during construction or conversion work and typically equipped at the rear with a claw-like device (known as a ripper) to loosen densely-compacted materials.
- They are used for moving earth up to a distance of about 100m and act as a towing tractor and pusher to scraper machines. They can be track-mounted or wheel-mounted.
- The heavy blade attached to the tractor pushes the material from one place to another.
- The tractor can be of the crawler or the wheeled type.

### ❖ **Classification of bull dozer**

#### 1. Position of blades

- Bull dozers in which the blade perpendicular to the direction of movement
- Angle dozers in which the blade is set at an angle with the direction of movement.

#### 2. Based on mountings

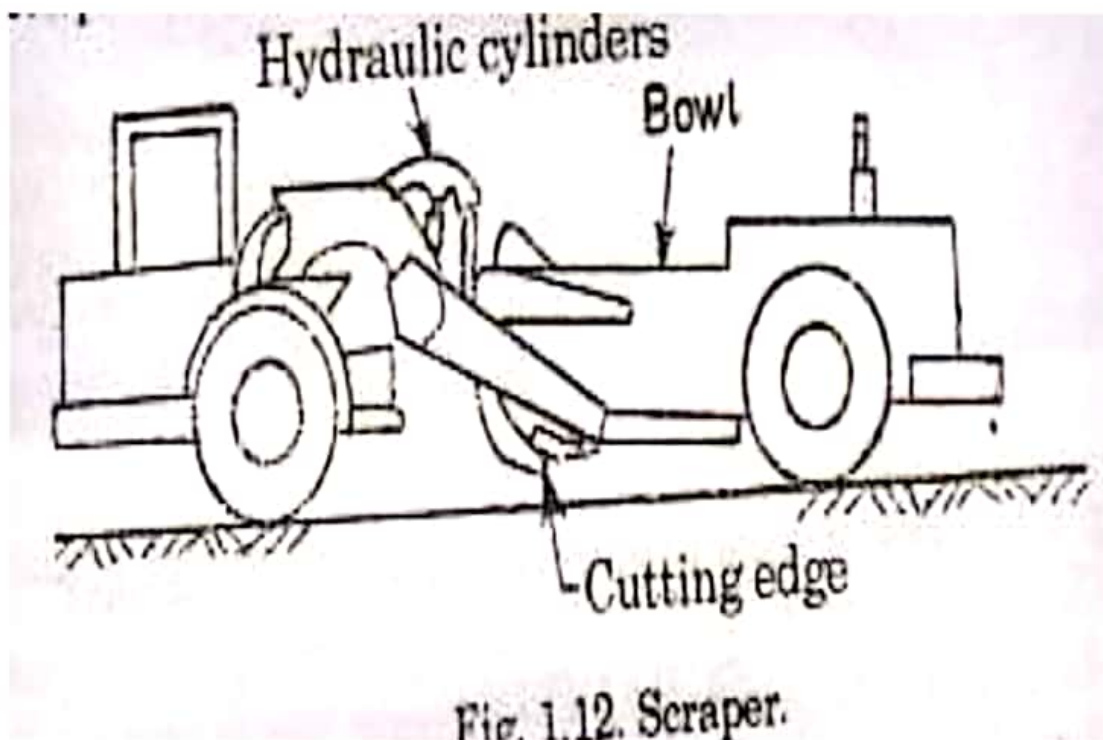
- Wheel mounted
- Crawler mounted

#### 3. Based on the control

- Cable controlled
- Hydraulically controlled

## 7. Scraper

- It is a device to scrap the ground & load it simultaneously, transport it over required distance. It can dig, load, haul and discharge the material in uniformly thick layers.
- In civil engineering, a **wheel tractor-scraper** is a piece of heavy equipment used for earthmoving.
- The rear part has a vertically moveable hopper (also known as the bowl) with a sharp horizontal front edge. The hopper can be hydraulically lowered and raised. When the hopper is lowered, the front edge cuts into the soil or clay like a plane and fills the hopper.
- When the hopper is full it is raised, and closed with a vertical blade (known as the apron). The scraper can transport its load to the fill area where the blade is raised, the back panel of the hopper, or the ejector, is hydraulically pushed forward and the load tumbles out. Then the empty scraper returns to the cut site and repeats the cycle.
- They are used for site levelling, loading, hauling over distances varying between 150m-900m. They may be towed, two-axle or three-axle type.
- Unique machine for digging and long-distance hauling of plough able materials.
- self-operating machine
- It is not dependent on other equipment.
- Wheels of machine cause some compaction.
- The basic parts of scrapers are the bowl, apron and tail gate or ejector.



## 8. Grader

- A **grader**, also commonly referred to as a **road grader**, a **blade**, a **maintainer**, or a **motor grader**, is a construction machine with a long blade used to create a flat surface.
- Typical models have three axles, with the engine and cab situated above the rear axles at one end of the vehicle and a third axle at the front end of the vehicle, with the blade in between.
- In civil engineering, the grader's purpose is to "finish grade" (refine, set precisely) the "rough grading" performed by heavy equipment or engineering vehicles such as scrapers and bulldozers.
- Graders are commonly used in the construction and maintenance of dirt roads and gravel roads.
- In the construction of paved roads they are used to prepare the base course to create a wide flat surface for the asphalt to be placed on. Graders are also used to set native soil foundation pads to finish grade prior to the construction of large buildings.
- It is used for grading and finishing the upper surface of the earthen formations and embankments. They usually operate in the forward direction
- It is self propelled or towed machine motor grader, Used for light or medium works. It shapes the ground and spreads the loose material..



## 9. Loaders

- A **loader** is a heavy equipment machine often used in construction, primarily used to lift material (such as asphalt, demolition debris, dirt, snow, feed, gravel, logs, raw minerals, recycled material, rock, sand, and woodchips) into or onto another type of machinery (such as a dump truck, conveyor belt, feed-hopper, or railcar).
- A bucket is attached to arms, capable of being raised, lowered and dumped through mechanical control. Application-Land filling, road Maintenance.
- **Skid-Steer Loader:**
  - A **skid loader** or **skid-steer loader** is a small rigid frame, engine-powered machine with lift arms used to attach a wide variety of labor-saving tools or attachments.
  - Though sometimes they are equipped with tracks, skid-steer loaders are typically four-wheel vehicles with the wheels mechanically locked in synchronization on each side, and the left-side drive wheels can be driven independently of the right-side drive wheels.



### ➤ **Wheeled Loader**



## ➤ Crawler Loader



- The **crawler loader** combines the stability of the crawler tractor with the abilities of a wheel loader.
- However, to construct a reliable crawler loader it requires more than simply attaching a loader bucket onto a crawler tractor. It must be designed with its specific purpose in mind to ensure it has the strength to withstand heavy excavating.
- The introduction of hydraulic excavators diminished the market for the crawler loader because it was unable to match the excavator's lifting power and flexibility.
- However, crawler loaders are capable of maneuvering across the entire construction site under its own power, whereas most hydraulic excavators require towing or transport. While crawler tractors are still being manufactured today for niche markets, they reached their peak of popularity in the 1960s.



## 11. Tractors

- Multi-purpose machines used mainly for pulling and pushing the other equipment.
- Important Equipment for earthmoving, worked by Diesel engines, having horse power ranging from 20HP to 200HP.
- Tractors may be classified as
  - a) **Crawler type tractor**- Used to move bull dozers, scrapers. The crawler has a chain by which these tractors can be very effective even in the case of loose or muddy soils. The speed of this type dose not exceed 12 kmph normally.



- b) **Wheel type tractor**- The engine is mounted on four wheels. The main advantage is higher speed, sometimes exceeding 50 kmph it is used for long-distance hauling and good roads.



## EARTH COMPACTION EQUIPMENTS

**Compactors** are machines frequently used to compact materials such as soil in order to increase its density for construction.

1. In addition, compactors are utilized in landfill tasks.
2. Common varieties are plate tampers (also known as rammers)
3. Vibratory plates, compactors (also known as tamping foot rollers) &
4. Vibratory pad foot compactors.

These categories are further divided below....

### **1. Smooth-wheel rollers**

- These are most suitable for compacting gravels, sand and such like materials. Examples are Three wheeled or macadam rollers and tandem rollers.
- Plain steel rollers
- Self-propelled type
- Weighing from 5 to 15 tonnes
- Used for ordinary rolling work where deep compaction is not required
- These rollers may have one front and two rear wheels
- The rear wheels being usually larger in diameter and the front one being winder.
- Weight of rollers may be increased by filling water or sand ballast in hollow cylinder.
- These rollers are effective in compacting granular soils, such as sand, gravel and crushed stone.



## **2. Sheep-foot rollers**

- It consist steel cylindrical drum with projection extending radial direction outward from surface of cylinder & may be propelled or towed by tractor. It is suitable for silty & clay sand, medium and heavy clay.
- For compacting earth work in embankments and canals (where compaction deep into the layer of the earth is required)
- These gives best result in compaction when the soil is clay or predominantly cohesive and impervious.
- The sheep foot rollers may weigh upto 15 tonnes or more
- Travel at a speed of 25 kmph
- As roller moves over the surface, the feet penetrate the soil to produce a kneading action and a pressure to mix and compact the soil from bottom to top layer.
- With repeated passages of the roller, the penetration of feet decreases.



### **3. Pneumatic-tyred rollers**

- It gives kneading action as well as compression to the soil underneath. It is suitable for moderately cohesive silty soils, clayey soils, gravelly and clean sand.
- It consists of a base or a platform mounted between two axles.
- The rear of which has one more wheel than the front.
- Most suitable for compacting fine-grained soil and well graded sands.
- Ballasting is done using water, sand or pig iron in order to increase the self weight.
- Major advantages are the ability to control the ground contact pressure by:
  - a) Altering the weights of machines,
  - b) Increasing the number of wheels,
  - c) Increasing the tyre width
  - d) Changing the contact area of the tyre by altering the contact pressure.



#### 4. Tippers

- A truck or lorry the rear platform of which can be raised at the front end to enable the load to be discharged by gravity also called **tip truck**.
- Tippers are suited for the rough and tumble of mining & quarrying operations, as well as for carrying bulk loads in construction and infrastructure industries. Complete maneuverability, high performance and long-term endurance are common to all trucks, resulting in lower operating costs.



## References

- Highway engg book "S.K. Khana & Jus to".
- <https://en.m.wikipedia.org>

## Assignment Questions

- Discuss the methods of earth excavation for road construction and the uses of various equipment.
- Explain the objects of compaction & the effect of inadequate compaction. Explain compacting equipment for construction of subgrade & embankment.
- Write short notes on
  - (I) Scraper
  - (II) Bulldozer
  - (III) dumper
  - (IV) shovel
  - (V) dragline
  - (VI) Tractor
  - (VII) Tipper