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An overview of Construction Equipments, soil properties and types.

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Abstract

Construction is the ultimate objective of a design. People and machines make it possible, estimating, determining quantity, production and cost, Construction and controlling these during progress of work. One of the most obvious problems in constructing a project is how to transport heavy materials. Equipments provide the solution that problem. Construction industry is essentially a service industry activities involves converting the specified by an engineer's into a finished project. Huge equipment and construction vehicles are involved in activities like transferring and moving of materials and heavy loads, placement of construction materials, compacting and leveling, excavation and digging of huge quantities of earth. These are the core operation of the machines and a sudden failure can cause damage to properties, increase in cost, delay in the project, production loss, and in some cases fatality. This paper gives a briefly about construction equipments, soil properties and types of construction equipments.

Keywords: Construction equipments, Soil, Resources, Excavating, Cleaning, Loading

Introduction:

Construction Industry is an industry involved in the planning, execution and evaluation of all types of civil works. Success in the construction industry depends largely on the ability of the management to plan and coordinate the numerous steps involved in the project execution. Physical infrastructures such as Buildings, Communication and Energy related construction works; Water supply and Sewerage civil works, etc. are some of the major projects programs in the construction Industry. Construction equipment is one of the three major inputs of the building construction process, together with labours and materials. One of the reasons for the development and use of equipments within the construction is, to enable construction activities to be performed where are beyond the limit of human strengths, and to achieve high standards, which is required by current construction technologies and designs. To make the construction process are more economic. The activities involved in Construction Projects where the magnitude of the work is on a large scale, Speedy Work and Timely Completion of Work with Quality Control are very vital. In order to achieve this, Mechanization of Work has to be done, where Construction Machinery & Equipment play a pivotal role.

Construction equipment is composed of a variety of heavy-duty vehicles, tools and machinery, which are capable of withstanding the harsh conditions experienced throughout construction sites.

It can virtually relate to any type of equipment used on site to increase productivity and achieve construction goals in a quicker and easier manner. Equipment such as this is used in a variety of ways throughout the industrial, earth-moving, mining and civil industries, plus a whole range more. Proper use of appropriate equipment contributes to Economy, Quality, Safety, Speed and Timely completion of the Project. Construction equipment is an important part of any construction process. It is not always desirable or possible for the Contractor to own each and every type of Construction Equipment required for the Project. Considering the various aspects of the utility of particular Equipment, the Contractor has to economically justify whether to purchase the Equipment or to hire it. The amount invested in the purchase of Equipment should be recovered during the useful period of such Equipment.

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Advantages of utilizing the construction equipments

- 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 laminates various other hazards and health issues.
- Maintain the planned rate of production where there is a shortage of skilled or unskilled labor and maintain the high quality standards often required by present-day design and specifications (technical standards).

Why Heavy Machinery is important?

In the present day industrial scenario, heavy industrial machinery is an important part of time and cost efficient construction. Industrial and heavy machines such as hydraulic cranes, earthmovers, generators, construction equipment, oilfields pieces, transport and other related accessories are very important in constructing big structures. These enable various construction companies and organizations to complete their targeted task in an easy way. When we do the projects, its need more manpower and time. In order to avoid heavy man power and time schedule, we need an alternative solution. The alternative solution is construction equipments. **Example:** If u want lift the water to the third floor, if need more man power? Alternative solution is Centrifugal pump. Capacity of

backhoe loader = 1 cubic meter Capacity of truck = 6 cubic meter, we need more labour and time to fill the sand. By using loader is easier to fill the sand.

The need for Mechanization arises due to the following reasons:

- Magnitude & Complexity of the Project,
- Projects involving large quantities of material handling.
- Complexity of Projects using high grade materials
- High quality standards, Importance of keeping the Time Schedules.
- Optimum use of Material, Manpower and Finance.
- Shortage of skilled and efficient Manpower and
- Construction has traditionally been labour intensive

Resources in Construction

- Finance (Money): the most liquid resource of a firm, The major resource used to secure other resources
- Human (capacity and capability): Is the resources that actually does the job
- Physical (Material, Equipment & Plant): The major resources used to do the job
- Information (Network) (Availability & access) as the saying goes "Information is power!"
- Time and space Managing the time and the space available for any action is importance for its success

Table 1: Comparison between labor Intensive and Machine intensive

Used in light constructions	Used in heavy constructions
Low rise buildings, Small structures in road constructions, Small irrigation projects, etc, Very useful in creating job opportunities	High rise buildings, Road projects Hydropower projects, Mining projects, Mechanized irrigations, etc Help achieve high quality efficient execution of tasks

Common factors affecting selection of equipment

- Scope of work to be carried out - since the first concern is getting the job done, the time frame within which the work is required to be carried out, the specification of work and the methodology adopted will be of primary concern
- Use of available Equipment - New Equip may not be fully utilized
- Suitability for job conditions - the equipment selected should suit the Demand of job, soil, topography climate and other working condition etc.
- Uniformity in type - it is desirable to have minimum number of types so that there is uniformity in the type of equipment on a project. It is desirable to select common type of engine for different machine such as excavators, dump trucks, tractor and scrapers purchased on the projects.
- Size of equipment - while large size of machines are capable of giving large outputs on full load, the cost of production is usually greater than that of smaller units if worked out on part loads. Large size of equipment requires corresponding large size of matching equipment.
- Uses of standard Equipment - standard equipment is commonly manufactured and are commonly available and are moderately priced. The spare parts of standard equipment are easily available and less expensive.

- Unit cost production - the economics is one of the most important considerations in selection of equipment.
- Suitability of local labor - available operators and technicians should be able to handle selected equipment.
- Technical consideration - the efficient performance of any piece of equipment and its service life are conditioned by following factors: Strength, Rigidity, Vibration stability, Resistance to wear, Heat resistance, Reliability and Maintainability.

Properties of Soil

In construction terms, excavation is the process of removing earth to form a cavity in the ground. Excavation may be carried out by manual means using tools such as picks, shovels and wheel barrows. Soils are a composition of mineral particles 45%, organic matter 5%, air 25%, and water 25%. Brown earths are fertile and very suitable for agriculture. Their suitability for agriculture are due to their characteristics of good texture, dark colour, and PH value.

Soil Volume Change Characteristics

Bank State - This is the state when the material is in its natural Unit - Bank cubic meter [Bm³]
Loose State - This is the state after the material is excavated - Loose cubic meter [Lm³]

Compacted State - state after the material is compacted. Unit- Compact cubic meter [Cm³].

Swelling in Soil

Swelling soils, also known as expansive soils, are ones that swell in volume when subjected to moisture. These swelling soils typically contain clay minerals that attract and absorb water. When water is introduced to expansive soils, the water molecules are pulled into gaps between the soil plates. The unit volume of the soil in the bank condition will occupy more than one unit volume after excavation.

Example 1: Find the swell of the soil that weight 1661kg/m³ in its natural state and 1186 kg/m³ after excavation.

Ans: Swell% $[1661/1186] \times 100 = 40\%$

Shrinkage (%) = $[1 - \text{weight of bank volume} / \text{weight of compacted volume}] \times 100$

Example 2: Find the shrinkage of a soil that weight 1661 kg/m³ in its natural state and 2077 kg/m³ after compaction.

Ans: Shrinkage = $[1 - 1661/2077] \times 100 = 20\%$

Classification of Construction Equipment

Earth works equipment: Bulldozers, power Shovels, Clamshells and Draglines, Loaders, Graders, Scrappers, Rollers, etc.

Hauling and Hoisting equipment - Tractors, Dump trucks, Scrapers, Hoists, Conveyors and Cranes.

Compaction and stabilization equipment- Compactors, Rollers, etc.

Foundation Equipment - Pile Driving Equipments

Pumping & Dewatering Equipment - Pumps, Hoses, Pipes, and Compressors.

Concreting equipment - Mixers, Vibrators

Tunneling equipment - Tunnel Boring Machines (TBM)

Drilling and blasting equipment

Table 2: Earth Work Equipment

Kinds of Work	Equipment Required
Clearing	Bull dozer, Backhoe, Loader, etc.
Excavating	Shovel (Backhoe, Dragline, Clamshell), Bull dozer, Ripper, Rock breaker
Loading	Wheel Loader, Track Loader, Loading Shovel (Front shovel)
Excavating/Loading	Power shovel(Backhoe, Dragline, Clamshell), Bucket wheel excavator
Excavating/Hauling	Bull dozer, Scraper, Loader, etc.
Hauling	Dump truck, Wagon, Conveyer, etc.
Spreading/Grading	Bull dozer, wheel dozer, Motor Grader
Compacting	Tire roller, Steel roller, Vibration roller, Tamping roller, Vibration compactor, etc.
Trenching	Trencher, Backhoe, excavator, etc.
Slant Finishing	Motor grader

Power Shovel: Power shovel is equipment used mainly in quarries, pits and on construction sites to excavate and load blasted rock. These equipments are more effective for excavations above the wheel or grade level. The basic parts of a power shovel include the mounting, cab, boom, dipper stick, dipper (bucket), and hoist line. Optimum depth of cut: is that depth which produces the greatest output and at which the dipper comes up with full load without undue crowding. The depth varies with the class of soil and the size of the dipper. The output of a power shovel is affected by numerous factors, including the following: Class of material, depth of cut, Angle of swing, job conditions, management conditions, size of hauling units, skill of operator and physical condition of the shovel.

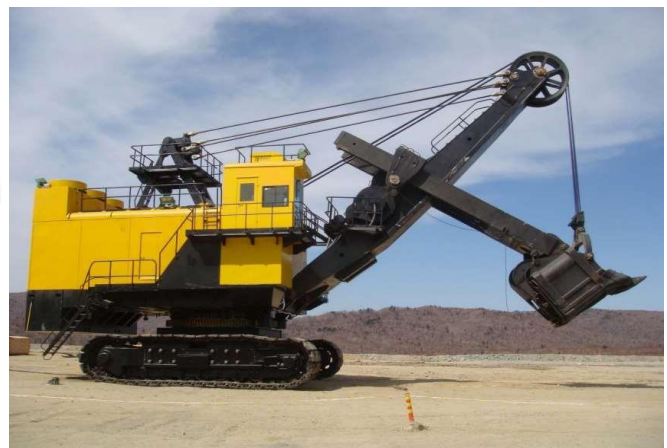
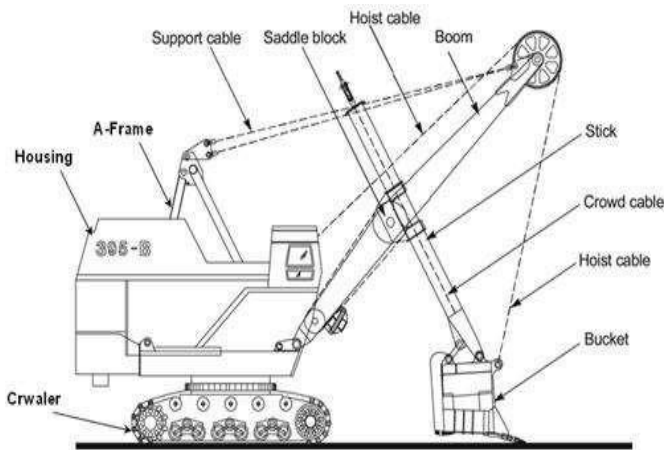


Fig. 1: Power shovel

Back Hoe: The machine is placed in operation by setting the boom at designed angle and pulling drag cable to move the dipper out to the desired position. The free end of boom is lowered by releasing the tension in the hoist cable until dipper teeth engaged the material to the dug. As the cable is pulled in, dipper is filled. The dipper is lifted by rising by raising the boom, and then swinging to the dumping

position, which may be a spoil bank or a truck. Very common piece of equipment, Many subcontractors own/lease, Very versatile, Easily transported, “Low” maintenance costs, Operator “friendly”, Easily rented, Backhoe used for digging holes or excavation on site. It is used for various landscaping job and backhoe used in breaking of asphalts, and paving road also.



Fig. 2: Backhoe

Dragline: Drag lines are useful for digging below its track level and handling softer materials. Draglines are used to excavate earth and load it into hauling units, such as trucks or tractors-pulled wagons, or deposit it into levees, dams and spoil banks near the pits from which it was excavated. These equipment are more efficient for excavation below the grade level and have the longest reach of all shovel equipment. A dragline can be used for dragging out sediments and is efficient for under water construction.

These equipment are weak while excavating hard materials and have a lesser productivity than a power shovels. The output of drag lines will vary with the following factors Class of material, Depth of cut, Angle of swing, Size and type of bucket, Length of boom, Method of disposal, casting, or loading, Size of the hauling units, when used Skill of the operator, Physical condition of the machine, Job conditions.

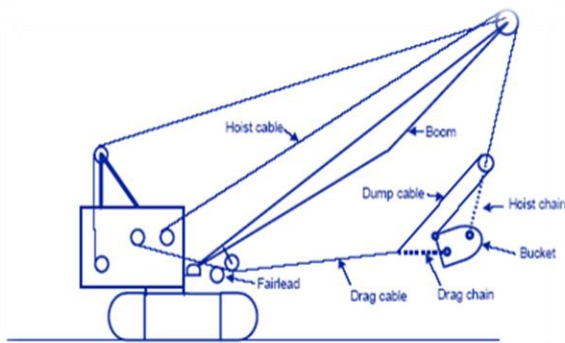


Fig. 3: Dragline

Clamshells: Clamshells are used primarily for handling loose materials such as sand, gravel, crushed stone, coal, etc. and for removing materials from inside cofferdams, pier foundations, sewer manholes, sheet-lined trenches, etc. They are especially suited to vertically lifting materials from one location to another, as in charging hoppers and overhead bins. Clamshell buckets are available in various

sizes, and in heavy-duty types for digging, medium-weight types for general-purpose work and lightweight types for rehandling light materials. The variable factors affecting operations include: The difficulty of loading the bucket, the size load obtainable, the height of lift, the angle of swing, the method of disposing of the load, and the experience of the operator.

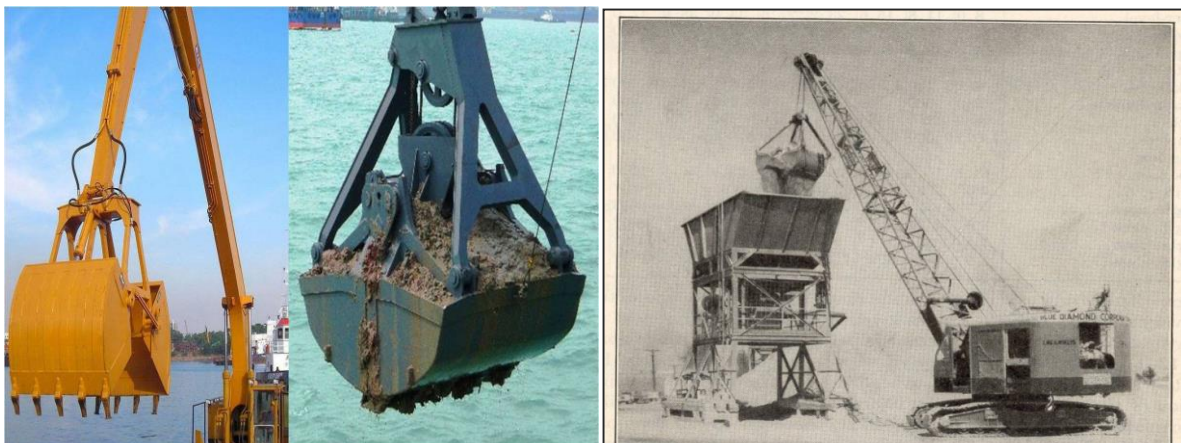


Fig. 4: Clamshells

Table 2: Comparison between different types of equipment

S.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 of Construction Equipments	Short	Shortly more than power shovel	More than power shovel	More than the other equipment

Excavators: Replaced the cable operated crane shovel family Excavators are basically digging machines, having the following three main components. An undercarriage to give mobility. This may be crawler track mounted or wheel mounted. A superstructure with operator’s cabin mounted on either a slew ring to traverse through 360° or on a rigid

frame. Hydraulically articulated boom and dipper arms with bucket. Excavators are designed to excavate below the ground surface on which the machine rests. Functions of excavators: Excavating – Earthworks, Loading Excavated Material, Making of Drains

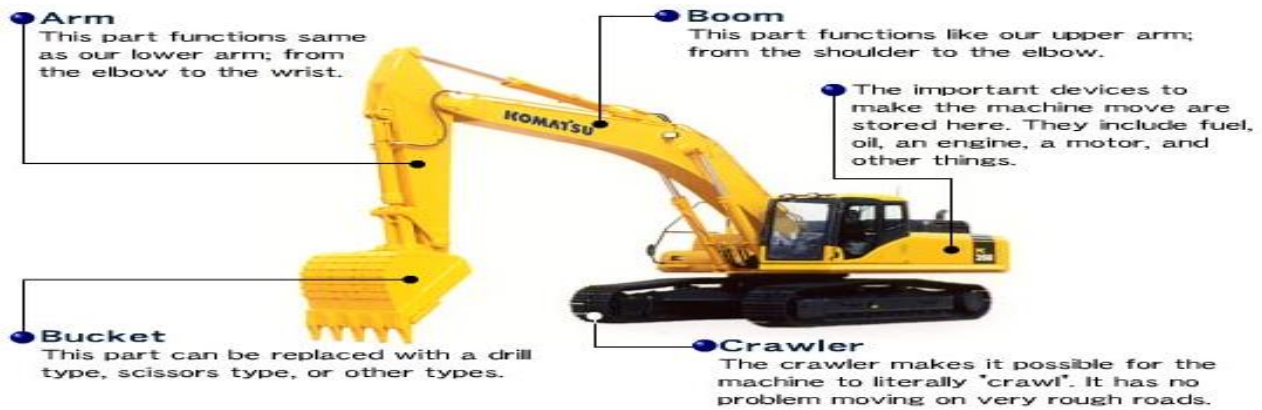


Fig. 5: Excavator

Loaders: A bucket is attached to the arms and capable of being raised, lowered, and dumped through mechanical or hydraulic controls. The loaders having bucket in the front, known as “front end loaders” are very common. The loaders are versatile, self-propelled equipment mounted

either on crawler or wheel-type running gear. These are equipments used primarily: To load excavated materials to a hauling unit, Excavate soft to medium materials, Loading hoppers, Stockpiling materials, Backfilling ditches, and Moving concrete and other construction materials.

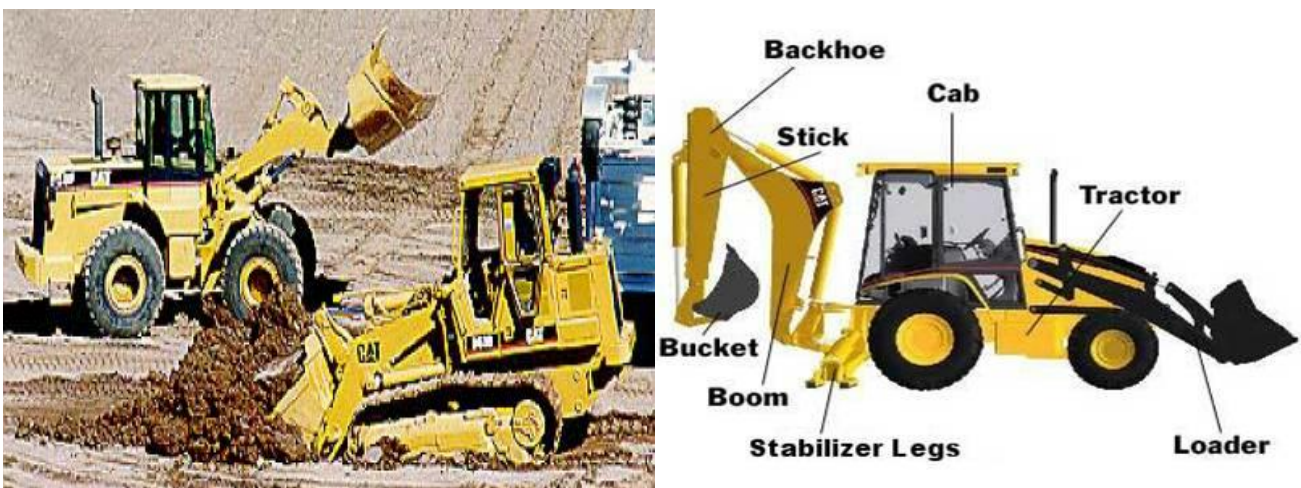


Fig. 6: Loaders

Dozers: Dozers are machines designed primarily for cutting and pushing the material over relatively short distance. They consist of a tractor equipped with a front-mounted earthmoving blade controlled by hydraulic cylinders to vary the depth of cut. A dozer moves earth by



lowering the blade and cutting until a full blade load of materials is obtained. It then pushes the material across the ground surface to the required location. Rear mounted hydraulic scarifiers and rippers can be fitted to loosen hard material prior to dozing.

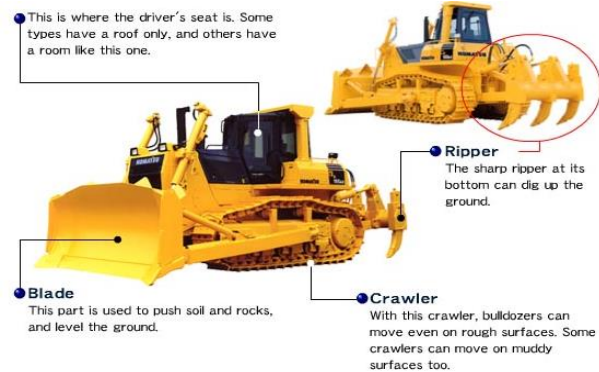


Fig. 7: Dozers

Pile Driving Equipment

Pile is structural members driven into the ground for the purpose of transferring surface loads are effective at an economical cost. A pile driver a mechanical device used to drive piles soil to provide foundation support for buildings or other structures. The term is also used in reference to members of the construction crew that work pile-driving rigs. One traditional type of pile includes a heavy weight placed between guides so that it is able to freely slide up and down in a single line. It is placed upon a pile. The weight is raised, which may involve the hydraulics, steam, diesel or manual labour. When the weight reaches its highest point it is then released and smashes on to the pile in order to drive it into the ground.

Conclusion

With the invent of compacting equipments and construction machinery, a lot of work can be done in a short span of time with economy. Working man hours and quantum of work are increased. Good quality of work can be maintained. Saving in project completion time and cost of project. Easy transportation of material from distant locations. Better ride quality of embankment can be achieved. Different materials can be blended/mixed to find a suitable material for earthwork. Typical tasks can be performed which are tough for manual labor. He factors affecting heavy equipment selection in construction works have been studied. Safety about the operators during equipment operation have been Studied.

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