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CONSTRUCTION EQUIPMENTS

The selection of t 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. It is therefore important for site managers and constructions p1anners to be familiar with the characteristics of the major types of equipment most commonly used construction. Construction equipments can be classified based on applications under the following heads:

¾ Excavation an Earthmoving equipments
¾ Concreting equipments
¾ Material handling Erection equipments
¾ Dewatering and Pumping equipments

Typically, construction equipments are used to perform essentially repetitive operations, and can be broadly classified accord to two basic functions:

¾ Operators such as cranes, graders, etc. which stay within the con of the construction site
¾ Haulers such as dump trucks, ready mixed concrete truck, etc. which transport materials to and from the site

In order to increase job-site productivity, it is beneficial to select equipment with proper characteristics and a size most suitable for the work conditions at the construction site

Excavation and Earthmoving equipments

Factors that could affect the selection of excavators include:

¾ Size of the job larger volumes of excavation will require larger excavators, or smaller excavator in greater number
¾ Activity time constraints Shortage of time for excavation may force contractors to increase the size or numbers of equipment for activities related to excavation
¾ Availability of equipment - Productivity of excavation activities will diminish if the equipment used perform them is available but not the most adequate.

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¾ Cost of transportation of equipment - This cost depends on the size of the job, the distance of transportation and the means of transportation.

Type of excavation - Principal types of excavation in building projects are cut and/or fill, excavation massive, and excavation for the elements of foundation

Soil characteristics The type and condition of the soil is important when choosing the most adequate equipment since each piece of equipment has different outputs for different soils.

Geometric characteristics of elements to be excavated - Functional characteristics of different types of equipment make such considerations necessary.

Space constraints - The performance of equipment is influenced by the spatial limitations for the movement of excavators.

Characteristics of haul units - The size of an excavator will depend on the haul units if there is a constraint on the size and/or number of these units.

Location of dumping areas - The distance between the construction site and dumping areas could be relevant not only for selecting the type and number of haulers, but also the type of excavators.

Normally there are three purposes of earth moving equipments,

Excavation of soil from below or above the track/wheel level of the equipment
Clearance of site at the track/wheel level of equipment

Hauling of spoil out of site

A few types of equipments under this head are:

Bull Dozers and Angle Dozers
Graders
Skimmers
Scrapers
Loaders
Face Shovels
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Backacters
Draglines
Multipurpose excavators

BullDozers and Angle Dozers

These machines consist of a track or wheel mounted power unit with a blade at the front, which is usually controlled by hydraulic rams and sometimes by wire cable operation. Many bulldozers have the capacity to adjust the mould blade to from angle dozers and the capacity to tilt the mould blade about a central swivel point. .

Some bulldozers can also be fitted with rear attachments such as rollers and scarifies.

The main uses of a bulldozer are:

Shallow excavations up to 300 nun deep either on levee, ground or side hill
cutting Clearance of shrubs and small trees
Clearance of trees by using raised mould blade as a pusher arm
Acting as a towing tractor
Acting as a pusher to scraper machines
Bulldozers push earth in front of the mould blade with some side spillage whereas angle dozers pu and cast spoil to one side of the mould blade.

Graders

These machines are similar in concept to bulldozers in that they have a long slender adjustable mould blade, which is hung, under the center of the machine. A grader is used to finish or grade the upper surface of a large area usually as a follow up operation to scraping or bulldozing. They can produce a fine and accurate finish but do not have the power of bulldozer. Therefore they are not suitable for over site excavation work. The mould blade can be adjusted in both the horizontal and vertical planes through an angle of 360 the latter enabling it to be used for grading sloping banks as well.

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Two basic types of graders are:

(i) Four Wheeled Graders

In this type of graders all wheels can be driven and steered. This facility gives the machine the ability to offset and crab along its direction of travel.

(ii) Six Wheeled Graders

Six Wheeled Graders have four wheels in tandem drive at the rear and two front tilting idler wheels giving it the ability to counteract side thrust.

Skimmers

These excavators are rigged using a universal power unit for surface stripping and shallow excavation work up to 300 mm deep where a high degree of accuracy is required They usually require attendant haulage vehicles to remove the spoil and need to be transported between sites

on a low loader. Because of their limitations and the availability of alternative machines, they are rarely used today.

Scrappers

Scrapers are multiple-units of tractor-truck and blade-bucket assemblies with various combinations to facilitate the loading and hauling of earthwork. Major types of scrapers include single engine two-axle or three aide scrapers, twin-engine all-wheel-drive scrapers, elevating scrapers, and push-pull scrapers. Each type has different characteristics of rolling resistance, maneuverability stability, and speed in operation.

These machines consist of a scraper bowl, which is lowered to cut, and collect soil where site stripping and leveling operations are required involving large volume of earth, When the scraper bowl is full, the apron at the cutting edge is closed to retain the earth and the bowl is raised to the disposal area. On arnval of disposal area, the bowl is lowered, the apron opened and the spoil pushed out by the tailgate as the machine moves forwards.

(i) Towed scrapers

It consists of a four wheeled scraper bowl with a power unit such as a crawler tractor. They tend to be slower than other forms of scrapers but are useful for small capacities with haul distances up to 300 m.

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(ii) Two Axle scrapers

These have a two-wheeled scraper bowl with an attached two wheeled power unit. They are veiy maneuverable with low rolling resistance and veiy good fraction.

(iii)Three Axle scrapers

It consists of a two-wheeled scraper bowl that may have a rear engine to assist the four-wheeled traction engine. Generally, these machines have a greater capacity than other scrapers, are easier to control and have a faster cycle time.

(e) Loaders

These machines are sometimes called tractor shovels. They are used to scoop up loose materials in the front mounted bucket, elevate the bucket and maneuver into a position to deposit the loose material into an attendant transport vehicle. Tractor shovels are driven towards the heap of loose material with the bucket lowered. The speed and power of the machine will enable the bucket to be filled. To increase their versatility tractor shovels can be fitted with a 4 in 1 bucket enabling then to car out bulldozing as well.

Both crawler mounted and wheel mounted types are available. The tracked loader being more suitable for wet and uneven ground conditions than the wheeled one, which has greater speed, and maneuvering capacities.

Face Shovels

The primary function of face shovels is to excavate above its own track or wheel level. They are available as a universal power unit based machine or as a hydraulic purpose designed unit. These machines can usually excavate any type of soil except that which needs to be loosened, usually by blasting, before excavation. Face shovels generally require attendant haulage vehicles for the removal of spoil and a low ladder transport lony for travel between sites. Most of these machines have a limited capacity of between 0.3 mand 0.4 m for excavation below their own track or wheel level.

Backacters

These machines are suitable for trench, foundation and basement excavations and are available as a Universal power unit base machine or Purpose designed hydraulic unit. They can be used

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with or without attendant haulage vehicles since the soil can be placed alongside the excavation for the use in back filling. These machines will require a low loader transport vehicle to be transported from one site to another. Backacters used in trenching operations with a bucket width equal to the trench width can be vely accurate with a high output rating.

Draglines

Draglines are based on the universal power unit with basic crane rigging to which is attached a drag bucket.

The machine is primarily designed for bulk excavation in loose soils up to 3 m below its own track level by

swinging the bucket out to the excavation position and haunting or dragging it back towards the power unit.

Dragline machines can also be fitted with a grab or clamshell bucket for excavating in very soils. **Mu1tIpurpose Excavators**

These machines are usually based on the agricultural tractor with 2 or 4 wheel drive and are intended mainly for use in conjunction with small excavation works such as foundation excavations, pipe laying and drainage trenches. Most multi-purpose excavators are fitted with a loading/excavating front bucket and a rear backwater hoe bucket both being hydraulically controlled. When in operation using the backwater bucket, the machine is raised off its axles by rear mounted hydraulic outriggers or jacks and In some models by placing the front bucket on the ground.

The choice of the type and size of haulers is based on the consideration that the number of haulers selected must be capable of disposing of the excavated materials expeditiously.

Factors which affect this selection include:

1. Output of excavators - The size and characteristics of the excavators selected will determine the output volume excavated per day.

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2. Distance to dump site - Sometimes part of the excavated materials nay be piled in a corner at the job site for use as backfill

3. Probable average speed - The average speed of the haulers to and from the dumping site will determine the cycle time for each hauling trip.

4. Volume of excavated materials - The volume of excavated materials including the part to be piled up should be hauled away as soon as possible.

5. Spatial and weight constraints - The size and weight of the haulers must be feasible at the job site and over the route from the construction site to the dumping area.

Concreting equipments

It is well known that the process of concreting involves batching, mixing, transporting, placing, compacting and curing. Accordingly common concreting equipments are,

- ¾ Concrete mixers
- ¾ Concrete Hauling Equipments
- ¾ Concrete pumps for placement in different conditions
- ¾ Concrete vibrators for compaction

Concrete mixers

These are generally related to their designed output performance. Machines are decided based upon what mixing and placing methods are to be employed to mix and place a certain amount of concrete in a given time period. Generally, a batch mixing time of 5 minutes per cycle of 12

batches per hour can be assumed as a reasonable basis for assessing mixer output.

(b) Concrete Hauling Equipments

(i) Wheel barrows

he usual means of transporting mixed concrete produced in a small capacity mixer is by wheelbarrow. The run between the mixing and placing positions should be kept to a minimum 8

and as smooth as possible by using planks or similar materials to prevent segregation of the mix within the wheelbarrow

(ii)Dumpers

These can be used for transporting mixed concrete from mixers up to 600-litre capacity and are available in two forms,

(iii)Ready Mix Concrete Mixers

These are used to transport mixed concrete from a mixing plant or depot to the site. Usual capacity range of ready mixed concrete trucks is 4 to 6 rn3. Discharge can be direct into placing position into some form of site transport such as dumpier, crane skip or concrete pump.

(d) Concrete pumps for placement in different conditions

These are used to transport large volumes of concrete in a short time (say up to 100 m3 per hour) in both the vertical and horizontal directions from the pump position to the point of placing. The pump is supplied

with pump able special concrete mix or with constant flow of ready mixed concrete lorries through out the pumping period. Concrete pumps are usually of a twin cylinder hydraulically driven form with a small bore pipeline (100 mm diameter) and can be trailer or lorry mounted. Pumping ranges may be up to 850.00 m vertically and 200 m horizontally depending on the pump model. It generally requires about 45 minutes to set up a concrete pump on site including coating the bore of the pipeline with a cement grout before pumping. After plumbing, the pipeline should be cleared and cleaned. Usually concrete pump and operator are hired for the period required

(e) Concrete vibrators for compaction

(i) Poker or Internal Vibrators

These consist of a hollow steel tube casting in which is a rotating impeller which generators vibrations as its head comes into contact with casing. Poker vibrators should be inserted vertically and allowed to penetrate 75mm into any previously vibrated concrete.

(ii) External Clamp or Tamping Board Vibrators

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These vibrators operate by shaking the formwork. Clamp vibrators powered by either compressed air or electricity whereas tamping board vibrators are usually petrol driven. Formwork must be stronger than is traditional to withstand vibration.

MATERIAL HANDLING AND ERECTION EQUIPMENTS

Horizontal transportation

Vertical transportation

Upward only

Downward only

Upward and downward

Derricks are commonly used to lift equipment of materials in industrial or building construction A derrick consists of a vertical mast and an inclined boom sprouting from the foot of the mast. The mast is held in position by guys or stiff legs connected to a base while a topping lift links the

top of the mast and the top of the inclined boom. A hook in the road line hanging from the top of the inclined boom is used to lift loads. Guy derricks may easily be moved from one floor to the next in a building under construction while stiff leg derricks may be mounted on tracks for movement within a work area.

Tower cranes are used to lift loads to great heights and to facilitate the erection of steel building frames. Horizon boom type tower cranes are most common in high rise building construction. Inclined boom type tower cranes are also used for erecting steel structures

Forklift trucks are useful for horizontal and limited vertical transportation of materials. Hoists are used in two-way vertical transportation of materials and passengers, whereas rubble chutes are used in downward transportation of construction and demolition debris. Cranes are the most versatile material handling equipments that can be chosen or designed for any kind of movement.

(a) Forklift Trucks

Forklift trucks are used for horizontal and limited vertical transportation of packaged materials positioned on paflets or banded together such as brick packs.

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They are generally suitable for construction sites where the building hieght does not exceed three dories. Although designed to negotiate rough terrain sites, forklift trucks have a higher productivity on firm and level soils.

Three types of forklift trucks with various height, reach and lifting capacities are in common use namely,

- ¾ Straight mast
- ¾ Overhead thicks
- ¾ Telescopic boom

(b) Hoists

Hoists are equipments used for transporting materials and passengers vertically. Common types of hoists are as follows:

(i) Material Hoists

These are designed for the vertical transportation of materials and under no circumstances should they be used to transport passengers. Most material hoists are mobile, can be dismantled, folded onto the chassis and moved to another position or site under their own power or towed by a haulage vehicle. When in use material hoists need to be stabilized and / or tied to the structure and enclosed with a protective screen.

(II) Passenger Hoists

These are designed to carry passengers although most are capable of transporting a combined load of materials and passengers within the lifting capacity of the hoist. A wide selection of hoists are available ranging from a single cage with rope suspension to twin cages with rack and pinion operation mounted on two sides of a static tower.

(c) Cranes

Cranes are machines designed to move materials vertically (raise by rope pulley operation) or horizontally. The range of cranes available is very wide, from gear wheel to a complex tower crane. Therefore, choice must be based on:

- ¾ The loads to be lifted

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- ¾ Height of lifting
- ¾ Horizontal distance to be covered
- ¾ Time period of lifting operations

¾ Utilization factors and
¾ Degree of mobility required

However, it may be possible to place most cranes into one following groups

(i) Mobile Cranes

These are low-pivot cranes capable of horizontal motion, either by itself or mounting on crawler or truck. They are classified based on the type of mobility as: Self propelled cranes with wheeled chassis

¾ Truck mounted hydraulic cranes
¾ Truck mounted lattice jib cranes
¾ Crawler mounted cranes

(ii) Static Cranes

These are either operating from affixed position on ground or is capable of longitudinal motion on rails

Depending on the height of pivot and operational ability , static cranes are of three types:

¾ Gantry Cranes which are not pivoted, and are cranes with pulley, rope and hook are hung from a portal frame
¾ Most Cranes which are similar to tower cranes are low pivot cranes
¾ Tower Cranes are high pivot cranes

Rubble Chutes

These are used in demolition, repair, maintenance and refurbishment. The concept involves connecting of several perforated dustbins vertically downwards for expedient and safe conveyance of materials. In customized forms the tapered cylinders are produced from reinforced rubber with chain linkage for continuity. Overall unit lengths are generally 1.1 m,

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providing an effective length of 1 m. Hoppers and side entry units are made for special applications.

Dumpers

These are used for the horizontal transportation of materials on and off construction sites generally by means of an integral tipping skip.

A wide range of dumpers is available depending on their carrying capacities, discharge control (gravity or hydraulic discharge) and tipping facilities (front tipping, side tipping). Special dumpers fitted with flat platforms, rigs to carry materials, skips and rigs for concrete, skips for crane hosting are also available. Highway dumpers are of a similar but larger design and can be used to carry materials such as excavated soil along the roads.

PILE DRIVING EQUIPMENTS

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Pile driving equipments are of three types

Impact type drivers which drive piles by impact of weight on or into piles

Vibration type drivers drive pile be vibrating the pile through the soil

Piling hammers combine the desirable effects of both impact and vibration driving.

Piling Hammers

Details of Piling Hammers

These are designed to deliver an impact to the pile to be driven. The hammer weight and drop height is chosen to suit the pile type and nature of subsoil through which it will be driven. There are four types of piling hammers depending on the mechanism of driving

Drop Hammers

Drop hammers are heavy iron blocks, which hammer the pile b free fall onto the pile top. Drop hammers require special arrangement on top of pile to ensure that impact is steady, vertical and correctly located. It also needs a winch to lift the wei2.ht and release it.

Single Acting Hammers

These hammers are raised by steam or compressed air and are lowered by free fall. Guide tugs or rollers are required on the piling frame leaders to maintain the hammer position but necessity of winches are eliminated.

Double Acting Hammers

These consist of a cast iron cylinder that remains stationary on top of the pile. Both up and down strokes are powered by steam or compressed air. This eliminates both winch arrangement and leader arrangements. However blow forces are lower in these hammers

Diesel hammers

These are self-contained hammers using free fall for down stroke, which in turn ignites diesel engine for upstroke. Hence, they do not require winches or leaders and deliver moderate impact energy.

Lifting and Erecting

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Derricks are commonly used to lift equipment of materials in industrial or building construction. A derrick consists of a vertical mast and an inclined boom sprouting from the foot of the mast. The mast is held in position by guys or stiff legs connected to a base while a topping lift links the top of the mast and the top of the inclined boom. A hook in the road line hanging from the top of the inclined boom is used to lift loads. Guy derricks may easily be moved from one floor to the next in a building under construction while stiff legs derricks may be mounted on tracks for movement within a work area.

Tower cranes are used to lift loads to great heights and to facilitate the erection of steel building frames. Horizon boom type tower cranes are most common in high rise building construction. Inclined boom type tower cranes are also used for erecting steel structures.

Mixing and Paving

Basic types of e for paving" include machines for dispensing concrete and bituminous materials for pavement surfaces. Concrete mixers may also be used to mix

Portland cement, sand. Gravel and water in batches for other types of construction other thin paving.

A truck mixer refers to a concrete mixer mounted on a truck which is capable of transporting ready mixed concrete from a central batch plant to construction sites. A paving mixer is a self propelled concrete mixer equipped with a boom and a bucket to place concrete at any desired point within a roadway. It can be used as a stationary mixer or used to supply slip form payers that are capable of spreading, consolidating and finishing a concrete slab without the use of forms.

A bituminous distributor is a truck-mounted plant for generating liquid bituminous materials and applying them to road surfaces through a spray bar connected to the end of „ he truck Bituminous materials include both asphalt and tar which have similar properties except that tar is used when the pavement is likely to be heavily exposed to petroleum spills.

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CONSTRUCTION TOOLS AND OTHER EQUIPMENT

Air compressors and pumps are wide! used as the power sources for construction tools and etc Common pneumatic construction tools include drills, hammers. grinders. saws, wrenches, staple

nuns. Sandblasting guns. And concrete vibrators. Pumps are used to supply water or to dewater at construction sites and to provide water jets for some types of construction.

Automation of Equipment

The introduction of new mechanized equipment in construction has had a profound effect on the cost and productivity of construction as well as the methods used for construction itself. An exciting example of innovation in this regard is the introduction of computer microprocessors on tools and equipment. As a result, the performance and activity of equipment can be continually monitored and adjusted for improvement. In many cases, automation of at least part of the construction process is possible and desirable. For example, wrenches that automatically monitor the elongation of bolts and the applied torque can be programmed to achieve the best bolt tightness. On grading projects, laser controlled scrapers can produce desired cuts faster and more precisely than ntholly manual methods. IIQJ Possibilities for automation and robotics in construction are. explored more fully in Chapter 16.

Concrete Hauling Equipments

Details of Concrete hauling equipments

Wheelbarrows

The usual means of transporting mixed concrete produced in a small capacity mixer is by wheelbarrow. The run between the mixing and placing positions should be kept to a minimum and as smooth as possible by using planks or similar materials to prevent senregat of the mix within the wheelbarrow

Dumpers

These can be used for transporting mixed concrete from mixers up to 600-litre capacity

Drop Hammers

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Details of Drop hammers

Drop hammers are heavy iron blocks, which hammer the pile by free fall onto the pile top. Drop hammers require special arrangement on top of pile to ensure that impact is steady, vertical and correctly located. It also needs a winch to lift the weight ht and release it. The major components of drop hammers are

¾ Block of iron which comprises the body of the hammer

¾ Rear lug that can be placed into the piling rig guides or leaders, so that the impact may be in position

¾ 3. A lifting eve at the top for attachment of the winch rope

¾ The number of blows that can be delivered with a free fall of 1.2 m to 1.5 m ranges from 10 to 20 per minute.

¾ The weight of the hammer should be not less than 50% of the concrete or steel pile

¾ weight and 1 to 1.5 times the weight of a timber pile.

Single Acting Hammers

Details of single acting hammers

Single Acting Hammers consist of a heavy falling cylinder raised by steam or compressed air sliding up and down a fixed piston. Guide tugs or rollers are located in the piling frame leaders to maintain the hammer position relative to the pile head. The number of blows delivered ranges from 36 to 75 per minute with a total hammer weight range of 2 to 15 tones Double Acting Hammers details of Double acting hammers

¾ Double Acting Hammers consist of a cast iron cylinder that remains stationary on

the pile head.

¾ A ram powered by steam or compressed air for both up and down strokes delivers a series of rapid blows that tends to keep the pile on the move durin2 driving. The blow delivered is a smaller force than that from a drop or single acting hammer.

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¾ The number of blows delivered ranges from 95 to 300 per minute with a total hammer wei2ht range of 0.7 to 6.5 tonnes.

¾ Diesel powered double acting hammers are also available. Diesel Hammers

Details of diesel Hammers

These are self-contained hammers, which are located in the leaders of the pile. The driving action is started by raising the ram within the cylinder that activates the injection of a measured amount of fuel. The free falling ram compresses the fuel above the anvil. This causes the fuel to explode and expand resulting in a downward force on the anvil. It also generates an upward force that raises the ram to restart the cycle. The process repeats itself until the fuel is cut off

The number of blows delivered ranges from 40 to 60 per minute with a total hammer weight range of 1.0 to 4.5 tones..

Standard Type Dumper Crane Skip Dumper

Ready mixed Concrete Trucks

These are used to transport mixed concrete from a mixing plant or depot to the site. Usual capacity range of ready mixed concrete trucks is 4 to 6 m3. Discharge can he direct into placing position into some form of site transport such as dumpier, crane skip or concrete pump.

Concrete Pumps

Details of Concrete Pumps

These are used to transport large volumes of concrete in a short time (say up to 100 m3 per hour) in both the vertical and horizontal directions from the pump position to the point of placing. The pump is supplied with pump able special concrete mix or with constant flow of ready mixed concrete Lorries throughout the pumping period.

Bore pipeline (100 mm diameter) and can be trailer or lorry mounted.

Pumping ranges ma be up to 850.00 in vertically and 200 in horizontally depending on the pump model.

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It generally requires about 45 minutes setting up a concrete pump on site including coaling the bore of the pipeline with a cement grout before pumping. After plumbing, the pipeline should be cleared and cleaned. Usually concrete pump and operator are hired for the period required.

Concrete Mixers

Details of Concrete mixers

Types of mixers are generally related to their designed output performance. Machines are decided based upon what mixing and placing methods are to be employed to mix and place a certain amount of concrete in a given time period. Generally, a batch mixing time of 5 minutes per cycle of 12 batches per hour can be assumed as a reasonable basis for assessing mixer output. Small Batch Mixers have outputs up to 200 liters per batch with wheel barrow transportation on hourly placing rate of 2 to 3 m3 can be achieved. Most small batch mixers are of the tilting drum type. General. These mixers are hand loaded which makes the quality control of successive mixes difficult to regulate.

Medium Batch Mixers have output ranging from 200 to 750 liters. Low output machines are

available as tilting drum mixers and high output ones are available as non-tilting drum mixers. Non-tilting mixers are either reversing drum or chute discharge, the latter usually having a lower discharge height. Such mixers usually have integral weigh batching facility loading hoppers. scraper shovels and water tanks thus giving better quality control than the small batch mixers. Generally they are unsuitable for wheel barrow transportation because of their high output.

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CONSTRUCTION EQUIPMENT

The selection of the appropriate type and size of construction equipment often affects the requirement amount of time and effort and thus the job-site productivity of a project. 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. L Excavation and Loading

One family of construction machines used for excavation is broadly classified as a crane-shove! as indicated by the variety of machines in Figure 4-3. The crane-shovel consists of three major components:

¾ A carrier or mounting which provides mobility and stability for the machine.
¾ A revolving deck or turntable which contains the power and control units.
¾ A front end attachment which serves the special functions in an operation.

The type of mounting for all machines in Figure 4-3 is referred to as crawler mounting which is particularly suitable for crawling over relatively rugged surface at a job site other types of mounting include truck mount1n and wheel mounting which provide 2reater mobility between job sites, but require better surfaces for their operation. The revolving deck includes a cab to house the person operating the mounting and “or the revolving deck The types of front end attachments in Figure 4-3 mi include a crane with hook, claim shell, dragline. Backhoe. Shovel and pile driver

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A tractor consists of a crawler mounting and a non-revolving cab. When an earth moving blade is attached to the front end of a tractor, the assembly is called a bulldozer. When a bucket is attached to its front end, the assembly is known as a loader or bucket loader. There are different types of loaders designed to handle most efficiently materials of different weights and moisture contents.

Scrapers are multiple-units of tractor-truck and blade-bucket assemblies with various combinations to facilitate the loading and hauling of earthwork. Major types of scrapers include single engine two-axle or three axle scrapers, twin-engine all-wheel-drive scrapers, elevating scrapers. and push-pull scrapers. Each type has different characteristics of rolling resistance, maneuverability stability, and speed in operation.

Compaction and Grading

The function of compaction equipment is to produce higher density in soil mechanically. The basic forces used in compaction are static weight.. kneading, impact and vibration. 21

The de of compaction that may be achieved depends on the properties of soil, itsmoisture content, the thickness of the soil layer for compaction and the method of compaction. Some major types of compaction equipment are shown in Figure 4-4, which nr1iideq rn1ler with different operating characteriics.

Concrete Vibrators

Details of Concrete Vibrators

Poker or Internal Vibrators

These consist of a hollow steel tube casting in which is a rotating impeller which generators vibrations as its head comes into contact with casing. Poker vibrators should be inserted vertically and allowed to penetrate 75mm into any previously vibrated concrete.

External Clamp or Tamping Board Vibrators

These vibrators operate by shaking the formwork. Clamp vibrators powered by either compressed air or electricity whereas tamping board vibrators are usually petrol driven. Formwork must be stronger than is traditional to withstand vibration.

The function of grading equipment is to bring the earthwork to the desired shape and evasion. Major types of grading equipment include motor graders and grade trimmers.

Drilling and blasting

Rock excavation is an audacious task requiring special equipment and methods. The de of difficulty depends on physical characteristics of the rock type to be excavated such as grain size planes of weakness. Weathering. Brittleness and hardness.

The task of rock excavation includes loosening, loading, hauling and compacting. The loosening operation is specialized for rock excavation and is performed by drilling, blasting or ripping. Major types of drilling equipment are percussion drills, rotary drills- and rotary- percussion drills. A percussion drill penetrates and cuts rock by impact while it rotates without cutting on the upstroke. Common types of percussion drills include a jackhammer which is hand-held and others which are mounted on a fixed frame or on a wagon or crawl for mobility. A rotary drill

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cuts by turning a bit against the rock surface. A rotary- percussion drill combines the two cutting movements to provide a faster penetration in rock.

Blasting requires the use of explosives, the most common of which is dynamite. Generally, electric blasting caps are connected in a circuit with insulated wires. Power sources may be power lines or blasting machines designed for firing electric cap circuits. Also available are nonelectrical

blasting systems which combine the precise timing and flexibility of electric blasting and the safely of non-electrical detonation.

Tractor-mounted rippers are capable of penetrating and prying loose most rock types. The blade or ripper is connected to an adjustable shank which controls the angle at the tip of the blade as it is raised or lowered. Automated ripper control may be installed to control ripping depth and tip angle.

In rock tunneling, special tunnel machines equipped with multiple cutter heads and capable of excavating full diameter of the tunnel are now available. Their use has increasing replaced the traditional methods of drilling and blasting.