INTRODUCTION

In order to have proper quality construction projects the use of mechanical equipment has become an important and essential feature. Use of construction equipment became unavoidable for execution of large and complex and projects with stringent schedules and critical performance standards.

Though construction equipment is used in several types of construction works including earth moving operations aggregate production, concrete production and its placement and so on. It has been estimated that about 20-30 % of the total project cost has been accounted towards equipment and machinery.

COMMON CONSTRUCTION EQUIPMENT

i. Equipment for excavation.
ii. Equipments for hauling.
iii. Equipment for compaction of earth.
iv. Drilling and Blasting equipment.
v. Rock crushing equipment.
vi. Concrete producing equipment.
vii. Pile driving equipment.
viii. Hoisting equipment.
ix. Dewatering and pumping equipment.

EQUIPMENT FOR EXCAVATION

Commonly used equipments for the exaction of earth may be listed below:

i. Tractor-Used to pull or push other equipments
ii. Scrapers
iii. Bulldozers
iv. Power shovels
v. Clamshells
vi. Draglines
vii. Ditchers
viii. Hoes Trenching machines

Tractors

These are multi-purpose machines used mainly for pulling and pushing the other equipments or heavy loads. They are also used for agricultural purposes.

Tractors may be classified as:

(I)CRAWLER TYPE TRACTORS: it is a versatile equipment used to move bull dozers, scrapers and wagons on rough roads. The crawler has a chain by which these tractors can be very effective even in the case of loose or muddy soils.

Maximum speed is generally 11.2 kmph average is about 4.8 to 5.6 kmph. Therefore best suited for short hauls say 60 to 150m, though are used for long distances too. Special advantage of crawler type tractors is their ability to travel over very rough surfaces and to climb steep grades up to 25 to 29% at speed of 3 kmph .

(ii) WHEEL TYPE TRACTORS: The travel with higher speeds than crawler type tractors. These of tractors are generally employed for light but speedy jobs. Maximum speed is generally more than 50 kmph. So advantageous jobs requiring travel over considerable distances.

Wheel type tractors are of two types:

a) Two-wheel type tractors
b) Four-wheel type tractors

(a) Advantages of Two-wheel type Tractors:

(I) Fewer tyres to provide and maintain.
(II) Increased maneuverability
(III) Decreased rolling resistance, because of the elimination of extra axle.

(b) Advantages of Four-wheel type Tractor

(I) Greater confidence of operator, due to better steering properties.

(II) Less tendency to bump over though haul roads.

(III) Greater speed due to better steering properties and less tendency to bump over rough haul roads.

Crawler tractors	Wheeled Tractors
1. Crawler tractors need expensive track. They are more so costly.	1. Wheeled tractors are less costly.
2. Crawler tractors are more compact and powerful. They can handle heavier jobs of hauling and digging.	2. They can handle light duty job of hauling and digging.
3. Crawler tractors require more skill in operation. They also need more maintenance and repair.	3 Wheeled tractors need less maintenance and repair. They need less skill to drive than crawler tractors.
4. Usually transportation of crawler tractor over long distances is done on trailers due to their low speed of travelling and to avoid excessive load over the tracks.	4. Wheeled tractors can be self driven over long distances
5.They crawlers tractors if moved on pavements and tarred roads will damage them	5. Wheeled tractors can move on tarred toads with speed without any damage to the road.

Gradability of Tractors

It is the minimum slope, expressed as percentage, upto which a crawler or wheel type tractors may move at a uniform speed.

Separate gradability is determined for an empty and a loaded vehicle. Gradability, for different gears is different.

The forward motion of a prime-mover is limited by the following factors:

(I) Power developed by the engine and available as drawbar pull or rimpull.

(II) The rolling resistance of the haul roads

(III) The gross weight of the prime-mover and its load.

(IV) The grade to be negotiated.

From the available drawbar pull, the pull required overcoming the rolling resistance in the unit and the load on the unit that is to be pulled is deducted. The balance pull is available to negotiate a gradient. In order to have a reasonable safety factor, only 85 percent of the rated draw bar pull is used for determining the gradability of the equipment.

Gradability can be determined by the following formula.

$$\mathbf{K} = \frac{\mathbf{972} * \boldsymbol{T} * \boldsymbol{G}}{\boldsymbol{R} * \boldsymbol{W}} - \frac{\mathbf{N}}{\mathbf{20}}$$

K= gradability, %

T=Rated engine torque lbs. ft

G= Total gear reduction for a particular gear selected

R= rolling radius, radius of the load driving wheel measured from centre of axle to the ground

Surface in inches

W=Gross weight of complete unit in lbs.

N= Rolling resistance in lbs per ton.

Scraper:

The scrapers are the devices that can load itself, carry the material and discharge at the other end. Scrapers are another example of combination of an excavator and a mover. They are not suited for

(I) Wet or muddy material which make discharging of scraper difficult.

(II) Hard rocks.

The self loading scrapers are available upto 40 cu.m. Suitable hauling distance is 150 to 300m in some cases upto 1500m. Scrapers are pulled by a tractor. They are self operating to the extent that they can load, haul and discharge material.

Depending upon the type of the tractor used, scraper can be classified as:

(a) **Crawler-Tractor Scraper**: The equipment consists of crawler tractor pulling a pneumatic self loading scraper. Even on rough and poor roads because of the high drawbar pull of the tractor and superior traction, it gives good performance.

For short hauls crawler type tractor, pulling a rubber tired self loading scraper can move earth economically. As distance of haul increase the low speed of crawler tractor makes it uneconomical in use.

(b) **Wheel Tractor scraper**: When the haul distance is long, this type of tractor is better suited for the job. It is more economical than crawler type.

(c) **Motor Scraper**: Motor scraper are those having their own engine and motoring arrangement.

Operation of scrapers

A scraper is loaded by lowering the front end of the bowl till the cutting edge, enters the ground and at the same time, raising the front apron to provide an open slot, through which the earth flows into the bowl. As the scraper is pulled forward, a strip of earth is forced into the bowl. The cutting edge is raised and the apron is lowered to prevent spillage during hauling.

The dumping operation consists of lowering the cutting edge to the desired height, above the fill, raising the apron, and forcing the earth out. Scrapers are available with either cable or hydraulic control for operations.

Factors Affecting Output of Scrapers

Following factors have been found to affect the output of scrapers:

(I) Size of tractor.
(II) Size and condition of borrow pit or cut-for-easy maneuvering.
(III) Type of material.
(IV) Slope of loading zone.
(V) Extent of loosening of material before loading for hard soil.
(VI) Haul distance.
(VII) Condition and slope of haul road.
(VIII) Altitude of site.
(IX) Management conditions.
(X) Climate conditions.

Output of a Tractor Pulled scraper

Output = Average net volume per load × No. of load per hour.

The number of loads depends on the time required to make a trip. It includes the following times:

(I) Travelling time between put and the fill.
(II) Loading time.
(III) Dumping and turning time.
(IV) Returning to the pit.
(V) Getting in position to load.

Bulldozer

Bull dozer are very popular earth moving equipment which can be used for the following jobs:

i) Site clearance
ii) Cutting in mountainous and rocky terrain
iii) Moving earth for haulages upto 100 metres
iv) Loading tractor pulled scrapers
v) Spreading earth fill
vi) Back filling trenches
vii) Earth road maintenance

There are two types of bulldozers

a) Bulldozer (these are mounted with the blades perpendicular to the direction of travel. It pushes the earth forward)
b) Angle dozer (these are mounted with the blades set at an angle with the direction of travel. It pushes earth forward and to one side)

Based on method of raising and lowering the blades bulldozers may be classified as:

a) Cable controlled
b) Hydraulic controlled

The cable controlled operation has the following advantages:

a) Simple to operate
b) Easier repair
c) Less danger of damage to the machine

The hydraulic controlled operation has the following advantages

A) Ability to provide high down pressure on the blades
B) More precise setting can be maintained

Size of bulldozer is indicated by the length and height of blade. Capacity of bulldozer varies with

i) Size of blade
ii) Type of earth
iii) Nature of slope-up, level, downgrade

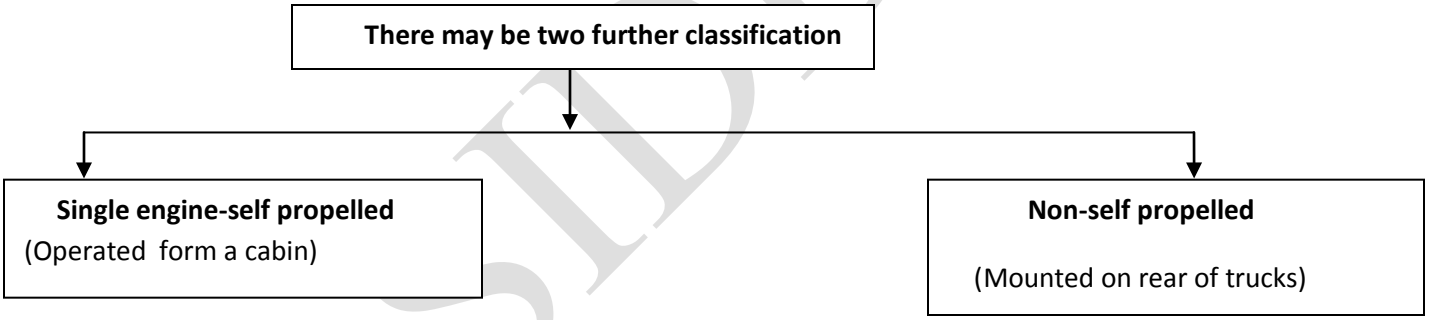
Economics of the use for a bulldozer should be worked out for a particular project in terms of lost for cubic metre and then economic type and size should be selected.

Comparative Advantages of crawler Tractor Mounted and Wheel Tractor Mounted.

Crawler tractor mounted	Wheel Tractor Mounted
(I) Higher tractive effort. (II) Can operate in rough and muddy surface (III) Can work in rock area. (IV) Can travel over rough surface (V) Can push large blade loads.	(I) High travel speed. (II) No hauling equipments is required for transporting the dozer from one job to the other. (III) Greater output. (IV) Less operator fatigue. (V) Ability to travel over paved highway without damaging the surface.

Power Shovels

Power shovels are used primarily to excavate earth and load it into trucks or tractor pulled wagons. They are capable of excavating all classes of earth except solid-rock. They may be mounted on Crawler Truck or Rubber-Tired wheels. Which are also called truck mounted power shovel.



Size of power of shovel is indicated by size dipper, expressed in cubic meters.

The size of a power shovel depends on the type of work. The size of bucklet or dipper denoted the size of power shovels. The size of power shovel varies from $\mathbf{0.375}\ \boldsymbol{m^3}$ to $\mathbf{5}\ \boldsymbol{m^3}$.
The basic parts of a power shovel include the track system, cabin, cables, rack, stick, boom foot pin, saddle block, boom, boom point sheaves and bucket.

Operation of a Power Shovel

The power shovel is moved into the required position such that the excavation face is within the reach .Them the bucket stick is lowered and cables are moved such that a bite is made into the ground. By moving the bucket forward, the earth gets excavated and gets filled in the bucket. Then the bucket is swung back to the required position and by opening the flap, the excavated earth is unloaded into the waiting truck. In this way the process is reaped.

Choice of Size and Type of Shovels

(a) Concentration of Work:

i) For numerous small jobs at different location a rubber-tyre mounted shovel will be better due to its mobility.

ii) For concentration of jo0b at a place, mobility is not so important tand so crawler type with its many advantages may be desirable.

(b) The Cost per Cubic Work

For selecting the size, cost should be worked out, taking the following factors into account:

i) Size of Job: Bigger jobs justify large shovels.

ii) Cost of transporting: Cost of transporting will be large for large shovel.

iii) Depreciating rate: Depreciation rate for a large shovel will be higher than the smaller one and more difficulties in selling.

iv) Cost of repairs may be more for large shovel due to delay in getting parts.

v) In rock works, excavating may be economical with large shovel which can handle large piece of rock.

vi) Cost of wages per cubic meter will be less for a large shovel than small one.

(c) Job Conditions

Following job conditions should be considered:

(I) In blasted rocks, large shovel will handle big rocks.

(II) For hard and tough material, dipper of large shovel will exert more pressure and handle the material easily.

(III) If time of excavation is less, large shovel may be preferred.

(IV) Size should be proper compared to size of hauling units.

Factor Affecting the Output of a shovel

Following factors affect the output of a shovel.

(I) Type of material.

(II) Effect of depth on output of shovel.

(III) Angle of swing effect on the production of the shovel.

(IV) Job condition-climatic, ground water, etc.

(V) Effect of management conditions on the output of shovel for greasing, lubricating, repairs, bonus, supervisors.

(VI) Size of hauling units

(VII) Skill of operator

(VIII) Physical condition of a shovel.

Application of Power Shovel

The power shovel finds a wide range of applications.

(I) It is the most suitable equipment for close range of work
(II) It is capable of digging very hard materials.
(III) It is used in various types of jobs such as digging in gravel, banks clay pits, digging cuts in road works, road side berms etc.

Clamshells

This machine is so named due to the resemblance of its bucket to a clam which is like a shell-fish a 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 the clamshell bucket is usually given in cubic metres. There are 3 methods to express capacity.

(I) Water level capacity is the capacity of the bucket if it was hugn level and filled with water.
(II) Plate line capacity: Plate line capacity indicates the capacity of bucket following a line along the top of the clams.
(III) Heaped capacity: Heaped capacity is the capacity of bucket when it is filled to the maximum angle of response for the given material.

For specifying heaped capacity angle of response is assumed as 45^0 .

Operation of clamshell

The clamshell bucket is brought over the location where the material is to be dug. The bucket is lowered with the shells open till a good contact is made with the ground. Now the bucket shells are closed-in through the closing line. As the two shells close-in, the weight of the bucket enables it to dig into the material, thereby filling it. It is then hoisted and swung to the position of dumping and the contents are dumped. The boom is then swung back to the digging position and the same cycle of operations are repeated. The operations are performed by manipulating the cables suitably.

Applications

(I) Clamshells, are commonly used for handling loose material such as crushed stone, sand, gravel, coal, etc.

(II) The main feature of Clamsheel is the vertical lifting of material from one location to another.

(III) Clamshells are mainly used for removing material from cofferdams, sewer manholes, well foundation etc.

Draglines

Draglines are used to excavate earth and load it into hauling units such as trucks, tractor pulled wagons, etc. or deposit on banks, dams etc.

Power shovel up to a capacity of1.9 cu.m can be converted into dragline, by replacing the boom of the shovel with a crane boom and substituting the dragline bucket for the shovel dipper. Although shovel and dragline can be used on some project for the same job, in many projects draglines would have advantages over shovels.

Advantages of Draglines

(I) Useful when earth is to be removed from a ditch or canal or pit containing water, as trucks won't have to go into mud.

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

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

Disadvantage of Dragline

Disadvantage of a dragline is lesser output as compared to a shovel of same capacity.

Operation of a Dragline

The bucket is lowered in fully dumped position, releasing both the hoist and drag cable, till it rests on the ground with the teeth digging into the earth. The hoist cable is slackened slightly and then the drag pull is applied. This action fill in the earth and the bucket takes a horizontal position. It is then hoisted. When the required dumping height is attained, the boom is swung to the position of dumping and the drag brake is released. This will dump the load off the bucket. The boom is then swung back to the digging position and the same cycle of operation are repeated.

Factors affecting the Output of a Dragline

(I) Balance of bucket.

(II) Width of bucket.

(III) Height of bucket.

(IV) Number and angle of teeth.

(V) Location of teeth.
(VI) Relationship between length of boom and overall capacity of bucket.
(VII) Type of material.
(VIII) Depth of cut.
(IX) Angle of swing.
(X) Size and type of bucket.
(XI) Length of boom
(XII) Job condition.
(XIII) Management condition.
(XIV) Method of disposal.
(XV) Size of hauling unit.
(XVI) Skill of operator.
(XVII) Physical condition of machine and maintenance of the mechine.

Applications

(I) It is the most suitable machine for digging softer material and below its track level.
(II) It is very useful for excavation trenches when the sides are permitted to establish their angle of response without shoring.
(III) It has long reaches.
(IV) It is mostly used in the excavation for canals and depositing on the embankment without hauling units.

Ditcher

Ditcher is a unit similar to clamshells used in taking out material from the ditches

Scoop

Scoop is essentially a cleanup tool for scraping material like stones, roots etc. Works of ditcher and scoop are largely special and they are rarely used as production units one the excavating job.

12.3.9 Hoes

Hoes is also termed as Back hoe, back shovel and pull shovel. It is an excavating machine of the power shovel group. It is generally used to excavate below the natural surface on which it rests. Hoes are used to excavate trenches, puts for basements and generally grading work, which requires precise control of depths. It also removes the earth as it coves into the ground to establish natural slopes.

A power shovel is converted to hoe, by installing a ‘dipper stick’ and a Dipper at the end of the shovel boom.

Operation of a Hoe

The operation is almost similar to that of a power shovel except that in the hoe, the digging action results from the drag or pull of the bucket towards the machine, unlike the shovel that makes outward strokes while digging.

The machine is placed in operation by setting the boom at the desired angle. Then the hoist cable is pulled in and the drag cable is released, thus moving the dipper to the required position. The free end of the boom is lowered by releasing the tension in the hoist cable until the dipper teeth bites then swinging into the earth. By pulling the cables the dipper is filled. The dipper is lifted by raising the boom and then swinging to the dumping position.

Applications

Hoes are used to:

(I) Excavate below the natural surface of the ground on which machine rests.
(II) Excavating trenches, puts for basement etc.
(III) In general grading work.

Trenching Machines

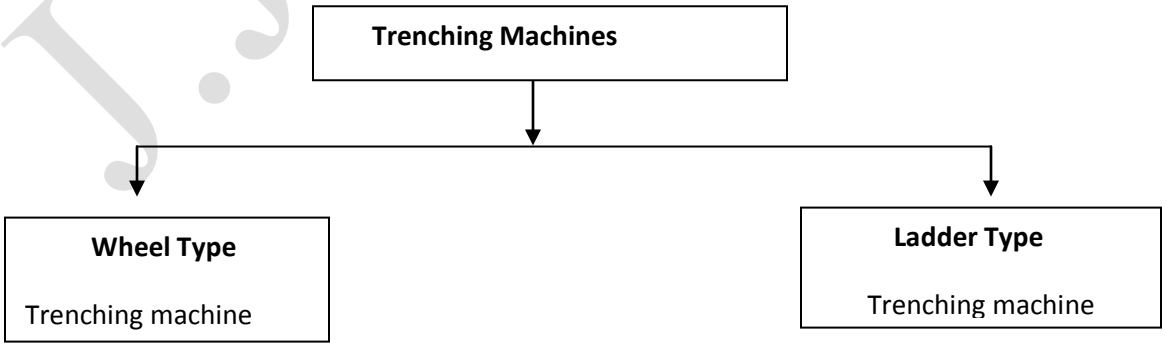
Trenching machines are used for excavating trenches for laying pipelines, sewers, telephone cables etc.

Their operation is quick giving the required depth or width.

(I) Fast digging.
(II) Positive control of depth and width of trenches.
(III) Reduce expensive 'Hand finishing' to minimum.

Types of Trenching Machines

There are two type of trenching machines as given below:



(I) **Wheel type trenching machine:** This can be used for providing depth upto 3 metres and width ranging from 0.3 to 0.6 m. This machine consists of a power driven wheel provided with a number of detachable buckets having cutting teeth. The earth picked up by the buckets is deposited on a belt conveyor which discharge the earth to the other side of the trench.

(II) **Ladder type:** this consists of a telescopic ladder or boom. The excavating parts of machine consists of Two Endless chains, which travel along the boom, to which are attached Cutter Buckets equipped with teeth. As the bucket travel up underside the boom they bring out earth and deposit it on belt conveyor, which discharges it on either side of the trench. It is not possible to vary length of Boom.
This machine can be used for excavations upto a depth of 10metres and a width of 3 metres. This machine is not suitable for muddy and rocky soil.

EQUIPMENT FOR HAULING

Hauling is defined as the movement of material from one place to another. The equipment used for transportation of material are known as hauling equipment.

Road haulers for haulage may be classified, according to the method of dumping the load, as follows:

1. Dump Trucks:
   (i) Rear dump trucks
   (ii) Bottom dump trucks
2. Dumpers
3. Belt-conveyor System
4. Rail-Road –Trains

1. Dump Trucks

These are used for earth moving purpose. Dumping of earth can be done on the rear, on the sides or at the bottom of the truck. The selection of the type of dump trucks for a specific job depends on the soil condition and the nature of the haul road.

(a) Rear du mp truck: The following are the special features of trucks.
   (i) Heavy duty truck having a strongly built body.
   (ii) Fitted with hydraulic ram on the underside for lifting the front of the body and tilt it backward while uploading or dumping.
   (iii) Body frame consists of channel section rigidly braced..

(iv) Hoisting valve is actuated by a lever near operator's seat.
(v) These tucks are suitable for use in hauling wet clay, sand, gravel, quarry rocks etc.
(vi)

(b) Bottom Dump Truck: The important features of these trucks are:
(i) Similar to semi-trailers in which their front is supported on the rear of the hauling tractor and their rear is resting on their own wheels.
(ii) The bottom is fitted with two longitudinal gates made of thick steel plate. These gates are reinforced with channel sections swinging on steel hinges.
(iii) The gates are hinged to the side of the body.
(iv) These trucks are suitable for use in hauling free flowing material such a sand, gravel dry, earth, hard clay etc.

2. Dumpers

Dumpers are high speed pneumatic wheeled trucks with short chassis and strong bodies. The materials, a can be dumped in front, or at the back. While dumping the body takes up upright vertical position. The dumpers are suitable for short hauls on rough roads and specially where a shuttle movement is required.

3. Belt-Conveyor Systems

Belt conveyor provide a most satisfactory and economical method for hauling and transporting materials, like earth, sand, gravel, crushed stone, cement, concrete etc. because of the continuous flow of materials at relatively high speeds.

4. Rail-Road Trains

Where railway lines sexist or on large works movement of excavated materials through rails may be economical. Size of cars depend upon local conditions, type of material. Cars are usually side dumping type.

EQUIPMENT FOR COMPACTION OF EARTH

Compaction equipment is used to increase the density of subbase, base, and pavement materials. By applying weight to a material, the size of the spaces between individual particles will be decreased. This will result in a higher density for the material, which will make it more stable under a load. There is a variety of compaction equipment available. The type of equipment that the Contractor uses will depend on the material being compacted. The Specifications require that the Contractor obtain approval of the equipment prior to beginning compaction.

(a) Steel-wheel Roller

Thee rollers are also referred to as smooth-wheel rollers. They are used for the compaction of sand, gravel, and mixtures of sand and gravel. The material being compacted will determine the kind of steel-wheel roller to be used. Steel-wheel rollers can be broken down into one of two types: static or vibratory. Static rollers consist of smooth drums that can be filled with water or sand to increase the weight of the roller, and thus the force of compaction. Vibratory rollers have motors attached to the compactive wheel that vibrate the wheel as it rolling. The frequency of vibrations can be set by the Contractor, and typically varies from 1,000 to 5,ooo vibrations per minute. Steel-wheel rollers come in several different wheel configurations. The self propelled roller has one steel wheel and two rubber tires, and is usually vibratory. The tandem roller has two steel wheels n a row. One of the wheels is the five wheel, and the other wheel may or may not be vibratory. Tandem rollers are commonly used to compact asphalt pavement, but may be used to compact soil and aggregate as well. Three-wheel tandem rollers are a variation on the tandem roller, with three wheels in a line instead of two. There are also towed steel-wheel rollers that can be attached to tractors. These are commonly used on smaller area. During compaction, material can accumulate on the surface of the steel wheel, possibly resulting in uneven compaction. To prevent this, rollers are equipped with scraper bars and sprinkler devices. It is important to verify that this equipment is in working order to prevent irregularities in the subbase and base course.

(b) <u>Sheep foot Rollers</u>

These rollers are also called padfoot rollers. They are used to compact fine-grained soils such as clays and silts, as well as mixtures of sand and fine-grained soils. The sheepsfoot rollers is a steel wheel that has a number of steel projections, or feet, welded to it. The roller compacts the soil by kneading it. The feet o0n the roller can sink through loose soil to a depth of approximately 10” (250 mm). These rollers work best, therefore, when the lift thickness is between 6:” and 10” (150 and 250mm). Lifts of this thickness allow the feet to sink through the loose material and knead it into the lift below. While the smooth surface of the wheel compacts the soil on the surface of the lift. As the lower portion of the lift becomes compacted, the feet ride up into the upper portions of the lift and compact it. Because of the manner of compaction, it is best not to compact a lift all the way to the top surface. By leaving the surface , material loose, a better bond will be achieved between that lift and the next lift that is placed. Like steel wheel rollers, sheepsfoot rollers can be static or vibratory, and come in several different models. The most common models are self-propelled, tandem, four wheel, nad towed. In addition, some sheepsfoot rollers come with small bulldozer-type blades, Which allows the roller to perform rough grading or backfilling as it compacts the soil.

(c) <u>Pneumatic-tire Rollers</u>

Pneumatic-tire, or rubber-tire, rollers can be used to compact almost any kind of soil. These rollers are also used to compact bituminous pavement. However, pneumatic-tire rollers are not useful for compacting aggregate Pneumatic-tire rollers have a number of tires arranged in two rows. The tires arranged in two rows. The tires can be small or large, although a roller will have only one size of tire . There are and odd number of tires, and the back row is offset from the front row so that the combined effort of the two rows will compact the soil for the entire width of the roller. Pneumatic-tire rollers are static only. They work by a combination of kneading and static pressure. Because of the number of tires on a pneumatic-tire roller, large amount of additional weight can be added to the equipment. This increases the total static compactive force. However, too much weight can break down the soil particles into sizes smaller than- the Specifications require. Therefore, the weight of the pneumatic tire rollers should be monitored to ensure that the resultant base course is in conformance with the Specifications.

Pneumatic-tire rollers are useful because the air pressure in the tires can be adjusted. On many machines, the pressure can be adjusted individually for each tire while the roller is moving. This allows the Contractor to vary the compactive effort. A lower tire pressure results in a smaller compactive force, but allows more of the tire to be in contact with the ground. A higher tire pressure will exert a higher fore on the ground over a smaller area. Therefore, it is common for the first passes of the roller to be made with a low tire pressure, ensuring that the entire lift is compacted, then ,% high tire pressure can be used for the final passes to achieve the required density. Because of this variability in compactive effort; fife required compaction can usually be achieved in fewer passes then with a different type of roller.

(d) <u>Manually Operated Compactors</u>

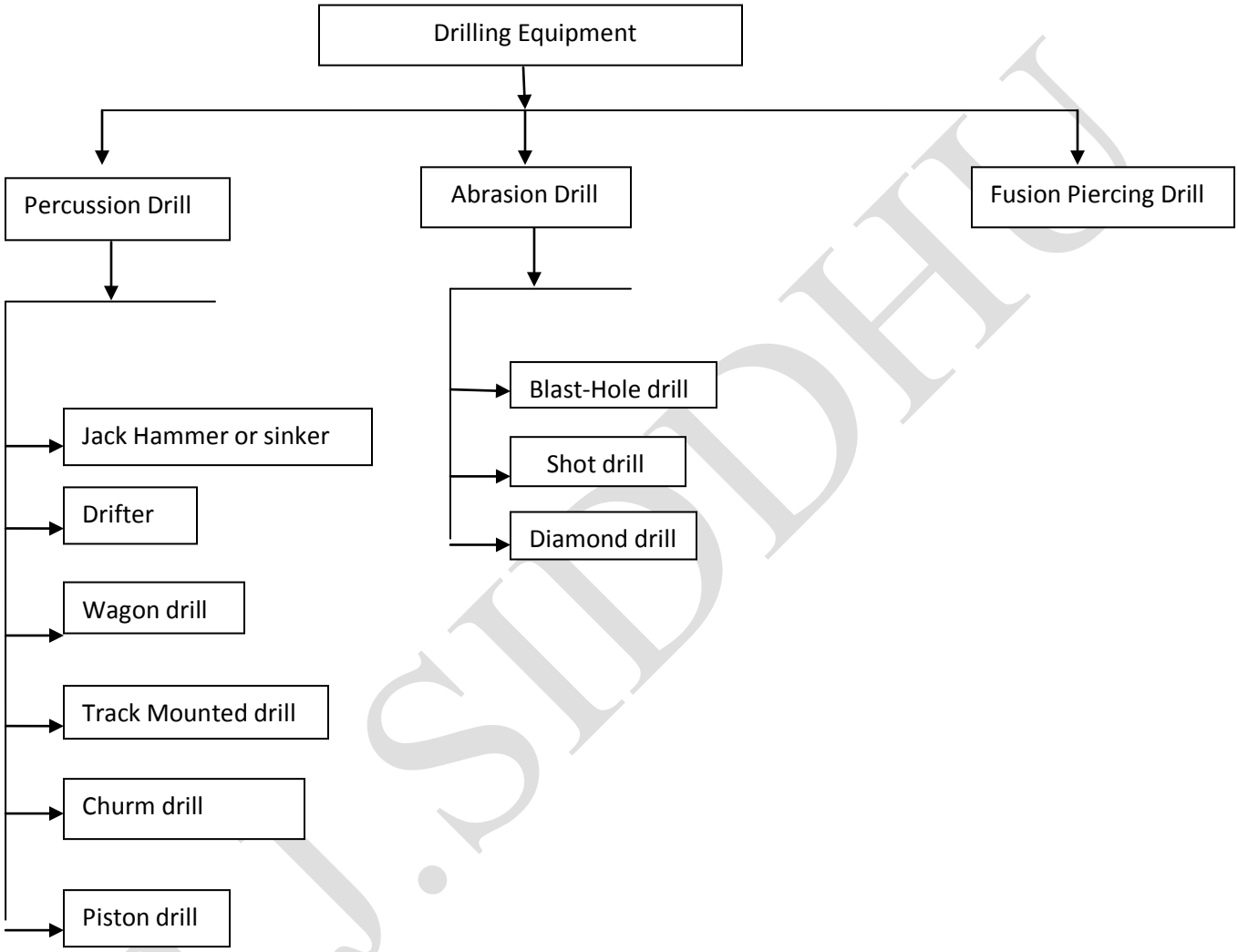
Manually operated compactors have a number of different applications. They are used in areas where it is not possible to use a full size compactor. This includes such applications as compacting the fill over a trench, compacting soil around a footing, or working in areas where large equipment might cause damage to adjacent structures or property. Manually operated compactors come in a number of different styles depending on the application. There are small steel-wheel rollers, vibratory plate compactors, and rammers. While these smaller compactors allow the Contractor to work in small areas, they require more time and effort to compact the material to the required density. The use of full-size equipment is generally preferred where possible.

DRILLING AND BLASTING EQUIPMENT

Drilling is making holes of appropriate dimensions in appropriate pattern, so that these holes may be filled up with the explosives and discharge the explosives. The process causes loosening the rock mass by fragmentation so that the fragmented rock may be easily excavated from the position.

Drilling Equipment

Various types of drilling equipment are available to drill the holes. The type selected for the propose will depend on the size of the project, the nature of the terrain, the kind of rock, the depth and size of the holes, the type of rock to be produced viz.. as aggregate or dimension blocks etc.



(A) **Percussion Drill**: The drill the breaks the rock into small pieces by the impact from repeated blows is known as percussion drill. Hydraulic fluids or compressed air can power this drill.

1. Jack hammer or sinker: Jack hammer is an air operated percussion type drill which is portable and hand-operated. It is mostly used for drilling vertical holes. The

machines vary in size from to 40 kg in weight and are best adopted to shallow works up to 5.8 metres in depth.

2. Drifter: Drifters are heavy rock drills of jack hammer type and weight 45 to 70 kg. They are mainly used for drilling horizontal holes in the tunnel, and mining work. These are sometimes mounted on wheel for easy mobility. They can drill holes of depth from 9 to 12 m.
3. Wagon drill: a wagon drill is a drifter mounted on a mast supported by two or more wheels to provide mobility to the equipment. The name 'wagon drill' is primarily due to these wheels which convert the drifter into wagon drill. They are extensively used to drill holes up to 12 cm diameter and up to 10- m or more in depth. They give better performance than jackhammer when used on simple terrain.
4. Track Mounted drill: track mounted drill is an improvement over the wagon drill which it is replacing fast. Because of the tack mounting the equipment can be shifted from one working location to the other comparatively easily. Another advantage due to track mounting is that it can operate almost at any angle along the sides, vertically up tor vertically down. All the operations are powered by compressed air. Holes upto 5 cm in diameter and 15 meters deep can be drilled by the machine.
5. Churn drill: It is a percussion type drill consisting of along steel bit that is mechanically lifted and dropped to disintegrate the rock. This drill is used to drill deep holes, usually 15 cms in diameter or more.
6. Piston Drill: In the piston drill, the drill rod is securely fastened to the piston and travels the full length of the piston stroke. A recent development of a piston drill has taken the trade name 'quarry master'. The drill rod is 6 cm in outside diameter with extension rods 10 m long. The drill strikes approximately 200 blows per minute. The stroke and rotation of the piston are adjustable to give best performance foe the particular type of rock.

(B) **ABRASION DRILL**: The drill that grinds rock into small pieces by the abrasive e effect of the bit that rotates in the hole is called abrasion drill.

(1) Blast-Hole Drill: it is a rotary drill consisting of a steel pipe drill stem at the bottom of which is a roller-bit that disintegrates the rock as it rotates over it. A continuous blast of compressed air is forced down the pipe to remove the rock-cutting s. This drill is suitable for drilling soft to medium rock, such as hard dolomite and limestone, but is suitable for drilling the harder igneous rock.

(2) **Shot Drill**: This is a rotary abrasive type drill whose bit consists of a steel pipe with a roughened surface at t e bottom. As the bit rotate sunder pressure chilled steel shot are supplied under the bit to accomplish the disintegration of the rock. The essential parts include a shot bit, core barrel, sludge barrel, drill rod, water pump and power driven rotation unit. They are capable of drilling holes up to depth 200 metres or more

with diameters upto 75 cms. The rate of drilling with a short drill is relatively slow, sometimes less than half meter per hour, depending upon the size of the drill and hardness of the rock.

(3) **Diamond Drill**: It is a rotary abrasive type drill, whose bit consists of a metal matrix in which large number of diamonds are embedded. As the drill rotates, the diamonds disintegrate the rock. This drill extensively is used for taking core samples.

C) **Fusion piercing Drill**: A recent development is drilling holes for blasting purposes is the fusion piercing. Fusion piercing is produced by burning a mixture of oxygen and a flux-bearing fuel such as kerosene at the end of a blow-pipe. When the flame is directed against the rock the high temperature of about 4000 degrees causes rock to spall or blake off. The flux in the fuel caused other types of rock to melt. Water is used to quench the heated rock, resulting in small fragments, which are blown out of the hole.

In drilling 24 cm dia, holes with fusion piercing method in coarse granite rock, the frilling rate was about 1000 cub.m. of oxygen, 420 gallons of water and 12 gallons of kerosene.

Blasting Equipment

Blasting, shattering, breaking or splitting of rock or other material by the discharge of an explosive placed within or in contact with it. It is a necessary part of many engineering operations. An ancient method of breaking rock consisted of heating the rock by fire and then pouring water on it, the sudden contraction resulting in shattering or cleavage. Modern methods of blasting involve four operations: Drilling the holes to receive the charge, placing it, stemming the hole, (i.e. filling the hole above the charge with earth or clay), and igniting or detonating the charge. The location, size, and number of holes drilled depend upon local conditions and the nature of the work. The holes vary from 1 to 3 in. (3-8) in diameter and from a few inches upto 20ft.(6) or more in depth. The charge is made up of some explosive, such as dynamite or ammonium nitrate, black powder, the oldest known explosive, is rarely used today.

Primer: Primer is the portion of a charge, loading with a firing device, which initiates the explosion.

Stemming: After the hole is filled with the desired explosive to the required depth, the remaining portion of the hole is filled with rock cuttings or other inert material to confine the energy released due to explosive and thereby to increase the effectiveness of the blast. The process of packing the inert material is known as stemming.

Primacord: it is initiated with a blasting cap or by a donor line of detonationg cord or other high explosive, it detonates along its entire length at a velocity of approximately 23,000 feet per second. It is used to create explosive effects and to build reliable explosive charges. It is used in

conjunction with other high explosive materials to form charges, including linear charges, capable of near instantaneous results.

Explosives

It is a solid or liquid substance or a mixture of substances which on application of a suitable stimulus is converted in a very short time interval into toher more stable substances, largely or entirely gaseous, with the development of heat and high pressure

CLASSIFICATION OF EXPLOSIVES

The explosives can be classified into the following types:

1) Low explosives
2) High explosives

Low explosives were the earliest to be developed. These lead to an explosion which is really a rapid fform of combustion in which the particles burn at their surfaces and expose more and more of the bulk until all has been consumed. Such an explosion is called deflagration and the reaction in this case moves slower than the speed of sound. Typical examples of this category are the blasting powder or gun powder, propellants in ammunition, rocket propellants and pyrotechnics.

High explosives, depending on their composition, explode at velocities of 1500-8000m/s and produce large volumes of gases at considerable heat at extremely high pressure. High explosives themselves may be further divided into primary and secondary explosives. Primary explosives are characterized by their sensitiveness to stimuli like weak mechanical shock, spark or flame, the application of which will take explosive compounds from state of deflagration to detonation easily, examples of these explosives are mercury fulminate, lead azide, lead styphnate, tetrazene and other mixtures. Secondary explosives are used as initiating charges in the initiating devices such as detonators, secondary explosives are capable of detonation only under the influence of a shock wave, normally generated by the detonation of primary explosives. Secondary explosives of this type are military explosives like TNT, RDX, PETN, Tetryl and other combinations of these and industrial explosives like nitro-glycerine, emulsion, slurries, watergels, ANFO and other poder explosives. These explosives are normally set off with suitable initiating devices like detonators or detonationg cords and in some cases there is need of initiation by another high explosive. The explosive needing another high explosive is called blasting agent such as ANFO, some slurries, some emulsions mixtures of emulsions and ANFO.

CONCERTE PROUCRING EQUIPMENT

Concrete constructions are the most popular forms of constructions taking place all over the world. The main reasons for this are the efficiency and tough qualities of construction material used in these constructions. Concrete is the construction material used in concrete constructions. It is highly durable and sustainable material goes into construction of various kinds of residential and commercial constructions in the world. It has capability to resist weathering, erosion and natural disasters. It needs fewer repairs and little maintenance and thereby helps in cutting up the construction costs and adding up to a solid investment in construction.

Concrete is not found naturally, it is produced by the mixing of appropriate proportions of sand, gravel, water and cement that are determined by the usage by and the conditions of the area where the concrete is being used for construction. Any ordinary mixing techniques cannot be used for .concrete production and thus a specific piece of equipment is required. The equipment used in production or mixing of concrete is known as concrete plant or batching plant. For smaller productions, compact transit mixers will serve the purpose but for the bigger projects where concrete requirement is higher a large concrete batching plant is required.

Advantages of Concrete

Some advantages of concrete as follows:

(i) Ability to be cast.
(ii) Economical
(iii) Durable
(iv) Fire resistant
(v) Energy efficient
(vi) On-site fabrication.

Constituents of Concrete

Constituents of concrete are --- cement, water, fine aggregates, coarse aggregates, coarse aggregates.

Operations Involved in Concrete Construction.

I. Batching
II. Mixing
III. Handling and Transporting
IV. Placing
V. Finishing
VI. Curing

1. Batching: Batching is the process of weighing or volumetrically measuring and introducing into a mixer the ingredients for a batch of concrete. To produce a uniform quality concrete mix, measure the ingredients accurately for each batch. Most concrete specifications require that the batching be performed by weight, rather than by volume, because of inaccuracies in measuring aggregate, especially damp aggregate. Water and liquid air-entratini9ng admixtures can be measured accurately be either weight or volumetric Batching by using weight provides greater accuracy and problems created by bulking of damp sand. Volumetric batching is used for concrete mixed in a continuous mixer, and the mobile concrete mixer (crete mobile) where weighing facilities are not at hand. Specifications generally require that materials be measured in individual batches within the following percentages of accuracy: cement 1%, aggregate 2% , water 1% and air-entraining admixtures 3%.

II Mixing: the mixing operation consists of rotation or stirring, the objective being to coat the surface the all aggregate particles with cement paste and to blind all the ingredients of the concrete into a uniform mass; this uniformity must not be disturbed by the process of discharging from the mixer.

Batch mixing: The usual type of mixer is a batch mixer, which means that one batch of concrete is mixed and discharged before any more materials pare put into the mixer. There are four types of batch mixer.

(a) Tilting drum mixer
(b) Non tilting drum mixer
(c) Pan type mixer
(d) Dual drum mixer
(e) Continuous mixer
(f) Charging the mixer

III Handling and Transporting: Modern demands on the transporting and handling of concrete have imposed a wide variety of requirements on the operations needed, and the methods and designed to satisfy these and other requirements. Concrete handling operations now employ such diverse equipment as trucks, hoopers, and chutes, wheelbarrows and carts operated over runways, buckets lifted by crane, tower hoist or cable way, belt conveyors, pumps and in special cases rail cars, helicopters and boats or barges.

Transporting the concrete mix is defined as the transferring of concrete from the mixing plant to the construction site. Keep in mind that not all concrete is mixed on the actual construction site and could require some significant travel. This is most common for ready mixed concretes.

The main objective in transporting concrete is to ensure that the water cement ratio, slump or consistency, air content and homogeneity are not modified from their intended states.

There are many modes of transportation as below:

1. Wheelbarrow or motorized buggy.
2. Truck mixer
3. Bucket or steel skip
4. Chute
5. Belt conveyor
6. Concrete pump
7. Pneumatic placer

IV Placing: the full value of well designed concrete cannot be obtained without proper placing and between mortar and coarse aggregate and assure complete filling of the forms. These requirements are necessary if the full strength and best appearance of the finished concrete is to be realized.

V. Finishing: The finishing process provides the desired surface effect of the concrete. The concrete finishing process may be performed in many ways, depending on the effect required. Occasionaly only correction of surface defects, filling of bolt holes or cleaning is necessary. Unformed surfaces may require only screeding to proper contour and elevation, or a broomed, floated or troweled finish may be specified.

VI curing:

(a) The curing of concrete has a major influence on the strength, wear resistance, final quality and durability of the wearing surface.

(b) Types of curing

- Ponding or continuous sprinkling
- Wet coverings
- Impermeable coverings
- Curing compounds (liquid membrane-forming materials) when the cure -- The curing must take place immediately after placing and finishing. The length of the curing period is normally a minimum of 3 days.

HOISTING EQUIPMENT

Hoisting equipment means commercially manufactured lifting equipment designed to lift and position a load of known weight to a location at some known elevation and horizontal distance from the equipment's center of rotation. "Hoisting equipment" includes but is not limited to

cranes, derricks, tower cranes, barge-mounted derricks or cranes, gin holes and gantry hoist systems.

Nowadays, many big projects such as construction of dams, industrial buildings etc. require hoisting equipment. As a hoisting equipment, crane is the only single machine which, as a single piece, is capable of providing 3-dimensional movement of a weight. It does hoisting operation speedily with safety and precision

Qualification for Operation Hosting Equipment

(a) Operators: Only qualified and designated personnel may operate hoisting equipment. Only operators qualified to operate a particular type of crane or hoisting device may operate that equipment.

(b) Proficiency: operators of cranes and hoisting equipment must be qualified through formal training, testing and demonstrated proficiency in operating the equipment to a designated person. After initial qualification, operators must complete a total of 24 hours of periodic refresher training over any 3-year period, covering safe operation of the types of cranes and hoisting devices they operate. Operators of non-reclamation-owned equipment must provide evidence of operator qualification before beginning work on reclamation activities.

(c) Physical Qualification: Operators must be physically qualified to operate hoisting equipment.

Operating Requirements for Hoisting Equipment

(a) Duty Period: Operators must not work or be at the jobsite more than 12 hours in any 24 hours period.
(b) Authority: Operators must be responsible for those operations under their direct control. Whenever there is any doubt as to safety, the operator must have the authority to stop or to refuse to handle loads unit safety has been ensured. Other onsite personnel must alert the operator if they believe unsafe operating conditions exist.
(c) Other duties: When hoisting equipment is in operation, operators must not perform any other work or leave the operator's position while load is suspended.

Cranes

A crane is a machine which is having a hoi8st with a longitudinal and cross movement. The hoist of a crane consists of wire rope and hook. The crane is used both for lifting and lowering materials, and to move them horizontally. Cranes uses one or more simple machines to create mechanical advantage and thus move heavy loads. Many factors are taken into consideration while selecting a crane. These factors include lifting capacity, capacity, crane use and application and the number of work cycles that the crane is required to undergo.

Types of Cranes

Cranes are of many types. Some of them are given below:

(a) Overhead or Gantry cranes: these types of cranes due to this large service area., freedom from floor obstructions and three-way-mobility, are widely used in erection, foundry, steel plants, storage yards and different types of industrial works. These type of cranes consist of two main parts i.e. the bridge and the crab. The bridge consist of two main girders fixed at their ends to the end carriages which are supported on tram wheels and capable of moving on gantry rails. The crab consists of the hoisting gear mounted on a frame. The frame itself is mounted on another set of heels and capable of travelling across the main girder.

(b) Mobile Cranes: Mobile crane is mounted on a carrier usually a truck which provides the mobility for this type of crane. This crane has two parts namely.
   (i) A carrier which is often referred to as the lower and
   (ii) A lifting component which includes the boom also referred to as the upper.

These are mated together through a turnable which allows the upper to swing from side to side. Modern hydraulic truck cranes are usually single engine achiness, with the same engine powering the undercarriage and the crane. The upper is usually powered via hydraulics run through the unable from the pump mounted on the lower. Older hydraulic truck cranes had two engines. One in the lower is use for the crane to travel on the road and ran a hydraulic pump for the outriggers and jacks. The second I n the upper ran the upper through hydraulic pump of its own. Generally, these cranes are able to travel on highways, eliminating the need for special equipment to transport the crane. When working on the job site, outriggers are extended horizontally form the chassis then vertically to level and stabilize the crane while stationary and hoisting. Many truck cranes have slow travelling capability while suspending a load. Great care must be taken not to swing the load sideways from the direction of travel, as most ant-tipping stability then lies in the stiffness of the chassis suspension,.

(c) Tower Cranes: It is usually fixed to the ground on a concrete. This crane often given the best combination of height and lifting capacity and is used in the construction of tall buildings. The base of the crane is attached to a mast which gives the crane its height. Further the mast is attached to the slewing unit that allows the cranes to rotate. On top of the slewing unit there are three main parts.
   Which are:
   (i) The long horizontal jib (working arm)
   (ii) Shorter counter jib
   (iii) Operators' cab.

The long horizontal jib is the part of the crane that carries the load. The counter jib carries a counterweight, usually of concrete blocks, while the jib suspends the load to the from the center of the crane. The crane operator either sits in a cab at the top of the tower or controls the crane by radio remote control from the ground. In the first case the operator's cab is most usually located at the top of the tower attached to the turnable, but can be mounted on the jib, or partway down the tower.

(d) Stationary Cranes or Derrick cranes: Derrick cranes consist of a mast, a boom and a bull wheel on which the boom rotates about a vertical axis and guys or supporting members. These cranes are either electrically operated, diesel operated ro diesel-electrically operated.

(i) Guy derrick type
(ii) Stiff leg derrick type