

UNIT-IV

Introduction :- In order to have proper quality construction projects the use of mechanical equipments 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. It has been estimated that about 20-30% of the total project cost has been accounted towards equipment and machinery.

① Common construction equipments :-

- * Equipment for excavation
- * Equipment for hauling.
- * Equipment for compaction of earth
- * Drilling and Blasting Equipment.
- * Rock crushing equipment.
- * Concrete producing equipment
- * Pile Driving equipment
- * Hoisting equipment. e.t.c.

Equipment for Excavation :-

1. Hoists
2. Cranes
3. Tractors
4. Bulldozers
5. Graders

7. Draglines

8. Calmshell bucket.

1. HOISTING EQUIPMENT

Hoisting is the operation of lifting the load. Hence equipments used for hoisting purpose lift the load from the place, hold it in suspension during transfer from one location to the another and finally place it on the desired location.

It should be strong enough to negotiate the load pressure and should consume minimum time possible in the operation and it must be quite safe while handling.

Types of Hoisting equipment:-

Mainly we have 4 types of hoisting equipments

- Those are
1. Pulley
 2. Chain hoists
 3. Jacks
 4. Winch.

Pulley:-

Pulley and sheave are used for lifting rough surface and heavy objects. Both chains and wire ropes are used for this purpose.

Chain Hoists :- It is used for lifting loads upto 50 tonnes. The system consists of hand chain and the

and the load chain the pull applied through the main chain is transmitted to the load chain with a multiplication factor over 20.

Jacks:- It is based on the principle of inclined planes. It is the shortname of screwjack. The smallest Jack may have a capacity of 5 tonnes and is generally used for lifting an automobile wheel, while the bigger variety may be of 100 tonnes capacity.

They are primarily of two types.

1. Mechanical

2. Hydraulic.

In the mechanical system, load is mounted on platform which is attached with spirally threaded spindle. The platform is rotated and load is lifted.

The hydraulic type, pressure is exerted by a liquid on the surface.

Winch:-

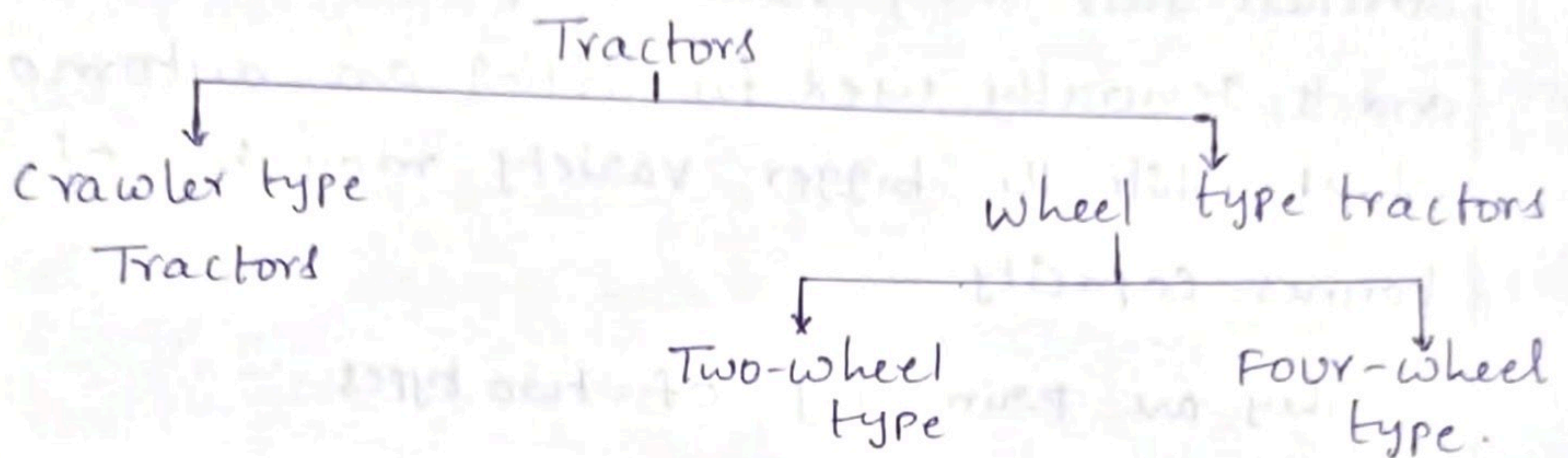
A winch is a combination of gears (spur and pinion) clutches and brake. The operation is controlled through a series of levers.

It is commonly used in lifting the railway gates.

(2) 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 bulldozers, 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 distance too. Special advantage of crawler type tractors is their ability to travel over very rough surfaces and to climb steep grades upto 25 to 29% at speed of 3 kmph.

(ii) Wheel type Tractors :- The travel with high speeds than crawler type tractor. These type of tractors are generally employed for light but speedy jobs. Maximum speed is generally more than 50 kmph.

Wheel type tractors are of two types.

(a) Two-wheel type tractors

(b) Four-wheel type tractors.

Advantage of Two-wheel tractors :-

- * Fewer tyres to provide and maintain
- * Increased maneuverability
- * Decreased rolling resistance, because of the elimination of extra axle.

Advantages of Four-wheel type Tractors:

- * Greater confidence of operator, due to better steering properties.
- * Less tendency to bump over rough haul roads.
- * Greater speed due to better steering properties and less tendency to bump over rough haul roads.

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.

$$K = \frac{972 \times T \times G}{R \times W} - \frac{N}{20}$$

Where K = gradability, %

T = Rated engine torque lbs.ft

G = Total gear reduction for a particular

gear, selected

R = Rolling radius

W = Gross weight of complete units in lbs

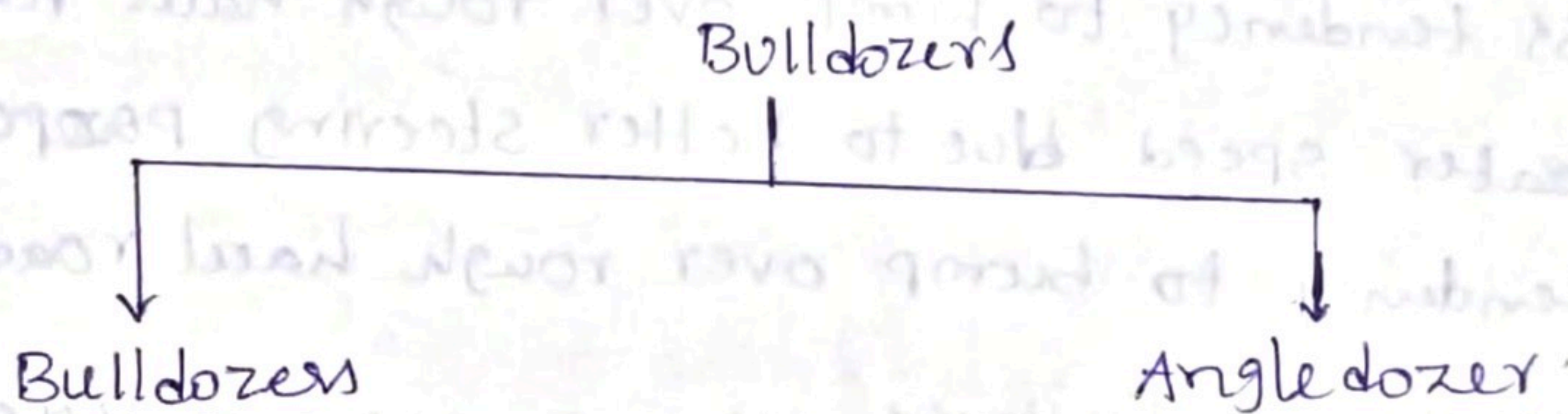
N = Rolling resistance in lbs per ton.

(3) BULLDOZER

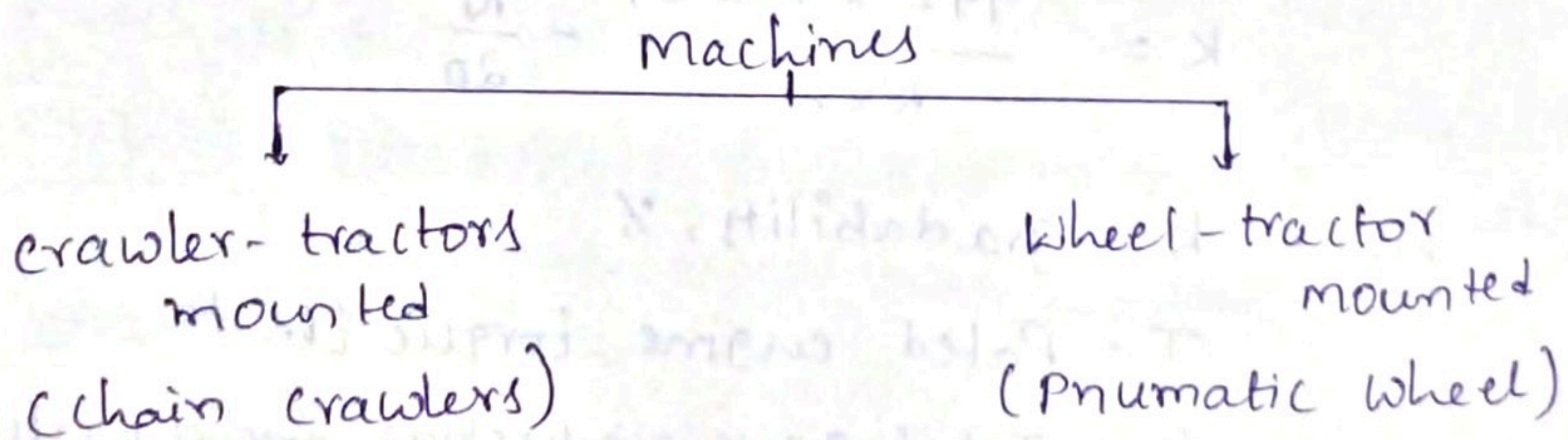
Bull dozer are very popular earth moving equipment which can be used for the following jobs:

1. Site clearance
2. Cutting in mountainous and rocky terrain
3. Moving earth for haulages upto 100 meters
4. Loading tractor pulled scrapers
5. Spreading earth fill
6. Back filling trenches
7. Earth road maintenance.

They are two types of bulldozers.



In some, blades may be adjusted to permit use as Bulldozer or angledozer. These machines may be divided on the basis of their mounting as.



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

- (a) cable controlled
- (b) Hydraulic controlled

The cables controlled operation has the following advantages

1. Simple to operate
2. Easier repair
3. Less danger of damage to the machine

The hydraulic controlled operation has the following advantages:

1. Ability to provide high down pressure on the blades.
2. More precise setting can be maintained

Crawler tractor mounted	Wheel Tractor Mounted.
<ol style="list-style-type: none">1. Higher tractive effort2. Can operate in rough & muddy surface3. Can work in rocky area4. Can travel over rough surface5. Can push large blade loads.	<ol style="list-style-type: none">1. High Travel speed2. No hauling equipments is req for transporting the dozer from one job to the other.3. Greater output4. Less operator fatigue5. Ability to travel over paved highway without damaging the surface.

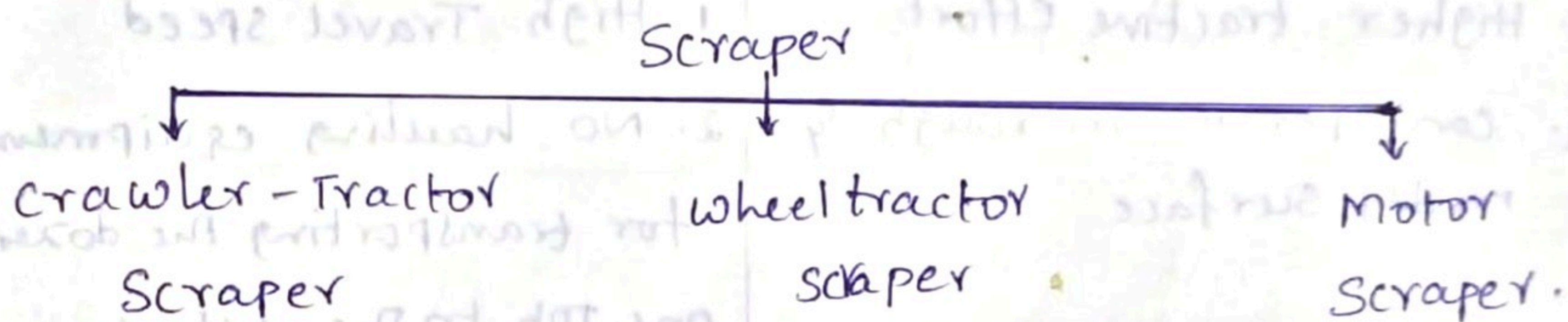
Comparative advantages between crawler tractor & wheel tractor mounted.

(4) Scraper

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

1. Wet or muddy material
2. Hard rocks.

The self loading scrapers are available upto 4000. Suitable hauling distance is 150 to 300m in some cases up to 1500m. Depending upon type of the tractor used scraper can be classified as.



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 the good performance.

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.

Motor scraper:- Motor scraper are those having their own engine and motoring arrangement.

Operation of scrapers :- A scraper is loaded by moving 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

(5) 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 capacity of 1.9 cu.m can be converted into draglines 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 shovel.

Advantages :-

- * 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
- * Draglines with long booms are helpful when earth is to be deposited on banks or dams, eliminating need of hauling unit

* Draglines are excellent for excavating trenches without shoring.

Disadvantage

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 fills 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 is repeated.

Applications :-

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

(6) 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 buckets loosely attached at the end through cables as in a drag line.

The capacity of the clam shell bucket is usually given in cubic meters. There are 3 methods to express capacity.

Water level capacity:- Water level capacity is the capacity of the bucket if it was hung level and filled with water.

Plate line capacity:- Plate line capacity indicates the capacity of bucket following a line along the top of the clams.

Heaped Capacity:- Heaped capacity is the capacity of bucket when it is filled to the maximum angle of repose for the given material.

For specially heaped capacity angle of repose is assumed as 45°

Operation:- 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 fall 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:-

- * Clamshells are commonly used for handling loose materials such as crushed stone, sand, gravel, coal, etc.
- * The main feature of clamshell is the vertical lifting of material from one location to another.
- * Clamshells are mainly used for removing from cofferdams, sewer manholes, well foundations etc.

(7) Cranes

A crane is a machine which is having a hoist 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 use 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, crane use and application and the number of work cycles.

Types of cranes :-

Cranes are of many type. Some of them are given below.

a. overhead or gantry cranes

b. Mobile cranes

c. Tower cranes

d. Stationary cranes

Gantry cranes :-

These types of cranes due to its large service area, freedom from floor obstruction and Three-way-mobility, are widely used in erection, foundry, steel plants, storage yards and different types of industrial works.

These type of cranes consists of two main parts

i.e. The bridge and

The crab

The bridge consists of two main girders fixed at their ends to the end carriage 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 wheels and capable of travelling across the main girder.

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 turntable which allows the upper to swing from side to side.

Modern hydraulic truck cranes are usually single engine machines, with the same engine powering the under carriage and the crane. The upper is usually powered via hydraulics run through the turntable from the pump mounted on the lower. Older hydraulic truck cranes had 2 engines. One in the lower is used for the crane to travel on the road

and second one, ~~a~~ ran a hydraulic pump for the outriggers and jacks. The second in the upper ran the upper through a 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 from the chassis then vertically to level and stabilize the crane while stationary and hoisting.

TOWER CRANES :-

It is usually fixed to the ground on a concrete. This crane often gives 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 3 main parts.

These are

1. The long horizontal jib (working arm)
2. Shorter counter jib
3. Operator's cab.

Stationary cranes :- These are also known as derrick cranes. They 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 or diesel-electrically operated.

A derrick crane can be classified into 2 types.

Those are

1. Guy derrick type
2. Stiff leg derrick type

8 GRADERS :-

Graders are multipurpose machines used for finishing, shaping, bank sloping and ditching. They are also used for mixing, spreading, side casting, leveling and crowning, light stripping operations, general construction and dirt road maintenance. A grader's primary purpose is cutting and moving material with the mold board. These machines are restricted to making shallow cuts in medium-hard materials; they should not be used for heavy excavation. A grader can move shallow amounts of material but cannot perform dozer-type work because of the structural strength and location of its moldboard.

Graders are capable of progressively cutting ditches to a depth of 3ft and for working on slopes as steep as 3:1. However, it is not advisable to run graders parallel with such steep slopes because they have a comparatively high center of gravity and the high pressure at a critical point on the moldboard could cause the machine to roll over.

The components of the grader that actually do the work are the moldboard (blade) and the scrape scarifier. Graders may also be equipped with lightweight rear-mounted rippers.

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Mold board :-

The mold board, commonly referred to as the blade, is the working member of the grader. A rotating circle carries the mold board. Through intricate hydraulics the mold board can be placed into many positions, either under the grader or to the side. It can be side-shifted horizontally for increased reach outside of the tires.

Moldboard Angle :-

The mold board can be angled (positioned) at almost any angle to the line of travel, parallel to the direction of travel, shifted to either side, or raised into vertical position.

Scarifier :-

Material too hard to cut with the moldboard should be broken up with the scarifier. A scarifier is an attachment hung between the front axle and the moldboard. It is composed of a scarifier log with removable teeth.

The teeth can be adjusted to cut to a depth of 12 in. When operating in hard material, it may be necessary to remove some of the teeth from the scarifier log. A maximum of 5 teeth may be removed from the log.

SP Reading :-

Graders are often used to spread and mix dumped loads. Because of their mechanical structure and operating characteristics, graders can only be effective spreading and mixing free-flowing materials. A general formula for figuring grader spreading and mixing production is

$$\text{Production (bcy) per hr} = 3.0 \times \text{hp}$$

where hp = Engine flywheel-brake horsepower of the grader and efficiency is assumed to be a 50 min working hour.

PRO: A large grader is rated at 220hp. What is its expected production, in bcy when used for spread dumped from haul trucks?

Sand is free-flowing material, therefore it can be used to calculate the production.

$$\begin{aligned} \text{production (bcy) per hr} &= 3.0 \times 220 \\ &= 660 \text{ bcy/hr.} \end{aligned}$$

TIME ESTIMATES :-

The following formula can be used to prepare estimates of the total time required to complete a grader operation.