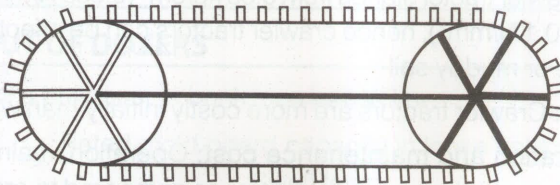


TRACTOR

The primary purpose of a tractor is to pull or push loads, and it may be used also as a mount for many types of equipment such as bulldozer, shovel, dragline, hoe, trenchers, etc.

■ Crawler Tractor

- A crawler track is an endless chain consisting of steel links made of steel plates connected together by pins and bushings as shown in figure.



- Generally, it is used for moving heavy units on rough surface having poor traction.
- The optimum pull that a crawler tractor can provide depends upon its weight and is equal to the coefficient of traction (depending upon road surfaces) multiplied by the weight of unit, regardless of the power supplied by the engine.
- It is suited for short haul say 60 to 150 m.

■ Wheel Tractor

- One of the basic advantages of a wheel tractor compared with a crawler tractor lies in its higher speed.
- However, in order to attain a higher speed, a wheel tractor must sacrifice its pulling effort.
- As the speed is increased through the selection of higher gears. The rimpull will be decreased in approximately the same proportion.

COMPARISON BETWEEN CRAWLER TRACTOR AND WHEEL TRACTOR

The following factors should be considered when comparing crawler tractors with wheel tractors:

1. **Traction:** Coefficient of traction for a crawler tractor is upto 0.9 where it is up to 0.6 for a wheel tractor.

2. **Useful Rimpull:** Since useful rimpull = machine weight × coefficient of traction, therefore, a crawler tractor negotiates very heavy loads whereas a wheel tractor is useful for light loads.
3. **Speed:** A wheel tractor possesses speed up to 3 to 4 times higher than a crawler tractor. Where haul distance is considerable and/or jobs are scattered at different locations, the wheel tractor can be used more efficiently as to be compared with crawler tractor.
4. **Maneuverability:** A wheel tractor has steering wheel which is easy to operate and control while a crawler tractor is provided with stick control which is not easy to control.
5. **Compaction:** Ground pressure of wheel tractors vary from 1.25 kg/cm² (0.125 N/mm²) to 1.50 kg/cm² (0.150 N/mm²) whereas the same for crawler tractor stands from 0.85 kg/cm² (0.085 N/mm²) to 1.00 kg/cm² (0.1 N/mm²), hence crawler tractors can be effectively used on loose or muddy soil
6. **Cost:** Crawler tractors are more costly initially than wheel tractors.
7. **Operation and maintenance cost:** Operation, maintenance and repair cost is less in wheel tractor as compared to crawler tractor.
8. The tar and concrete pavements are liable to damage by crawler tractors while wheel tractors are liable to slip over smooth footing.

DOZERS

- Dozers are very efficient excavating tools for short haul applications upto 100 m.
- A dozer is a tractor-power unit that has a blade attached to the machine's front. It is designed to provide tractive power for drawbar work.
- **Types of Dozers**
The dozers are classified on the following basis of the mounting i.e
 - (i) crawler-mounted dozer
 - (ii) wheel-Mounted dozer
- **Comparison of wheel dozer and crawler dozer**

Wheel Dozer	Crawler Dozer
1. Good on firm soils and concrete and abrasive soils that have no sharp-edged pieces	1. Can work on a variety of soils; sharp-edged pieces not as destructive to dozer though fine sand will increase running gear wear

- | | |
|--|--|
| 2. Best for level and downhill work. | 2. Can work over almost any terrain |
| 3. Wet weather causing soft & slick surface conditions will slow or stop operation | 3. Can work on soft ground and over mud-slick surfaces; |
| 4. The concentrated wheel load will provide compaction & kneading action to ground surface | 4. Will exert very low ground pressures with special low ground pressure undercarriage and track configuration |
| 5. Good for long travel distances | 5. Good for short work distances |
| 6. Best in handling loose soils. | 6. Can handle tight soils. |
| 7. Fast return speeds, 8-26 mph | 7. Slow return speeds, 5-10 mph |
| 8. Can only handle moderate blade loads | 8. Can push large blade loads |

THE OUTPUT OF DOZERS

Output of a bulldozer in bank measure vol/hr

$$= \frac{\text{Rated mold board capacity in loose volume}}{\text{Swell factor}} \times \frac{\text{Actual operating time in minutes per hour}}{\text{Time required per trip in minutes}}$$

whereas,

time required per trip in minutes or cycle time in minutes is given by

$$= \frac{D}{F} + \frac{D}{R} + G$$

D = Haul distance in metres

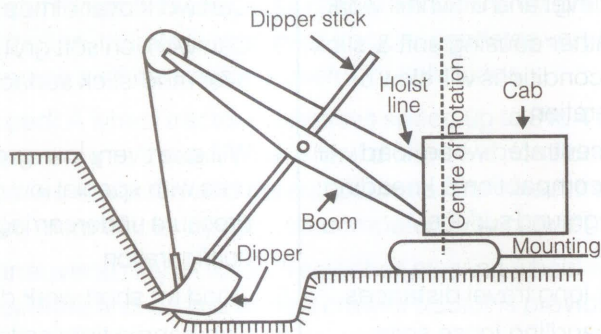
F = Forward speed in meters/minute

R = Reverse speed in meters/minute

G = Gear shifting time in minutes (0.15 minute to 0.30 minutes)

POWER SHOVEL

- Power shovels are used predominantly for hard digging above track level and for loading units.
- They are capable of excavating all classes of earth, except the solid rock without prior loosening.
- The size of a shovel is indicated by the size of bucket of dipper, expressed in cubic meters and varies from 0.375 m³ to 5 m³.



OUTPUT OF POWER SHOVEL

- The output of power shovel is expressed in cubic meter per hour based on bank-measure volume.
- If no allowance is made for any lost time, then

$$\text{Output of shovel} = \frac{\text{Bank measure capacity of dipper}}{\text{Cycle time in seconds}} \times 3600 \text{ (m}^3/\text{hr)}$$

In general cases,

$$\text{Output of shovel} = \frac{\text{Loose volume of dipper}}{1 + \text{swell friction}} \times \frac{\text{actual time in sec./hr}}{\text{cycle time in sec.}} \times \text{efficiency}$$

expressed in cubic meter/hr.

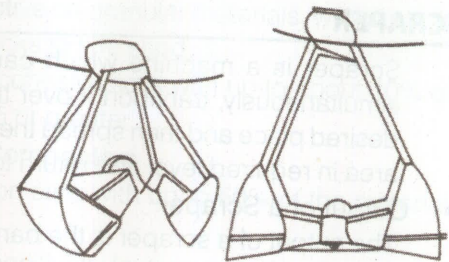
DRAGLINE

- Since the basic character of the machine is dragging the bucket against the material to be dug, it is called as dragline.
- A dragline has distinct advantages compared with a power shovel because of its long light boom.

CLAMSHELLS

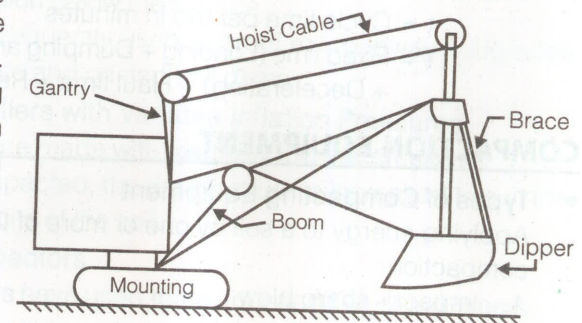
- Clamshell is a machine having most of the characteristics of dragline and crane in common. Digging is done like a dragline and once the bucket is filled, it works like a crane.
- The clamshell bucket is designed to excavate material in a vertical direction.

- It works like an inverted jaw with a biting motion.
- The clamshell is capable of working at, above and below ground level.
- The clamshell machine consists of a clamshell bucket hung from a lattice-boom crane.



HOE

Hoe is an excavating equipment of the power-shovel group. Since the digging mechanism resembles to an ordinary garden hoe, it is named as Hoe. But it is referred by several names such as hoe, backhoe, back shovel and pull shovel.



HOE PRODUCTION

The basic production formula for a hoe used as an excavator is Hoe (excavation) production

$$\frac{3600 \text{ sec} \times Q \times F}{t} \times \frac{E}{60 - \text{min. hour}} \times \frac{1}{\text{Volume correction}}$$

where, Q = heaped bucket capacity in lcy
 F = bucket fill factor for hoe buckets
 t = cycle time in seconds
 E = Efficiency (in minutes per hour)

Volume correction for loose volume to bank volume, $\frac{1}{1 + \text{swell factor}}$;

for loose volume to tons, $\frac{\text{loose units weight, lb}}{2,000 \text{ lb / ton}}$

SCRAPER

Scraper is a machine which can scrape the ground and load it simultaneously, transport it over the required distance, dump at the desired place and then spread the dumped material over the required area in required level and return to the pit for the next cycle.

- **Output of a Scraper**

The output of a scraper is the bank measure volume per hour (cubic meter/hr)

$$\text{Output} = \text{Optimum loose volume per trip} \times S \times \frac{60}{t} \times \text{Efficiency}$$

where, S = Swell factor depending upon type of soil

t = Cycle time per trip in minutes

t = Fixed time (Loading + Dumping and turning + Accelerating + Decelerating) + Haul time + Return time in minutes.

COMPACTION EQUIPMENT

- **Types of Compacting Equipment**

Applying energy to a soil by one or more of these methods will cause compaction :

1. Impact – sharp blow
2. Pressure – static weight
3. Vibration – shaking
4. Kneading – manipulation or rearranging

1. **Sheepsfoot Roller**

- The sheepsfoot roller is suitable for compacting all fine-grained materials, but is generally not suitable for use on cohesionless granular materials.

2. **Tamping Rollers**

- Tamping foot compactors are high speed, self-propelled, non-vibratory rollers.
- A tamping foot roller is effective on all soils except clean sand.

3. **Vibrating Compactors**

- Vibration has two measurements – amplitude and frequency.
- The amplitude controls the effective area, or depth to which the vibration is transmitted into the soil.

4. **Smooth Drum Vibratory Soil Compactors**

- The smooth drum compactors, whether single-or dual-drum models, generate three compactive forces :
(1) Pressure (2) Impact (3) Vibration

- These rollers are most effective on granular materials, with particle sizes ranging from large rocks to fine sand.
- They can be used on semicohesive soils with up to about 10% of the material having a PI of 5 or greater.

5. **Padded Drum Vibratory Soil Compactors**

- These rollers are effective on soils with up to 50% of the material having a PI of 5 or greater.
- These units are designed specifically for trench work or for working in confined areas.

6. **Pneumatic-Tired Rollers**

- These are surface rollers that apply the principle of kneading action to effect compaction below the surface.
- These units are frequently used to proof roll roadway subgrades and airfields bases and on earth-fill dams.

7. **Pneumatic-Tired Rollers with Variable Inflation Pressures**

- The first passes are made with relatively low tire pressures.
- As the soil is compacted, the tire pressure is increased to suit the particular conditions of the soil.

8. **Towed Impact Compactors**

- These compactors have used three, four and five-sided drums.
- As the compactor is towed, the drum rotates, lifting itself up on edge, and then falls back to earth.
- These compactors can be used on a wide range of materials viz. rock, sand, gravel, silt, and clay.

9. **Compaction Wheels**

- To avoid the hazards of having to have men working in trenches, a compaction wheel attached to an excavator boom is often used to achieve compaction when backfilling utility trenches.

10. **Manually Operated Vibratory-Plate Compactors**

- A self-propelled vibratory-plate compactor used for consolidating soils and asphalt concrete in locations where large units are not practical.

11. **Manually Operated Rammer Compactors**

- Small compactors such as the self-propelled vibratory-plate or the rammer will provide adequate compaction if:
 1. Lift thickness is small (usually 3 to 4 in.)
 2. Moisture content is carefully controlled, and
 3. Coverages are sufficient

ROLLER PRODUCTION ESTIMATION

The production formula for a compactor in compacted cubic yards per hour =

$$\frac{16.3 \times W \times S \times L \times \text{Efficiency}}{n}$$

where,

W = compacted width per roller pass in feet

S = average roller speed in miles per hour

L = compacted lift thickness in inches

n = number of roller passes required to achieve the required density.

