Construction Equipment

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Introduction

- In the case of huge construction projects;
- Proper use of the appropriate equipment contributes to economy, quality, safety, speed and timely completion of a project.
- Equipment are use for highway projects, irrigation, buildings, power projects etc.
- 15-30% of total project cost has been accounted towards equipment and machinery.

Classification of Construction Equipment

1. Earth-moving equipment
2. Hauling equipment
3. Hoisting equipment
4. Conveying equipment
5. Aggregate and concrete production equipment
6. Pile-driving equipment
7. Tunneling and rock drilling equipment
8. Pumping and dewatering equipment

Operations involved in construction of any project

- Excavation
- Digging of large quantities of earth
- Moving them to distances which are sometimes fairly long
- Placement
- Compacting
- Leveling
- Dozing
- Grading
- Hauling

EXCAVATING AND EARTH MOVING EQUIPMENT

- Power shovel
- Back hoe
- Drag line
- Clam shell
- Scrapers
- Bull dozer

POWER SHOVEL

- To excavate the earth and to load the trucks
- capable of excavating all types of earth except hard rock
- size varies from 0.375m^3 to 5m^3 .
- Basics parts of power shovel including the track system, cabin, cables, rack, stick, boom foot-pin, saddle block, boom, boom point sheaves and bucket.

APPLICATIONS

- Suitable for close range of work
- Capable of digging very hard materials,
- can remove big sized boulders.
- 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.

Factors affecting output of power shovel

- Class of material
- Depth of cutting
- Angle of swing
- Job condition
- Management condition
- Size of hauling units
- Skill of the operator
- Physical condition of the shovel

OLD → NEW

BACK HOE

- Also known as hoe, back shovel and pull shovel
- It is used to excavate below the natural surface on which it rests.
- Generally used to excavate trenches, pits for basements and also for grading works, which requires precise control of depths.
- The basic parts are boom, Jack boom, Boom foot drum, Boom sheave, Stick sheave, Stick, Bucket and Bucket sheave

Back hoe


Backhoe
Cab
Stick
Tractor
Bucket
Boom
Stabilizer Legs
Loader

Application

- It is the most suitable machine for digging below the machine level, such as, trenches, footings, basements etc.
- It can be efficiently used to dress or trim the surface avoiding the use of manual effort for dressing the excavated the surface.

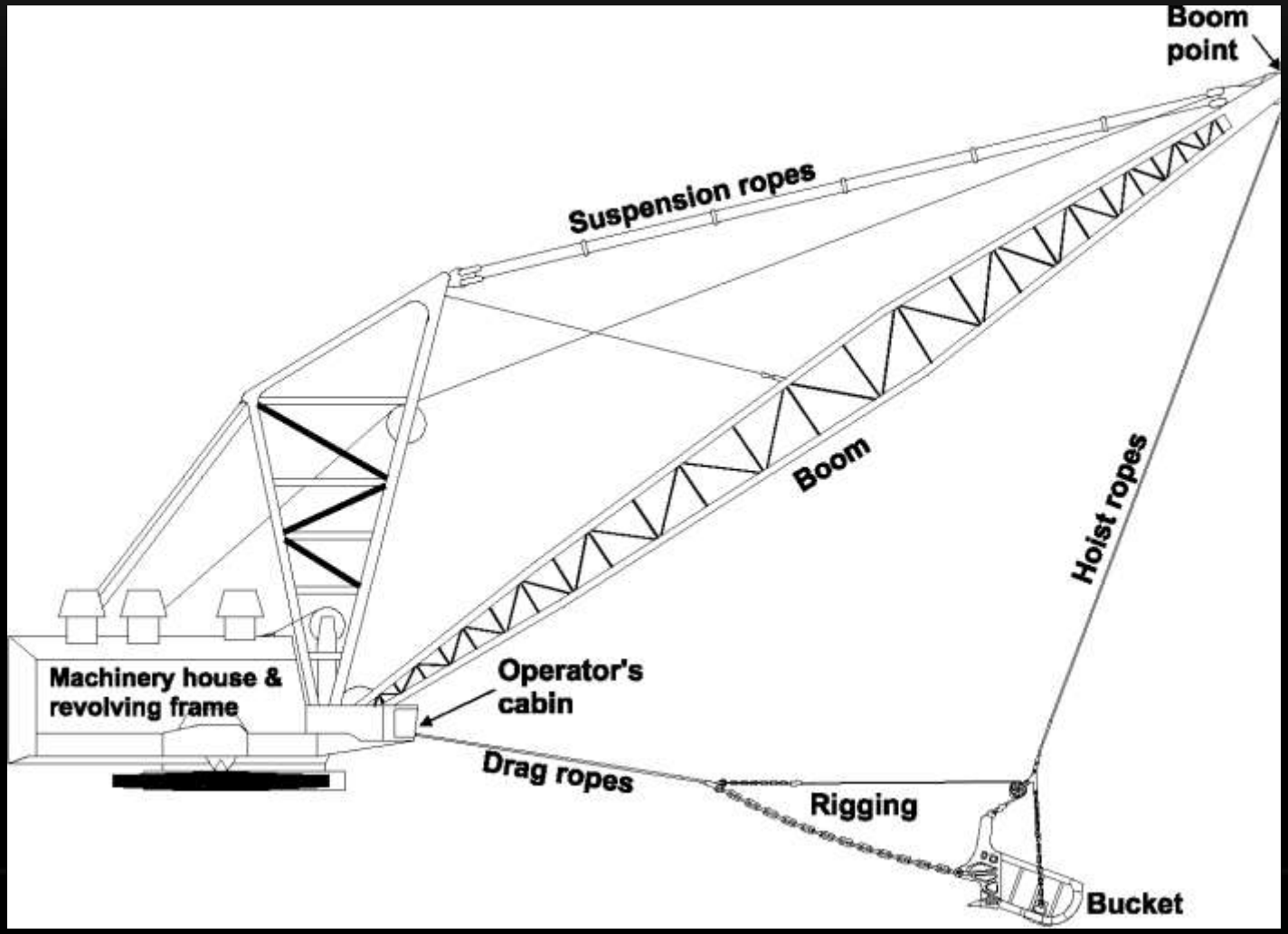
Drag line

- The drag line is so name because of its prominent operation of dragging the bucket against the material to be dug.
- Unlike the shovel, it has a long light crane boom and the bucket is loosely attached to the boom through cables.
- Because of this construction, a dragline can dig and dump over larger distances than a shovel can do.
- Drag lines are useful for digging below its track level and handling softer materials.
- The basic parts of a drag line including the boom, hoist cable, drag cable, hoist chain, drag chain and bucket.

Application

- It is the most suitable machine for dragging 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 reaches.
- It is mostly used in the excavation for canals and depositing on the embankment without hauling units.

DRAG LINE


Boom point
Suspension ropes
Boom
Hoist ropes
Machinery house & revolving frame
Operator's cabin
Drag ropes
Rigging
Bucket

Clam shell

- This is so named due to resemblance of its bucket to a clam which is like a shell-fish with 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 a clam shell bucket is usually given in cubic meters.
- The basic parts of clam shell bucket are the closing line, hoist line, sheaves, brackets, tagline, shell and hinge.

Application

- Used for handling loose material such as crushed stone, sand, gravel, coal etc.
- Main feature is vertical lifting of material from one location to another.
- Mainly used for removing material from coffer dam, sewer main holes, well foundations etc.

CLAM SHELL

Comparison between different types of equipment

s.no.	Items of comparison	Power shovel	Back hoe	Drag line	Clam shell
1	Excavation in hard soil or rock	Good	Good	Not good	Poor
2	Excavation in wet soil or mud	Poor	Poor	Moderately good	Moderately good
3	Distance between footing and digging	Small	Small	Long	Long
4	Loading efficiency	Very good	Good	Moderately good	Precise but slow
5	Footing required	Close to work	Close to pit	Fairly away from pit	Fairly away from pit
6	Digging level	Digs at or above footing level	Digs below footing level	Digs below footing level	Digs at or below footing level
7	Cycle time	Short	Shortly more than power shovel	More than power shovel	More than the other equipment

Trenching machine

- Used for excavating trenches for laying pipelines, sewer, cables etc.
- Operation is quick giving the required depth or width.
- Two types of trenching machine wheel type, ladder type

Scrapers

- Unique machine for digging and long-distance hauling of plough able materials.
- self-operating machine
- It is not dependent on other equipment.
- Wheels of machine cause some compaction.
- The basic parts of scrapers are the bowl, apron and tail gate or ejector.

SCRAPER

Bull dozer

- The heavy blade attached to the tractor pushes the material from one place to another.
- The tractor can be of the crawler or the wheeled type.
- Classification of bull dozer

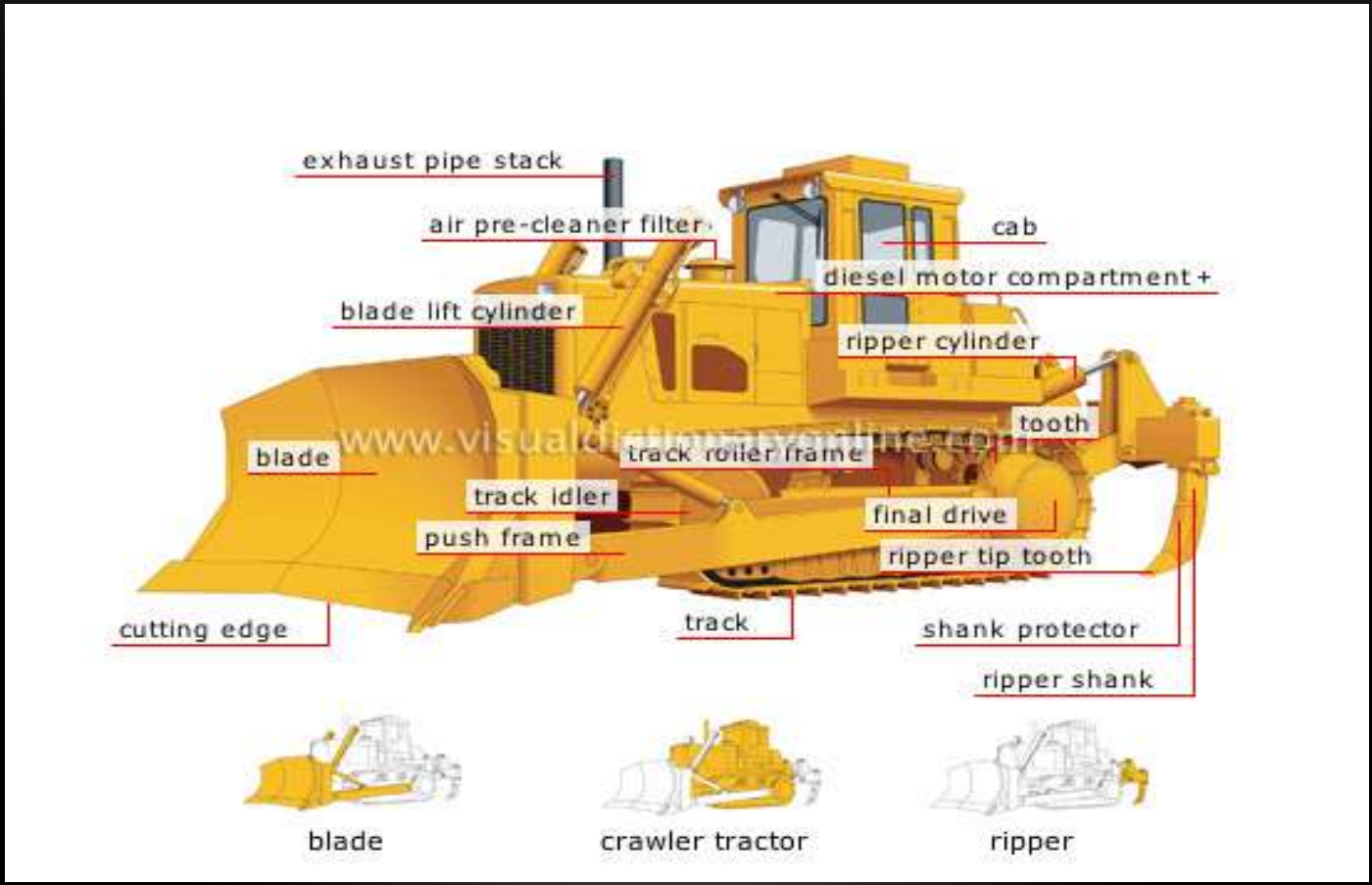
1. Position of blades

a) Bull dozers in which the blade perpendicular to the direction of movement

b) Angle dozers in which the blade is set at an angle with the direction of movement.

2. Based on mountings
    a) Wheel mounted
    b) Crawler mounted
3. Based on the control
    a) Cable controlled
    b) Hydraulically controlled

Bull dozer


exhaust pipe stack
air pre-cleaner filter
cab
diesel motor compartment +
blade lift cylinder
ripper cylinder
tooth
blade
track roller frame
track idler
final drive
push frame
ripper tip tooth
cutting edge
track
shank protector
ripper shank
blade
crawler tractor
ripper

Applications

Bull dozers are mainly used for the following operations

1. For spreading the earth fill
2. For opening up pilot roads through mountainous and rocky terrains.
3. Clearing construction sites.
4. Maintaining haul roads
5. Clearing land from the trees and stumps
6. back-filling trenches at construction sites by dragging the earth from one place to another

Tractors

- Multi-purpose machines used mainly for pulling and pushing the other equipment.
- Tractors may be classified as

a) **Crawler type tractor-** Used to move bull dozers, scrapers. The crawler has a chain by which these tractors can be very effective even in the case of loose or muddy soils. The speed of this type dose not exceed 12 kmph normally.

b) **Wheel type tractor-** The engine is mounted on four wheels. The main advantage is higher speed, sometimes exceeding 50 kmph it is used for long-distance hauling and good roads.

TRACTOR

Comparison between crawler and wheeled tractors

Crawler type	Wheeled type
1. Slow speed	1. Greater speed
2. More compact and powerful and can handle heavier jobs	2. Con handle only lighter jobs
3. costly	3. cheaper
4. Cost of operation and maintenance is high	4. Operational and maintenance cost is less
5. Stick control for steering	5. Wheel steering control
6. Moves on rough roads only	6. Moves on rough as well as good roads
7. Used for short distances	7.Used for longer distances
8. Requires skillful operation, maintenance and repairs	8. Lesser skills required for operations, maintenance and repairs

Earth compaction equipment

- Smooth-wheel rollers.
- Sheep-foot rollers
    a) Ordinary sheep-foot roller
    b) Convertible roller
    c) Turn foot roller
- Pneumatic-tyred rollers

Smooth-wheel rollers

- Plain steel rollers
- Self-propelled type
- Weighing from 5 to 15 tonnes
- Used for ordinary rolling work where deep compaction is not required
- These rollers may have one front and two rear wheels
- The rear wheels being usually larger in diameter and the front one being winder.

- Weight of rollers may be increased by filling water or sand ballast in hollow cylinder.
- These rollers are effective in compacting granular soils, such as sand, gravel and crushed stone.

SMOOTH WHEEL ROLLER

Sheep-foot rollers

- For compacting earth work in embankments and canals (where compaction deep into the layer of the earth is required)
- These gives best result in compaction when the soil is clay or predominantly cohesive and impervious.
- The sheep foot rollers may weigh upto 15 tonnes or more
- Travel at a speed of 25 kmph
- As roller moves over the surface, the feet penetrate the soil to produce a kneading action and a pressure to mix and compact the soil from bottom to top layer.
- With repeated passages of the roller, the penetration of feet decreases.

SHEEP FOOT ROLLER

Pneumatic-tyred rollers

- It consists a base or a platform mounted between two axles.
- The rear of which has one more wheel than the front.
- Most suitable for compacting fine-grained soil and well graded sands.
- Ballasting is done using either water, sand or pig iron in order to increase the self weight.

- Major advantages are the ability to control the ground contact pressure by:

a) Altering the weights of machines,

b) Increasing the number of wheels,

c) Increasing the tyre width

d) Changing the contact area of the tyre by altering the contact pressure.

PNEUMATIC TYRED ROLLER

Hauling equipment

- The equipment used for transportation of material are known as hauling equipment or simply haulers.
- Haulers may operate on the roadways or railways
- It involve
  - transportation of building materials,
  - carriage and disposal of excavated earth
  - haulage of heavy construction equipment.

- These are classified on the basis of method of dumping the load
  1. Dump trucks
     a) Side or rear dump trucks
     b) Bottom dump trucks
  2. Dumpers

Dump trucks

- These are used for earth moving purpose.
- The selection of the type of dump trucks for a specific job depend on the soil condition.

(a) Side or rear dump trucks-

- These are heavy duty trucks with strongly built body which is hinged on the truck chassis at the rear end and one side respectively, and can be fitted to the rear in the case of rear dump and to the hinged side in case of the side dump, through the action of hydraulic jacks.
- These trucks are suitable for use in hauling wet clay, sand, gravel, quarry rocks etc.

Side dump truck

Rear dump truck

Bottom dump trucks

- These are 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.
- The body of the truck remains in the same position and the discharge of the material takes place through its bottom after opening of two longitudinal gates.
- The gates are hinged to the side of the body.
- These trucks are suitable for use in hauling free flowing material, such as, sand, gravel, dry earth, hard clay etc.

BOTTOM DUMP TRUCK

Dumpers

- High speed pneumatic wheeled trucks
- Short chasis
- Strong bodies
- Loading, hauling and dumping is done very fast as compared to other equipment
- Suitable for short hauls on rough roads
- Specially where a shuttle movement is required.

Dumper

Hoisting equipment

- Hoisting is the lifting a weight from one location and moving it to another location which is at a reasonable distance.
- Big projects such as, construction of dams, industrial buildings etc. require hoisting equipment.
- Hoisting equipment includes jacks, winches, chain hoists and cranes.
- Crane is the only single machine which, as a single piece, is capable of providing three-dimensional movement of a weight.

- Cranes are broadly classified as :

i. Stationary or derrick cranes
ii. Mobile cranes
iii. Overhead or gantry cranes
iv. Traveller cranes
v. Tower cranes

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.
- Electrically operated, diesel operated or diesel-electrically operated.
- The boom can revolve through 360º.
- This crane is used for heavy loads upto 200 tons.

Mobile cranes-

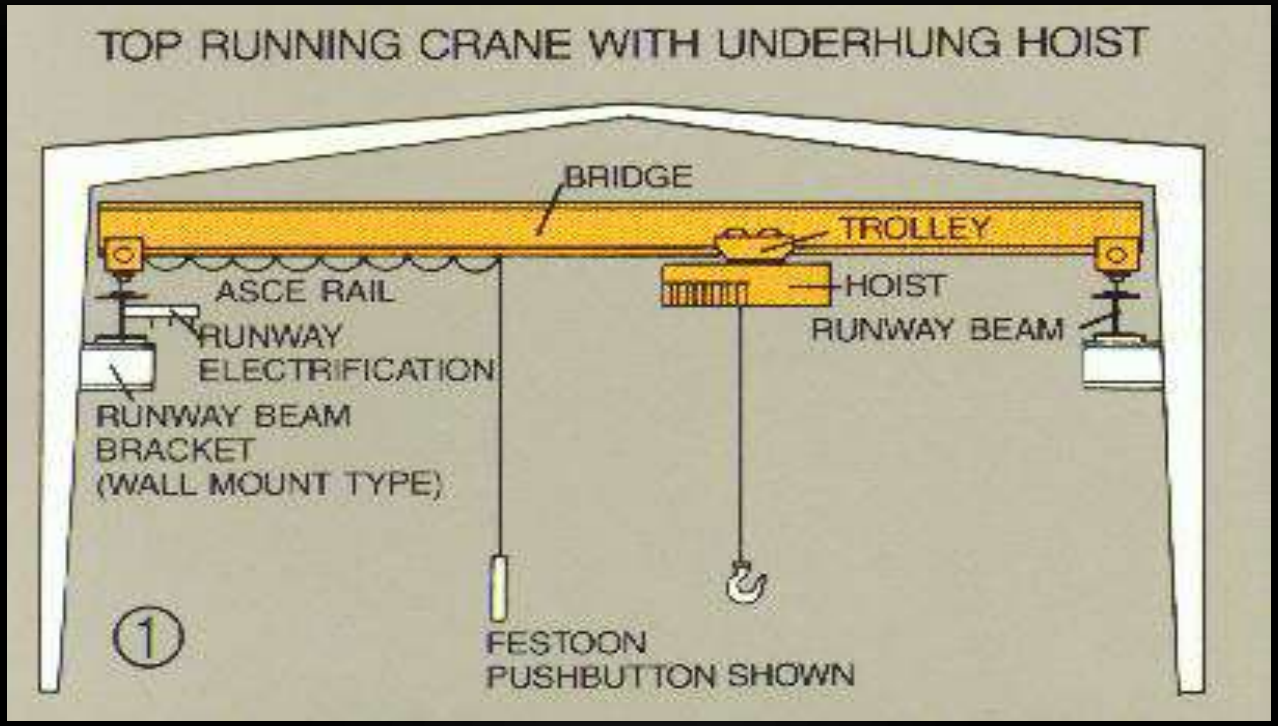
- These cranes are mounted on mobile units which is either crawler type or wheel type
- Truck cranes have high mobility while the crawler mounted cranes move slowly.
- Crawler mounted cranes are capable of moving on rough terrain.

MOBILE CRANES

Overhead or gantry cranes-

- large service area,
- freedom from floor obstructions
- and three-way mobility,
- 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 consists of two main girders fixed at their end to end 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.

OVERHEAD CRANE



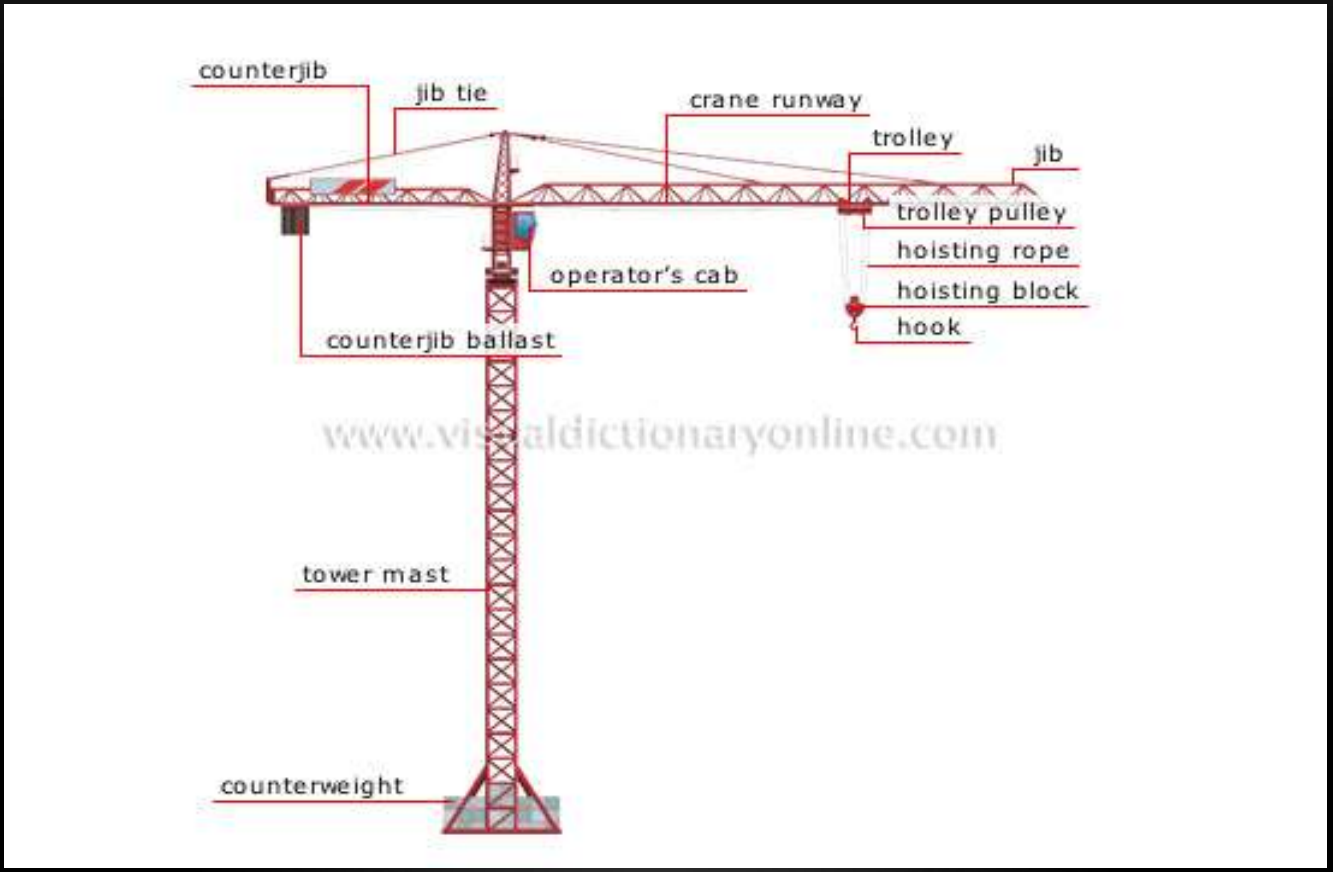
TRAVELLER CRANES

- Travelling or bridge cranes have their crabs moving on girders which are supported on legs instead of on overhead gantry track as used in overhead cranes.
- The legs are capable of moving on tracks laid on the floor.

Tower cranes

- Tower cranes are actually a derrick crane mounted on a steel tower.
- Tower cranes are usually used for industrial and residential high-rise buildings.
- These are commonly used for assembly of industrial plants with steel structures.
- The main parts of tower crane are under carriage, slewing platform, tower with operator’s cabin and jibs.
- The tower has a truss structure welded from steel bars and channels.

TOWER CRANE


counterjib
jib tie
crane runway
trolley
jib
trolley pulley
hoisting rope
operator's cab
hoisting block
hook
counterjib ballast
tower mast
counterweight

Conveying equipment

- Transporting material from one place to another over a stationary structure.
- Caries material in continuous stream with its distinct feature such as endless chain or belt.
- Can be done horizontally, vertically or inclined.
- When the equipment does horizontal conveying, it is known as conveyor and when it does vertical, it is known as elevator.
- Conveying are mainly used in mining, construction and in some of the industries.
- In construction industry, conveyors are mainly used for concreting purpose.

Utility

The Advantage of using conveyors are as follows:-

1. It increases the output.
2. It facilitates continuity in operation.
3. It results in time saving.
4. There are no waiting periods.

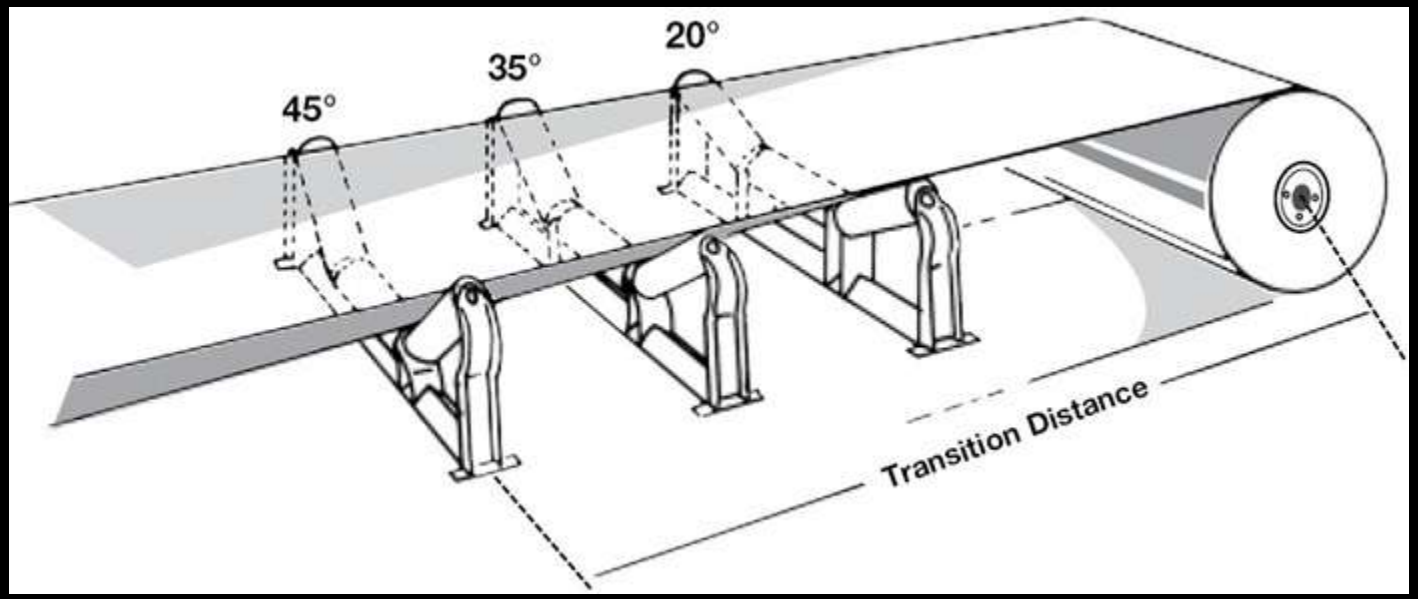
Some of the popular conveyors are as follows:-

1. Belt conveyor
2. Screw conveyor
3. Bucket conveyor
4. Aerial transport

Belt conveyor

- Used when large quantities of materials have to be conveyed over long distances at fast speed.
- It consists of a belt running over a pair of end drums or pulleys and supported at regular intervals by a series of rollers called idlers.
- These idlers are supported on a conveyor frame.
- The middle sag provided in the belt prevent the spilling of material.
- Generally, rubber is most commonly used as conveyor belt.

BELT CONVEYOR



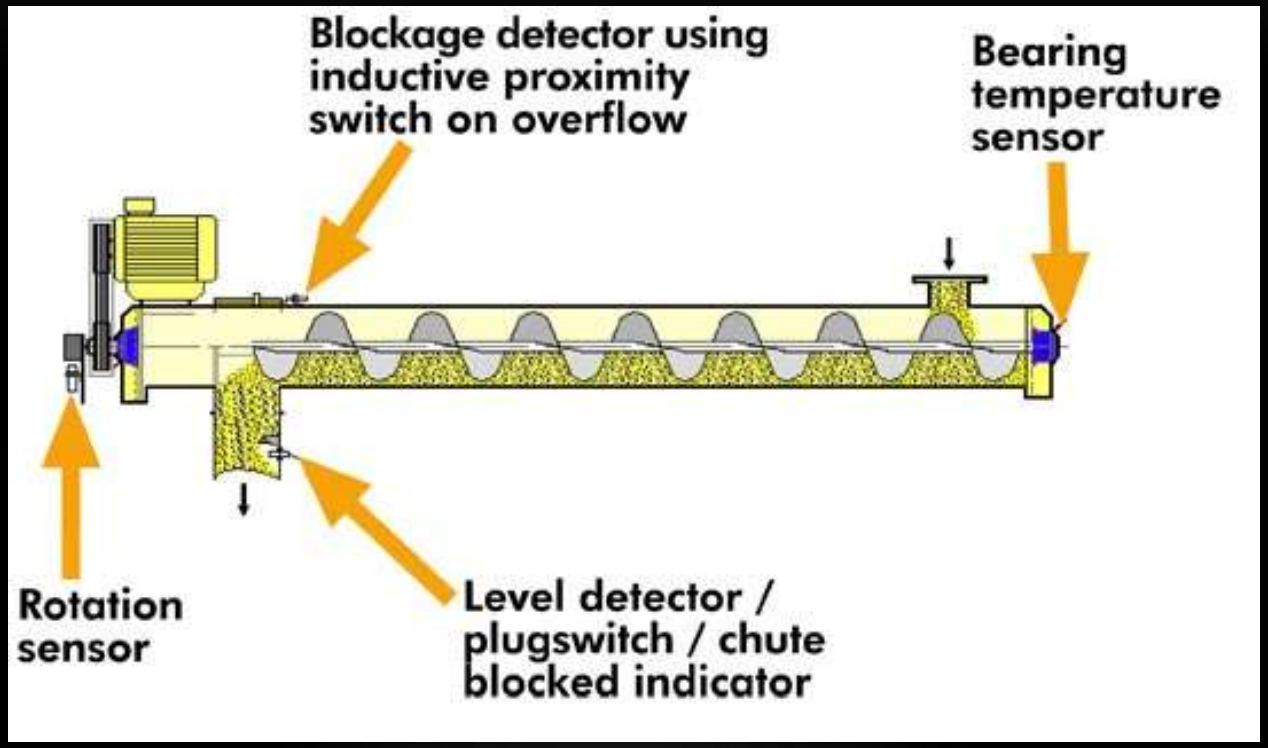
The advantages of using belt conveyor are as follows:-

1. It can handle light as well as heavy materials, dry or wet, fine or coarse etc.
2. It can and for distances to convey several thousand tons of material per hour and for distances of distances of several kilometers.
3. It can carry material horizontally or inclined.
4. It is lighter in weight then other conveyors.
5. It gives controlled discharge of material and discharge can be controlled by the speed of the belt.

SCREW CONVEYOR

- Widely used for handling granular or pulverized material.
- The quantity of material conveyed is less compared to the conveyor, but at the same time the cost is also less.
- A screw conveyor consists of a helix mounted on a bearing at the ends and at intermediate points and is driven by a motor from one end.
- The material enters the through at one end is carried to the other end by screwing action of helix.
- The length of the conveyor is about 65m. with an inclination up to a maximum of 350.

SCREW CONVEYOR



Bucket conveyor

- It has buckets in the shape of ‘V’ which are open at the top.
- They may be feeder loaded or may drag in a vertical movement or along an incline.
- The length of these type of conveyors are generally limited to 25 m. (due to weight of the conveyor and strength of the chains.)
- This type of conveyer is mainly used in coal handling where bucket elevators carry the material vertically.

BUCKET CONVEYOR

Aerial transport

- Aerial transportation through cableways, rope-ways and tram ways
- Often used with advantage for transportation of material in hilly regions.
- Reducing the distance of transportation as well as cost of transportation
- The load being passed over intermediate towers or stations for long distances.

Aerial transport

Aggregate and concrete production equipment

- Aggregate has to be produced at the site, if the quantity needed is very large.
- Therefore, in any project where concrete requirement is very high, an aggregate preparation and processing plant is essential to complete the concreting operations.
- Aggregate production consists of two stages is recovery and processing.
- Basic material, such as stone, is recovered from a rock quarry or from the river bed and processing is done which consists of crushing, grading, washing and stock piling of aggregate.

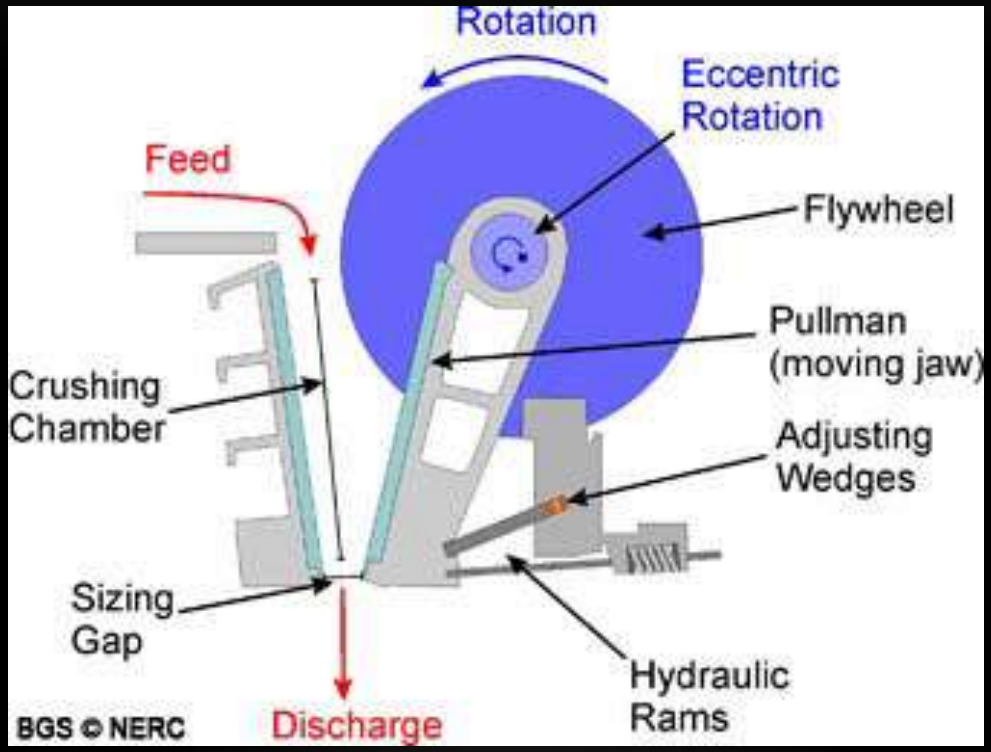
Aggregate production equipment

- Crushers are used mainly to reduce the size of large stone or rock to smaller uniform sized aggregates required for concrete mix.
- Crushing consists of
  - Pressure,
  - Impact,
  - Attrition
  - A combination of these operations.

Jaw crushers

- It is one of the primary crushers.
- It operates by allowing stone to flow into the space between two jaws, one of which is stationary and other is movable, which together constitute the crushing surfaces.
- The distance between the two jaws decreases as the stone travels downward under the effect of gravity and ultimately passes through the lower opening.
- The moveable jaw is capable of exerting a pressure sufficiently high to crush the hardest rock.
- The movable jaw is suspended from a shaft mounted on bearings on the crusher frame.
- The jaw plates are made of manganese steel which can be removed, replaced or reversed.

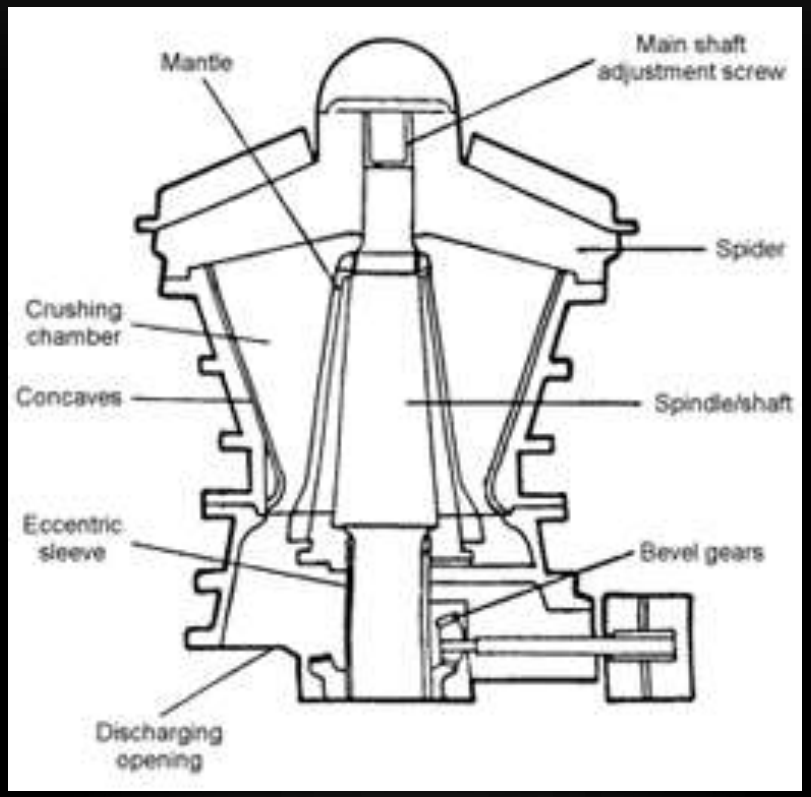
Jaw crushers



Gyratory crusher

- This is another type of primary crusher.
- This type of crusher comprises a hardened steel head has a long conical shape, with a trough shaft suspended in a bearing at the top, and an eccentric base connection connected to gears.
- Thus, as the cone is rotated, the gap between itself and the walling changes from a maximum to minimum for each cycle.
- The rock is feed into the chamber at the top and as it moves downward, crushing is done and finally emerges through the bottom gap.
- The size of this type of crusher is the width of the receiving opening measured between the concaves and the crushers head.
- It is available in sizes varying from 20cm to 200cm.

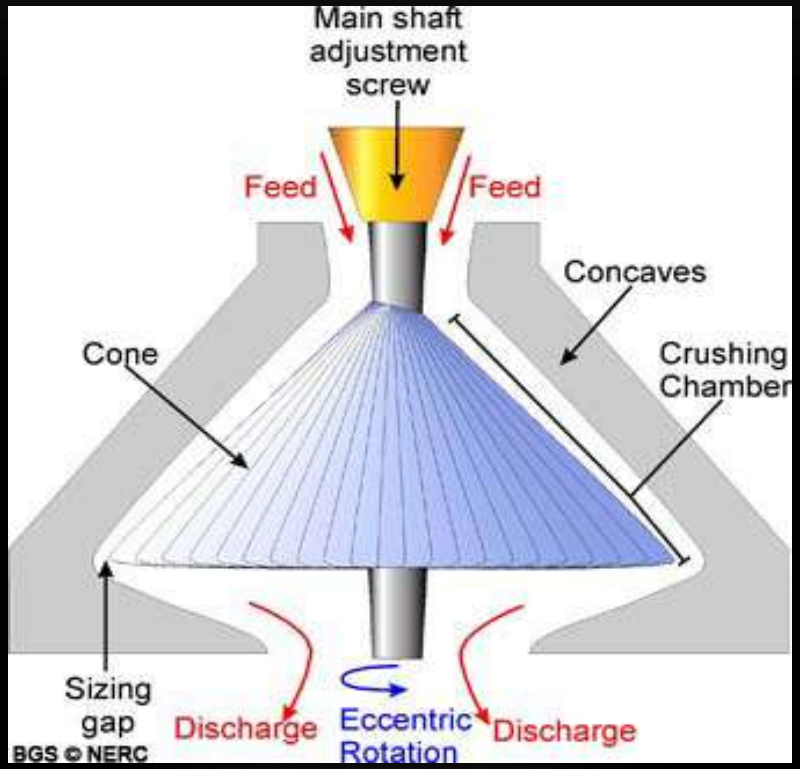
Gyratory crusher



Cone crusher

- Cone crusher are used as a secondary or tertiary crusher.
- These crusher are capable of producing large quantities of uniformly fine crushed stone.
- It has a shorter cone with smaller inlet and outlet openings as compared to the gyratory crusher.

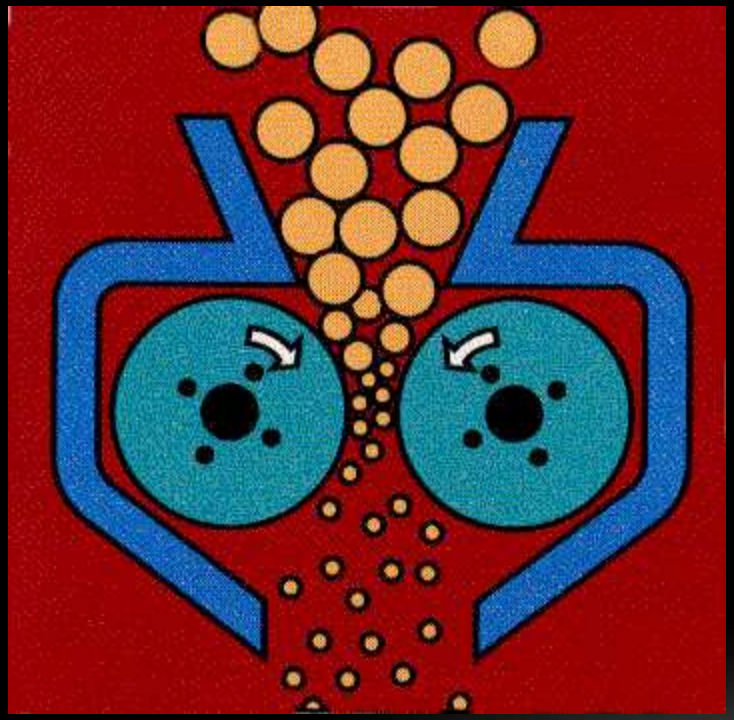
Cone crusher



Roll crusher

- Roll crushers are also one of the secondary or tertiary crushers.
- This crusher consists of a heavy cast iron frame equipped with two counter rotating rollers mounted on a separate horizontal shaft.
- The crushed rock from the primary crusher is feed through the gap between the two rollers for crushing further.
- Usually one roller has a fixed axis while the other can be adjusted to give the required setting.
- The crusher is compact, light weight and low in cost.

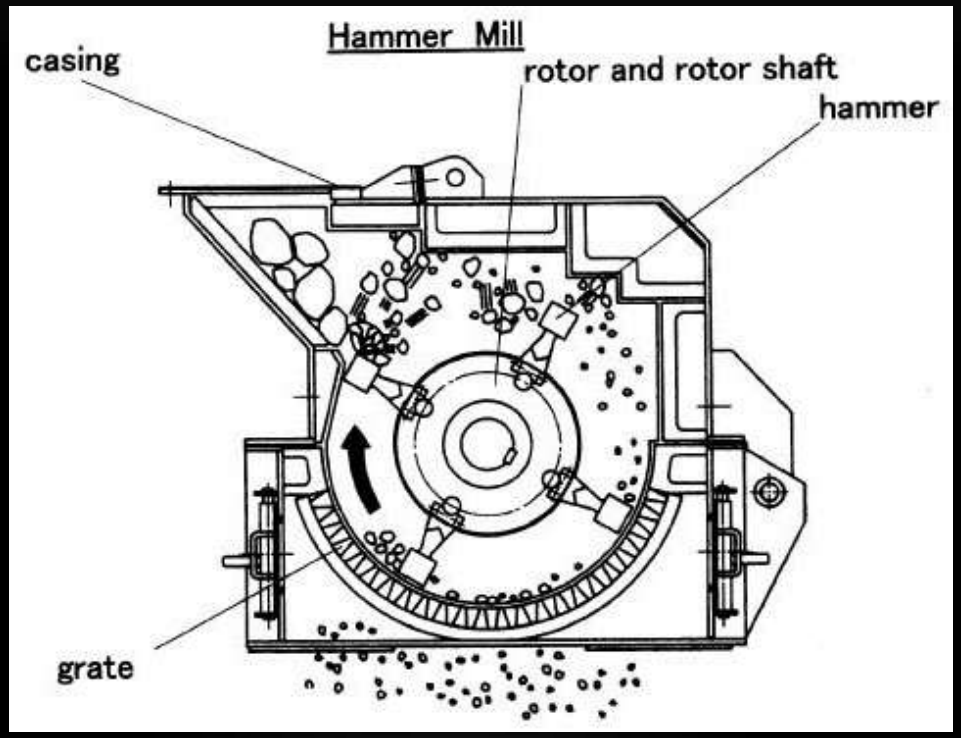
Roll crusher



Hammer mill

- Hammer mill is one of the impact crushers mostly used as primary or secondary crusher.
- It consists of a housing frame, a horizontal shaft extending through the frame, number of frames and hammers attached to the frame and one more hard steel breaker plates.
- As the stone is feed to the mill, the hammers, which are driven by a motor, move at the high speed and brake the stone into pieces and driving them against the hard plate, further reduce their size.

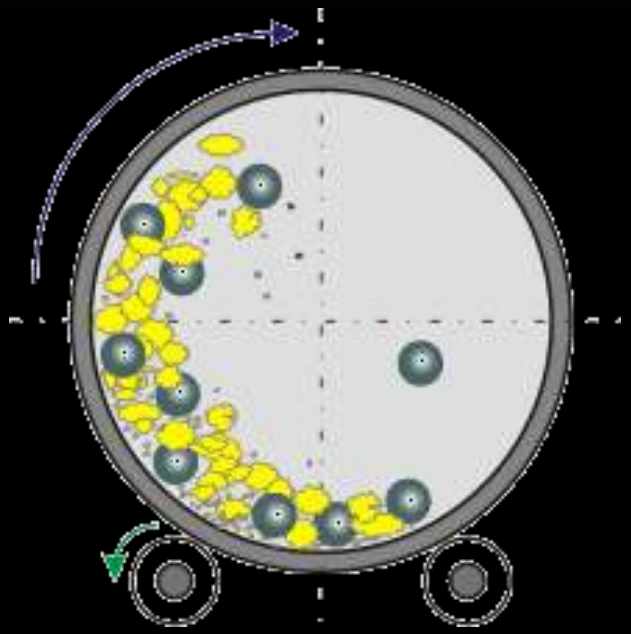
Hammer mill



Rod mill and ball mill

- This are the tertiary crushers.
- A rod mill consist of a circular steel shell.
- The interior of the shell is lined on the inside with a hard material wearing surface.
- The shell contains a number of steel rods.
- The length of these rod is slightly less then the length of the shell.
- Crushed stone is feed through the inlet and fine aggregate of the size of sand is discharged at the other end.
- If the rods are replaced by steel balls to provide the impact required the grind the stones, the crusher is known as the ball mill crusher.
- The size of the balls generally used is 50 mm dia. Size.

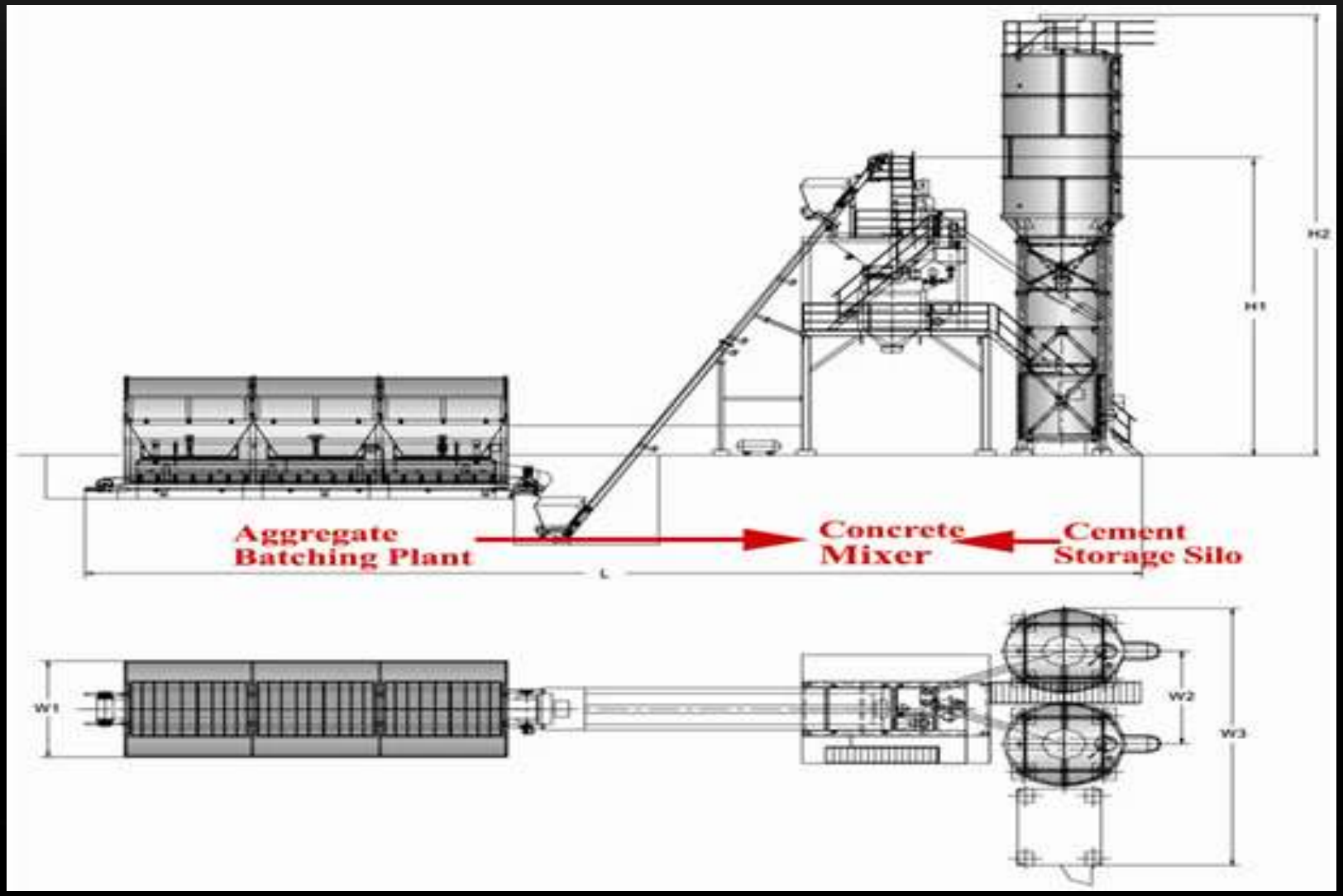
Rod mill and ball mill



Concrete production plants

- For mixing different ingredients in required proportion.
- It consists of storage bins for storing materials like cement and admixtures.
- Aggregate is mix in it with the help of a hopper which is fixed in plant.

Concrete production plants



Pile driving equipment

- The process of pile driving involves lifting the piles into position, holding it to refusal or to a specified depth.
- Driving is accomplished through hammering the pile top with a hammer.
- Equipment are so designed for driven effectively at an economical cost.
- Major pile driving equipment are:
  - Pile driving rigs
  - Pile driving hammers

PILE DRIVING EQUIPMENT

CFG pile driving machine

Rotary drill rig

REFERENCES

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- wikipedia.com
- Goggle images


Thank you