

Chapter 1

Introduction to Construction Equipments

General

Mechanization is the process of shifting from working largely or exclusively by hand to do that work using machines. Construction projects are becoming more demanding and complicated in construction and delay of projects would arise if conventional construction method is used. Delays in construction are costly and have prompted developers to embrace mechanization. Construction machineries are used in order to achieve larger output, cost-effective, execution of work that is not feasible by manual efforts, reduce the amount of heavy manual work which would cause fatigue, maintaining large output, and finalize projects on time.

Motivations for Mechanization of Construction Industry

- The work can be done speedily which avoid time and cost over-runs.
- Large quantity of materials can be handled, so the size of the project can be increased
- The complex projects involving high grade material.
- High quality standards can be maintained.
- Time schedule can be kept.
- Optimum use of material, man power and finance.
- Shortage of skilled and efficient man power.
- To control on the duration and cost implications by using mechanized equipment over the Conventional method, which can be used in the planning of construction project.
- Lower insurance costs for builders.
- Easier and safer work for construction workers.
- Increased sustainability over a building's lifetime.
- Little to no building-site construction waste.

The common types of construction equipments to be discussed in this chapter are:

- Surveying equipment
- Earth excavation equipments
- Hauling equipments
- Dozing equipments
- Compaction equipments
- Grading equipments
- Trenchers
- Scrapers
- Tunneling and rock drilling equipment
- Lifting equipments
- Concrete mixing equipments
- Truck mixers
- Pumping and de- watering equipment
- Concrete vibrating equipments
- Asphalt drum mix plants

1. Surveying Equipment

1.1 Theodolites

A theodolite is an instrument for measuring both horizontal and vertical angles, as used in triangulation networks. It is a key tool in surveying and engineering work, particularly on inaccessible ground. A modern theodolite consists of a movable telescope mounted within two perpendicular axes, the horizontal or turn-on axis and the vertical axis. When the telescope is pointed at a desired object, the angle of each of these axes can be measured with great precision, typically on the scale of arc seconds.

1.2 Total Stations

A total station is an electronic/optical instrument used in modern surveying. It is an electronic theodolite (transit) integrated with an electronic distance meter (EDM) to read distances from the instrument to a particular point where an assistant staff holds reflector. Robotic total stations

allow the operator to control the instrument from a distance via remote control. This eliminates the need for an assistant staff member as the operator holds the reflector and controls the total station from the observed point.

1.3 Automatic level

It is an instrument to take levels of any surface. Good level instrument shall have property of automatic horizontal adjustment of the line of sight, an erect figure and a horizontal circle of 0 - 360° and large ribbed control buttons to simplify the adjustment of the instrument. The compensator shall be magnet damped, so that after the instrument has been set almost horizontal, the line of sight can be carefully leveled using the automatic compensation mechanism.

1.4 Global Positioning System

For accurate navigation in the field applying the Global Positioning System (GPS) which uses satellite signals is used for navigation. GPS are available as a manageable, lightweight, waterproof (and floating) instrument with a clearly readable LCD screen. These equipment works on principle of navigation. Navigation using up to 12 satellites, WAAS enabled (Wide Area Augmentation System is System of satellites and ground stations that provide GPS signal corrections), memory for up to 500 landmarks and 50 routes. These equipments have built-in database showing the location of towns and cities and have large user friendly control buttons and menu controlled software. They have accuracy for position less than 15 meters. The accuracy of position can be increased to within 3 meters applying WAAS.

1.5 Compasses

A compass is a navigational instrument for determining direction relative to the Earth's magnetic poles. It consists of a magnetized pointer (usually marked on the North end) free to align itself with earth's magnetic field. A compass is any magnetically sensitive device capable of indicating the direction of the magnetic north of a planet's magnetosphere. The face of the compass generally highlights the cardinal points of north, south, east and west.

Compass is used to measure horizontal angle from north-south direction. The equipment should have underlying mirror which allows very simple sighting with a high accuracy of one degree.

The needles shall be rotating on sapphire bearings in antistatic fluid with adjustable declination scale.

1.6 Measuring tape

A tape measure or measuring tape is a flexible form of ruler. It consists of a ribbon of cloth, plastic, fiber glass or metal strip with linear measurement markings. It is a common measuring tool. Its flexibility allows for a measure of great length to be easily carried in pocket or toolkit and permits one to measure around curves or corners. Surveyors use tape measures in lengths of over 100 m.

1.7 Plumb Bobs

A plumb bob or a plummet is a weight, usually with a pointed tip on the bottom, which is suspended from a string and used as a vertical reference line or plumb line. It is also used in surveying to establish the nadir with respect to gravity of a point in space. They are used with a variety of instruments including levels, theodolites and steel tapes to set the instrument exactly over a fixed survey marker or to transcribe positions onto the ground for placing a marker.

2. Earth Excavators

Excavators are heavy equipment consisting of a boom, bucket and cab on a rotating platform known as the control room. The house sits atop an under carriage with tracks or wheels. All movement and functions of the excavator are accomplished through the use of hydraulic fluid, be it with rams or motors.

Types of excavator:

- Compact excavator
- Crawler excavator
- Wheeled excavators
- Backhoe loader
- Dragline excavator
- Long reach excavator
- Power shovel
- Suction excavator

Excavators are used in many ways:

- Digging of trenches, holes and foundations
- Material handling
- Brush cutting with hydraulic attachments
- Forestry work
- Demolition
- General grading/landscaping
- Heavy lift, e.g. lifting and placing of pipes
- Mining, especially, but not only open-pit mining
- River dredging
- Driving piles, in conjunction with a Pile Driver

1. Compact Excavator

A compact or mini excavator is tracked or wheeled vehicle with an approximate operating weight from 0.7 to 7.5 tons. It generally includes a standard backfill blade and features independent boom swing. Hydraulic Excavators are somewhat different from other construction equipment in that all movement and functions of the machine are accomplished through the transfer of hydraulic fluid. The compact excavator's work group and blade are activated by hydraulic fluid acting upon hydraulic cylinders. The excavator's slew (rotation) and travel functions are also activated by hydraulic fluid powering hydraulic motors.



Fig. Compact excavator

2. Crawler Excavator

a) Mini-Crawler Excavator

With a wide range of available sizes and features like Power Tech engines, zero-tail-swing, offset boom, multiple attachments and ultra comfortable operator stations, there's excavator to fit

every job. Hydraulic management system, which helps by balancing hydraulic pressure and flow and sensing when extra power is needed without draining other systems.



Fig. Mini-Crawler Excavator

b) Heavy Crawler Excavator

Crawler excavator gets the job done with muscle, control and peerless productivity. Efficient, cool-running engines and enhanced hydraulics make these the most-reliable and hardest-working excavators yet. Climb into one of these best-in-class cabs and unleash a mighty workhorse to tackle toughest jobs.

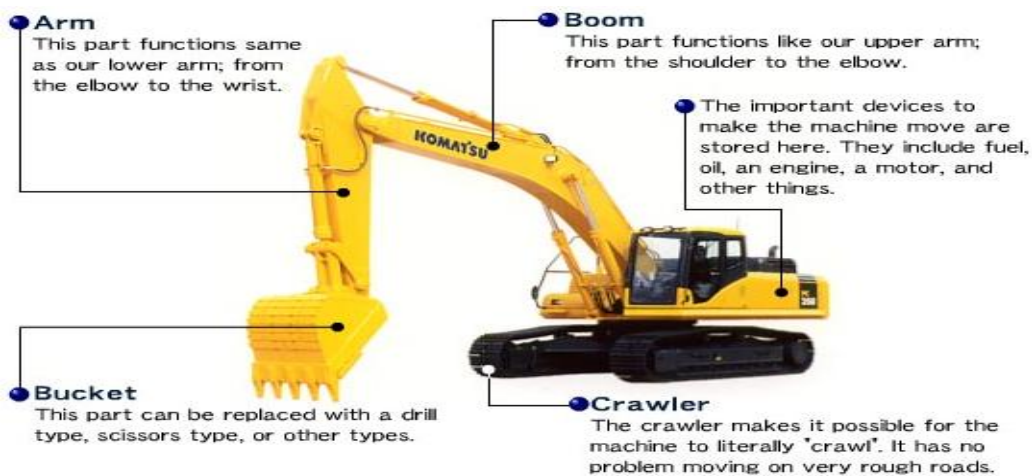


Fig. Basic parts of excavator

3. Wheeled Excavators

Wheeled excavators easily navigate streets and hard surfaces to deliver powerful bucket forces in well-balanced, high-stability machines. Even with all that muscle outside, operators find quiet comfort inside spacious air conditioned cabs. Low effort levers deliver smooth boom and bucket control.



Fig. Wheeled Excavators

4. Backhoe loader

Backhoe loader, also called a loader backhoe and commonly shortened to backhoe, is a heavy equipment vehicle that consists of a tractor fitted with a shovel/bucket on the front and a small backhoe on the back. Due to its relatively small size and versatility, backhoe loaders are very common in urban engineering and small construction projects (such as building a small house, fixing urban roads, etc).



Fig. Backhoe loader

Backhoe loaders deliver versatility and power in a cost-efficient package, whether placing pipe, busting up blacktop or digging deep. Each model features excavator-style boom, bucket and hydraulics. Crowd power, swing torque and boom and dipper stick lift are impressive and high pressure hydraulics are powerful and quick. Easy-to-operate controls smoothly blend functions.

5. Dragline Excavator

Dragline Excavation Systems are heavy equipment used in civil engineering and surface mining. In civil engineering the smaller types are used for road and port construction. The larger types are used in striping operations to move overburden above coal, and for tar sand mining. Draglines are amongst the largest mobile equipment ever built on land, and weigh in the vicinity of 2000 metric tons, though specimens weighing up to 13,000 metric tons have also been constructed.

A dragline bucket system consists of a large bucket which is suspended from a boom (a large truss like structure) with wire ropes. The bucket is maneuvered by means of a number of ropes and chains. The hoist rope, powered by large diesel or electric motors, supports the bucket and hoist coupler assembly from the boom. The dragrope is used to draw the bucket assembly horizontally. By skillful maneuver of the hoist and the dragropes the bucket is controlled for various operations. A schematic of a large dragline bucket system is shown below.



Fig. Dragline Excavator

6. Long Reach Excavator

The long reach excavator or high reach excavator is a development of the excavator with an especially long boom arm, which is primarily used for demolition. Instead of excavating ditches, the long reach excavator is designed to reach the upper stories of buildings that are being demolished and pull down the structure in a controlled fashion. Today it has largely replaced the wrecking ball as the primary tool for demolition.



Fig. Long Reach Excavator

7. Power Shovel

A power shovel (also stripping shovel or front shovel or electric mining shovel) is a bucket equipped machine, usually electrically powered, used for digging and loading earth or fragmented rock and for mineral extraction.



Fig. Power Shovel

8. Suction Excavator

A suction excavator or vacuum excavator is a construction vehicle that removes earth from a hole on land or removes heavy debris on land, from various places, by powerful suction through a wide suction pipe which is up to a foot or so diameter. The suction inlet air speed may be up to 100 meters/second.

The suction nozzle may have two handles for a man to hold it by; those handles may be on a collar which can be rotated to uncover suction release openings (with grilles over) to release the suction to make the suction nozzle drop anything which it has picked up and is too big to go up the tube.

The end of the tube may be toothed. This helps to cut earth when use for excavating; but when it is used to suck up loose debris and litter, some types of debris items may snag on the teeth. The earth to be sucked out may be loosened first with a compressed-air lance or a powerful water jet.



Fig. Cleaning out a sewer manhole

3. Tipper (dumper truck)

A tipper or dump truck is a truck used for transporting loose material (such as sand, gravel or dirt) for construction. A typical dump truck is equipped with a hydraulically operated open-box bed hinged at the rear, the front of which can be lifted up to allow the contents to be deposited on the ground behind the truck at the site of delivery.

Types of dump trucks

- Standard dump truck
- Articulated dump truck
- Transfer dump truck
- Truck and pup
- Semi trailer end dump truck
- Semi trailer bottom dump truck
- Double and triple trailer bottom dump truck
- Side dump truck
- Off-road dump truck

3.1 Standard dump truck

A standard dump truck is a truck chassis with a dump body mounted to the frame. The bed is raised by a hydraulic ram mounted under the front of the dumper body between the frames and the back of the bed is hinged at the back to the truck. The tailgate can be configured to swing on

hinges or it can be configured in the "High Lift Tailgate" format wherein pneumatic rams lift the gate open and up above the dump body.

3.2 Articulated dump truck

An articulated dump truck has a hinge between the cab and the dump box, but is distinct from semi trailer trucks in that the cab is a permanent fixture, not a separable vehicle. Steering is accomplished via hydraulic rams that pivot the entire cab, rather than rack and pinion steering on the front axle. This vehicle is highly adaptable to rough terrain. In line with its use in rough terrain, longer distances and overly flat surfaces tend to cause driveline troubles and failures. Articulated trucks are often referred to as the modern scraper, in the sense that they carry a much higher maintenance burden than most trucks.



Fig. Articulated dump truck or dumper

3.3 Transfer dump truck

A transfer dump is a standard dump truck which pulls a separate trailer which can also be loaded with aggregate (gravel, sand, asphalt, snow, wood chips, triple mix etc.) The second aggregate container on the trailer is powered by either an electric, pneumatic motor or hydraulic line. It rolls on small wheels, riding on rails from the trailer's frame, into the empty main dump box. This maximizes payload capacity without sacrificing the maneuverability of the standard dump truck. Transfer dump trucks typically haul between 26 and 27 tons of aggregate per load.



Fig. transfer truck and trailer

3.4 Truck and pup

A truck and pup is very similar to a transfer dump. It consists of a standard dump truck pulling a dump trailer. The pup trailer, unlike the transfer, has its own hydraulic ram and is capable of self-unloading.

3.5 Semi trailer end dump truck

A semi end dump truck is a tractor-trailer combination wherein the trailer itself contains the hydraulic hoist. A typical semi end dump has a 3-axle tractor pulling a 2-axle semi-trailer. The key advantage of a semi end dump is rapid unloading. A key disadvantage is that they are very unstable when raised in the dumping position limiting their use in many applications where the dumping location is uneven or off level.

3.6 Semi trailer bottom dump truck

A semi trailer bottom dump truck is a 3-axle tractor pulling a 2-axle trailer with a clam shell type dump gate in the belly of the trailer. The key advantage of a semi bottom dump is its ability to lay material in a wind row (a linear heap). In addition, a semi bottom dump is maneuverable in reverse, unlike the double and triple trailer configurations. These do not work well with larger materials. Likewise they are not suitable for use where spreading is not desired such as when hot asphalt paving material is being dumped into a paving machine.



Fig. Bottom dump trailer

3.7 Double and triple trailer bottom dump truck

Double and triple bottom dumps consist of a 2-axle tractor pulling one single-axle semi-trailer and an additional full trailer (or two full trailers in the case of triples). These dump trucks allow the driver to lay material in windrows without leaving the cab or stopping the truck. The main disadvantage is the difficulty in backing double and triple units.

The specific type of dump truck used in any specific country is likely to be closely keyed to the weight and axle limitations of that jurisdiction. Rock, dirt and other types of materials commonly hauled in trucks of this type are quite heavy and almost any style of truck can be easily overloaded. Because of this, this type of truck is frequently configured to take advantage of local weight limitations to maximize the cargo. For example, the maximum weight limit of 40 tons throughout the country, except for specific bridges with lower limits. Individual states, in some instances, are allowed to authorize trucks up to 52.5 tons.

3.8 Side dump truck

A side dump truck consists of a 3-axle tractor pulling a 2-axle semitrailer. It has hydraulic rams which tilt the dump body onto its side, spilling the material to either the left or right side of the trailer. The key advantages of the side dump are that it allows rapid unloading and can carry more weight. In addition, it is almost immune to upset (tipping over) while dumping unlike the semi end dumps which are very prone to tipping over. It is, however, highly likely that a side dump trailer will tip over if dumping is stopped prematurely. Also, when dumping loose materials or cobble sized stone, the side dump can become stuck if the pile becomes wide enough to cover too much of the trailer's wheels. Trailers that dump at the appropriate angle (50° for example)

avoid the problem of the dumped load fouling the path of the trailer wheels by dumping their loads further to the side of the truck, in some cases leaving sufficient clearance to walk between the dumped load and the trailer.

3.9 Off-road dump truck

Off-road dump trucks more closely resemble heavy construction equipment or engineering vehicles than they do highway dump trucks. Off-road dump trucks are used strictly off-road for mining and heavy dirt hauling jobs. There are two primary forms: rigid frame and articulating frame.

Bottom dump normally describes a trailer that discharges its load by opening two clamshell doors under the load space. In some instances, one tractor may pull several trailers (road train). This large capacity truck is used for the transportation of coal from a loading device (shovel) directly to a power station or bulk storage area.

4. Dozing Equipment

Powerful machine for pushing earth or rocks, used in road building, farming, construction and wrecking; it consists of a heavy, broad steel blade or plate mounted on the front of a tractor. Sometimes it uses a four-wheel-drive tractor, but usually a track or crawler type, mounted on continuous metal treads, is employed. The blade may be lifted and forced down by hydraulic rams. For digging, the blade is held below surface level; for transporting, it is held at the surface level and for spreading, it is held above the surface level, as the tractor moves forward.

Responsive Operation:

A single joystick on the left controls all speed and directional changes including:

- Forward and reverse
- Right and left steering

A single joystick on the right controls all blade functions including:

- Lifting
- Angling
- Tilting

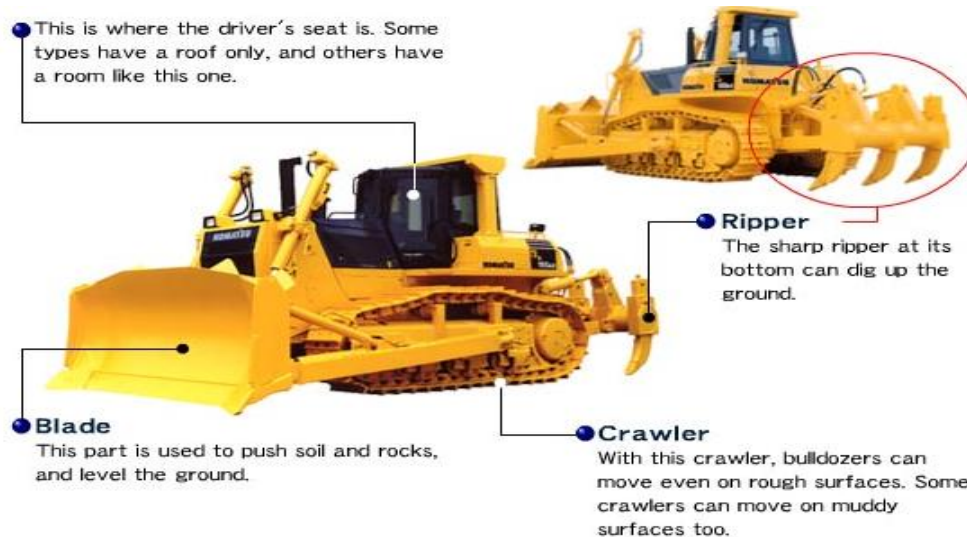


Fig. Crawler dozer

Bulldozers:

Bulldozer, which pushes earth and rocks with a blade installed at the machine's front end. Large-sized crawler dozers normally have a set of claws called a ripper that is installed at the machine's rear end and can crush a hard rock. Swamp bulldozers are equipped with an undercarriage that is configured to enable them to freely move around on a marshy land. As a fellow machine, there is a pipe-laying machine that lays down a large steel pipe in the construction of a pipeline and a dozer shovel (crawler loader) for loading.

5. Compaction Equipment: Vibratory Roller

Salient Feature

- Transported in standard normal vehicle dual to compact design
- 180° rotation of operator seat with controls & locking at 90°, 45° & 30° in both direction.
- Optimum configuration of drum axle load, dual amplitude & dual frequency.
- Hyd. kit for longer Life.
- Thick & rigid drum construction to ensure smooth & wobble free compaction.
- Articulated sturdy chassis design.
- Superb all-round view and improved front rear visibility.
- Uniform working pressure on front - rear drums.
- Higher gradeability due to higher capacity engine.

5.1 Single Drum Vibratory Rollers

Single Drum Vibratory Rollers are used to compact all types of soil with the exception of rock fill. The rollers are suitable for most types of road construction, airfields, dam construction, harbor projects and industrial constructions. Heavy-size vibratory rollers are used for a very wide range of applications.

5.2 Earth Compactor

Earth compactors are designed for diverse application in compacting soil, sand and breaking stone. Therefore these earth compactors are ideal for construction purposes and road projects since these works require compaction.

5.3 Plate Compactor

Plate Compactor is particularly suitable for application like compacting loose gravel and sand on footpaths, sub-grade for concrete floors, trenches, column footings & for small repair works like pot-hole repairs.

5.4. Road roller

Road rollers use the weight of the vehicle to compress the surface being rolled. Initial compaction of the substrata is done using a pneumatic roller, with two rows (front and back) of pneumatic tyres. The flexibility of the tyres, with a certain amount of vertical movement of the wheels, enables the roller to operate effectively on uneven ground. The finish is done using metal-drum rollers to ensure a smooth, even result.



Fig. Vibratory Roller

6. Grading Equipment

A grader, also known as a road grader, a blade, a maintainer or a motor grader. This is a construction machine with a long blade used to create a flat surface. Graders can produce inclined surfaces, to give cant (camber) to roads. In some cases they are used to produce drainage ditches with shallow V-shaped cross-sections on either side of highways.

Graders are commonly used in the construction and maintenance of dirt roads and gravel roads. In the construction of paved roads they are used to prepare the base course to create a wide flat surface for the asphalt to be placed on. Similarly, graders are used for leveling the surface during earthwork is embankments and providing blanket surface before spreading ballast and laying track. Graders are also used to set native soil foundation pads to finish grade prior to the construction of large buildings and for underground mining. Capacities range from a blade width of 2.50m to 7.30 m and engines from 93–373 kW (125–500 hp).



Fig. Grader Machine

7. Trenchers

Trenchers or Trenching machines are used to excavate trenches in soil. These trenches are generally used for pipeline laying, cable laying, drainage purposes etc. Trenching machines are available in two types namely chain trenchers and wheeled trenchers.

Chain trenchers contain a fixed long arm around which digging chain is provided. Wheeled trenchers contain a metal wheel with digging tooth around it. To excavate hard soil layers, wheeled trenchers are more suitable. Both types of trenchers are available in tracked as well as wheeled vehicle forms.

8. Scrapers

The design of scrapers (tractor scrapers) allows for loading, hauling, dumping, and spreading of loose materials. Use a scraper for medium-haul earthmoving operations and for moving ripped materials and shot rock. The haul distance (zone of operation), the load volume, and the type and grade of surface traveled on are the primary factors in determining whether to use a scraper on a

particular job. The optimum haul distance for the small and medium-size scrapers is 300 to 3,000 feet. There are larger scrapers that are effective up to 5,000 feet.

A scraper has the following main parts:

- **Bowl:** The bowl is the loading and carrying component. It has a cutting edge, which extends across the front bottom edge. Lower the bowl until the cutting edge enters the ground for loading, raise it for carrying, and lower it to the desired lift thickness for dumping and spreading.
- **Apron:** The apron is the front wall of the bowl. It is independent of the bowl and, when raised, it provides an opening for loading and spreading. Lower the apron during hauling to prevent spillage.
- **Ejector.** The ejector is the rear wall of the bowl. Keep the ejector in the rear position when loading and hauling materials. Activate the ejector to move forward during spreading to provide positive discharge of materials.



Fig. Scraper

9. Tunneling Equipment

Tunneling equipment is a machine used to excavate tunnels with a circular cross section through a variety of soil and rock strata. They can bore through hard rock, sand and almost anything in between. Tunnel diameters can range from a meter (done with micro-TBMs) to almost 16 meters. Tunnels of less than a meter or so in diameter are typically done using trenchless construction methods or horizontal directional drilling.

Tunneling equipment has limiting disturbance to the surrounding ground and producing a smooth tunnel wall. This significantly reduces the cost of lining the tunnel and makes them suitable to

use in heavy urbanized areas. The major disadvantage is the upfront cost. TBMs are expensive to construct and can be difficult to transport. However, as modern tunnels become longer, the cost of tunnel boring machines versus drill and blast is actually less-this is because tunneling with TBMs is much more efficient and results in a shorter project period.

Type of tunneling equipment:

- Auger boring machine
- Gripper tunnel boring machine
- Double shield tunnel boring machine
- Single shield tunnel boring machine
- Earth pressure balance tunnel boring machine
- Micro tunneling boring machine
- Slurry pressure balance tunnel boring machine

9.1. Auger Boring Machine

An Auger Boring Machine (ABM) is used to bore horizontally through soil or rock with a cutting head and auger. The majority of ABMs are used to install pipe casing under railroads, highways, airport runways, creeks or any area of ground that cannot be open cut or disturbed in any way.

There are many types of cutting attachments for this machine. They range from Backhoe Teeth cutters for cutting through soil to the Small Boring Unit for boring hard rock.

Initially the ABM is set up in the starting pit on a predetermined length of track. A backing plate, usually steel or reinforced concrete block is installed in the wall opposite of the boring to withstand the thrust exerted by the boring machine. The machine bores through the earth with a cutting head and the jacking force is provided by the hydraulic thrust. The pipe casing and auger sections are added as the machine advances. Spoil is removed from the auger through the casing to a door located on the side of the machine.

9.2. Gripper Tunnel Boring Machine (TBM)

Main Beam of TBM is complex in its design, yet relatively simple in concept. The front of the TBM is a rotating cutter head that matches the diameter of the tunnel. The cutter head holds disc cutters which are positioned for optimal boring of the given rock type. As the cutter head turns,

hydraulic propel cylinders push the cutters into the rock. The transfer of this high thrust through the rolling disc cutters creates fractures in the rock causing chips to break away from the tunnel face. A unique floating gripper system pushes on the sidewalls and is locked in place while the propel cylinders extend, allowing the main beam to advance the TBM.

The machine can be continuously steered while gripper shoes push on the sidewalls to react the machine's forward thrust. Buckets in the rotating cutter head scoop up and deposit the muck on to a belt conveyor inside the main beam. The muck is then transferred to the rear of the machine for removal from the tunnel. At the end of a stroke the rear legs of the machine are lowered, the grippers and propel cylinders are retracted. The retraction of the propel cylinders repositions the gripper assembly for the next boring cycle. The grippers are extended, the rear legs lifted, and boring begins again.

9.3. Double Shield Tunnel Boring Machine (TBM)

A Double Shield TBM consists of a rotating cutter head mounted to the cutter head support followed by three shields: a telescopic shield (a smaller diameter inner shield which slides within the larger outer shield), a gripper shield and a tail shield.

In normal operation ("double shield mode"), the gripper shoes are energized, pushing against the tunnel walls to react the boring forces. The main propel cylinders are then extended to push the cutter head support and cutter head forward. The rotating cutter head cuts the rock. The telescopic shield extends as the machine advances keeping everything in the machine under cover and protected from the ground surrounding it.

The gripper shield remains stationary during boring. A segment erector is fixed to the gripper shield allowing pre-cast concrete tunnel lining segments to be erected while the machine is boring. The segments are erected within the safety of the tail shield. It is the Double Shield's ability to erect the tunnel lining simultaneously with boring that allows it to achieve such high performance rates. The completely enclosed shielded design provides the safe working environment.

If the ground becomes too weak to support the gripper shoe pressure, the machine thrust must be reacted another way. In this situation, the machine can be operated in "single shield mode". Auxiliary thrust cylinders are located in the gripper shield. In single shield mode they transfer the thrust from the gripper shield to the tunnel lining. Since the thrust is transferred to the tunnel lining, it is not possible to erect the lining simultaneously with boring. In the single shield mode, tunnel boring and tunnel lining erection are sequential operations.

Regardless of the operating mode, working crews remain protected within the shields. Double Shield TBMs are capable of safely excavating a wide range of geologic conditions on a project. Double Shield TBMs are manufactured to suit project requirements, in diameters from 1.6 m to 15 m.

9.4. Single Shield Tunnel Boring Machine (TBM)

Single Shield TBMs protect workers from broken rock until the tunnel lining can be safely installed. The body of the machine is enclosed in a shield that is marginally smaller than the diameter of the tunnel. The flat, low-profile cutter head minimizes disturbance of the face as it bores and prevents large blocks from collapsing and causing excessive boring stresses. The front of the TBM is a rotating cutter head that matches the diameter of the tunnel. As the cutter head turns, a ring of hydraulic cylinders provides forward thrust through shoes that push against the tunnel lining.

The cutter head holds disc cutters positioned for optimal boring. The transfer of high thrust through the rolling disc cutters creates fractures in the rock, causing chips to break away from the face. Boring and lining installation are performed sequentially. To steer, cylinders orient the articulated cutter head in the required direction.

9.5. Earth Pressure Balance Tunnel Boring Machine (EPB TBM)

If the geology ranges from soft soils to weathered rock, then Earth Pressure Balance Machine (EPBM) is the correct technical solution for project. This is particularly true when project is located in an urban environment and ground surface subsidence cannot be tolerated.

EPBMs are utilized in the construction of rail tunnels, metropolitan subway systems, highway tunnels, and other projects where the tunnel will be constructed either partly or completely in soft soil beneath the water table.

9.6. Micro tunneling Boring Machine (MTBM)

Small Boring Units is a small diameter rock cutting head (from 600 mm to 1.8 m) that can be used with any Auger Boring Machine (ABM) to excavate hard rock on drives less than 150 m.

Motorized Small Boring Units (SBU-Ms) is used to bore a small diameter tunnel in hard rock where line and grade are critical. These machines have been specifically designed for long bores (over 500 ft/150 m) with difficult ground conditions. They are offered in cutter head diameters from 1.2 m to 2.0 m.

9.7. Slurry Pressure Balance Tunnel Boring Machine (SPB TBM)

Bentonite slurry, consisting of a specific clay and water mixture is universally used in boring and digging operations. The slurry has numerous properties: sealing of the cutting face, reduced friction on the TBM's structure and transport of cuttings to the separation plant outside the tunnel.

The basic principle of this TBM is to maintain the tunnel's cutting face during the excavation phase by filling the working chamber, located behind the cutter head, with slurry. Slurry pressure is carefully controlled by a large air bubble which is maintained by a separately-controlled air supply system. This air bubble acts as a damper by absorbing sudden variations in mucking output.

10. Lifting Equipments

Crane

A crane is a lifting machine, generally equipped with a winder (also called a wire rope drum), wire ropes or chains and sheaves that can be used both to lift and lower materials and to move them horizontally. It uses one or more simple machines to create mechanical advantage and thus move loads beyond the normal capability of a human. Cranes are commonly employed in the construction industry, lifting of heavy material, girders etc.

10.1 Mobile cranes

The most basic type of mobile crane consists of a truss or telescopic boom mounted on a mobile platform - be it on road, rail or water.

1. Truck-Mounted Crane



Fig. Truck-Mounted Crane

Crane mounted on a truck carrier provides the mobility for this type of crane.

These cranes are able to travel on highways, eliminating the need for special equipment to transport the crane. When working on the jobsite, outriggers are extended horizontally from the chassis then vertically to level and stabilize the crane while stationary and hoisting. Many truck cranes have slow-travelling capability (a few miles per hour) while suspending a load. Great care must be taken not to swing the load sideways from the direction of travel, as most anti-tipping stability then lies in the stiffness of the chassis suspension.

Most cranes of this type also have moving counterweights for stabilization beyond that provided by the outriggers. Loads suspended directly aft are the most stable, since most of the weight of the crane acts as a counterweight. Factory-calculated charts (or electronic safeguards) are used by crane operators to determine the maximum safe loads for stationary work as well as (on-rubber) loads and travelling speeds. Truck cranes range in lifting capacity from about 12900kg to 13155kg.

2. Rough Terrain Crane

A crane mounted on an undercarriage with four rubber tires that is designed for pick-and-carry operations and for off-road and "rough terrain" applications. Outriggers are used to level and stabilize the crane for hoisting.

These telescopic cranes are single-engine machines, with the same engine powering the undercarriage and the crane, similar to a crawler crane. In a rough terrain crane, the engine is usually mounted in the undercarriage rather than in the upper, as with crawler crane.

3. Side lift Crane

A side lifter crane is a road-going truck or semi-trailer, able to hoist and transport containers. Container lift is done with parallel crane-like hoists, which can lift a container from the ground or from a railway vehicle.

4. All Terrain Crane

It is a mobile crane with the necessary equipment to travel at speed on public roads and on rough terrain at the job site using all-wheel and crab steering. AT's combine the road ability of Truck-mounted Cranes and the maneuverability of Rough Terrain Cranes. AT's have 2-9 axles and are designed for lifting loads up to 1,200 tons.

5. Crawler Crane

A crawler is a crane mounted on an undercarriage with a set of tracks (also called crawlers) that provide stability and mobility. Crawler cranes range in lifting capacity from about (35.7 to 3,125.0 tons).

Crawler cranes have both advantages and disadvantages depending on their use. Their main advantage is that they can move around on site and perform each lift with little set-up, since the crane is stable on its tracks with no outriggers. In addition, a crawler crane is capable of traveling with a load. The main disadvantage is that they are very heavy, and cannot easily be moved from one job site to another without significant expense. Typically a large crawler must be disassembled and moved by trucks, rail cars or ships to its next location.



Fig. Crawler Crane

6. Floating Crane

Floating cranes are used mainly in bridge building and port construction, but they are also used for occasional loading and unloading of especially heavy or awkward loads on and off ships. Some floating cranes are mounted on a pontoon, others are specialized crane barges with a lifting capacity exceeding 9,072 tons and have been used to transport entire bridge sections. Floating cranes have also been used to salvage sunken ships. Crane vessels are often used in offshore construction.



Fig. Floating Crane

7. Tower Cranes

Tower cranes are a modern form of balance crane that consist of the same basic parts. Fixed to the ground on a concrete slab (and sometimes attached to the sides of structures as well), tower cranes often give the best combination of height and lifting capacity and are used in the construction of tall buildings. The base is then attached to the mast which gives the crane its height. Further the mast is attached to the slewing unit (gear and motor) that allows the crane to

rotate. On top of the slewing unit there are three main parts which are: the long horizontal jib (working arm), shorter counter-jib, and the 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 and 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 turntable, but can be mounted on the jib or partway down the tower. The lifting hook is operated by the crane operator using electric motors to manipulate wire rope cables through a system of sheaves. The hook is located on the long horizontal arm to lift the load which also contains its motor.



Fig. Tower Crane Rotates on its axis

11. Concrete Mixer

There are two main categories of mixer: batch mixers and continuous mixers. The first type of mixer produces concrete one batch at a time, while the second type produces concrete at a constant rate. The first type needs to be emptied completely after each mixing cycle, cleaned (if possible), and reloaded with the materials for the next batch of concrete. In the second type, the constituents are continuously entered at one end as the fresh concrete exits the other end. The various designs of each type of mixer will now be discussed.

11.1 Batch Mixers

Two main types of batch mixer can be distinguished by the orientation of the axis of rotation: horizontal or inclined (drum mixers) or vertical (pan mixers). The drum mixers have a drum, with fixed blades, rotating around its axis, while the pan mixers may have either the blades or the pan rotating around the axis.

a) Drum Mixers

All the drum mixers have a container with a cross section similar to that shown in Fig. 1. The blades are attached to the inside of the movable drum. Their main purpose is to lift the materials as the drum rotates. In each rotation, the lifted material drops back into the mixer at the bottom of the drum and the cycle starts again. Parameters that can be controlled are the rotation speed of the drum and, in certain mixers, the angle of inclination of the rotation axis.

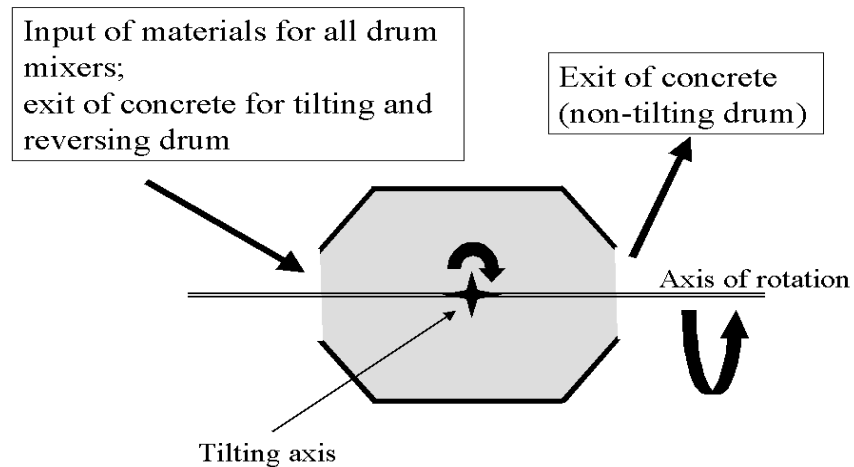


Fig. Cross section of drum mixer

There are three main types of drum mixers:

- Non-tilting drum;
- Reversing drum;
- Tilting drum.

The non-tilting drum mixer implies that the orientation of the drum is fixed. The materials are added at one end and discharged at the other. The reversing drum is similar to the non-tilting mixer except that the same opening is used to add the constituents and to discharge concrete. The drum rotates in one direction for mixing and in the opposite direction for discharging the concrete. There are two types of blades attached to the inner walls of the drum. One set drags the concrete upwards and toward the center of the mixer when the drum rotates in one direction; the

second set of blades pushes the concrete toward the opening when the drum rotates in the other direction. The blades have a spiral arrangement to obtain the desired effect for discharge and mixing. Reversing drum mixers are usually used for batches up to 1 m³.

The truck mixers belong to the reversing category of drum mixers. The driver of the truck can control the speed of rotation with a clutch in the cabin. The speed depends on whether the concrete has been well mixed prior to being placed in the truck or whether the truck has to do most of the mixing. Typically the speed for mixing is 1.57 rad/s (15 rpm), while the transport of pre-mixed concrete uses only 0.2 rad/s (2 rpm) to 0.6 rad/s (6 rpm).

In a tilting drum mixer, the inclination can be varied. When the drum is almost horizontal (inclination ≈ 0), more energy is provided to the concrete because more concrete is lifted to the full diameter of the drum before dropping. It is during the drop that the concrete is knitted and mixed. Therefore, the higher the drop, the higher the energy imparted to the concrete. If the axis of rotation is almost vertical the blades cannot lift the concrete and the concrete is not well mixed. The drum axis usually stays at an angle of about 15° from horizontal during mixing. To discharge the concrete the drum is tilted downwards below the horizontal plane. The tilting drum is the most common type of drum mixer for small batches (less than 0.5 m³) both in the laboratory and in the field.

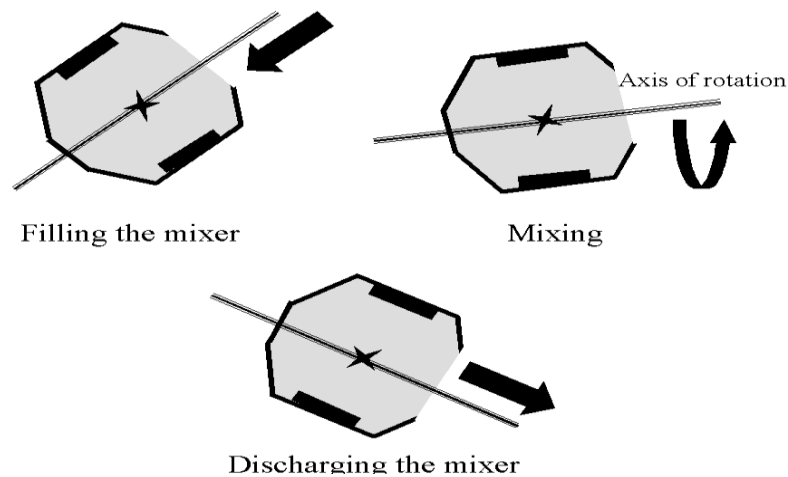


Fig. Cross section of tilting mixer

b) Pan Mixers

All pan mixers work on basically the same principle: a cylindrical pan (fixed or rotating) contains the concrete to be mixed, while one or two sets of blades rotate inside the pan to mix the materials and a blade scrapes the wall of the pan. The shapes of the blades and the axes of rotation vary. Figure below shows the different combinations of blade configurations and pan. The other element of the mixer is the scraper

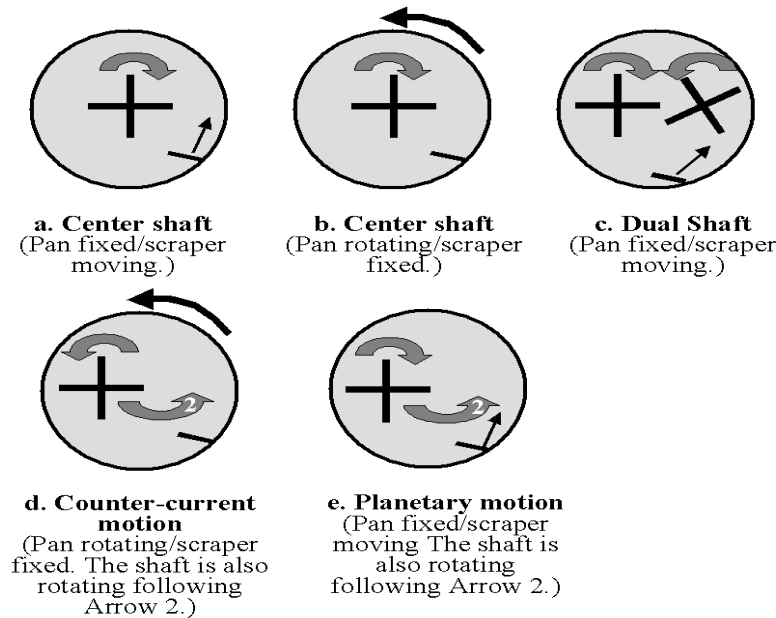


Fig Various configurations for pan mixers. The arrows indicate the direction of rotation of the pan, blades, and scraper.

11.2 Continuous Mixers

The second category of mixers is continuous mixers. As the name indicates, the materials are continuously fed into the mixer at the same rate as the concrete is discharged. They are usually non-tilting drums with screw-type blades rotating in the middle of the drum. The drum is tilted downward toward the discharge opening. The mixing time is determined by the slope of the drum (usually about 15°).

These mixers are used for applications that require a short working time, long unloading time, remote sites (not suitable for ready-mix) and/or small deliveries. A major use of these types of mixers is for low slump (non flowable concretes (e.g., pavements)). Due to the short mixing time, the air content is not easily controlled even with the addition of air entraining admixtures.

12. Concrete Mixer Truck

Concrete Mixer Truck transports concrete /mortar directly from plant to the place where it is to be poured. Concrete mixer with various capacities is mounted on truck. It has a wide range of applications specially for mass concreting works like Multi-storeyed buildings, Bridge works etc.

The basic function of transit mixer is to maintain the concrete's liquid state, through the turning of the drum till the point of delivering at construction site.

13. Concrete Pump

A concrete pump is a tool used for transferring liquid/flowable concrete by pumping. There are two types of concrete pumps.

The first type of concrete pump is attached to a truck. This is known as a trailer-mounted boom concrete pump because it uses a remote controlled articulating robotic arm (called a boom) to place concrete with pinpoint accuracy. Boom pumps are used on most of the larger construction projects as they are capable of pumping at very high volumes and because of the labour saving nature of the placing boom.

The second main type of concrete pump is either mounted on a truck and known as a truck-mounted concrete pump or placed on a trailer, and it is commonly referred to as a line pump or trailer-mounted concrete pump. This pump requires steel or rubber concrete placing hoses to be manually attached to the outlet of the machine. Those hoses are linked together and lead to wherever the concrete needs to be placed. Line pumps normally pump concrete at lower volumes than boom pumps and are used for smaller volume concrete placing applications such as swimming pools, sidewalks and single family home concrete slabs and most ground slabs.

There are also skid-mounted and rail mounted concrete pumps, but these are uncommon and only used on specialized jobsites such as mines and tunnels.

Type of concrete pump:

- Concrete boom pump

- Truck Mounted Concrete Pumps
- Trailer Mounted Concrete Pumps
- Concrete Distributor

13.1. Concrete boom pump

Concrete Boom Pumps are an indigenous solution that ensures faster completion of job and reduced down time. These boom pumps are available in different lengths. The boom allows quick setting-up by overcoming the necessity of cumbersome pipeline laying. Some of the major features available in such pumps are mentioned below:

- Effective reverse pumping and reverse cleaning
- Digital hour meter
- Digital temperature display
- Suitable for two axle chassis
- Less ground space required
- Anti Stalling Device (ASD) to save engine overloading
- Remote control for boom operations
- Pump unloading valve to shut-off oil flow of hydraulic pump during blockages
- Maintenance friendly
- RPM and output regulation
- Water separator with display
- High pressure cleaning pump with large water tank

13.2. Truck Mounted Concrete Pumps

Truck Mounted Concrete Pump is a complete solution for Ready Mix. And equipped with the highly wear resistant transfer tube and can pump the most difficult concrete. It carries its own pipelines and accessories and consists of a water tank and a flushing water pump. The highlighting features of such pumps are listed below

- Highly wear-resistant S-transfer tube system
- Less wear parts
- Powerful agitator from both sides
- State-of-art 'easy clean' hopper
- Maintenance friendly

- Integrated water tank with high pressure pump
- Storage capacity for 100 m pipeline with all accessories
- Air compressor with tank (capacity 160 liters)
- Hydraulic out riggers.

13.3. Trailer Mounted Concrete Pumps

Trailer Mounted Concrete Pumps are ideal for wide range applications and the high-pressure models are extensively used for high-rise and long distance conveying. Some of the salient features of our range are mentioned below:

- Highly wear-resistant S-transfer tube system
- Less wear parts
- Powerful agitator
- State-of-art 'easy clean' hopper
- Maintenance friendly
- Leaf spring suspension for the demanding Indian roads



Fig. Trailer mounted concrete pump

13.4. Concrete Distributor

The Hydro Mechanical Concrete Distributors provide an inexpensive solution, as a practical complement to stationary concrete pumps, when separate concrete placing booms cannot be used to their full value. The reach of a placing boom on a truck mounted pump can also be increased with the help of concrete distributor.



Fig. Concrete distributor

14. Concrete Vibrator

Concrete Vibrator- Consolidation of concrete should proceed immediately after placing the concrete to make impermeable/dense enough to gain desired strength. The concrete mass should be consolidated or compacted till the cream of concrete starts appearing on the surface. This may be done by hand or by mechanical device. Mechanical compaction is done by use of vibrators. Compaction of concrete by vibration is considered essential for all important work specially in situations where reinforcement are congested or the member is required to have exposed concrete surface finish.

Type of vibrator:

1. Plate Vibrator:

Plate vibrators are used to compact concrete to avoid blowholes on concrete slabs. The compaction level can be adjusted as per the thickness of the slab.

2. Screed Board or Surface Vibrator:

Screen board vibrators are used while pouring the concrete floors to level the faces and making the concrete free of porosity.

3. Needle/ Internal/ Immersion Vibrator:

Internal concrete vibrators are used to consolidate the concrete surface so that it becomes sturdier and gets free of any risk of voids. Based on operation this is either electrically operated or diesel operated. Needle vibrator is mounted on a round plate which dampens the vibrations generated in the engine/motor. The vibrators' needles work on the pendulum principle showing both high frequency and amplitude, distributing vibration equally over the whole needle.

4. Table Vibrator:

Table vibrators are used extensively for precasting. Its main function is to compact the granules for which the controlled vibrations are required.

5. Shutter Vibrator:

This type of vibrator is attached with formwork with nut and bolt attachment where concreting is to be done. After concreting this machine is started and vibration is produced which helps in expelling voids from concrete.

15 Asphalt Drum Mix Plant

15.1 Hot mix plant

Hot Mix Plant or Asphalt Drum Mix Plant is equipment for producing good quality of hot mix for flexible pavement construction. The ingredients of the hot mix in required proportion are continuously fed to the rotating drum in drying & mixing zones and the discharge end of the drum delivers continuous output of the hot mix. The main ingredients of hot mix are virgin cold aggregates of different grades, asphalt (bitumen) and mineral fillers. The output capacity of this plant varies from 30 TPH to 120 TPH (Tone per hour). Asphalt drum mix plant generally consists of :

- Cold Aggregate Four Bin Feeder
- Single Deck Vibratory Screen For Oversized Material Removal
- Slinger (Cold) Conveyor
- Drying Cum Mixing Thermo drum
- Load out conveyor with Gob hopper
- Asphalt Tank
- Mineral Filler Unit
- Centralized Control Panel with Insulated Cabin
- Dryer Auto Burner
- Fuel Storage Tank
- Pollution Control Unit (Optional)

In this the cold aggregates of different grades which are stored in the multiple feeder bins are transferred in required proportion to the primary section of the rotary drum through slinger conveyor. The burner fitted on the in feed side of the drum produce appropriate flame to remove

the moisture from the aggregates and heat the dried aggregates to the desired temperature in the primary section of the drum.

The hot aggregates then travel down the secondary section where they are mixed & coated with the asphalt & filler material. The asphalt and filler material are pumped in the secondary section in predetermined proportion from asphalt tank and mineral filler unit respectively. These hot mix from the drum is then transferred to truck through load out conveyor. The heavy dust is collected by the multi cone type dust collector and the exhaust is passed through wet scrubber type pollution control unit before letting it to the atmosphere.

Asphalt Drum Mix Plants offer advantages of higher production rates, less moving parts, lower maintenance, simple to operate, lower fuel consumption & better economy.

15.2. Wet Mix Macadam Plant / Wet mix plant Soil Stabilizing Plant

Wet Mix Macadam Plant is also Wet mix plant /Soil Stabilizing Plant. This equipment is employed for producing homogenous mixture of aggregates, sand, cement and water which is laid in base or sub base preparation of rigid or flexible pavements. The output capacity of Wet Mix Macadam is 60 TPH, 100 TPH, 160 TPH and 200 TPH. The aggregates and sand stored in multiple feeder bins discharged by each bin feeder belt in desired proportion to gathering belt. This mixed material is then conveyed by gathering belt to Pug mill where it is mixed with water and cement in order to produce the homogenous mixture. The homogenous mixture is further on conveyed to storage silo or trucks for lying at site.

15.3. Road cleaning Machine

Road cleaning machine are used to sweep roads quickly. This machine cleans the road completely and removes the dirt and dust from it in order to assist in road construction. This machine is provided with a rotary brush which mechanically operates and cleans the dust particles settled on the road. This machines is extensively used to clean the sand of the road with a powerful high pressure air blower within a short time there by it saves labour, time and also bitumen.

15.4. Road Kerbing Machine

A curb/kerb is the edge where a raised pavement/sidewalk/footpath, road median or road shoulder meets an unraised street or other roadway. Typically made from concrete, asphalt or long stones (often granite), the purpose is twofold: first as a gutter for proper drainage of the roadway and second for safety, to prevent motorists from driving onto the shoulder, median, sidewalk or pavement.

Road kerbing equipment is widely used in various road projects. These concrete kerbing machine are built under strict guidelines as per international quality standards.

15.5. Asphalt Paver Finisher

Mechanical Asphalt Paver Finisher is a unique paver with combination of features designed and engineered to give maximum output with comforts and efficiency. The hydraulically extendable screed allows step less and hassle free width adjustment. The higher H.P. engine ensures smooth paving in gradients. The paver can be employed for both asphalt as well as wet mix paving with slight modifications.

Paver Finisher is used in road construction industry for paving or laying hot mix material on constructed surface. This is simple to operate and require negligible maintenance.

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