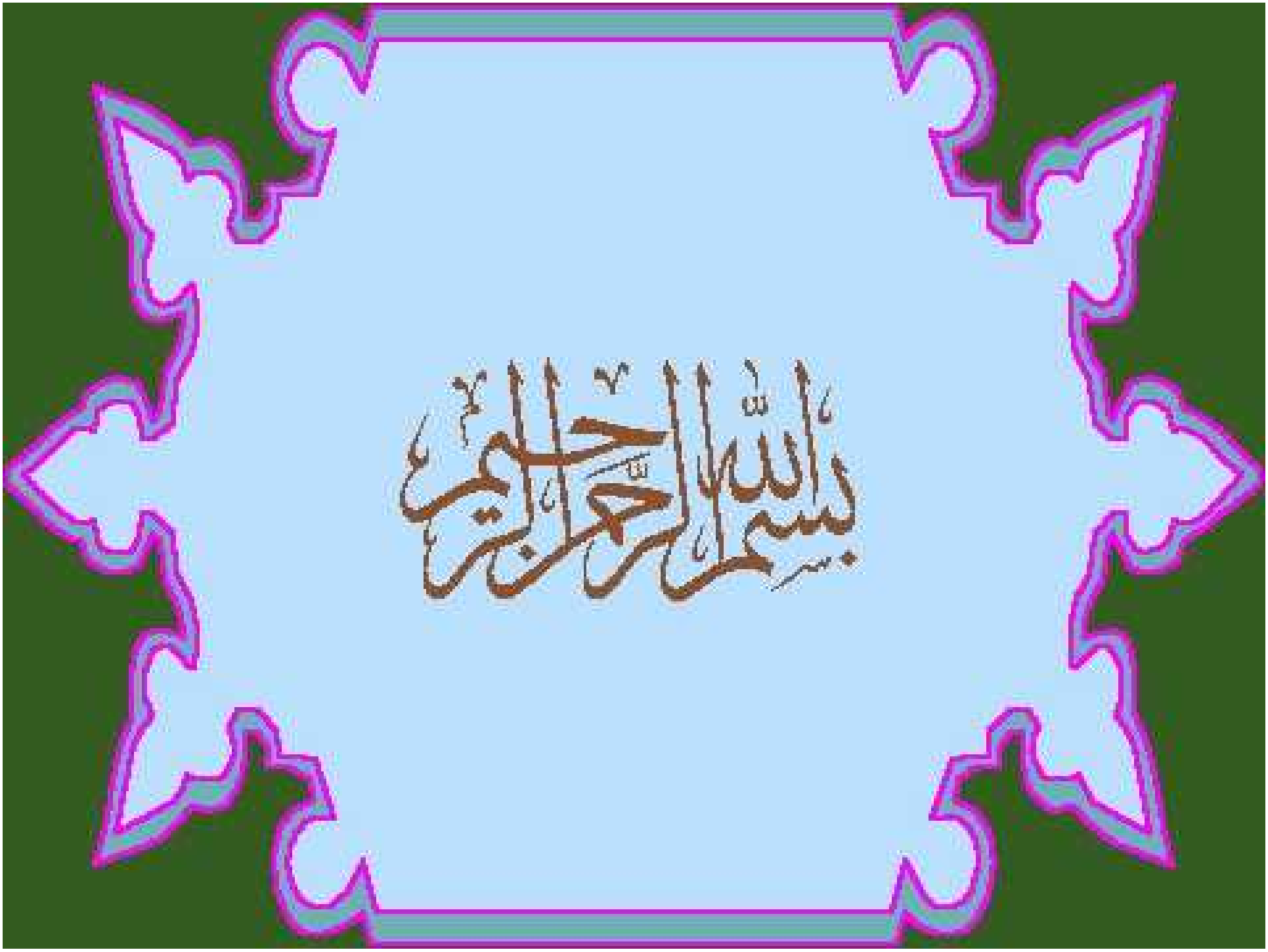

بسم الله الرحمن الرحيم

Lecture # 3

Civil Engineering Practice

Stone Aggregates and Concrete

-Stone Crushers-Machine for cleaning and grading of Aggregates

- Concrete Mixers and Vibrators

Department of Civil Engineering

Swedish College of Engineering and Technology-Wah Cantt.

Production of Aggregates

- The production of crushed-stone aggregate involves:
- Drilling
- Blasting
- Loading
- Transporting
- Crushing
- Screening
- Product handling and storage

Production of Aggregates

- In operating a quarry and crushing plant, the drilling pattern, the amount of explosives, the size shovel or loader used to load the stone, and the size of the primary crusher should be coordinated to assure that all stone from the quarry can be economically utilized.

RECOMMENDED MINIMUM SIZES OF PRIMARY CRUSHERS

Recommended minimum sizes of primary crushers for use with shovel buckets of the indicated capacities

Capacity of bucket [cu yd (cu m)]		Jaw crusher [in. (mm)][†]		Gyratory crusher, size of openings [in. (mm)][‡]	
$\frac{3}{4}$	(0.575)	28 × 36	(712 × 913)	16	(406)
1	(0.765)	28 × 36	(712 × 913)	16	(406)
$1\frac{1}{2}$	(1.145)	36 × 42	(913 × 1,065)	20	(508)
$1\frac{3}{4}$	(1.340)	42 × 48	(1,065 × 1,200)	26	(660)
2	(1.530)	42 × 48	(1,065 × 1,200)	30	(760)
$2\frac{1}{2}$	(1.910)	48 × 60	(1,260 × 1,525)	36	(915)
3	(2.295)	48 × 60	(1,260 × 1,525)	42	(1,066)
$3\frac{1}{2}$	(2.668)	48 × 60	(1,260 × 1,525)	42	(1,066)
4	(3.060)	56 × 72	(1,420 × 1,830)	48	(1,220)
5	(3.820)	66 × 86	(1,675 × 2,182)	60	(1,520)

[†] The first two digits are the width of the opening at the top of the crusher, measured perpendicular to the jaw plates. The second two digits are the width of the opening, measured across the jaw plates.

[‡] The recommended sizes are for gyratory crushers equipped with straight concaves.

TYPES OF CRUSHERS

- Crushers are classified according to the stage of crushing which they accomplish, such as:
  - Primary
  - Secondary
  - Tertiary
- A primary crusher receives the stone directly from a quarry after blasting, and produces the first reduction in size.
- The output of the primary crusher is fed to a secondary crusher, which further reduces the stone size. Some of the stone may pass through four or more crushers before it is reduced to the desired size.
- The degree of breakage is spread over several stages as a means of closely controlling product size and limiting waste material.

- As stone passes through a crusher, the reduction in size may be expressed as *reduction ratio.*
- The reduction ratio is the ratio of crusher feed size to product size.
- The sizes are usually defined as the 80% passing size of the cumulative size distribution.
- For jaw crusher, the ratio can be estimated by the gap.
- The gap is the distance between the fixed and moving faces at the top, divided by the distance of the open-side setting at the bottom.
- The reduction ratio of a roller crusher can be estimated as the ratio of the dimension of the largest stone that can be nipped by the roller, divided by the setting of the rolls, which is the smallest distance between the faces of the rolls.

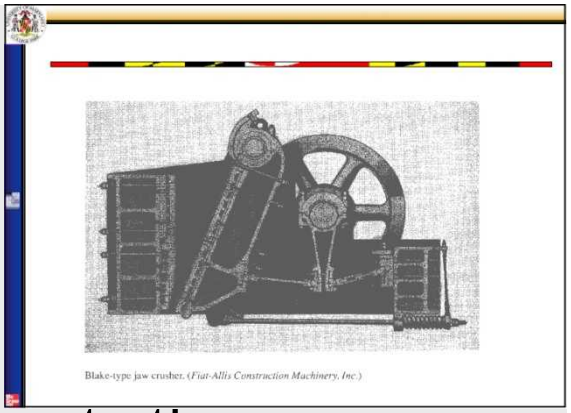
TYPES OF CRUSHERS

- Crushers are also classified by their method of mechanically transmitted fracturing energy to the rock.
- *Jaw, gyratory, and roll crushers* work by applying compressive force.
- Impact crushers such as single rotor and hammer mill apply high-speed impact force to accomplish fracturing

TABLE 17-2
The major types of crushers

Crusher type	Reduction ratio range
Jaw	
a. Double toggle	
(1) Blake	4:1–9:1
(2) Overhead pivot	4:1–9:1
b. Single toggle: Overhead eccentric	4:1–9:1
Gyratory	
a. True	3:1–10:1
b. Cone	
(1) Standard	4:1–6:1
(2) Attrition	2:1–5:1
Roll	
a. Compression	
(1) Single roll	Maximum 7:1
(2) Double roll	Maximum 3:1
Impact	
a. Single rotor	to 15:1
b. Double rotor	to 15:1
c. Hammer mill	to 20:1
Specialty crushers	
a. Rod mill	
b. Ball mill	

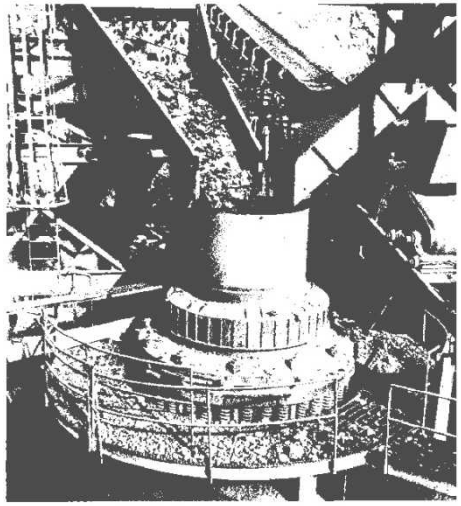
Jaw Crusher


Blake-type jaw crusher. (*Fiat-Allis Construction Machinery, Inc.*)

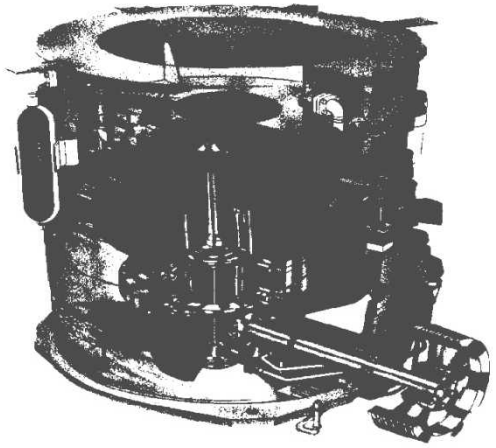
- Jaw crushers operate by allowing stone to flow into the space between two jaws, one of which is stationary while the other is movable .
- The distance between the jaws diminishes as the stone travels downward under the effect of gravity and the motion of the movable jaw, until the stone ultimately passes through the lower opening
- Jaw crushers are usually designed with the toggle as the weakest part. The toggle will break if the machine encounters an un-crushable object or is subjected to overload. This limits damage to the crusher.
- In selecting a jaw crusher, consideration must be given to the size of the feed stone.

GYRATORY CRUSHERS

- Gyratory crushers are characterized by a gyrating mantle mounted within a deep bowl.
- Gyratory crushers provide continuous crushing action and are used for both primary and secondary crushing of hard, tough, abrasive rock.
- Gyratory Standard Cone crushers are used as secondary or tertiary crushers.
- Cone crushers are capable of producing large quantities of uniformly fine crushed stone
- A cone crusher differs from a true gyratory crusher in the following respects:
  - It has a shorter cone.
  - It has a smaller receiving opening.
  - It rotates at a higher speed, about twice that of a true gyratory
  - It produces a more uniformly sized stone.



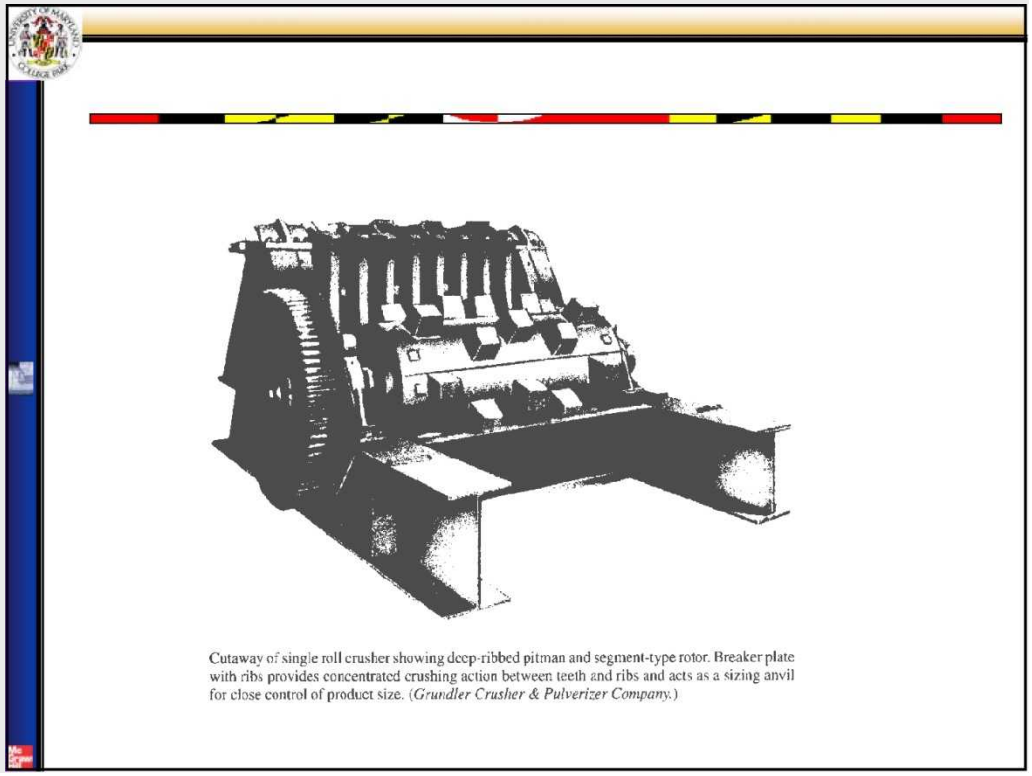
Gyrosphere crusher in an aggregate plant. (*Telesmith Division, Barber-Green Company.*)



Rollercone crusher. (*Cedarapids Inc., A Raytheon Company.*)

ROLL CRUSHERS

- ***Roll crushers*** are used for producing additional reductions in the sizes of stone after the output of a quarry has been subjected to one or more stages of prior crushing.
- A roll crusher consists of a heavy cast-iron frame equipped with either one or more hard-steel rolls, each mounted on a separate horizontal shaft.



Cutaway of single roll crusher showing deep-ribbed pitman and segment-type rotor. Breaker plate with ribs provides concentrated crushing action between teeth and ribs and acts as a sizing anvil for close control of product size. (*Grundler Crusher & Pulverizer Company.*)

SIZES OF STONE PRODUCED BY JAW AND ROLLS CRUSHERS

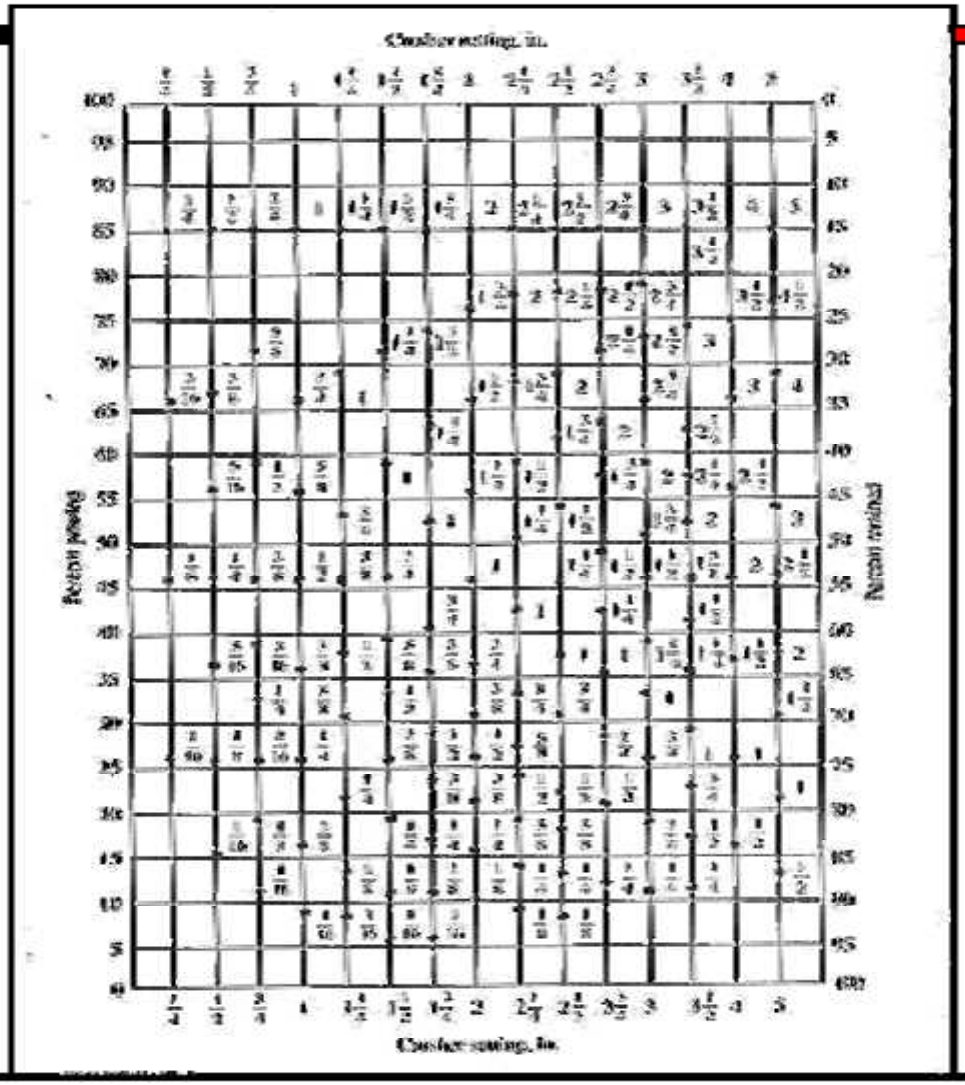
- Even though the setting of the discharge opening of a crusher will determine the maximum-size stone produced, the aggregate sizes will range from slightly greater than the crusher setting to fine dust.
- For any given setting for jaw or roll crusher approximately *15%* of the total amount passing through the crusher will be larger than the setting.
- If the opening of the screen which receives the output from such crusher are the same size as the crusher setting, 15% of the output will not pass through the screen.
-

SIZES OF STONE PRODUCED BY JAW AND ROLLS CRUSHERS

Analysis of the Size of Aggregate Produced by Jaw and Roll Crushers

To read the chart:

- Select the vertical line corresponding to the crusher setting
- Then go down this line to the number which indicates the size of screen opening
-From the size of the screen opening proceed horizontally to the left to determine the percent of material passing through the screen or the right to determine the percent of material retained on the screen.



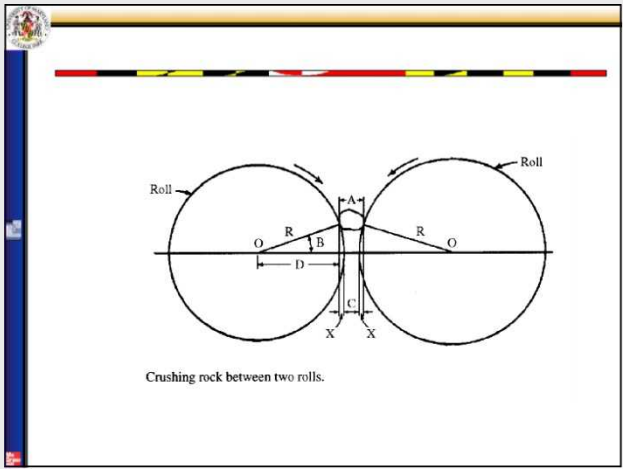
Example

- A jaw crusher with a closed setting of 3 in produces 50 tons per hour of crushed stone. Determine the amount of stone produced in tons per hour within the following size range: in excess of 2 in; between 2 and 1 in; between 1 and 1/4 in.
- From Figure 1, the amount retained on a 2 -in screen is 42% of 50, which is 21 tons per hr.
- Similarly, the amount in each of the size range is determined as shown in the following Table.

Size Range (in)	% Passing Screen	Percent in Size Range	Total Output of Crusher (ton/hr)	Amount Produced in Size Range (ton/hr)
Over 2	100 – 58	42	50	21.0
2 –1	58 – 33	25	50	12.5
1 – 1/4	33 – 11	22	50	11.0
¼ - 0	11 - 0	11	50	5.5
Total		**100 %**		**50.0 tph**

FEED SIZE

- The maximum size of material that may be fed to a roll crusher is directly proportional to the diameter of the rolls.
- If the feed contains stones that are too large, the rolls will not grip the material and pull it through the crusher.
- The angle of nip, *B*, in the following figure has been found to be 16.76^0
- The maximum-size particles that can be crushed is determined as follows:
- Let *R* = radius of rolls *B* = angle of nip
- $D = R \cos B = R \cos(16.76) = 0.9575\ R$ *A* = maximum-size feed
- *C* = roll setting = size of finished product
- Maximum - size Feed (*A*) = $0.085R + C$



Crushing rock between two rolls.

Example 2.

- Determine the maximum-size stone that may be fed to a smooth-roll crusher whose rolls are 40 in. in diameter when the roller setting (size of finished product) is 1 in.
- Maximum - size Feed (A) = $0.085R + C$
- $A = 0.085(20) + 1 = 2.7$ in

Capacity of Roll Crusher

- The capacity of a roll crusher will vary with:
- The kind of stone
- The size of feed
- The size of the finished product
- The width of rolls
- The speed at which the rolls rotate
- The extent to which the stone is fed uniformly into the crusher.

CONCRETE MIXERS

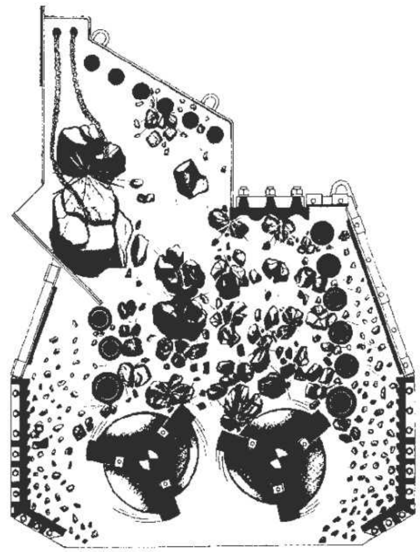
INTRODUCTION.

Concrete mixers are used for mixing all the ingredients of concrete to make a mix of specified consistency

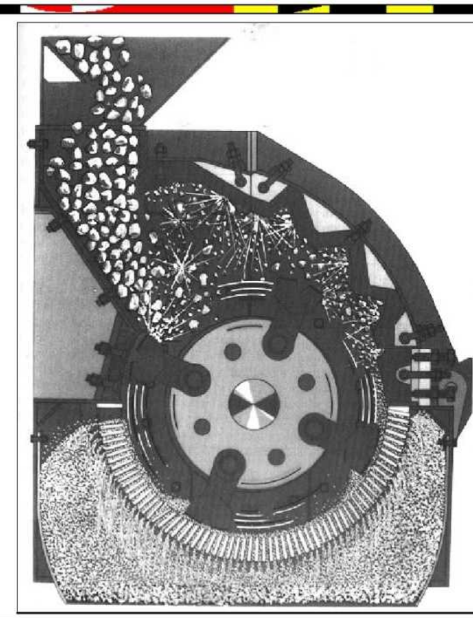
IMPACT CRUSHERS

- In impact crusher stones are broken by the application of high-speed impact forces.
- **Single rotor.** The single rotor-type impact crusher breaks the stone both by the impact action of the impellers striking the feed material and by the impact which results when the impeller-driven material strikes against the aprons within the crusher unit.
- **Double rotor.** These units are similar to the single rotor models and accomplish aggregate-size reduction by the same mechanical mechanisms. They will produce a somewhat higher proportion of fines. With both single and double rotor crushers, the impacted material flows freely to the bottom of the units without any further size reduction.

- **Hammer mills.** The hammer mill, which is the most widely used impact crusher, may be used for primary or secondary crushing. The basic parts of a unit include a housing frame, a horizontal shaft extending through the housing, a number of arms and hammers attached to a spool which is mounted on the shaft, one or more manganese-steel or other hard-steel breaker plates, and a series of grate bars whose spacing may be adjusted to regulate the width of openings through which the crushed stone flows.



Cutaway showing double rotor impact breaker. (*Iowa Manufacturing Company*)

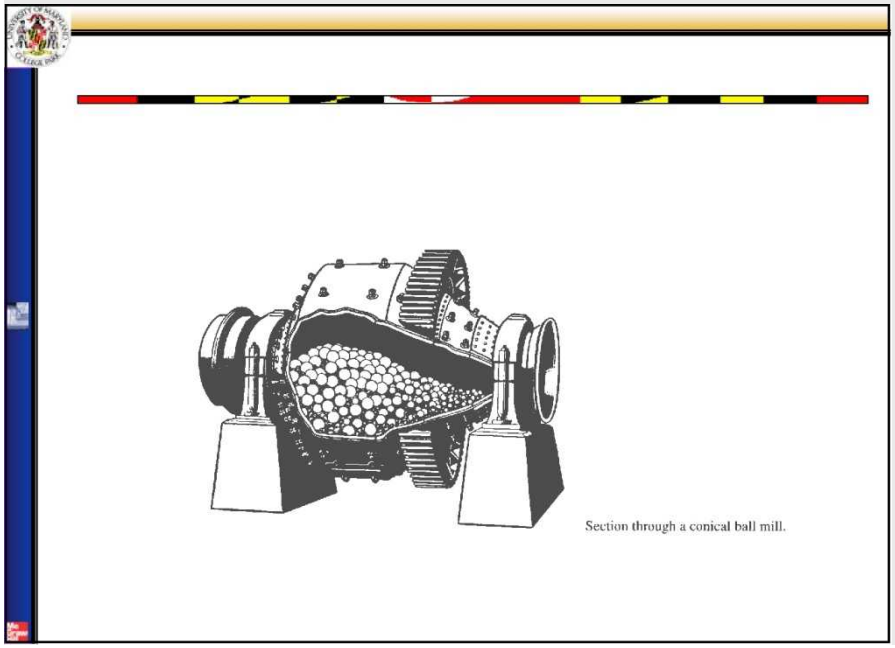


- Cutaway of Hammer Mill Rock
- Crusher Showing Breaking Action

SPECIAL AGGREGATEPROCESSING UNITS

- To produce fine aggregate, such as sand, from stone that has been crushed to suitable sizes by other crushing equipment, rod or ball mills are frequently used.
- It is not uncommon for concrete specifications to require the use of a homogeneous aggregate regardless of size.
- If crushed stone is used for coarse aggregate, sand manufactured from the same stone can satisfy the specifications.
- *A rod mill* is a circular steel shell that is lined on the inside with a hard wearing surface.
- Rod mill is equipped with a suitable support or trunnion arrangement at each end and a driving gear at one end. It is operated with its axis in a horizontal position. The rod mill is charged with steel rods, whose lengths are slightly less than the length of the mill.

- Crushed stone, which is fed through the trunnion at one end of the mill, flows to the discharge at the other end. As the mill rotates slowly, the stone is constantly subjected to the impact of the tumbling rods, which produce the desired grinding. A mill may be operated wet or dry, with or without water added.
- A ***ball mill*** is similar to a rod mill but it uses steel balls instead of rods to supply the impact necessary to grind the stone.
- ***Ball mills*** will produce fine material with smaller grain sizes than those produced by a rod mill.



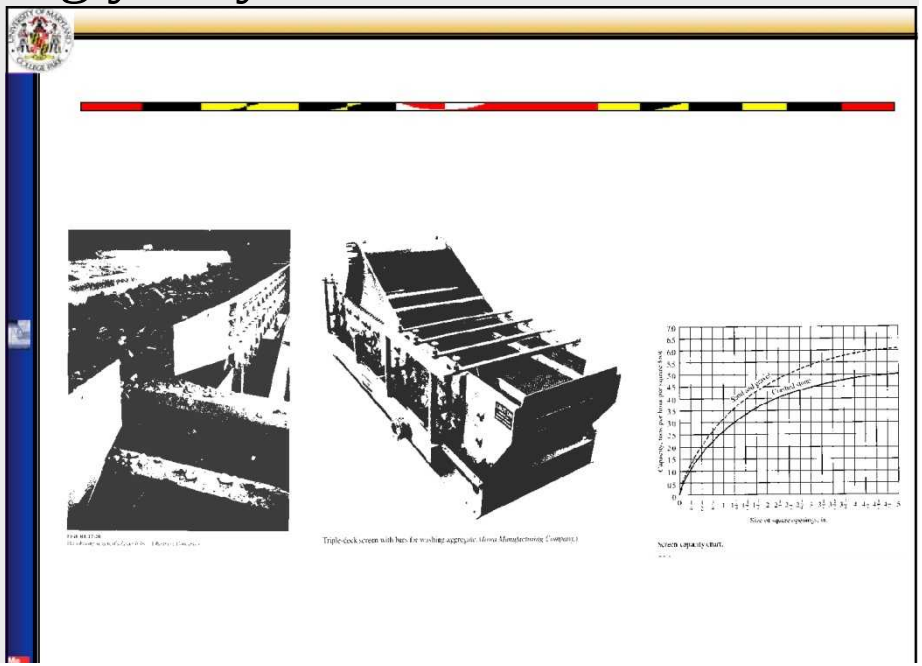
Section through a conical ball mill.

Selection of crushing equipment

- The information needed should include, but will not necessarily be limited to, the following items:
- The kind of stone to be crushed.
- The maximum individual size of the feed stones and perhaps the size ranges of the feed to the plant.
- The method of feeding the crushers.
- The required capacity of the plant.
- The percent of material failing within specified size ranges.

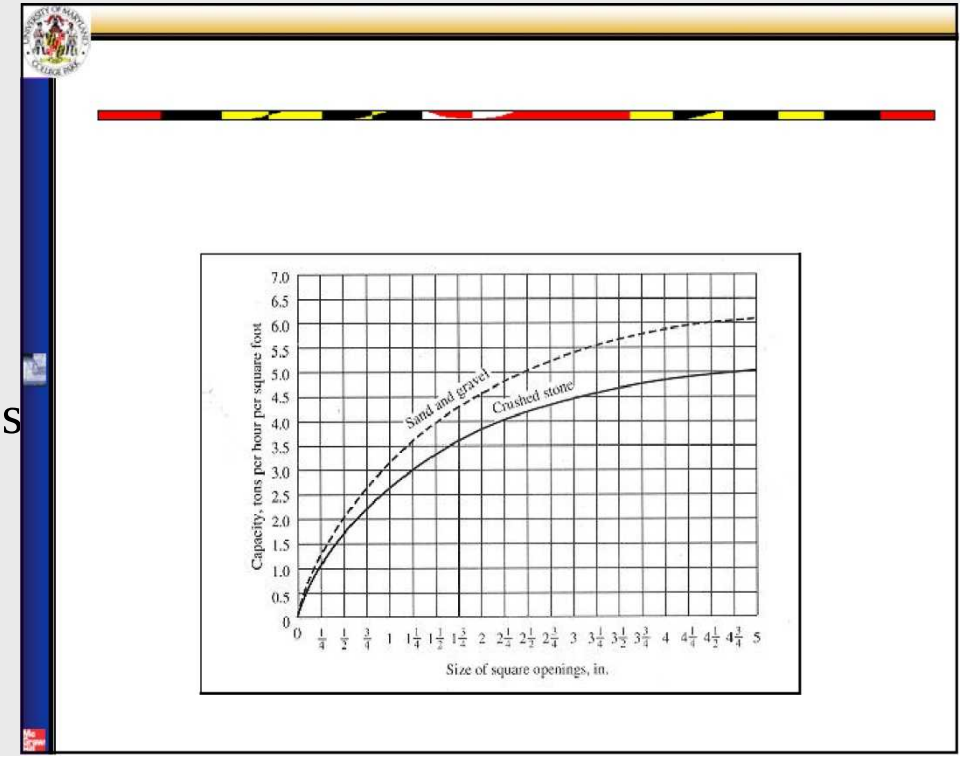
2. Screening

- Screening of crushed stone is necessary in order to separate the aggregate by size ranges.
- Most specifications covering the use of aggregate stipulate that the different sizes shall be combined to produce a blend having a given size distribution.
- Persons who are responsible for preparing the specifications for the use of aggregate realize that crushing and screening cannot be done with complete precision, and accordingly they allow some tolerance in the size distribution.



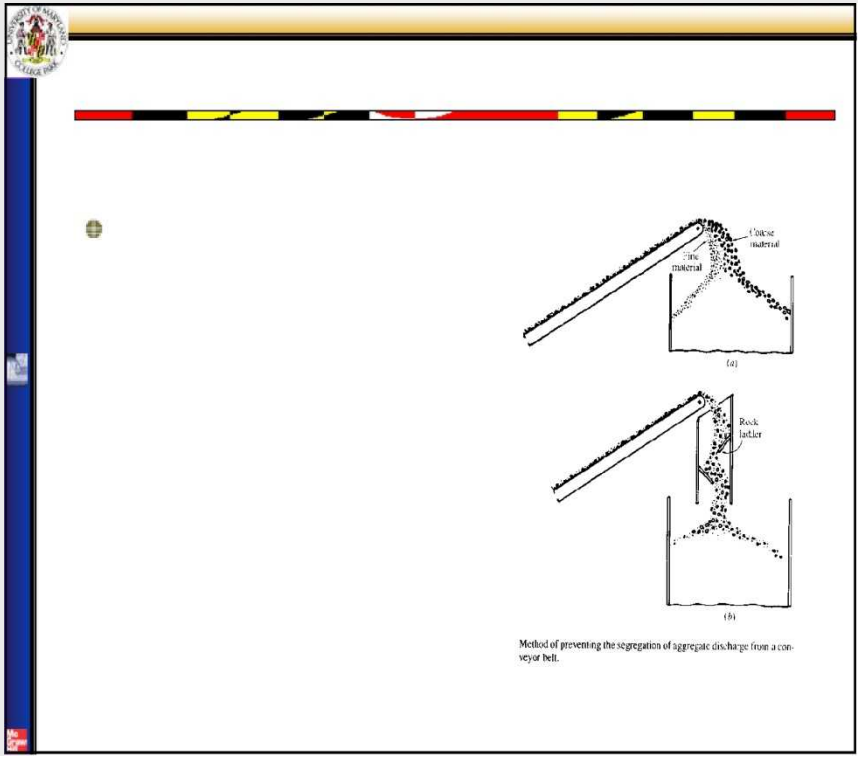
DETERMINATION OF REQUIRED SCREEN SIZE

- Figure gives the theoretical capacity of a screen in tons per hour per square foot based on material weighing 100 lb per cu ft when crushed
- The corrected capacity of a screen is given by the following equation
- $Q = ACEDG$
- Where
- Q = capacity of screen, tons per hour
- A = area of screen, sq ft
- C = theoretical capacity of screen, tons
- E = efficiency factor D = deck factor
- G = aggregate factor



HANDLING CRASHED-STONE AGGREGATE

- After stone is crushed and screened to provide the desired size ranges, it is necessary to handle the stone carefully or the large and small particles may separate, thereby destroying the blend in sizes which is essential to meeting graduation requirements. If aggregate is permitted to flow freely off the end of a belt conveyor, especially at some height above the storage pile, the material will be segregated by sizes.

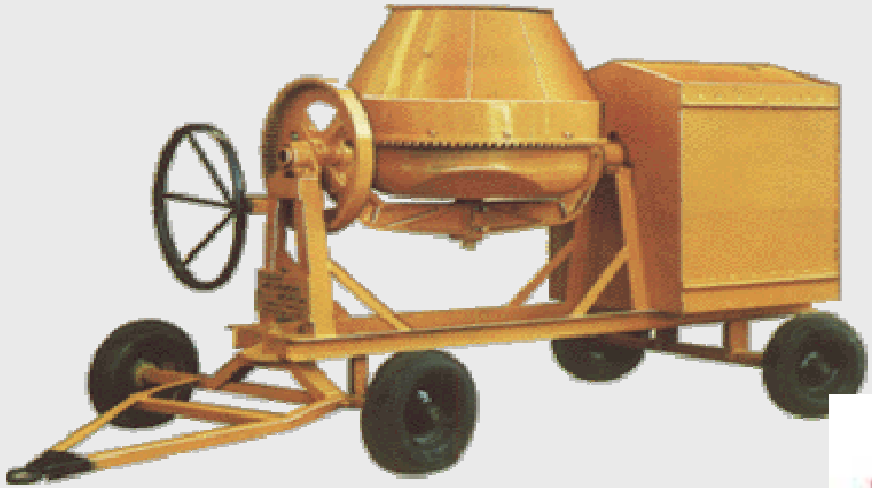


Method of preventing the segregation of aggregate discharge from a conveyor belt.

CONCRETE MIXING

MACHINERY

CONCRETE MIXERS



MIXER SIZES

- B.S. 1305 specifies the following standard sizes for batch type mixers:
- Tilting mixers: 3.5 T, 5T, and 7T,
- Non-tilting mixers: 5NT. 7NT.10NT.14HNT 28NT. 56NT.

  (The numbers indicate the mixed batch capacity in cubic feet.)

CONCRETE MIXING TRUCK

Portable Concrete Batching Plant & Fixed Concrete Batching Plants

MANUAL MIXING OF CONCRETE

DISADVANTAGES

DISADVANTAGES OF MANUAL MIXING OF CONCRETE ARE

- IN MOST OF OUR SMALL PROJECTS THE MIXING OF CONCRETE IS MAINLY DONE MANUALLY.
- REDUCTION IN STRENGTH
- SEGREGATION OF COARSE AND FINE AGGREGATES
- INCOMPLETE MIXING CAUSES NON UNIFORMITY OF CEMENT IN CONCRETE.
- FALSE SET OF CEMENT
- WAISTAGE OF CEMENT SAND SLURRY
- REDUCTION IN WORKABILITY OF CONCRETE

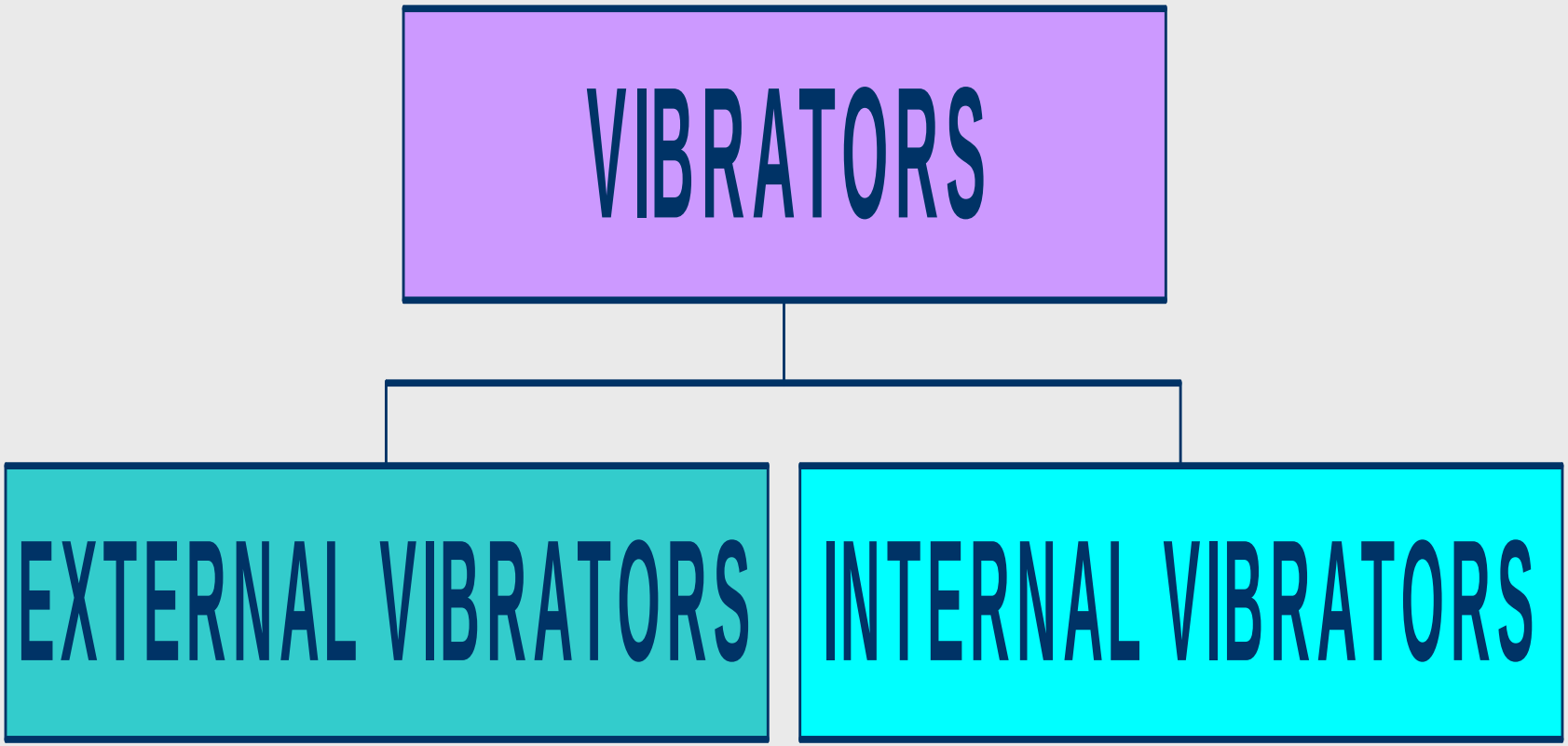
VIBERATORS

MACHINERY

VIBERATORS

Vibration is generally accepted as an economical, labour saving and quality improving method of compaction, which is used in most of concrete jobs. It is especially adapted to the stiffer consistencies associated with high quality conceit.

VIBERATORS



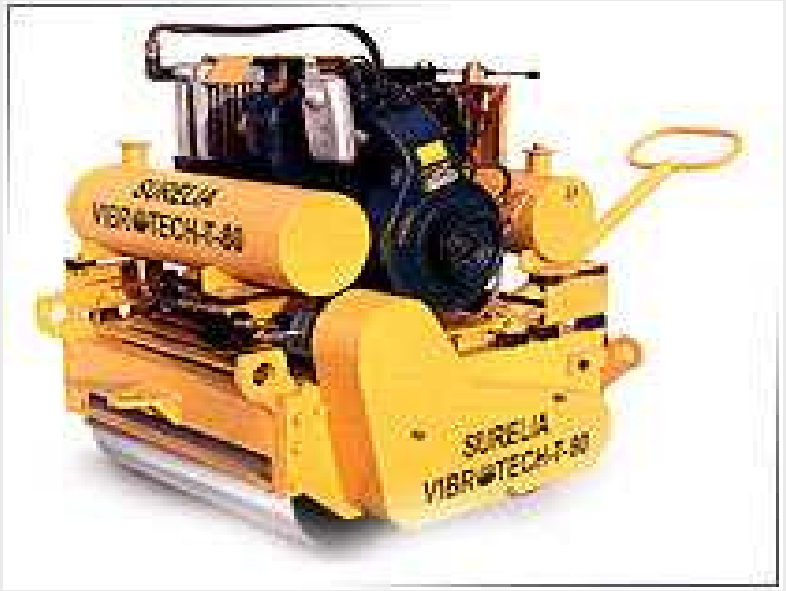
INTERNAL BIBERATORS

These are portable machines driven by compressed air, petrol or electric motors are most commonly used for compaction of concrete on various "in-situ" construction works

INTERNAL VIBERATORS

INTERNAL VIBERATORS

EXTERNAL VIBERATORS



MANUAL COMPACTION

THE PURPOSE OF VIBERATION IS TO REMOVE THE AIR VOIDS IN FRESH CONCRETE, THIS CAN ALSO BE DONE MANUALLY.

- **THE RATE OF COMPACTION DEPENDS UPON TYPE OF EQUIPMENT USED AND DEPTH OF CONCRETE LAYER.**

LABOR LAYING CONCRETE MASONRY UNITS

LABOUR

LABOR LAYING CONCRETE MASONRY UNITS

- **CONCRETE MASONRY UNITS ARE LAID BY MASONS**

- **JOINTS ARE MADE BY SPREADING MORTAR ALONG THE INSIDE AND OUTSIDE HORIZONTAL AND VERTICLE EDGES**

LABOR LAYING CONCRETE MASONRY UNITS

- **JOINTS MAY BE CUT SMOOTH WITH A STEEL TROWEL, OR THEY MAY BE TOOLED AS FOR BRICKS.**

- **THE JOINTS ARE MORE RESISTANT TO THE INFILTRATION OF MOISTURE WHEN THEY ARE TOOLED, BECAUSE THE TOOLING INCREASES THE DENSITY OF THE MORTAR.**

LABOR REQUIRED TO BUILD FORMS

LABOR

LABOR REQUIRED TO BUILD FORMS

THE FACTORS THAT DETERMINE THE AMOUNT OF LABOR REQUIRED TO BUILD FORMS FOR COCRETE STRUCTURES INCLUDE

- **SIZE OF THE FORMS**
- **KIND OF MATERIALS USED**
- **SHAPE OF THE STRUCTURE**
- **LOCATION OF THE FORMS**
- **RIGIDITY OF THE DIMENSIONS REQUIRED**

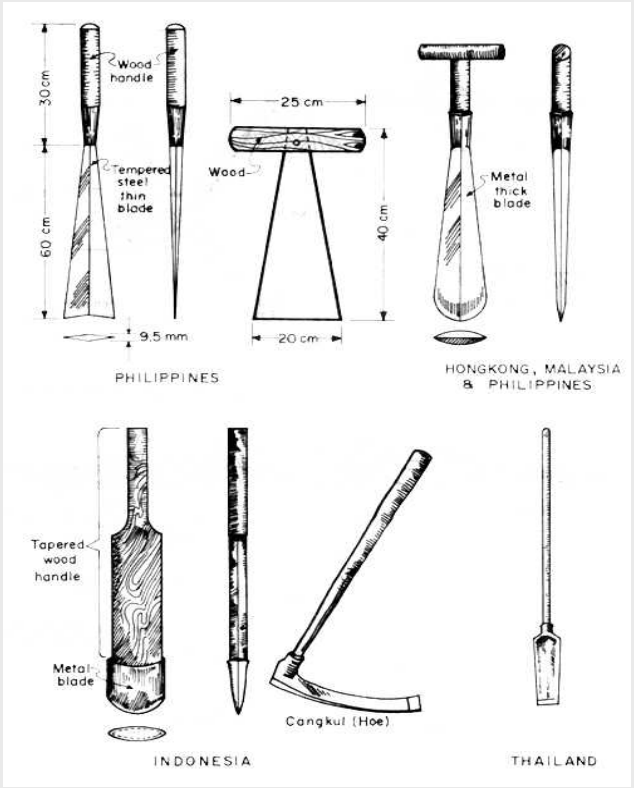
LABOR LAYING BRICKS

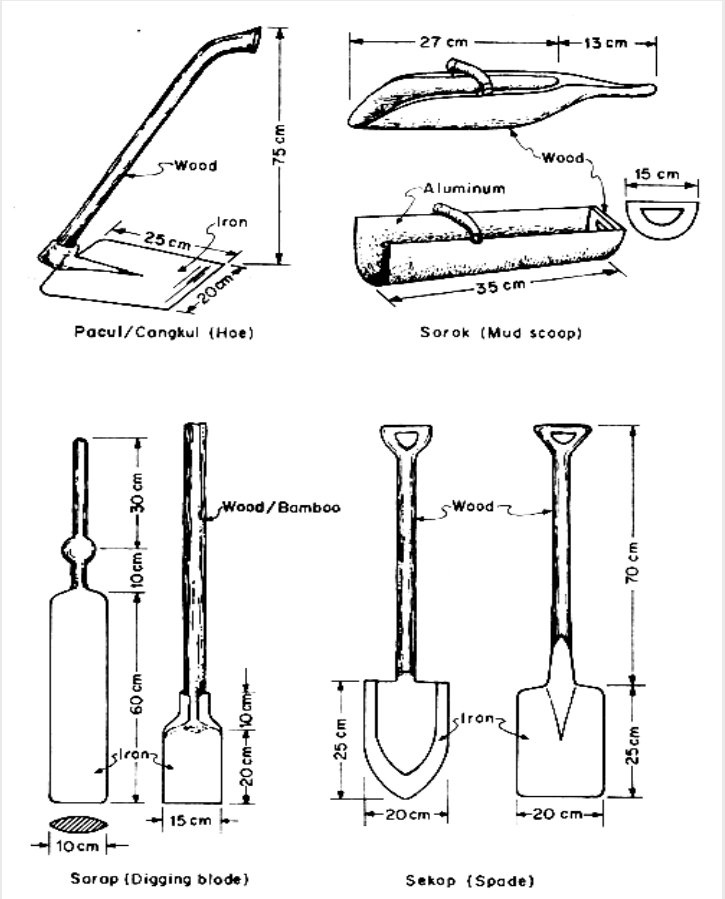
LABOUR

LABOR LAYING BRICKS

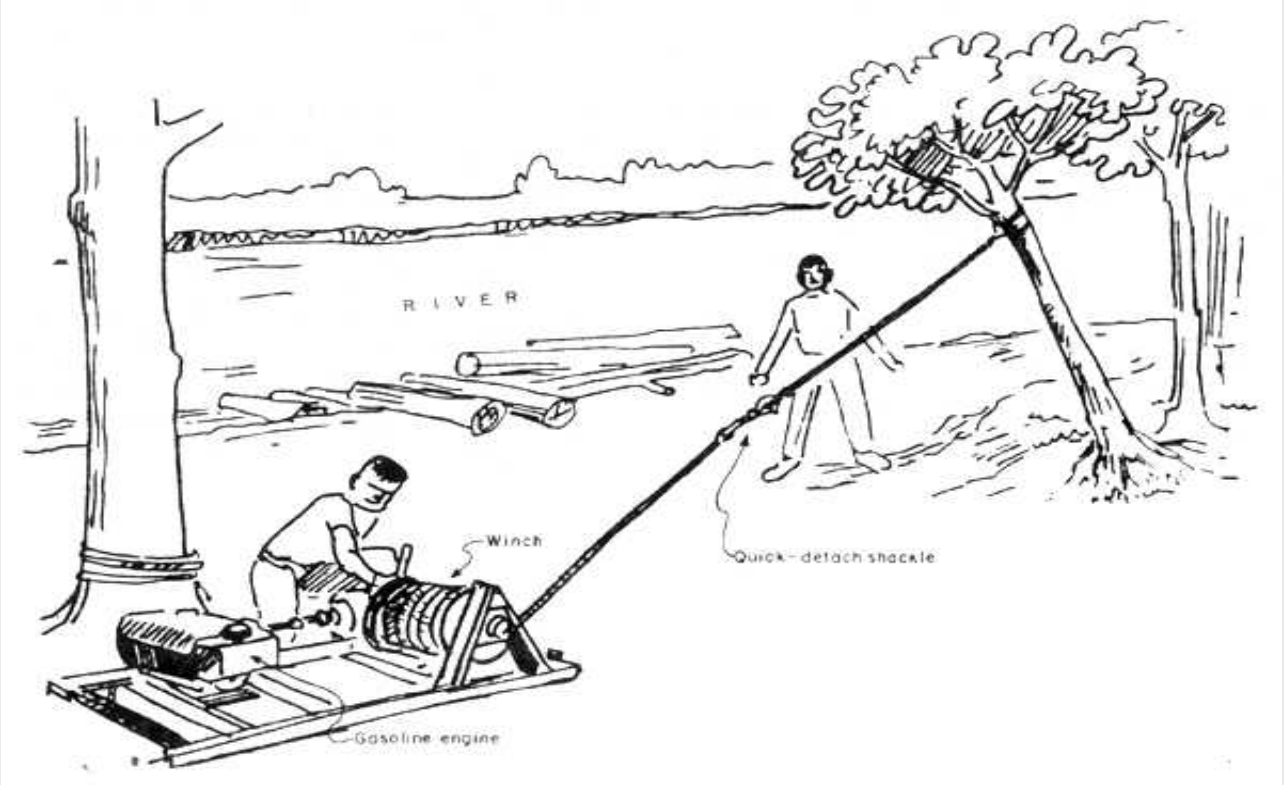
- **THE LABOUR HOURS REQUIRED TO LAY BRICKS VARY WITH A NUMBER OF FACTORS, SUCH AS THE**
- **QUALITY OF WORK**
- **TYPE OF BRICKS KIND OF MORTAR USED**
- **SHAPE OF THE WALLS**
- **KIND OF BOND PATTERN USED**
- **WEATHER CONDITIONS**

LABOUR EQUIPMENT





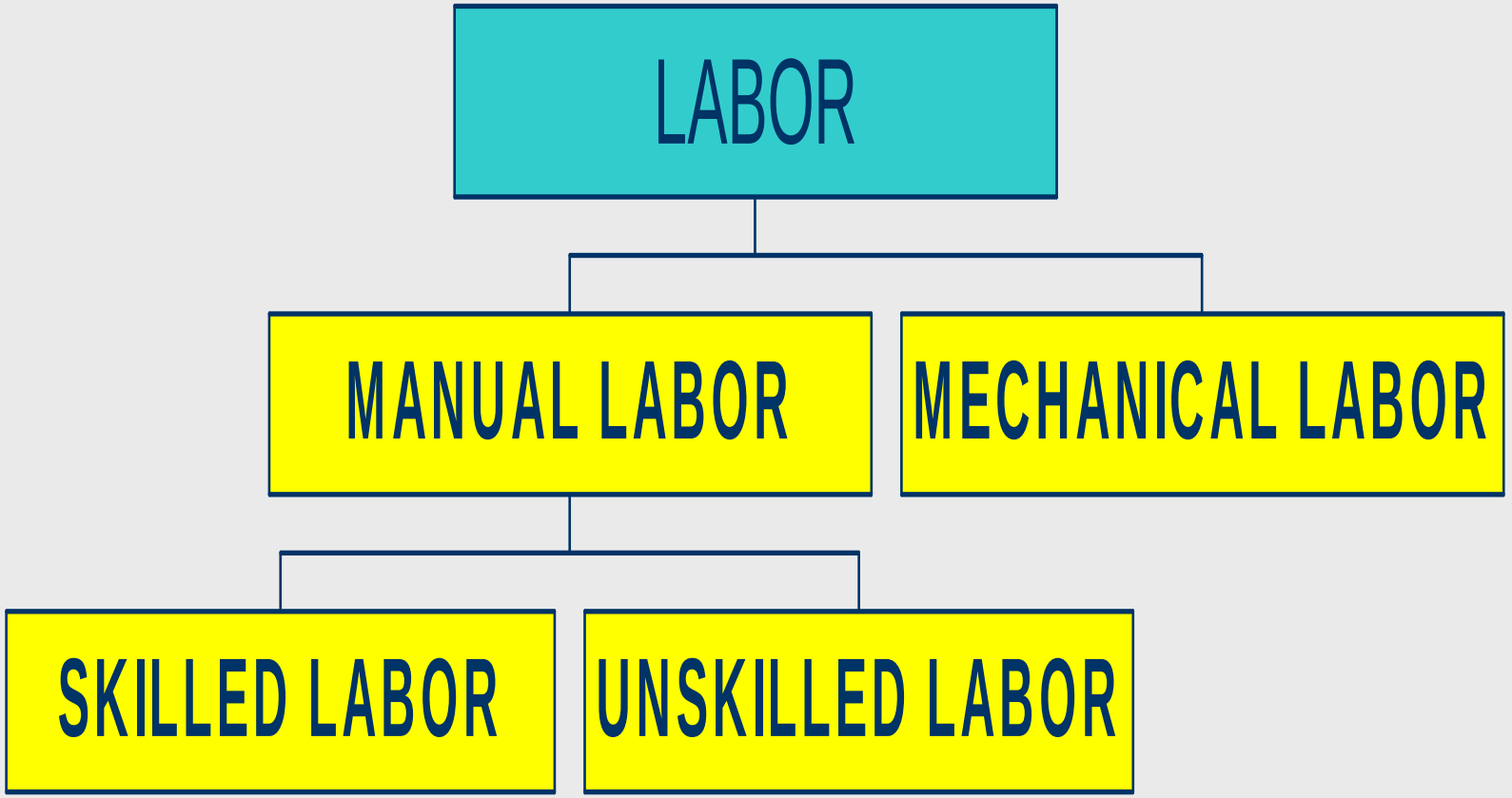
LABOUR EQUIPMENT



KERB PAVER

KERB PAVER

TYPES OF LABOR



MECHANICAL LABOR

- MAY BE DESCRIBED AS HEAVY MACHINERY OPERATED BY FUEL AND ELECTRICITY.

MANUAL LABOUR

- HUMAN AND ANIMAL POWER ASSISTED BY SIMPLE IMPLEMENTS LIKE WHEEL BARROWS, NORMAL PICK AXE AND SPADE ETC.

SKILLED LABOR

- Includes persons having training in performing jobs needing skill e.g: operators of mechanical and electrical equipments, drivers of all kinds , masons , carpenters, electricians, blacksmiths etc.

UNSKILLED LABOUR

- not requiring any particular skill e.g., laborers, helpers, mates, cleaners, oilmen, greasers, etc.

ADVANTAGES OF MANUAL LABOUR

- Improves the economic conditions of common people of the project area.
- Increases the circulation of the money and the per capita income of the people.
- Earthwork rates for machines are invariably higher than the corresponding rates through manual labor.

MANUAL LABOUR VS CONSTRUCTION MACHINERY

- Here we will discuss the interaction between manual labor and construction machinery for different construction works separately.

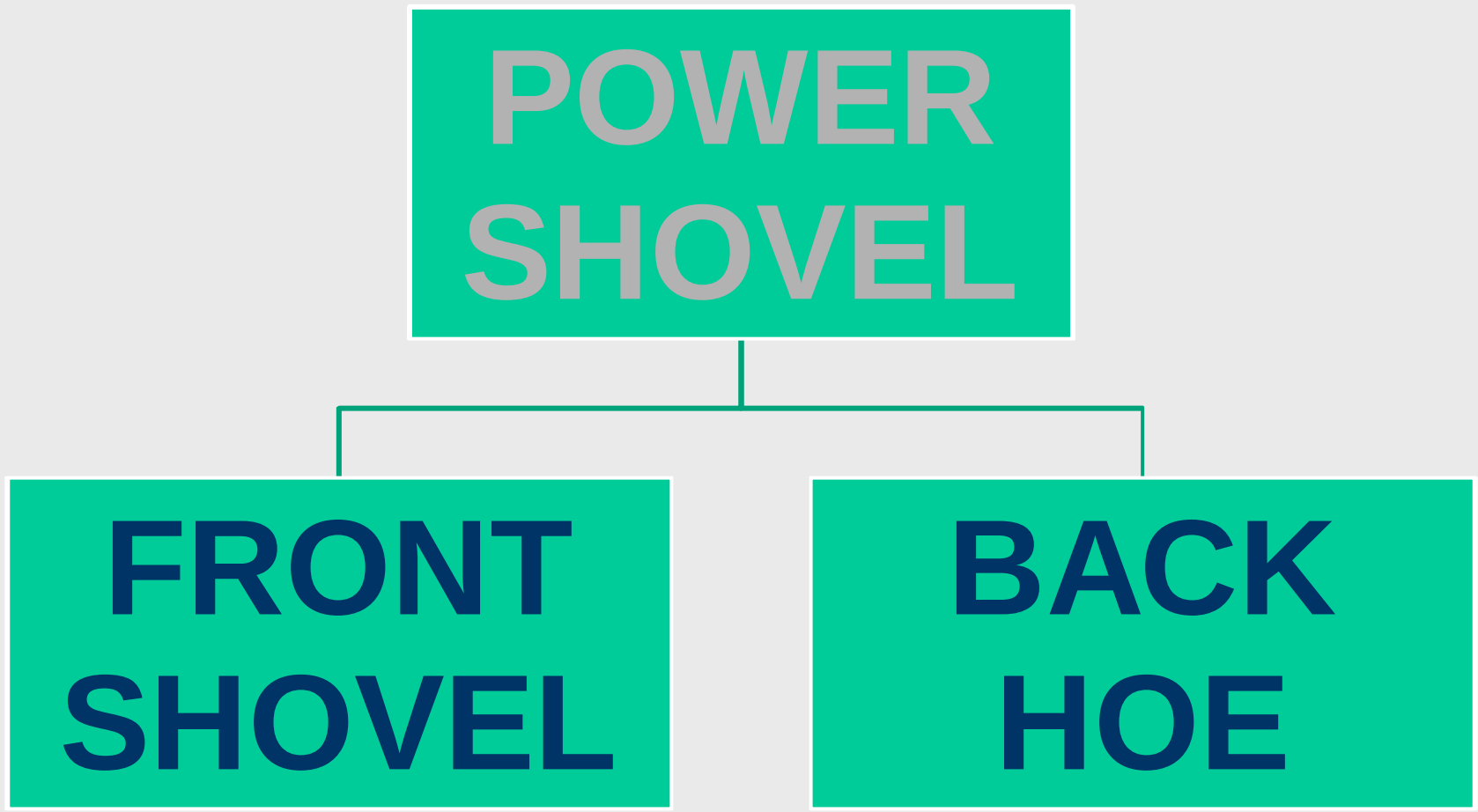
EXCAVATION

MACHINERY

POWER SHOVEL

- used primarily to excavate earth and land it into trucks or tractor-pulled wagons or on the conveyer belts.
- may be mounted on crawler trucks and rubber tired wheels. But power shovels mounted on rubber tired wheels have high speed w.r.t. crawler mounted units.

CLASSIFICATION



FRONT SHOVEL

- A front shovels bucket excavates in upward direction. It develops excavation breakout force by crowding material away from the machine. It is used to excavate about the earth surface.

BACK HOE

- A backhoe is in the form of a downward are unit. It develops exaction breakout force by pulling the bucket toward the machine and curling the bucket inward. It is used to excavate below the earth surface.

FRONT SHOVEL

FRONT SHOVEL

BACK HOE

BACK HOE

SIZE OF A POWER SHOVEL

The size of a power shovel is indicated by the size of the bucket, expressed in cubic yards. Power shovels are commonly available in the following sizes: 3/8, 0.5, 0.75, 1, 1.25, 1.5, 2 and 2.5 cub. Yds.

APPLICATIONS

1. Embankment Digging
2. Loading into Haul Units
3. Side Casting
4. Dressing Slopes
5. Dumping on Soil Banks
6. Digging Shallow Trenches

DRAG LINES

- It is a excavating unit to excavate earth and load it into hauling units, such as trucks or wagons or to deposit it in levees, dams and spoil banks near the pits from which it is excavated.

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aus061 www.fotosearch.com

TYPES OF DRAG LINE

- Draglines may be divided into the following types:

1. Crawler–mounted
2. Wheel–mounted

DRAG LINE

ADVANTAGE

- it can be used over soft soil, when water for handling loose, dry sands and gravel and occurs at some distance below the surface.

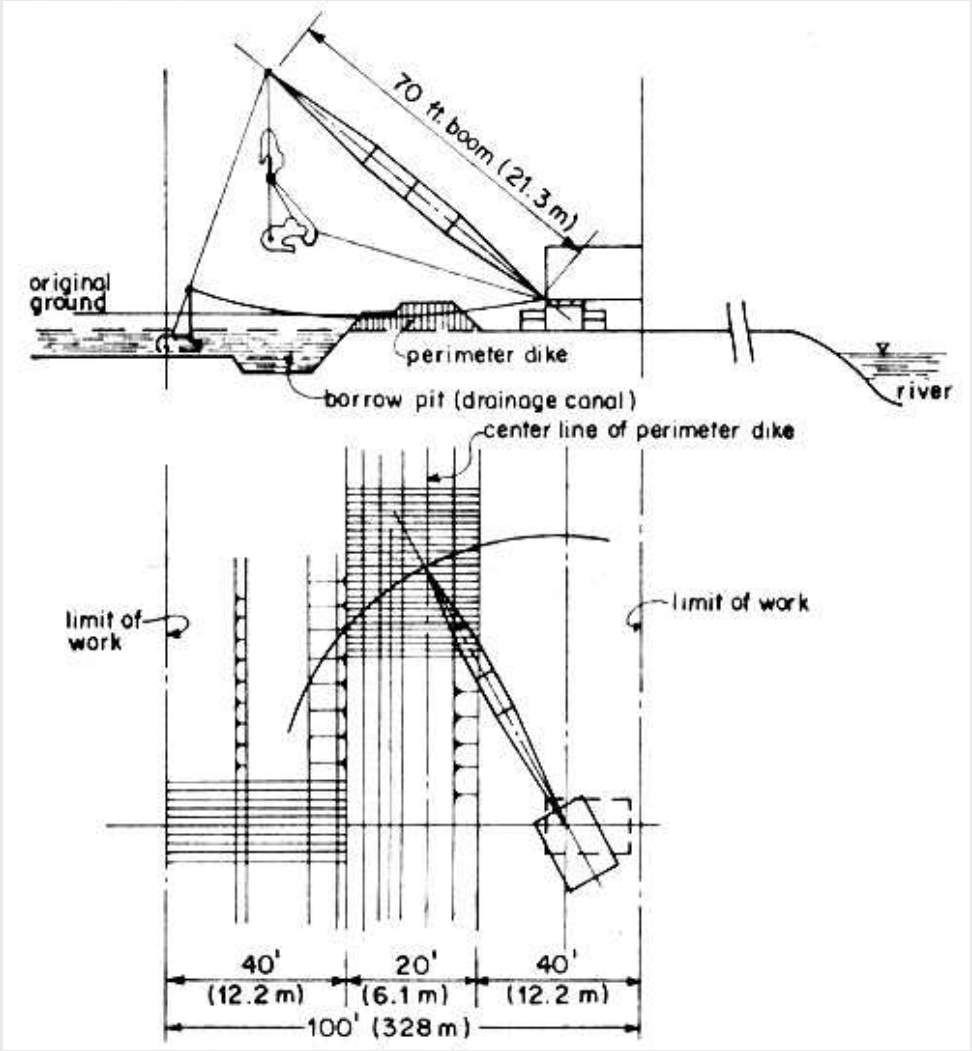
DISADVANTAGE

- its output is lower than power shovel.

APPLICATIONS

1. Bulk Pit Excavation
2. Digging Canal or a Ditch or near a pit

DRAG LINE


70 ft. boom (21.3 m)
original ground
perimeter dike
river
borrow pit (drainage canal)
center line of perimeter dike
limit of work
limit of work
40'
(12.2 m)
20'
(6.1 m)
40'
(12.2 m)
100' (328 m)

TRACTOR PULLED SCRAPERS

It is a excavating as well as carrying units. Tractor-pulled scrapers have established an important position in the earth moving field.

TYPE OF TRACTOR PULLED SCRAPERS

There are two types of tractor – pulled scrapers

1. Crawler - Tractor Scrapers

2. Wheel - Tractor Scrapers

1. CRAWLER - TRACTOR SCRAPERS

It is used for short haul distances, the crawler type tractor, pulling a rubber typed self loading scraper can move earth economically.

DISADVANTAGE

It has low speed w.r.t. wheel tractor scraper.

WHEEL TRACTOR SCRAPERS

- It is used for long haul distances; the higher speed of a wheel type tractor pulled scraper will permit it to move earth more economically than with the crawler type tractor. Its loading speed is lower w.r.t. crawler tractors but higher travel speed, will offset this disadvantage.

ADVANTAGES OF USE OF EXCAVATORS OVER MANUAL LABOURS

ADVANTAGES & DISADVANTAGE

- Excavators can excavate earth over surface as well as below the earth surface
- Their excavation speed is high as compared to use of manual labor.
- They can excavate soft soil, hard rocky strata canals, tunnels etc.

Disadvantage

- Its use increase the cost factor. This disadvantage is not so prominent because its use decrease the time of completion of a project.

EXCAVATION BY HAND

EXCAVATION BY HAND

- Generally, it is desirable to use excavating equipment instead of excavation by laborers, however, at some jobsites the space is not sufficient for equipment to operate.

BULLDOZER

The term Bulldozer may be used in a broad sense to include both a bulldozer and an angle dozer. Bulldozers are mounted with the blades perpendicular to the direction of travel, while Angle dozers are mounted with the blades set an angle with the duration of travel.

BULLDOZER

CLASSIFICATION

- On the basis of their mountings:

1. Crawler Tractor mounted
2. Wheel – Tractor mounted.

On the basis of lowering and rising their blade, Bulldozer may be classified as cable or hydraulic controlled.

APPLICATIONS/USES

1. Clearing land from timber and stumps.
2. Opening up pilot roads through mountains and rocky terrain.
3. Moving earth for haul distances up to approximately 300 feet.
4. Spreading earth fills

APPLICATIONS/USES

5. Back filling trenches.
6. Clearing construction sties off debris.
7. Maintaining haul roads.
8. Clearing the floors of borrow and quarry pits.
9. Excavating ponds for stock water.

COMPACTION

MACHINERY

COMPACTION TECHNIQUES

Compaction is attained by applying energy to a soil by one of the following methods:

1- Kneading

2- Static Weight.

3- Vibration

4- Impact

5- Explosives

TYPES OF COMPACTING ROLLERS

1 - PLAIN/FLAT WHEALED ROLLER

TYPES OF COMPACTING ROLLERS

1 - PLAIN/FLAT WHEALED ROLLER

TYPES OF COMPACTING ROLLERS

2- TAMPING ROLLER / SHEEP'S FOOT ROLLER

Tandem Rollers

MANUAL COMPACTION

LABOUR

MANUAL COMPACTION

If necessary, soil compaction can also be done manually.

- THE RATE OF COMPACTION AND THE CHOICE OF LABOR DEPENDS UPON
- TYPE OF SOIL
- NUMBER OF LABORERS AVAILABLE
- TYPE OF EQUIPMENT USED

HAULING

MACHINERY

TRUCKS AND WAGONS

INTRO.

Hauling is the transportation of material by mobile units over highways or country roads. Transportation includes movement over rail, road or water; but hauling is a term confined to the movement over roads such as with trucks, trailers or wagons.

TYPES OF TRUCKS

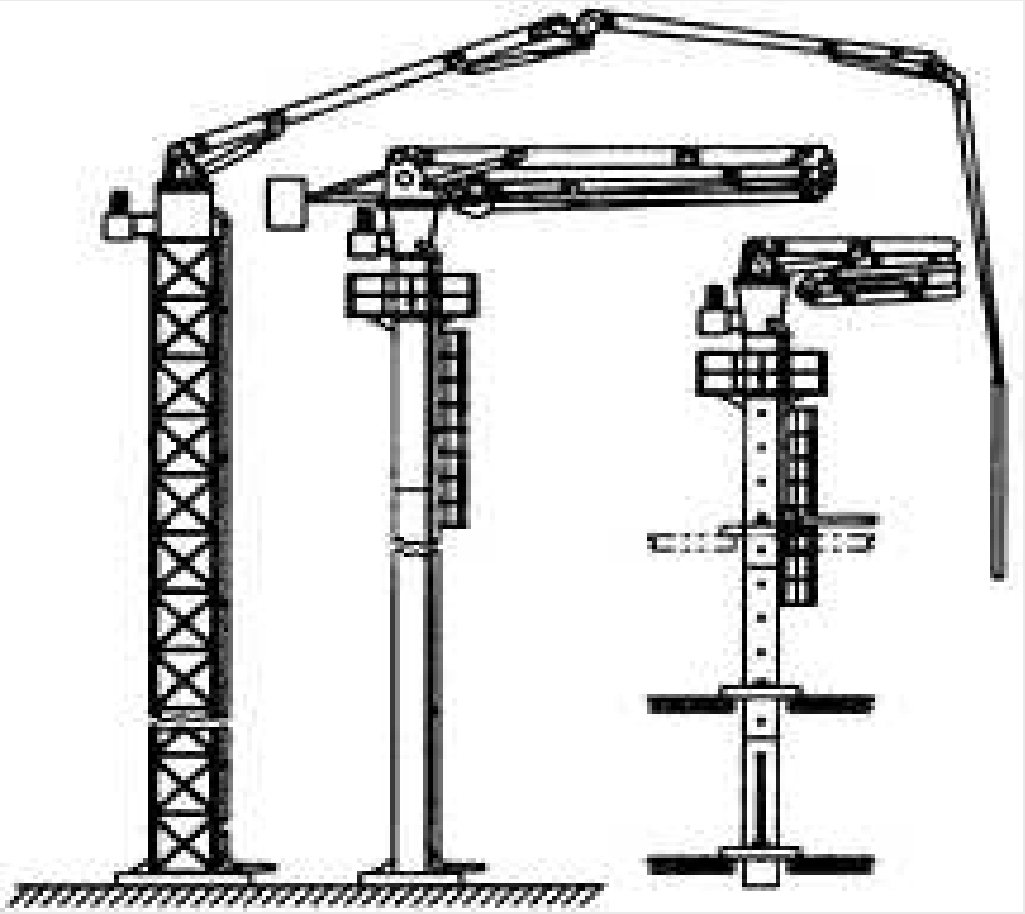
Trucks may be classified according to

- Size and type of engine, gasoline, diesel, butane, propane etc
- Number of gears.
- Kind of drive, two wheel, four wheel, six wheels etc.
- Number of wheels and axles
- Method of dumping the load, rear dump, side dump
- Class of material hauled, earth, rock etc.
- Capacity in tons or cubic yards.

Truck and Asphalt Paver

TRUCKS

Concrete Placing Booms



MANUAL TRANSPORTATION

LABOUR

MANUAL TRANSPORTATION

FOR MANUAL TRANSPORTATION OF MATERIALS, LABOR CAN ALSO BE USED

THE RATE OF TRANSPORTATION MAILNLY DEPENDS UPON

- TYPE OF EQUIPMENT USED AND
- NUMBER OF LABORER AVAILABLE

MANUAL TRANSPORTATION