Scope of Civil Engineering

Civil Engineering is the field of engineering concerned with planning, design and construction for environmental control, development of natural resources, buildings, transportation facilities and other structures required for health, welfare safety employment and pleasure of mankind

The main scope of civil engeering is planning, designing estimating, supervising, construction execution, and maintenance of structures like building roads, bridges, dams, etc.

Civil Engineering Contribution to the welfare of society.

* A civil engineer applies technical skills to create improve and maintain beautiful national land, safe and comfortable livelihood and prosperous society through contributing to society through knowledge and virtue.
* The monuments and structures speak plently concerning sensible development of the civil engineering technology of this world.
  a. Great wall of china
  b. The Tajmahal.
  c. Egypt pyramids.
* High rise building apartment tower, office tower are tall building or structures used for residential use.
* The road network of India is the third largest road network in the world, consist of Express ways, National highways.
* Flyover are constructed with the aim of saving time and reducing congestion in city roads.

* Over bridges are constructed to continue the road in the Presence of obstacles like rail tracks, rivers, valleys low lands etc.

* Construction of a dam across river result in the ponding of water on its upstream side conveniently used for irrigation purposes.

India has 5202 dams These dams are specially designed for flood control and generates high electric power. Mettur dam.

Civil engineering contribution information technology has bought about a sarcastic changes in India. Amazing spectacular office buildings are constructed in the last two decades.

Modern health care centres and hospitals and pharmaceutical industries are contribution in the health care sector.

AIIMS, Delhi.
Apollo, Chennai.
CMC, vellore

Large scale steel industry Cement plants, automobile industry thermal powerplants atomic centre, rocket launch pads etc are the developments carried out by civil Engineer

Specialized sub disciplines in civil Engeering

* Building Materials
* Construction Engg
* Structural Engg
* Geotechnical Engg
* Hydraulics, water resources and irrigation engineering.
* water supply and Sanitary Engg.
* Environmental Engg.

* Transportation Engg
* Town planning and architecture
* Surveying
* Drawing
* Estimation and specification
* Management techniques
* Computer application.

① Building Materials.

* shelter is the basic need of civilized society.

stones, bricks, timber, concrete are used the traditional material used for the construction of houses and other buildings

* Steel, aluminium, glass, plastic, plaster of paris, paint and varnishes have improved the quality of building

② Construction Engineering.

It is a professional discipline that deal, with the designing, planning, construction and management of infrastructures such as tunnels, bridges, airports railroads, facilities, building dams, utilities and other project

The following stages are carried out for any type of project

1. In the beginning, technical feasibility, environmental impact assement, and economic aspects of the project are studies.
2. Soil investigation.
3. Surveying includes Preparing site plan, contour map and measurement of field dimension and levels.
4. Planning & Designing and Drawing are prepared.
5. Estimates are prepared to ~~carryout different activities in time without any delay~~. know the Probable cost of completion of work and detailed planning and schedule are prepared to carryout different activities in time without any delay.

a) During Construction

Owner engineer and Contractor are the three constituents of a construction team in civil engineering profesion hence continuous liason among themself is essential for the speedy progress of the work

b) After Construction

Maintainence and repair Valuation after the construction regular maintenence of the structures are to be carriedout.

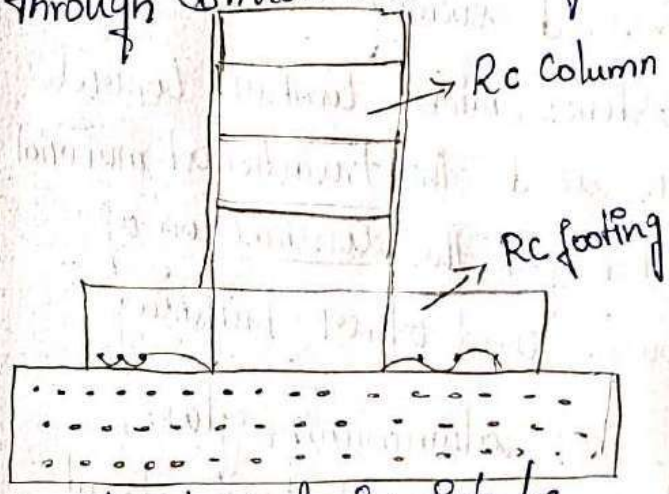
Function of Construction Management

* Project is divided into different phases.
* Planning & preparing construction schedule.
* Estimating requirement of Material and Labour.
* Procurement of material, Machinery, employing labour
* Arrangement for finance and payment for material, salaries.

Structural Engineering.

* The objectives of structural analysis is to determine the internal forces and corresponding displacements of all structural elements as well as those of the entire structure system.

The safety and proper functioning of the structure can be ensured only through a through structural analyses.



* Structural analysis is to be done to calculate stress in structural components on the basis of loads acting on structures.
* Before building a structures it should be analysed and designed to decide about its size to resist the possible forces coming on it.

The roles of Structural Engineers

* The structural engineering to understand predict and Calculate the stability. Strength and rigidity of build structures for buildings and non building structures.
* Develope design and supervise construction of project on site
* A structural engineer has to not only give a role structure but also has to give economical structure
* study earthquake forces and build earthquake resistant structures.

④ Geotechnical Engineering.

Geotechnical engineering deals with soil investigation and design of Proper foundations of structures.

Soil investigation:

* It includes collection and testing of soil samples.
* Soils are considered as three phase materials composed of rock or mineral particle water and air.
* The engineering properties (of soil) are affected by four factors -
  a) size of the mineral particle
  b) Type of mineral particles
  c) Grain size distribution
  d) Relative quantities of mineral.

Foundation design.

It includes construction and design of simple foundations well foundation, construction of dams, construction of tunnels, sub base of roads and earth related construction.

Environmental Engineering:

* It deals with pollution control and public health engineering.
* Different type of pollutions are water, Air, noise and others.

* Due to large scale industrialization, population growth, rapid urbanization and several other human activities like construction mining, transportation, etc. environment get polluted.

Environment Engineering deals with technologies and facilities which are engaged in reducing pollution.

It includes design construction and maintence of water treatment plant. waste water treatment plant water distribution network and sewerage system.

It also deals with solid waste management in towns and cities.

Environmental engineering is concerned with the application of scientific and engineering principles for the protection of human population from the effects of adverse environmental factor. protection of environment and improvement of environmental quality.

* Environmental engineers has to design municipal water supply and industrial waste water treatment system.
* They address environmental issues such as global warming ozones layer depletion, water pollution and air pollution from automobile exhaust and industrial sources.
* Due to industrialization air pollution becoming a major problem.
* It is estimated that for every tonne of cement produced, one tonne of Co_2 is released in the environment.
* vehicles also produces lot of Co_2.

During last one centurys the environmental pollution has resulted in global warming by 4°C

⑥ Transportation Engineering

* Transportation means movement of passengers and good by means of vehicles on land, ships on water and aircrafts in air and trains on railways.

* Transportation engineering is that branch of civil engeering which deals with planning, designing and construction of roads, bridges, railways, tunnels, harbors, ports, runways and airports.

* for development of nation good transportation nekwork is of prime importance.

* It is the application and scientific Principle to the Planning, functional design operation and management of facility for any mode of transportation inorder to Provide for safe, efficient rapid, comfortable, convenient economical and environmentally compatible movement of people and goods.

* The planning aspects of transportation engineering related to elements of estimation of trip generation (how many trips for what purpose). Trip distribution (destination choice, where is the traveller going), mode choice (what mode is being taken) and naught assignment (which streets or routes are being used).

* The design aspects of transportation engineering include the sizing of transportation facilities (how many lanes or how much capacity the facility has), determining the materials and thickness used.

Advantages of road transport.

* Less capital
* Door to Door servile
* Servile in rural areas
* suitable for short distances.

Disadvantages:
* Seasonal nature
* Unsuitable for long distance
* slow speed:

Advantages of rail/ transport.
* Dependable
* Better organised
* High speed over by distances.
* suitable for bulky and heavy goods.
* Cheaper transport (less cost)
* Safety.

Disadvantages of railways.
* Lack of door to door service
* Unsuitable for short distances and low loads.
* No rural Service.

Classification of Highways.
a) freeways
b) Express ways
c) Highways

* Freeways are four lanes. two lanes in each direction.
* Express ways are designed for high speeds (120 kmph) high traffic volume and safety.
* Highways are of two types

a) Rural Highways
These are passing through the rural areas.

b) Urban highways
These are passing through the Urbans areas.

Different ganges in Indian railways.
1. Broad gange (1676mm)
2. metre gange (1000mm)
3. Narrow gange (762mm)

When the clear horizontal distance between inner faces of two Parallel rail forming a track is 1676mm. It is called Broad gauge, 1000mm meter gange and 762mm its narrow gange.

⑦ Water resource Engineering

* Water is an important need for all living beings.
* study of mechanics of water and its flow characteristics is another important field in civil Engg and it is known as Hydraulics
* Water resource engineering means, measurement, utilization and development of water resources for architecture municipal and powder generation purpose.

Rural areas need water for agriculture field also Hence civil engg have to look for new water resources and for storing them

It involves the design of new system and equipment that helps to manage human Water resources

Water resources engineering deals with planning, designing and developing water resources by constructing several hydraulic structures like dams barrages, hydropower stations, canals and pipe networks etc.

Water stored in reservoirs by building dams should be bought to agricultural fields through canals and distributories

Hydrology is also a part of water resource engineering, that includes study of sources of water, measurement of rainfall, study of rainfall and flood control.

Contribution of Mechanical Engineers to Society

* Mechanical engineers Provides better transport facilities to the society as it includes the study of internal combustion engineers.
* Large number of benefits to the society, due to economical improvement of the country, become of industrial development, chance for export of articles was also be increase

Due to large industrial development, new power station have to be started.

Increased employment opportunities will be created in the field of industries and power stations.

Specialized sub disciplines in Mechanical Engineering

① Production Engineering
   a) Casting Process
   b) Metal joining Process
      * Welding
      * Brazing
      * Soldering
   c) Metal Cutting
   d) Drilling
② Automobile Engineering
③ Energy Engineering

Metal Casting Process.

* casting Process involves the pouring of molten metal into a cavity or mould of the desired shape and size and allowing it to solidify
* When the casting is removed from the mould, it is of the same shape but slightly smaller due to the contraction of metal

* Casting process required moulding sand which can with sand high temperatures
* By using a replica of the required cast which is called pattern, a cavity of desired shape and size is made in the moulding sand
* The metal is melted in a furnace and poured in the cavity
* After the solidification is completed the casting is removed and cleaned.

Advantages of casting process.

* cost involved is very low.
very heavy and bulk parts which are difficult to fabricate can be manufactured by the casting process.
* casting can be employed for mass and batch production.
* Product can be cast as a single piece and hence the metal joining process can be eliminated.

Patterns.

A pattern is a model or a replica of the object to be manufactured around which moulding sand is packed to get a mould of desired shape and size.

* The quality of casting in terms of dimensional accuracy surface finish and mechanical properties depends largely on
a) Material used for pattern
b) Type of pattern
c) Design and Construction of pattern

Pattern Materials.

The selection of pattern material depends upon
a) Number of casting to be produced
b) Dimensional accuracy.

* Surface finish required
* Shape and size of casting
* Type of moulding Process
Either Sand moulding or machine moulding.

Pattern Materials are
1. Wood (Mahogany, teak, pine)
2. Metals & Alloys
3. Plastics
4. Plaster
5. Wax

Metals & alloys → Aluminium, steel
cast iron, Brass, white metal

plastics → Epoxy resins
polyester resins
polystrene

plaster → plater of paris Gypsum

Pattern allowance:
In the metal casting process the pattern is used to produce a casting of the desired dimensions. but the pattern is not identical with the casting. The various reasons are the following

1. All metals Shrink in size when there is a change from the liquid to the Solid State.
2. Casting requires Surface finish The pattern should be removed from the mould cavity without tearing the mould cavity surface.
3. Therefore, the pattern are made with certain allowances on size. The various pattern allowances are include -
a) Shrinkage allowence
b) finishing or machining allowance
c) Draft allowance or Taper allowance
d) Distortion or Camber allowance
e) Shrinkage (or) Rapping allowance

Shrinkage allowance.
It is the allowance given on the Pattern size for avoiding any change in the dimensions of the casting because of Shrinkage of metal during Solidification

* Different metal have different Shrinkage allowances

Grey Cast iron - 7-10.5 mm/m

Steel - 20mm/m

Aluminium - 18mm/m.

Shrinkage allowance depend upon

* The type of metal being used
* The Size and Shape of the casting.

Finishing allowance (or) Machining Allowance

It is the allowance given on the Size of the pattern for finishing or machinery the rough Surface on the casting

For ferrous metals - 3mm

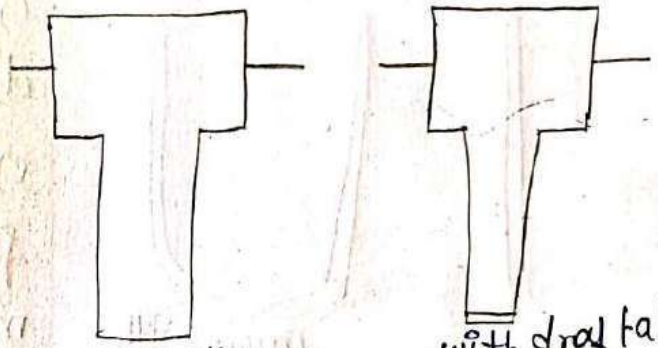
for non ferrous metals - 1.5mm

finishing allowances depend upon

* The type of metal used
* The casting design
* The method of casting
* The method of cleaning
* The degree of finish required
* for the casting

Draft (or) Taper allowance

This allowance is allowed on the vertical faces of a pattern for easy removal of the pattern from the mould, without damaging the mould cavity surface



No Draft Allowance

with draft allowance

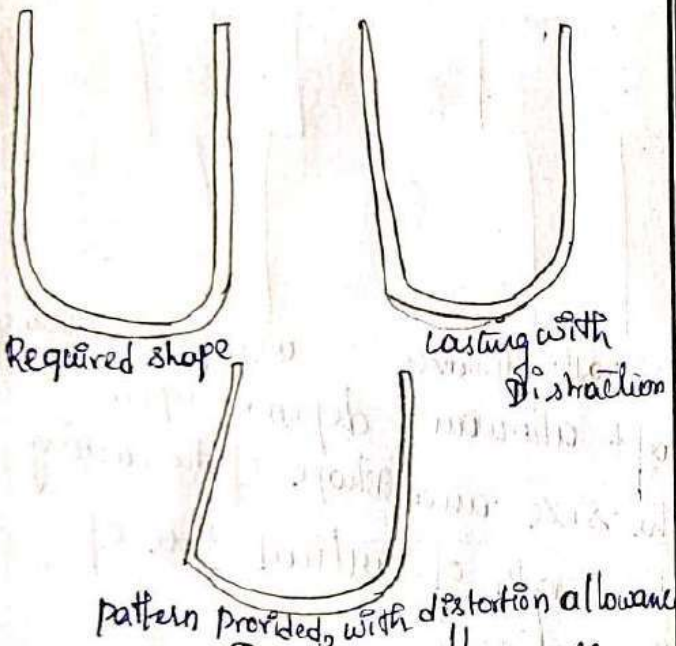
Draft allowance depends upon

* The size and Shape of the casting
* The length of vertical face of the casting.
* The method of moulding
* Fine details of the casting

Distortion or camber allowances

* Due to internal Stresses developed during cooling, the casting may be distorted
* Distortion allowances is given to avoid distortion by intentionally deflecting the leg inwards

This allowance depend upon
* Type of metal being used
* The design of casting
* The length of this section in the casting



Shake or Rapping allowance.

For easy withdrawal of the pattern from the moulding sand, the pattern is slightly rapped or shaked around the vertical faces which leads to a slight enlargement in the mould cavity.

Types of pattern.

various factor to be considered to the selection of a pattern type are the following

a) Shape and size of the casting
b) Number of casting
c) Method of moulding adopted
d) Complexity of the casting
e) Accuracy required.
f) Problems associated with the moulding operations such as the removal of the pattern from the mould.

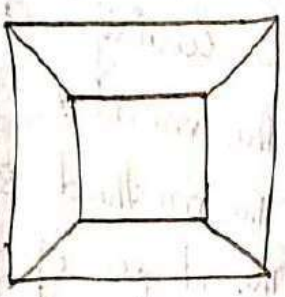
Types of patterns

They are 10 types of patterns are available.

a) Solid or single piece pattern

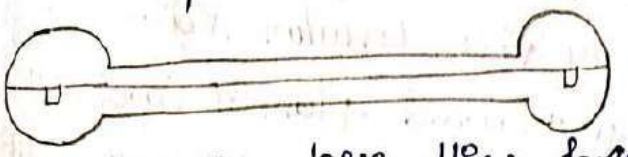
The simplest form of pattern made without any joints, partings or loose piece in its construction is called solid or single piece pattern.

It is inexpensive and generally used for large casting of simple shape.



b) Split pattern

* This pattern cannot be made in a single piece.

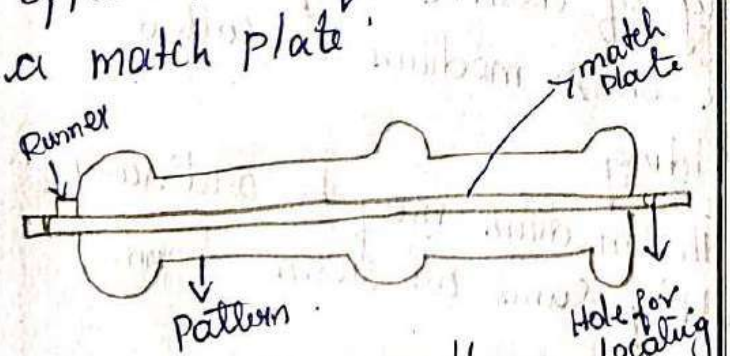


because the difficulties faced in removing them from the mould.

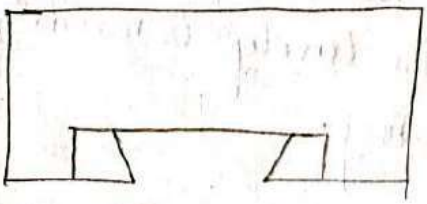
To overcome this problem some patterns are made in two parts so that half of the pattern will rest in lower part of the mould and other half on the upper part.

c) Match plate pattern

In this type, each half of the pattern are mounted on opposite sides of a plate called a match plate.



d) Loose piece pattern

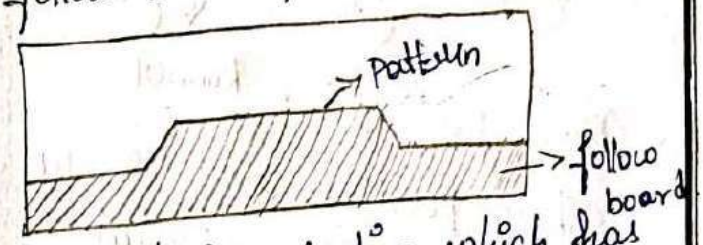


It is a pattern with loose pieces which are necessary to facilitate the withdrawal of the pattern from the mould.

e) Skeleton Pattern

Skeleton pattern is used for making few large castings.

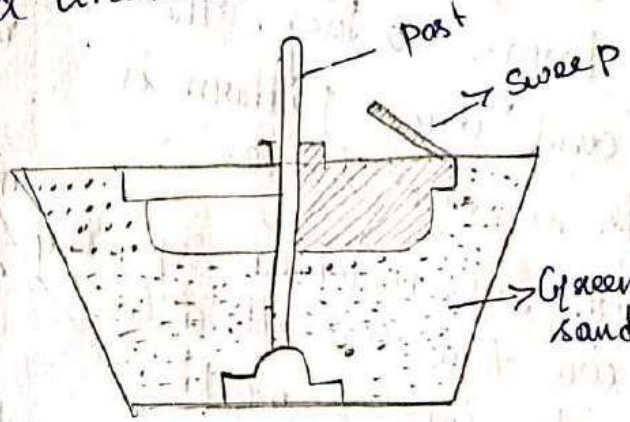
f) Follow board pattern.



It is used for casting which has some structually weak portions which need some support for avoiding breakage during the moulding process.

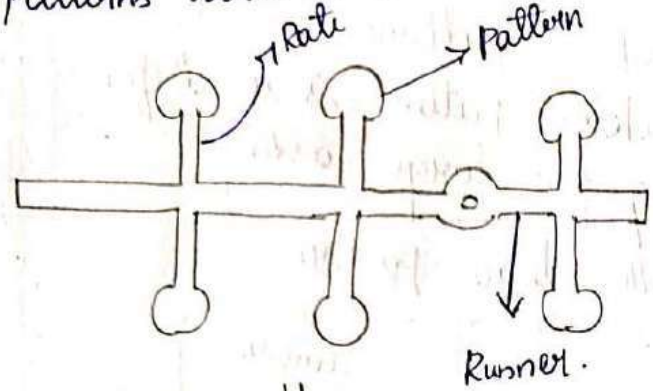
g) Sweep pattern

Sweep pattern are used to manufacture large castings of symmetrical shape and with a circular cross section.



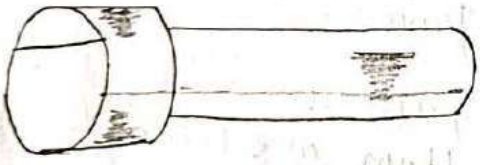
h) Gated pattern.

When large number of small casting are required, gated patterns are used.



I) Shell pattern.

Shell pattern are widely used for large symmetrical casting such as drainage fittings and pipes.



J) Cope and Drag pattern.

* It is widely used for very large casting. The cope and drag pattern is made in two halves.

* Both are moulded seperately and are then assembled to make the complete mould.

Pattern making

* For making wooden patterns utensils such as work benches carpenter vice, circular saw band saw, wood planner, wood boring machine are required.

For making a metal pattern lathe, Drilling machine milling machine, Shaper, planner machines are required.

Moulding:

are the pattern of correct shape and size for the casting is prepared, it is necessary to make cavity with the help of a medium.

The process of making this cavity of desired shape and size on a medium is called moulding.

The medium may be ordinary moulding sand or resins - bonded sand.

Moulding sand is the medium in which the cavity is made for the casting.

Properties of Moulding Sand

* Refractoriness.

It is the ability of the moulding sand to with stand high temperature

* Strength.

It should have sufficient strength to retain the mould shape under green, dry, hot condition.

* Flowability:

It is the ability of moulding sand to get compacted to take up the required shape.

Porosity or Permiability.

The moulding sand should be porous enough to allow the gases picked up by the molten metal to escape from the mould.

Cohesiveness.

It is the ability of moulding sand to adhere to each other.

Adhesiveness

Ability of moulding sand to adhere to the walls of moulding boxes.

Collapsibility

It is the readiness to get collapsed by the moulding sand after the solidification of casting

Chemical resistivity:

It is the ability of moulding sand to resist any chemical reaction with the molten metal

Ingredients of moulding sand

a) Refractory sand grains

b) Binders → Fire clay and Bentonite

c) Water

d) Additives

* Coal dust for good surface finish
* Iron oxide powder for hot strength
* Dextrin for collopsibility
* molasses for high dry strength

Preparation of Moulding Sand.

Sand Preparation means mixing the moulding sand ingredients such as sand, binder, water and other additives together.

* The mixing may be carried out by mannually or by machine

Types of Moulding Sand

* Green Sand Moulding.

In this type, the molten metal is poured into the mould when the mould is in moist condition.

* Dry sand mould.

In this type, the mould is prepared with the moulding sand having high dry strength and is then dried in an oven.

* Skin dried Moulding.

In this type, the moisture from the surface layer of the mould size is dried to a depth of 25mm by heaters.

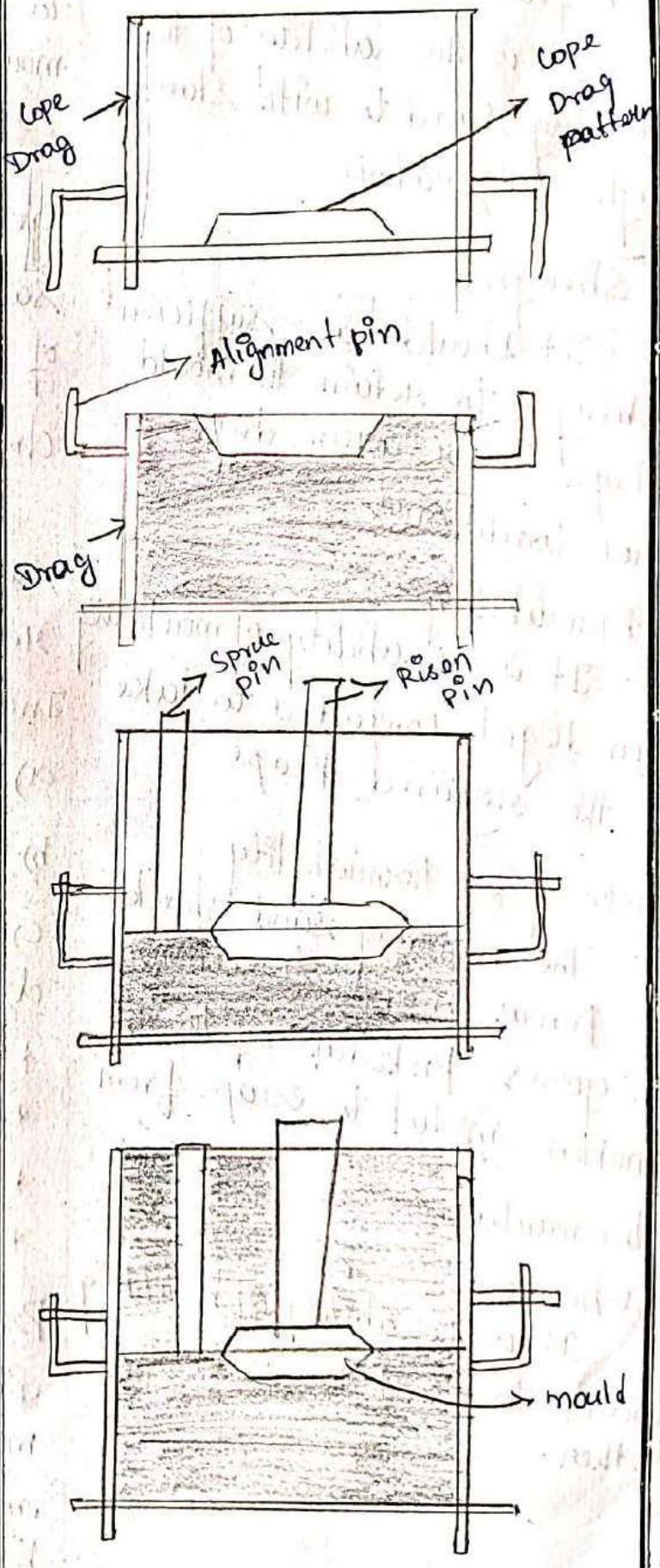
* Loan sand moulding.

In this type a mixture of equal amount of sand grains and clay wetted to the consistency of mud is used.

* Oil sand moulding.

In this type, an organic binder like vegetable oil, mineral oil, animal oil, natural resins along with dextrin and bentonite are mixed with moulding sand.

Preparation of green sand moulding



* A bottom board on mou[illegible] board is placed on the moulding platform or on the floor.

* The drag portion of the moulding box is kept upside down on the bottom board.

* The drag portion of the pattern is placed at the centre of the moulding box walls as shown in diagram

* Dry facing sand is sprinkled all around the pattern to avoid the sticking of pattern with the moulding sand.

* Sufficient amount of moulding sand is put into the moulding base and on the drag pattern so as to fill the box completely

* The moulding sand is added, if necessary

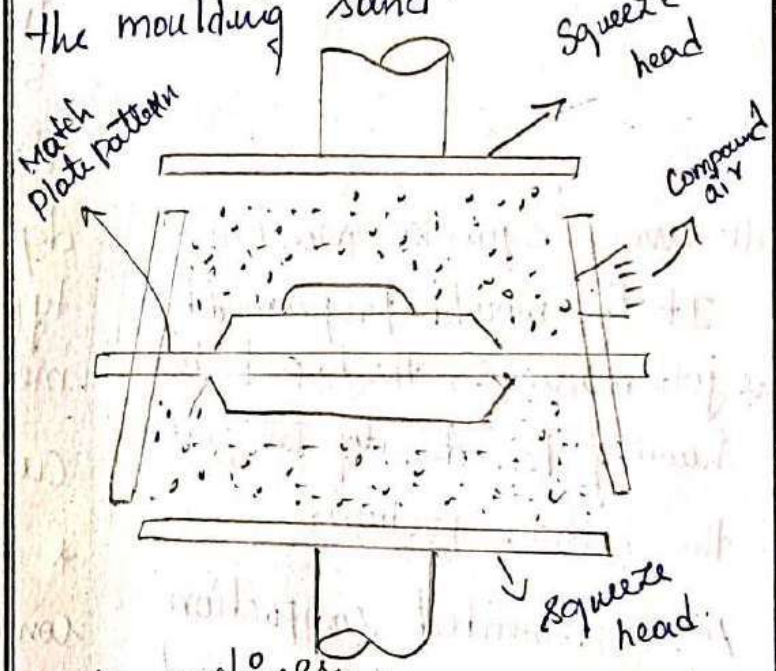
Moulding Machines.

Mass production of casting is done by using machine moulding which uses the following methods.

a) Squeezers.
b) Jolt machines
c) Jolt & squeeze machines
d) Slingers

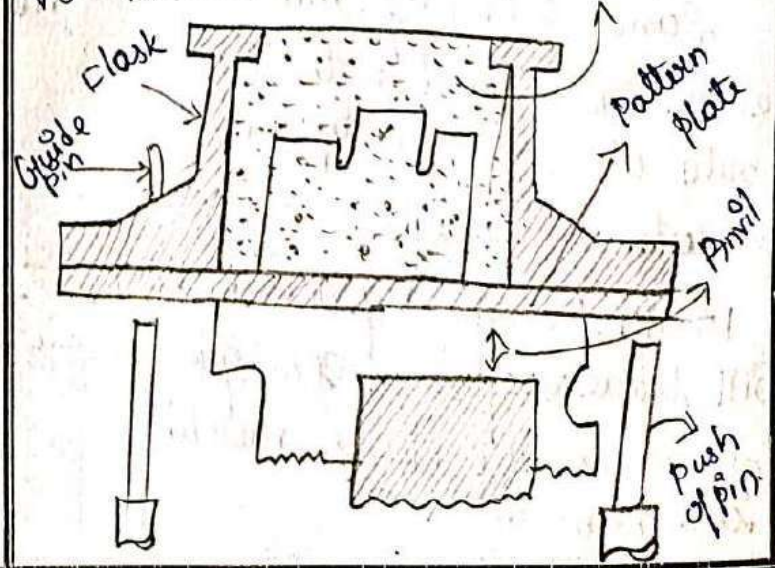
Squeezers.

Squeeze moulding machines utilize pressure for compacting the moulding sand.



Jolt machines.

This machine operate with the pattern mounted on a pattern plate, which is in turn fastened to the machine table.



Jolt and squeeze Machine

If the mould prepared by the jolt machine, the top portion is having less density compared to the bottom portion.

A supplemented compaction is done by a squeeze head which compacts the loose sand at the top.

Sand slinger

Sand slinging machines deliver the sand into the mould at high velocity from a rotating impeller

* Moulds made by this method will have very high strength because a very dense mould can be made

Melting of cast iron.

Furnace is used for melting of cast iron. various types of furnaces are

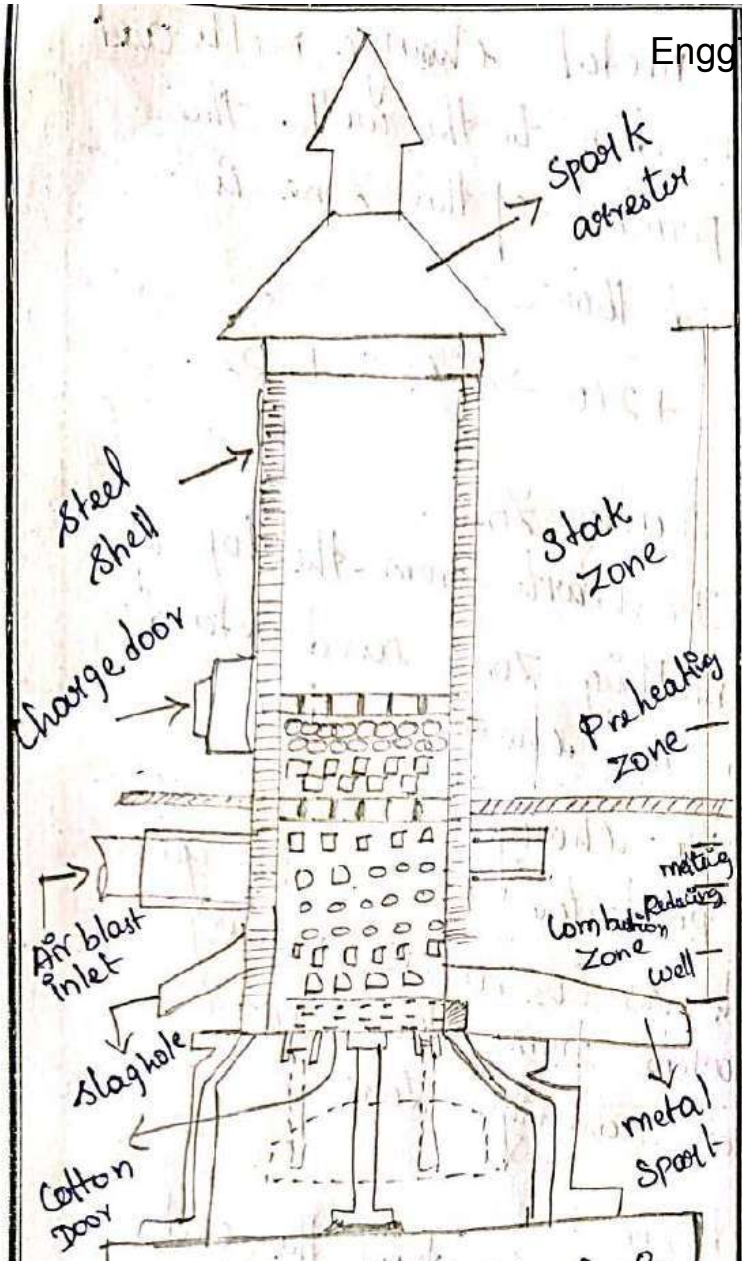
1. pit furnace
2. open hearth
3. Rotary
4. cupola
5. Electric arc.

The choice of furnace for melting depends upon the amount and type of metals or alloys to be melted.

Cupola Furnace.

* A cupola furnace basically consist of a cylindrical steel shell with both its top and bottom open.

The inner walls of the shell are lined with heat resisting materials such as the fire bricks.



* The charge consist of pig iron, scrap iron coke and flux

The spark arrester at the top arrests the spark or building particles from going outside while allowing the hot gases to escape out.

Various steps in cupola furnace Operation

1. Preparation of cupola
2. starting of ignition
3. charging
4. melting
5. slagging and topping.
6. Dropping down the bottom.

After the cupola furnace has been fully charged the charge is allowed to get heated slowly for about 45 minutes without allowing the air blast. This is called soaking of iron

Zones of cupola furnace

well : It extends upto the bottom of from the sand bed
* It is a sort of a well of molten metal.

Super charging Zone, Combustion Zones or oxidizing Zone.
* It extends upto 15-30 cm above the well.
* Combustion take place in this Zone with the aid of oxygen from air blast.

* The exothermic reactions which occurs in this zone are

$C + O_2 \rightarrow CO_2 + Heat$

$Mn + O_2 \rightarrow MnO_2 + Heat$

$Si + O_2 \rightarrow SiO_2 + Heat$

Temperature of this Zone is 1550°C - 1650°C.

Reducing Zone:

* It starts from the top of combustion zone and extends upto the bottom of first metal charge.

In this zone, the exothermic reaction reducing CO_2 to CO is taking place.

$CO_2 + C(coke) \rightarrow CO + Heat.$

The above reaction reduces the heat in the zone and the temperature in the zone is around 1200°C only.

Melting Zone:

It starts with the first layer of the metal charge and extends upto 90cm.

The metal charge melts and moves down to the well. The temperature of this zone is around 1600°C

$3Fe + 2CO \rightarrow Fe_3C + CO_2.$

Preheating Zone.

It starts from the top of the melting zone and extends upto the charging door.

The charge in this zone is preheated by the hot gases such as CO_2, CO, N_2 moving upwards from the combustion and reducing zones.

Stock Zone:

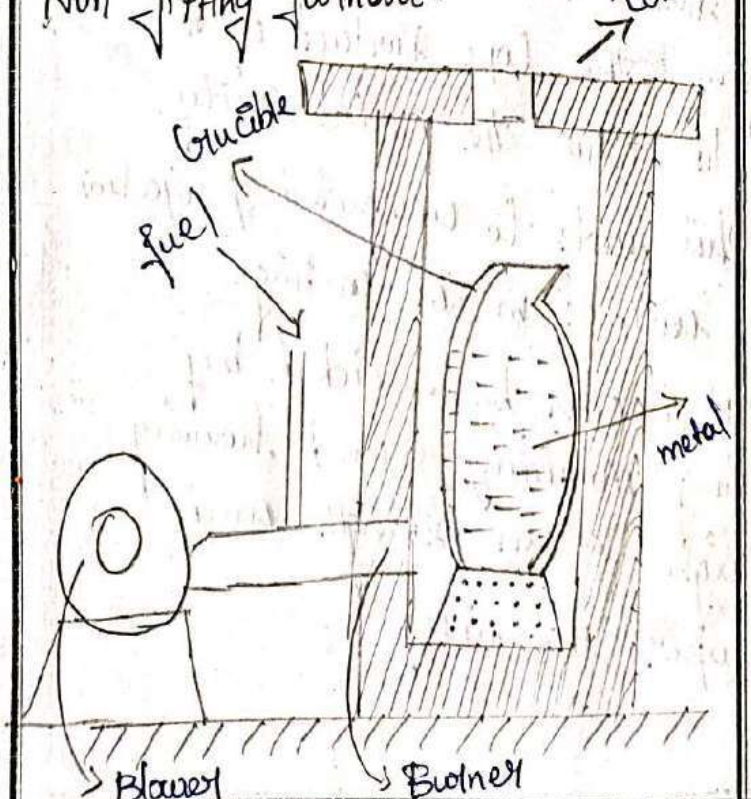
It extends from the end of preheating zone to the end of cupola shell and includes the spark arrester.

Crucible furnace:

* It is used to melt non ferrous metals like brass, bronze, Aluminium etc.
* A crucible is usually made of mixture of graphite and clay.
* The material to be melted and they is placed inside the crucible and they are heated with coke or oil as fuel.
* Crucible furnace are of two types

a) Non tilting furnace
b) Tilting furnace

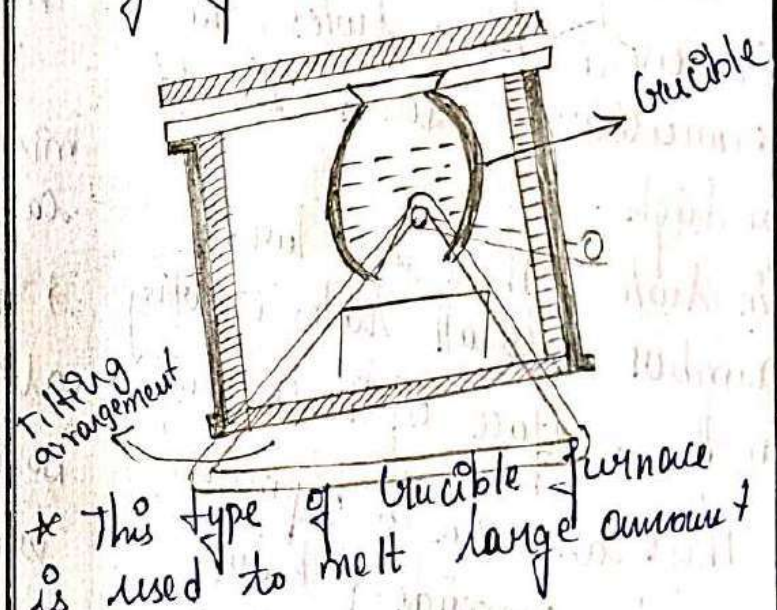
Non tilting furnace.



~~* This type of crucible furnace is used to melt large amount of metal~~

* This is a stationary type crucible furnace
* A blower is used for supplying primary air for combustion.

Tilting type crucible furnace.



* This type of crucible furnace is used to melt large amount of metal.

When the molten metal is ready to be poured, the furnace is tilted and transfered to a preheated ladle.

Fettling

* Fetting is the process of cleaning and finishing a casting.
* This includes the removal of lowers, sand and oxides scale from the surface of casting

Casting Defects

Blow holes: These are the cavities present inside the casting or on the surface of the casting.

* These are caused by entrapped gases or steam in the casting.
* To avoid blow holes, the permiability of sand should be high.

Pin holes: These are large number of small holes occuring on the surface of the casting

These can due to hydrogen or carbon monoxide picked up by the molten metal in the furnace or while transferring it for pouring.

Swell:

A swell is an enlargement of the mould cavity because of the pressure exerted by the molten metal.

* This causes some error in the dimensions of the casting
* This can be avoided by the proper ramming

Shrinkage cavity:

It is a void or depression caused by shrinkage of the metal

This can be avoided by proper mould design

Shift:

This caused when there is a mismatch of the sections of a casting usually at parting line

* This can be avoided by proper alignments of the pattern, moulding boxes etc.

Drops

It is caused by the falling of some loose moulding sand from the cope surface of the mould into the mould cavity.

This leads to unwanted projection or cavities in the casting

This can be avoided by using moulding sand having high green strength and proper ramming.

Misruns:

These are caused by the incomplete filling of the mould cavity by the molten metal.

* This leads to unfilled cavities in the casting
* This can be avoided by having an increased fluidity of the metal and by avoiding the small thickness of the casting

Cold Shuts:

It is caused by incomplete fusion of the molten metal stream while meeting in the mould cavity.

* This lead to a discontinuity or a weak spot in the casting
* This can be avoided by having increased fluidity of the metal and by avoiding too small thickness of the casting.

Run out:

* This the leakage of molten metal from the mould cavity.
* This lead to unwanted Projection in the casting
* This can be avoided by Proper ramming while making the mould.

Metal Penetration:

* A metal penetrating is caused by the entering of molten metal into the space between the grains of the moulding sand.

This can be avoided by using moulding sands having lower Permiability and smaller grains.

Metal joining Processes.

It is the process in which, metal piece is joined by the application of heat by some means

The various metal joining Process are

a) Welding
b) Brazing
c) Soldering

Welding

Welding is a metal joining Process in which the joining of metal is done by the application of Presence.

Welding process may be classified into two types

Arc welding

Gas welding

In arc welding, heat is applied by producing an electric arc between two conductors

In gas welding, heat is applied by the combustion of a flue gas with oxygen.

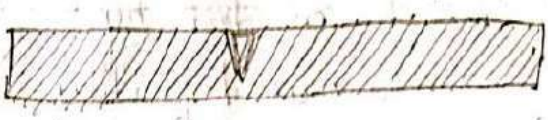
Types of welded joints.

1. Lap joint
   a) Single b) Double
2. Butt joint
   a) Single V
   b) Double V
   c) U-shaped
   d) Single strap
   e) Double strap
3. Edge joints
   a) Straight joint
   b) Right angled joint
4. Corner joints
5. Plug joint
6. T-joint.

1a)

1b)

2a)

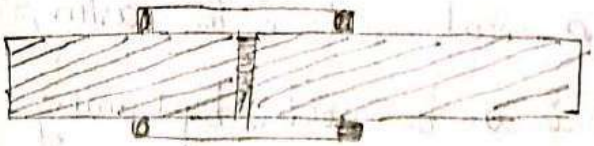


2b)

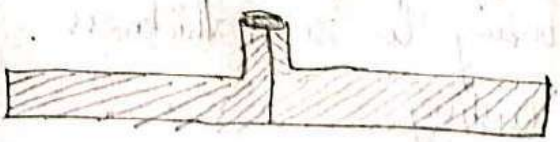
2c)

2d)

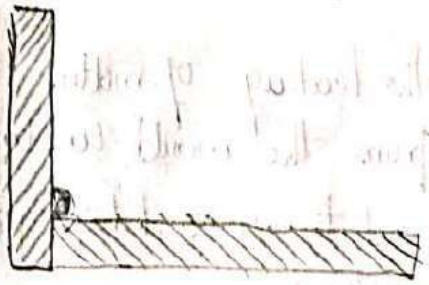
2e)



3a)



3b)



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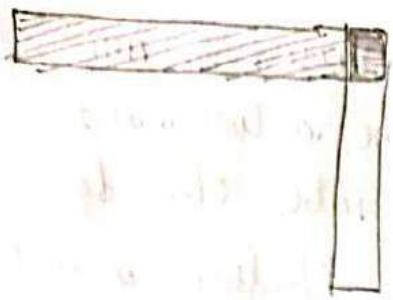

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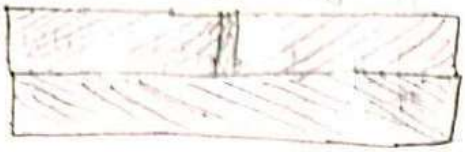

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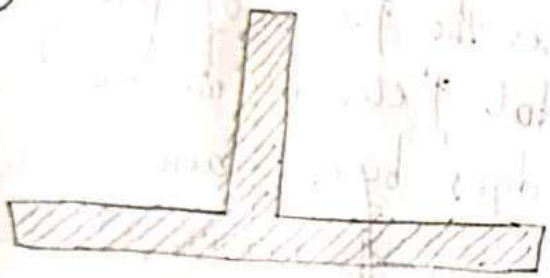


Basis welding terms.

a) Base metal (or) Parent metal

The metal to be joined is known as base metal

b) filler metal

It is a metal or alloy used for filling the weld cavity

c) weld metal

It is the metal solidified in the weld cavity

d) Edge Preparation

It is the preparation of the edges of metal pieces to be joined into some forms of depending on thickness of the metal and type of welded joints.

e) Root : It is the narrow region at the bottom of the welded joint.

f) weld pass

* movement of the welding torch or electrodes along the length of the joint is called as weld pass.

A welding can be completed in single pass or multipass.

g) Penetration

The depth upto which the weld metal combines with the parent metal is called metal Penetration.

h) Deposition rate

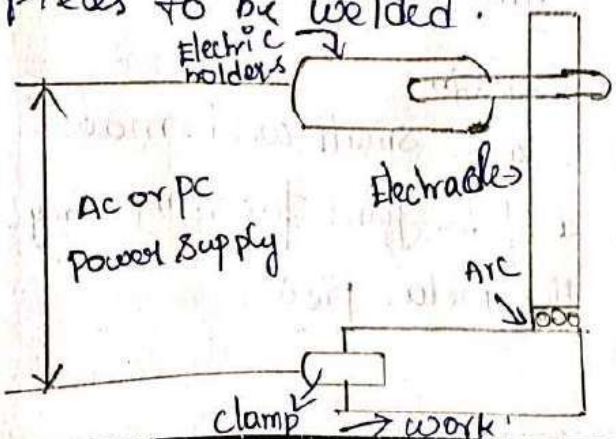
It is the rate at which the weld metal deposits in the joint per unit time

i) Track Welds

These are small welds made at the end of the joint for temporarily holding the metal pieces.

Arc Welding

* It is the process of joining two metal pieces by melting their edges with an electric arc.
* An arc is an electric discharge through the ionised gas column between two conductor of electricity namely Arode and Cathode.
* When two conductor are touched and then seperated by a small distance, electrons and Pborated from the cathode and move towards the anode.
* An arc useful for generating heat can be obtained between an electrode and the work piece, between two electrodes and also between two metal pieces to be welded.



Electrodes

Electrodes used in arc welding may be a consumable or a non consumable electrode

A consumable electrode is used to produce an arc and is also melted to fill the weld cavity

Gas welding.

It is the process of joining two metal pieces by melting their edges by a flame resulting from the burning of a gas fuel and oxygen

* Oxygen and Acetylene combination is the most widely used in this process.
* In this process, the flame is produced at the tip of the torch.
* It is used for heating the metal.

Oxy Acetylene welding

* In this welding the flame is produced by burning a mixture of oxygen and acetylene.
* This mixture burns to produce the high flame temperature upto 3480°C in two stage reaction

Stage 1:

In the first stage oxygen and acetylene react to form carbon monoxide and hydrogen

$$C_2H_2O_2 \rightarrow H_2 + 2CO$$

Stage 2:

In the second stage carbon monoxide and hydrogen react with oxygen forming carbon dioxide and water vapour respectively

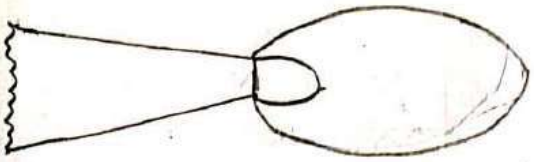
$$2CO + O_2 \rightarrow 2CO_2$$

$$2H_2 + O_2 \rightarrow 2H_2O$$

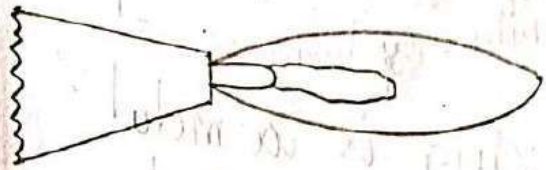
* Based on ratio of oxygen and acetylene in the mixture the flame can be classified into

a) Neutral flame
b) Carburising flame (Excess Acetylene)
c) Oxidising flame (Excess oxygen).

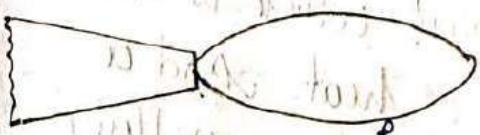
a)



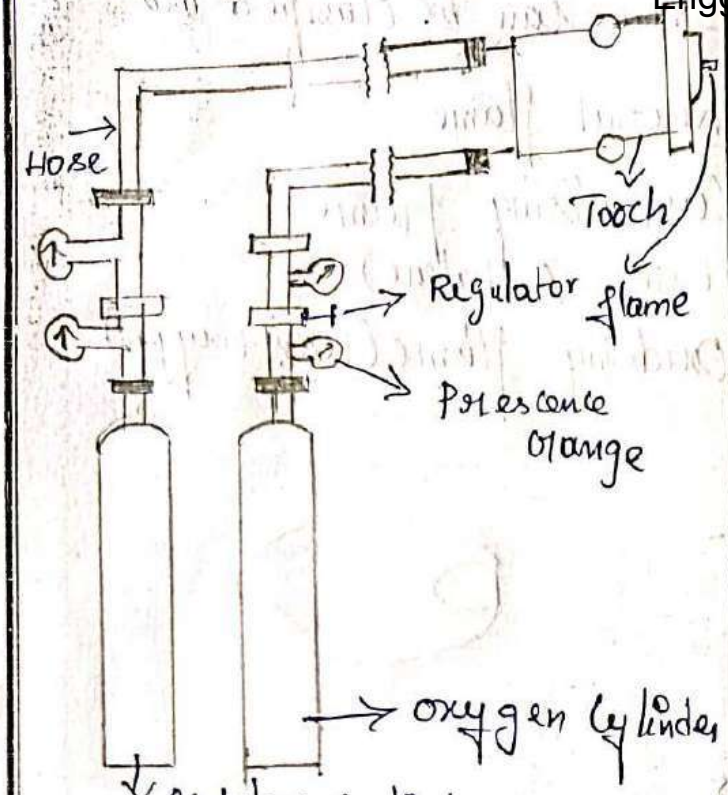
b)



c)



* Neutral flame is used for welding steel, stainless steel, cast iron and copper.
* Carburising flame is used for welding monel low carbon steels and some alloy steels.
* Oxydising flame is obtained by supplying more volume of oxygen than Acetyle
* It is used for welding copper and copper alloys.



Brazing

Brazing is a metal joining process which is done by the use of heat and a filler metal whose melting temperature is above 450°C but below the melting point of the metal being joined

* Brazing differs from welding in the following ways

a) The strength of the brazing alloy is lower then that of base metal.

b) the melting point of brazing alloy is lower than of the base metal

Most commonly used brazing metals are copper and copper alloy, Silver and silver alloys Aluminium alloys.

Purpose of fluxes

* To dissolve oxides present on the surface of base metal
* Preventing the formation of oxides during heating
* promoting the molten metal to flow into the joint.

Method of brazing

* Torch brazing
* Dip brazing
* Salt brazing
* furnace brazing
* Induction brazing
* Resistance brazing

Soldering

It is a metal joining Process in which the joining of metal is done by the use of heat and a filler metal whose melting temperature is below 450°c

* joint Strength is relatively low in case of Soldering adhesion between the filler metal called the Solder and the parent metal.

Solder metals

The most widely used solder metals are Tin-Zinc Cadmium-Zinc or aluminium-Zinc or Cadmium Silver alloys.

Flux removal in soldering and brazing.

Hot water
Alcohol
Grease

Drilling machine

* In drilling machine, holes are drilled by rotating a cutting tool called drill.
* Drilling machines can also be used for other operations like boring, reaming, taping spot facing etc.

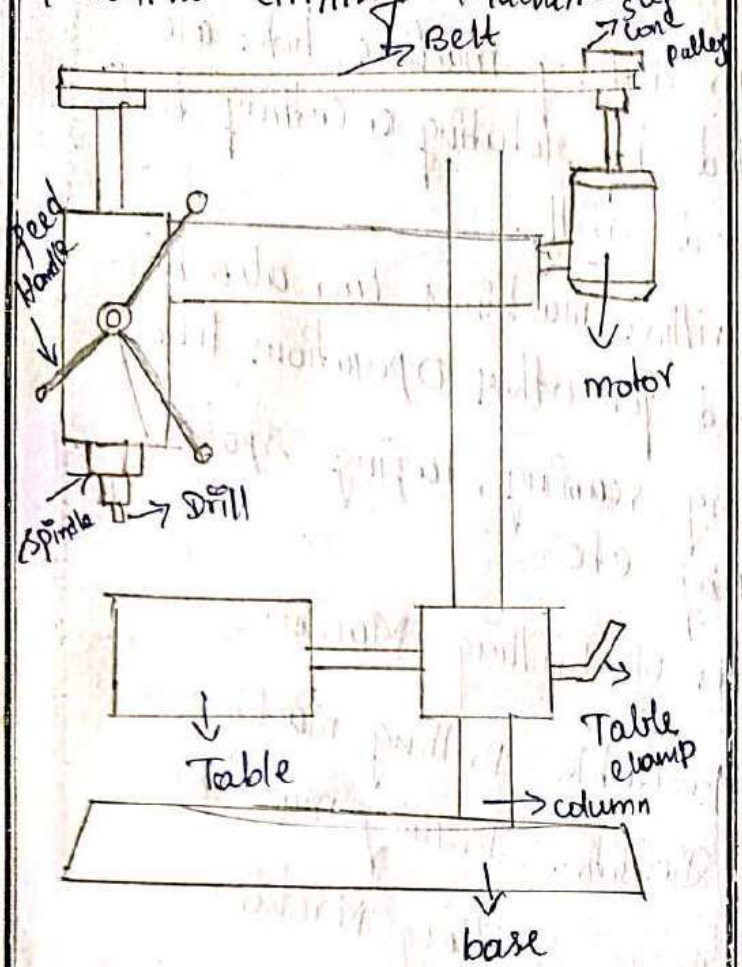
Types of Drilling Machine.

1. Portable Drilling machine
2. Sensitive Drilling machine

Portable Drilling Machine.

* These machines are small Compact machines which can be easily carried out
* It has an inbuilt electric motor which rotates the drill at high speeds.
* It is used for drilling small holes in a large job at any desired angles.

Sensitive drilling Machine



* It has a base on which a cylinder or cylindrical post is mounted vertically.

A table is attached to the column by means of a table clamp

The table supports the work piece and work holding devices

It can be mound along the column for proper positioning of the work piece.

A spindle head and a drive mechanism are mounted at the top of the column.

It has an electric motor which drives the spindle by means of a belt and cone pulley arrangement

Lathe

* Lathe is one of the oldest and most important machine tool
* The lathe has become a general purpose machine tool which is used widely in production works.

Main parts of lathe.

1. Bed.

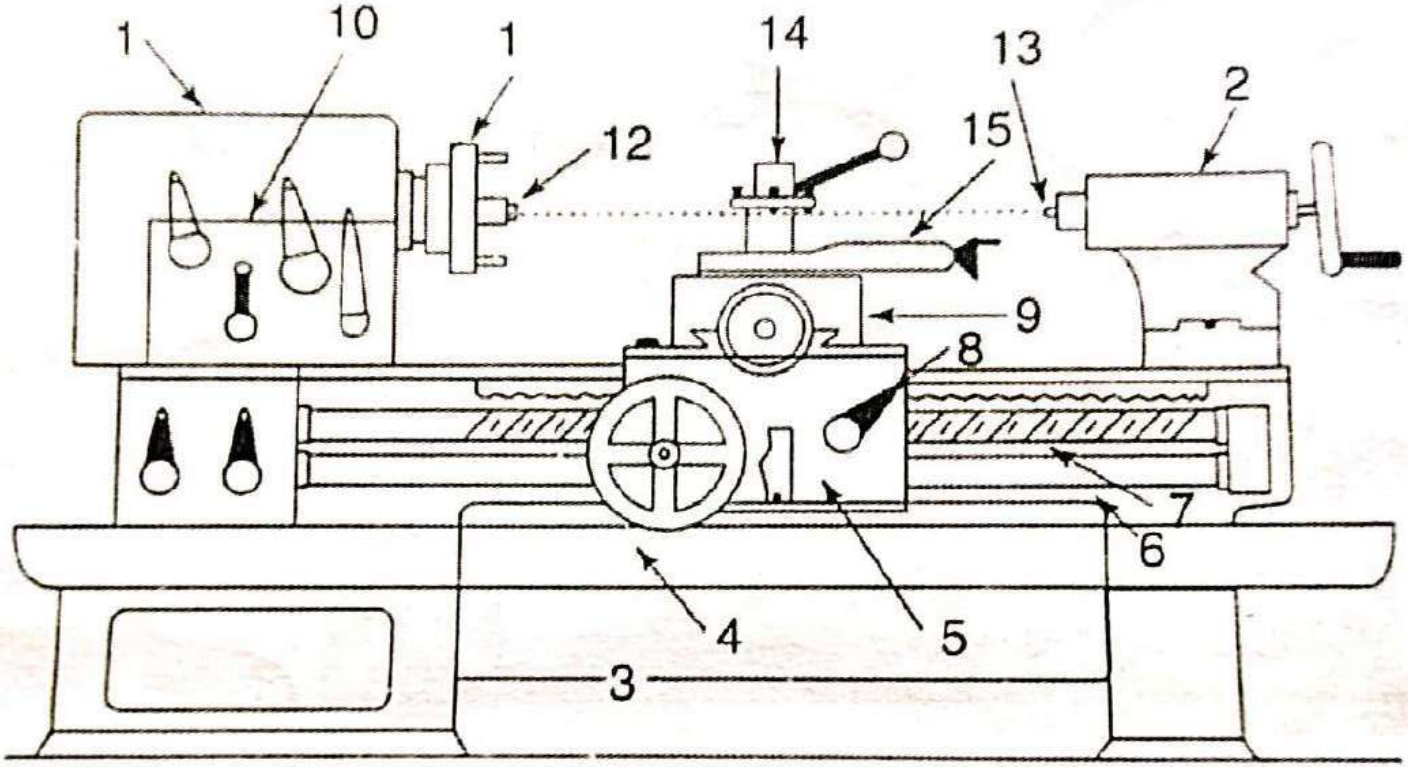
It is the basis structure of the lathe and constitutes 70-90% of the total weight of the lathe. All other parts of the lathe are fitted to the bed.

2. Head stock.

The head stock is mounted on the left side of the bed.

It provides the power required for rotating the work at various speeds and for the tool movement as well.

Big diagram



1. Head stock
2. Tail stock
3. Leg/Bed
4. Tray
5. Carriage
6. Feed shaft
7. Lead screw
8. Half-nut lever
9. Cross-slide
10. Gear box
11. Driving plate
12. Live centre
13. Dead centre
14. Tool post
15. Compound rest

Fig. 1.33 *Centre lathe*

3. Tail stock.
* It is mounted on the right side of the bed.
* It can be moved along the lathe bed for accomodating work pieces of different size
* It is used to support one end of a long work piece
* To hold a tool for the operation like drilling, reaming tapping. etc.

4. Carriage:
The carriage provides the mean for mounting and moving the cutting tools.

5. The Saddle
It is H-Shaped casting fitted on to the bed and moves along the outside of guide ways on the bed surface

6. The Cross Slide
The cross slide is used to move the cutting tool along a perpendicular direction to the axis of rotation of work piece

7. The compound rest
It consist of a base which is mounted on the cross slide

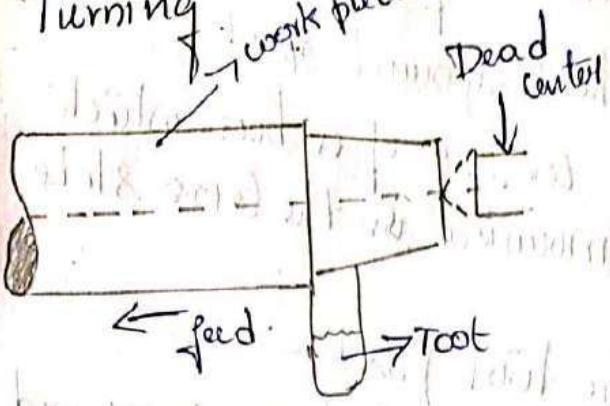
8. The tool post
* It is mounted on compound rest
* It is used to clamp the cutting tool.

9. The apron
* It is attached to the front of the carriage
It consist of the mechanism for the manual and automatic motion of the carriage and cross slide

10. feed mechanism.
The proces is transmitted to the apron through the feed mechanism

Operations done on a lathe

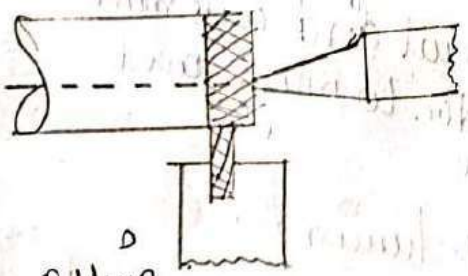
① Turning



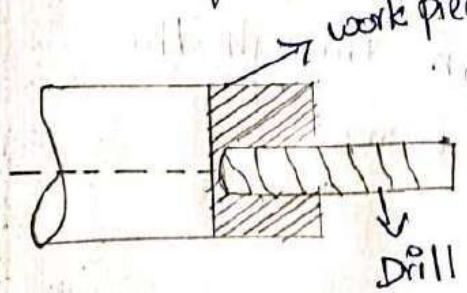
Turning is the lathe operation in which the diameter of cylindrical job is reduced

② Knurling

In knurling, the surface of the work piece is made through rough for easy handling



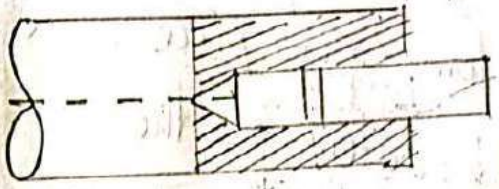
3 Drilling



Drilling is the operation by which a hole is produced in the work piece

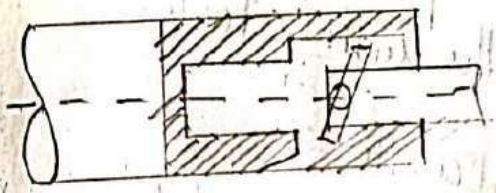
4. Reaming

It is the operation by which the dimension of a hole are corrected.



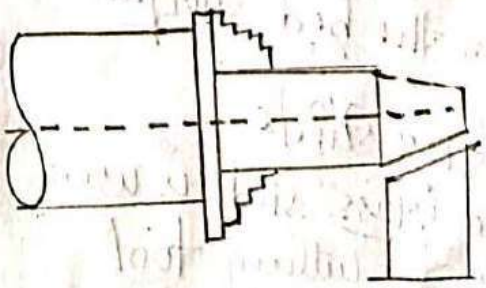
5. Boring

Boring is the operation by which the drilled hole is enlarged

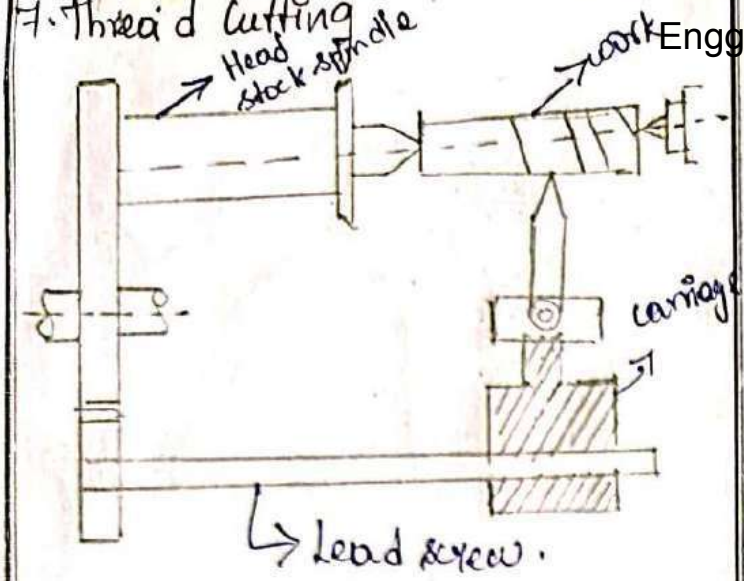


6. Taper turning

It is the operation by which the tapered surface is produced.



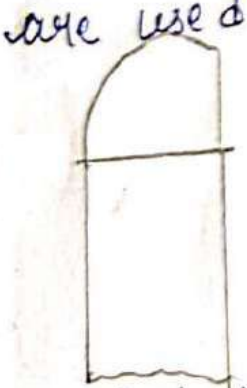
7. Thread cutting



Lathe tools.

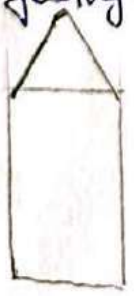
* most of the lathe operation are done with simple and single point cutting tools.

These tools slightly vary in their shapes according to the operation for which these are used.


Turning tool


facing tool.


Parting tool


Threading tool

Interdisciplinary concepts in Civil & Mechanical Engineering.

* Ventilation facility especially in multi-storied building for safety in buildings.
* In hospitals construction of dust and micro organism free operation theatres
* for construction of steel industry, paper industry dams bridges
* In transportation sector civil and mechanical engg work together for executing facility like roadways and railways
* Marine engineers have to coordinate with civil, mechanical engg to construct harbours
* Aeronautical engineers have to interact with civil mechanical engineers for the development of air ports

* chemical engineer for metal ore like iron, gold etc
* Bio medical engineer for pharmacy industry
* food processing engineers for food industry preservation of milk, cheese, butter, ghee milk powder etc.

Thus civil engineers should understand the importance of inter disciplinary approach in their planning construction and erection activities to avoid criticism from any corner of the society.

Though civil & mechanical engineering professionals have their own system in place in their field, if other engineers play an interdisciplinary role, it will enhance values to their systems

Surveying

Surveying is the art of determining the relative positions of distinctive features on the earth's surface. This is achieved by the measurement of distances and directions.

Objectives of Surveying

* To prepare the archeological maps, geological maps, military maps.
* To establish boundary points of properties
* To measure quantities in cutting contour maps.
* To layout the alignment of engineering Structures like roads, railways etc.
* To determine the relative position of desired points with reference to a known bench mark.
* To measure the distance.

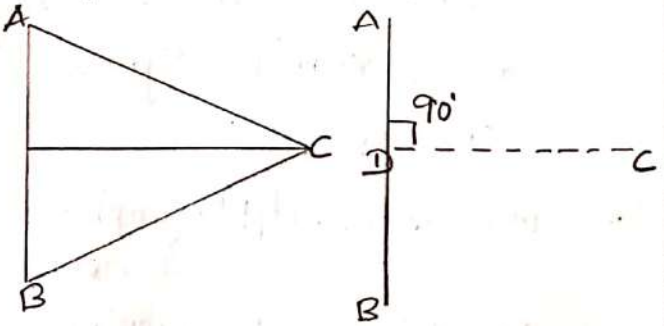
principle of Scaveying

(a) Working from whole to part:

* Inorder to prevent accumulation of errors and to localize the minor errors, a set of primary control points are established first with higher precision in and around the area to be surveyed.
* Later on, in between those primary control points, inner control points are established with less precision method.

(b) Fixing a point with reference to two fixed points.

Let the points 'A' and 'B' are known and the distance between them is measured.



Let it be required to locate or mark a point 'c'. The relative position of the point 'c' is located with reference to the two fixed points 'A' and 'B'.

Classification of Surveying

(1.) Based on the nature of the field:

(a) Land Surveying

(i) Topographical Surveying
Streams, lakes, forest, Roads, railways, Canals, Towns & villages.

(ii) Cadastral Surveying
calculation of land area, transfer of land property from one owner to another

(iii) City Surveying
Construction of Streets, water supply system, sewers etc.

(b) Marine (or) Hydrographic Surveys.
Navigation, water supply, harbour works, determination of mean sea level.

(c) Astronomical Survey
Determination of absolute locations of any point.

(2) classification based on objective of Survey

(a) Engineering Survey
Determination of quantities which will be useful for the designing of engineering works.

(b) military (or) Defence Survey
Preparation of maps of important military areas.

(c) Geological Survey
These are carriedout to find the earth's crust.

(d) Mine Surveys
For exploring the mineral wealth below the earth surface

(e) Archaeological Surveys
These are executed to prepare maps of ancient cultures.

(3) Based on methods employed.

(a) Triangulation Survey

(b) Traverse Survey.

(4) Based on Instruments used.

(a) Chain Surveying

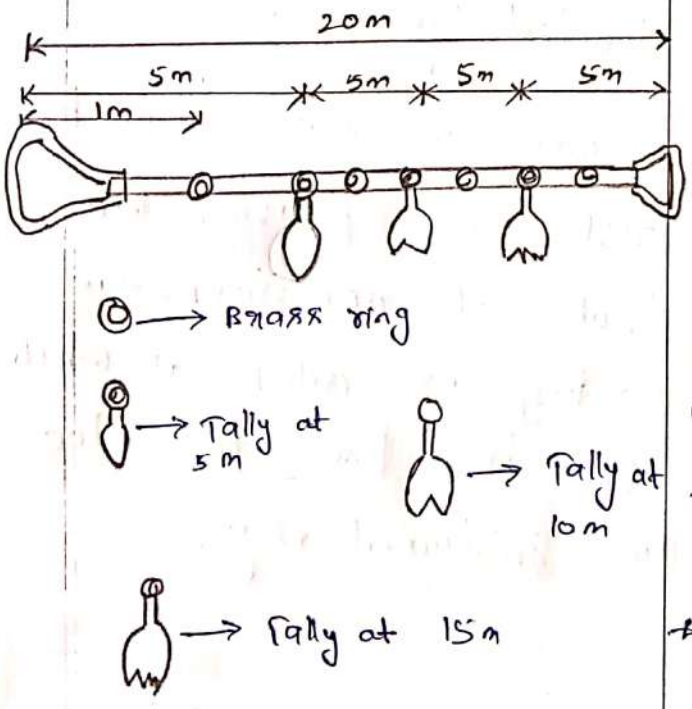
(b) Compass Surveying

(c) plane table Surveying

(d) Tacheometric Surveying

(e) photographic Surveying

chain Surveying



The instruments used for chain Surveying are

(a) Chain (c) Pegs

(b) Arrows (d) Ranging rods

(e) Offset rods

(f) Plumb bob.

* The chain is made of mild steel.
* The ends of the chain are provided with brass handles for dragging the chain on the ground.
* The length of the chain measured from the outside of one handle to the outside of the other.
* the length of the link is the distance between the Centers of the two Consecutive middle rings.
* Survey chains are available in lengths of 20m and 30m.
* The 20m chain Contains 100 links and 30m chain contains 150 links

Compass Surveying

* This instrument essentially contains a freely suspended magnetic needle on a pivot, which can move over a graduated scale.
* In addition to the above, it has an object vane and an eye vane which will be useful to get the line of sight.
* This instrument will be supported by a tripod stand while taking observations.

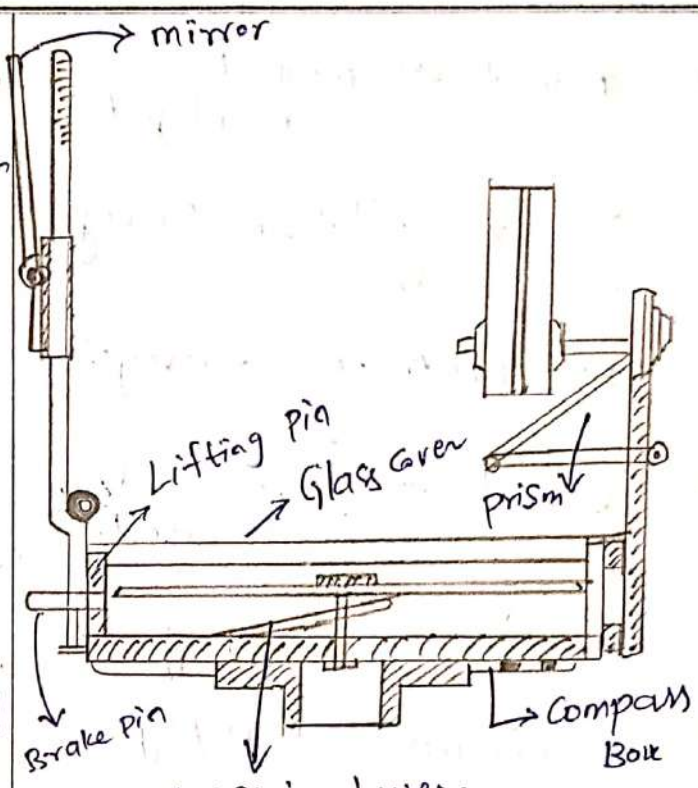
There are two types of Compass are available.

(a) prismatic compass.

(b) Surveyor's Compass

prismatic Compass

The Compass is usually mounted on a light tripod which carries a vertical spindle in a ball and socket joint to which the box is screwed.



* The Compass should be centered over the station where the reading is to be taken.
* the Compass should be leveled by eye.
* when the needle comes to rest, by pressing the knob, if necessary, the reading is noted at which the hair line appears on the graduated ring.

Plane table Surveying

Plane table is a graphical method of survey in which the field observations and plotting proceed simultaneously.

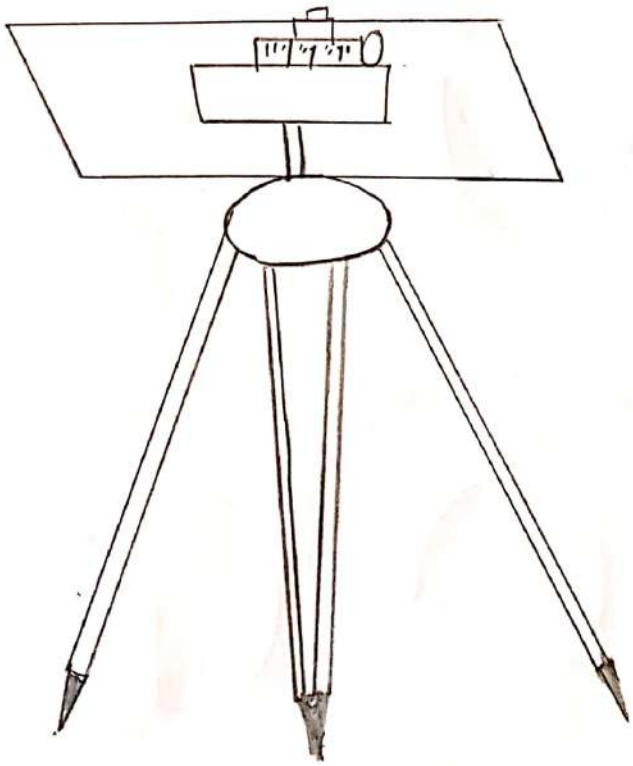
* It is means of making a manuscript map in the field while the ground can be seen by the topographer and without intermediate steps of recording the transcribing field notes.

Instruments used

1. The plane table with leveling head having arrangement of
   (a) Leveling
   (b) Rotation about vertical axis
   (c) clamping
2. Alidade
3. plumbing fork
4. Spirit level
5. Compass
6. Drawing paper with rain proof Cover.

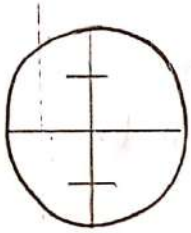
working operations

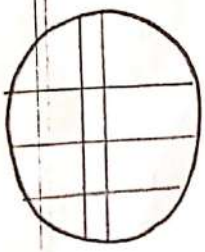
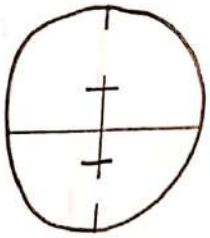
(a) fixing
(b) Setting
   (i) Leveling the table
   (ii) Centring
   (iii) Orientation
(c) Sighting the points.



Tachometaric Surveying

It is the branch of angular Surveying, in which the horizontal, vertical distances of points are obtained by Optical means.



The primary objective of tachometry is the preparation of Contoured maps or plans which include both horizontal as well as vertical Contour.

Levelling

Leveling is the art of determining the relative height or elevation of points or objects on the earth's surface.

Instruments used for leveling

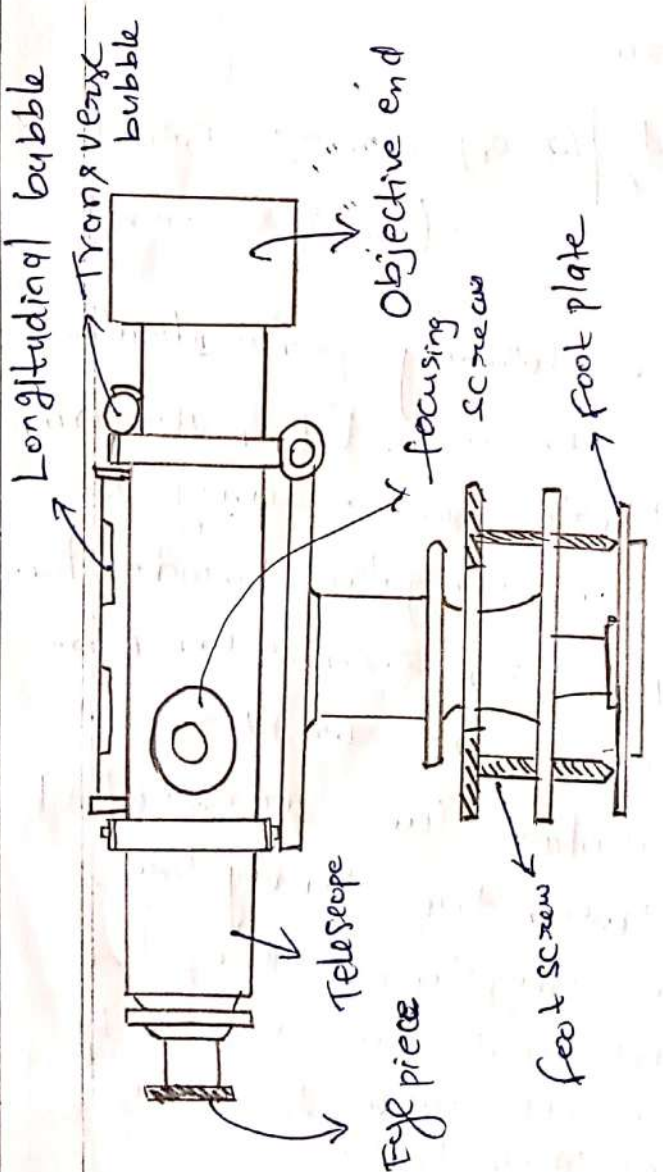
1. Level
2. Levelling Staff.

Level

The purpose of Level is to provide a horizontal line of sight.

parts of Level are
(a) Telescope
(b) Level tube
(c) Leveling head
(d) Tripod.

* Telescope is used to provide line of sight
* Level tube is used to make line of sight horizontal
* Levelling head is used to bring the bubble in its Centre of run.
* Tripod is used to support the instrument



Levelling Staff

It is a straight rectangular rod having graduations, the foot of the staff representing Zero reading.

* The purpose of levelling staff is to determine the amount by which the station is above or below the line of sight.

Types of levelling staff

a) Self reading staff
b) Target staff

self reading staff

It can be read directly by the instrument man through the telescope.

Target staff

It contains a moving target against which the reading is taken by staff man.

Leveling Staff

Determination of Areas

The area can be calculated by following methods.

(a) Mid ordinate rule
(b) Average ordinate rule
(c) Trapezoidal rule
(d) Simpson's rule

Mid ordinate rule

$$\text{Area} = (O_0 + O_1 + O_2 + \cdots O_n)\,d$$

O_0, O_1, O_2 = Ordinates at the mid point of each division.

n = Number of divisions

d = Distance of each division

L = Length of base line = nd

Average ordinate rule

$$\text{Area} = \frac{(O_0 + O_1 + O_2 + \cdots + O_n)\,L}{(n+1)}$$

Trapezoidal rule

$$\text{Area} = \left[\frac{(O_0 + O_n)}{2} + (O_1 + O_2 + \cdots + O_{n-1})\right] \times d$$

Simpson's rule

$$\text{Area} = \frac{d}{3}\left[(O_0 + O_n) + 4(O_1 + O_3 + \cdots O_{n-1}) + 2(O_2 + O_4 + \cdots O_{n-2})\right]$$

The following perpendicular offsets were taken at 10m intervals from a survey line to an irregular boundary line. 3.15m, 4.3m, 8.2m, 5.6m, 6.85m, 7.6m, 4.2m, 5.6m, 4.3m. Calculate the area enclosed between the survey line, the irregular boundary line, first and last offsets by the application of above four methods.

d = The interval between the offset = 10 m

n = number of Divisions = 8

L = Length of the base line

= n x d

= 8 x 10

= 80 m

mid ordinate rule

$$\text{Area} = (O_0 + O_1 + O_2 - - - - + O_n)\, d$$

$$= (3.15 + 4.3 + 8.2 + 5.6 + 6.85 + 7.6 + 4.2 + 5.6 + 4.3)\, 10$$

$$= 49.8 \times 10$$

$$= 498\ m^2$$

Average ordinate rule

$$\text{Area} = \frac{(O_0 + O_1 + - - - O_n)}{n+1} \times L$$

$$\frac{(3.15 + 4.3 + 8.2 + 5.6 + 6.85 + 7.6 + 4.2 + 5.6 + 4.3) \times 80}{8+1}$$

$$= 442.66\ m^2$$

Trapezoidal rule

$O_0 = 3.15$, $O_1 = 4.3$, $O_2 = 8.2$

$O_3 = 5.6$, $O_4 = 6.85$, $O_5 = 7.6$

$O_6 = 4.2$, $O_7 = 5.6$, $O_8 = 4.3$

$$\text{Area} = \left[\frac{O_0 + O_n}{2} + O_1 + O_2 + - - O_{n-1}\right] d$$

$$= \left[\frac{3.15 + 4.3}{2} + 4.3 + 8.2 + 5.6 + 6.85 + 7.6 + 4.2 + 5.6\right] \times 10$$

$$= (3.725 + 42.35) \times 10$$

$$= 46.07 \times 10$$

$$= 460.7\ m^2$$

Simpson's rule

$$\text{Area} = \frac{d}{3}\left[\frac{O_0 + O_n}{2} + 4(O_1 + O_3 + - - O_{n-1}) + 2(O_2 + O_4 - - + O_{n-2})\right]$$

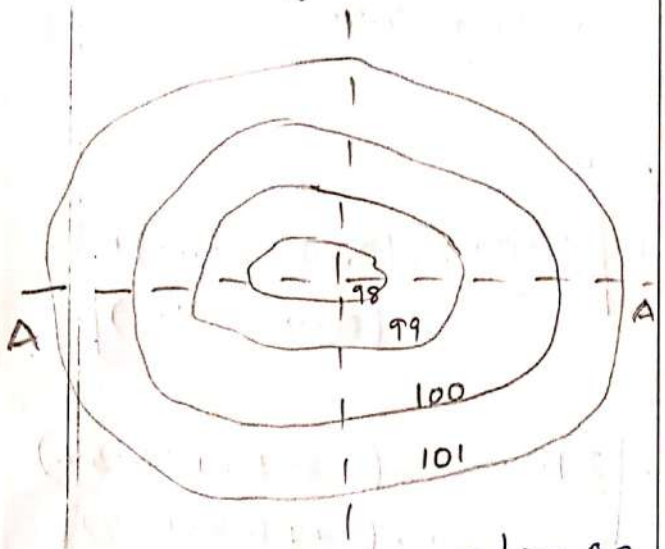
$$\frac{10}{3}\left[\frac{3.15 + 4.3}{2} + 4(4.3 + 5.6 + 7.6 + 5.6) + 2[8.2 + 6.85 + 4.2)\right]$$

$$\frac{10}{3}\left[7.45 + 92.4 + 38.5\right]$$

$$= 461.16\ m^2$$

Contour

* Contour is an imaginary line on the ground joining the points of equal elevation.
* It is a line in which the surface of ground is intersected by a level surface.



* A Contour line is a line on the map representing a Contour.
* The above diagram shows a pond with water at an elevation of 101.00m as shown in the plan by the water mark.
* If the water level is now lowered by 1m, another water mark representing 100.00m elevation will be obtained.
* These water marks may be surveyed and represented on the map in the form of Contours.

Distance measurement

The following are the methods used for measurement of distances.

1. Direct method
   a) Pacing
   b) passometer
   c) pedometer
   d) Odometer and Speedometer
   e) Chaining
2. measurements by optical means
3. Electro magnetic methods.

pacing

It is confined to the preliminary surveys and explorations where a surveyor is called upon to make a rough survey as quickly as possible.

* The method consists in counting the number of paces between the two points of a line.
* The length of the line can then be computed by knowing the average length of the pace.

passometer

It is an instrument shaped like a watch and is carried in pocket.

* The mechanism of the instrument is operated by motion of the body and it automatically registers the number of paces, thus avoiding the monotony and strain of counting the paces, by the surveyor.
* The number of paces registered by the passometer can then be multiplied by the average length of the pace to get the distance.

pedometer

It is a device similar to the passometer except that adjusted to the length of the pace of the person carrying it, it registers the total distance covered by any number of paces.

Odometer and Speedometer

The odometer is an instrument used for registering the number of revolutions of a wheel.

* A well known Speedometer works on this principle.

* The odometer is fitted to a wheel which is rolled along the line whose length is required.

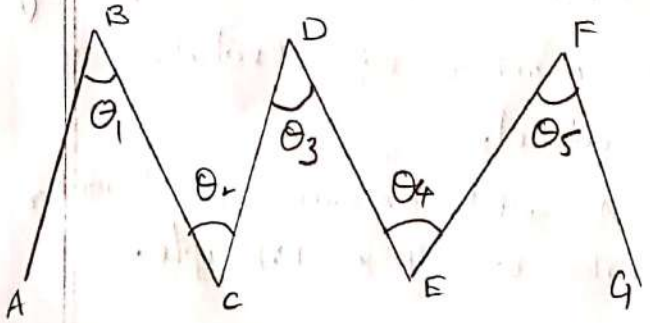
* The number of revolutions registered by the odometer can then be multiplied by the circumference of the wheel to get the distance.

Measurement of angles

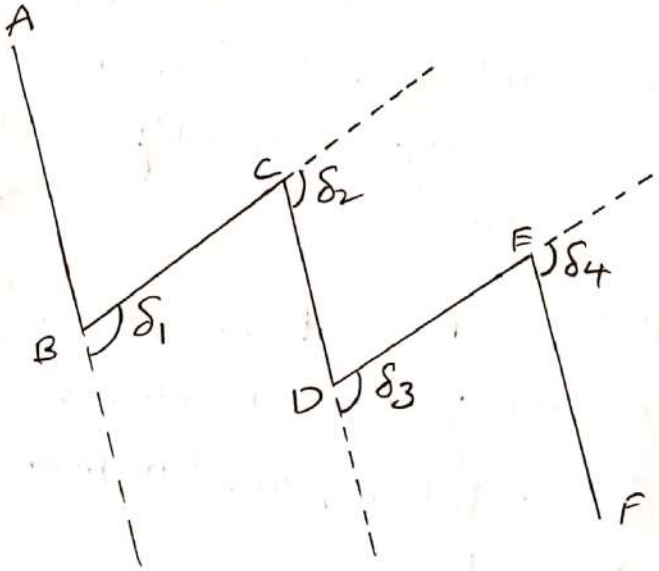
* The instruments commonly used for measurement of angles are compass and the theodolite.

* The horizontal angles may be measured in two ways.

(a) Included angle



(b) Deflection angles between successive lines



Civil Engineering materials

a) Bricks
b) Stones
c) Sand
d) Cement
e) Concrete
f) Steel
g) Timber
h) modern materials

The Service Conditions of buildings demand a wide range of materials with specific properties.

* Hence the properties of the materials are studies properly to select suitable building materials.

Bricks

Qualities of Good Bricks

* Bricks should have perfect edges, well burnt in kiln, copper coloured, free from cracks with proper rectangular shape and standard size (19x9x9 cm)
* Bricks should give a clear ringing sound when struck with each other.
* Bricks must be homogeneous and free from voids.
* The percentage absorption of water by weight should not be greater than 20%. for first class bricks and 22%. for second class bricks, when soaked in cold water for 24 hours.
* Brick should be sufficiently hard. The average weight of brick should be 3-3.5kg
* Brick should not broken when dropped from a height of 1m
* It should have low thermal conductivity and should be sound proof.
* The minimum crushing strength of brick should be $3.5 N/mm^2$
* Brick should not show deposits of salts when immersed in water and dried.

Classification of Bricks

a) first class bricks

* These are of standard shape.
* These are used for superior and permanent works.
* These comply with all good qualities of bricks.

(b) Second class bricks

* These are good moulded and burnt in kilns.
* The surfaces of such bricks are rough and are slightly irregular in shapes.

(c) Third class bricks

* These bricks are not hard but rough with irregular and distorted edges.
* These gives a dull sound when struck with each other.
* These are used for unimportant and temporary structures and at places where there is less rainfall.

(d) Over burnt Bricks

* These are irregular shapes with dark colours.
* These are used as aggregates for concrete in foundations, floors, roads.

Uses of bricks

* Bricks are mainly used in construction of walls.
* These can be used as drains.
* Bricks with cavities known as hollow bricks can be used for insulation purpose.
* paving bricks prepared from clay containing higher percentage of iron can be used for pavements.

* Bricks with holes are used in multi-storeyed framed structures.
* Fire bricks made of fire clay can be used as a refractory material
* Sand-Lime bricks are used for ornamental work.
* Bricks are used in the construction of common Compound wall, Columns.
* Broken bricks are used as aggregates in Concrete.
* Bricks are used in the construction of chimneys and other special works.
* Bricks of superior quality can be used in the facing of a wall.

Constituents of brick

a) Alumina: It is the chief constituent of clay.
* A good brick should have 20-30% of alumina.

(b) Silica
* It exists in clay in a free or combined form.
* A good brick should contain about 50-60% of Silica.
* The presence of Silica in brick prevents cracking, shrinking and warping of raw bricks.
* The Durability of brick depends upon proper proportion of Silica.
* It imparts uniform shape to the brick.

(c) Lime
* upto 5% of lime is desirable in good brick.
* It prevents shrinkage in raw bricks.
* Bricks may melt and lose their shape due to excess of lime content.

(d) Oxide of iron
It gives red colour to bricks. Desirable is 5-6%.

(e) Manganese It imparts yellow tints to brick and reduces shrinkage

Advantages of bricks

* Bricks are cheaper and easy to handle.
* They are of standard size and hence easy to have proper bonding.
* Consumes less mortar when compared to stone masonry.
* Labour required for brick masonry is less.
* Brick walls can be raised to a large height, when compared to stone masonry.
* It gives neat appearance.
* Brick masonry consumes less mortar for plastering.
* Easy to drill holes.
* Bricks have low thermal conductivity and high sound insulation properties.
* They posses very high resistance to fire.
* They are not combustible and non-flammable.

Disadvantages

* The compressive strength of brick is less compared to stone and concrete.
* Only a selected variety of clay can be used for manufacturing of bricks.
* Kilns are required to be constructed for manufacturing of bricks.
* It has got a very low tensile strength compared to other building materials.

Tests on bricks

The following are the tests by judgement for assessing the quality of bricks.

(a) field test

* The brick should be truly rectangular in shape with sharp edges and plane faces and of same size.
* They should be hard and

well burnt and should give a metallic ringing sound when struck with a steel rod.

* They should be of uniform red colour and fine texture.
* When the bricks are dropped on the ground from one meter height, they should not crack or break.
* They should be free from cracks, fissures, pebbles or nodules of free lime.

Lab tests

(a) Test for water absorptions.

* 3 samples of clean well dried bricks are taken and their dry weight is founded out individually.
* The bricks are then immersed in water for 24 Hours.
* After 24 hours, the bricks are takenout, surface dried and weighed in a balance and wet weight foundout
* If the wet weight of each brick is W_2, the percentage water absorption of each brick

$$= \frac{W_1 - W_2}{W_1} \times 100$$

* The average percentage of water absorption of three samples is the water absorption of bricks.
* The average absorption of water should not be greater than 20%.
* Too much of water absorption indicates under burnt condition and poor strength.

(b) Test for efflorescence

* Salt like sulphates of Calcium, magnesium, sodium and potassium in the brick will cause efflorescence on brick surface, when they get

dissolved in water.

* Bricks containing too much of salt are less resistance to weathering and will have poor strength.
* Three samples of bricks are immersed in good water for 24 hours.
* After 24 hours, the bricks are taken out and examined for white patches of salt on the surfaces.
* If the white patches of salt present are heavy, the bricks are poor and are to be rejected.
* If the white patches present are small to medium, the bricks can be accepted.

(c) for Compressive strength

* The load carrying capacity of brick is increased as the compressive strength increases.
* Three samples of bricks are taken and immersed in good water for 24 hours.
* After 24 hours of immersion, the bricks are taken out and surface dried.
* Each brick is placed on compression testing machine and the load on the brick is gradually increased until the brick fails.
* The failure load of each brick is found out.
* The average failure load of the 3 bricks is the Compressive strength of the bricks.

Required Standards

I class bricks → 7.5 – 12.5 N/mm²
II class bricks → 5 – 7.5 N/mm²
III class bricks → 3.5 – 5.00 N/mm²

Manufacturing of bricks

The following are the four processes involved in the manufacturing of bricks.

(a) Preparation of brick earth
(b) Moulding of bricks
(c) Drying of bricks
(d) Burning of bricks

Preparation of brick earth

Preparation of brick earth involves the following operation.

(a) Removal of loose soil

The top layer of the loose soil about 20 cm depth contains lot of impurities and hence it should be taken out and thrown away.

(b) Digging, Spreading and cleaning.

* The undesirable materials like stones, vegetable etc are removed. Lumps of clay should be converted to powder form.

(c) Weathering

The earth is then exposed to atmosphere for softening. The period of exposure varies from weeks to full season.

(d) Blending

The clay is then mixed with suitable ingredients. It is carried out by taking a small portion of clay every time and by turning it up and down in vertical direction.

(e) Tempering

* This is done to make the whole mass of clay homogeneous and plastic.
* The required water is added to clay and the whole mass is kneaded under the feet of men or cattle.

Moulding of Bricks

The tempered clay is then sent for the next operation of moulding. There

are two methods of moulding.

(a) Hand moulding
(b) machine moulding

Hand moulding

This is done by a mould which is a rectangular box with open at top and bottom. It may be of wood or steel.

The following are the ways of hand moulding.

(i) Ground moulding
(ii) Table moulding

machine moulding

* When bricks are manufactured in huge quantity, at the same spot then moulding is done by machines.
* These machines contain a rectangular opening of size equal to the length of the brick and width of the brick.
* The tempered clay is placed in the machine and as it comes out through the opening under pressure it is cut into strips by wire fixed in frames.

Drying of bricks

* After the bricks are moulded they are dried.
* This is done on specially prepared drying yards.
* * Bricks are stacked in the yard with 8 to 10 bricks in a row.
* Bricks are dried for a period of 5 to 12 days.

Burning of bricks

* Burning imparts hardness and strength to bricks and makes them dense and durable.
* Burning of bricks is done either in clamp or in kilns.

Stones (Rocks)

* Building Stones are obtained from rocks.
* Rocks are formed by the cooling of the molten material from beneath the earth's surface.
* Granite which is widely used in building construction is a good example.

Qualities of good Stone

* The crushing strength of stone should be greater than 100 N/mm².
* Stones must be decent in appearance and be of uniform colour.
* Stones must be durable
* Stones should be such that these can be easily carved.
* for a good building stone its fracture should be clear.
* If the stone is to be used in road work, it should be hard enough to resist wear and tear.
* A good building stone must have a wear less than 3%.
* Stones must be fire resistant. These must retain their shape when a fire occurs.
* A good stone should not contain quarry sap (moisture)
* A good building stone must have specific gravity greater than 2.7
* A good stone should not absorb water more than 0.6% by weight.

Uses of Stone

* In the construction of buildings from very ancient times.
* for foundations, walls, columns, arches, roofs, etc.
* for facing work in brick masonry to give a massive appearance.
* Since stones are hard, these can be used for pavements.
* As ballast in railways, flux in blast furnace.
* It can be used as blocks in construction of bridges, light houses, Dams etc.

Quarring of Stones

It is the process of extracting stone blocks from existing rocks.

* It is done at some depth below the top surface of rock where the effects of weathering are not found.

Quarrying of soft and hard rocks is done by

(a) Digging, Heating or wedging. Limestone, marble are obtained by digging, heating.

(b) Blasting.

Explosives can be used to blast the rocks to obtain the stones.

Dressing of Stone

Stones obtained after quarrying have rough surface and are irregular in shapes and size.

* Dressing is the process of cutting the stones to a regular shape and size and the required shape and size.

Testing of building stones

To determine the suitability of stones for construction work, the following tests are conducted on stones.

(a) Hardness test

* It is tested by a pen knife which will not be able to produce a scratch on a hard stone.
* Hardness number is determined by mohr's scale of hardness.

(b) Impact test

It is carried out on an impact testing machine to determine the toughness of a stone.

* In this test a cylinder of 25 mm diameter and 25 mm height is taken out from the sample of the stone.
* A steel hammer of 2 kg weight is allowed to fall axially on the cylinder from 1 cm height for the first blow, 2 cm height for the second blow and 3 cm height for the third blow and so on.
* The blow at which the specimen breaks is noted.
* If it is the nth blow, 'n' represents the toughness index of the stone.

(c) Testing for crushing strength.

In this test, a cube of sample stone of size 40mm x 40mm x 40mm is tested in a compression testing machine.

The rate of axial loading on the Cube is 13.7 N/mm²/min. The maximum load at which the Stone crushes is noted.

Crushing Strength of stone = Maximum load at failure / Area of bearing face

(d) fire resistance test

A Stone which is free from calcium carbonate, can resist fire.

* the presence of Calcium Carbonate in the Stone can be detected by dropping a few drops of dilute Sulphuric acid which will produce bubbles.

(e) Electrical resistance/ water absorption test

* As the electrical resistance of a wet Stone is less, the Stone should be non absorbent.

(f) Attrition test/Abrasion test

* Attrition test is carried out to determine the percentage of wear of Stones used for the Construction of road.

*In this test, Some known weight of Stone pieces are taken and put in the Deval's attrition test cylinder.

* The cylinder is rotated about its horizontal axis at the rate of 30 rpm for 5 hours.

* Then the contents of the cylinder are sieved.

* The quantity of material retained on the sieve is weighed.

* percentage wear = (Loss in weight / Initial weight) x 100

(g) Acid test

In this test, a specimen Stone is kept for 1 week in

the solution of sulphuric acid and hydrochloric acid.

* The corners of stones with high alkaline content turn roundish and base particles will get deposited on its surface.

(h) Smith's test

In this test, the sample of the stone is broken into small pieces and put into a test tube containing clear water.

* The test tube is then shaken vigorously.
* The colour will show the presence of argillaceous materials.

(i) Crystallization test

* This test determines the durability or weathering quality of a stone.
* In this test a sample of stone is immersed in the solution of sodium sulphate and dried in hot air.
* The process of welling and drying is carried out for 2 hours.
* The difference in weight, if any is recorded.
* Little difference in weight indicates durability and good weathering quality of stone.

(j) microscopic Test

In this test, the sample of stone is subjected to microscopic examination to study the following properties

(1) mineral Constitution
(2) Texture of stone
(3) Average grain size
(4) Nature of Cementing material
(5) presence of pores, fissures and veins.

(k) freezing and thrawing test

* In this test, the specimen stone is kept in water for 24 hours. It is then placed in a freezing mixture at -12°c for 24 Hrs.
* It is then thrawed (warmed) to atmospheric temperature.
* the procedure is repeated for several times and the behaviour of Stone is studied.

Types of building Stones and their uses

(a) Granite

It is obtained from igneous rocks.

* It is hard, durable and available in different colours.
* It is highly resistant to weathering and has good crushing strength.
* It can take mirror like polish.

Uses: Construction of walls, Column and bridges piers Steps, Sills and facing works. It is used as ballast for road metal, rail metal, rail track.

(b) Basalt and Trap

* These are also quarried from igneous rocks.
* These are hard, tough and durable and available in different colours.

uses Constructing masonry floors, Ornamental and Decorative works.

(c) chalk

* It belongs to sedimentary rocks.
* It is pure white Stone, soft and easy to form powder.

Uses It is used as colouring material in the manufacture of portland Cement.

(d) Lime Stone

It is derived from sedimentary rocks.

* It is easy to work.
* It Consists of a high percentage of Calcium Carbonate

Uses It is used for the manufacturing of Cement.

* It is also used for floors, Steps, walls and as road metal.

(e) Sand Stone

It belongs to sedimentary Variety.

* Its Structure shows sandy grains.
* It is easy to work and dress.
* It is available in different Colours.
* It strength is low.

Uses: It is used for different building works, Carving, Steps, walls, Columns and road metals.

(f) Laterite

* It is derived from meta-morphic rocks.
* It is sandy clay Stone.
* It is porous and soft.
* It can easily be quarried in blocks.
* It Contains high percentage of iron oxides.

Uses wall construction, Rough Stone masonry, Road work.

(g) Gneiss

* It is metalmorphic in nature.
* It is easy to work and split into thin Slabs.

Uses Thin Slabs for flooring Street paving, Rough Stone masonry work.

(h) Marble

* It is also metamorphic.
* It can take good Polish.

* It can be easily cut with saw and carved.
* It is available in different colours.

Uses * It is used for flooring, wall lining, facing work, steps, columns.
* It is used for interior decorations and ornamental works.
* Taj mahal is built fully of white marbles.

(I) Gravel It is available in river beds in the form of pebbles of any kind of Stone.

Uses It is used for surfacing of roads.
* It is also used in concrete.

(J) Slate It is metamorphic
* It is black in colour, and can be split easily.

Uses Roofing tiles, paving works.

(K) Quartz
It is metamorphic.
* It is hard, durable, brittle and crystalline.

Uses
Concrete, Retaining walls and road metals.

CEMENT

* Cement is obtained by burning at a very high temperature a mixture of calcareous and argillaceous materials.
* The calcined product is known as clinker.
* A small quantity of gypsum is added to the clinker and is pulverised into very fine powder known as cement.

Good qualities of Cement

* The colour should be uniform
* Cement should be uniform when touched.
* Cement should be cool when felt with hand.
* If a small quantity of cement is thrown into a bucket of water, it should sink.
* Cement should be free from lumps.
* Cement mortar at the age of 3 days should have a compressive strength of 11.5 N/mm². Tensile Strength of 2 N/mm².
* At the age of 7 days, compressive strength should be not less than 17.5 N/mm² and tensile strength should not be less than 2.5 N/mm².
* In cement, the ratio of percentage of alumina to that of iron oxide should not be less than 0.66.
* when ignited, cement should not loose more than 4% of its weight.
* The total sulphur content of cement should not be greater than 2.75%.
* The weight of insoluble residue in cement should not be greater than 1.5%.
* Weight of megnesia in cement should not exceed 5 per cent.
* The specific surface of cement as found from the fitness test should not be less than 2250 mm²/gm
* The initial setting time of cement should not be less than 30 minutes and the final setting time shall be around 10 hours.

* the expansion of cement should not be greater than 10mm when gauthen test is conducted.

Uses of Cement

* Cement mortar, a mixture of cement and sand, is used for masonry works, plastering pointing and in joints of pipes, drains.
* Cement can be used as binding material in concrete used for laying floors, roofs and constructing inlets, beams, weathers sheds, stairs, pillars.
* Cement can be used in construction of structures such as bridges, culverts, dams, tunnels, storage reservoir, light houses.
* the manufacturing of pipes, garden seats, flower pots, dust bins, fencing pots.
* Under water construction quick setting cement is used.
* Rapid hardening cement is used for structures requiring early strength.
* white and coloured cements are used for imparting coloured finishes to the floors, panels and exterior surface of buildings.
* Expansive cements, which expands while setting can be used in repair works of cracks.

Types of Cement

By changing the chemical composition and by using different raw material, and additives, many types of cements can be produced.

① Rapid hardening Cement

This Cement is similar to ordinary portland Cement.
* It develops Strength rapidly.
* This Cement is used when high Strength is required.

② Sulphate resisting Cement

This type of Cement with higher Silicate Content is effective in fighting back the attacks of Sulphates.
* This Cement is used in Construction of Sewage treatment works, marine Structures and foundations in Soil having large sulphate Content

③ Low heat Cement

This Cement hardens Slowly but produces less heat than other Cements, while reacting with water.
* This Cement can be used in mass concreting works like Construction of dams.

④ Quick Setting Cement

* This Cement Sets very quickly
* This is due to the reduction of gypsum Content in the normal portland Cement
* this is used for underwater Construction.

⑤ portland pozzolana Cement (PPC)

* pozzolana is a siliceous material.
* PPC is produced by grinding portland Cement clinkers and pozzolana with gypsum.
* It offers greater resistance to the attack of aggressive water.

⑥ High alumina Cement

* This Cement produces high heat when reacts with water.
* It Causes high early Strength development.

* This Cement can be used for generating high early strength in cold Climates.

(7) Air entraining Cement

* This Cement is produced by mixing a small amount of an air entraining agent with Ordinary portland Cement.

(8) Masonry Cement

This Cement has great plasticity, workability and water retentivity as Compared with ordinary portland Cement.

* This is used for masonry constructions in making mortars and plasters.

(9) Expansive Cement

This cement produces an expansion in Concrete during Curing.

* As a result of expansion, cracks due to shrinkage of Concrete are avoided.

* So this can be used for filling the cracks by grouting and also to overcome cracks formation in reinforced Cement Concrete structures.

(10) Hydrophobic Cement

This is a water repellent cement and is of great utility when the Cement has to be stored for longer duration in wet climatic Conditions.

* This Cement also improves the workability of Concrete.

(11) coloured Cement

It consists of ordinary portland Cement with 5 to 10% pigment for colouring. This is used for aesthetic purpose.

(12) White Cement

The colour of this Cement is white

* It has the properties same as ordinary port land cement.
* this cement can be used for architectural purposes and for manufacturing coloured concrete, flooring tiles etc.

(13) High Strength Cement

* Certain special works require high strength concrete.
* To improve the strength a higher content of C_3S and higher fitness are incorporated in ordinary portland cement.
* this cement can be used for railway sleepers, prestressed concrete, pre cast concrete and air filled works.

Mortar

It is the paste prepared by adding required quantity of water to a mixture of binding material (cement or lime) and fine aggregate (sand).

Grades of Cement

(a) M33 Grade Cement

'M' refers to the mix, 33 refers to compressive strength of 15x15x15 cm size concrete cube at the age of 28 days.
* It is used for plastering work.

(b) M43 Grade Cement

'M' refers to the mix, 43 refers to compressive strength of 15x15x15 cm size concrete cube at the age of 28 days.

* It is used for bricks or stone masonry walls constructions.

(c) M53 Grade Cement

'M' refers to the mix, 53 refers the compressive strength of 15x15x15cm size concrete cube at the age of 28 days.

* It is used for concreting works.

Sand

Classification of sand

According to nature of source.

(i) Natural Sand

*

It is the one, which is carried by the river water and it is quarried from the river bed, when the river become dry.

(ii) Artificial sand

*

It is the one which is the outcome of crushing and breaking stones into different sizes of stone aggregates in a stone crushing plant.

Qualities of good sand

* Sand should be clean, hard and durable and preferably dry.
* It should be free from mica, chemical salts, organic and inorganic impurities and foreign materials.
* It should be free from, clay, silt and fine dust.
* In case if the presence of them is unavoidable,

they should not be present by more than 5% by weight (or) 7% by volume.
* Sand particle should be well graded and shall have sizes ranging from 0.15mm to 4.75mm.
* The fineness modulus of sand shall be from 1.6 to 3.5

Uses of Sand

* It is used for making mortar and Concrete.
* It is used for filling in the basement of buildings to receive the flooring Concrete.
* It is used as a binding material on the top of the road.
* It imparts mechanical strength to the mortar and prevents shrinkage and cracking of mortar while setting.
* It forms major portion of mortar and reduces the cost of mortar.
* It is mixed with expensive clay soils to stabilise them and prevent cracking of clay soils due to seasonal moisture changes.

Tests on Sand

(a) Sieve analysis and fitness modulus test

* The sand is sieved through sieves 4.75mm, 2.36 mm, 1.18mm, 600 microns, 300 microns and 150 microns sieves and percentage retained in each sieve is found out.

fineness modulus of sand =

$$\frac{\text{Sum of percentages retained in each sieve}}{100}$$

(b) Test for bulkage of sand

* The volume of dry sand will increase due to the presence of water in the sand, upto about 25% of water content and thereafter it will decrease and become equal to its dry volume, when it is saturated with water.
* This increase in volume of sand is known as bulking of sand.

percentage bulking of sand = $\frac{H_1 - H_2}{H_2} \times 100$

$H_1 \rightarrow$ Level of sand in jar

$H_2 \rightarrow$ Level of wet sand in jar.

(c) Test for Silt content

* A small quantity of sand is poured into a glass measuring jar.
* Now water is poured until sand is well submerged in water.
* The glass jar is now shaken several times so that the silt and dust layer floats at the top of sand layer.
* The level of sand layer (Excluding silt layer) is noted (say H_2).
* The top level of silt layer above sand is noted. (Say H_1)

The percentage of silt by volume = $\frac{H_1 - H_2}{H_1} \times 100$

Cement Concrete

It is a mixture of cement, sand, crushed rock and water which when placed in the skeleton of forms and allowed to cure, becomes hard such as stone.

* Concrete has attained the status of a major building material in all branches of modern construction and hence it is necessary to know the properties and uses of Concrete.

Properties of Concrete

* It should have high compressive strength and its strength depends on the proportion in which cement, sand, stones and water are mixed.
* It is free from corrosion and there is no appreciable effect of atmospheric agents on it.
* It hardens with age and the process of hardening continues for a long time after the concrete has attained sufficient strength.
* As it is weak in tension, steel reinforcement is placed in it to take up the tensile stress. This is termed as reinforced cement concrete.
* It shrinks in the initial stage due to loss of water through forms. The shrinkage of cement concrete occurs as it hardens.
* It has a tendency to become porous. This due to the presence of voids which are formed during and after its placing.
* It forms a hard surface, capable of resisting abrasion.

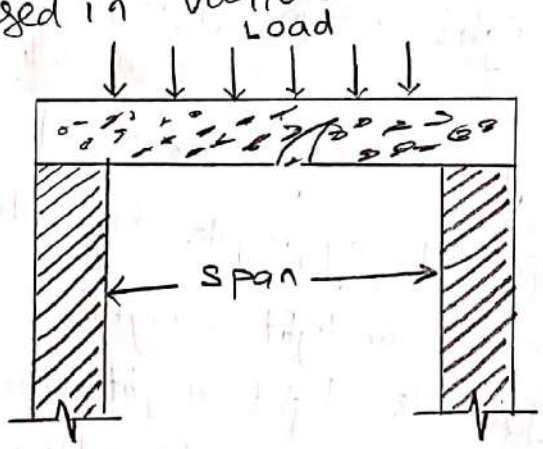
Uses of concrete

* Concrete can be made impermeable by using hydrophobic cement. This is used for the construction of R.C.C flat - roof slabs.
* Coloured Concrete is used for ornamental finishes in buldings, park, Separating lines for road surfaces, underground pedestrain crossing etc
* Light weight concrete is used in multi- storeyed constructions.
* No-fines concrete is one in which sand is eliminated. This can be used for external load bearing walls of single and multi storey houses, retaining walls etc.
* Concrete is mainly used in floors, roof slabs, colamns, beams, lintels, foundations and in precast constructions.
* It is used in massive structures such as dams and bridges.
* concrete is used in the construction of roads, runways, play grounds, water tanks and chimneys.
* It is used in the construction of roads, runways, play grounds,
* It is used in the construction of sleepers in railways.
* Concrete trusses are used in factory constructions.
* It is used in the construction of silos, bunkers.

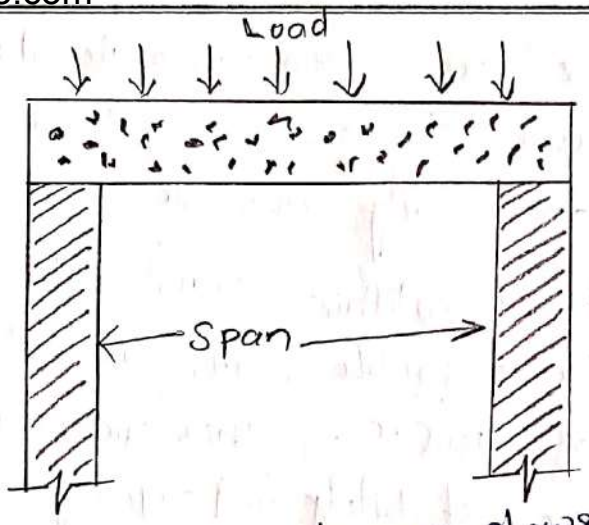
* Concrete finds a place in the construction of nuclear reactors because of its high shielding capacity for the radio activity.
* Thin economical shell constructions are possible with the use of Concrete.

Reinforced Concrete

A combination of Concrete and Steel is known as reinforced Cement Concrete and is widely used in various situations.



The above diagram shows a plain Concrete member subjected to flexure.



The above diagram shows a reinforced Concrete member subjected to flexure.

* Reinforced bars are available from 6-32 mm diameter and of 22 feet length.

Advantages of Reinforced Concrete

* It is a versatile building material and can be used for casting members of any shape.
* It has good resistance to fire, temperature and weathering actions.
* R.C.C construction is easy and fast.

* The component materials used for preparing R.C.C are easily available.
* Monolithic Construction is possible with the use of R.C.C. This increases the stability and rigidity of the Structure.
* R.C.C is tough and durable.
* Maintenance of R.C.C construction is very cheap.
* With proper cover, R.C.C can be made free from rusting and Corrosion.

Types of Concrete

(a) Light weight concrete
  (i) Light-weigh aggregate concrete
  (ii) Aerated Concrete
  (iii) No-fine Concrete
(b) High density Concrete
(c) Polymer Concrete
(d) Fibre reinforced Concrete

Light weight Concrete

The light weight concrete was devoloped, whose density varies from 300–1850 kg/m³.

Advantages

* It has low density
* It has low thermal conductivity
* It lowers handling cost.

Light-weigh aggregate concrete

By replacing the usual mineral aggregate by cellular porous or light weight aggregate, light weight aggregate Concrete can be produced.

* Light weight aggregate Concrete can be classified into two types.
  1. Natural light weight aggregate
  2. Artificial light weight aggregate

Natural light weight aggregate are -

pumice, Diatomite, Scoria, volcanic cinders, Saw dust, Rice husk.

Artificial light weight aggregates are

* Artificial Cinders
* foamed slag
* Bloated Clay flyash.
* Sintered

Aerated Concrete

By introducing gas or air bubbles in mortar, aerated concrete can be produced.

No fine Concrete

It can be produced by removing sand from aggregate..

* This Concrete is made up of only single sized aggregate of size passing of 20mm and retained on 10mm coarse aggregate, Cement and water.

(b) High density Concrete

The concrete whose unit weight ranges from about 3360 - 3840 kg/m³ and which is about 50% higher than the unit weight of normal concrete is known as high density Concrete.

* these are mainly used in radio active shield.
* the aggregates used in this type of Concrete should be clean, strong, inert and relatively free from deleterious material.
* Normally Banite, magnetite and lemonite are used to make high density Concrete.
* to produce high density and high strength concrete, it is necessary to control water-cement ratio, vibrators for good compaction.

(c) polymer Concrete

* The impregnation of monomer and subsequent polymerisation is the latest technique adopted to reduce the inherent porosity of the Concrete, to improve the strength and other properties of Cement-
* This type of polymer is known as polymer Concrete.

Types of polymer Concretes

1. polymer impregnated concrete (PIC)
2. polymer Cement Concrete (PCC)
3. polymer Concrete
4. partially impregnated and surface Coated polymer Concrete.

monomers used in polymer Concrete are

* methyl meltha crylate
* Styrene * T- butyl Styrene
* Acrylonitrile.

Applications of polymer Concrete

* prefabricated Structural elements.
* prestressed Concrete
* marine works
* Desalination plants
* Nuclear power plants
* Sewage works
* for water proofing of Structures.
* Industrial applications.

(d) Fibre reinforced Concrete

* These have high tensile strength, high ductility and resistance to cracking.
* In order to reduce the micro cracks, addition of small, closely spaced and uniformly dispersed fibres are used.

* These fibres can act as crack arrester and substantially improves its static and dynamic properties.
* This type of concretes are called as fibre reinforced concrete (FRC).
* Some of the commonly used fibres are

Steel, polypropylene, Nylons, Asbestos, Coir, glass and Carbon.

* The property of FRC may vary depending upon the type, diameter, length and volume of fibre.

Applications

Road pavements, Industrial flooring, bridge, canal lining, explosive resistance structure, Refractory linings.

Tests on concrete

1. Compressive Strength
2. Tensile Strength
3. Non destructive test for concrete

Steel sections

* Steel is very ductile and elastic properties.
* mild steel having a carbon content of 0.1–0.25% is used for structural work.
* To be used in construction works steel must be available in a certain form.
* These are called market forms.

* Bars, plates, flats, Angle sections, channel Sections, I- Sections, T-Section, Expanded metal.

Bars

* Bars are the common form of steel in building construction.
* They may have either round or square cross section.
* Square cross section of size 5 - 32 mm are commonly used in building works.
* Steel bars are available varying from 10-12m.
* The common round bars vary from 6-32mm diameter.

Plates

* Rolled plates have a maximum area of $30m^2$.
* The thickness of the plates varies from 5-28mm
* plates thinner than 5mm are called sheets.
* These plates are used as webs and flanges for deep beams, column flanges, column bases.

Flats

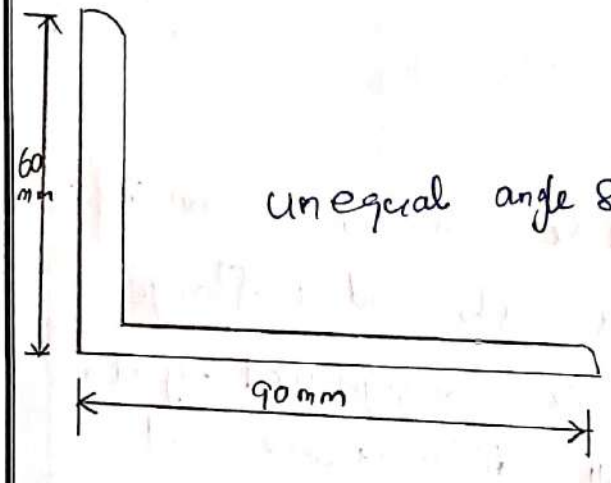
* These are rolled as in the case of plates but are much longer and have shorter width.
* The width varies from 18-500mm and the thickness varies from 3- 80mm.
* These are used in grill works and railings.

Angle Sections

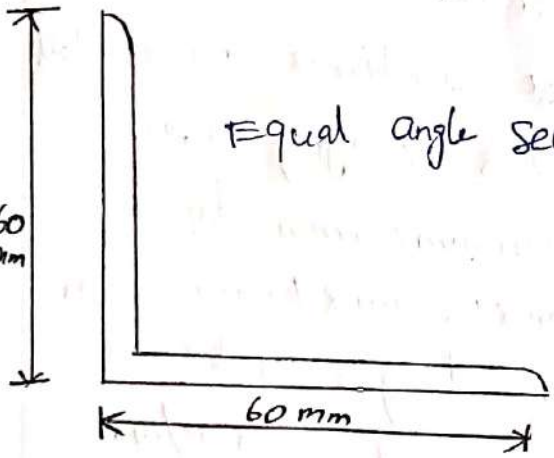
* Angle sections may be of equal legs or unequal legs.
* Equal angle sections are available in sizes varying

from 20mm x 20mm x 3mm to 200mm x 200mm x 25mm.

* The corresponding weights per meter length are 9 N and 736 N respectively.



Unequal angle section

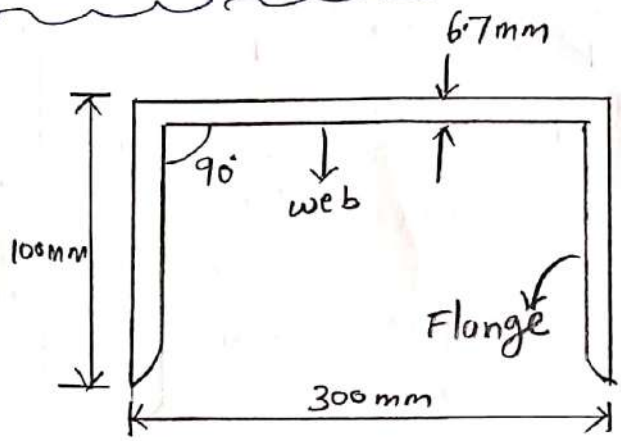


Equal angle section

* Angle sections are used in construction of steel roof trusses, filler joist floors, Steel columns, steel beams.

* They can be mainly used in the construction of steel bridges.

Channel section



* A channel section consists of a web with equal flanges.

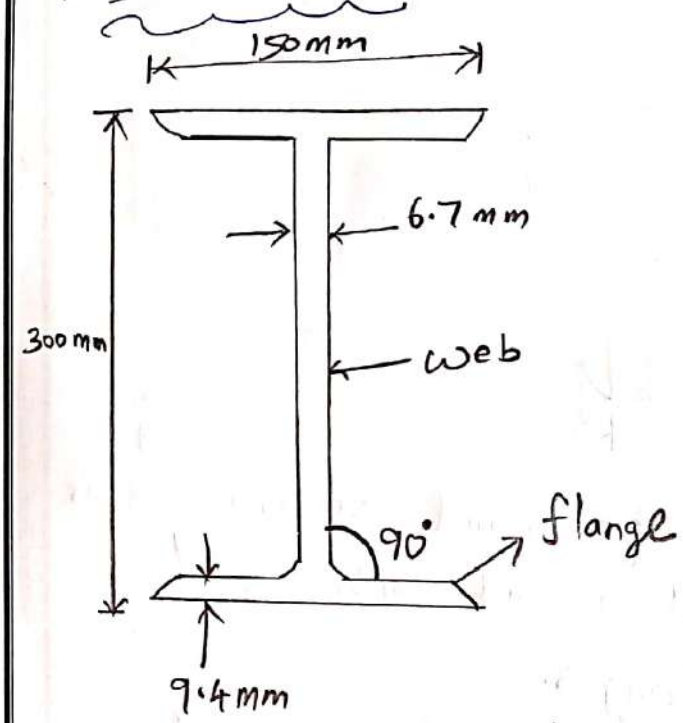
* Typically a channel section is designated by the height of the web and width of the flange.

* These sections are available from 100mm x 45mm to 400mm x 100mm with weight per meter length of 58 N and 494 N respectively.

* They are widely used in structural members of the steel - framed structures.

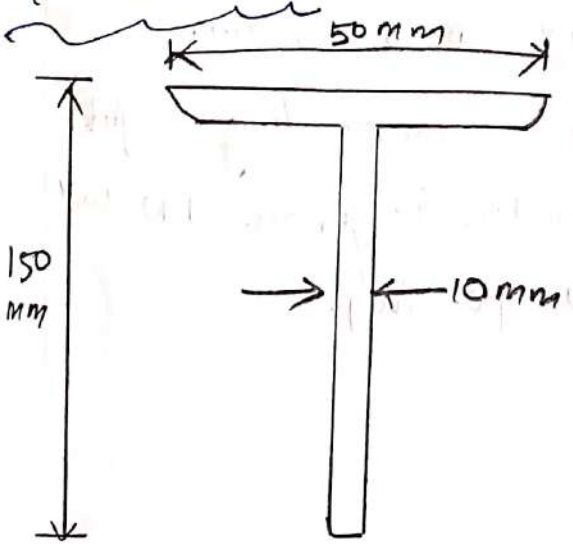
* They can be used in construction of beams and steel bridges.

* I - Sections



* These are popularly known as rolled steel joints (RSJ) or beams.
* An I-section consists of two flanges connected by a web.
* It is designated by overall depth, width of flange and weight per meter length.
* These are available in various forms
  75mm x 50mm at 61 N/m to 600mm x 210mm at 995 N/m.
* These are used to make floor beams, lintels, columns,

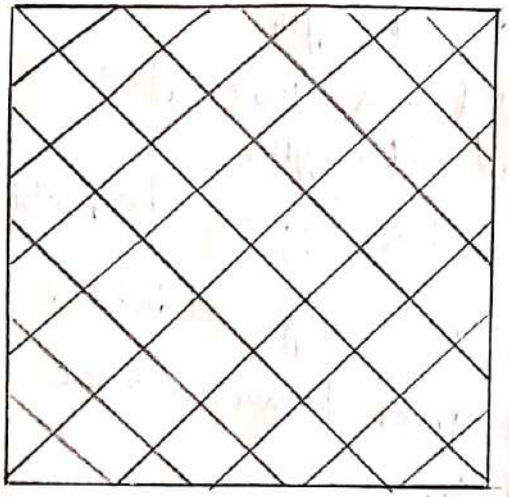
T- Sections



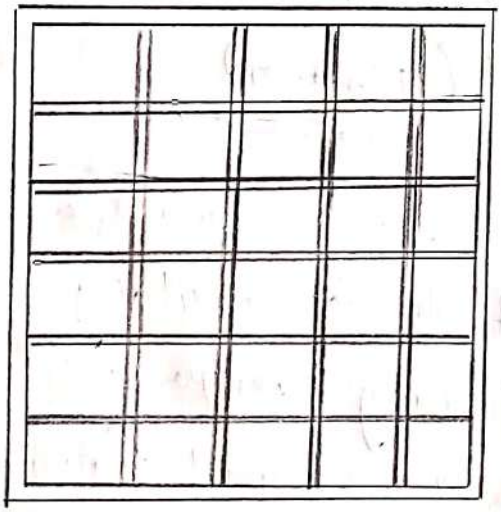
* These sections consists of a web and a flange.
* It is designated by its overall dimensions and thickness.
* These sections are available in sizes varying from 20mm x 20mm x 3mm to 150mm x 150mm x 10mm with corresponding weights of 9 N/m and 228 N/m.
* T- Sections are used in steel roof trusses and form built-up sections.
* These are also used in steel water tanks.

Expanded metal

Diamond mesh



Rib mesh



* This material is formed by cutting and expanding plain sheets.
* The manufactured sheets are known as diamond mesh or rib mesh.
* Expanded metal is used as a ferrocement reinforcement for concrete, pavement formation.

Steel as Reinforcing material

* It develops a good bond with concrete.
* It has high tensile strength.
* It has high modulus of elasticity.
* Its temperature coeffient of expansion and contraction is same as that of concrete and so thermal stresses do not develope.
* It is cheap and readily available.

Properties of mild steel

* It can be magnetised permanently
* It can be readily forged and welded.
* It has fibrous structure.
* It is malleable and ductile
* It is not easily attacked by salt water.

* It is tougher and more elastic than wrought iron.
* It is used for all types of Structural work.
* It rusts easily and rapidly.
* Its melting point is 1400c
* Its ultimate compressive Strength is 80–120 KN/cm²
* Chemical Composition:
  Sulphur : 0.06%
  Phosphorous : 0.065%
  Carbon upto 0.1%

Applications

* It is used in heavy and light engineering industries, ship building, railways, automobiles, sheet metal industries, power generation and electrical industries, depends upon property of magnetism of steel.

Advantages of mild steel

* It has 65% greater yield Strength.
* It has 100% greater bond Strength.
* It has higher bendability,
* It is easily weldable.
* It gives lesser crack width.
* It provides 20% more factor of safety.

Wood (Timber)

* Timber is a form of wood suitable for building or engineering purpose.
* It is obtained from trees.
* All trees are divided into the following two groups based on their mode of growth.
  (i) Endogenous trees
  (ii) Exogenous trees.

Endogenous trees

These are grow by the formation of layers of new wood crossing and penetrating the fibres of the wood previously formed. Eg:- Bamboo, Coconut.

Exogenous trees

which grows outwards by the addition of rings of young wood. eg. Teak, Sal etc.

* The cross section of these trees shows distinct concentric rings, called annual rings.
* Timbers obtained from the exogenous trees are mainly used in engineering works.
* Types of exogenous trees.
  (a) Conifers
  (b) Deciduous

Conifers

These trees yield soft wood. Eg:- Pine, deodar

Deciduous

These trees yield hard wood. Eg:- Teak, Sal etc.

Characteristics of Soft timber

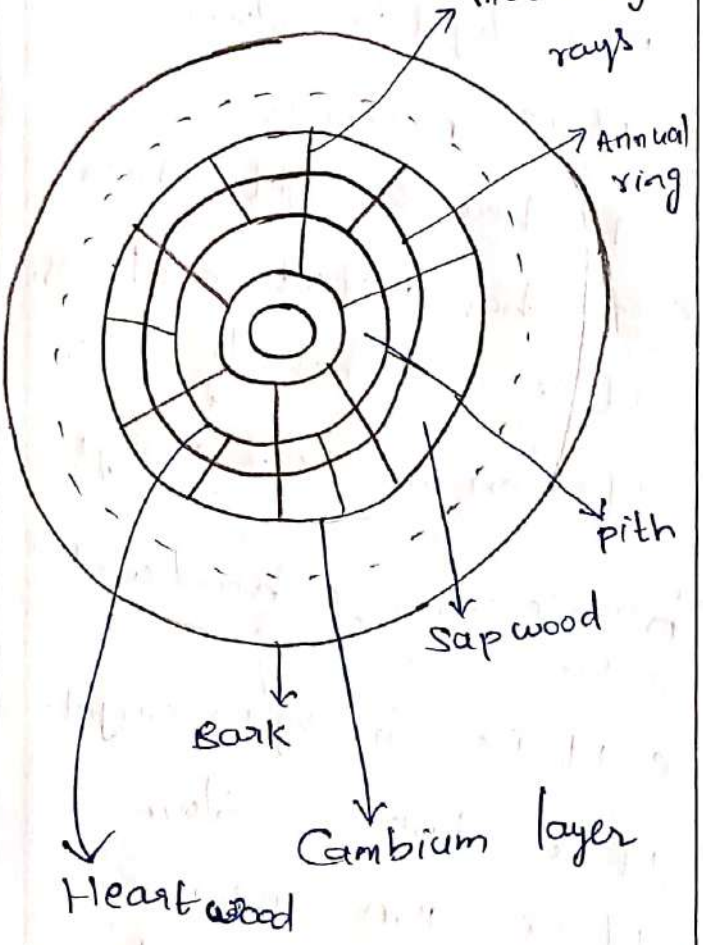
* Soft timber is light in weight
* It is light in Colour
* It is resinous
* It has straight fibres
* It has distinct annual rings.
* It is comparatively weak.
* It can be split easily.

Characteristics of hard wood

* It is heavy in weight
* It is dark in Colour
* It is non resinous
* It is close grained
* It does not show clear annul rings
* It is strong.
* It is durable.

Structure of an exogenous tree

The cross section of an exogenous tree is shown below



Pith It is the inner most Central portion of a tree.
* It consists of cellular tissues.

Heartwood It is inner annual ring surrounding the pith. It is darken in colour. It is strong and durable.

Sapwood It is the portion containing the two outer annual rings between the Cambium layer and the heart wood.
* It is light in colour.

Cambium layer It is the soft ring surrounding the outer most ring of sapwood

Bark It is the outer most layer or ~~skin~~ skin of the trunk which covers the wood.

medullary rays
They are the thin radial fibres extending from pith to Cambium layer.

Seasoning of timber
The process of removing the moisture from the timber is known as seasoning.

The following methods are used for seasoning of timbers.

(a) Natural seasoning (or) Air seasoning
(b) water seasoning
(c) Boiling
(d) Electrical seasoning
(e) Chemical seasoning
(f) kiln seasoning.

Properties of wood

Colour and odour
Specific Gravity
moisture content
Grain
Shrinkage and Swelling
Strength

Uses of timber

* It is used for door and window frames.
* It is used for formwork of Cement Concrete, Centering of an arch.
* It is used for making furniture, agriculture instruments, sports goods, musical instruments etc.
* It is used for making railway coach wagons.
* It is used for making toys, engraving work, matches etc.
* It is used for packing cases.
* It is used for temporary bridges and boats.

plywood

These are boards which are prepared from thin layer of wood or veneers.

* Three or more veneers in odd numbers are placed one above the other such that the direction of grains of successive layers are at right angles to each other.

Advantages

* plywoods are light in weight
* They are available in different sizes.
* Plywoods do not split in an axial direction.
* They posses uniform tensile strength in all directions.
* they are not easily affected by moisture.

Plastics

Plastics are organic substances, which consists of resin in combination with a moulding compound.

Advantages

* They are high resistance to corrosion.
* They are light in weight and hard.
* They can be used as thermal, Electrical insulators.
* They can be easily moulded
* They have good shock absorbing capacity.
* They are cheap.

Types of plastics

1. Thermo plastics
2. Thermo Setting plastics.

Properties of building materials

1. physical properties
2. chemical properties
3. mechanical properties
4. Electrical properties
5. magnetic properties
6. optical properties
7. Thermal properties.

physical properties

(a) Bulk Density

It is the mass per unit volume of material in its natural state.

(b) Chemical resistance

It is the ability of the material to resist against the action of acids, alkalies, gases and salt solution.

(c) Coefficient of Softening

It is the ratio of Compressive Strength of material with water to that in dry state.

* If value is not less than 0.8.

(d) Density It is the mass per unit volume of the material in its homogeneous state.

(e) Density index

* It is the ratio of bulk density of the material to its density.
* It should be less than unity.

(f) Durability

It is the property of material to resist the combined

action of atmospheric and other factors.

(g) porosity the degree by which the volume of material is occupied by pores is termed as porosity.

(h) Specific heat

It is quantity of heat required to raise the temperature of material by 1°C.

(I) Thermal capacity

It is the property by which the material absorbs the heat.

(J) Water Absorption

It is the ability of material to absorb and retain water.

(k) Thermal Conductivity

It is the ability of material to conduct heat through an unit area.

(L) Permeability

The capacity of material to allow water to pass through it under pressure

Mechanical properties

(a) Abrasion

It is the properties of a material by which it resists the action of moving load.

(b) Elasticity

It is the property by which a material regains its original shape and position after the removal of external load.

(c) plasticity It is the property of a material by which no deformation vanishes, when it is relieved from the external load.

(d) Strength

It is the ability of material to resist failure under the action of external load.

(e) Impact Strength

It is the quantity of work required to cause failure per unit of its volume

(f) Wear the failure of a material under the combined action of abrasion and impact is called wear.

(g) Fatigue

When the material is subjected to repetitive fluctuating stress, they will fail at a stress much lower than that required to cause fracture under steady load. This property is called as fatigue.

(h) Hardiness

It is the ability of a material to resist penetration by a harder body.

(i) Brittleness

It is said to be brittle when the material can not be drawn into wires. Eg:- Glass, rock materials.

(j) Ductility

It is the ability of material to draw into wires under tension.

(k) Malleability

It is the ability of material that can be uniformly extended in a direction without any rupture.

(l) Toughness

It is the ability of material, that absorbs energy without fracture.

Foundations

The lowest artificially built parts of piers, abatments etc, which are in direct contact with the sub soil supporting the structure are called as foundations.

The factors which affect the selection of foundation depends up the following —

* Type of Soil
* The nature of Soil
* The type of the bridge
* The velocity of water
* Superimposed load on bridge.

Objectives of foundations

* To distribute the total load coming on the structure on a larger area.
* To Support the Structures.
* To give enough stability to the structures against various disturbing forces such as wind, rain.

Safe bearing capacity of Soil

It is the maximum load per unit area which the soil will resist safely without displacement.

* By dividing the ultimate bearing power of soil by a factor of safety, the safe bearing capacity is obtained.
* The bearing capacity of soil can be found by loading the soil, noting the settlement and by dividing the maximum load by the area on which the load is applied.

methods to improve safe bearing capacity of Soil

* Increase the depth of foundation.
* Compacting the soil. compacting can be done by
  a) Running ~~the~~ moist soil
  b) flooding the soil

c) Vibrating the soil
d) Vibroflotation method
e) Compaction by preloading
f) Using sand piles.

* Draining the subsoil water
* Confining the soil mass
* Grouting with cement
* Chemical treatments like injecting silicates etc.

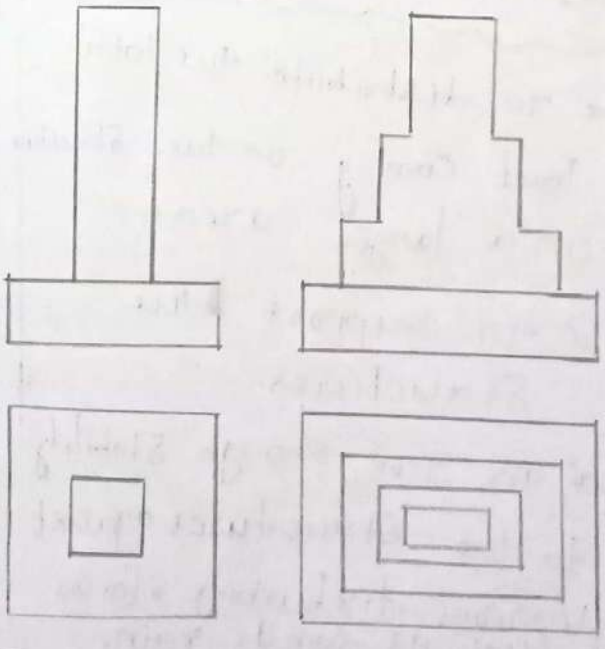
Types of foundations

1. Shallow foundation
   (a) Isolated column footing
   (b) Wall footing
   (c) Combined footing
   (d) Cantilever footing
   (e) Continuous footing
   (f) Inverted arch footing
   (g) Grillage foundation
   (h) Raft or mat foundations
   I) Stepped foundation
2. Deep foundation

* A shallow foundation is one in which the depth is equal to or less than its width.

a) Isolated column footing

* In framed structures where several columns are to be constructed, isolated footings can be adopted.
* The columns involved can be provided with masonry or concrete footing.



(b) Wall footing

* If the footing is provided throughout the length of the wall in the case of load bearing walls, it is called as wall footing.

Depth of footing, D

$$D = \frac{P}{W}\left[\frac{1-\sin^2\phi}{1+\sin\phi}\right]$$

P = Safe bearing capacity of Soil in kg/m^2

W = Unit weight of Soil in kg/m^3

ϕ = Angle of response of soil in degrees.

Width of footing, $B = \frac{T}{P}$

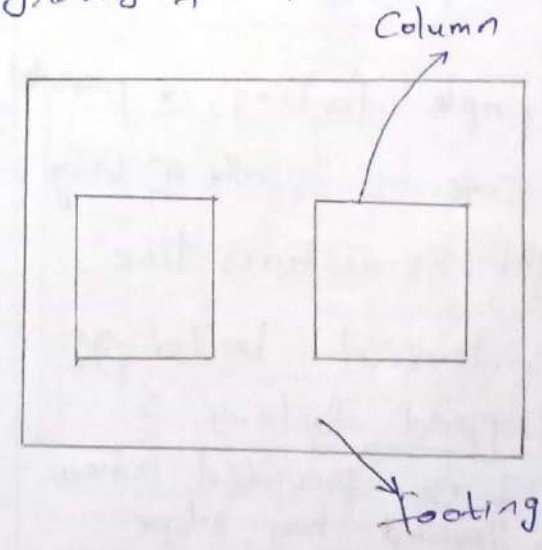
T = Total load per meter

P = Safe bearing capacity of Soil

(c) Combined footing

* This type of footing is adopted when the space between two columns are so small such that the foundation for individual columns will overlap.

* In combined footing, the center of gravity of load coincides with the center of gravity of foundation.

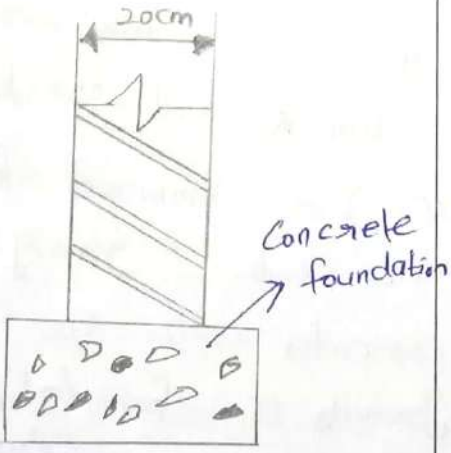


(d) Strip Footing

* This foundation is used where soil of good bearing capacity is available at a depth of less than 3m from the ground level.

* It is divided into two types.

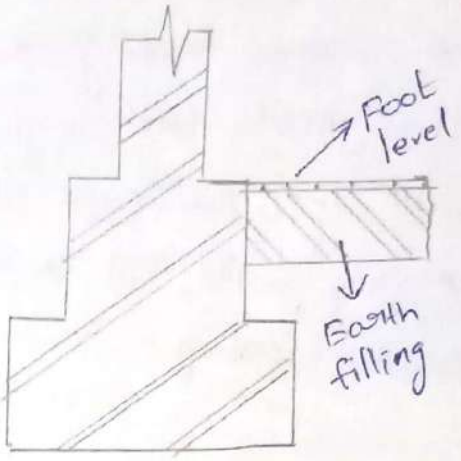
Simple footing



Simple footing is provided in case of walls of very light structures like residential buildings.

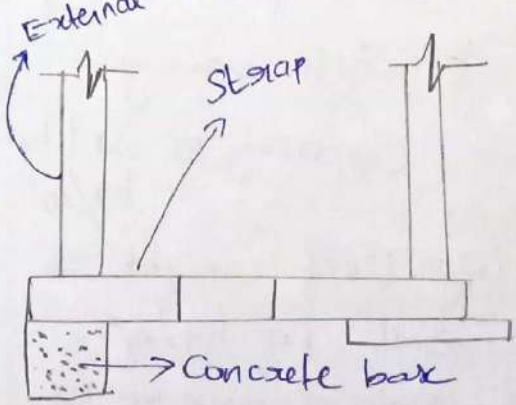
Stepped footing

It is provided when the ground has slope.



(e) Cantilever footing

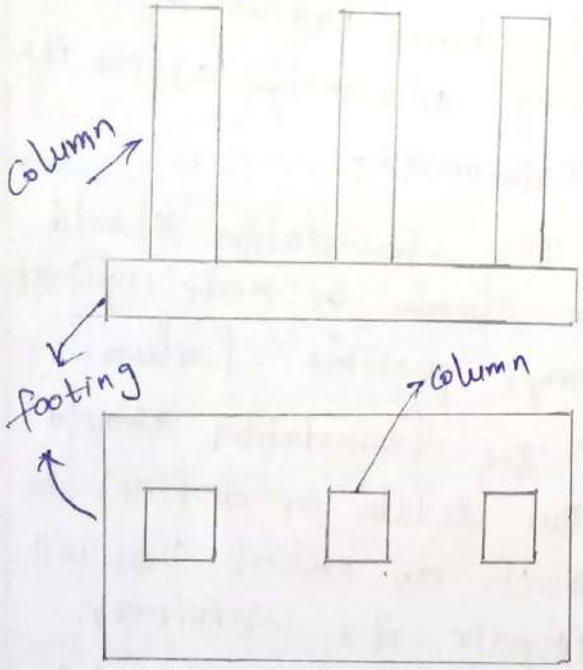
* Cantilever footing consists of an eccentric footing for Exterior Column and a Concentric footing for the interior column and they are connected by a Strap or a Cantilever beam.



(f) Continuous footing

In this type of footing, a single continuous R.C slab is provided as foundation for three or four column in a row.

* This type of footing is more suitable to prevent the differential settlement in the structure and for the safety against earthquake.



(g) Inverted arch footing

In this type of footing, inverted arches are constructed between two walls at the base.

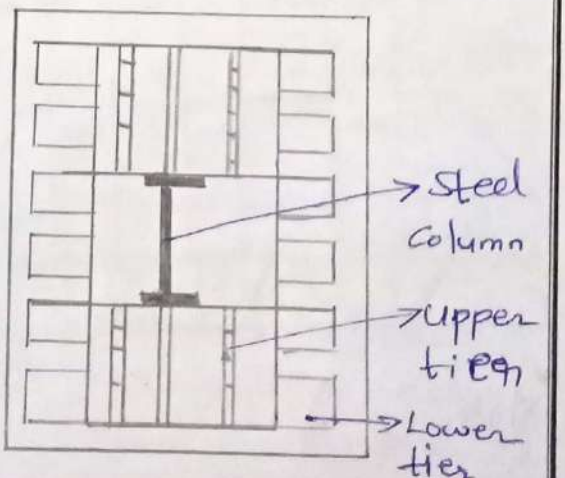
* It is suitable for soil of low bearing capacity and when the depth of foundation is to be kept less.

* The end columns must be strong enough to resist the outward pressure caused by such actions.

* This type of foundation is suitable for bridges, sensors and tanks etc.

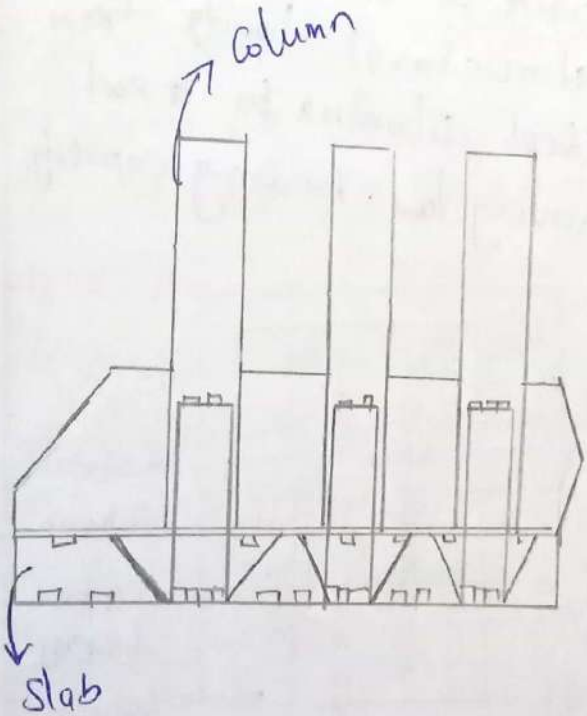
(h) Grilled foundations

* This foundations are used to transfer the heavy structural loads from steel columns to a soil having low bearing capacity.



(1) Raft foundation or mat foundation

* It is used when the structure is very heavy and the bearing capacity of the soil is very low.
* In this type of foundation, the load is transmitted to the soil by means of a continuous slab that covers the entire area of the bottom of a structure similar to a floor.



Deep foundations

In deep foundations, the depth is more than the width.

Requirements of a good foundations

* The foundation should be so located that it is able to resist any unexpected fracture influence which may adversely affect its performance.
* The foundation should be stable or safe against any possible failure.
* The foundation should not settle or deflect to such an extent that will impair its usefulness.
* The foundation should sustain load and transmit these loads to soil.
* foundations should be taken sufficiently deep to guard the buildings

against damage.

Settlement of foundation

The total vertical displacement that occurat foundation level is termed as settlement.

* The cause of foundation settlement is the reduction of volume air void ratio in the soil.
* Inevitably, soils deform under the load of foundation structures.
* Differential settlement occurs if there is difference in soils, loads or structural systems between parts of the building structure could settle by substantially different amounts.
* Consequently, the frame of the building may become distorted, floors may slope, walls and glass may crack, Doors and windows may not work properly.

foundations for machinery

* The design of a machine foundation is more complex than that of a foundation which supports only static loads.
* In machine foundations, the designer must consider the dynamic forces caused due to the operation of machine, in addition to static load.

General requirements of machine foundations

* The foundation should be able to carry all the imposed loads without causing shear or

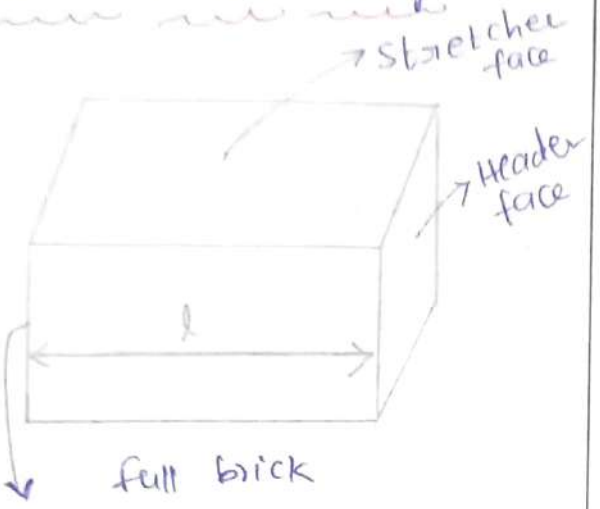
crushing failure.
* The settlements should be within the permissible limits.
* The Combined Centre of gravity of machine and foundation should be in the same vertical line as the Centre of gravity of base plate.
* No resonance should occur.
* The amplitudes under service conditions should be within permissible limits.
* All rotating and reciprocating parts of a machine should be well balanced.
* Machine foundations should be seperated from adjacent building components by means of expansion joints.
* Any Steam or hot air pipes embedded in the foundation must be properly isolated.
* The foundation must be protected from machine oil by an acid-resisting coating or a suitable chemical treatment.
* machine foundations should be taken to a level lower than the level of the foundations of adjoining buildings.

Building Structures

* The Structure consists of mainly of walls, doors, windows and lintels.
* The purpose of Structure is to provide the necessary utility of the building, structural safety, fire safety, sanitation and ventilation.
* The art of construction is called masonry.
* If the Structure is constructed by Stones, then it is called Stone masonry.

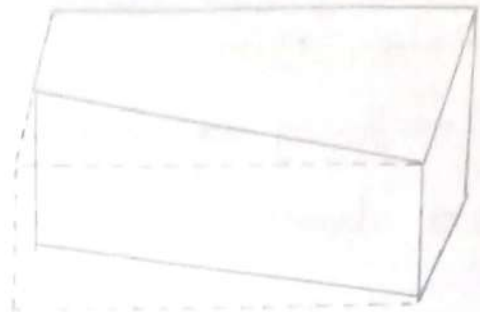
* If the structure is constructed by bricks, then it is called brick masonry.

Brick masonry

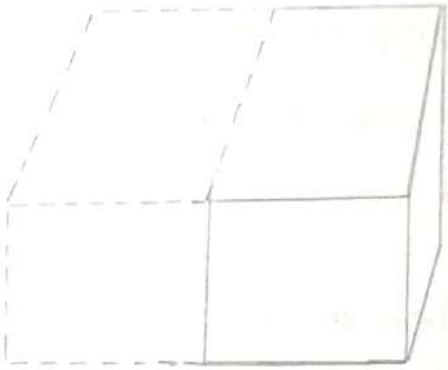


full brick

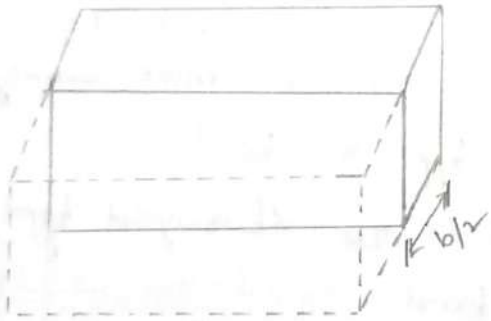
Arrises



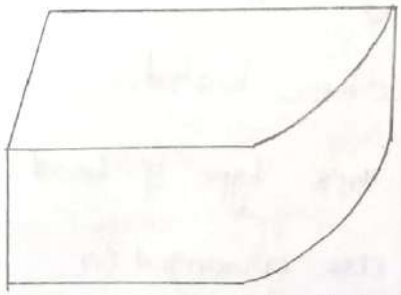
Bevelled closer



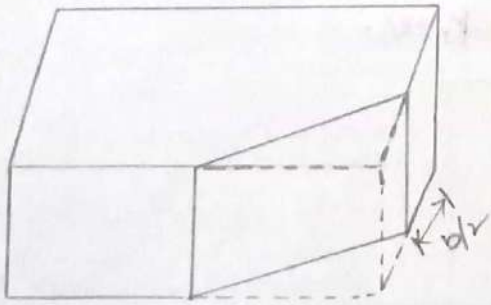
Half brick



Queen closer



Bull nose brick



King closer.

Bonds in brick work

A bond is an arrangement of layers of bricks by which no continuous vertical joints are formed.

* Bricks can be arranged in various forms.

The following are the various types of bonds in brickwork.

(a) Stretcher bond

(b) Header bond

(c) English bond

* One brick wall
* One-and-a half brick wall

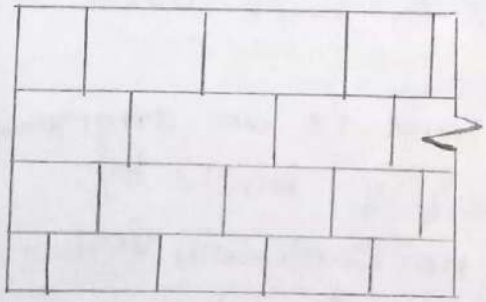
(d) flemish bond

(e) Raking bond

(f) Zig-zag bond

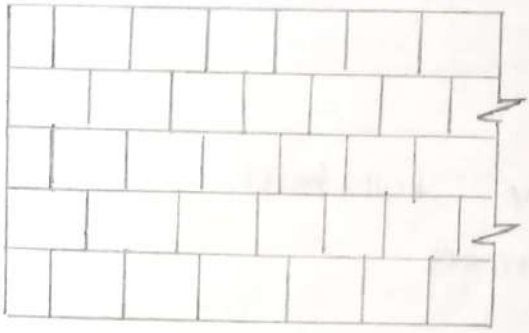
Stretcher bond

* In this type of bond, bricks are arranged in Stretcher courses.



Header bond

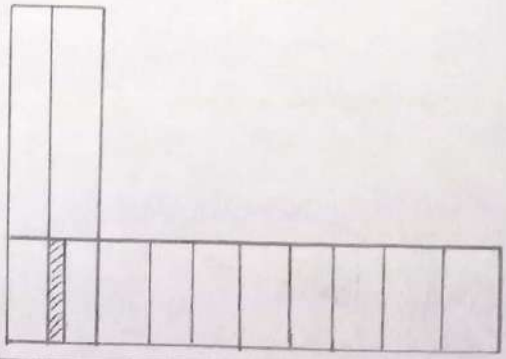
* In this type, all the bricks are arranged in header courses.
* It can be used for curved surfaces since the length will be less.



English bond

One brick wall

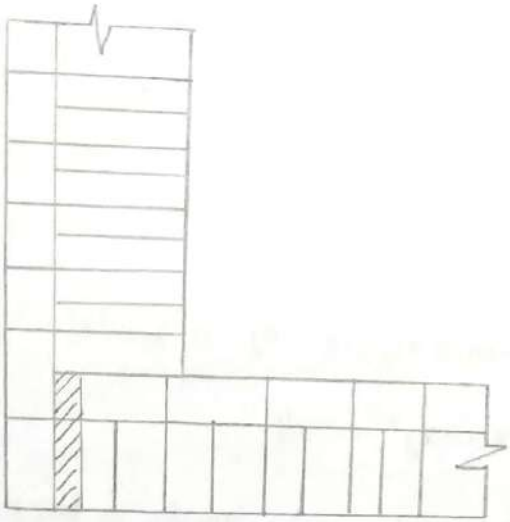
* It is the most commonly used type of bond.
* It is the strongest type of bond.
* It is used for all wall thickness.



one and half brick wall

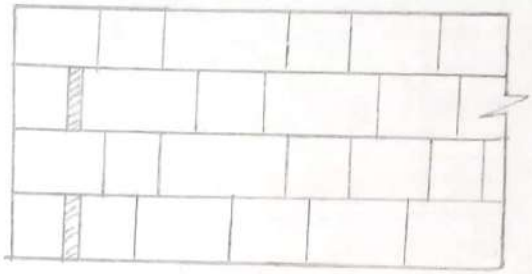
In this type of wall, each alternate header is centrally placed over a Stretcher.

* If the thickness of the wall is an even number of half brick, the wall presents the same appearance on both the faces.



(d) Flemish bond

* In this type of bond, the headers are distributed evenly.
* In every course header and Stretcher are placed alternatively.
* The queen closer is put next to the queen header in alternative courses to develope the lap.
* Every header is centrally supported over a Stretcher below it.



(e) Raking bonds

In this type of bond, the bonding bricks are kept at an inclination to the direction of the wall.

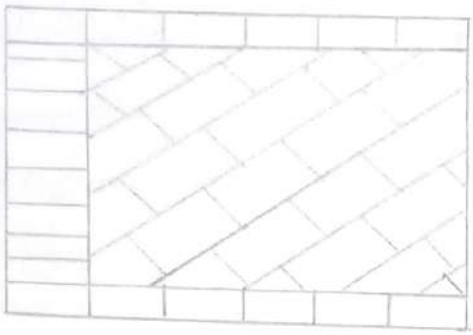
These bonds are classified into two types.

* Diagonal bond
* Herringbone bond

Diagonal bond

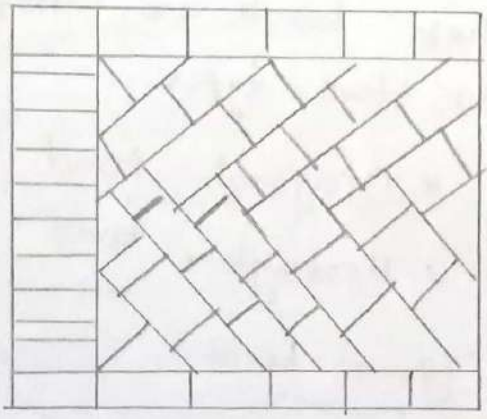
* In this type of bond, bricks are laid diagonally.
* Internal placing of bricks

is made in one direction only at certain angle of inclination, after face bricks are laid.



Herringbone bond

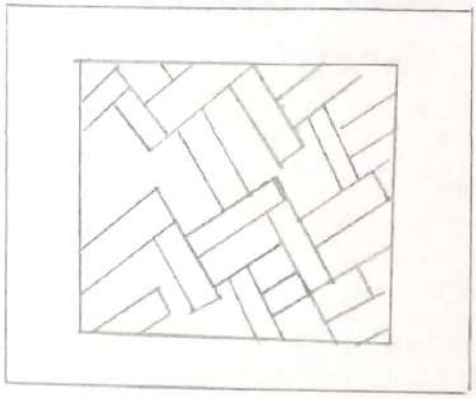
* In this type of bond, the bricks are laid at an angle of 45° from the centre in both the directions.



(f) Zig-zag bond

In this bond, the bricks are laid zig-zag.

* This method is used for paving in the brick floor.



Dimensions of a brick masonry wall

* In order to make a brick masonry wall safe, its thickness must be sufficient enough to withstand the load coming on it.
* The loads acting on a wall are dead loads, live loads, and wind loads.

* For domestic buildings, the floor height may be 3-4m.
* The thickness of wall depends upon the strength of bricks as well as the strength of cement mortar.

Cracks in a brick masonry wall

The cracks appear in a brick masonry wall due to the following reasons-

* Combining the brick work with other materials having greater deflections and strains.
* Effect of deflection and shrinkage of the concrete slabs resting on walls.
* Development of internal forces due to moisture absorption, temperature variations etc.

The measures to prevent cracks in brick masonry

* The foundation supporting masonry walls should be designed with sufficient stiffness.
* The provision of horizontal and vertical expansion joints in the walls helps in reducing the occurance of cracks.
* The usage of concrete with low shrinkage characteristics also prevents cracking.
* It is preferable to have short spans for the floor slabs.

Stone masonry

* Stone masonry is the construction carriedout using stones with mortar.
* Because of high cost of transportation, costly work of dressing and need for experienced labour, Stone masonry is presently not popular.
* Further Stone masonry walls occupy more space Compared to brick masonry.

Types of Stones used in Stone masonry are

* Dense Stones like Granites and quartzite
* fire resistance Stones and Sand Stones.
* Soft Stones like lime Stone, marble and Slate used for Carvings, arches etc.

Uses of Stone masonry

* Foundation, floor, walls, lintels, roofs etc.
* for facing works in brick masonry to give massive appearance.

Tools used for dressing of Stones.

Mason hammer,
Scrabbling hammer
mash hammer
Waller's hammer
Spalling hammer
face hammer
Crow chisel
Soft Stone chisel
Draught chisel
plain chisel
Splitting chisel
punch chisel
point chisel
Axes and punching machine

Types of Dressing

(a) Hammer Dressing

* For rubble masonry, Stones are roughly dressed with hammers.
* The surface thus obtained is called hammer dressed.
* The lower and upper surfaces of the stones are almost dressed flat.

(b) Chisel dressing

* for good finish, the faces of stones are finely dressed by means of Chisel.

(c) Axed finish

* It is employed in hard stones like granites.
* An axe is used for the dressing operation.

(d) polished finish

* Granite, marble and trap takes a good polish.
* This is achieved manually or by the aid of polishing machine

Classification of Stone masonry

Stone masonry is classified based on the thickness of joints, continuity of courses and finish of face.

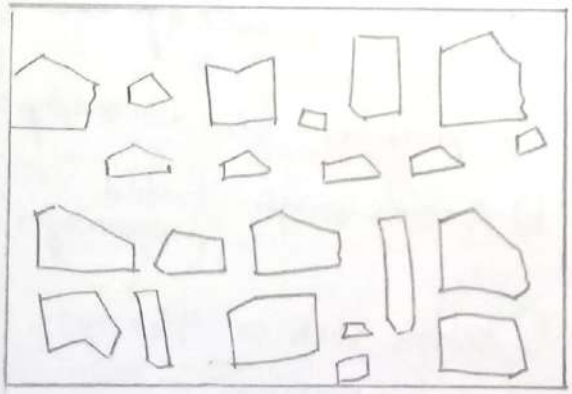
* Stone masonry can be classified into following types.

1. Rubble masonry
   a) Random rubble masonry uncoursed and coursed
   b) Squared rubble masonry Un Coursed and coursed
   c) polygonal rubble masonry
2. Ashlar masonry
   a) Ashlar fine masonry
   b) Ashlar rough-tooled masonry
   c) Ashlar rock or quarry faced masonry.
   d) Ashlar chamfered masonry
   e) Ashlar facing masonry.

Rubble masonry

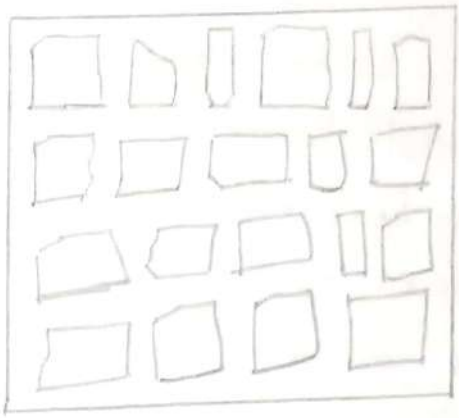
* A rubble masonry wall is made up of irregular sizes and shapes.
* The stones obtained from the quarry are broken into small sizes and are directly used in the construction.
* In some cases, these stones may be shaped to suit the requirements, with the help of hammers just by removing excess projections.

Uncoursed random rubble masonry



* It is the cheapest type of stone masonry.
* Stone blocks are not dressed, but used in the masonry as obtained from the quarry.
* They are of varying sizes and placed in the irregular pattern.

Coursed rubble masonry



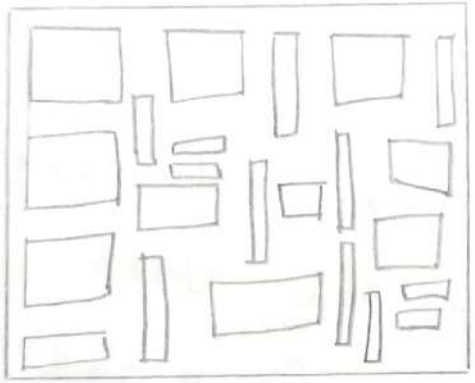
* In this type, stones of 5cm to 20cm size are used.
* Stones are hammer dressed.
* Stones of equal heights are used in every course of the stone masonry.

Squared rubble masonry

* In this type, the stones are roughly squared with straight edges and sides with hammer blows.
* In uncoursed rubble masonry, the stones of varying sizes

with different heights, but with straight edges and sides are used.

* In coursed square rubble masonry, the work is carried out and leveled in courses of different heights.

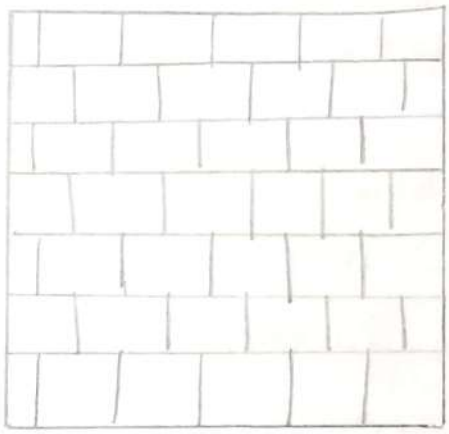


polygonal rubble masonry

* In this type, the stones are hammer finished on the face of the wall to an irregular polygonal shape.

Ashlar masonry

* In this type no irregular stones are used.
* The entire construction is done by square or rectangular dressed stone blocks of required dimensions.
* The height of stones varies from 25 cm to 30cm.



* In ashlar fine masonry, all the stone blocks used should be finely chisel dressed on all the beds, sides and faces.
* Height of each course is generally not less than 30 cm.
* In Ashlar rough tooled masonry, the beds and sides of each stone block are finely chisel dressed just in the same manner as for ashlar fine. But, the

exposed face is dressed by rough tooling.

* In ashlar rock or quarry faced masonry, a strip of 25 mm wide, made by means of a chisel is provided around the perimeter of the exposed face of each stone.
* The remaining portion of the face of the stone is left in the same form as received from the quarry.

* Ashlar chamfered masonry is a special form of rock faced ashlar masonry.
* In this masonry, a strip provided around the perimeter of the exposed face chamfered or beveled at an angle of 45° using the chisel to a depth of 25 m.
* Due to this, a groove is formed in between the adjacent blocks or stones

* Ashlar facing masonry is the combination of ashlar masonry and rubble masonry.
* This type of construction is used for heavy engineering works and sea walls etc.

* Ashlar Block in course masonry is an intermediate approach between the ashlar masonry and rubble masonry.
* It is constructed of large stone blocks.
* The faces of each stone block are hammer dressed.
* It is actually coursed rubble masonry of superior variety.

Comparision of brick masonry with stone masonry

S.No	Aspects	Brick masonry	Stone masonry
1	Availability	These are manufactured using clay	These are available in nature and obtained from quarry.
2	Handling	Handling is easy	Handling is difficult
3	Labour	Semi skilled labour is needed.	skilled labour is necessary.
4	Strength	Reasonably good compressive strength	very high compressive strength.
5	Durability	Resonably durable and moderate long life	Highly durable and long lasting.
6	maintaining the bond	made to regular size and shape. Due to this, proper bond can be maintained.	Stones require dressing for maintaining the bond.
7	Quantity of mortar required	Less quantity	more quantity
8	plastering	plastering is needed	plastering is not done.
9.	moisture Absorption	Absorbs moisture from atmosphere	Stones are water tight
10	mortar joint	Thin and uniform	Thick

S.no	Aspect	Brick masonry	Stone masonry
11	wall thickness	Thinner walls can be constructed	Difficult to construct walls of thickness less than 30 cm.
12	openings and connections	Construction of openings and connections are easy	Dressing of stones is required to achieve this.
13	Cost of Construction	Less cost	High cost
14	maintenance cost	More cost	Less cost
15	Architectural treatment	Less suited	Amenable to architectural
16	fire resistance	Highly fire resistant	Reasonably resistant to fire.
17	Dead load	Dead load of wall is less.	Dead load is more.
18	Special lifting devices	Not needed	needed
19	Appearance	Elegant appearance, used in residential, commercial buildings	massive appearance, hence used for monumental works, temples, bridges.

Beams

* Beams are horizontal members of a structure, carrying transverse loads.
* Beams carry the floor slab or the roof slab.
* They transfer all the loads such as dead load and live loads, including its self weight to the vertical members of the structure.

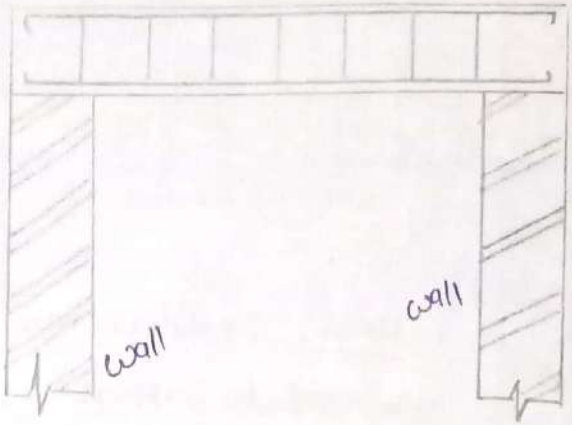
Types of beams

Depending on the support, a beam maybe classified into the following types.

(a) Simply supported beam
(b) fixed beam
(c) Cantilever beam
(d) Continuous beam
(e) Over hanging beam.

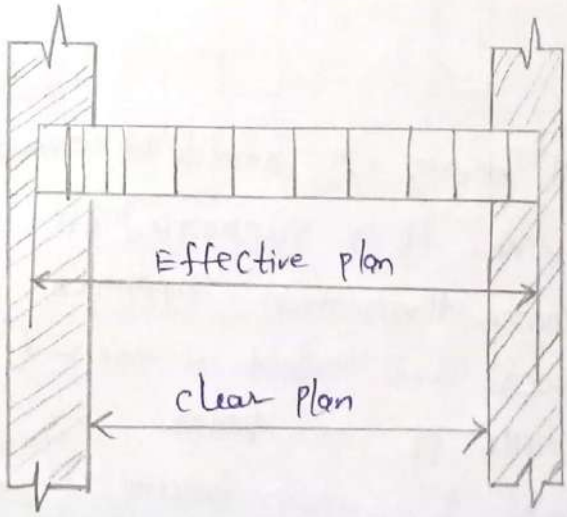
Simply supported beam

A beam supported freely at the two ends on wall or



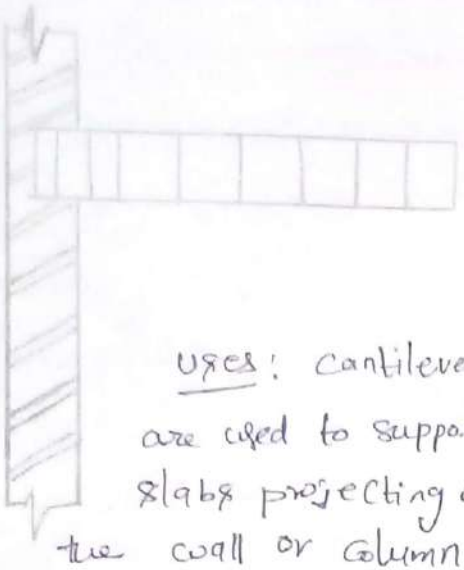
fixed beam

Here both the ends of the beams are rigidly fixed or embedded into the supports (walls or columns).



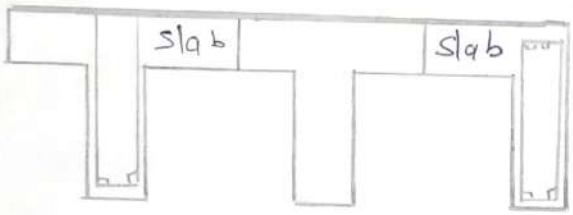
Cantilever beam

When a beam is fixed in a wall or column at one end and the other end is free, it is called as Cantilever beam.



Uses: Cantilever beams are used to support slabs projecting outside the wall or column.
portico, Balcony.

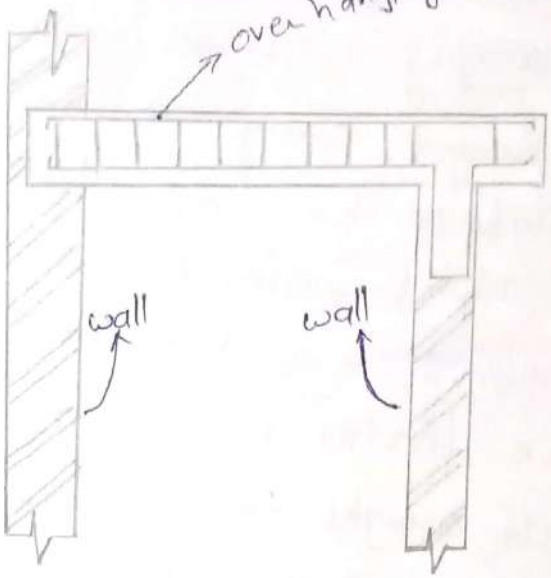
Continuous beam



A beam is said to be continuous when it is supported on more than two supports. These are used at the end walls of a room.

Over hanging beam

* In this type of beam, its end extends beyond the wall or column support.
* Over hanging of the beam is the unsupported portion of the beam.
* It may be on one side or both the sides of the support.



Types of loading on beams

(a) Concentrated load
(b) Uniformly distributed load
(c) Uniformly varying load
(d) Arbitrary loading.

Columns

* A column is a vertical structural member.
* It transmits the load coming from the slab(ceiling/roof) and beam, including its self weight to the foundation of the building.
* Columns may be subjected to a pure compressive load (axial) or a combination of compressive load and bending.

classification of Columns

Columns can be classified based on

a) Length of column
   * Long column
   * short Column

b) material used to construct column
   * R.C.C column
   * Steel column

Long column

* If $\frac{l_{eff}}{a} > 12$, it is long column.
* If $\frac{l_{eff}}{a} < 12$, it is short column.

l_{eff} → Effective length of column which depends on the condition of the end support

a → Least lateral dimension of the column.

R.C.C. Column

* If the effective length of a compression member is equal to or less than thrice the least lateral dimension, the member is made up of plain cement concrete.
* If the effective length of a compression member is more than thrice the lateral dimension, the member should be reinforced.

Uses R.C.C columns are used in multi storeyed buildings and heavily loaded structures.

Steel Columns

* These are also called as Stanchions.
* These are widely used in industrial Structures.
* They are used to carry floors and roofs of buildings of light loads supported on long columns.

Lintels

* A lintel is a horizontal member which is placed across an opening to support the portion of the Structure above it.
* Lintels are made up of following materials

a) wood
b) Stone
c) Brick
d) Steel
e) Reinforced Concrete Cement (R.C.C) lintel.

Roofing

A roof is the uppermost part of a building which is supported on Structural members and covered with roofing materials to give protection to the building against rain, wind, heat, snow.

* A good roof is just as essential as a safe foundation.
* A roof must be designed and Constructed to meet the requirements of different climates and the covering materials available.
* A roof should be durable, stable, Strong enough to take the loads coming on it, be well drained and water proof.

Types of roof

Roofs can be classified according to shape, span and structural design principles.

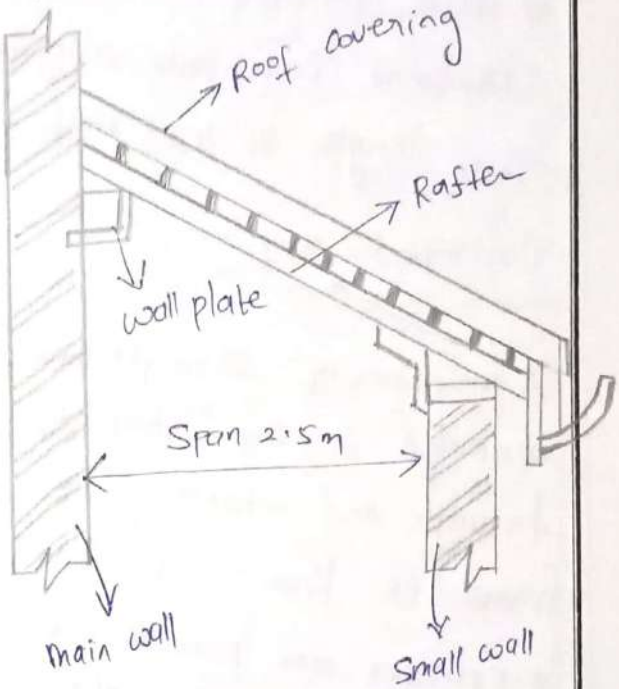
(a) R.C.C roof
(b) Single roof
(c) Double roof
(d) Trussed roof
(e) Shell roof
(f) Dome roof

R.C.C roof

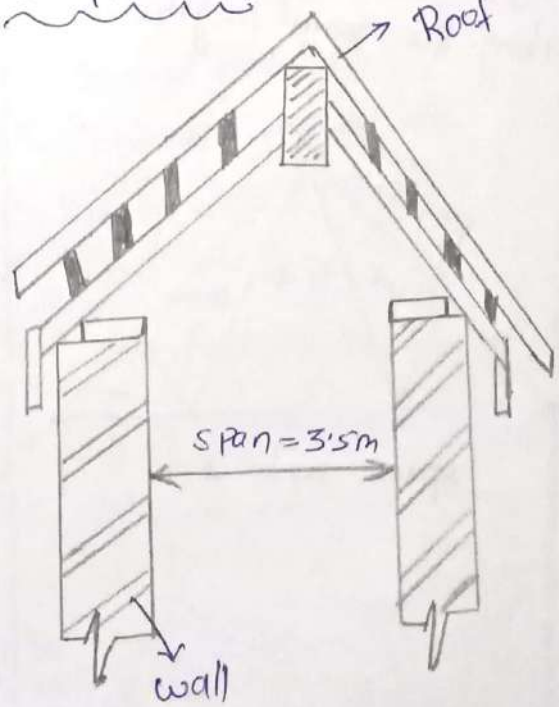
* A R.C.C roof is commonly and most widely used.
* In this roof, Concrete with steel reinforcement bars are used to form a flat roof.
* Here the load is carried by the slabs which is directly supported by the columns.

Single roof

* Single roof consists of only common rafters, supporting the roofing material
* Rafters are supported at the wall plates and rigid pieces.
* Single roofs are used for spans up to 5m.



coupled roof



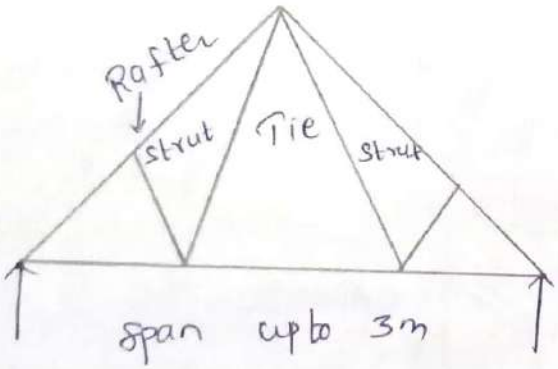
In a coupled roof, a pair of rafters slope upwards from the walls.

* The rafters are kept at uniform intervals along the length of the roof.

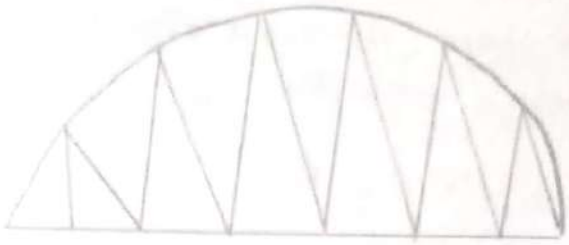
Trussed roof

A number of straight members connected in the shape of triangle and forming a frame is known as truss.

* Trusses are provided at regular intervals of about 3m along the room length.



Dome roof



Flooring

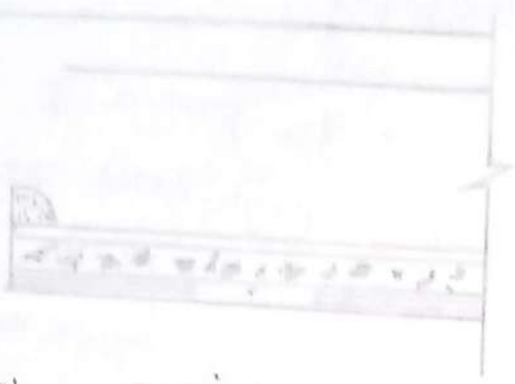
Floors are the horizontal elements of a building structure which divide the building into different levels for the purpose of creating more accommodation within a limited space.

The floor consists of the following two components.

a) A subfloor (or) Base course
b) Floor covering (or) flooring

A Sub floor

The purpose of this component is to impart strength and stability to support floor covering and all other superimposed loads.



floor covering

This is the covering over the subfloor and is meant to provide a hard, clean, smooth, impervious, durable and attractive surface to the floor.

* A floor may be defined as a building component that divides a building in different levels, for the purpose of creating accomodations within a restricted space, at levels one above the other.
* The bottom most floor of a building is called the ground floor and the other floors above it are termed as the upper floors or first floor, second floor etc.
* If the floor is below the natural ground level, it is called a basement floor.

Selection of flooring

The selection of flooring can be made considering the following factors.

1. Initial cost
2. Appearance
3. cleanliness
4. Durability
5. Sound insulation
6. Thermal insulation
7. Smoothness
8. Hardness
9. Comfortability
10. fire resistance
11. Maintenance

materials used for flooring

1. Stones 2. Bricks
3. Wood or Timber 5. Concrete
6. Mosaic 7. Terrazo
8. Asphalt 9. plastic
10. Tiles 11. Rubber
12. Linoleum 13. Cork
14. magnesite 15. Glass
16. Marble

Requirements of good quality floor

* It should give a hard and smooth surface.
* It should have adequate strength and stability
* It should have good thermal insulation capacity
* It should be durable and easy to maintain
* It should be fire resistant
* It should have an aesthetic look.

Plastering

It is the process of covering rough walls and uneven surfaces in the construction of house and other structures with a plaster or mortar.

Objectives of plastering

* To provide an even, smooth, regular, clean and durable finished surface and hence to improve the appearance.
* To protect the surfaces from the effects of atmospheric agencies.
* To conceal the defective workmanship.
* To cover up the use of inferior quality and porous materials and the joints formed in masonry work

* To provide satisfactory base for white washing, colour washing, painting or distempering.
* In case of internal plastering the object is to protect the surfaces against dust.

Types of plasters

1. Lime plaster
2. Cement plaster
3. Mud plaster
4. Water proof plaster

* In lime plaster, a mixture of equal proportions of lime and sand, ground in a mortar mill to form a paste of required consistency.
* The sand to be used in mortar should not pass through a 100 mesh sieve.
* Fat lime or poor lime is used in lime plaster.

* Cement plaster uses a mixture of portland cement and sand with required amount of water to make a plaster mass.
* The proportion of cement and sand depends upon nature of work.
* mud plaster is prepared with equal volumes of clay or brick earth and of chopped straw, hay, loose soil or cowdung and hemp.
* The ingradients are mixed and left for seven days, with large quantity of water.
* Water proof plaster consists of one part of cement, two parts of sand and pulverised alum at the rate of 12kg/m^3 of sand.

Requirements of good plaster

* It should provide a smooth, non absorbent and washable surface.
* It should not shrink while drying which results in cracking of the surface.
* It should adhere firmly to the surface and resist the effects of atmospheric agencies.
* It should offer good insulation against sound and high resistance against fire.
* It should provide a decorative appearance to the surface and should be durable.

methods of plastering

Plastering can be done in the following methods

a) plastering in one coats

It is the cheapest construction.

* The mortar joints are raked out to a depth of 10mm.

b) plastering in two coats

* In this type, the mortar joints are raked out to a depth of 20 mm and the surface is cleaned and well watered.
* If the surface to be plastered is very rough, a preliminary coat is applied.
* The completed work is allowed to set for 24 hours and it is well watered for at least one week.

c) plastering in three coats

* The total depth of coat in this plastering is

18mm - 22mm

first coat - 9mm - 10mm
second coat - 6mm - 9mm
Third coat - 3mm

Defects in plastering

* Small patches swell out beyond the plane and this is particularly seen inside the building. This is known as blistering of plastered surface.
* Cracks are formed on the surface which may be visible or invisible.
* The development of fine hair cracks are known as crazing.
* Soluble salts are present in plaster materials as well as in building materials.
* The formation of very small loose mass on the plastered surface is known as flaking.
* The plaster from some portions of the surface comes off and a patch is formed. This is known as peeling.

Remedies for minimising the defects in plastering

* Workmanship should be the best in brick work and plastering work.
* Bond of brick work should be proper.
* Efflorescence is removed by rubbing brushes on the surface.
* A solution of 1 part of Hcl acid or H_2SO_4 acid and 5 parts of clean water is prepared and applied on the affected area. The surface is then cleaned with water.
* Bricks of superior class should be used.
* The surface to be plastered should be well watered so that it may not absorb water from the plaster.
* Excessive trowelling should be avoided.

Lintels

A lintel is horizontal member which is placed across an opening to support the portion of the structure above it.

* These can be used to carry transverse loads.
* The materials used for lintels are —

wood, Steel, Brick, Stone and Reinforced cement Concrete.

* wood pieces can be used as lintels. A Single piece of timber or three pieces bolted together along the thickness of the wall can be adopted.
* In Stone lintels, slabs of stones are placed across the openings. Relieving arches are to be provided Since Stones have low tensile resistance.
* In brick lintels, a temporary wood support known as turning piece is used to construct a brick lintel.
* The depth of the lintel must be some multiple of brick courses.
* Steel lintels consists of steel angles or rolled steel joists.
* Steel angles are used for small spans.
* Rolled Steel are used for large Spans.
* The R.C.C lintels are fire proof, durable, strong and easy to construct.
* The usual Concrete mix used for lintels are 1:2:4
* Plain Concrete lintels are used upto a span of 900mm

Bridges

A bridge is a structure providing passage over an obstacle such as a valley, road, railways, canal, river, without closing the way.

* The required passage may be for road, railway, canal, pipe line, or pedestrains.

Necessity of bridges

* Bridges enable the free flow of traffic during monsoons and other periods of inclement weather.
* Bridges provide additional communication facilities.
* The development of backward area which may be rich agriculturally, critically depends on the existence of bridges.
* Bridges provide more socio-economic benefits to the people.

Site selection for construction of bridge

* The bridge should cross the river at right angles to the direction of flow of stream or river water so as to minimise the length of the bridge.
* The banks on either sides of the river should have firm soil and be straight and well defined. This will increase the stability of the bridge.
* The selected site should be at a place where the river is narrow and the flow is streamlined without serious whirls.
* precautions should be taken to see that the selected site should be far away from where the river is likely to change the course.

* Hard rock should be available close to the river bed level.
* There should not be any sharp curves in road approaches.

Preliminary data to be Collected for Construction of bridge

* volume and nature of traffic
* velocity of the stream and high flood level (HFL) obtained.
* catchment area
* Strength and nature of soil and extent and type of vegetation. (climatic condition)
* frequency of rainfall and flood occurance.
* Scour depth determination
* Nearest place of availability of cement, steel, timber
* means of transport of materials
* Availability of electrical power.
* Facilities required for housing labour during construction
* Liability of site to earthquake disturbances.

classification of bridges

1. According to expected utility of service
   (a) Temporary bridges
   (b) permanent bridges.

* Temporary bridges are constructed for the following purposes
  - During Construction of Dam
  - During Construction of permanent bridges
  - During the Survey work of Projects

* The temporary bridges can be dismantled when the object of their construction is fulfilled.

* permanent bridges are constructed and maintained at high cost and have long span of time.

* These bridges are built to last for centuries.

* These are constructed by Steel and R.C.C

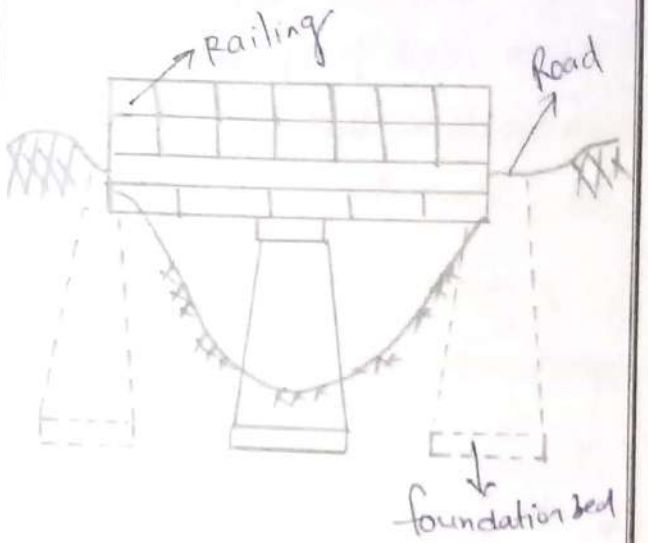
2. According to position of the floor of the bridge

Relative to formation level, highest flood discharge, the bridges are classified as

a) Deck bridge
b) Through bridge
c) Semi - through bridge

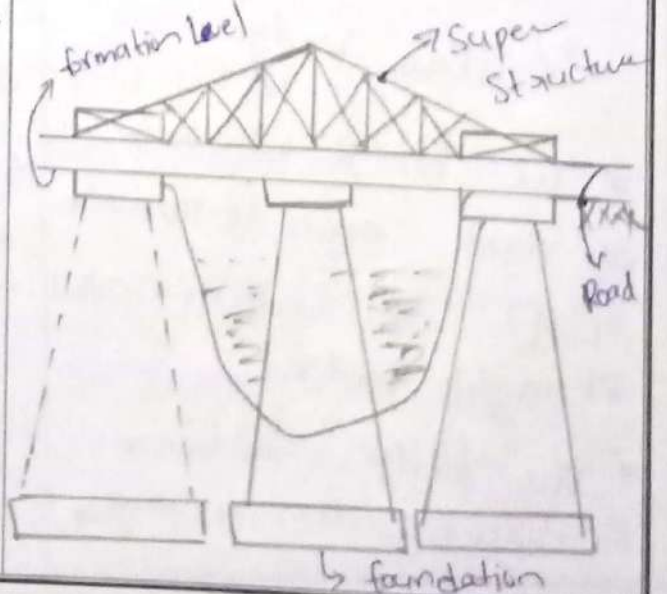
Deck bridge

When the platform of a bridge carrying the communication of route is supported at the top of the superstructure, it is known as deck bridge.



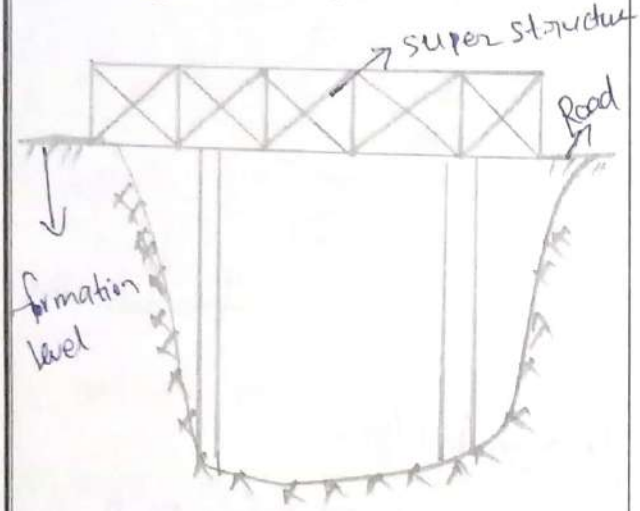
Through bridges

When the platform of a bridge carrying the communication route is supported at the bottom of the super structure, it is called through bridges.



Semi through bridges

When the super structure of a bridge projects partly above and partly below the formation level, it is known as semi through bridges.



3. According to the inclination of bridges

a) Straight bridge
b) Skew bridge

* the bridge which is at right angles to the axis of flow of water is called straight bridge.
* the bridges which are constructed at an angles other than 90° to water flow are called skew bridge.

4. According to the position of high flood level

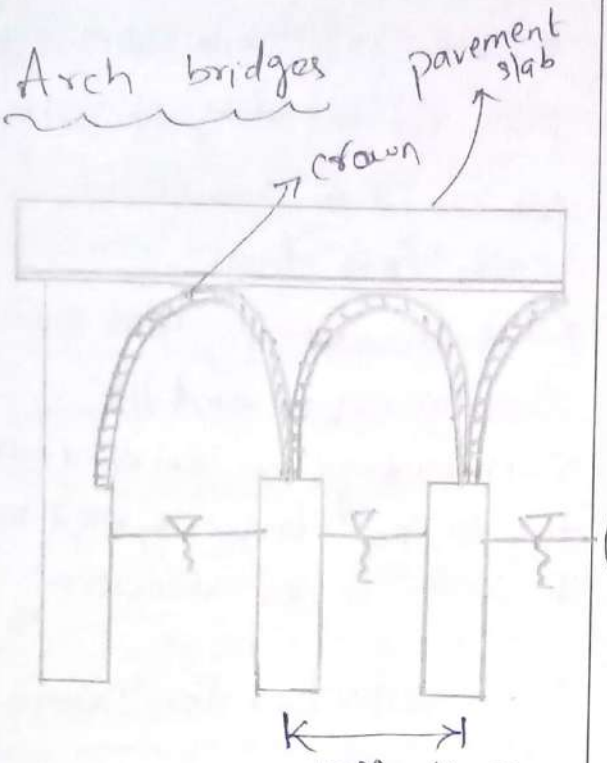
a) Submersible (or) Low level bridges
b) Non submersible (or) High level bridges.

* In submersible bridge, the highest flood can be allowed.
* It allow highest flood to pass over its superstructure.
* the non submersible bridges does not allow the high flood water to pass over the floor carrying the communication route.

5. According to the type of Super Structure

a) Arch bridges
b) Girder bridges
c) Truss bridges
d) Suspension bridges

Arch bridges



(6) According to the Span
a) Culvert (span less than 6m)
b) Minor bridges (span 8-30m)
c) Major bridges (span above 30m)
d) Long Span bridges (span above 120m)

(7) According to loading
a) class AA bridges
b) class A bridges
c) class B bridges

(8) According to Level of Crossing (a) over bridge (b) under bridge

(8) According to their function
a) foot bridge
b) Highway bridge
c) Railway bridge
~~d) Adequal~~
d) Aqueduct bridge

(9) According to materials
a) Timber bridge
b) Steel bridge
c) R.C.C bridge
d) prestressed concrete bridge.

(10) According to inter span relationship
a) Simple bridge
b) Continuous bridge
c) Cantilever bridge

Dams

A dam is an impervious barrier or an abstruction constructed across a natural stream or a river to hold up water on one side of it, upto a certain level.

purpose of Dam

* The stored water in the dam can be conveniently used for irrigation purpose.
* The dam forms a very good source of water supply in areas where ground water source is inadequate.
* If Sufficient head of water is stored, that can be used for power generation.
* In case of heavy floods, if water is left unabstructed, the result will be very hazardous.
* It can be used as recreation purpase such as boating, Swimming.
* The reservoir forms a good place for breeding of fish, which is a considerable wealth from dam.
* The atmospheric heat around the reservoir and its surroundings is controlled well due to the large exposed area of water in the reservoir.

Site Selection for Dam

a) Availability and characteristics of materials for Construction.
b) Availability of suitable site for construction facility
c) Availability of utility services.
d) Climate
e) Diversion during construction
f) foundation
g) flood control aspects
h) Availability of water
I) Irrigation Command

j) Sediment load

k) Spillway site

l) Submergence

m) Topography and Storage Capacity.

Classification of Dam

Dams can be classified as

a) Rigid Dams

b) Non rigid dams.

Rigid dams

As the name implies, these dams are constructed by rigid materials such as bricks, Stones, R.C.C.

Types of rigid dams

a) Solid gravity dam

b) Arch dam

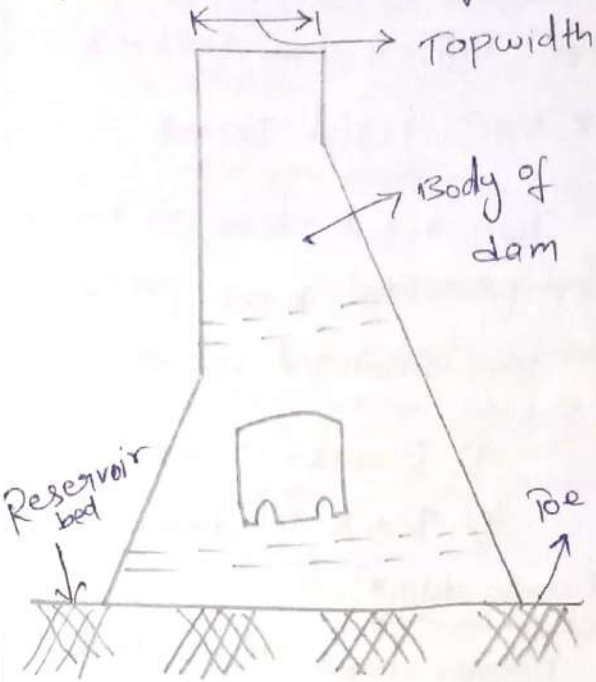
c) Buttress Dam

d) Timber and steel dam

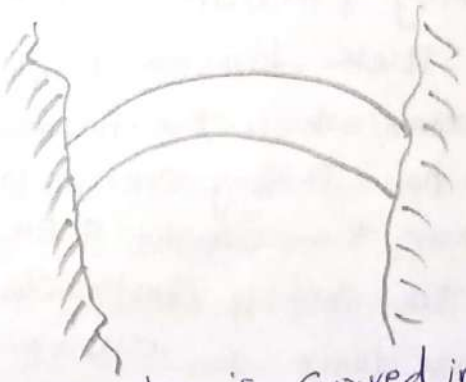
Solid gravity dams

These dams are designed in such a way that its own weight can resist the external forces.

* These type of dams are durable and has more rigidity.



Arch dam



An arch dam is curved in plan with its Convex face holding the water.

* This dam is suitable for narrow valleys.

Buttress Dam

It consists of sloping sections, buttress and a base slab.

Timber and steel dam

These dams are not used for bigger dam sections.

* Non rigid Dams

Non rigid dams are having trapezoidal basic profile.

Types of non rigid dams

a) Earth dams
b) Rock fill dams

Earth dams

Earth dams are made of soil with minimum processing using primitive equipment.

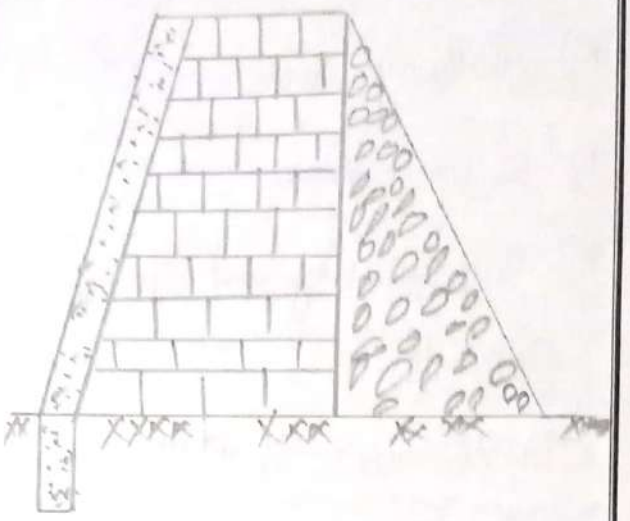
* These dams are built in areas where the foundation is not strong enough to bear the weight of the dam.

* The cost of construction of these dams are cheap.

ROCK fill dams

These are made up of loose rocks and boulders piled in river bed.

* A slab of reinforced concrete is often laid on the upstream face to make it water tight.



HFL (High flood level)

It is the level of highest flood ever recorded in a river or stream.

OFL (Ordinary flood Level)

It is the flood level which generally occurs every year.

LWL (Low water Level)

It is the low water level (minimum water level) in the dry weather.

Water supply

* Without food man can survie for days but not without water.

* It is necessary to have portable (Drinking) water and disposing the water waste safely.

* The sources of water are precipitation and underground water.
* water supply engineering deals with the location, collection of water, its treatment method, tests for standard limits and efficient water supply.

Objectives of public water supply system

* To supply safe and wholesome water to the consumer.
* To supply water in adequate quantity.
* to make water available within easy reach of the consumers.

Sources of water

* Surface sources of water
* Sub surface or underground sources of water

* surface sources of water are
  a) lakes and ponds
  b) Streams or Rivers
  c) Storage reservoirs
  d) Oceans.
* Sub surface or under ground sources of water are
  a) Infiltration galleries
  b) Infiltration wells
  c) wells.

Quality of water

The water required for public water supply schemes should be portable or wholesome water that is fit for drinking purpose.

* The portable water or wholesome water with relation to various uses of water are as follows.

a) Domestic use

The following are requirements of portable water for domestic use.

* It should be clear, colourless and odourless.
* It should be free from harmful and disease producing bacteria.
* It should be fresh and cool.
* It should be tasty
* It should not cause corrosion.

b) Civic use

for this purpose, large quantity of water is required.

Examples are washing roads, cleaning of sewers.

c) Trade or business use

* The water required for laundry should not be hard.
* The water required for bathing cattles and washing floors may contain any type of impurity.

d) Commercial or Industrial use

Water required for this purpose is chemically pure.
* A slight amount of impurity may considerably affect the final results of the product.

Analysis of water

In order to predict the quality of water, it is subjected to various test.

a) physical test

under this test, water can be examined for the following

* Colour
* Taste and odour
* Temperature

b) chemical test

* Chlorides
* Dissolved gas
* Hardness
* Hydrogen-Ion Concentration
* Alkalinity
* Acidity
* metals and other chemical substances
* Nitrogen and its compounds
* Total Solids.

c) Bacteriological test

a) Total count or Agar plate count test

b) B-Coli test

This is an index or number which represents approximately the number of B-coli per C.C of sample of water under consideration.

Rain water harvesting

It is the process of augmenting the natural filtration of rain water into the underground formation by some artificial methods.

* Concious collection of rain water and Storage to cater to the demands of water, for drinking, domestic purpose and irrigation is termed as Rain water harvesting.

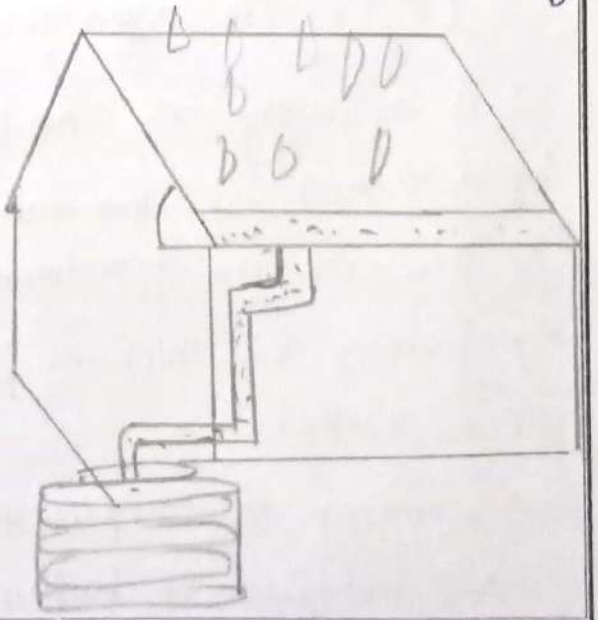
Objectives of rain water Harvesting

* To provide water for domestic purpose
* To increase water resource
* To reduce water scarcity
* To arrest ground water decline
* To conserve Surface water runoff during monsoon
* To reduce soil erosion
* To inculcate a culture of water conservation.

methods of rainwater harvesting

* By Storing in vessels, tanks, and reservoirs above and below the ground.
* By Constructing pits, lagoons, dug wells and check dams.
* By recharging the ground water.

* In urban areas, rain water flows away as surface runoff.
* Roof top rain water harvesting



Benefits of rain water harvesting

* It improves the quality of ground water
* Rises the water levels in wells for future use.
* Improves soil moisture
* low cost expenses with little maintenance
* Helps in recharging the aquifers
* Reduces water scarcity.

Carpet area

It is the area that can actually be covered by a carpet or the area of the of the apartment excluding the thickness of inner walls.

* carpet area is usually around 70% of builtup area.

floor Space Index

It is the ratio of a building's total floor area to the size of the piece of land upon which it is built.

* It is also called as floor area ratio.

Engine

Engine is a device which can be used to convert heat energy into mechanical energy.

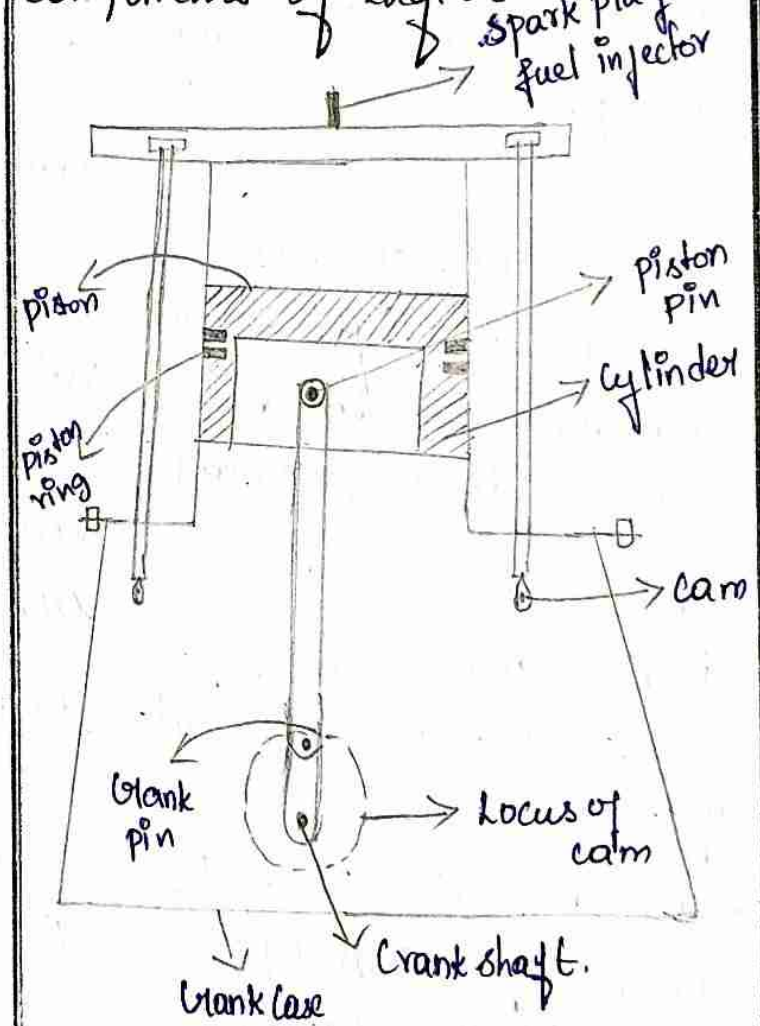
classification of Internal Combustion Engines.

In Internal combustion engines the combustion of fuel takes places inside the engines.

I.C engines are classified as follows -

1. According to type of fuel used.
   a) petrol engines
   b) Diesel Engines.
2. According to cooling system
   a) Air cooled engines
   b) water cooled engine
3. According to the cycle of operation.
   a) 4-stroke engines
   b) 2-stroke engines.
4. According to charge pressure
   a) Naturally aspirated
   b) Super charged (or) Turbo charged engines
5. According to the number of cylinder used.
   a) single cylinder engines
   b) Multi cylinder engines.

Components of engine.



Cylinder:

The cyclinder allows the piston to move to and fro. It is made up of Cast iron or Steel or an aluminium alloy

Cylinder head:

* It is filled on the top of the cyclinder.
* A gasket is provided between the cyclinder and the cylinder head to prevent the leakage of hot gases.

piston:

The function of rings is to provide gas tight sealing to maintain the compression pressure inside the cylinder.

Connecting rod.

* It transmit the force from the piston to the crank-shaft.
* It helps to convert the reciprocating motion of piston into the rotary Motion of the crank shaft.

Crank Shaft.

The crank shaft is provided with suitable holes to help in the lubrication System.

Fly wheel.

It is mounted on the crank Shaft.

The fly-wheel stores the excess energy during the power stroke of the engine and helps the movement of the piston during the remaining idle strokes.

Cams.

It controls the opening and closing of the inlet and exhaust valves in case of 4-S engines

cams are rotated by a cams Shaft driven by the crank-shaft through gears

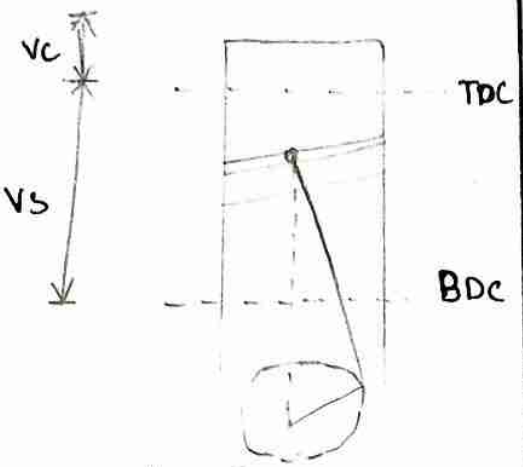
Compression Ration (r)

It is the ratio between total cyclinder volume to the clearance volume.

$$r = \frac{V_s + V_c}{V_c}$$

V_s = Swept volume

V_c = clearance volume.



A motor cycle has a cylinder diameter of 4.6cm and a stroke of 4.2 cm If the clearance volume is 12.2 c.c Determine the compression ratio.

Given

Diameter of cylinder

$D = 4.6cm$

Length stroke, $l = 4.2cm$

$V_c = 12.2\ cc$

$V_s = \frac{\pi}{4} D^2 l$

$= \frac{\pi}{4} (4.6)^2 \times 4.2$

$= 67.8\ cc.$

$r = \frac{V_s + V_c}{V_c}$

$= \frac{67.8 + 12.2}{12.2} = 6.552$

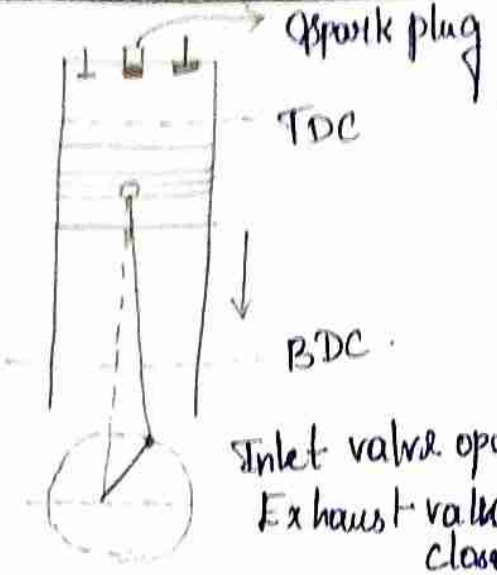
Working of 4 stroke petrol Engine.

* Four stroke petrol engine consist of 4-strokes of piston or two revolution of crank.
* The different strokes of 4-stroke petrol engine are as follow.

a) Suction stroke
b) Compression stroke
c) Expansion (or) stroke
d) Exhaust stroke.

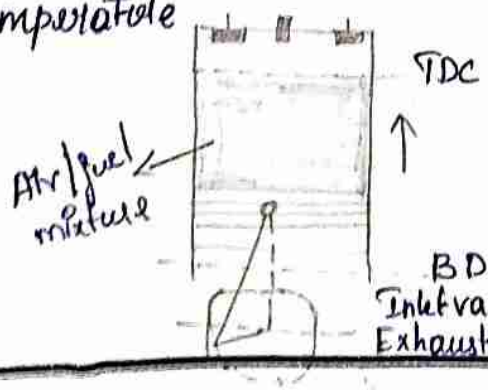
Suction stroke:

* During this stroke. inlet valve is opened and exhaust valve is closed.
* The piston comes down to the bottom dead centre (BDC) from the top dead centre (TDC)
* Air-fuel mixture (petrol Air) in the correct proportion from the carburettor is drawn inside the engine cylinder through the inlet valve.



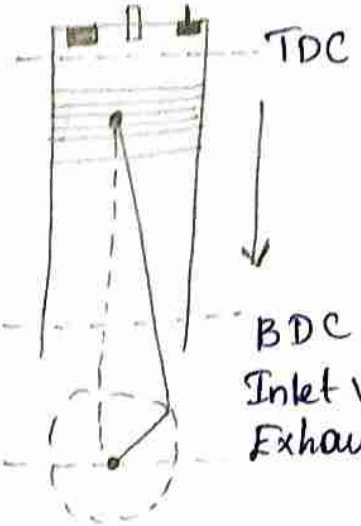
Compression Stroke

* In this Stroke, both valves remain closed.
* The air-fuel mixture is compressed when the piston moves up to TDS.
* The compression ratio varies from 7-10.
* At the end of the compression Stroke, Spark is produced by the Spark plug, due to which combustion starts resulting in combustion of fuel with high pressure and temperature



Expansion Stroke.

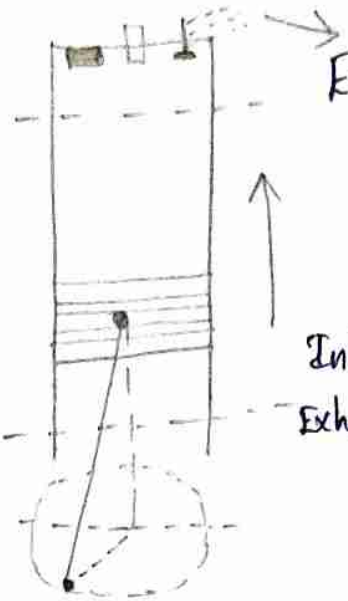
* During this Stroke, both valves remain closed.



* The piston is pushed from TDC to BDC.
* The force above the piston is transmitted to the crank shaft through the connecting rod and crank mechanism.

Exhaust Stroke:

* During this Stroke, the exhaust valves is opened and inlet valve is closed.
* The poison can move from BDC to TDC.
* The products of combustion can escape through the outlet valve.
* This is called Scavenging.
* The cycle is repeated.



4-Stroke Diesel engine.

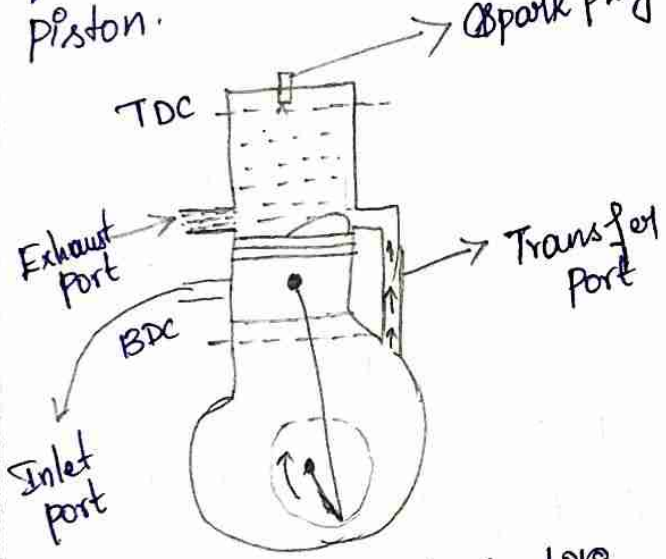
* 4-Stroke diesel engine is similar to 4-S petrol engine.
* Instead of petrol - air mixture only air is entered into the cylinder during ~~the~~ Suction Stroke
* The compressed air can burn the diesel sprayed at the end of compression Stroke.
* Diesel engine is also called as compression ignition engines.

Petrol Engine Spark Ignition engine (SI)	Diesel Engines Compression Ignition Engine (CI)
* Compression ration is 7-10	* Compression ratio is 15-20
* Petrol-Air mixture can be Compressed	* Air alone can be Compressed.
* Compression temperature is about 400°C	* Compression temperature is about 550°C.
* Peak Pressure is in the range of 50-70 bar	* Peak pressure is in the range of 80-100 bar.
* Thermal efficiency is low in the range of 20-25 due to low compression ratio.	* Thermal efficiency is high in the range of 25-30%. due to high compression ratio.
* Spark plug is needed to initiate ignition of air fuel mixture	* No need of Spark Plug, as compression temperature is enough to ignite.
* Due to low peak Pressure thickness of parts is less	* Due to high pressure thickness of parts is high.
* Weight of engines is less	* weight of engines is more.
* Cost of engine is less	* Cost of engines is more
* Operating cost pa k.M is high due to bw thermal efficiency	* Operating cost per km is less due to high thermal efficiency.
* Due to better mixing of air fuel, it is in the range of 17-18.	* Due to poor mixing of air and diesel, Air fuel ratio, is very high 25-40.

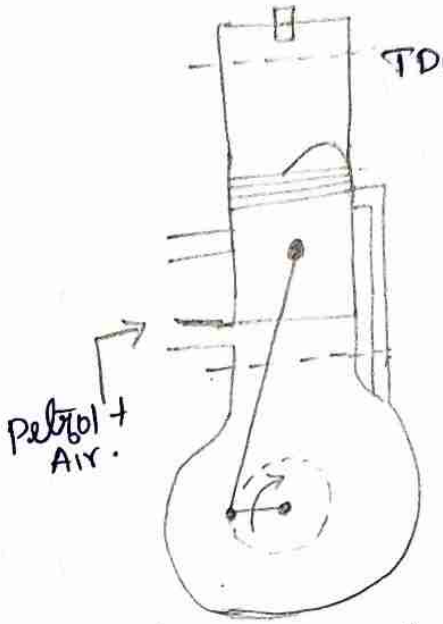
2 Stroke petrol Engine.

In this engine, the cylinder is provided with inlet port, transfer port and exhaust port. These ports are opened and closed by the movements of the piston itself.

The cycle of operation is completed by one revolutions of cranks or two strokes of the piston.



* Let us study the condition when the piston is at TDC
In this position. only the inlet port is kept opened and the other two ports are closed.
The mixtures of air petrol is drawn into the crank case.



* Also the mixture of air and petrol above the piston is compressed
* when the spark occurs, the combustion starts and the piston is pushed down due to the pressure created.
* During this downward motion the inlet port is closed due to which the A/F mixture will get compressed inside the crankcase
* Simultaneously. from the BDC, the exhaust port is opened, and the gases are sent to the atmosphere
* At about 60 from BDC, the transfer port is opened, the A/F mixture from the crank cases enters into the cyclinder.

4- Stroke engines	2- Stroke engines.
* One power stroke for every 4 strokes of piston or two revolution of crank.	* one power stroke for every 2 strokes of piston or one revolution of crank.
* As the number of cycles is less power output is less for the same cylinder size.	* Power produced is more for the same cylinder size. more suitable for diesel power plants.
* The weight of the engine is more for same power output	* The weight of the engine is considerable less.
* Operating temperature is less so less consumption of lubricating oil.	* Operating temperature is more so more consumption of lubricating oil.
* Variation of torque is more so heavier fly wheel is necessary.	* Smaller flywheel is enough as the torque is more uniform.
* Noise is less	* Noise is more due to frequent exhaust.
* Higher thermal efficiency	* Thermal efficiency is less due to possible wastage of fuel air mixture through the exhaust port.
* Due to a valve mechanism the design and manufacturing of engine is difficult and cost is more.	* Easier in design and manufacturing cost is low.

arburettor:

* It is a devile used in petrol engine to evaporate the liquid petrol and mix with the correct amount of air and supply the petrol air mixture in the designed ratio at all speeds and loads
* It can be used for easy starting of engine (choke).

Ignition System.

There are two types of ignition system can be used in petrol engine.

(1) Battery ignition system (or) coil ignition system
(2) magneto ignition system.

Cooling System

Due to combustion of fuel inside the cylinder very high temperature is produced.

If the engine is not cooled properly, the parts such as piston, cylinder cyclinder head, piston rings and the valves will get over heated resulting in the reduction of strength and possibility of distortion of components

Methods of cooling.

1. Air cooling System
2. Water cooling system.

Lubricant System:

Lubricant System can be used for following purposes.

a) To reduce the friction blw the rubbing parts and redule the wear and tear
b) To reduce the temperature of working parts.
c) To redule the noise.
d) To keep the parts clean by removing worn out materials
e) To remove the carbon dust particle.

Parts of lubricated.

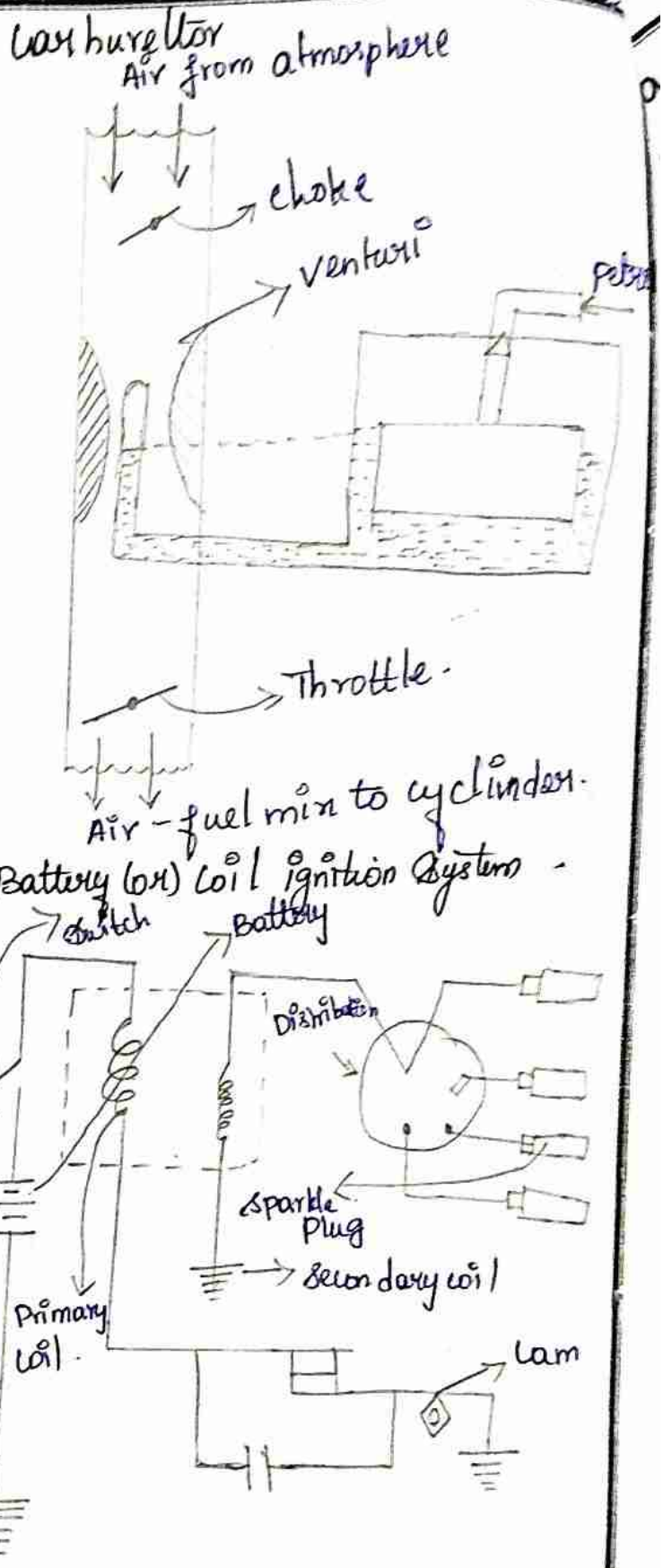
a) Reciprocating parts like piston
b) cyclinder
c) Rotating parts like crank shaft.
d) Oscillating parts like Connecting rod.

Types of lubricants.

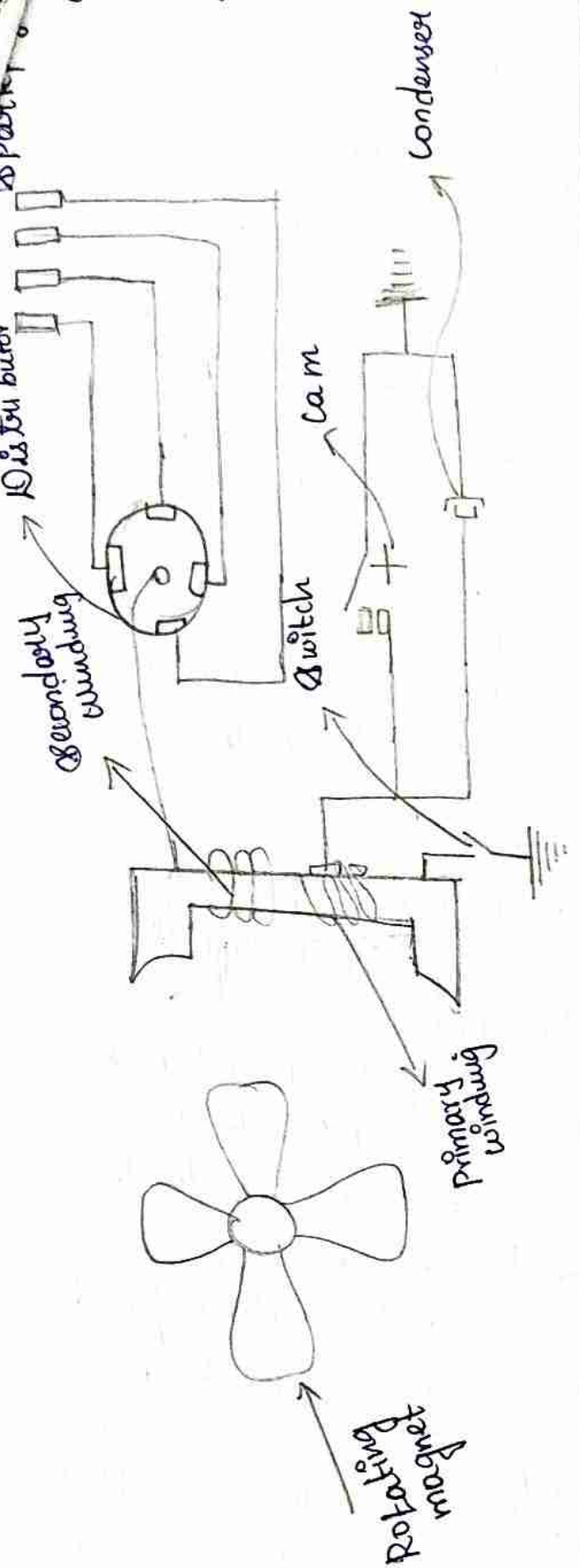
1. Liquids like mineral oil, vegetable oil
2. Semi liquids like grease
3. Solid lubricant like graphite powder alone or mixed with oil or grease.

Requirements of good Lubricants

* High viscosity index High flash point and low Pour point temperature
* Non corrosive
* Good detergent quality to keep the rubbing surfaces clean.
* Ability to maintain a thin film of oil even at high load.



Magneto ignition System



Fuel pump.

* The fuel pump is a device used in diesel engine to produce the high pressure necessary for injection of diesel in the order of 100 - 400 bar, depending upon the engine size and type of combustion chamber used.
* It is also controls the amount of fuel pumped for different loads and speeds.

Fuel injector:

* Fuel injector can be used to atomise the diesel.

It consist of a needle valve which is kept in the seat by a helical spring.

The fuel under pressure from the fuel pump enters the pressure chamber through the fuel duct.

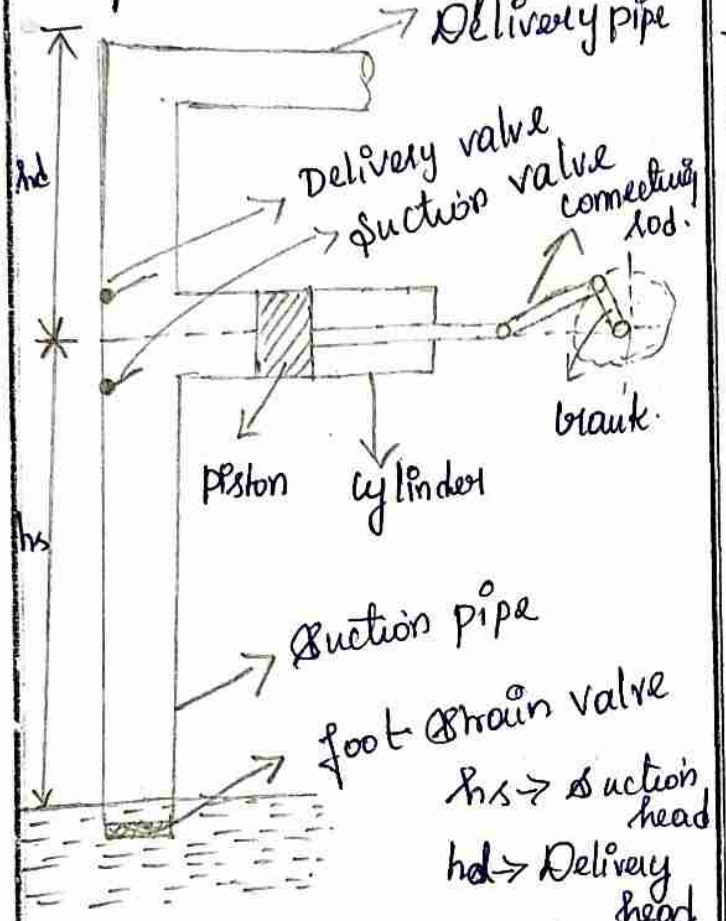
Hydraulic pumps.

Pumps is a devile which can be used to pumb water fuel, chemical and various fluids like lubricant.

classification of pumps.

1. Reciprocating pump
   a) Single acting
   b) Double acting.
2) Centrifugal pump.

Single reciprocating pump.



The parts of reciprocating pump are

1. Suction pipe
2. Deliver pipe
3. Suction valve
4. Delivery valve
5. pistor.
6. cylinder
7. Connecting rod.
8. Crank
9. foot Strain valve

* Here the Crank Shaft is Connected to an electric motor
* when the motor is Started the piston moves forward and backword inside the cyclinder.

when the piston moves from left to right, a vacuum will be created in the cylinder due to which the Suction valve is opened and the water is taken up from the pump and enters the cylinder through the suction pipe.

* when the piston moves in the left direction, pressure is created at the water, due to which the delivers valve is opened and the water is forced into the delivery pipe and finally to the required height
* A foot Strain valve is attached to the suction pipe. to filter any dust on impurity Present in water, before entering the cylinder

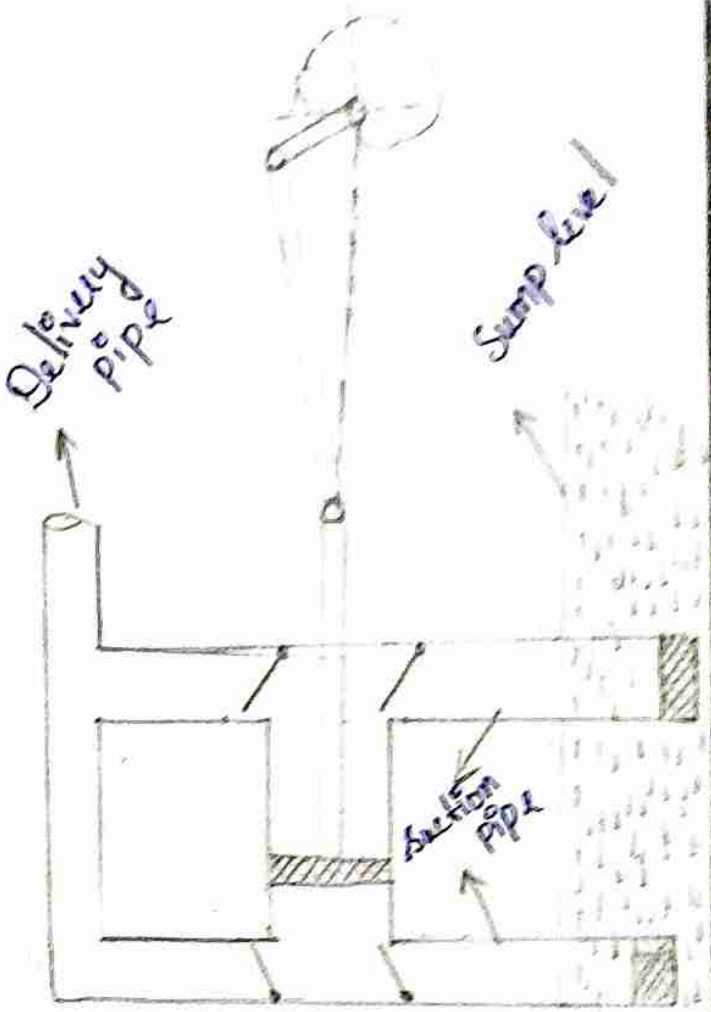
Double acting reciprocating Pump

* In this pump, water acts on both sides of piston.

There are two suction pipes and two delivery pipes are present as shown in diagram.

When there ~~will~~ is a suction stroke on one side of the piston, there will be delivery stroke on other side of the piston.

So far each revolution of the crank shaft, there will be two delivery strokes and doubles the amount of water is delivered by this type of pump.



Single acting reciprocating pump	Double acting reciprocating pump
* One Solution pipe only	* Two Suction pipes are present
* One delivery pipe only	* Two delivery pipes are present
* Water acts on one side of the piston	* Water acts on two sides of the piston.
* During one revolution of the crank, there is only	Two delivery Stroke's for each revolution of crank.
* Water pumped will be less	* Water pumped will be more.
* Power of the motor is less	* High power motor is required
* Cost is less	* Cost is more.

Discharge of reciprocating Pump (Q)

Consider a single acting reciprocating pump,

Let 'L' be the length of Stroke,

A be the cross Sectional area of piston, 'N' be the number of revolution of crank per minutes then discharge of Pump.

$Q = LAN/60$

for double acting reciprocating Pump, discharge $Q = \frac{2LAN}{60}$

Slip of the pump.

* The actual discharge of the pump is always less than the theoritical discharge

Slip is defined as the difference between theoritical discharge and actual discharge.

Double acting Reciprocating Pump

* In this pump, water acts on both sides of piston.

There are two suction pipes and two delivery pipes are present as shown in diagram.

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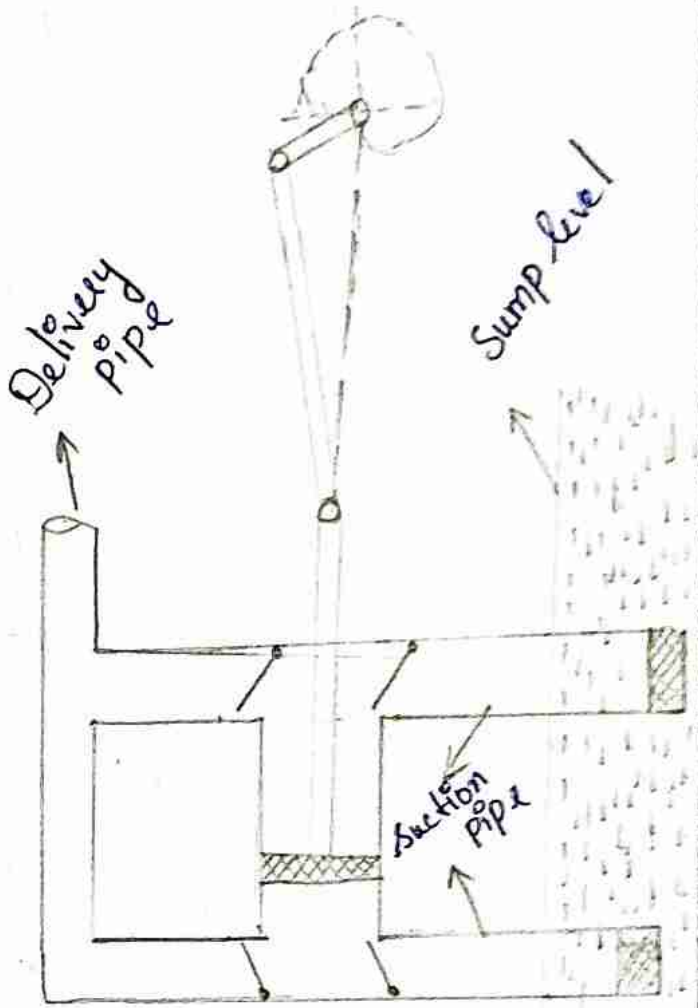

Single acting reciprocating Pump	Double acting reciprocating Pump
* One Solution pipe only * One delivery pipe only * Water acts on one side of the piston * During one revolution of the crank, there is only * Water pumped will be less * Power of the motor is less * Cost is less	* Two Suction pipes are present * Two delivery pipes are present * Water acts on two sides of the piston. Two delivery Stroke's for each revolution of crank. * Water pumped will be more. * High power motor is required * Cost is more.

Discharge of reciprocating Pump (Q)

Consider a single acting reciprocating pump,

Let 'L' be the length of Stroke,

A be the cross Sectional area of piston, 'N' be the number of revolution of crank per minutes

then discharge of Pump,

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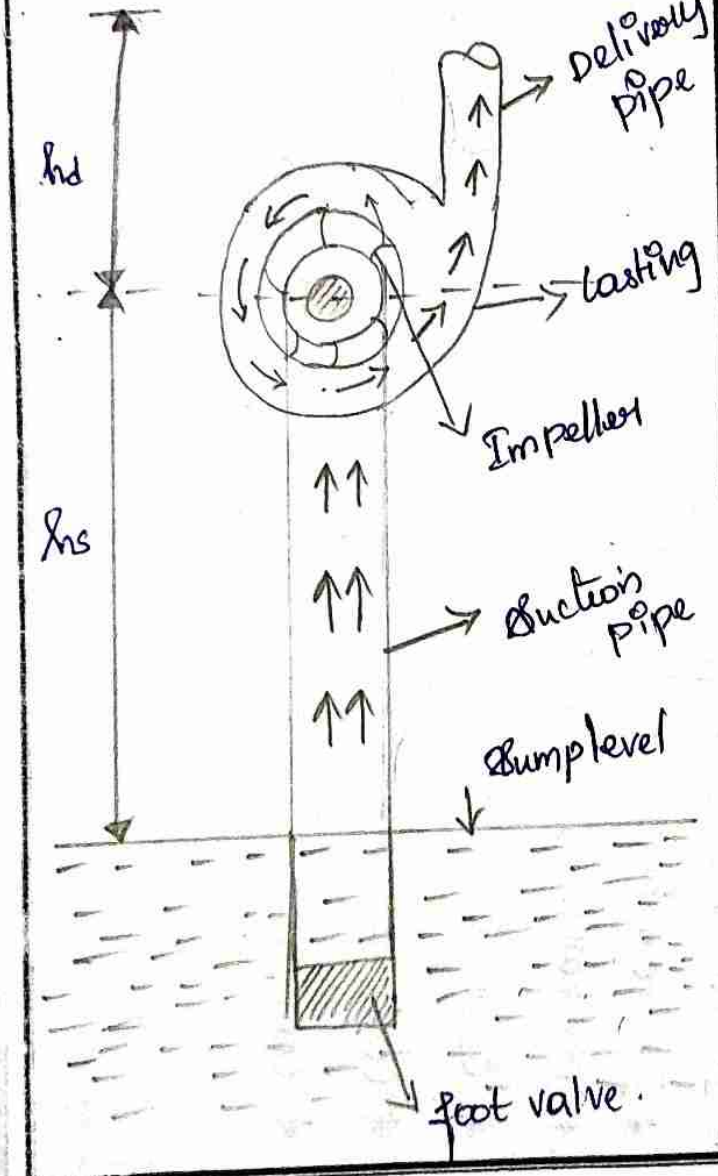
...trifugal pump.

In Centrifugal Pump the water is lifted by the Centrifuga force created by the impeller

The main Parts of Centrifugal Pumps are

a) Impeller
b) casing
c) Suction pipe
d) Delivery pipe.
e) foot & main valve.



* The impeller is a metallic disc fitted with a number of curved vanes.
* Initially water will be Poured inside the casing and the process is called Priming
* After Priming, the impeller will be immersed in water inside the casing.
* when the impeller is rotated by an electric motor, it will Produce Centrifugal, kinetic energy will be produced in the water.
* The casing Surrounds impeller
* These area between the impeller and casing is gradually increasing, till the delivery pipe
* Due to this, the velocity of flow of water will be gradually decreased.
* Due to the reduction in kinectic energy, the Pressure energy of water is increased.

Cavitation:

It is the process of formation of bubbles or cavity in liquid.

* Cavities will be developed in areas of relatively low pressure around on impeller.
* The collapsing of these bubbles trigger intense schock waves inside the pump causing significant damage to impeller.

Priming.

The process of increasing the flow of water in the pump by adding water is called priming. priming can be used to avoid cavitations.

Centrifugal pump.

* It can be used for medium speed.
* Large quantity of fluids can be pumped.
* Discharge is continuous
* Cost is less.
* It can run at high speed.
* It can pump viscous fluids.

Reciprocating Pump

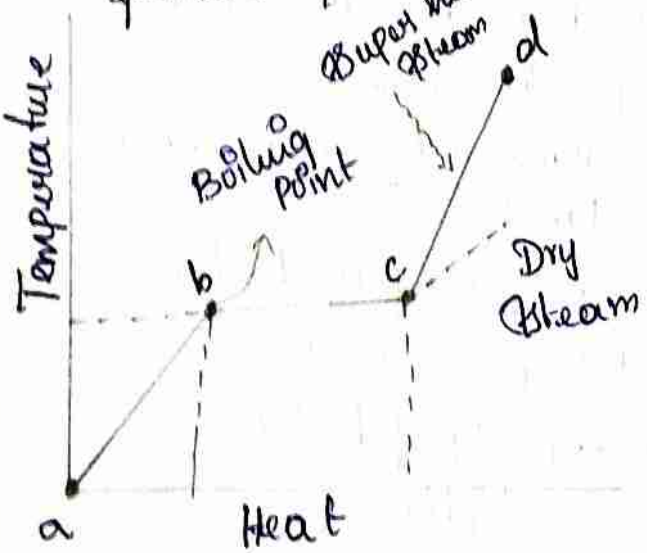
* It can be used for high head.
* It can pump less quantity of fluid only
* Discharge is not continuous
* cost is high.
* can not run at high speed
* Can not pump viscous fluid.

Boilers.

The function of boiler is to evaporate water into steam at a pressure higher than the atmospheric pressure

* The prime function of is to heat and evaporate the water and super heat the steam
* water free from impurities such as dissolved salts, gases and non soluble solids should be supplied to boiler.
* Steam is useful for running steam turbines in electrical power station, ships and steam engines in railway locomotives.

formation of steam



Types of boiler.

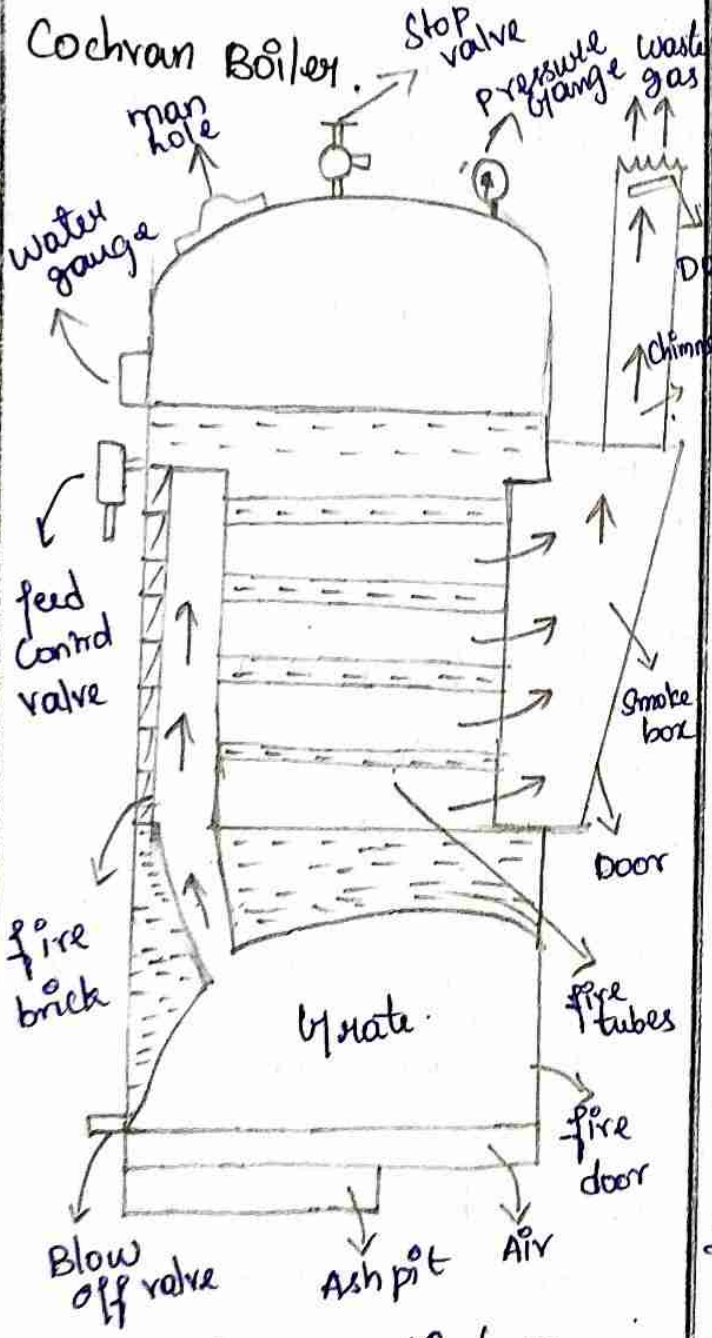
1. Fire tube boiler.
   - Cochran boiler
   - Lancashire boiler
   - Locomotive boiler.
2. Water tube boiler
   - Babcock and wilcox boiler
   - Stirling boiler.
3. High pressure boiler
   - Velox boiler
   - Lamont boiler
   - Benson boiler.
4. Low pressure boiler
   - Cochran, Babcock and wilcox, Lancashire, Locomotive boiler.

* In fire tube boiler hot gases can flow in the tubes and water surrounds the tube
* In water tube boilers water flows in the tube and hot gases surrounds the tube.
* The boilers which produce steam at a Pressure greater -

than 80 bar are called high Pressure boiler.

* The boilers which Produce Steam below 80 bar pressure called as Low Pressure boilers.

Cochran Boiler.

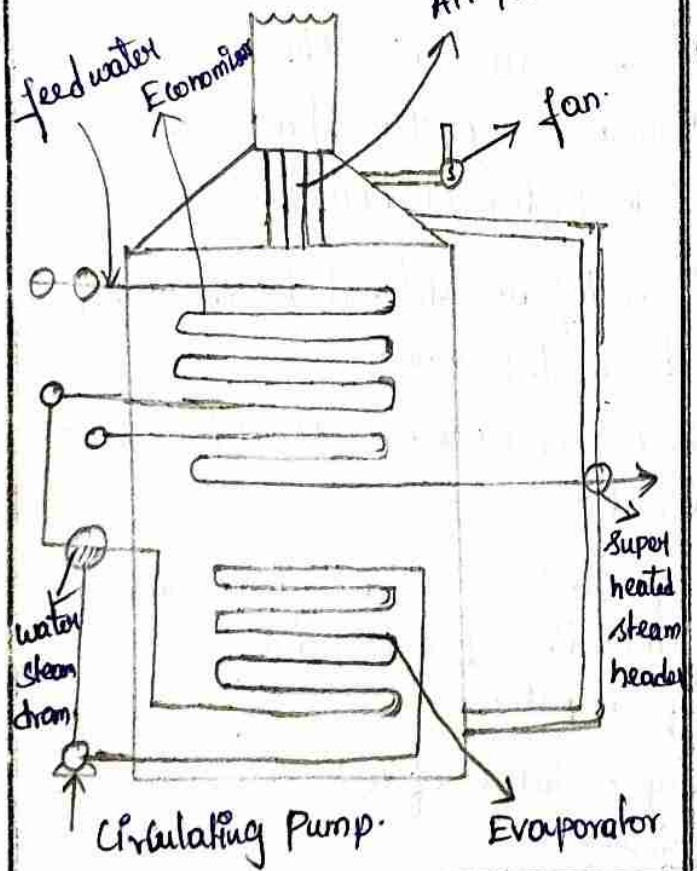


* This is a vertical fire tube boiler.
* It can Produce the Steam at a Pressure less than 80 bar.
* Hence it is a Low Pressure boiler.
* The fuel is fed into the grate through the fuel door and lighted
* The fuel is burnt in the grate and hot gases go to the Combustion continuous in the Combustion chamber.
* The fire brick layer Prevents the over heating of the boiler Shell.
* The hot gases pass through a large number of fire tubes and heat the Surrounding water and Convert it into Steam.
* The waste gases enter the Smoke box. and are released through the chimney.
* The diameter of boiler ranges from 1m to 3m.
* The height of the boiler ranges from 2m - 6m.
* The capacity of boiler is 20 - 300 kg/hr.

Lamont boiler.

It is a high pressure boiler

* It is a water tube boiler
* It is a forced circulation boiler in which circulation is maintained by a centrifugal pump driven by a steam turbine.
* In this boiler, water is circulated through the evaporator tubes.
* Hot gases from the furnace or the combustion chamber heat the water and evaporate into steam.



* wet steam will come to the steam space in the steam water drum.
* In the super heated tubes the moisture from the wet steam is removed and also the temperature is considerably raised.
* The thickness of the drum and the pipes should be more due to high pressure.

Benson Boiler.

* It is similar to lamont boiler.
* But there is no drum.
* This boiler can produce steam even at critical Pressure (221.2 bar)
* absence of the drum reduces the weight and cost of the boiler.

Advantages of high pressure boiler.

* High Pressure Steam out so power output from the turbine and the generator will be high.
* Thermal efficiency is high.
* Evaporative capacity of boiler is high due to forced circulation of water.
* The investment cost for each MW output will be less.

Characteristics of good boiler.

* The boiler should be able to evaporate Steam at the designed capacity, Pressure and temperature

Total cost of boiler with all mounting and accessories should be low.

The boiler should have provision for inspection of all the parts for cleaning and maintenance.

The boiler should have automatic control of water level, pressure and temperature

* The parts should be able to withstand fluctuations in Pressure and temperature.
* The transport and erection of the boiler at site should be easy and at the low cost
* The boiler should confirm to all the safety regulation as laid down in the Indian boiler act.

Indian boiler act.

* Unless the boiler is inspected with the chief inspector of Boiler, it should not be put into operation.
* Fitness certificate should be obtained every year from the chief inspector of boiler.
* The certificate should be displayed in the boiler room.
* The boiler operator should be trained person.
* Any failure or accident should be immediately reported to chief inspector.
* Any violation of act is punishable

Difference between Fire tube and water tube boilers.

Fire tube Boiler	Water tube boiler.
* Hot gases pass through the tube and water surrounding them.	* water passes through the tubes and hot gases surrounding them.
* It is used for low pressure steam as the diameter of shell is large.	* It is used for high pressure steam as the diameter of shell is small.
* Pressure is restricted to 10 bars	* Pressure can be reached upto 100 bars.
* used for industrial application only due to low pressure.	* It is used for power plants where needed high pressure
* More steam space and so Pressure fluctuation is less	* less steam space. Hence Pressure fluctuation is more
* Transport is difficult due to large shell diameter.	* Transport is comparatively easier due to small shell diameter.
* Maintenance cost is low.	* maintenance cost is high.
* water circulation is poor	* water circulation is better.
* Thermal efficiency is low	* thermal efficiency is high.
* Heating surface is less	* Heating surface is high due to large numbers of tubes for water.
* Less skilled operator is enough for the operation of the boiler.	* more skilled operator is needed for the operation of boiler.

Boiler mountings.

* Boiler mounting are a set of safety devices used for the safety operation of a boiler.

These equipments can save boilers from extreme Pressure steam back flow, shell Collapse due to vacuum, unregulated steam Pressure, low water level, back flow of feed water to the pump etc.

Boiler mounting are follows-

a) water gauge.

* It indicates the level of water inside the boiler.

According to boiler regulation two level water gauges should be fitted in each boiler.

b) Pressure gauge.

It indicates the Pressure of steam inside the boiler

Periodically, the pressure gauge should be tested with a standard gauge and calibrated if necessary

c) Safety valve.

* It is used to open and let some steam out when the Pressure exceeds the safe designed valve.

* In each boiler, there should be a minimum of two safety valves must present, as per the boiler regulations

d) Main steam valve.

This is used to regulate or stop the flow of steam going out of the boiler to the turbine, engine or process work.

e) Blow off valve.

* It is used to remove the salt deposits and other impurities Present in the bottom portion of the boiler.

* This valve is fitted at lower level of water.

Fusible plug.

It Prevents over heating of the fire bar and other parts of boiler in case the water level becomes too low due to the failure of the automatic control.

* The plug will melt and create an opening through which water and steam will be allowed to put out the fire in the grate.

Boiler accessories.

Boiler accessories are the devices used in boiler to increase the efficiency of boiler.

The following are the examples of boiler accessories.

a) feed water pump.
b) Injector Pressure reducing valve.
c) Economiser
d) Air Pre heater
e) Steam drier.

Steam turbines.

* A Steam turbine is a Prime mover in which rotary motion is obtained by the gradual change of momentum of the Steam.

* Steam turbine are primarily used to run alternators, or generator in thermal power plants.

* It is also used to rotate the Propeller of Ships through reduction gearing.

Components of Steam turbines

a) Nozzle: It can be used to drop Pressure of Steam and the pressure drop can be converted to velocity or kinetic energy.

b) Rotor: It consists of a Circular disc fixed to a horizontal Shaft.

* The rotor is mounted on Suitable bearing

c) Blades: on the periphery of the rotor, a large number of blades are fixed.

* The steam jet from the nozzle impinges on the surface of the blades due to which the rotor rotates.

d) casting

* It is a steam tight steel container, which encloses the rotor, blades etc.
* The casting helps the flow of steam and also protects the inner parts from any accident.

Types of Steam Turbine.

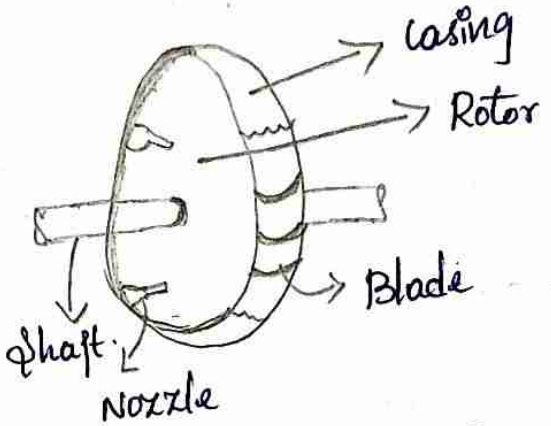
1. Impulse turbine
2. Reaction turbine.

* In impulse turbine, the force is exerted on object when a jet of fluids strikes the object when a fluid leaves the object with a higher relative velocity.

Eg :- Swimming, Jet plane

Working of Steam turbine

* In steam turbine, first the pressure energy is converted into velocity energy or kinetic energy by the expansion of steam through a set of nozzle.



* Normally in steam turbines a convergent - divergent nozzles.
* The kinetic energy is converted into mechanical energy with the help of moving blades fixed on a rotor.
* The rotor is connected to the output shaft.
* All the above mentioned parts are enclosed in a casing.

Impulse Turbine	Reaction Turbine
* Power is obtained only due to the impulsive force of the incoming steam.	* Power is obtained due to the reactive force of the outgoing steam
* Pressure drop is only in the nozzle or in fixed blades which acts as nozzles.	* Pressure drop occurs both in fixed and moving blades
* The relatives velocity of steam at inlet and outlet and outlet of moving blades are equal	* The relative velocity of steam at outlet is higher to get the reactive force.
* Blades are symmetrical.	* Blades are not symmetrical
* Inlet area of moving blades is equal to the outlet area.	* Outlet area of the moving blades are smaller than the inlet area.

Alternate Sources of energy.

The need for alternate sources of energy has two reasons.

1. Non availability of the fossil fuels.
2. Environmental awareness.

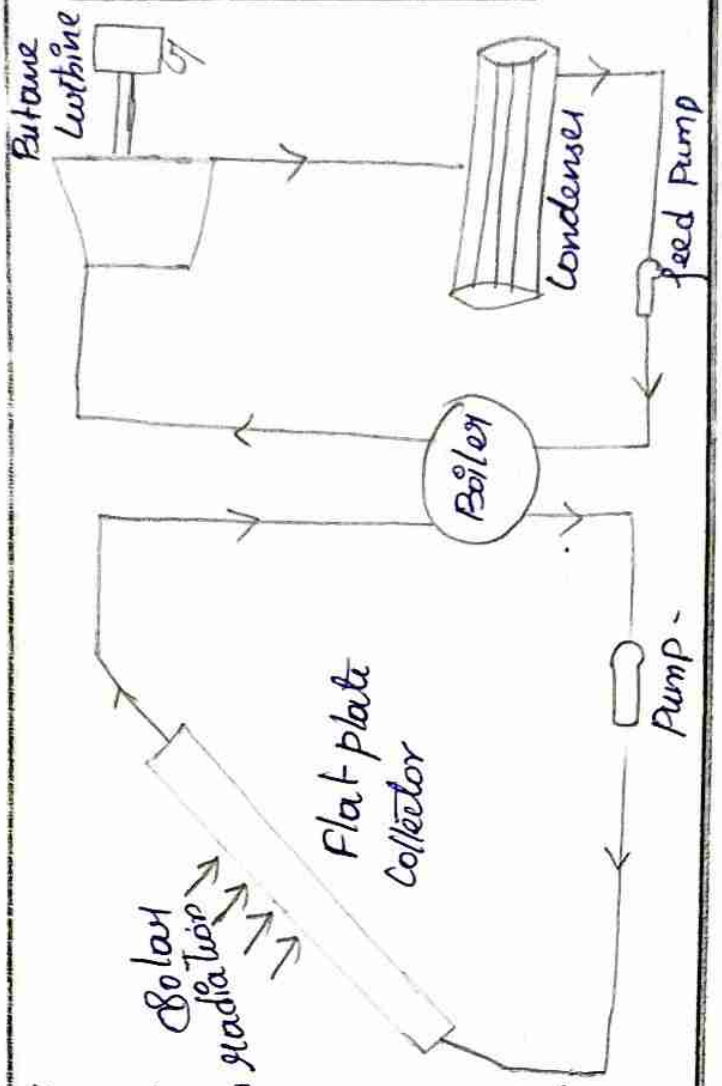
The following are the different alternate sources of energy.

a) Solar energy
b) Wind energy
c) Tidal ~~Energy~~ Power
d) Geo thermal power.
e) Ocean thermal energy conversion
f) Magneto Hydro dynamic power

Solar energy

* In spite of the enormous distance between the sun and earth, the radiation output by the sun is very powerful.

A small percentage of sunlight incident on the earth is effectively utilised to produce energy.



* water in the flat plate collector is heated at 70°C - 80°C due to Solar radiation
* The hot water heats the butane liquid in the butane boilers.
* As butane vaporizes at 50°C, water at 70°C to 80°C is able to vaporize butane.
* Hot water after transferring the heat to butane is pumped by a circulating pump to the flat-plate collector when it is again heated.
* Butane vapour from the boiler is taken to the butane turbine which is connected to an electric generator
* Exhaust vapour from the turbine is condensed in a condenser and liquid butane is pumped by a feed pump to butane boiler.
* The cycle is repeated.

Advantages.
* Heat energy from the Sun is freely available.
* No pollution Problem.
* No transportation of fuel Problem.
* No Storage of fuel Problem.
* Easy to construct and erect.

Disadvantages:
* Solar energy is not available during night.
* Power produced is rather Small.

nd energy

A total of 10^{11} giga watts of wind power is available around the earth surface

The potential of wind energy in india is 20000 Mw

Theoritical wind power is calculated by.

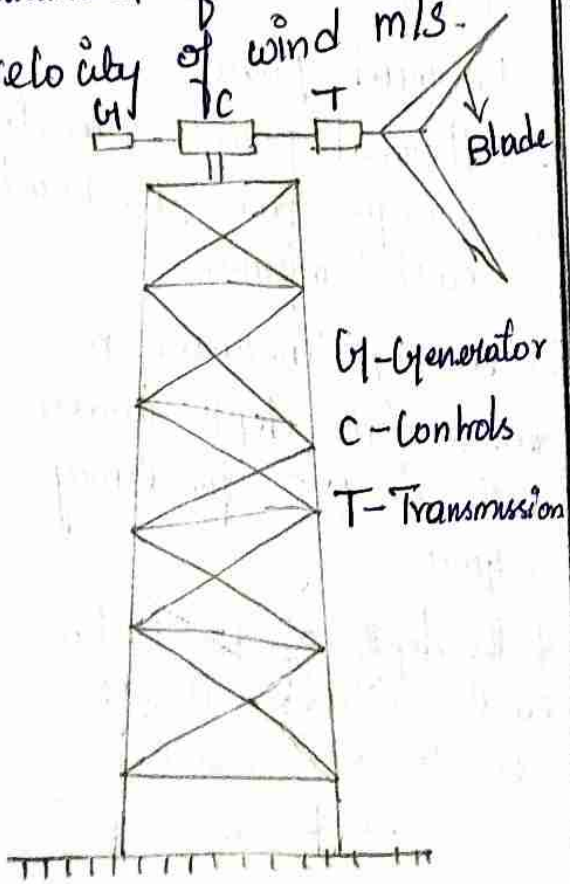
$$P = \frac{\pi}{8} \rho d^2 v^3.$$

P = Power available is watts

ρ = Density of air kg/m³.

d = Diameter of blades in 'm'

V = velocity of wind m/s.



* A wind mill consists of a tower mounted two blades or multi bladed rotor facing the wind rotating around o horizontal axis and turning on electrical generator

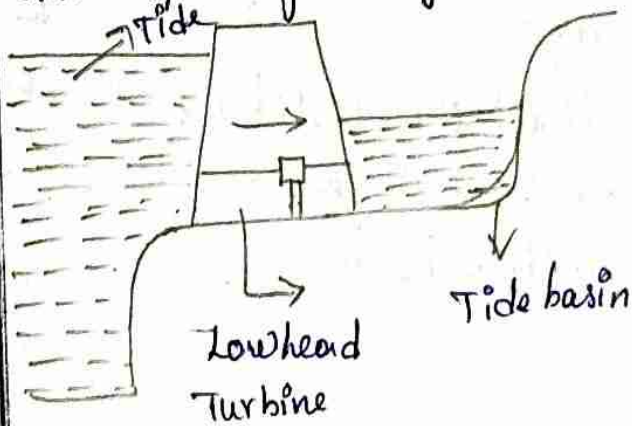
The power in wind increases with the cube of the wind speed.

for the capacity of 100kw, the diameter is in the range of 20m and for 250kw, the diameter is about 32m.

The total cost of a windmill set up having a capacity of 250kw. is in the range of 1 Crore.

Tidal energy.

* The risk and fall of tides, when tide flow from sea to river mouth can be made use of to drive specially designed water turbines



* These turbines can operate even at very low heads as 0.5m.

A tidal power plant consists of

a) A barrage with sluice and gates
b) One or more basins
c) A power house.

A barrage is a barrier constructed across the tidal reach to create a basin for storing water.

A barrage has to withstand the pressure exerted by the water head and should also resist the shock of the waves.

A basin is the area where water is retained by the barrage.

A tidal power scheme can have a single basin or multiple basins.

Advantages:

* It is an inexhaustible source of energy.
* There is no problem of pollution.
* cost of power generation is low

Disadvantages.

* capital cost is high.
* variable output is obtained because head is not constant
* The operation of the turbines will have to be stopped when the available head is less than 0.5m.

Geo thermal power.

* Geo thermal power plants derive energy from the head of the earths interior.

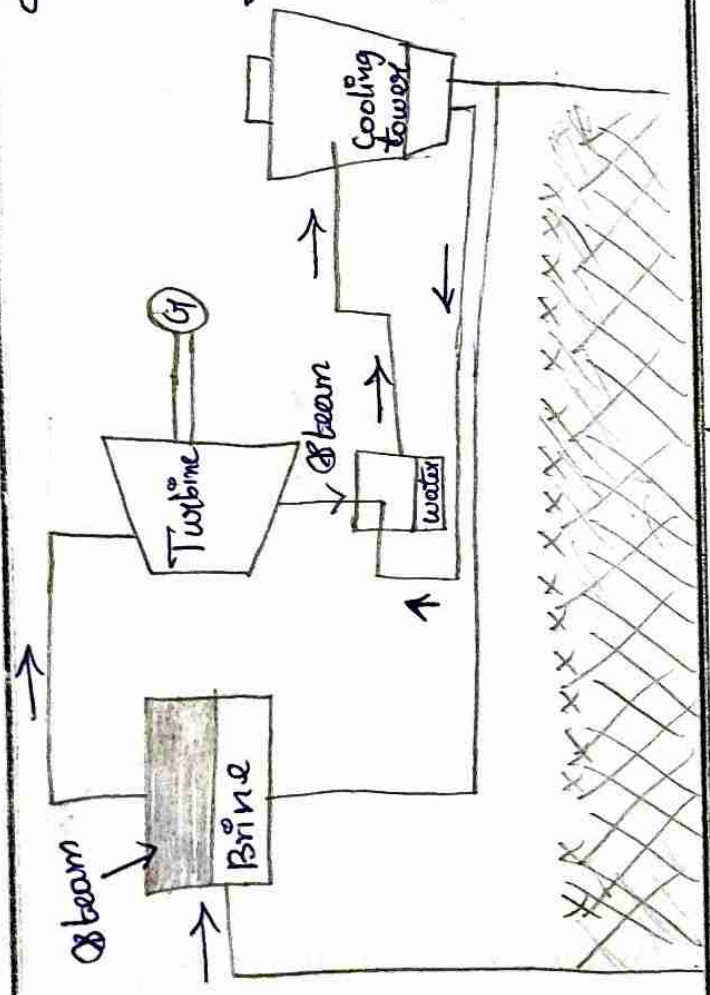
The average increases in temperature with depth under the earth is 1°C for every 30m - 40m.

At the depth of 10-15 km the earth interior is as hot as 1000 - 1200°C

In certain areas of our planet, the underground heat has raised the temperature of water to over 200°C which burst out as hot steam through the cracks in the earth's crust.

*These are called as thermal springs.

*This steam can be used to generation of electricity.



*The steam is transmitted by pipe line to the power station.

*Due to low steam pressure the station efficiency is only 10% - 15%

Ocean thermal energy conversion (OTEC)

*Heat obtained in the ocean could be converted into electricity by utilizing the temperature difference of 20-25k between the warm water on the sea surface and cold water at depth of about 100m.

*The high temperature of surface water could be used to heat some low boiling organic fluid, the vapour of which could run a heat engine.

*The exit vapour could be condensed by pumping cold water from the deeper regions.

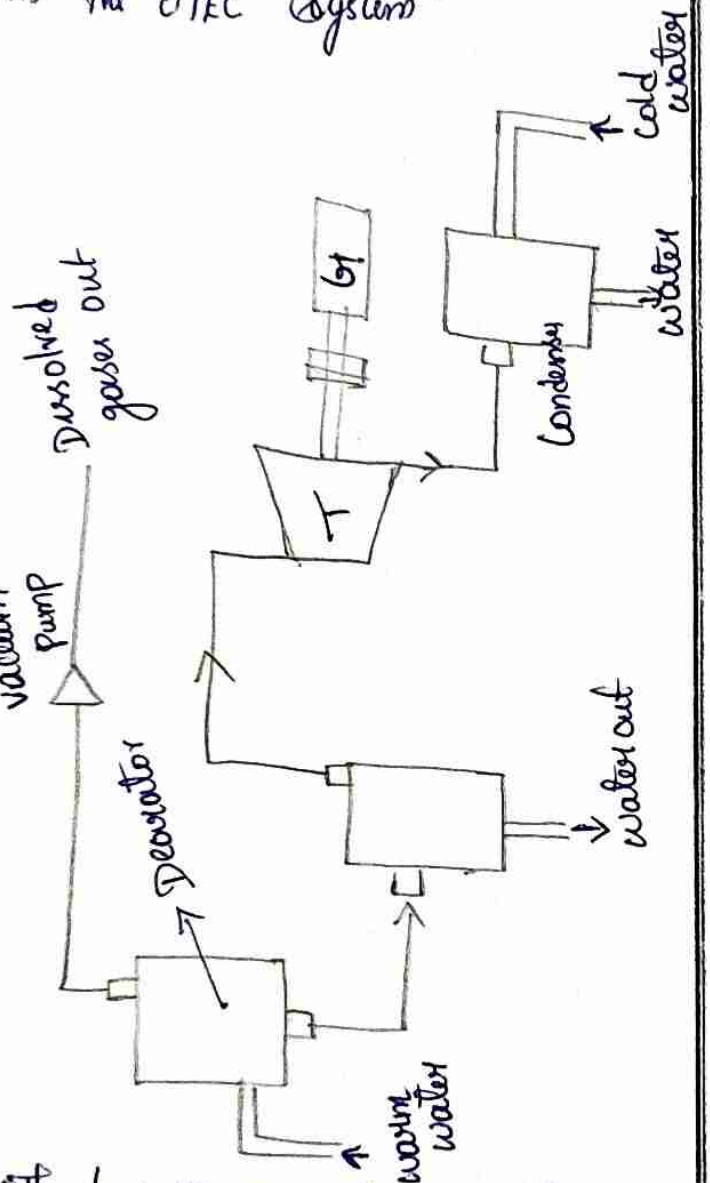
OTEC can be classified into
a) Open cycle OTEC.
b) closed cycle OTEC.

Open cycle OTEC:

*The open cycle OTEC uses sea water as the working fluid.

*. The warm water is first sent to the deaerator where the dissolved gases are removed by means of a vacuum pump.

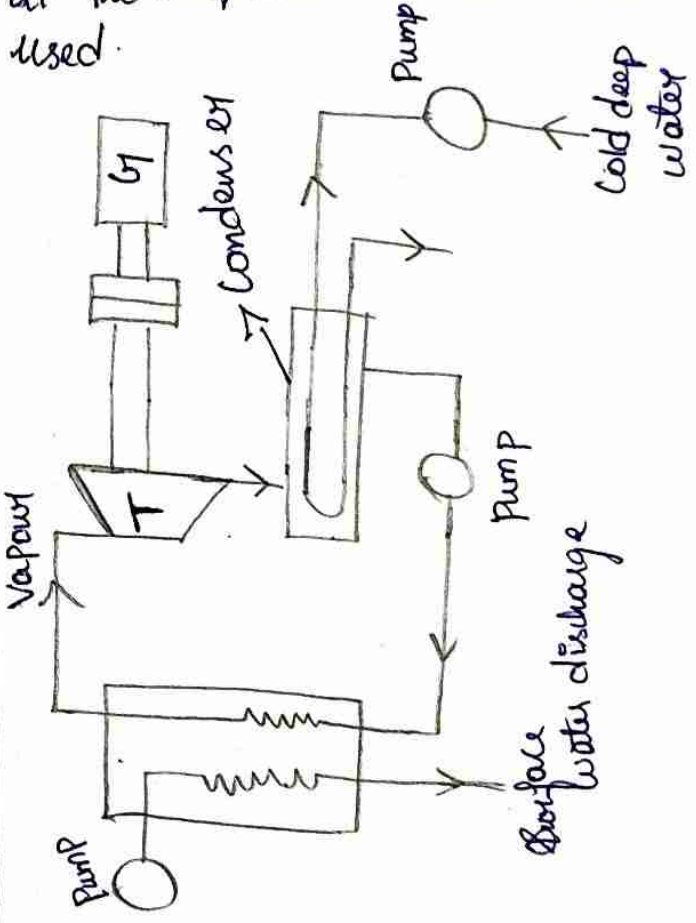
* Then the warm water is flash evaporated under a partial vacuum in the flash evaporator
* This process produces as a low pressure water vapour/steam which will be the working fluid in the OTEC System.



* The low pressure steam is then passed through a turbine which extracts energy from it and run a generator.
* The vapour after expansion in turbine, is then cooled in spray condenser is used where the condensate is mixed with the cooling water and the mixture is discharged into the ocean.

Closed cycle OTEC System

* In this System, the working fluid is Ammonia. Propane or freon with higher vapour pressures at the temperature available were used.



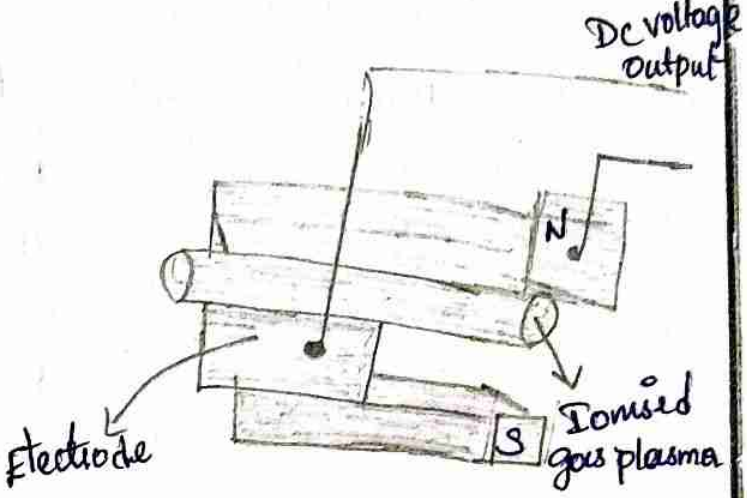
* The Propane is used as working fluid, with a 20°C temperature difference between the warm surface and cold water.

cold water was taken from depth of about 600m

* In boilers and condenses extensive areas are needed to transfer significant amount of heat due to low temperature differences.
* The warm water from the surface of the sea is pumped into heat to the propane and it discharged out.
* The propane get vapourized and is expanded in the turbine coupled to a generator producing the electrical power.
* The vapour after expansion is condensed into the surface condenser by mean of cool deep sea water.
* The condensed propane is again sent to the boiler by mean of pump.

Magneto Hydro Dynamic (MHD) Power generation.

* A MHD generator is a Magneto hydro dynamic device that transforms thermal energy and kinetic Energy into Electricity.
* MHD generator are different from traditional electric generator in that they operate at high temperature without moving parts.



MHD generator system is a non-conventional source of energy which is based upon faraday's law of electro magnetic induction.

It consist of wedge shaped pipe or tube of same non-conductive material.

MHD generator. like a conventional generator. relies on moving a conductor through a magnetic field to generate electricity.

* The MHD generator uses hot conductive plasma (Gas in the range of 2000 to 3000°C) as the moving conductor.
* When an electrically conductive fluid flows through the tube in the presence of significant perpendicular magnetic field a charge is induced in the field, which can be drawn off as Electrical power by placing the electrodes on the sides at 90° angles to the magnetic field.
* The amount of power that can be extracted, is proportional to the cross sectional area of the tube and the speed of the conductive flow

Power plants.

* Power plant are used for the generation of electric power
* To improve the standards of living, rapid industrialisation is necessary for which adequate electrical power is necessary.

Classification of power plants.

1. Steam power plant
2. Nuclear power plant
3. Gas turbine power plant
4. Diesel electric power plant
5. Hydro electric power plant.

Steam Power plant.

* In Steam Power plant the source of power generation is Steam.
* The Steam from the boiler is taken to the turbine through the Steam pipe fitted with an expansion joint.
* From the turbine, the Steam enters a condenses at which, the exhaust Steam from the turbine is condensed due to which a high vaccum is produced.
* The condenser water can be recirculated in the System.
* The turbine is fitted with a generator.

...en a steam expands turbine, the blades can ...e rotated.

* As a result, the generator ...coupled to turbine, shaft can rotate, so the electricity produced.

* The produced electricity can be stored in the batteries

* The steam from the turbine can be condensed into water in the condenser.

* The condesed water can be sent to boiler with the help of feed pump. The cycle is repeated.

* In condenser, cooling water is circulated by a pump through the water tubes to condense the exhaust steam.

The cooling water at the outlet becomes hot and it is taken to a cooling pond. or a cooling tower to a cool and to recirculate the same water.

Different circuits of steam power plants.

1. Coal and ash circuit
It consist of a coal supply dump, coal conveyer, Pulverizer electro static, precipitar, Boiler ash handling Chimney.

2. Air and Gas circuit
It consist of air preheater, economiser etc.

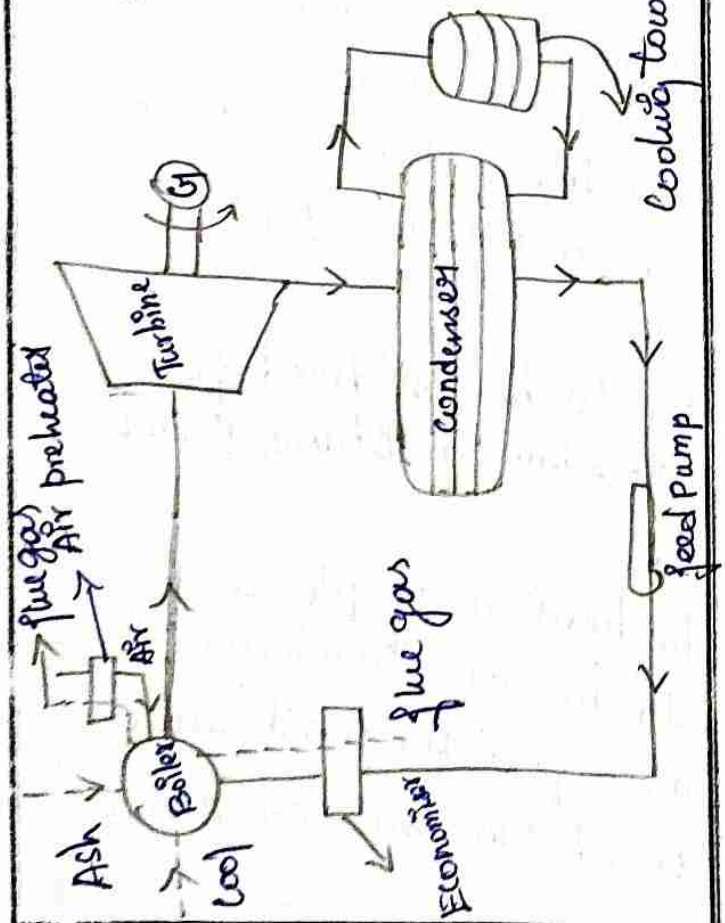
3. Feed water and steam flow circuit: It consist of feed water treatment plant, feed pump, turbine, condenser etc

4. Cooling water circuit.
It consists of condenser cooling tower, hot well, pump, makeup water supply from river.

Factor to be considered for site selection of steam power plant.

* The location of plants should be at a minimum distance from the load centre to avoid transmission losses.

* Availability of water is desirable factor.
* The water should be preferably free from salt to reduce the cost of water treatment
* The soil should be satisfactory for a strong foundation.
* The site should be away from thick populated area to avoid the effect of pollution
* Adequate transport facility is desirable.
* Space should be available to store coal and ash.

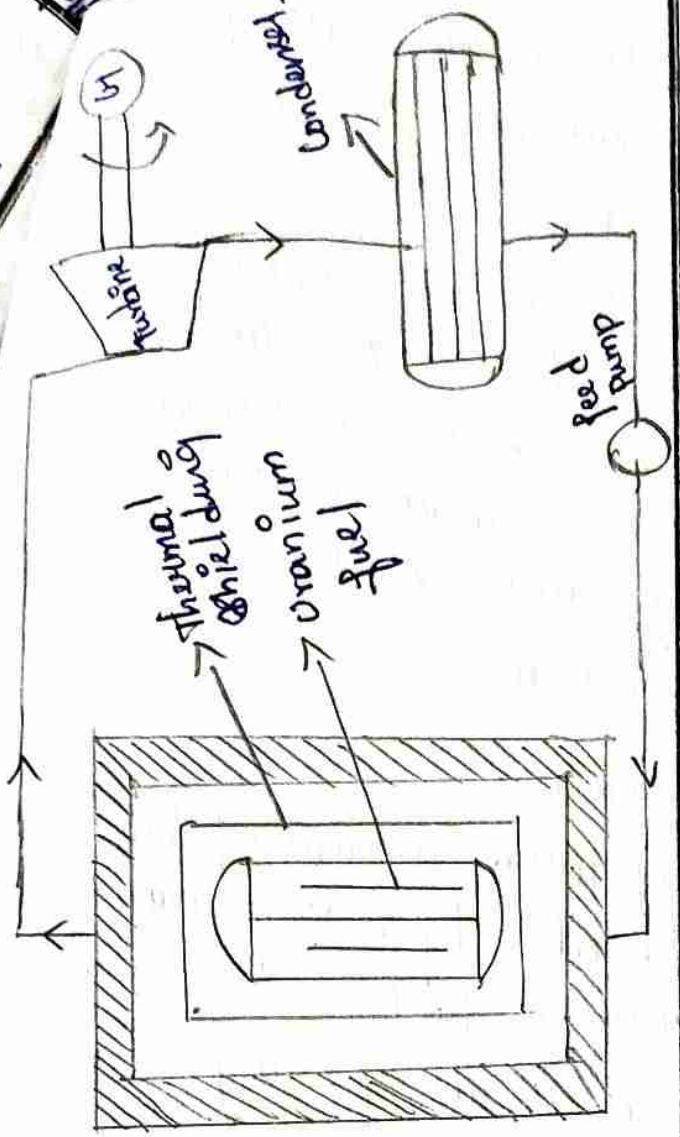


Nuclear Power plant.

* The boiler of steam power plant is replaced by a nuclear reactor.
* The nuclear reactor is the boiler in nuclear power plant.
* It has been estimated that complete fission of 1kg of Uranium U^{235} produces heat energy equivalent to 4500 tons of coal or 1700 tons of oils
* The source of heat in nuclear power plant is the mechanism of nuclear fusion process.

Nuclear fission is the process in which a large amount of heat energy is delivered by fissioning of the nucleous of a fissionable material like Uranium U^{235}.

* when a neutron bombards the nucleus of U^{235} the atom splits into krypton and barium and releases 2 or 3 fast moving neutrons and also produces a large amount of heat energy.



Working Principle.

* Due to nuclear fission of the fuel Uranium, large amount of heat is produced.
* The nuclear reaction and temperature is controlled by moderators.
* The coolant can be used to absorb the heat produced in the reactor
* The coolant used in Water.
* The water evaporates and steam is generated in the reactor itself.
* The steam produced in the reactor is used to run the turbine which is coupled with a generator from which we can get electrical power.
* The steam after expansion in the turbine is condensed in the condenser.
* The condensate from the condenser is sent into reaction again by feed water pump.
* In the reactor, the thermal ~~Energy~~ Shielding reduces the heat loss and the thick concrete Shielding prevents external radiation.

Safety Precautions for nuclear power plant.

* The first level of Safety in nuclear reaction is the careful design of the reaction and other components of the System with a high degree of reliability.

* Controlling devices is to be provided Eg. Control rods, moderator and coolant.
* When the primary protection system fails, each reactor is provided with some type of back-up protection.
* If the temperature rises above the safe value, sufficient volume of gas enters the reactor core and reactivity decreases due to which the temperature automatically comes down.
* It can be done by the device gas fuse.

Nuclear waste disposal.

* Nuclear waste produced in different stages of nuclear fuel cycle must be disposed off without any hazard to human and plant life.
* Gaseous wastes are discharged to the atmosphere through high stacks.
* Liquid wastes after preliminary treatment are discharged into deep pits.
* Active liquid are kept in concrete tanks. These tanks are buried in the ground till their radioactivity decays upto a safe level for disposal.

Advantages -

* very large amount of heat is liberated by a very small quantity of fuel.
* It is suitable for large power generation
* Cost of fuel transportation and storage is less

Disadvantages.

* Installation cost is very high. availability of nuclear fuel is scare and cost is high.
* Large number of trained and qualified personnel are required to operate the plant
* Maintenance cost is high.

mic Power Stations in India

: Tarapur atomic power station in Maharastra.
Capacity: 540 MW.

* Madras atomic power station at kalpakkam.
Capacity: 500mw.
* Koodankulam nuclear power plant, Tamilnadu.
Capacity: 9200 MW.

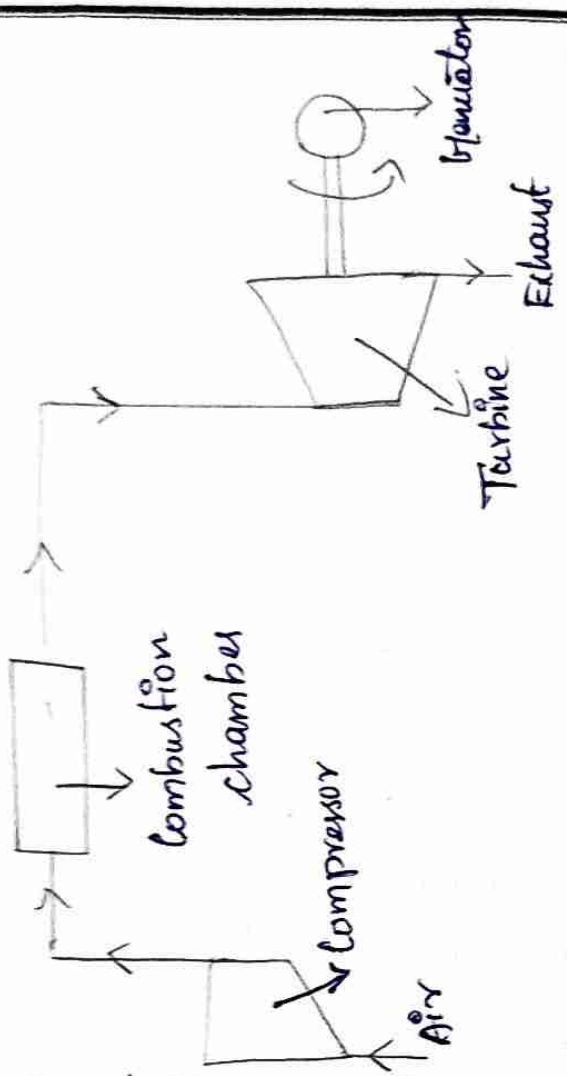
Gas Turbine power plant.

Gas turbines are mainly used for power generation and also in jet engines of air craft and in turbo charges of Internal combustion engines.

Gas turbines power plant are mainly classified into
a) Open cycle
b) Closed cycle.

Open cycle Gas turbine power plant.

* It consist of a compressor a combustion chamber, and a turbine
* Compressor can be used to compress atmospheric air.
* The compressed air is sent into combustion chamber where some amount of fuel is added
* The combustion of fuel can take place inside the combustion chamber.
* The burnt gases can be sent into turbine where the hot gases can expand.
* The turbine is connected to a generator.
* The expanded gases can be sent into atmosphere from the turbine.



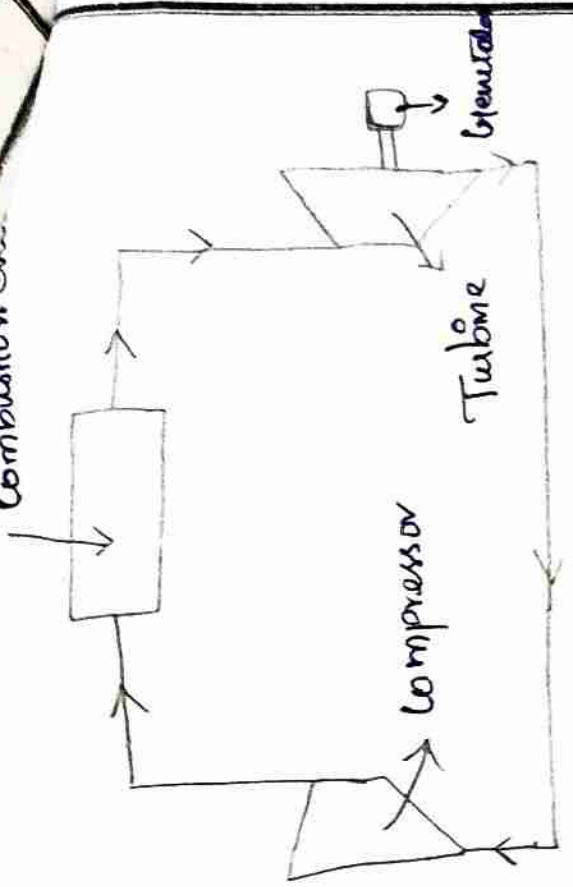
* The gas turbine can works on Brayton joule cycle.

Advantages.

* possibility of using any type of fuel.
* Compact size, less weight low space requirement.
* Simple foundation and low installation cost.
* less requirement of lubrication oil, water etc.
* less vibration.

Disadvantages.

* There is high operating temperature in the combustion chamber, and in the turbine So we need special high temperature alloys
* Thermal efficiency is very low.
* High pitch noise due to very high speed.
* Gas turbines are not suitable for high capacity, Closed cycle gas turbine.
* the operation of closed cycle Gas turbine power plant is similar to open cycle gas turbine power plant, but the expanded gas from the turbine can again sent to the compression.

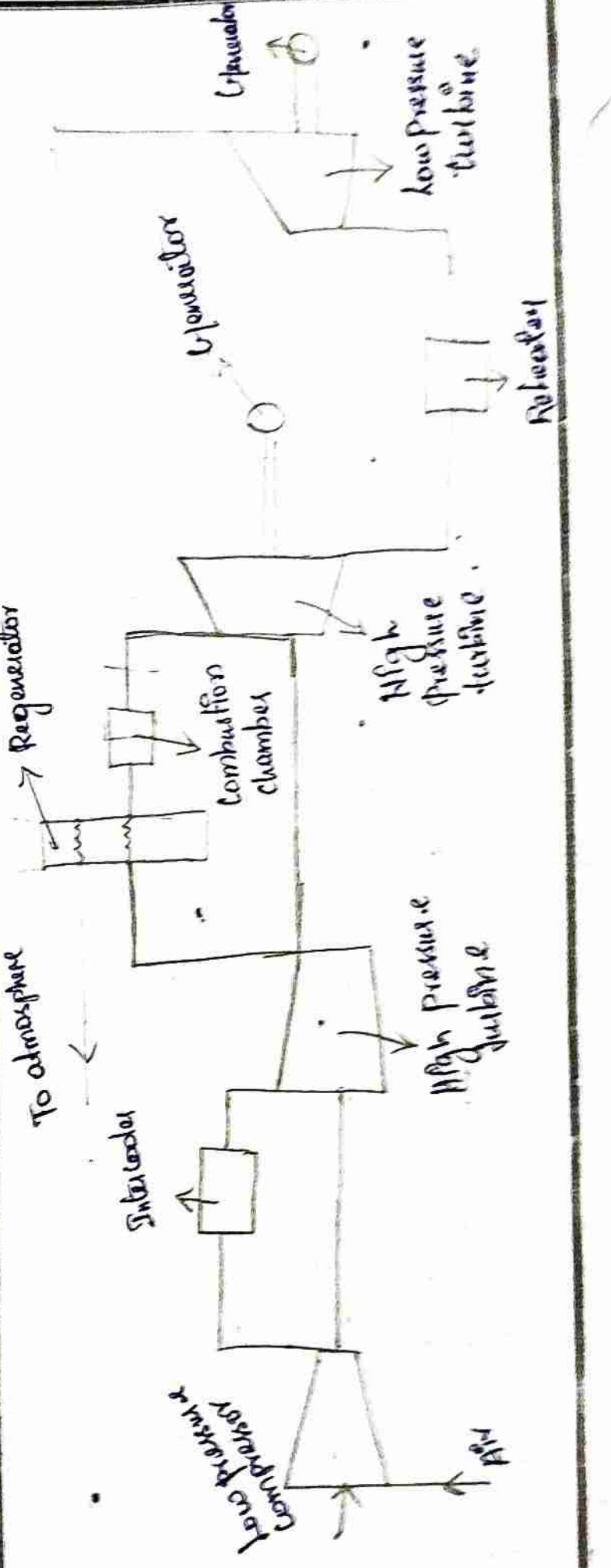


Methods to improve efficiency of gas turbines power plant.

1. Inter cooler
2. Regeneration
3. Reheating.

Inter cooler.

It is a device which can be used to cool the air coming from the low pressure compressor



* Inter coolers can reduce the work of compressor

Reheater.

* The gases which are expanded in high pressure turbine are entered into the reheater where some quantity of fuel is added and burnt these gases can be allowed to expand in low pressure turbine.

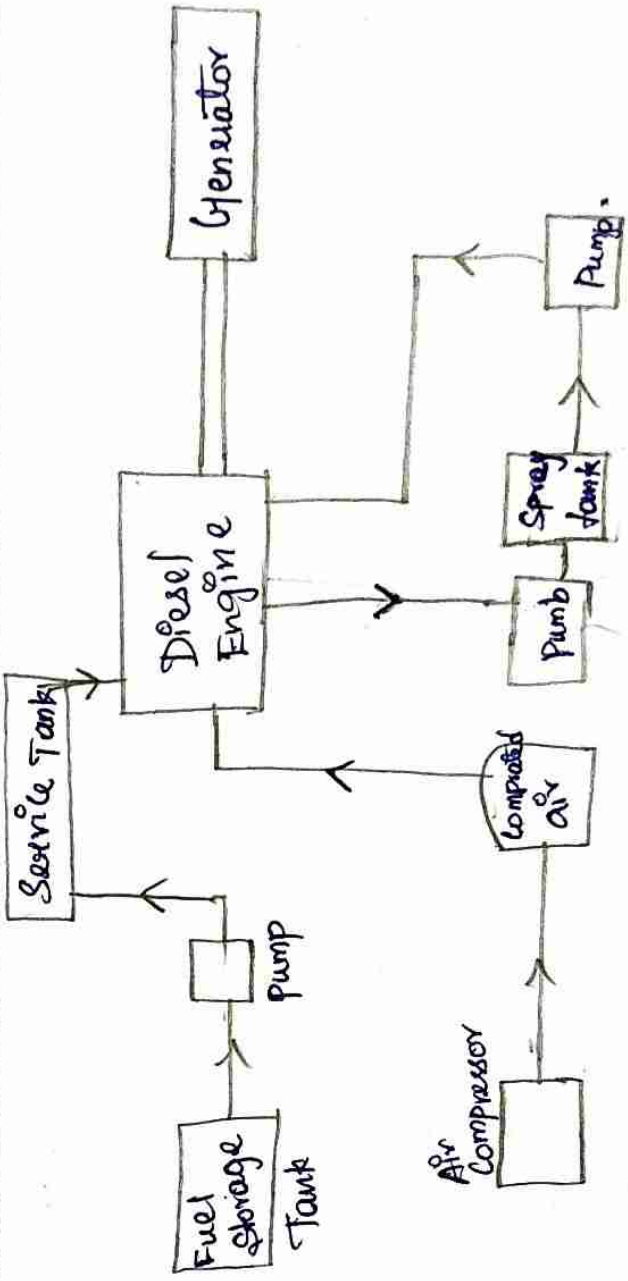
Regeneration

* The gases coming out from low pressure turbine are traped in regeneration device where the heat from gases can be exchanged to the compressed air coming from high pressure compressor.

Diesel electric power plant:-

* In diesel electric power plant, a multi cyclinder, 2-state turbo charged diesel engine are used.

The components used in diesel electric power plant are shown in diagram.



* In a turbo charged engine the atmospheric air is compressed by a compressor run by an exhaust driven gas turbine and the compressed air is taken inside the cyclinder.

ue to this, mass of air take and amount of fuel want will be considerable increased.

* Hence increased output power and thermal efficiency can be achieved.

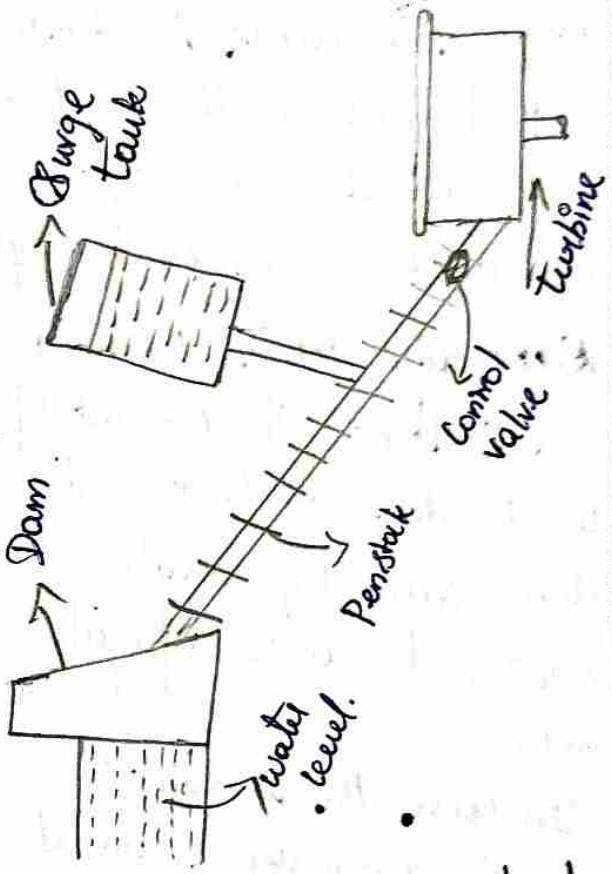
Advantages:

* Plant layout is simple
* Easy to install
* Quick Starting
* Easy pickup
* It can be located near the load centre.
* The load operation is easy and requires less technical staff.
* Efficiency at part load does not fall low.
* fuel handling is easier.

Disadvantages:

* The maximum capacity of the plant is limited to 50mw of power.
* Diesel fuel is much more expensive than coal.
* Cost of maintenance and lubrication is high.
* Overload running may not be possible.

Hydro Electric Power plant.



* In hydro electric power plant the potential energy plant, the potential energy of water stored in a dam is made use of running a water turbine.

* The turbine is coupled to generator
* The water from the dam is brought to the water turbine by a large diameter pen stock pipe.
* The pen stock pipe is made of steel or reinforced concrete.
* It is desirable to eliminate sharp bends in the penstock pipe to avoid the loss of head and special anchoring.
* Depending upon the load on the turbine the amount of water needed is controlled automatically by a valve operated by a centrifugal governor.
* In case the amount of water is suddenly reduced or stoped by the governor mechanism, water coming down with a high velocity will produce turbulence resulting in a water hammer in the pipe.
* The pen stock may damage due to water hammer.
* To prevent this, a surge tank is provided.
* Surge tank, is a large closed tank, which will get filled with water in the event pressure rise in the pen stock and the air inside the surge tank shall get compressed.
* This will safe gaurd the turbine control value and penstock itself
* When the pressure becomes normal the accumulated water will flow back to the penstock and the turbine to produce power.

Advantages of Hydro electric power plant	Disadvantages
* No fuel cost * Operating cost is very low * Efficiency is high * There are auxillary benefits like Irrigation * No - atmospheric pollution.	* Initial cost is high. * As the load centre is normally away from the dam, the transmission lines are quite long.

Thermal (or) Steam power plant	Hydro electric power plant.
* Not affected by seasons. * Can be installed at any place * Operating cost is high * Transmission of power is comparatively easier. * capital cost is comparatively less * fuel may be exhausted due to cause of time * Atmospheric pollution	* affected by seasons * Only near a dam * Negligible cost as there is no fuel * cost including dam is much higher * water will not be exhausted * free from pollution

Types of Water turbines.

Depending upon the height of water available, different types of water turbines are used can be classified as.

Pelton wheel
Francis turbine
Kaplan turbine

Pelton wheel is an Impulse turbine

pelton wheel can be used at the head (height) of more than 900m

Francis turbine is a reaction turbine where the head ranging from 50-400m.

Kaplan turbine is an axial flow turbine.

It head is ranged between 1m-5m.

Environmental Constraints for Power generation

* Raw energy is processed and transformed into usable energy forms by means of energy-Conversion Process.
* The energy Conversion Process Create Pollution Problems which disturb the ecological balance.

Some of the important environmental constraints of Power generation are follows.

a) Particular matter.

* Solid or liquid particles present in the air are called Particular matter.
* This sizes varies from 100nm to 2.5 μm.
* Dust and fly ash emitted from the power plants are the significant sources of particular matter.

Acid rain, Acid Snow.

Increased Concentrations of Sulphur oxides (SO_x) and nitrogen oxides (NO_x) in the atmosphere cause these global environmental effects.

c) Green house effect.

* A green house has transparent glass panes, which allow Sunlight to enter and prevent exit of heat CO_2 and moisture.

* The climate inside the green house is warm due to high Concentration of CO_2 and moisture.

* A similar effect is created by higher concentration of CO_2 in the atmosphere and is called the green house effect.

d) Global Warming.

* The warming up of earth due to the green house effect is called global warming

* In this process CO_2 in the air allows the entry of radiation heat of Sunlight, which contains short waves and visible portion of the Spectrum.

* This heat is then absorbed by the earth and atmosphere.

Refrigeration:

* The Science of providing and maintaining the temperature below that of the Surrounding atmosphere.
* For this, heat has to be removed from the Source at a lower temperature and rejected to the atmosphere at a higher temperature
* Heat can Spontaneously flow from higher temperature to a lower temperature for heat to flow in a reverse direction, the Second law of Thermodynamics Stipulates that external work / energy Should be Supplied.

Unit of Refrigeration.

"Ton of Refrigeration" (TR) which is defined as "the quantity of heat to be removed to produce one ton of ice at 0°C within 24 hours when the initial condition of water is also at 0°C"

* 1TR is equivalent to 210 kJ/min (or) 3.5 kW.
* Higher the Cop, Performance is better.

Performance of a Refrigerator.

When a Refrigerator is removing 'Q' amount of heat (it is also called cooling load) Consuming 'W' amount of work, then the performance of the refrigerator is determined by the ratio Q/W, which is called Coefficient of performance (Cop)

$$\boxed{Cop = Q/W}$$ when Q & W are in Same units.

* Cop is always more than 1.

Applications:

* In Water cooler
* To manufacture ice
* For preservation of food Vegetable, milk icecream etc... in houses, Hotels, Ships etc.
* For Preservation of Perishables like. fish meat etc...
* Preservation of medicines blood tissues etc, in Hospital.

* Preservation of dead bodies in mortuaries in hospitals
* Industrial application
* For air conditioning in houses offices, theatres, hospitals Computer centre etc.

Refrigerant.

A Refrigerant is the working fluid in a Refrigerator. It is capable of absorbing heat at a lower temp & rejecting heat at a higher temp in the form of Sensible heat or latent heat or both.

Desirable Properties of Refrigerants

* Low boiling point, low freezing point, high latent heat of evaporation.
* Low Specific heat & low viscosity.
* Easy to liquify.
* Odourless and no hazardous effect on leakage.
* chemical Stability.
* Non-flammable
* Low cost.

Types of Refrigerants.

① Freon 12 : CCl_2F_2

Dichlorodifluromethane.

Most commonly used refrigerant

Non & Cofriendly.

② R134a : $-C_2H_2F_4$

Tetrafluroethane.

* Replacement for R12 CFC in the area of centrifugal, Rotary Screw, Scroll & Reciprocating Compressor
* Safe & Non toxic, Non-flammable & non corrosive

③ Freon 22 :- $CHClF_2$.

Monochlorodifluromethane.

* Boiling Point - 41°C
* Mostly used in Air conditioners

④ Ammonia : R717 (NH_3)

* Boiling point - 33.3°C
* Mostly used in absorption System

⑤ Other Refrigerants :

CO_2, SO_2 & methyl chloride (CH_3Cl)

CO_2 mainly used in marine refrigerators.

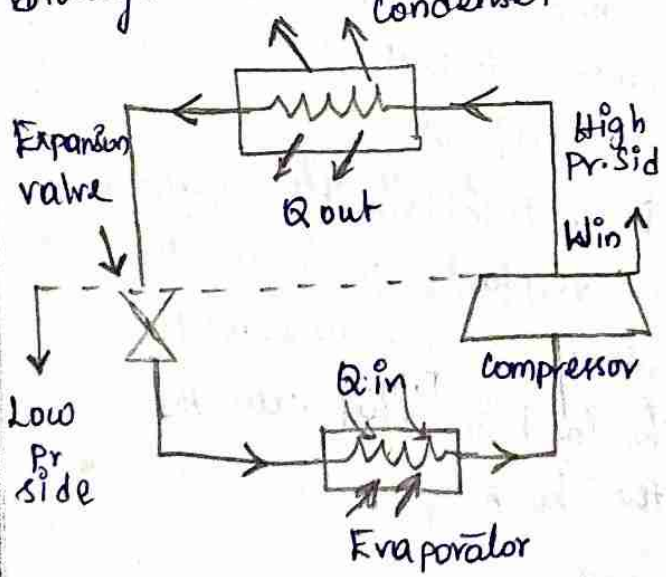
Methods of Refrigeration

* Vapour - Compression refrigeration
* Vapour - Absorption refrigeration

Vapour - Compression Refrigeration System -

* Mainly used in refrigeration application like.

Refrigerator water cooler, air - conditioner and cold storage.



The refrigerant enters the evaporator at a lower pressure & temperature & absorbs its latent heat of vapourisation from substances kept around the evaporator thus cooling them & comes out with its phase changed to dry saturated (or) slightly superheated state

Then enter the compressor & compressed to a higher pr & temp. as superheated vapour for this power is supplied to the motor connected to the compressor which constitutes major running cost of the system

The compressed vapour is led to the condenser. Atmospheric air is blown over the condenser using fan and it carries away latent heat from the refrigerant vapour is condensed into high pr liquid.

The liquid refrigerant enters the expansion device which is a long spirally wound capillary tube is small refrigerators.

The Refrigerant is throttled to low pr & low temp wet vapour thus completing the cycle.

* Refrigerant System shall be provided with an accumulator to store the refrigerant for maintenance and any shut down

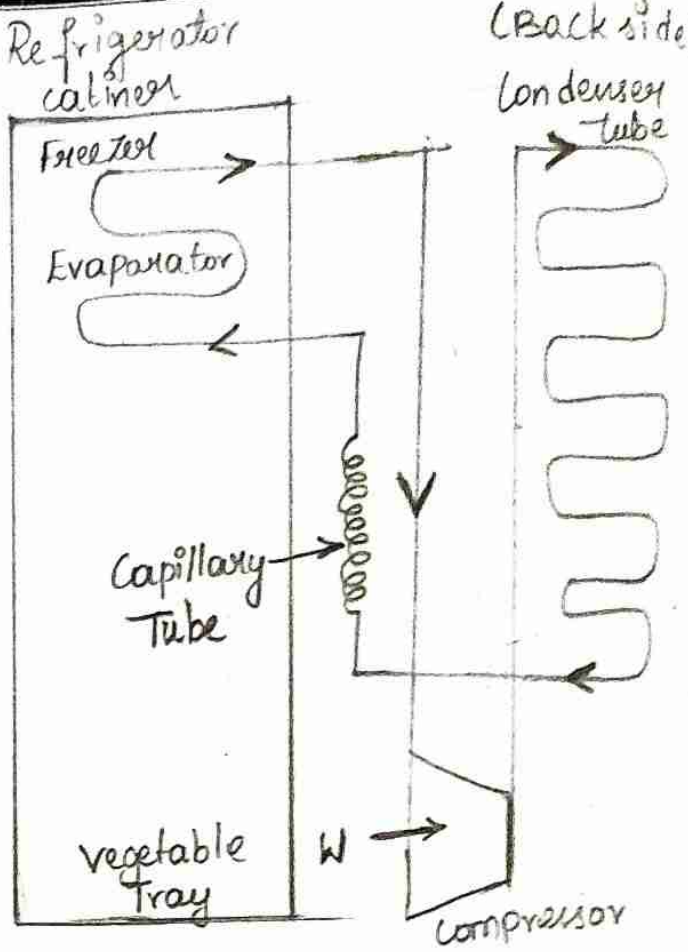
* It is very low temp - 50°C is needed CASCADE System can be used & It comprises of two individual vapour-compression refrigeration System in series shall have two different refrigerants

Domestic - Refrigeration System

* It belongs to vapour compression Refrigeration System

The evaporator which is the coldest part is located at the top in Freezer compartment.

A separate door is provided for freezer where, ice, ice cream & Punishable like meat, fish etc. can be stored.



Domestic Refrigerator Layout

* Just below the freezer a chiller tray is provided.

* Further below & behind the main door, there are several compartment with progressive higher temperatures

* The bottom-most compartment is for vegetables where a very low temp is not necessary

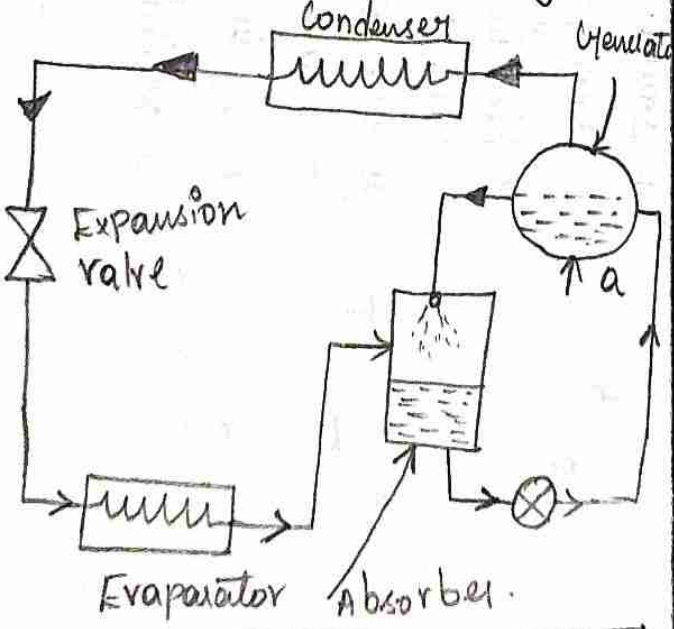
* The condensor tubes are kept on the back of the refrigerator cabinet.

The refrigerant vapour is condensed with the help of surrounding air is circulated by natural convection

* In the NO-frost refrigerator the evaporator is located outside the freezer compartment the cold air is made to flow into the freezer compartment by a fan.

Vapour - Absorption Refrigeration System -

* Similar to vapour - compression system except the compressor & compressor effect is produced by an absorber, a pump & a generator



Vapour - Absorption Refrigerator

* The refrigerant used is Ammonia (NH_3) and the absorber is water

* NH_3 vapour coming out from the evaporator at low Pr. is absorbed by water available in the absorber tank resulting is strong Ammonia (NH_3) solution

* The pump, pumps the solution & increases pr and send it into the generator. Inside the generator the solution is heated by external heat supply.

* Now the high pr. Ammonia gas is generated which enters the condenser.

* The weak ammonia solution available in the generator contains more amount of water. It goes back to the absorber tank. Where it absorbs incoming NH_3 vapour and become strong solution.

* The process takes place in condenser, expansion device and evaporator are similiar to vapour compression system

The absorber used in the vapour-absorption refrigeration system should have high affinity for the refrigerant remain in the liquid phase under the operating conditions & should posses high boiling points, low specific heat & good chemical stability

Comparison.

Vapour absorption	Vapour compression.
1. very large in size for the same capacity	1. Small in size
2. Ammonia	2. Refrigerant is Freon-12
3. Heat input can be supplied by a heater (or) exhaust steam (or) even by solar energy.	3. Electric power is needed to run the compressor.
4. Lower.	4. COP is higher
5. Less	5. Wear and tear more.
6. silent in operation	6. System produces noise.
	7. Maintenance cost is high.

Solar Refrigerator / air-conditioning System

* This System belongs to vapour-absorption type
* Instead of heating the Solution in the generator by an eletric heater (or) by supplying the heat by burning any fuel the Solution can be heated in a Solar Collector
* Its Suprising to note that Solar heat can be used to produce cooling effect in the refrigerator or to cool a room by a Solar air-conditioner.
* As the crude-oil is expected to be exhausted Solar refrigeration / air conditioning System will become popular in the future.

AIR - CONDITIONING

* AIR-CONDITIONING involves controlling & maintaining the designed temperature humidity velocity and direction of flow of air in a closed Space. Also, filtering and cleaning of air is carried out by air conditioning System.

Air conditioning does not always mean cooling the air In extremely cold areas, air conditioning mean heating and humidification.

Application of Air-conditioning

(1) Air Conditioning of houses hotels, theatres etc.
(2) Hospitals, operation threates and Intensive care units are air conditioned.
(3) For comfort of passengers in cars, buses, trains, Ships and aeroplanes.
(4) Air Conditioning becomes very essential in Many Industries like textiles, food, printings machines, tools etc.

Terminology:

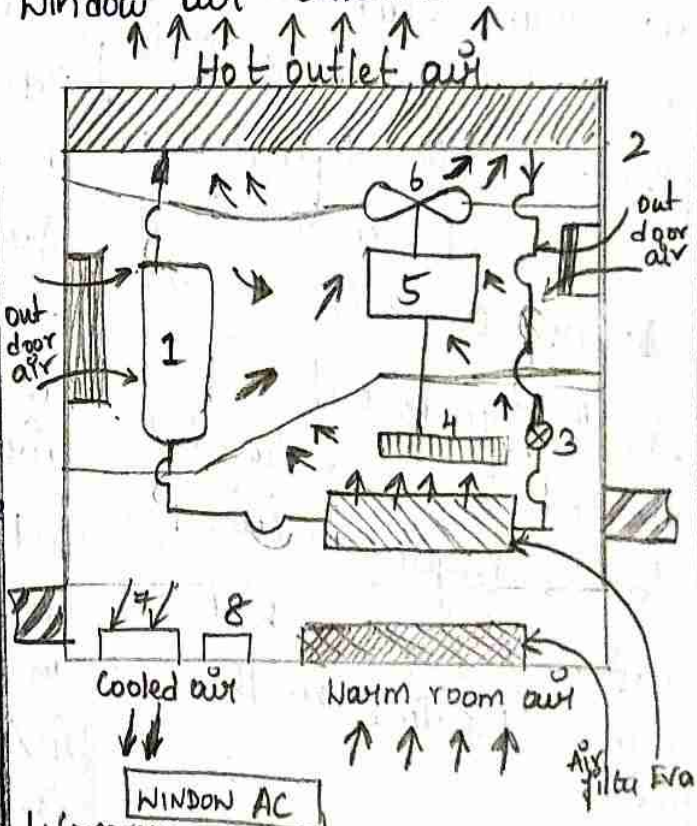
* **Dry air**: Air without water vapour / moisture.
* **Moist air**: Mixture of dry air and water vapour.
* **Dry bulb temperature**: Actual temperature of a gas measured by a standard mercury thermometer.
* **Wet bulb temperature**: The temperature measured by a mercury thermometer, when the bulb is covered by a moistened cloth.
* **Saturated air**: A mixture of dry air along with the maximum possible water vapour at dry-bulb temperature.
* **Relative humidity**: The ratio of mass of water vapour in a given volume of air at the given temperature to the mass of water vapour present in the same volume under the same temperature of air when it is fully saturated.

Requirements of Comfort Air-Conditioning.

Dry-bulb temperature of 20°C and relative humidity of 60% in the room needed for human comfort.

WINDOW AIR-CONDITIONER.

* A simple air-conditioning system without ducts assembled inside a casing suitable for installation on windows (or) wall openings is called a "window air conditioner"



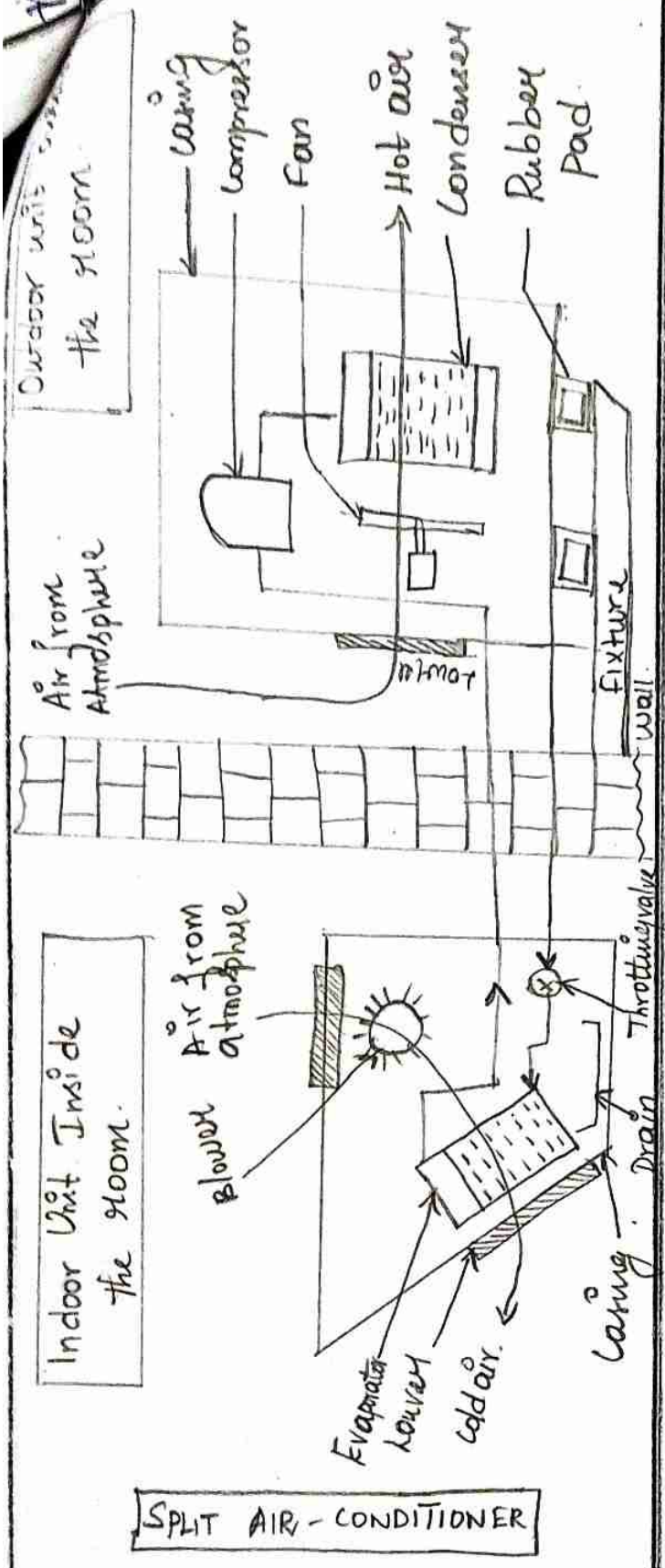
The unit consist of a vapour compression refrigeration system a double shaft motor a blower, a fan, air filter supply air grill, return air grill, fresh air damper drain tray and a control panel.

* The flower sucks the warm air from the room through the air filter and the evaporator or cooling coil of the refrigeration system.
* It delivers the cooled and dehumidified air back into the room through the supply air grill.
* The Moisture condensing out when the inlet air is passed over the evaporator coil is drained out.
* The supply air grill has adjustable louver or deflector for changing the direction of air upward (or) downward (or) horizontally.
* Mechanised louvers are available is some window air conditioner which continuously change the direction of air flow.
* The conditioned air sent into the room mixes with the room air and decreases the temperature and humidity level and thereby maintains human comfort inside the room
* It operate on 230v, single phase ac supply and available cooling capacities from 0.5TR to 3TR.

Split air Conditioner:

* In split air conditioner all the 4 major components, compressor, condensor, throttling device & evaporator are placed into two cabinets, namely Indoor unit & outdoor unit.
* The Main components of indoor unit are the blower, evaporator, throtting valve and drainage system.

* The high pressure liquid refrigerant from the outdoor unit is allowed to flow thro the throttling valve to obtain low Pressure vapour refrigerant.
* The low Pressure wet vapour refrigerant is the allowed to pass through the evaporator
As the flower flows air over the evaporator, low Pressure refrigerant obtained from the throttling valve is evaporated to Produce chillness in the surrounding of the evaporator.
* Air inlet and outlet louvers are placed or suitable location to enable free cold-air flow.
* The main components of the outdoor unit are the fan, Condenser and compressor
* The low pr. vapour refrigerant from the evaporator of the indoor unit is allowed to flow through the compressor to obtain high Pr high temp refrigerant.
The high pr. & high temp vapour is then allowed to pass through the Condenser.
As the fan blows air over the condenser. high pr. vapour condenses to form high Pressure liquid refrigerant.
Air inlet & outlet louvers are placed at suitable location to enable free air flow.



SPLIT AIR-CONDITIONER

* Rubber-Pads are used to mount the outdoor unit as the working of compressor will produce vibration.

Central Air Conditioning.

* various components of the central air conditioning system are not assembled at the factory. Instead they are all assembled at a site in control room from where conditioned air distributed to the required places through duct work.

The duct should be carefully designed, fabricated and erected

This system is used only for heavy load of about 20 tons or more.

This system is adopted for large buildings Star hotels hospitals, cinema, theatres etc.

Comparison of Unitary & Central Air Conditioning System.

Unitary Type	Central
1. The capital cost is high per ton of refrigeration	1. Cost is low.
2. Factory Assembled	2. Assembled at sight.
3. Located in the space to be conditioned	3. Located away from the conditioned space
4. Smaller capacity units	4. Larger capacity units of 20 tons or more
5. No need for duct work	5. Extensive duct work is essential
6. Failure in the system will affect one room only	6. Will affect all the rooms
7. Installation charges are less.	7. Much higher.