LECTURE NOTE
ADVANCE CONSTRUCTION TECHINIQU EEQUIPMENT
6TH SEMETER
Diploma(CivilEngineering)

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Ch.1ADVANCEDCONSTRUCTIONMATERIALS

Fibers:-

Fiber or fibers is a class of material which are having continuous filaments orhaving discrete elongated pieces similar to the length of thread.

Therearemainlythreetypesoffiberswhicharecommonlyusedasaconstruction material.

- Steel fiber
- Carbonfiber
- Glassfiber

Steelfiber:-

- Steel fiber are made from the cold drawn steel wire with low content of carbon or stainless-steel wire.
- They are manufactured in various types such as hooked steel fibers, undulated or flat steel fibers according to the need required in the construction project.
- Thesefibersareusedintheconstructionforconcretereinforcement.
- Steel fiber reinforced concrete is less expensive than hand tied re-bar. Shape, dimensions and length of the fiber are more important because it increases the tensile strength of the concrete.
- Fiber-reinforced normal concrete is mostly used for on-ground floors and pavements and also used for the construction parts such as beams, pillars, foundation etc.

Properties:-

- Itincreasesthetensilestrengthofconcrete.
- Itismoretoughandhard.
- Itavoidscorrosionandruststains.
- Theyaremoreelasticinnature.
- Steelfibersareavailablewith standards asASTM820/96, ASTMC 1116/95 and DIN 1045.
- Ithasatensilestrengthof1100N/mm².

- Theyareavailableintheshapeslikeflat,hookedandundulated.

Applications/uses: -

- Steelfibersarehighlyusedintunnelliningwork.
- It is mostly used in the construction of airport runways and highway pavements.
- Most commonly used in precast concrete so as to increase the tensile strength.
- Theyareusedinshotcrete.
- Usedintheconstructionofparking.
- Itisusedinanti-seismicbuildings.

Carbonfibers:-

- Carbon fiber is a material consisting of extremely thin fibers about 0.005 mm to 0.010 mm in diameter and mostly composed of carbon atoms.
- Carbonfiberisalternatelycalledgraphitefiber.
- The carbon atoms are bonded together in microscopic crystals which are more or less aligned parallel to the long axis of the fiber. The crystal alignmentmakessizeoffiberstronger.Numberofcarbonfibersaretwisted together so as to forma Yarn which can beused as it exists or woven into a fabric.
- It can be combined with a plastic resin and wound or moulded to form composite materials like carbon fiber reinforced plastic to provide a high strength to weight ratio of the materials.

Properties:-

- Ithasahightensilestrength,lowweightandlowthermalexpansion.
- Theyarerigidmaterialswhichareresistanttostretchingand compression.
- Itischemicallyinertorunreactivematerials.
- Theyareresistanttocorrosion.
- Fiberscontainedabout85%carbonhasexcellentflexuralstrength.

Applications/uses: -

- Carbonfiberismostlyusedtoreinforcecomposite material.
- Reinforced Carbon-Carbon (RCC) consists of carbon fiber-reinforced graphite and is used structurally in high temperature applications.
- Itincreasesthetensileaswellascompressivestrengthofconcrete.
- Due to high tensile strength, low weight and low thermal expansion it makes the carbon fiber very popular in aerospace, military and motorsports along with other competition sports.

- Carbon fiber is extensively used in the bicycle industry, especially for high-performance racing bikes.
- Itisalsousedinsometennisrackets.
- It is now being used in musical instruments for its weather resilience and ability to recreate the tone of guitars.

Glassfibers:-

- Itisalsocalled asfiberglass.Glass fiberisthematerialmadefrom extremely fine fibers of glass.
- ItwasinventedIn1938byRussellGamesSlayter.
- The fresh and thin fibers are stronger because the thinner fibers are more ductile.

Properties:-

- Ithashighratioofsurfaceareatoweight.
- Theyhavegoodthermalinsulation.
- Ithasagoodtensilestrengthbuthasnostrengthagainstcompression.
- Compressive strength is weak but can be increased by reinforcing itwith plastic.
- Whentheglassfiberisreinforcedwithplastic,thenreinforcedmaterial can resists both compressive and tensile forces as well.
- It is resistant to chemical attack. However, if its surface area is increased,thenitmakesthemmoresusceptibletochemicalattack.
- Theyarecorrosionresistant.

Applications/uses: -

- Corrugated fiber glass panels are widely used for outdoor canopy or greenhouse construction.
- It is used as a reinforcing agent for many polymer products like FRP andGRPwhichusestubes,pipesfordrinkingwaterand‘sewers,office plant containers and flat roof systems etc.
- Itisreinforcedwithplasticmaterialsoastoincreasetensilestrength.
- Uses of regular fiber glass are mats, insulation, reinforcement sound absorption, heat resistance fabrics, corrosion resistant fabrics and high strength fabrics.
- Glassfiberreinforcedplasticsareusedinthehousebuildingmarketfor theproductionofroofinglaminate,doorsurrounds,over-doorcanopies, window canopies and dormers, chimneys, coping system, heads with keystone and sill etc.
- The reinforced glass fiber with polymer and plastic is commonly used in fire water systems, cooling water systems, drinking water systems, sewage systems, waste water systems, gas system etc.

Plastics:-

- Plasticisanorganicmaterialpreparedoutofresin.
- Plasticmaybedefinedasanaturalorsyntheticorganicmaterialwhichare having the property of being plastic at some stage of their manufacture when they can be moulded to required size and shape.
- Thetypicalusesofplasticsinbuildingsarelistedbelow:

  1. Corrugatedandplainsheetsforroofing.
  2. Formakingjointlessflooring.
  3. Flooringtiles.
  4. Overheadwatertanks.
  5. Bathandsinkunits.
  6. Cisternhallfloats.
  7. Decorativelaminatesandmouldings.
  8. Windowanddoorframesandshuttersforbathroomdoors.
  9. Lightingfixtures.
  10. Electricalconduits.
  11. Electricalinsulators.
  12. Pipestocarrycoldwaters.

- Primarilytherearetwotypesofplastics
  - Thermoplastic
  - Thermosettingplastics

Thermoplastics: -

- In this variety,the linkage between the molecules is very loose.They can besoftenedbyheatingrepeatedly.Thesearealsocalledreversibleplastics.
- Thispropertyhelpsforreuseofwasteplastic.
- Bitumen,celluloseandshellacaretheexamplesofthisvarietyofplastics.

Thermosetting plastics: -

- Thermosettingplasticsaremadeupfromlongchainsofmoleculesthatare cross-linked.
- Theyhaveaveryrigidstructure.
- Once heated, thermosetting plastics can be moulded, shaped and pressed into shapes. Once set they cannot be reheated since they are permanently set. These are also called irreversible plastics.
- Thescrapofsuchplasticisnotreusable.
- Bakeliteisanexampleofsuchplastic.

Typesofplastics:-

PVC:-

- PVCisPolyvinylChloride.
- PVCaretoughandexceptionallyresistanttochemicalattack
- PVC require protection from ultraviolet exposure if installed outdoor and start softening when subjected to high temperature.
- PVC Pipes are made by an Extrusion processand Fittings, flanges, andvalves are manufactured by injection molding method
- PVChas many applicationsin industries andit'salso used inhomewater piping.
- PVCisreplacingtraditionalbuildingmaterialslikewood,metal,concrete and clay in many applications duetoits versatility and cost effectiveness.

RPVC:-

- RPVCmeansRigidPolyVinylChloride.
- PVC comes in two basic forms: flexible and rigid (RPVC). RPVC is used inconstruction(especiallypipes),packaging(especiallybottles),andcredit cards, just to list a few examples.
- ThesearеStrong&durable
- Theseareflexible,light-weight&henceeasytotransport
- Therequireeasyinstallation&lowmaintenance
- Thesearehighelectrical&chemicalresistance
- Thesearetermiteproof&UVresistant
- ThesearemanufacturedconformingtoIS4985:2000 standards
- Theseareresistanttomoisture,abrasion&wearing
- RPVC applications include Saltwater handling, Potable water supply schemesinurbanareas,Acid&slurrytransportation,Disposalofchemical effluent & waste etc.

HDPE:-

- HDPEplasticbetterknownasHigh-densitypolyethyleneisapolyethylene thermoplastic created from petroleum. Also known as alkathene or polythene when used for pipes.
- HDPE is commonly used to produce items like plastic bottles and cutting boards.
- HDPE is made when intense heat is applied to petroleum. Also known as cracking,thisprocesscreatesethylenegas.Atthisstageofproduction,the gas molecules will then attach forming polymers---which in turn, produce polyethylene.
- HDPEiscommonlyusedtocreatecontainerslikemilkandwaterjugs.
- HDPEisalsoveryflexibleandstrong.

- HDPE is resistant to corrosion and lightweight, making it an ideal option when compared to other types of plastic.
- Itiseasyto recycle
- Italsousedaslinedmaterialwithcarbonsteelpipe

FRP: -

- FiberReinforcedPolymer(FRP)compositeisdefined asapolymerthat is reinforced with fiber. Fibers may be carbon, glass etc.
- FRPcompositesareanisotropic.Therefore,theirpropertiesaredirectional, meaningthatthebestmechanicalpropertiesareinthedirectionofthefiber placement.
- These materials have a high ratio of strength to density, exceptional corrosion resistance and convenient electrical, magnetic and thermal properties. However, they are brittle and their mechanical properties may be affected by the rate of loading, temperature and environmental conditions.
- The primary function of fiber reinforcement is to carry the load along the length of the fiber and to provide strength and stiffness in one direction.
- Fiber+polymermatrix= FRP
- Used in prestressed concrete, underwater piping and structural parts of offshore platform, as internal reinforcement for concrete structures, for strengthening of various structures constructed from concrete, masonry, timber, and even steel, for seismic retrofitting etc.

GRP:-

- Glass-reinforcedplastic(GRP)isacompositematerialconsistingofplastic reinforced with fine glass fibers. These fibers may be arranged randomly, flattened as a sheet, or woven to make a fabric-like material.
- A plastic resin is then overlaid onto the glass fibers to create combined uniform material. This resin may include epoxy, vinyl ester, polyester, polyurethane, or polypropylene.
- The glass fibers in GRP are cheaper, more flexible, and lighter than their carboncounterpart,makingitanidealreinforcingagentformanypolymer products.
- Additionally, glass fibers are also non-magnetic, corrosion-resistant, resistant to electromagnetic radiation, and chemically inert under specific circumstances.ThesepropertiesmakeGRPmaterialsanidealmaterialfor structures and components, such as: Aircraft, boats, automobiles, water tanks, roofing, oil and gas lift systems etc.

Artificialtimbers:-

- Thetimberwhichisconvertedinafactorybysomemechanicalprocesses is termed as ‘Artificial timber’ or ‘Industrial timber’.
- Such timberpossesses desired shape,appearance,strength anddurability. Following are some varieties of artificial timbers.

1) Plywood
2) Veneer
3) Fibreboard
4) Blockboard
5) Particleboard
6) Flushdoor

Theuseofartificialtimberisjustifiedovernaturaltimberforfollowingreasons 1]

Available in large sizes for which least jointing required.

2] More stable to atmospheric changes as compared to timber.

3]Surfacesareplaneandnojack-planingormachiningneeded. 4]

Pasting of veneers or laminates is easier and more durable.

5]Strongerthanthesolidwoodasithassamestrengthinalldirections. 6] The thinner sheets are flexible.

7]Storing,stackingandtransportingiseasier.

Acousticmaterials:-

- Whenthesoundintensityismore,thenitgivesthegreattroubleornuisance totheparticulararealikeauditorium,cinemahall,studio,recreationcenter, entertainmenthall,collegereadinghall.Henceitisveryimportanttomake that area or room to be sound proof by using a suitable material called as ‘Acoustic material’.
- acousticstreatmentisprovidedsoastocontroltheoutsideaswellasinside soundofthevariousbuildinguntilsuchthatsoundwillbe audiblewithout any nuisance or disturbance.

Typesofacousticmaterials;-

- Acousticplaster.
- Acoustictiles.

- Perforatedplywood.
- Fibrousplaster.
- Strawboard.
- Pulpboard.
- Compressedfiberboard.
- Hairfelt.
- Corkboardslabs.
- Foamglass.
- Asbestoscementboards.
- Thermocoal.
- Foamplastic.
- Chipboards.
- Gasket cork sheet.

Propertiesofacousticmaterials:-

- Soundenergyiscapturedandadsorbed.
- Ithasalowreflectionandhighabsorptionofsound.
- Higherdensityimprovesthesoundabsorptionefficiencyatlower frequencies.
- Itcontrolsthesoundandnoiselevelsfrommachineryandothersourcesfor environmental amelioration and regulatory compliance.
- Acousticmaterialreducestheenergyofsoundwavesastheypassthrough.
- Itsuppressesechoes,reverberation,resonanceandreflection.

Uses of acoustic materials; -

Acoustic material plays a vital role in the various area of building construction. In studio, class room, reading hall, cinema theatre etc.

Artificialsand:-

It is obtained as a by-product while crushing stones to get coarse aggregates/chips.

Wallcladding:-

It refers to external layer of building which provides aesthetic effect along with protects the building structure from weathering phenomena like rainfall. It may be of stone cladding, vinyl cladding or aluminium cladding etc.

Micro-silica:-

- Micro silica, also known as silica fume or condensed silica fume is a mineraladmixturecomposedofveryfinesolidglassyspheresofsilicon dioxide.
- It is usually found as a by-product in the industrial manufacture of ferrosiliconandmetallicsiliconinhigh-temperatureelectricarcfurnaces.
- Theseareusedtoimprovestrengthanddurabilityofconcrete.

Ch.2 PREFABRICATOIN

Conceptofprefabrication:-

- Prefabrication is the method of construction which includes assembling componentsofastructure inamanufacturingor productionsiteotherthan the actual site and then transporting complete assemblies or partial assemblies to the actual site where the structure is to be located.
- It is combination of good design with modern high-performance components and quality-controlled manufacturing procedures.
- This work is carried out in two stages, manufacturing of components in a place other than final location and their erection in position.
- Prefabricatedsectionsareproducedinlargequantitiesinafactoryandthen shipped to various construction sites.
- This procedure mayallow work tocontinue despite poor weather conditionsandshouldreduceanywasteintimeandmaterialatthesite.
- Precast concrete units are cast and hardened before being used for construction.Sometimesbuilders castcomponents at thebuilding siteand hoist them into placeafter they harden. This technique permits the speedy erection of structures.
- For ex: - The conventional method of building a house is to transport bricks, timber, cement, sand, steel and construction aggregate, etc. to the site, and to construct the house on site from these materials. In prefabricated construction, only the foundations are constructed in this way,whilesectionsofwalls,floorsandroofareprefabricated(assembled) inafactory(possiblywithwindowanddoorframesincluded),transported to the site, lifted into place by a crane and bolted together.
- Prefabrication avoids the need to transport so many skilled workers to the construction site, and other restricting conditions such as a lack of power, lack of water, exposure to harsh weather or a hazardous environment are avoided.

Stagesofprefabrication:-

ThePrefabricationasdefinedwillbedoneintwostages

1. Manufacturingatfactoryconditionanderectionof
2. componentsattherequiredlocation.

Casting: – Precast components are casted with controlled cement concrete in mouldsof required shapeand sizes.Reinforcement is placedbeforePouring any concrete. The vibrator is used to vibrate concrete and this removes any honeycombing inside the components. This removes any honeycombing inside the components.

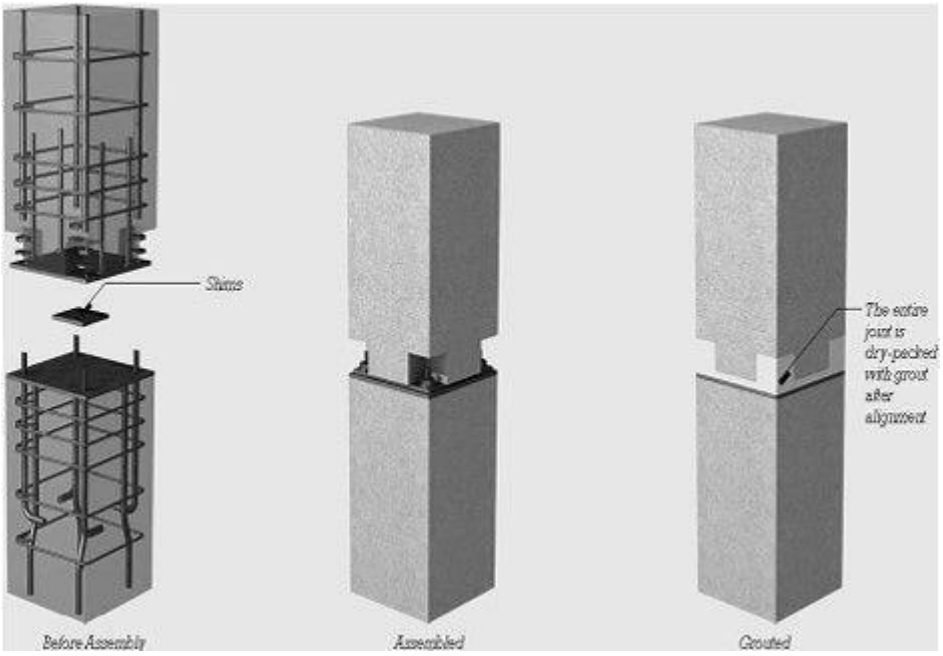
Curing: –After24hoursofcasting,thecastedcomponentsarereleasedfromthe mould and transported to curing tanks. Certain special components like railway sleeperswherehighstrengthisrequiredaresteamcured. Curingwillbedonefor at least 3 days and further it will be cured after erecting these components at the site.

Transportation and erection: – After complete curing is done the components aretransportedtothesitewithheavytrucksanderectionwillbedoneusingcranes with skilled labour force.

Prefabricatedbuildingcomponents:-

Columns: -

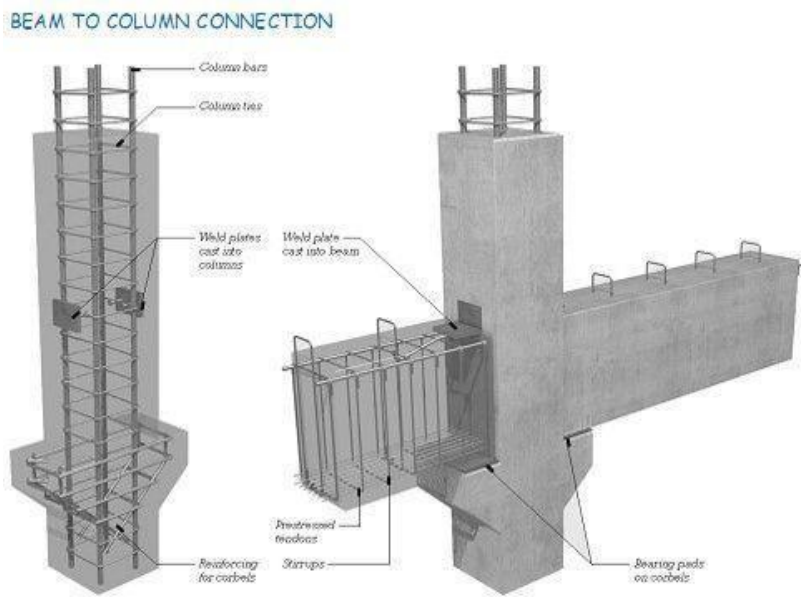
- Column is a vertical member carrying the beam and floor loadings to the foundation
- It is a compression member and therefore the column connection is required to be proper and this can be done by ensuring continuity.



Beams:-

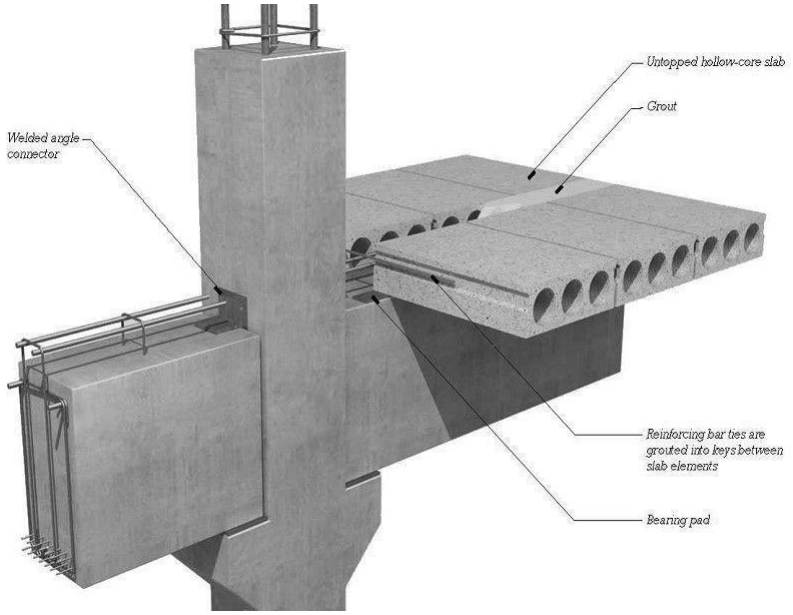
- Beams can vary in their complexity of design and reinforcement from the very simple beam formed over an isolated opening to the more common encountered in frames where the beams transfer their loadings to the column. Methods of connecting beams and columns are: -
    - Aprecastingconcretehaunchiscastontothecolumnwithalocating dowel or stud bolt to fix the beam.

- A projecting metal corbel is fixed to the column and the beam is bolted to the corbel.
- Columnandbeamreinforcement,generallyintheformofhooks,are left exposed. The two members are hooked together and covered with insitu concrete to complete the joint. This is as shown in the figure.



Slabs:-

- Waffle unit for flooring / roofing: – These are suitable for roofs / floors spanning in two directions. They are laid in a grid pattern. These units are cast in moulds. The saving achieved is not much. Also Shuttering are complicated and costly. Time consumption for construction is less.



Advantagesofprefabrication:-

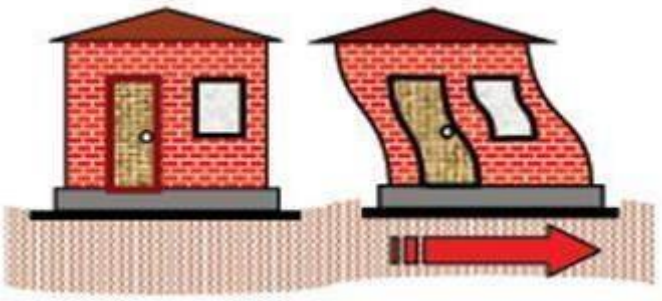
- Savingincost,material,time&manpower.
- Shutteringandscaffoldingisnotnecessary.
- Installationofbuildingfinishescanbedoneimmediately.
- Independentofweathercondition.
- Componentsproducedatclosesupervision.Soqualityisgood
- Cleananddryworkatsite.
- Possibilityofalterationsandreuse
- Correctshapeanddimensionsandsharpedgesaremaintained.
- Verythinsectionscanbeentirelyprecastwithaccuracy.

Disadvantagesofprefabrication:-

- Handlingandtransportationmaycausebreakagesofmemberssocarehas to be taken.
- Itisanon-monolithicconstruction.
- Leakscanformatjointsinprefabricatedcomponents.
- Placementofmembersplaysamajorrole
- High transport cost and also Large prefabricated sections require heavy-duty cranes.
- Needoferectionequipment.
- Skilledlabourandsupervisionarerequired.

Ch.3EARTHQUAKERESISTANTCONSTRUCTION

- Earthquake is a natural phenomenon occurring with all uncertainties. Among all the natural calamities, the most devastating one is earthquake.
- During the earthquake, ground motions occur in a random fashion, both horizontally and vertically, in all directions radiating from epicentre.
- Hence structures in such locations need to be suitably designed and detailed to ensure stability, strength and serviceability with acceptable levels of safety under seismic effects.



Theprincipleofearthquake-resistantdesignofbuildinghastwoaims:

1. Thebuildingshallwithstandwithalmostnodamagetomoderateearthquake which have probability of occurring several times during life of a building.

2. Thebuildingshallnotcollapseorharmhumanlivesduringsevereearthquake motions which have a probability of occurring less than once during the life of the building.

Inordertosatisfytheseaims,buildingdesignshouldconformfollowingrules:

(a) The configuration ofthebuilding (Plan and elevation) should be as simple as possible.

(b) Theformationshouldgenerallybebasedonhardanduniformground.

(c) Themembersresistinghorizontalforcesshouldbearrangedsothattorsional deformation is not produced.

(d) Thestructureofthebuildingshouldbedynamicallysimpleanddefinite.

(e) Theframeofthebuildingstructureshouldhaveadequateductilityinaddition to required strength.

(f) Deformations produced in a building should be held to values, which will not provide obstacles to safety use of building.

Classificationofearthquake:-

Intensity of an earthquake is measured by an instrument called Richter Scale.Classifications of earthquakes are as follows:

Slight: Magnitudeupto4.9ontheRichterScale

Moderate: Magnitude 5.0 to 6.9

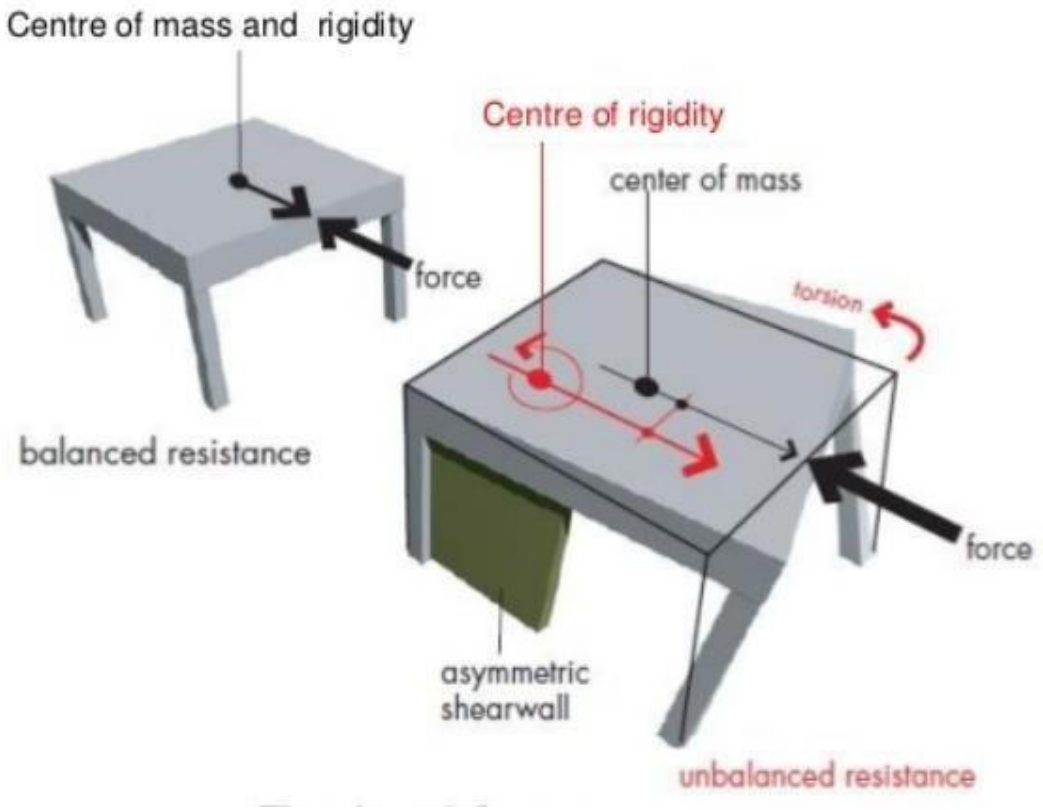
Great: Magnitude 7.0 to 7.9

VeryGreat:Magnitude8.0andabove

- Indiaisdividedinto4seismiczones

Buildingconfiguration:-

1. The building should have a simple rectangular plan and be symmetrical both with respect to mass and rigidity so that the centres of mass and rigidity (centre of mass is the point at which whole mass of an object is assumedtobeconcentratedwhilecentreofrigidityisthepointatwhichif a lateral force acts it won't cause torsion rather translation only) of the building coincide with each other in which case no separation sections other than expansion joints are necessary.



2. If symmetry of the structure is not possible in plan, elevation or mass, provision shall be made for torsional and other effects due to earthquake forces in the structural design or the parts of different rigidities may be separated through crumple sections. The length of such building between separation sections shall not preferably exceed three times the width.

3. Buildingshavingplanswithshapeslike,L,T,E andYshallpreferablybe separated into rectangular parts by providing separation sections at appropriate places. Typical examples are shown in Fig. 1.

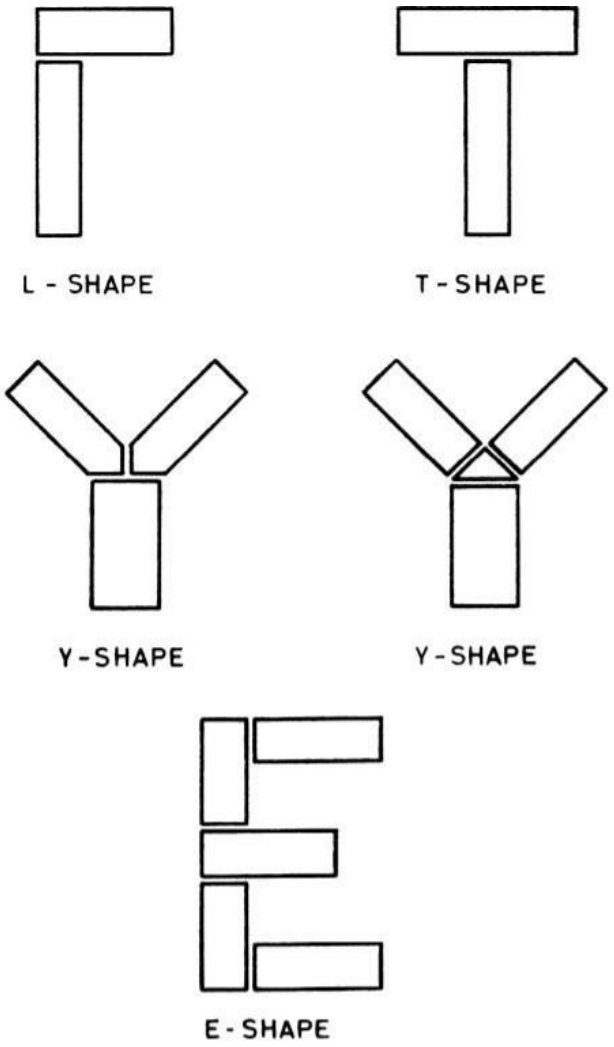


FIG. 1 TYPICAL SHAPES OF BUILDING WITH SEPARATION SECTIONS

Buildingcharacteristics:-

- Since the earthquake force is a function of mass, the building shall be as light as possible consistent with structural safety and functional requirements. Roofs and upper storeys of buildings, in particular, should be designed as light as possible.
- Asfaraspossible,thepartsofthebuildingshouldbetiedtogetherinsuch a manner that the building acts as one unit.
- Forpartsofbuildingsbetweenseparationorcrumplesectionsorexpansion joints, floor slabs shall be continuous throughout as far as possible.

Concreteslabsshallberigidlyconnectedorintegrallycastwiththesupport beams.

- Additions and alterations to the structures shall be accompanied by the provision of separation or crumple sections between the new and the existingstructuresasfaraspossible,unlesspositivemeasuresaretakento establish continuity between the existing and the new construction.
- Projecting parts shall be avoided as far as possible. If the projecting parts cannot beavoided,they shall beproperly reinforced and firmlytied to the main structure.
- Ceiling plaster shall preferably be avoided. When it is unavoidable, the plaster shall be as thin as possible.
- Suspendedceilingshallbeavoidedasfaraspossible.Whereprovidedthey shall be light, adequately framed and secured.
- The structure shall be designed to have adequate strength against earthquake effects along both the horizontal axes.
- The structure shall not be founded on such loose soils which will subside orliquefyduringanearthquake,resultinginlargedifferential settlements.
- Themainstructuralelementsandtheirconnectionshallbedesignedtohave a ductile failure. This will enable the structure to absorb energy during earthquakes to avoid sudden collapse of the structure. Providing reinforcingsteelinmasonryatcriticalsections,asprovidedinthisstandard will not only increase strength and stability but also ductility.
- Suitabledetailsshallbeworkedouttoconnectthenon-structuralpartswith thestructural framingsothat thedeformationofthestructural frameleads to minimum damage of the non-structural elements.
- Fire frequently follows an earthquake and therefore, buildings shall be constructed to make them fire resistant.

<u>Lateralloadresistingstructures:-</u>

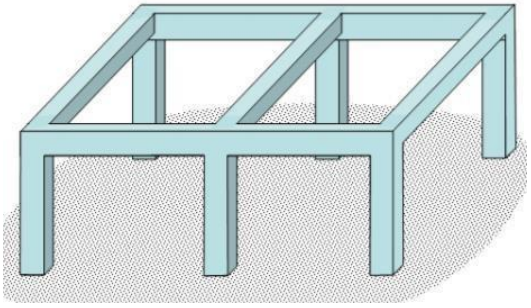
- Momentresistingframes
  - Ordinarymomentresistingframes(OMRF)
  - Specialmomentresistingframes(SMRF)
- Cross-bracedframes
- Structuralorshearwalls

<u>Moment resisting frames: -</u>

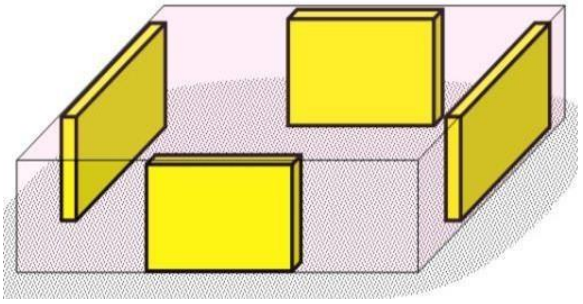
Itisaframeinwhichmembersandjointsarecapableofresistingforcesprimarily by flexure. OMRF is a moment-resisting frame not meeting special detailing requirements forductilebehaviour. SMRFisamoment-resistingframespecially detailed to provide ductile behaviour.

<u>Shearwalls:-</u>

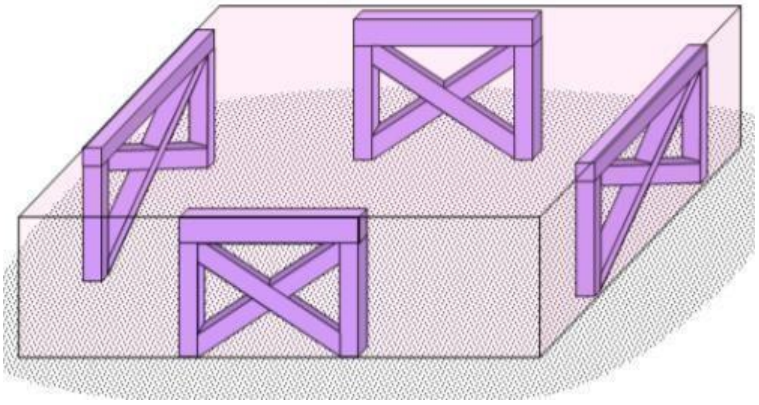
A wall designed to resistlateral forceinitsownplane.Braced frames,subjected primarily to axial stresses, shall be considered as shear walls for the purpose of this definition.



Momentresistingframes



structuralorshearwalls



Cross-bracedframes

Bands:-

- A reinforced concrete or reinforced brick runner provided in the walls to tie them together and to impart horizontal bending strength in them.
- Horizontal bands are the most important earthquake-resistant feature in masonry buildings. The bands are provided to hold a masonry building as asingleunitbytyingallthewallstogether.Therearefourtypesinatypical masonry building named after their locations in the building. They are:

(a) Plinthband:This shouldbeprovidedinthosecaseswherethesoilis soft or uneven in their properties, as it usually happens in hilly areas. This band is not too critical.

(b) Lintelband:Thisisthemostimportantbandandcoversalldoorandwindow lintel.

(c) Roof band: In buildings with flat reinforced concrete or reinforced brick roofs,theroofbandisnotrequiredbecausethe roofslabitselfplaystheroleofa band.However,inbuildingswithflattimberorCGIsheetroof,aroofbandneeds

to be provided. In buildings with pitched or sloped roof, the roof band is very important. It is a band provided immediately below the roof or floors.

(d) Gable band: It is employed only in buildings with pitched or sloped roofs. It is a band provided at the top of gable masonry below the purlins.

- The band shall be made of reinforced concrete of grade not leaner than M15 or reinforced brick-work in cement mortar not leaner than 1 : 3. The bands shall be of the full width of the wall, not less than 75 mm in depth and reinforced with steel.

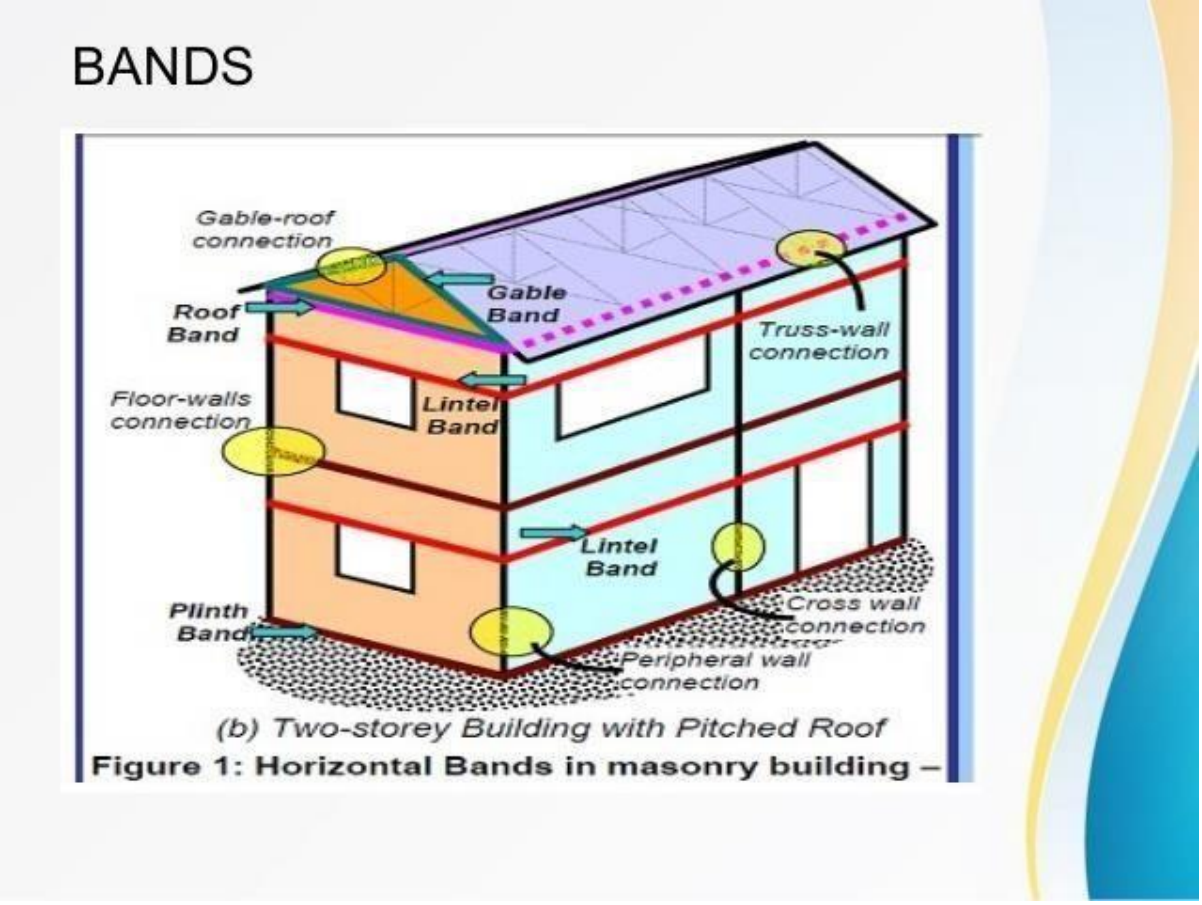


Figure 1: Horizontal Bands in masonry building –

Theirregularityinbuildingstructuresmaybeduetoirregulardistributionintheir mass, strength and stiffness along the height of building. There are broadly two types of irregularities: -

1. Planirregularities
2. Verticalirregularities

Plan Irregularities (Fig. 3)

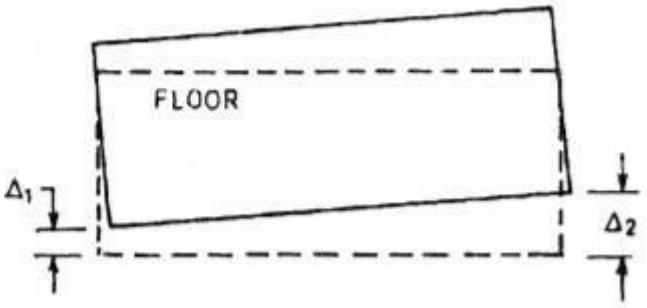
(*Clause* 7.1)

Sl No.	Irregularity Type and Description
(1)	(2)
i)	*Torsion Irregularity* To be considered when floor diaphragms are rigid in their own plan in relation to the vertical structural elements that resist the lateral forces. Torsional irregularity to be considered to exist when the maximum storey drift, computed with design eccentricity, at one end of the structures transverse to an axis is more than 1.2 times the average of the storey drifts at the two ends of the structure
ii)	*Re-entrant Corners* Plan configurations of a structure and its lateral force resisting system contain re-entrant corners, where both projections of the structure beyond the re-entrant corner are greater than 15 percent of its plan dimension in the given direction
iii)	*Diaphragm Discontinuity* Diaphragms with abrupt discontinuities or variations in stiffness, including those having cut-out or open areas greater than 50 percent of the gross enclosed diaphragm area, or changes in effective diaphragm stiffness of more than 50 percent from one storey to the next
iv)	*Out-of-Plane Offsets* Discontinuities in a lateral force resistance path, such as out-of-plane offsets of vertical elements
v)	*Non-parallel Systems* The vertical elements resisting the lateral force are not parallel to or symmetric about the major orthogonal axes or the lateral force resisting elements

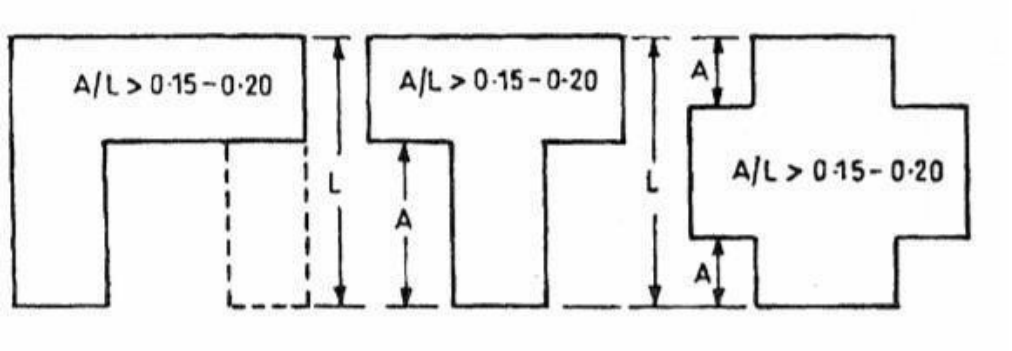
Vertical Irregularities (Fig. 4)

(*Clause* 7.1)

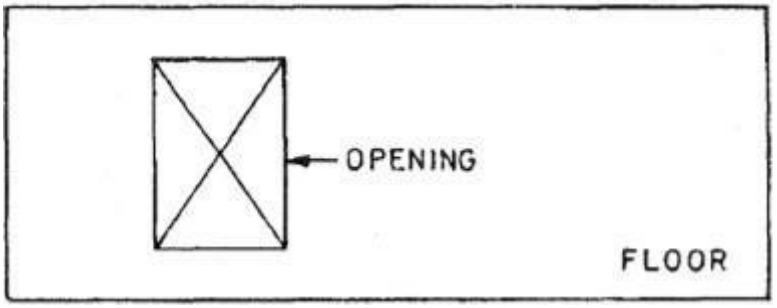
Sl No.	Irregularity Type and Description
(1)	(2)
i)	a) *Stiffness Irregularity — Soft Storey* A soft storey is one in which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three storeys above b) *Stiffness Irregularity — Extreme Soft Storey* A extreme soft storey is one in which the lateral stiffness is less than 60 percent of that in the storey above or less than 70 percent of the average stiffness of the three storeys above. For example, buildings on STILTS will fall under this category.
ii)	*Mass Irregularity* Mass irregularity shall be considered to exist where the seismic weight of any storey is more than 200 percent of that of its adjacent storeys. The irregularity need not be considered in case of roofs
iii)	*Vertical Geometric Irregularity* Vertical geometric irregularity shall be considered to exist where the horizontal dimension of the lateral force resisting system in any storey is more than 150 percent of that in its adjacent storey
iv)	*In-Plane Discontinuity in Vertical Elements Resisting Lateral Force* A in-plane offset of the lateral force resisting elements greater than the length of those elements
v)	*Discontinuity in Capacity — Weak Strorey* A weak storey is one in which the storey lateral strength is less than 80 percent of that in the storey above. The storey lateral strength is the total strength of all seismic force resisting elements sharing the storey shear in the considered direction.



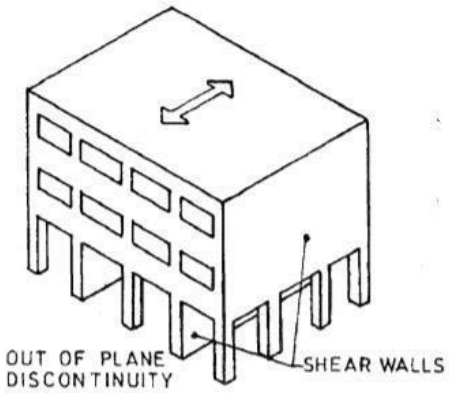
(Torsionalirregularity)



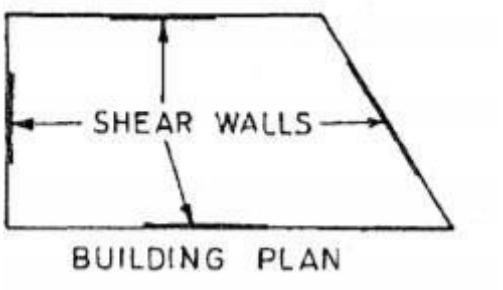
(Re-entrantcorner)



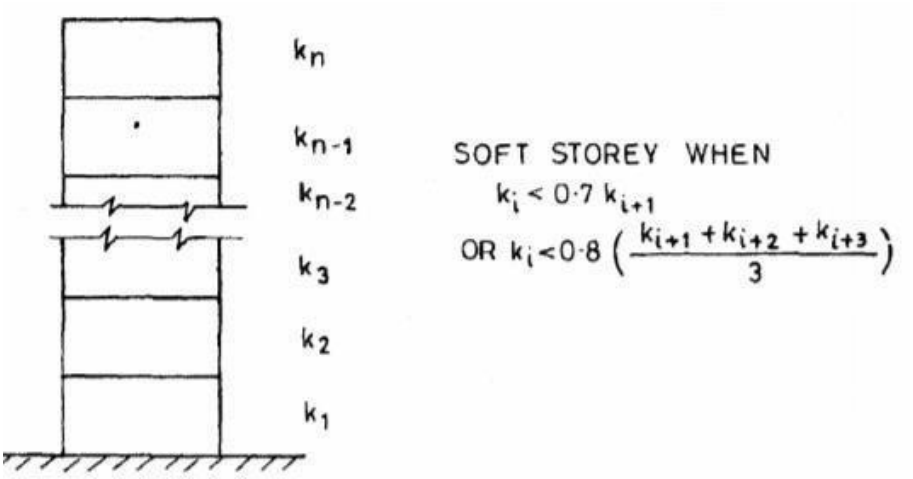
(Diaphragmdiscontinuity)



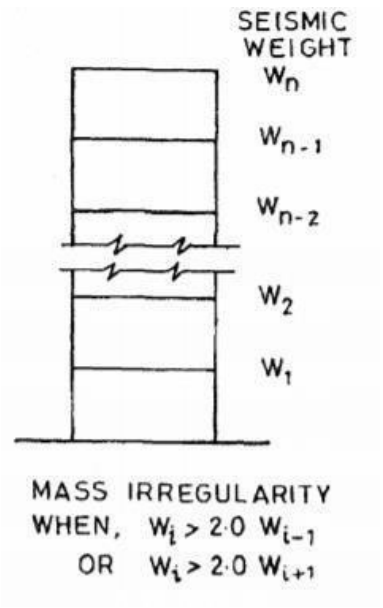
(Outofplaneoffsets)



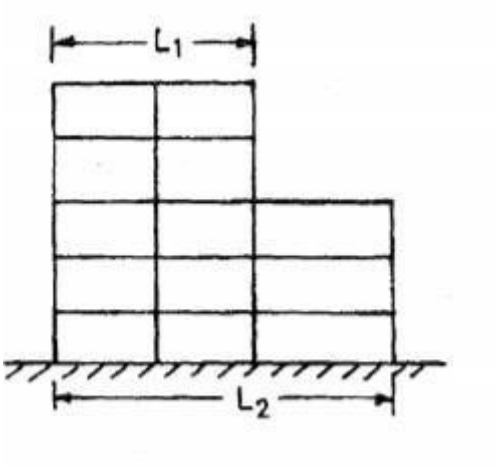
(Non-parallelsystem)



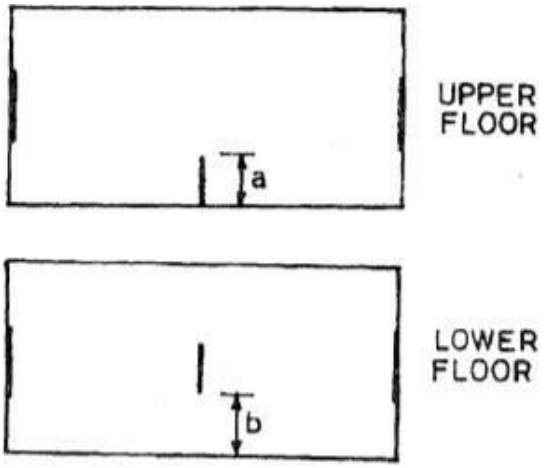
(Stiffnessirregularity)



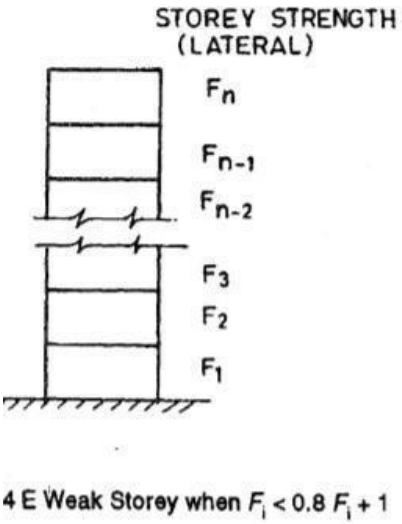
(Massirregularity)



(Verticalgeometricirregularity)



(In-planediscontinuity)



4 E Weak Storey when $F_i < 0.8\ F_i + 1$

(Discontinuityincapacity)

Additionstoexistingstructure:-

Additionsshallbemadetoexistingstructuresonlyasfollows:

a) An addition that is structurally independent from an existing structures shall bedesignedandconstructedinaccordancewiththeseismicrequirementsfornew structures.

b) Anadditionthatisnotstructurallyindependentfromanexistingstructureshall bedesignedandconstructedsuchthattheentirestructureconformstotheseismic force resistance requirements for new structures unless the following three conditions are complied with:

1) Theadditionshallcomplywiththerequirementsfornewstructures,

2) The addition shall not increase the seismic forces in any structural elements of the existing structure by more than 5 percent unless the capacityoftheelementsubjecttotheincreasedforceisstillincompliance with this standard, and

3) The additicn shall not decrease the seismic resistance of any structural element of the existing structure unless reduced resistance is equal to or greater than that required for new structures.

Ch.4RETROFITTINGOFSTRUCTURES

Retrofitting is the process by which we add new features to existing structures, such as heritage sites, older buildings, and bridges, etc. Retrofitting helps in reducingthevulnerabilityofdamagetoanexistingstructureincaseofanynatural disaster or seismic activity.

Seismicretrofittingofconcretestructures:-

Itisthemodificationofexistingstructurestomakethemmoreresistanttoseismic activity,groundmotion,orsoilfailureduetoearthquakes.Theretrofittechniques arealsoapplicableforothernaturalhazardssuchastropicalcyclones,tornadoes, and severe winds from thunderstorms.

Need/importanceofretrofitting: -

- Toensurethesafetyandsecurityofabuilding,employees,structure functionality, machinery and inventory
- Essentialtoreducehazardandlossesfromnon-structuralelements.
- predominantly concerned with structural improvement to reduce seismic hazard.
- Important buildings must be strengthened whose services are assumed to be essential just after an earthquake like hospitals.

Basicconceptofretrofitting:-

Retrofitting aims at,

- Upgradationoflateralstrengthofthestructure
- Increaseintheductilityofthestructure
- Increaseinstrengthandductility

SourceofweaknessofRCframedbuildings:-

Mainly,thereare3sourcesofweaknessofRCframedbuildingstheyare

a) Discontinuousloadpath/interruptedloadpath/irregularloadpath
b) Lackofdeformationcompatibilityofstructuralmembers
c) Qualityofworkmanshipandpoorqualityof material

a) StructuralDamageduetoDiscontinuousLoadpath

Every structure must have two load resisting systems, (a) vertical load resisting system for transferring the vertical load to ground (b) horizontal load resisting systemfortransferringthehorizontalloadtoverticalloadsystem.Itisimperative thattheseismicforcesshouldbeproperlycollectedbythehorizontalframing

system and properly transferred into vertical lateral resisting system. Any discontinuity/irregularity in this load path or load transfer may cause one of the major contributions to structural damage during strong earthquakes. In addition it must be ensured that each member both of horizontal or vertical load resisting system must be strong enough and not fail during an earthquake. Therefore, all the structural and non-structural elements must have sufficient strength and ductility and should be well connected to the structural system so that the load path must be complete and sufficiently strong.

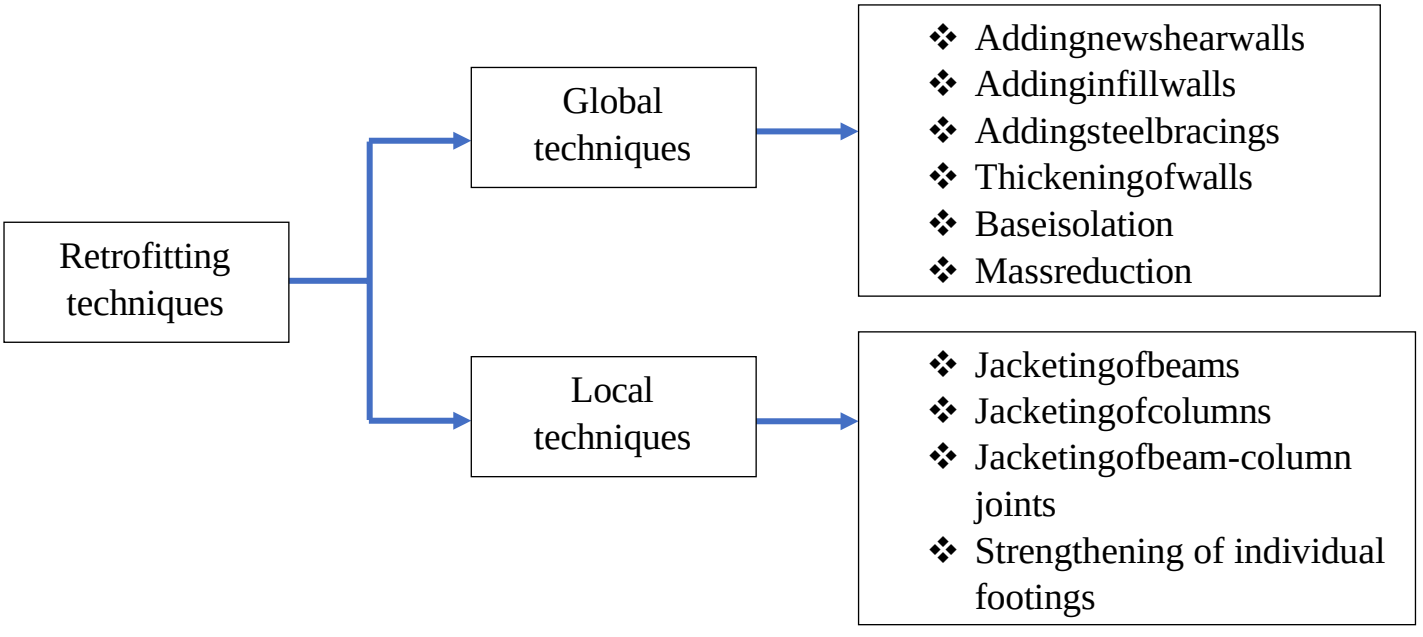
b) StructuralDamageduetoLackofDeformation

Themainproblemsinthestructuralmembersofmomentresistingframebuilding are the limited amount of ductility and the inability to redistribute load in order to safely withstand the deformations imposed upon in response to seismic loads. Themostcommonregionsoffailureinanexistingreinforcedconcreteframemay be in columns, beams, walls and beam-column joints. It is important to consider the consequences of member failure or structural performance. Inadequate strength and ductility of the structural member can and will result in local or complete failure of the system.

c) QualityofWorkmanshipandMaterials

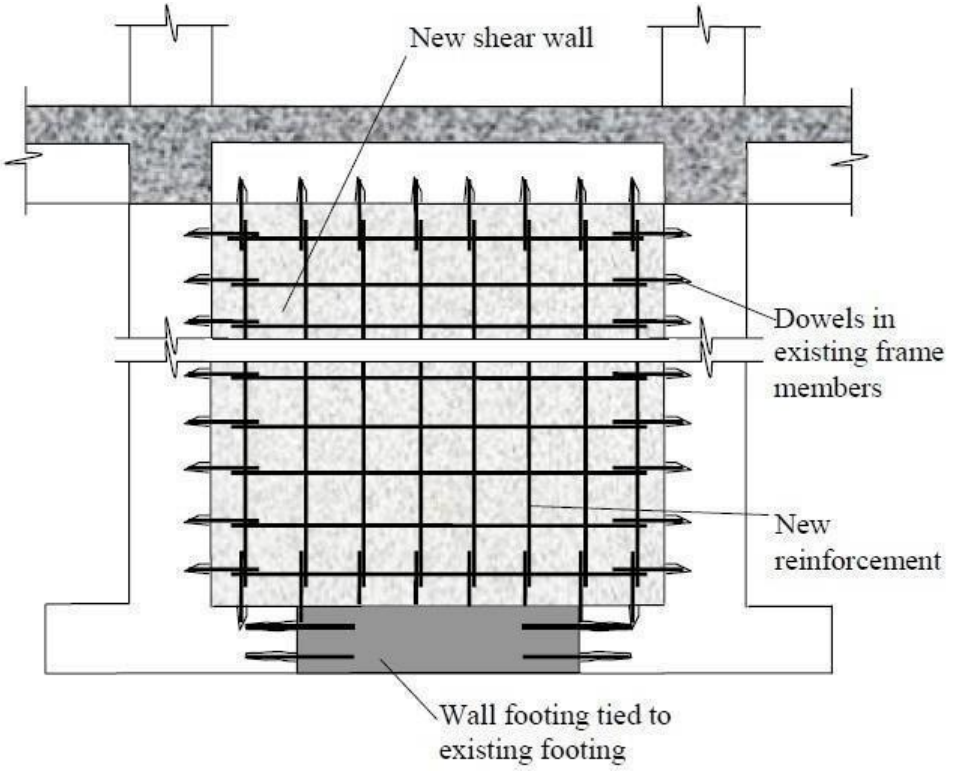
There are numerous instances where faulty construction practices and lack of qualitycontrolhavecontributedtothedamage.Thefaultyconstructionpractices maybelike,lackofamount anddetailingofreinforcement asperrequirement of codeparticularlywhentheendoflateralreinforcementisnotbentby135degrees as the code specified. Many buildings have been damaged due to poor quality control of design material strength as specified, spelling of concrete by the corrosionofembeddedreinforcingbars,porousconcrete,ageofconcrete,proper maintenance etc.

Classificationofretrofittingtechniques:-



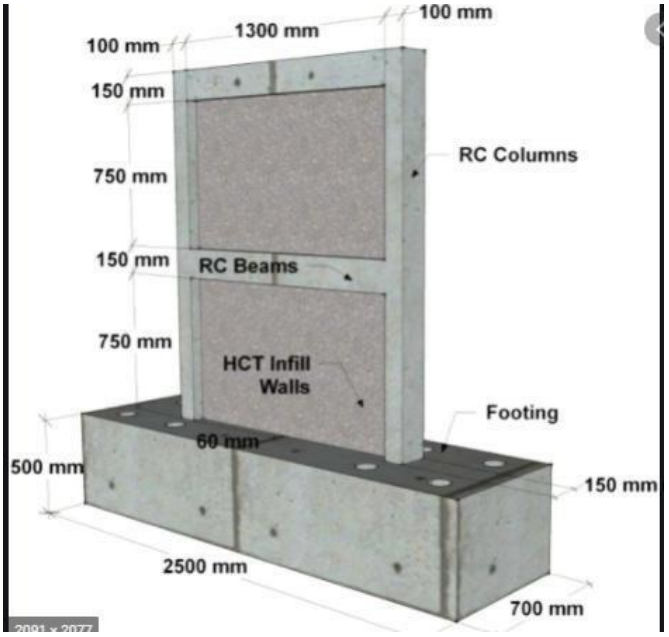
Addingnewshearwalls:-

- ❖ Thesearefrequentlyusedforretrofittingofnonductilereinforcedconcrete frame buildings.
- ❖ The added elements can be either cast-in-place or precast concrete elements.
- ❖ Newelementspreferablybeplacedattheexteriorofthebuilding.
- ❖ Notpreferredintheinteriorofthestructuretoavoidinteriormouldings.



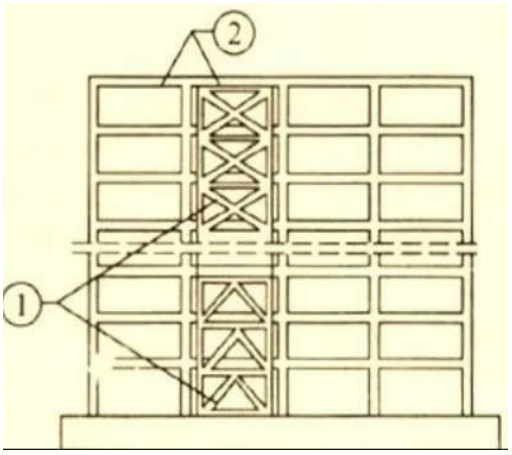
Addinginfillwalls:-

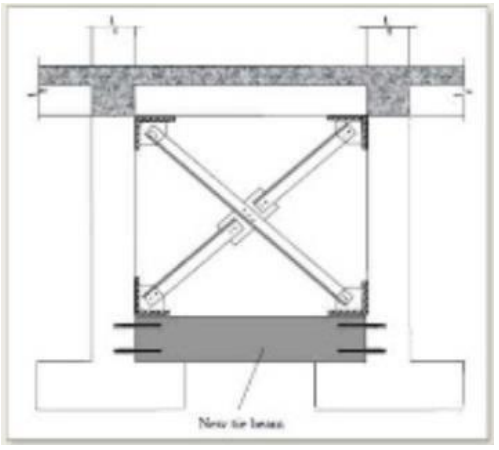
- Adding infill walls increases the stiffness and reduces the fundamental period of the structure by up to 20%, indicating the effect of the infill on the structural stiffness.
- Thesewalls are enclosed in steel and concrete frames and can withstand part ofthe earthquake force at the time of the earthquake due to strength and stiffness.
- This method is mostly used in short steel buildings. Depending on the materials used, the infill's can be made of brick, concrete, etc.



Addingsteelbracings:-

- Thistechniqueisaneffectivesolutionwhenlargeopeningsarerequired.
- Potential advantages due to higher strength and stiffness, opening for naturallightcanbeprovided,amountofworkislesssincefoundation cost maybe minimized and adds much less weight to the existing structure.





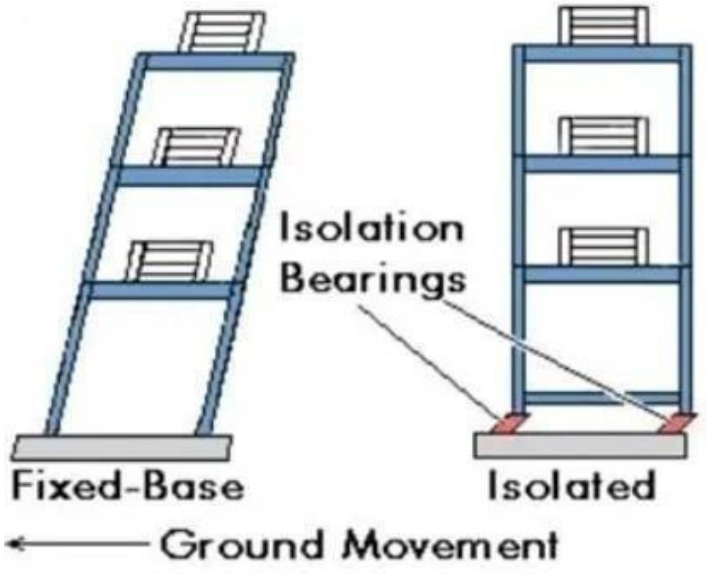
1–existingstructure

2-steelbracingsadded Base

isolation: -

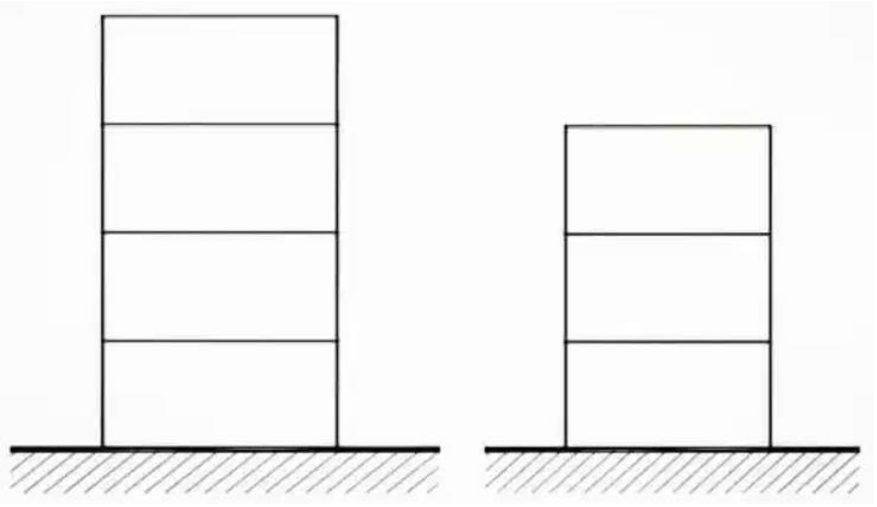
Isolation of superstructure from the foundation is known as base isolation. It is the most powerful tool for passive structural vibration control techniques.

- ❖ IsolatesBuildingfromgroundmotion–Lesserseismicloads,hencelesser damage to the structure, -Minimal repair of superstructure.
- ❖ Buildingcanremainserviceablethroughoutconstruction.
- ❖ Doesnotinvolvemajorintrusionuponexistingsuperstructure



Massreductiontechniques:-

This maybeachieved,forinstance,byremovalofoneormorestorey'sasshown in Figure. In this case it is evident that the removal of the mass will lead to a decreasein the period, which will lead to an increase in the required strength.



Wallthickening:-

The existing walls of a building are added to certain thickness by adding bricks, concreteandsteelalignedatcertainplacesas reinforcement,suchthattheweight of wall increases and it can bear more vertical and horizontal loads, and also it's designedunderspecialconditionsthatthetransverseloadsdoesnotcausesudden failure of the wall.

Jacketing:-

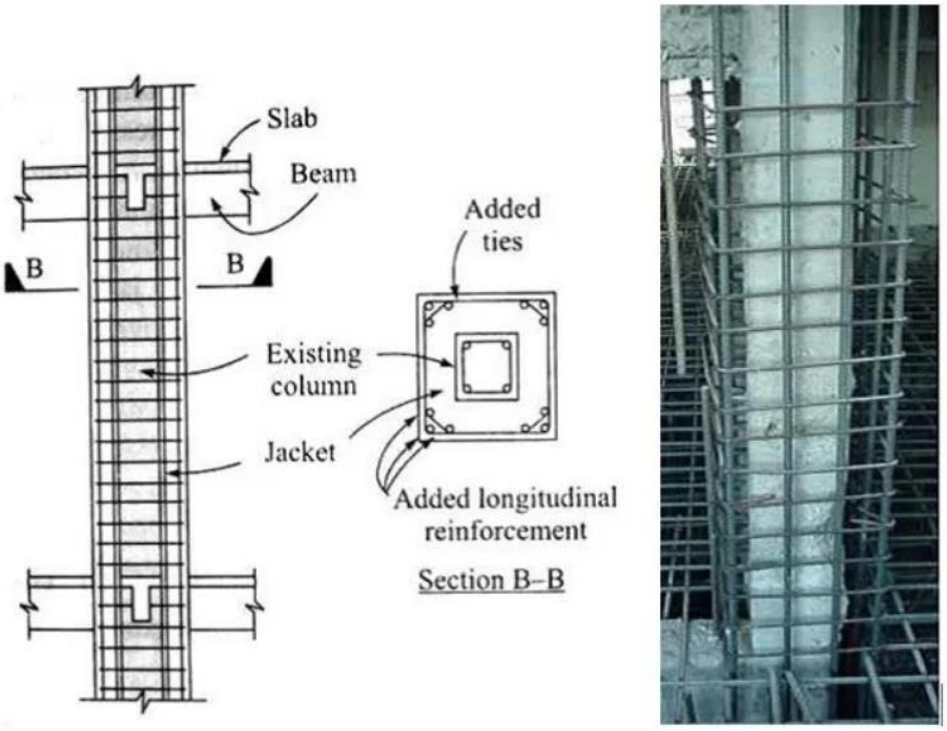
- A local retrofitting technique

Thereare3typesofjacketingmainly,

- Steeljacket
- Reinforcedconcretejacket
- Fibrereinforcedpolymercompositejacket

Jacketing is provided,

- Toincreaseconcreteconfinement
- Toincreaseshearstrength
- Toincreaseflexuralstrength



(Columnjacketing)

BUILDINGSERVICES

COLDWATERDISTRIBUTIONINHIGHRISEBUILDING,LAYOUTOFINSTALLATION: -

Therearethreewaysofcoldwaterdistributioninabuilding,they are

- Bynormalwaterpressure
- Byoverheadfeedsystem
- Byairpressuresystem

By normal water pressure: -

In this method only the normal water pressure is used to supply the cold water to various floors. Normally, the water pressure available is not muchadequate to serve the buildings. Hence, the alternative solutions are by overhead feed system and by using compressed air pressure distribution system.

Byoverheadfeedsystem:-

In this method, water is pumped into a large tank on top of building and is distributedto the fixtures by means of gravity.

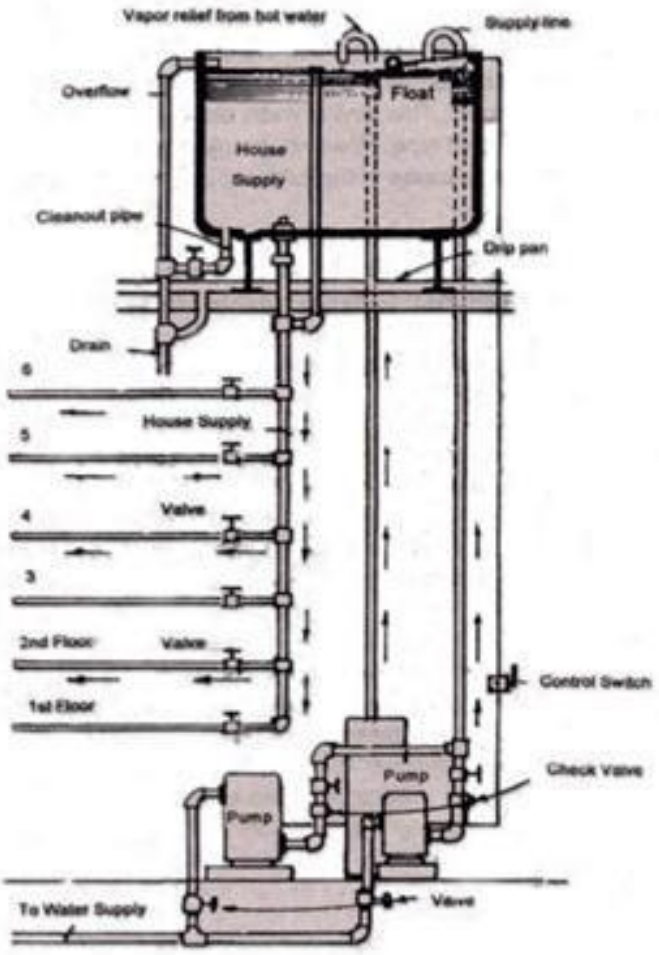
Advantages:-

- watersupplynotaffectedbypeaktimehour
- watersupplynotaffectedbypowerinterruption
- Replacementofpartswillnotaffecttheregularsupplyofwater.

Disadvantages: -

- wateriss.tcontamination
- needshighmaintenancecost
- occupiesmuchspace
- Requires stronger foundation and other structures to carry additional load of tank and water.

BUILDINGSERVICES



Byairpressuresystem:-

In this methodofwater supply,compressed airisused to raise andpushwaterinto the system.

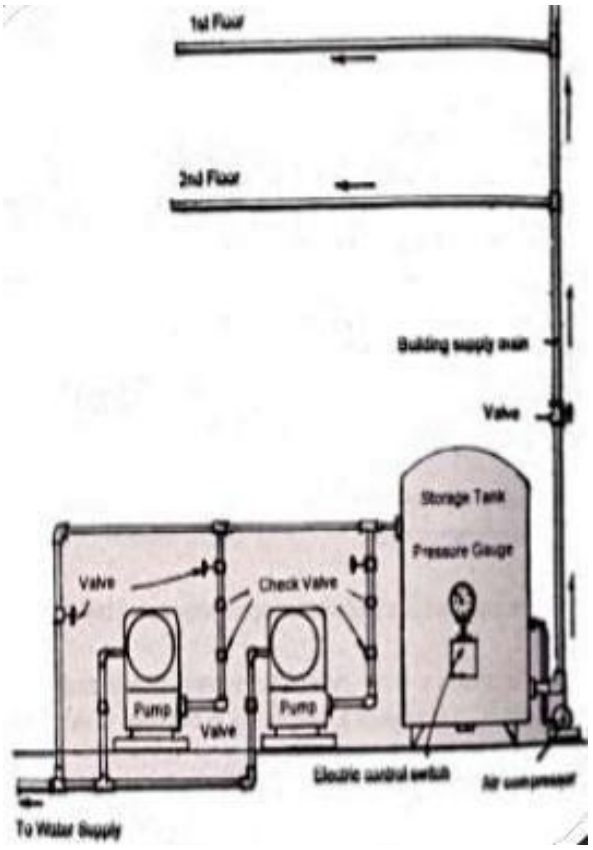
Advantages:-

- Withcompactpumpingunit
- Sanitaryduetotightwaterchamber
- Oxygeninthecompressedairservesaspurifyingagent
- Economicalassmallerpipedia.required
- Lessinitialconstructionandmaintenancecost

Disadvantages: -

- Water supply gets affected by loss of pressure inside the tank in case ofpower interruption.

BUILDINGSERVICES



Assignment:whatdoyoumeanbyvalves?Whyaretheyprovidedinpipelines? Explain the functions of different types of valves available with sketch.

HOT WATER SUPPLY – GENERAL PRINCIPLES FOR CENTRALPLANTS-LAYOUT : -

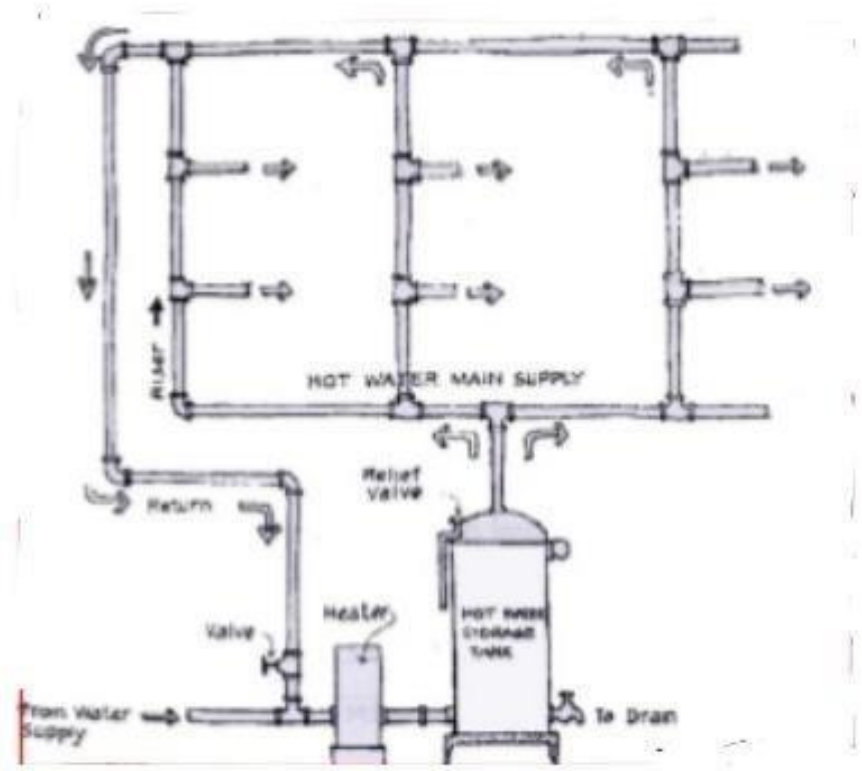
Therearebasicallytwotypesofhotwatersupplysystems,theyare

- Upfeedsystem
- Downfeedsystem

Upfeed system: -

- Thissystemrequiresacontinuingnetworkofpipestoprovideconstant circulation of water with sufficient pressure.
- Hotwaterrisesonitsownanddoesnotneedanypumpforitscirculation,
- Hotwatercanbeimmediatelydrawnfromthefixturesatanytime.
- Proveseconomicalasunusedcirculatingwaterreturnsbacktomainsupplypipe.
- Predominantlyusedformediumrisebuildings.(40-60fthigh)
- Pipe at the top of risers is usually large and size diminishes as it approaches tolower floors of building.

BUILDINGSERVICES

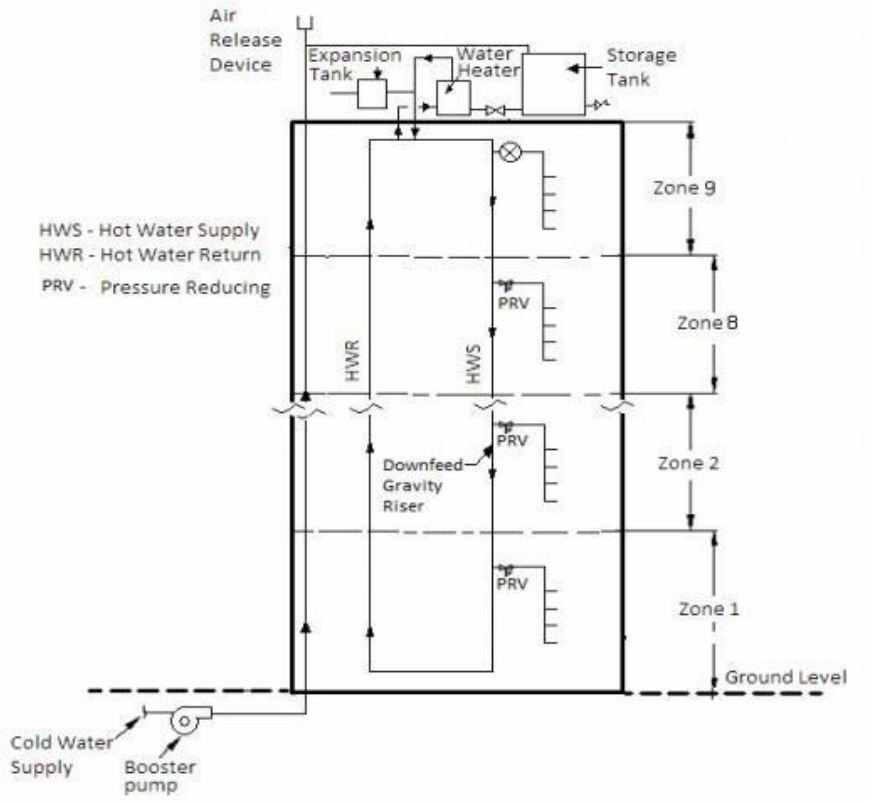


Downfeedsystem:-

- Inthissystem,hotwaterrisesontothehighestpointoftheplumbingsystemand travels to the fixtures by gravity (closed pipe system).
- Inthis,waterdistributionisdependentontheexpansionofhotwaterandgravity
- Larger pipes are installed at bottomof riser and size diminishes as it approaches towards the upper floors of building.
- Thissystemismoresuitableforverytallbuildingsi.e.above40-60ftheight.

Assignment:-writetheadvantagesanddisadvantagesofupfeedanddownfeedsystem of hot water supply.

BUILDINGSERVICES



SANITATIONINBUILDINGS:-

- **Waste**: Waste can be defined as used up unwanted and discarded solid, liquid or gaseous substances generated from a community which can create hazardous impact to the environment.
- **Sewage**: Sewage can be defined as the used water or liquid waste generated by the community which includes human and household waste together with waste fromthestreet washing,industrialpurpose,institutionalwaste,groundwaterand storm water.

Constituentsofwastewaterorsewage

a) Domesticsewage
b) Industrialwaste
c) Groundwaterorsubsoilwaterenteringintosewers
d) Stormwaterorrainwater
e) Irrigationreturnwater

Itrequirespropertreatmentbeforefinaldisposaltotheenvironment.

- **Sullage**: The liquid waste from kitchen, bathroom, wash basin are called sullage. Sullage can be carried in open drains and is not very foul smelling. So no treatment is needed before disposal. It does not include discharge from hospitals, operation theatres and slaughter house.

BUILDINGSERVICES

- **WaterPipe**:Awaterpipeisanypipeortubedesignedtotransporttreated drinking water to consumers. The varieties includes:
  a) Largediametermainpipewhichsupplyentiretown
  b) Smallerbranchlinesthatsupplyastreetorgroupofbuildings
  c) Smalldiameterpipelocatedwithinindividualbuildings

Materialscommonlyusedtoconstructwaterpipesinclude-castiron,polyvinyl chloride (PVC), copper, steel or concrete.

- **Soil Pipe**: The pipe which conveys the discharge of water closet or fixtures having similar functions with or without the discharge from other fixtures. The soil pipe also known as soil vent pipe. Soil pipes are vented high at the top or near to top of a building to allow gases produced by waste to vent safely into the atmosphere.
- **Waste pipe or Sullage pipe**: A waste pipe is often a similar diameter pipe that carries waste from sinks, washing machine, shower bath and any other appliance that uses water.
- **Vent Pipe**: A pipe in a sanitary pipe work system which helps in the circulation of air within the system and protects trap, seals from excessive pressure fluctuation.
- **Rain water pipe**: The pipe which carries rainwater from the roof and other part of a building to the building drain is called rain water pipe.
- **Sewer**: Sewer is a conduit or pipe usually circular laid below the ground level and generally slopping continuously towards the outfall. Sewers are generally designed to flow under gravity. Sewer can be divided into two categories.
  a) **Sanitary sewer**: It is a system of underground pipes that carries waste from bathrooms, sinks, kitchen and other plumbing component to a wastewater treatment plant.
  b) **Storm sewer**: It is designed to carry rainfall runoff and drainage. It is not designed to carry sewage.
- **Sewerage**: The entire system of conduits and appurtenances excluding for wastewater treatment is called „sewerage system".

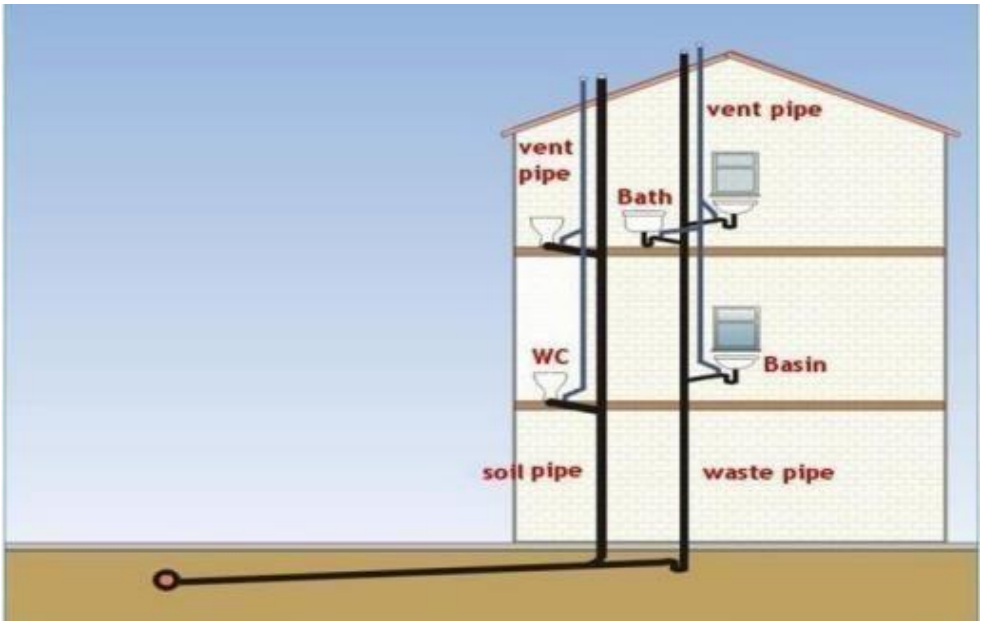
Therearefoursystemsofwastewaterinstallations/drainageplumbing.Theyare

- Twopipesystem
- Onepipesystem
- Singlestacksystem
- Partiallyventilatedsinglestack

Twopipesystem:

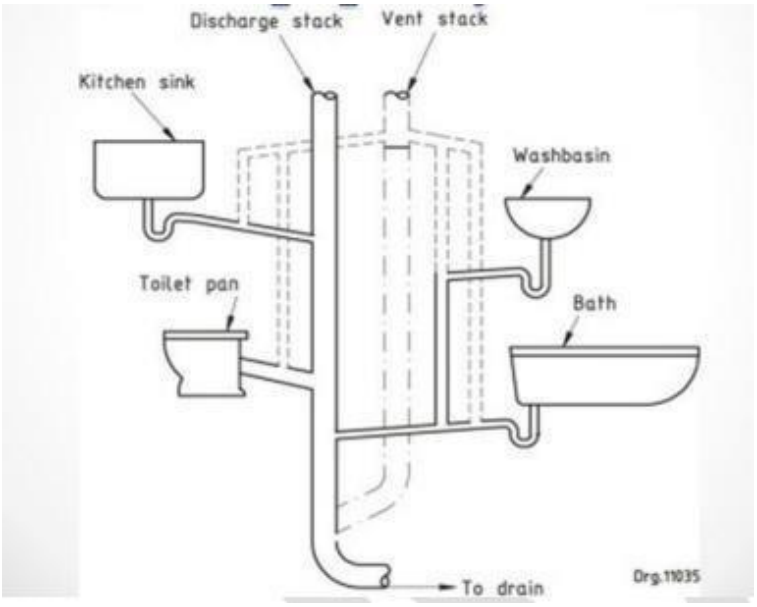
In this system, two different sets of vertical pipes are installed. One for draining night soil(humanexcreata)andtheotherfordrainingsullage.Thenightsoilcarryingpipes

are called Soil pipe and the pipes which carry sullage from bathrooms, kitchen etc. is called Sullage pipe or Waste pipe. The soil pipes as well as waste pipes are ventilated by providing separate vent pipes. This is best and most improved system of plumbing though it involves a large number of pipes and thus quite costly.



Onepipesystem:

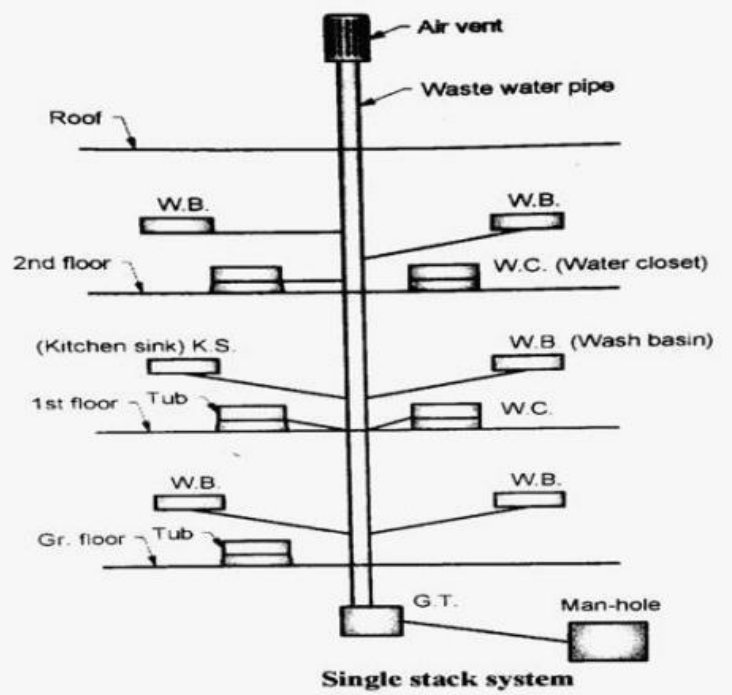
Instead of two separate pipes, in this system only one main vertical pipe is provided, which collects the night soil as well as sullage water from their respective fixtures through branch pipes. The main pipe is ventilated by providing cowl at its top. In addition to this, a separate vent pipe is also provided. This system requires fewer pipes than two pipe system.



BUILDINGSERVICES

Singlestacksystem:

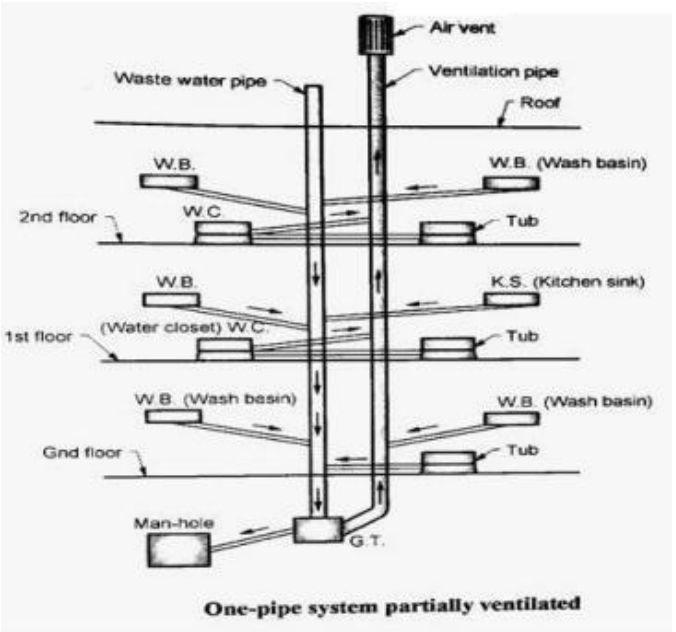
It is basically One pipe system, where the single pipe carries the sewage as well as the sullage. No separate vent pipe is provided here. Instead of providing separate ventpipe, the waste pipe is extended up to about 2m higher than the roof and provided with a cowl for removal of foul gases.



Single stack system

Partiallyventilatedsinglestacksystem:

This is an improved form of single stack system. In this system the traps of the water closets are separately ventilated by a separate vent pipe called relief vent pipe. The sullage fixtures are not connected to the vent pipe.



One-pipe system partially ventilated

BUILDINGSERVICES

LAYOUTANDTYPESOFELECTRICWIRING:-

Electrical wiring is an electrical installation of cabling and associated devices such as switches, distribution boards, sockets, and light fittings in a structure.Following arethe types of electric wiring,

- CleatWiring
- CasingandCappingWiring
- BattenWiring(CTSorTRS)
- ConduitWiring(SurfaceorConcealed)
- LeadSheathedWiring

Cleatwiring:-

In this, porcelain, wood or plastic cleats are fixed to walls or ceilings at regular intervals, i.e., 0.6 m between each cleat. PVC insulated cables are taken through the holes of each cleat and hence, the cleat supports and holds the wire.

This is an inexpensive method of wiring and is used for temporary installations. Therefore, it is not suitable for home electrical wiringand also it is an outdatedmethod.

CasingandCappingWiring:-

In this, cable is run through a wooden casing having grooves. The wood casing is prepared in such a way that it is of a required fixed length with parallel grooves that accommodates the cables. The wooden casing is fixed to the walls or ceiling with screws.

After placing the cables inside the grooves of casing, a wooden cap with grooves is placed on it to cover the cables. This is also a cheap wiring system, but there is a high risk of fire in case of short circuits.

BattenWiring:-

In this, insulated wires are run through the straight teak wooden battens. The wooden battens are fixed on the ceilings or walls by plugs and screws. The cables are fittedonto the battens by using tinned brass link clips.

BUILDINGSERVICES

These clips are fixed to the battens with rust-resistant nails. This wiring installation is simple and cheap as compared to other electrical wiring systems also takes less time to install. These are mainly used for indoor installations.

In this type of wiring, Cabtyre Sheathed Wire (CTS) or Tough Rubber Sheathed Wire (TRS) is generally used as the electrical conductor.

ConduitWiring:-

In this wiring, PVC cables are taken through either PVC conduit pipes or through steel conduit pipes. This conduit wiring can be either surface conduit wiring or concealed conduit wiring.

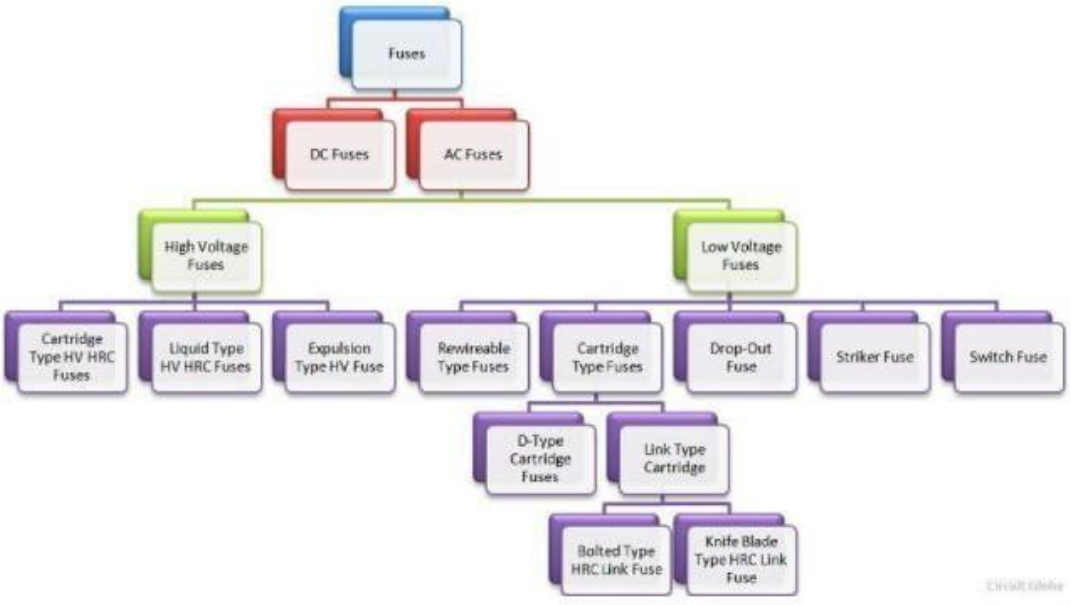
If the conduit pipes are run on surface of the walls and ceilings, it is called a surface conduit wiring. If the conduits are run inside the surface of the walls and ceilings and are covered with plastering, it is called as concealed conduit wiring.

FUSEANDTHEIRTYPES:-

A Fuse or an Electric Fuse is an Electrical / Electronic device that protects the circuit from different electrical faults like over current and overload. Fuses can be considered as a sacrificial element in the circuit as they act as a weak link in the entire circuit.

The principle of a fuse is based on the heating effect of the electric current. A simple fuse consists of a small conductive material with low resistance and it is placed inseries with the circuit.

Differenttypesoffusesare,



BUILDINGSERVICES

DCFuse

The DC fuse opens or breaks the circuit when the excessive current flow through it. The only difficulty with the DC fuse is that the arc produced by the direct current is very difficult to extinct because there are no zero current flows in the circuit. For reducing the DC fusearcing the electrodes are placed more distance apart due to which the size of the fuse increases as compared to AC fuse.

ACFuses

The AC fuses are categorised into two types they are the low voltage fuses andthehigh voltage fuses. The frequency of the AC fuses changes it amplitude from 0º to 60º in very one second. Thus, the arc extinction in the AC circuit can be done easily as compared to the DC circuit.

RewirableFuses

This type of circuit is mostly used in the small current circuit or for domestic wiring. The fuse case and the fuse carrier are the two main parts of the rewirable fuse. Thebase of the fuse is made up of porcelain, and it holds the wires which may be made up of lead, tinned copper, aluminium or alloy of tin-lead. The fuse carrier can be easily inserted or taken out in the base without opening the main switch.

CartridgeTypeFuses

The fuse element is totally enclosed in an enclosed container, and it has metal contacts on both sides. These fuses are further classified as D-type cartridge fuses and the Link type cartridge fuses.

D-TypeCartridgeFuses

The main parts of the D-type fuse are the base, adapter ring, cartridge and a fuse cap. The cartridge is kept in the fuse cap, and the fuse cap is fixed to the fuse base. The cartridge tip touches the conductor when it is completely screwed to the base and thus completes the circuit through the fuse links.

LinkTypeCartridgeorHighRupturingCapacity

In such type of fuses, the fuse element carries the fault current for a long duration. Ifthe fault is not clear, then the fuse element will melt and open the circuit. The major advantage of HRC fuse is that it clears the low as well as a high fault current.

BUILDINGSERVICES

DropoutFuse

The melting of fuse causes the fuse element to drop out under gravity about its lower support. Such type of fuse is used for the protection of outdoor transformers.

StrikerFuse

It is a mechanical device having enough force and displacement which can be used for closing tripping/indicator circuits.

SwitchFuse

Such type of switches is used for low and medium voltages circuit. The rating of the fuse unit is in the range of 30, 60, 100, 200, 400, 600, and 800 amperes. The fuse unitis available as 3-pole and 4-pole unit. The making capacity of such type of fuses is up to 46 kA. They can safely break depending upon rating currents of the order of 3 times the load current.

CartridgeTypeHVHRCFuse

ThefuseelementoftheHRCfuseiswoundintheshapeofthehelixwhichavoids the corona effect at the higher voltages. It has two fused elements placed parallel with each other, one of low resistance and the other is of high resistance. The low resistance wire carries the normal current which is blown out and reducing the short circuitcurrent during the fault condition.

LiquidTypeHVHRCFuse

Such type of fuses is filled with carbon tetrachloride and sealed at both the ends of the caps. When the fault occurs then the current, exceed beyond the permissible limit, and the fuse element is blown out. The liquid of the fuse acts as an arc extinguishing medium for the HRC fuses.They may be employed for the transformer protection and the backup protection to the circuit breaker.

ExpulsionTypeHVFuse

Expulsion type fuses are widely used for the protection of feeders and transformer becauseoftheirlowcost.Itisdevelopedfor11kV,andtheirrupturingcapacityisupto 250 MVA. Such type of fuses comprises a hollow open-ended tube made of synthetic resin-bonded paper.

The fuse elements are placed in the tubes, and the ends of the tubes are connected to suitable fittings at each end. The arc producing is blown off in the inner coating of the tube, and the gases thus formed extinguish the arc.

BUILDINGSERVICES

Requirementoflighting:-

The Requirements of good Light Good light is essential for efficient vision. Poor lightening lead to straining and eye fatigue. The following light factors are essential: 1.sufficiency 2.distribution 3.absence of glare 4.absence of sharp shadows 5.steadiness 6.coloroflight7.surroundings.

SufficiencySufficient light is essential to recognize the surroundings details without eyes straining. An illumination of 15-20 foot candles is accepted as a basic minimum for satisfactory vision.

DistributionFor efficient vision, lighting should be a uniform and of the same distribution all over the area without contrast; if not, eyes straining and fatigue occur.

AbsenceofglareGlare isexcessivecontrast.Glaremay befromthedirect light source or reflected from another object such a table tops and polished furniture. Glare causes annoyance. The eye can‟t tolerateglare because it causes acutediscomfort and reduces critical vision.

Absence of sharp shadows Slight shadows are inevitable; but sharp and contrasting shadowsaredisturbing.Shadowscausesconfusiontotheeyesandshouldn‟tbepresent in the vision field.

SteadinessThe source of the light should be constant; and it shouldn‟t flicker, because flickering causes eye strain and may lead to accidents.

Color of the light The colour of the light is not very important so long as the intensity is adequate. Since the natural light has a comforting effect onthe eye, the artificiallight should be as far as possible approximate the daylight colour.

SurroundingsFor efficient vision the colour schemes in rooms is very important. Room item reflection factor: - Roofs80 % Walls50 - 60 % Furniture30 -40 % Floor≤ (10 – 20 %)

Measurementoflightintensity:-

- Lumenisthemeasureoflightintensity
- Luxrepresents1lumenpersquaremeter.
- Thefundamental unitof lightisthe candela.Onecandelapersteradian istermed a lumen. One lux is one lumen per square meter.
- While lightoutput isexpressedin lumens,light intensityis measured intermsof lumens per square meter or lux.

BUILDINGSERVICES

VENTILATION:-

Ventilation moves outdoor air into a building or a room, and distributes the air within the building or room. The general purpose of ventilation in buildings is to provide healthy air for breathing by both diluting the pollutants originating in the building and removing the pollutants from it.

Naturalventilation:-

Natural forces (e.g. winds and thermal buoyancy force due to indoor and outdoor air density differences) drive outdoor air through purpose-built, building envelope openings. Purpose-built openings include windows, doors, solar chimneys,windtowers and trickle ventilators. This natural ventilation of buildings depends on climate, building design and human behavior.

Mechanical/artificialventilation:-

Mechanical fans drive mechanical ventilation. Fans can either be installed directly in windows or walls, or installed in air ducts for supplying air into, or exhausting airfrom, a room.

Thetypeofmechanical ventilationuseddepends on climate.Forexample,inwarmand humid climates, infiltration may need to be minimized or prevented to reduce interstitial condensation (which occurs when warm, moist air from inside a building penetrates a wall, roof or floor and meets a cold surface). In these cases, a positive pressure mechanical ventilation system is often used. Conversely, in cold climates, exfiltration needs to be prevented to reduce interstitial condensation, and negative pressure ventilation is used. For a room with locally generated pollutants, such as a bathroom, toilet or kitchen, the negative pressure system is often used.

In a positive pressure system, the room is in positive pressure and the room air isleaked out through envelope leakages or other openings. In a negative pressure system, the room is in negative pressure, and the room air is compensated by “sucking” airfrom outside. A balanced mechanical ventilation system refers to the system where air supplies and exhausts have been tested and adjusted to meet design specifications. The room pressure may be maintained at eitherslightly positive or negativepressure,which is achieved by using slightly unequal supply or exhaust ventilation rates. For example, a slight negative room pressure is achieved by exhausting 10% more air than thesupply in a cold climate to minimize the possibility of interstitial condensation. In an airborne precaution room for infection control, a minimum negative pressure of 2.5 Pa is often maintained relative to the corridor.

CONSTRUCTION AND EARTHMOVING EQUIPMENTS

CLASSIFICATION OF CONSTRUCTION EQUIPMENTS

1. EARTH MOVING EQUIPMENT
2. HAULING EQUIPMENT
3. HOISTING EQUIPMENT
4. CONVEYING EQUIPMENT
5. AGGREGATE AND CONCRETE PRODUCTION EQUIPMENT
6. PILE DRIVING EQUIPMENT
7. TUNNELING AND ROCK DRILLING EQUIPMENT
8. PUMPING AND DEWATERING EQUIPMENT
9. DREDGING EQUIPMENT

FACTORS AFFECTING SELECTION OF CONSTRUCTION EQUIPMENT

- USE OF EQUIPMENT AVAILABLE WITH THE ORGANIZATION
- SUITABILITY FOR JOB CONDITION WITH SPECIAL REFERENCE TO CLIMATIC AND OPERATING CONDITIONS
- UNIFORMITY OF TYPE
- SIZE OF EQUIPMENT
- USE OF STANDARD EQUIPMENT
- COUNTRY OF ORIGIN
- UNIT COST OF PRODUCTION
- AVAILABILITY OF SPARE PARTS AND SELECTION OF MANUFACTURERS

EARTH MOVING EQUIPMENTS:

The equipment which perform excavation digging of large quantities of earth , moving them t distances , placement , compacting, leveling dozing, grading, hauling etc., are called eart moving equipment.

CLASSIFICATION:

- EXCAVATING EQUIPMENT
- EXCAVATING AND EARTH MOVING EQUIPMENT

TYPES OF EARTH MOVING EQUIPMENTS

1. POWER SHOVEL
2. BULLDOZER
3. DRAG LINE
4. TRACTOR

POWER SHOVEL

- LONG-LASTING.
- EXCAVATE ALL TYPES OF EARTH EXCEPT HARD ROCK

TYPES:

- WHEEL MOUNTED (HIGH SPEED - FIRM GROUND)
- CRAWLER MOUNTED (LOW SPEED - UNSTABLE SOIL)

BASIC PARTS:

* TRACK SYSTEM
* CABLES
* BOOM FOOT PIN
* BOOM POINT SHEAVE
* CABIN
* RACK & STICK
* SADDLE BLOCK
* BUCKET (Size = .375 m^3 to 5 m^3)

POWER SHOVEL

OPERATION:

CABLE CONTROLLED & IT MAKES *OUTWARD STROKES* WHILE DIGGIN

APPLICATIONS:

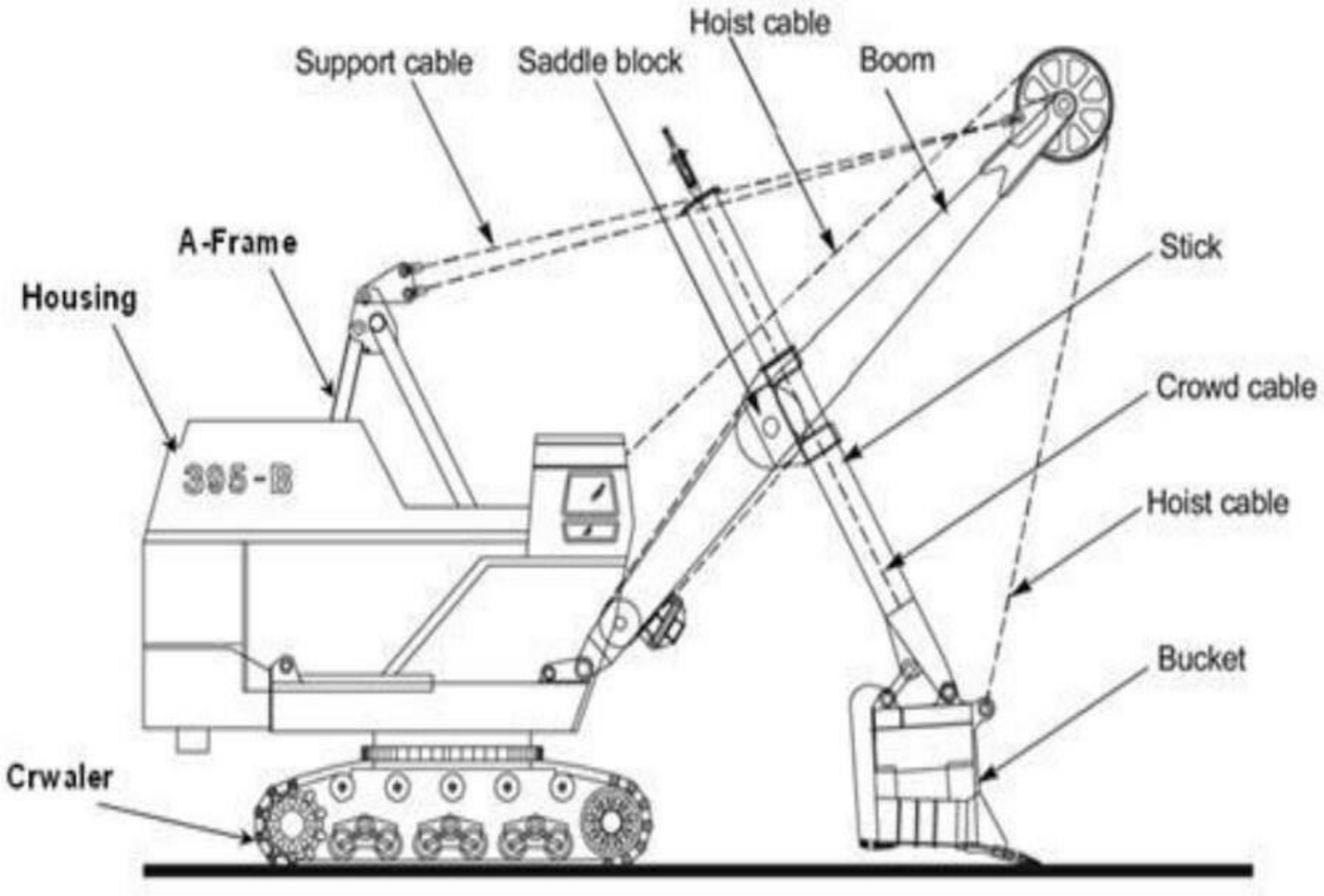
- CLOSE RANGE OF WORK.
- VERY HARD MATERIALS, BIG SIZED BOULDERS.
- DIGGING IN GRAVEL BANKS, CLAY PITS, CUTS IN ROAD WORKS, ROA

SIDE BERMS Etc.,

FACTORS CONTROLLING OUTPUT:

* CLASS OF MATERIAL
* DEPTH OF CUTTING
* ANGLE OF SWING
* SKILL OF OPERATOR
* SIZE OF HAULING UNITS
* JOB CONDITION

POWER SHOVEL



DRAG LINE

- The drag line is so name because of its prominent operation of dragging the bucket against the material to be dug.
- Unlike the shovel, it has a long light crane boom and the bucket is loosely attached to the boom through cables.
- Because of this construction, a dragline can dig and

DRAG LINE

BASIC PARTS:

* BOOM
* DRAG CABLE
* DRAG CHAIN
* HOIST CABLE
* HOIST CHAIN
* BUCKET

APPLICATIONS:

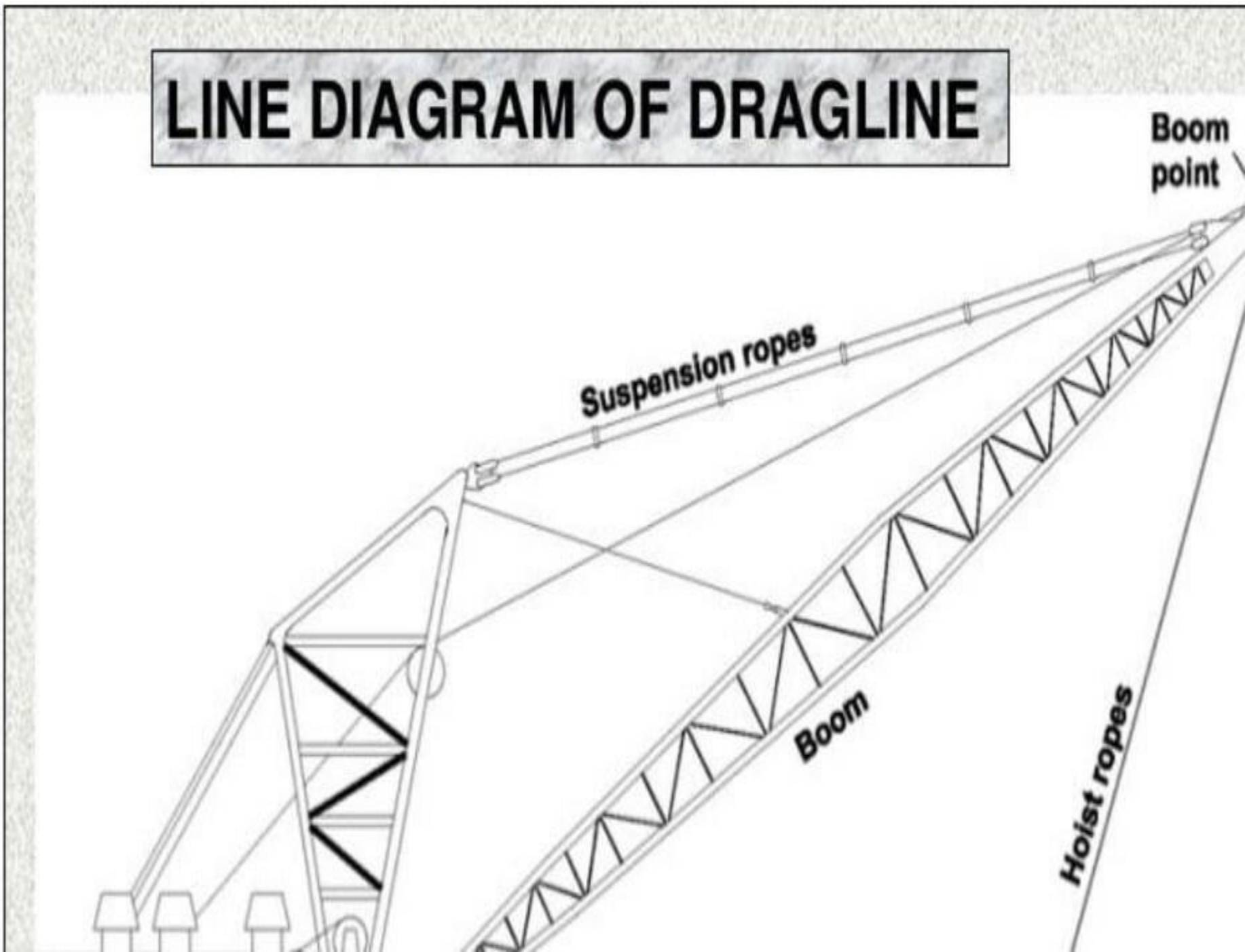
- Dragging softer material and below its track level
- It is very useful for excavating trenches when the sides a permitted to establish their angle of repose without shoring.

DRAG LINE

FACTORS CONTROLLING OUTPUT:

- TYPE OF MATERIAL
- DEPTH OF CUTTING
- SIZE AND TYPE OF BUCKETS
- SKILL OF OPERATOR
- SIZE OF HAULING UNITS & METHOD
- ANGLE OF SWING

LINE DIAGRAM OF DRAGLINE



BULL DOZERS

- VERSATILE EQUIPMENT- ESSENTIALLY A HEAVY STEEL BLADE MOUNTED ON THE FRONT OF TRACTOR.

CLASSIFICATION BASED ON:

POSITION OF BLADES
- PERPENDICULAR BLADES
- BLADES AT AN ANGLE

MOUNTING
- WHEEL MOUNTED
- CRAWLER MOUNTED

BULL DOZERS

CONSTRUCTION:

- CONSIST OF HEAVY BLADE WITH CONCAVE PROFILE.
- BLADE IS ATTACHED TO THE BODY WITH TWO ARMS, A SUPPORTING FRAME & HELD BY TWO PUSH ARMS

APPLICATION:

- SPREADING EARTH FILL

BULL DOZERS

TRACTORS

- MULTI PURPOSE MACHINES MAINLY USED FOR PULLING AND PUSHING OTHER MACHINES FOR AGRICULTURAL PURPOSES.

TYPES:

1. WHEEL TYPE (<50 km/Hr)
2. CRAWLER TYPE (<12 km/Hr)

APPICATIONS:

EARTH COMPACTION EQUIPMENTS

1. SMOOTH – WHEEL ROLLERS
2. SHEEP – FOOT ROLLERS
3. PNEUMATIC TYRED ROLLERS

SMOOTH – WHEEL ROLLERS:

- PLAIN STEEL ROLLERS
- SELF – PROPELLED (5 TO 25 TONNES)
- NO DEEP COMPACTION
- REAR WHEELS ARE LARGER IN DIAMETER AND THE FRONT ONES ARE WIDER
- DIESEL ENGINE TYPE
- COMPACTION IS BY STATIC WEIGHT OF ROLLER

SUITABILITY:

- GRANULAR SOILS

SMOOTH WHEEL ROLLER

SHEEP – FOOT ROLLERS

- HOLLOW STEEL DRUM WITH PROJECTED FEET MOUNTED AT 100 TO 200 MMC/C
- WEIGHT - 15 TONNES
- SPEED - 25 KM/HR
- COMPACTION IS BY KNEADING ACTION
- IN CONVERTIBLE ROLLERS THE FOOT PLATE CAN BE REMOVED

SHEEP – FOOT ROLLERS

PNEUMATIC TYRED ROLLERS

- ✓ CONSISTS OF A BASE PLATFORM MOUNTED BETWEEN TWO AXLES
- ✓ TRACKS OF THE REAR WHEEL LIE INBETWEEN THE TRACKS OF THE FRONT WHEEL
- ✓ COMPACTION IS BY CONTROLLING THE GROUND CONTACT PRESSURE
- ✓ WEIGHT OR WIDTH OF THE WHEEL CAN BE SUITABLY

PNEUMATIC TYRED ROLLER

SOILREINFORCINGTECHNIQUES

Necessityofsoilreinforcing:-

- Soil reinforcement is a technique used to improve the stiffness and strength of soil using geo-engineering methods.
- It is particularly useful in areas with soft soil as it cannot provide adequate support to any construction or building.
- With the help of this technique, we can increase the engineering property of soil such as shear strength, bearing capacity, reduction in permeability, reduction in compressibility, etc.
- Soilreinforcementisalsoaprocessofimprovingsoilstabilityagainstslopefailure.
- So, with the help of soil reinforcement, we can make more durable, stable, and free from the settlement.

Materialsofsoilreinforcement:-

There are 3main materialswhichare commonly usedintheconstruction of reinforced soil. They are: -

- Soilorfill matrix
- Reinforcementoranchorsystem
- Geosynthetics

Soil or fill matrix: -

It means using well graded cohesionless or good cohesive frictional soils because of the following advantages like.

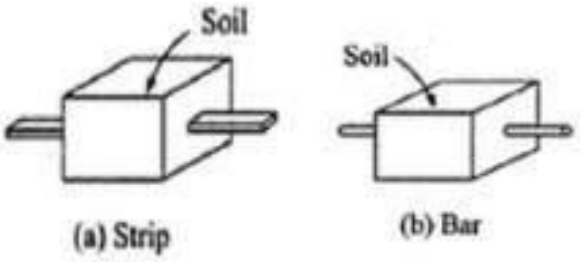
- Theyarestable
- Freedraining
- Notsusceptibletofrost
- Relativelynoncorrosivetoreinforcingelements

Reinforcement or anchor system: -

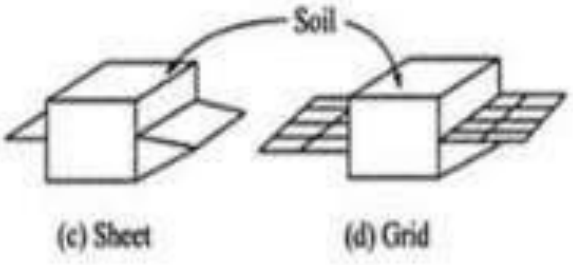
Awiderangeofmaterialssuchassteel,glass,concrete,fibre,wood,aluminium,rubber and thermoplastics can be used as reinforcing agents. These reinforcements can take the structural forms of strips, grids, sheets or a combination of these.

- Strips:- These are flexible linear elements, having their thickness less than their breadth. They can be comprised of copper, polymers, aluminium, glass fibreorbamboo.Galvanisedorcoatedsteelstripsarepairedwitheitherplain or with projects to increase the friction between reinforcement and fill.

SOILREINFORCINGTECHNIQUES



- Grids: - Grids are also used as reinforcements. They consist of steel (in the form of plain or galvanised weld mesh/ expanded metal).



- Sheets:- Thisreinforcementmay be formedfrom fabricor metals suchas galvanised steel sheet and expanded metals.

Similarly, composite reinforcements can be developed by using different materials and forms to suit the soil conditions. The principal requirements of reinforcing materials are their strength, stability, durability, handling, coefficient of friction and soil compatibility. Factors such as cost and availability are also accounted for while choosing the soil reinforcement materials.

Geosynthetics:-

Geosynthetics refers to man made products; they are flexible in nature and planar (sheet like). These materials are manufactured from synthetic polymers and sometimes are comprised of natural materials. These are vital in the engineering field as they are used as filters, drains, reinforcements, barriers and have erosion control applications.

Geotextiles are a permeable synthetic textile material; this is generally produced from polyester or polypropylene polymers. These are used to increase the overall soil strength, stability, prevent erosion and aid in drainage. A range of geotextiles can be produced using various manufacturing processes anddifferent polymers; they can bewoven ornon-woven.Woven geotextiles aremadeby interlacing 2ormorefibres (atright angles).Non-woven geotextiles are produced by mechanical bonding or needle punching.

Geogrids is a geosynthetic material with a mesh like structure which has square or rectangular openings that are larger than the thickness of the ribs. The thickness of ribs ranges from 5 to 15mm, and the mass varies from 200 to 1500gms.

SOILREINFORCINGTECHNIQUES

Effectpfsoilreinforcement:-

- Reinforcementimprovesthestrengthandbearingcapacityofthesoil.
- The increased numbers of layers and confining pressure lead to an improvement in the performance of reinforced soil.
- Compaction behavior of soil is affected by fibre inclusion with an increase of fibre content dry density is reduced and a marginal increase inoptimummoisture content (OMC) is noted.
- Fibre reinforcement increases the tensile strength of soil with an increase in dry density.
- It is observed that the stress-strain behaviour of soil has changed from brittle to ductile with the inclusion of basalt fibre.

Applicationsofsoilreinforcement:-

Embankmentsonweakfoundations:

The main challenge for embankmentsonweaker foundations such as airports near softor sandy ground is to reinforce the soil and stabilise it.

Retainingwalls:

Geotextiles are combined with different kinds of wall applications such as on-site fills to reinforce the supporting walls. Geotextile provides an alternative to traditional methods such as cast-in-place concrete structures for retaining walls.

SubgradeStabilising:

For soft and organic soils, the tensile strength is low. The cost required for traditional land filling can be up to 50% higher than the cost of soil reinforcement with geotextiles. Geotextiles can be utilised to disperse the load uniformly within the soil and reduce the displacement of small soil particles.

ReinforcingBaseCourse:

By increasing tensile strength of granular base course material, the overall load bearing capacity of soft soil is improved. The use of geotextiles increases the tensile strength by increasing its load bearing capacity at the granular base structure. A grid is commonly used for this.

SteepingSlopes:

Layers of geotextiles are placed methodically on the land to steepen soil slopes. This achieves overall increase of tensile strength without the risks of soils sliding or rotating.