PART - A

1.1 (a) Fibres

Def":- Fiber or fibre is a natural or synthetic substance that is significantly longer than it is wide. fibres are often used in manufacture of other materials. The strongest engineering material often incorporate fibres, for example:- carbon-fibre and ultra high-~~molecular~~ molecular weight polyethylene.

Uses of fibres as construction material

→ Fibre is a small piece of reinforcing material possessing certain characteristics properties. They can be circular or flat. The fibre is often described by a convinient parameter called "aspect ratio". The aspect ratio of the fibre is the ratio of its length to its diameter. Typical aspect ratio ranges from 30 to 150.

→ Fibre reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. fibres include steel fibres, glass fibres, synthetic fibres and natural fibres. Within these ~~fibres~~ the different fibres the character of fibre reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation & densities.

→ Fibre reinforcement is normally used in shotcrete but can also be used in normal concrete. Fibre reinforced normal concrete are mostly used for on-ground floors and pavements, but can be considered for a wide range of construction parts (beams, pillars, foundations etc) either alone or ~~be~~ with hand tied rebars.

→ Concrete reinforced with fibres (which are usually steel, glass, or plastic fibres) is less expensive than hand-tied rebars, while still increasing the tensile strength many times. Shape, dimension and length of fibre is important. A thin or short fibre, example:- short hair-shaped glass fibre, will only be effective the first hours after pouring the concrete (reduces cracking while the concrete is stiffening) but will not increase the concrete tensile strength.

~~1.1 (b) Plastics~~ #2. Prefabrication

Fabrication

Def":- Manufacturing process in which an item is made (fabricated) from raw or semi-finished materials instead of being assembled from ready-made components or parts is called fabrication.

~~Classify~~ Classification of process of Prefabrication

Fabrication is the act of taking raw stock material and turning into a part for use in an assembly process. There are many different types of fabrication processes. The most common are —

1. cutting
2. Folding
3. Machining
4. Punching
5. Shearing
6. Stamping
7. Welding

1. Cutting :- There are many ways to cut now-a-days. The old standby is the saw. Others now include plasma torches, water jets and lasers. There is a wide range of complexity and price, with some machines costing in the millions.

2. Folding :- Some parts need to be bent. The most common method is a press brake (or brake press). It has a set of dies that pinches the metal to form a crease. This operation can only be performed in very specific cases due to the movement of the part and the possible shape of the dies. Designing for lean manufacturing though, can help prevent complex shapes that slow down production. Sometimes using two different types of fabrication processes on two different pieces fastened together work better than one complicated piece.

3. Machining :- This is the process of removing metal from a piece of material. It might be done on a lathe, where the material rotates against a cutting tool, or in some other cutting machine where a rotating tool is moved in a variety of ways against a stationary piece. Drills fall into this latter category. The range of motion of the cutting head is defined by the number of axes (i.e. a 3 axis machine).

4. Punching :- Punching is the act of a punch and a die forming a "scisson" effect on a piece of metal to make hole in it. Obviously the punch and die must be of the same shape & size of the desired hole. In some cases, the main piece of material is kept, as in when hooks are added for fastners. In other cases, the piece that is removed is the desired product and is called blanking.

5. Shearing :- Shearing is the process of making a long cut on a piece of metal. It is infact, just like the action of those paper cutters with the long chop handle. This is done on sheet metal.

6. Stamping :- Stamping is very similar to punching except the material is not cut. The die is shaped to make a raised portion of material rather than penetrating.

7. Welding :- Welding is the act of joining two pieces of metal together. A variety of welding exist for use in different applications and for the range of metals used in manufacturing.

Advantages & Disadvantages of ~~fabrication~~ Prefabrication

Advantages

1. Moving partial assemblies from a factory often costs less than moving pre-production resources to each site.

2. Deploying resources on site, can add costs; pre-fabricating assemblies can save costs by reducing on site work.

3. Factory tools - jigs, cranes, conveyors etc can make production faster & more precise.

4. Factory tools - shake tables, hydraulic testers etc can offer added quality assurance.

5. Consistent indoor environments of factories eliminate most impacts of weather on production.

6. Cranes and reusable factory supports can also allow shapes and sequences without expensive onsite falsework.

7. Higher precision factory tools can add more controlled movement of building heat & air, for lower energy consumption & healthier buildings.

8. Factory production can facilitate more optimal material usage, recycling, noise capture, dust capture etc.

9. Machine mediated parts movement and freedom from wind & rain can improve construction safety.

Disadvantages

1. Transportation costs may be higher for voluminous prefabricated sections than for their constituent materials which can often be packed more densely.

2. Large prefabricated sections may require heavy duty cranes & precision measurements and handling to place in position.

Prefabrication

Def^n :- Prefabrication is the practice of assembling components of a structure in a factory or other manufacturing site and transporting complete assemblies or sub-assemblies to the construction site where the structure is to be located. The method controls construction costs by economizing on time, wages and material. Prefabricated units may include doors, windows, walls, wall panels, roof trusses etc.

Materials used in Prefabrication System

1. Concrete 2. Steel 3. Treated wood 4. Aluminium 5. Cellular Concrete
6. Light weight concrete element 7. Ceramic Products

→ Prefabricated metal buildings use galvanized steel and galvalume as the chief materials for buildings. Galvalume is a form of steel coated with aluminium zinc. This is to protect building against rust & fire.

→ It also provides a sturdy and protective covering to the prefabricated building. Almost all components of metal building such as beams, frames columns, wall & roofs are made of steel. Most fabricated military buildings use steel or aluminium frames. Synthetic materials are used for walls & roofs.

→ To provide enhanced security a combination of both metal & cloth materials used. Plastic flooring materials can be quickly assembled and are very durable. Prefabricated building materials used for small prefabricated buildings are steel, wood, fibre glass, plastic or aluminium materials.

→ These materials are cheaper than regular brick and concrete buildings. Materials like steel, fibre glass, wood and aluminium are used as Prefabricated building materials for sports buildings. These materials provide flexibility and preferred for making structures and accessories like stands and seats for stadium & gyms.

(14)

→ For low cost house moving prefabricated materials like bhaan brick ferrocement consists of a cement matrix reinforced with a mesh of a closely spaced iron rods or wires. In this type of construction the techniques used are simple & quick. Using prefabricated material one can make durable, cooler & fire resistant and cheap prefabricated buildings. Most of the prefabricated building materials are also eco-friendly & affordable.

1.1 (b) Plastics

Types of plastics used as construction materials

The various types of plastics used are as follows :-

(i) Polyethylene plastic (PE) :- Polyethylene plastic is made from the polymerized vinyl monomers.

Monomer is a kind of simple compound, which can be polymerized to become macromolecular compound. Three ways are used to polymerize the monomer: high-pressure process, middle-pressure process and low-pressure process.

Different ways make different degrees of crystallinity and density. High pressure polyethylene has low crystalline and density while low-pressure polyethylene has high crystallinity and density. As the crystallinity and density increases, on one hand, the hardness, softening point and strength increase accordingly; on the other hand, the impact toughness and elongation decrease.

Polyethylene plastic has better chemical stability and water resistance. Even though its strength is not high, it is quite flexible in low temperature. A certain amount of carbon black can strengthen the aging resistance of polyethylene.

(ii) Polyvinyl plastic chloride (PVC) :- Polyvinyl plastic chloride is a kind of common building plastic made from the polymerized vinyl chloride monomer. Polyvinyl chloride plastic has better chemical stability and aging resistance but poor heat resistance. It may decompose and metamorphose if the temp^{n} exceeds 100°C. Usually, it should be used at temp^{n} of below 60-80°C. By adding different amounts of plasticizer, hard and soft polyvinyl chloride plastic can be made.

(iii) Polystyrene Plastic (PS) :- Polystyrene plastic is made from the polymerized styrene monomer. It has the merits of good light transmittance, easy pigmentation, better chemical stability, water resistance, light resistance, easy processing and low price.

However polystyrene plastic has the disadvantages of weak stiffness, poor impact toughness, weak heat resistance and easy flammability. These weak points set resistance to its use.

(iv) Polypropylene plastic (PP) :- Polypropylene plastic is made from the polymerized acrylic monomer. It has the properties of light weight (density 0.90 gm/cm^3), strong heat resistance (100-120°), regular ductility and water resistance. The weak points are that it has poor stiffness in low temp^{n} and poor air resistance. Therefore, polypropylene plastic is fit to be used indoors. Recent years have seen

the rapid development of polypropylene. Polypropylene together with polyethylene and polyvinyl chloride, has become the main varieties of building plastics.

(v) Polyster Resin (PR) :- Polyster resin is made by condensing dicatomic or polybasic alcohol and diatomic or polybasic acid. Polyster resin has the properties of good bonding capacity, elasticity, better colourcebility, flexibility, heat resistance and water resistance.

(vi) Phenolic Resin (PF) :- Phenolic resin is made by polymerizing phenol and aldehyde under the influence of acid catalyst or alkaline catalyst. Phenolic resin has better corrosion strength, light resistance, water resistance, head resistance, corrosion resistance and electrical insulation. However, it has poor stiffness. Phenolic resin added by filling material and curing agent, can be made into phenolic plastic. Phenolic plastic is smooth, strong, durable and cheap. It has become a type of commonly used plastic.

(vii) Organic Silicon Resin (SI) :- Organic silicon resin is made by hydrolysing of one or more types of organic silicon monomer. Organic Silicon resin has the properties of head resistance, cold resistance, water resistance and corrosion resistance. However it is poor in mechanical performance and cohesive force. These two weak points can be improved by adding synthetic resin (phenolic aldehyde, epoxy and polyster), glass, fibre and asbestos etc.

Uses of plastics in construction

Applications of plastic in civil engineering / building construction are many. The prime reason for this is the property of plastics which makes it durable, non-corrosive, low cost and many others.

i. Concrete and mortar with thermosetting resin bonding agents.

ii. Thermoplastic and thermosetting resin covering applicable to facades and concrete epidemics.

iii. New roof covering and roof tightening materials (accessory covering materials tightness network) easy to place and standing up well to normal to severe.

iv. Large foam component units and new shaping techniques.

v. Developing techniques for quick shaping of plastic into large components.

vi. Assembling and fixing processes more suitable for plastics.

vii. New developments in sanitary equipments and piping, applying thermoplastic and thermosetting resins.

viii. New developments in the way of shuttering and of elements in permanent shuttering.

1.2 Artificial Timber

Properties

The quality of timber must be ensured before using it for a purpose. The quality can be ensured by investigating the properties of timber. The properties are as follows :-

I. Colour :- colour is a uniform property by which most trees are characterised as they show variation from tree to tree. Light colour indicates weak timber. eg :- freshly cut teak, deodar and walnut have a golden yellow, wheatish and dark brown shades respectively.

II. Appearance :- Smell is a good property as timbers for few plants as they can be identified by their characteristic aroma. Fresh cut timbers have a good smell. for eg. resinous smell from pine.

III. Hardness :- For the resistance of any kind of damage, hardness is an obvious property.

IV. Sp. gravity :- Variation of timber in specific gravity (0.3 - 0.9) is found. It depends on pores present inside the timber. The sp. gravity of the light material is less than that of water (<1). But incase of compact wood where pores are almost absent and become heavier, their sp. gravity increases upto 1.5.

V. Moisture content :- Timbers are hygroscopic and gain water from nature (atmosphere). The absorption of water or dehydration depends on atmospheric humidity. If timbers moisture content is high that means quality is low. water content is the risk of fungal attack.

VI. Grain :- Several types of grain arrangement is found. On the grain structure quality of timber varies. Grain remains closely related.

* Straight grain :- Arrangement of vascular tissue is important which grow parallel to the length of timber that is termed as straight grain.
* Course grain :- vascular tissue and fibre arranged broadly & widely.
* Interlocked grain :- Instead of parallel arrangement twisted, a spiral arrangement may be found.

VII. Shrinkage and Swelling :- The percentage of shrinkage and swelling varies from plant to plant. Some give higher percentage after drying. Shrinkage starts when cell walls of timber start to release water. On atmospheric moisture timber swell when cell walls absorb water. Good quality timber swell less. Timbers having thicker wall swell more than thinner one.

VIII. Toughes :- Timber has to have the capability to bear shocks, jerk, anti-bending, and split ting characteristic is needed. Old timbers have annual rings which indicate their age.

ix. Strength :- Best quality timbers have the highest strength. Strength means capable to bear loads. Some types of strength of timber are -

* Comp. strength :- 500 kg/cm² to 700 kg/cm² load is enough to test timber strength.
* Tens. strength :- 500 - 200 kg/cm² is the range of tensile strength.
* Transeverse strength :- Enough bending stress indicates good quality timber.

x. Density :- Timbers having higher density have thicker walls. There may be some of the natural and artificial defects in timber such as cross-grain, knots, and shakes etc. All of them cause a decrease in the strength of timber.

xi. Elasticity :- Another property is elasticity which means timber should attain it's own shape after use. Because of this quality it is used in sports boat.

xii. Warping :- Environmental change with season can't effect good quality timber.

xiii. Durability :- A good quality timber has the property to resist the attack of fungus and other insects. The resistance quality makes the timber better.

xiv. Workability :- A good timber is always easy to work on it. Easy to drag using saw on good timber. The finishing can be done well.

xv. ~~Soundness :- A good~~

xv. Texture :- A good quality timber is fine and even.

xvi. Free of abrasion :- Timber should not be damaged by external environment. It has to gain ability to protect it's skin.

Uses

Following are the uses of timber.

i. Air dispensers (eg. aquariums)
ii. Boat & ship construction
iii. Cladding
iv. Blacony, decks & terraces
v. Cabinet making
vi. Fencing
vii. Flooring
viii. Furniture
ix. Log cabins
x. Musical instruments
xi. Paper & paper products
xii. Power poles
xiii. Windows & doors
xiv. Scaffoldings

1.3 Miscellaneous Materials

* Acoustic Materials

→ Acoustic materials are those materials which protect building from noise & sounds. The noise can be diffused, echoes can be emitted & vibrations of sounds can be dampened using several types of acoustical materials for different purposes. It is necessary to use these materials in cinemas & recording studios for best sound quality.

→ Uses of acoustic materials can be devided into 3 categories.

* Sound proofing
* Sound absorption
* as diffusers of sound waves.

→ Following are the acoustic materials

* Sound absorbing underlayment
* Acoustic brass traps
* Rigid fibre glass insulation
* Acoustic polyster panels.

* Micro-silica

Micro-silica, also known as silica fumes is fine amorphous silica. Added to concrete around 20kg/m³. It changes the rheology and reacts with cement hydration products to dramatically improve concrete strengths durability and impermeability, allowing concrete to be used in ways never before possible.

* Artificial Sand

It is an substitute for river sand, it is also known as fine aggregates which is manufactured by crushing either granite or basalt rock using 3 stages crushing process by some companies. This sand is manufactured in conformance to IS code and is an effective alternate to river sand & popularly known as "M sand".

* Cladding

→ Cladding is the application of one material over another to provide skin or layer intended to control infiltration of weather elements or ~~to control~~ condition but is instead a control element. This control element may only serve to safely direct water or wind in order to control runoff and prevent infiltration into the building structure. This is also a control element to prevent noise from entering or escaping. Cladding applied to windows is often referred to as window capping and is a very specialized field.

→ The various types of cladding are as follows :-

1. Stone cladding
2. Wood cladding
3. uPVC cladding
4. Tile cladding
5. Glass cladding
6. Aluminium composite panel (ACP)
7. Ceramic cladding
8. Porcelain cladding.

i. Building Configuration

→ Buildings having simple regular geometry & uniformity distributed mass & stiffness in plan as well as in elevation, suffer much less damage is known as building configuration.

→ The configuration of building (plan & elevation) should be as simple as possible.

→ The formation should generally be based on hard & uniform ground.

→ The members resisting horizontal forces should be arranged so that the torsional deformation is not produced.

→ Structure of building should be dynamically simple & definite.

→ The frame of building structures should have adequate ductility in addition to required strength.

→ The buildings shaped like a box such as rectangular in both plan & elevation is inherently stronger than one that is U-shaped i.e a building with wings.

→ The effects give origin to undesired stresses concentration in some resisting members of the building.

ii. Lateral Load Resisting Structures

→ The first step in architectural planning of a building is to select the lateral load resisting system.

→ The load resisting system must be closed loops, so that it is able to transfer all forces acting either vertically or horizontally on ground.

→ BIS has approved 3 major types of lateral resisting system. Such as

1. Moment resisting frame
2. Bearing wall system
3. Dual system.

iii. Building characteristics in earthquake resistant construction

The following assumptions should be made in the earthquake resistant-design of structure.

→ Earthquake causes impulsive ground motion which are complex & irregular in character. Changing in period and amplitude each lasting for a small duration. Therefore, resonance of the type as visualized under steady state sinusoidal excitations will not occur as it would need time to build up such amplitudes.

→ Earthquake is not likely to occur simultaneously with wind or maximum flood or maximum sea waves.

→ The value of elastic modulus of materials, whenever required may be taken as for static analysis unless a more definite value is available for use in such condition.

~~available fo~~

iv. Structural Irregularities In Buildings

→ A building that lacks symmetry and has discontinuity in geometry, mass or load resisting elements is called irregular. The irregularities may cause interruption of force flow & stress concentration. A symmetrical arrangement of mass & stiffness of element may cause a large torsional force.

→ IS 1893 (Part-1) : 2002 enlists the irregularities in building configuration system. These irregularities may be classified as follows.

1. Horizontal Irregularities :- Refers to sudden change of strength stiffness, geometry and mass which results in irregular distribution of forces and deformation over the height of building. They are also known as Plan irregularity or Plan configuration problems. and they are as follows :-

* Torsion Irregularity :- Torsion irregularity is considered when the floor diaphragms are rigid in their own plan in relation to vertical structural elements that resists the lateral forces. Torsion irregularity is considered to exist when the maximum storey drift, computed with design eccentricity at one end of the structure transverse to axis is more than 1.2 times of the average of the storey drifts at two ends of the structures.

* Diaphragm Discontinuity :- Discontinuity in diaphragm stiffness leads to plan irregularity. The diaphragm is a horizontal resistant element that is responsible for transferring forces between vertical resistant elements. The diaphragm discontinuity may occur with abrupt variation in stiffness including those having cut out or open area greater than 50% of the gross enclosed diaphragm area, or change in effective diaphragm stiffness of more than 50% from one storey to the next.

The diaphragm acts as a horizontal beam & its edges acts as flanges. It is obvious that openings cut in the tension flange of a beam seriously weaken its load carrying capacity. In a number of buildings, there have been evidence of roof failures which is caused by tearing of diaphragms.

* Re-entrant corners :- The re-entrant or inward cutting corner is a common irregularity in overall building configuration that in plan, assume the shape of L, T, H, + or combination of these shapes resulting in lack of tensile capacity and force concentration. When an otherwisely regular buildings has a large re-entrant corner, wings of the buildings tend to vibrate in a manner different from that of the entire building and hence a building is treated as irregular when

off-set dimensions exceeds certain limits. According to IS 1896 (Part-1):2002, plan configuration of a structure and its lateral force resisting system contain re-entrant corners, where both projections of structure beyond re-entrant corners are greater than 15% of its plan dimensions in the given direction.

The re-entrant corners of the buildings are subjected to 2 types of problems. The first is that they tend to produce variations of rigidity & hence differential motions between different parts of the building, resulting in a local stress concentration at the notch of the re-entrant corners. The second problem is torsion. The magnitude of the induced forces depends upon mass of the building, structural system, length of the wings and their aspect ratios, height of the wings and their height depth ratios. Examples of damage to re-entrant corner buildings are common & to avoid this type of damage, either a separation joint between two wings of the buildings are provided or the buildings are tied together strongly in the region of stress concentration and locate resistant elements so as to increase tensile capacity of re-entrant ~~corner~~ corners.

* Projections :- All projections (vertical & horizontal) are most vulnerable to damage during earthquakes. As they are basically cantilevers, there is no redundancy and hardly any ductility at their junctions with the main structure. Design of structures is to be made taking five times the seismic co-efficient in line with the international practice.

* Non-parallel systems :- In this case, the vertical load resisting elements are not parallel or symmetrical about the major orthogonal axis of the lateral force resisting system. Such situations are often faced by architects and these lead to high probability of torsional forces under a ground motion because the centre of mass and centre of resistance do not coincide. This problem is often ~~exagging~~ exaggerated in the triangular or wedge shaped buildings resulting from street intersections at an acute angle. The narrower portion of the building will tend to be more flexible than the wider ones, which increases the tendency of torsion. In the design of such types of buildings, special care must be exercised to reduce the effect of torsion or to increase torsional resistance of the narrow parts of the buildings.

2. Vertical Irregularities :- Refer to sudden change of strength, stiffness geometry and mass which results in irregular distribution of forces and deformation over the height of building. Following are the vertical irregularities ;

* Vertical discontinuities in load path :- One of the ~~most~~ major causes to structural damage in structures during strong earthquake is the discontinuities or irregularities in the load path or load transfer. It is desirable that the structure should contain a continuous load path for transfer of the seismic forces, that develops due to acceleration of individual elements to the ground. Failure to provide adequate strength and toughness of individual elements in the system of failure to the individual element together can result in distress or complete collapse of the system. Therefore all structural or non-structural elements must be adequately tied

to the structural system to act as a unit. The load path must be complete & sufficiently strong. The sequence of general load path is as follows :-

* Earthquake forces, originate in all elements of the building are delivered through structural connections to horizontal diaphragms.

* The diaphragms distribute these forces to vertical resisting components such as columns, shear walls, frames & other vertical elements in the structural system which ultimately these forces into the foundation.

The examples of load path irregularities are discontinuous columns, shear walls, bracings, frames that arises in a floating box type situation.

* Irregularities in Strength & Stiffness :- The presence of a weak or soft storey in a building contributes to irregularity in either strength or stiffness. A weak storey may be defined as one in which the storey's lateral strength is less than 80% of that in the storey above, where as a soft storey is one in which the lateral stiffness is less than 70% of that in the storey immediately above or less than 80% of the combined stiffness of the three storey above.

Here the storey's lateral strength is the total strength of all seismic resisting elements sharing the storey shear for the direction under consideration i.e the shear capacity of the columns or the horizontal components of the axial capacity of the diagonal braces. The deficiency that usually makes the storey weak is inadequate strength of frame columns. Thus, the essential characteristics of a weak or soft storey consists of a discontinuity of strength and stiffness, which generally occurs at the second storey connections. Of course, this continuity caused by lesser strength or increased flexibility of the structure results in extreme deflections in the first storey of the structure which in turn results in concentration of forces at the second storey connections. The result is a concentration of inelastic action.

However, the soft storey concept has technical and functional advantages over the conventional construction.

1. First, is the reduction in spectral acceleration and base shear due to increase of natural period of vibration of the structure as in a base isolated structure. But the advantage of this force reduction is nullified by an increase in structural displacement & inter-storey drift which is a threat to stability of the structure.

2. Secondly, a taller first storey is sometimes necessitated for parking of vehicles and/or retail shopping, large space for meeting room or a banking hall. Due to this functional requirement, the first storey has lesser stiffness of columns as compared to stiffness of upper floor frames which is generally constructed with masonry infill walls.

The failure of reinforced concrete buildings due to soft storeys have remained the main reason in past earthquake. Undoubtedly, it is recognised that this type of failure results from the combination of several other unfavourable reasons such as torsion, excessive mass on upper floors. P-Δ effect and lack of ductility in the bottom storey. These features lead to local stress concentration accompanied by large plastic deformations. Therefore, the soft storeys deserve a special consideration in analysis design and it is not always necessary that all storeys of the buildings are soft storey; if the columns of the first storey have been designed on the basis of capacity of ductility.

* **Mass Irregularity** :- Mass irregularity is induced by the presence of a heavy mass on a floor like swimming pool. As per IS 1893, mass irregularities are considered to exist where the effective mass of any storey or floor is more than twice the effective mass of adjacent storey or floor. However, NEHRP defines it when the weight exceeds 150% of that of the adjacent floor / storey.

Here the effective mass is the real mass consisting of the dead weight of the floor plus the actual weight of the partitions & equipments. Excess mass can lead to increase in lateral inertial forces, reduced ductility of vertical load resisting elements & increased tendency towards collapse due to P-Δ effect.

Irregularity of mass distribution in vertical and horizontal planes can results in irregular responses and complex dynamics. The characteristic characteristics swaying mode of a building during the earthquake implies that masses placed in the upper storey of the building produce considerably more unfavourable effects than masses placed lower down. The centre of gravity of lateral forces is shifted above the base in the case of heavy masses in upper floors resulting in large bending moments. Massive roofs and heavy plants rooms at high level are therefore to be discouraged to be wherever possible. When mass irregularity exists, the lateral force resisting elements to be checked using a dynamic analysis for a more realistic lateral load distribution of the built shear.

* **Vertical Geometric Irregularity**:- All buildings with vertical off-sets fall in this category. Also, a building may have no apparent off-set, but its lateral load carrying elements may have irregularity. It is considered, when the horizontal dimensions of the lateral force resisting system in any storey is more than 150% of that in an adjacent storey. For instance, shear wall length may be suddenly reduced. Also when a building has such larger dimension above the smaller dimensions, it acts as an inverted pyramid and is undesirable.

The set back can also be visualized as a vertical re-entrant corner. The general solution of a set back problem is the total seismic separation in plan through separation ~~section~~, so that the portion of the building are free to vibrate independently. When the building is not separated, the lateral force resisting elements are checked using a dynamic analysis.

* **Out of plane offset** :- This is a very serious irregularity where in there is an out of plane offset of vertical element that carries the lateral loads. Such an offset imposes vertical & lateral load effects on horizontal elements, which are difficult to design for adequately. In this case shear walls are not obvious.

* **Proximity of adjacent buildings** :- Pounding damage is likely to be caused by mutual hitting of two buildings constructed in close proximity with each other. Pounding may result in irregular response of adjacent buildings of different heights due to different dynamic characteristics. Several examples of building failure have been observed due to pounding during earthquakes.

This problem arises when buildings are built without separation right upto property lines in order to make maximum use of the space. When floor of these buildings are constructed of the same height, the damage due to pounding usually is not serious. If this is not the case, there may be two problems. Damage due to pounding can be minimized by drift control, building separation & aligning floors floors in adjacent buildings.

#V. Safety consideration during additional construction and alteration of existing buildings

If sufficient precautions with respect to safety of work aren't taken, there are chances of serious accidents involving heavy loss of men & materials. Some of the safety rules to be observed during the erection process of structures are as follows:-

→ All guys and anchorages should be closely viewed regularly so as to ascertain their bearing capacity of loads.

→ Suitable packing piece must be provided at the required point so as to avoid the slipping of load.

→ The chains should not be dropped from a height but should be lowered gradually.

→ The equipments and devices employed in the erection procedure should never be over-loaded.

→ The legs of brethan chains should not be opened out to such as angle so as to endanger the stability of the work.

→ The levels of panel points on the falsework should be maintained as per desired camber for truss to avoid strain and distortion during assembly.

→ The lifting devices and mechanisms should be maintained in perfect running order so as to avoid their sudden failure without notice.

→ The lifting should be carried out smoothly without sudden shocks.

#VI. Additional strengthening measures in masonry building

The earthquake force shall be calculated for the full dead load plus the percentage of imposed load.

→ The proportions of imposed load indicating above for calculating the lateral design forces for earthquakes are applicable to average conditions.

→ Lateral design force for earthquake shall not be calculated on ~~excessive~~ contribution of impact effects from imposed loads.

→ When the lateral load resisting elements are oriented along orthogonal horizontal direction, the structure shall be designed for the effects due to full design earthquake load in one horizontal direction plus 30% of the designed earthquake load in the other direction.

→ When effects due to vertical earthquake loads are to be considered the design vertical force shall be calculated.

→ Other loads apart from those given above shall be considered as appropriate.

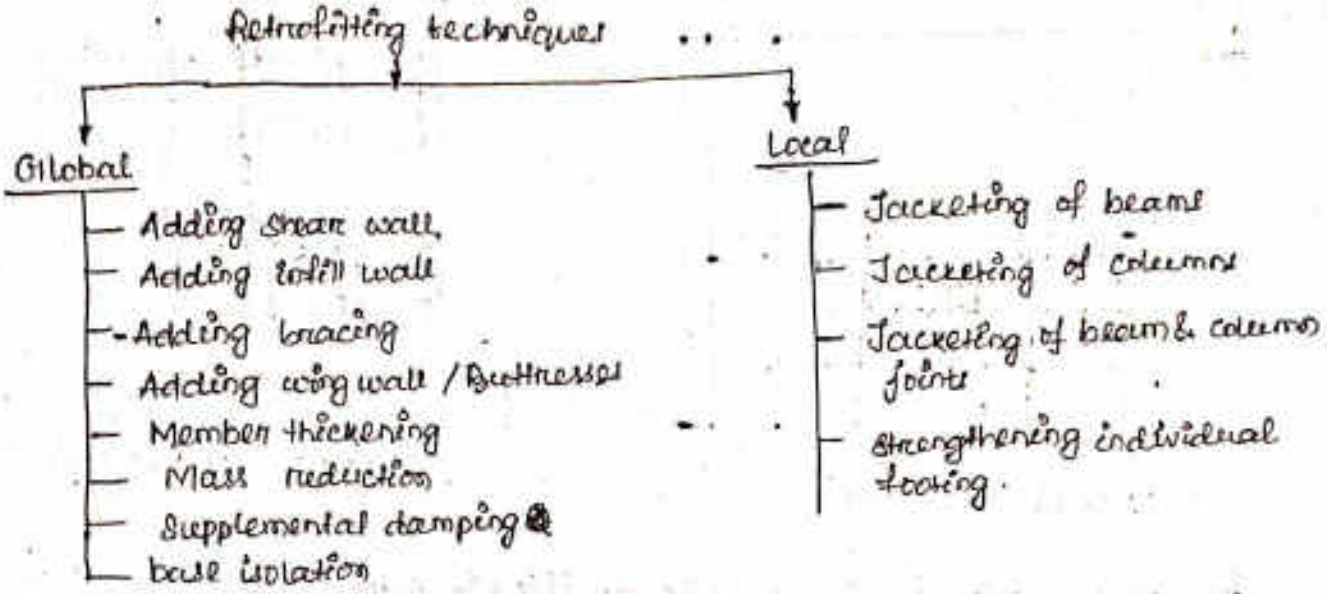
vii. Retrofitting Technique

* **Def^n:-** It is the process of increasing resistance of damaged or weak building by appropriate technique. Retrofitting proves to be a better economic consideration and immediate shelter to problems rather than replacement of building.

Classification of retrofitting techniques

Or It is the modification of existing structure to make them more durable and resistant to seismic density, ground motion or soil failure due to earthquake. The retrofitting techniques are also applicable for other natural hazards e.g tropical cyclones, tornados and severe wind from thunder storms.

* **Classification of retrofitting techniques**



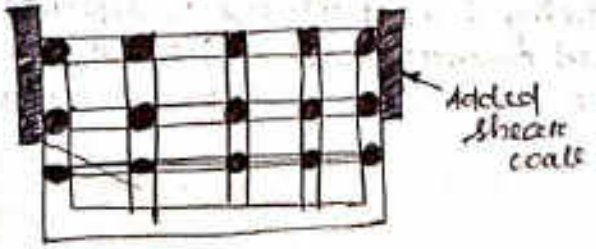
There are 2 way to enhance the seismic capacity of existing structures.

1. The first is a structural level of approach of retrofitting which involves global modification to the structural system.
2. The second is a member wise approach of retrofitting or local retrofitting which deals with an increase of the ductility of components with adequate capacities to satisfy their specific limit state.

1. Structural level or Global level Retrofitting

(i) **Adding shear walls :-** One of the most common methods to increase the lateral strength of the R.C. buildings. It is the last simple method.

→ **Limitation :-** Increase in lateral resistance but it is concentrated at a few places & increases the dead load of the structure.



(ii) Adding Infill wall :- It is an effective economical method for improving strength reducing drift of existing frame.

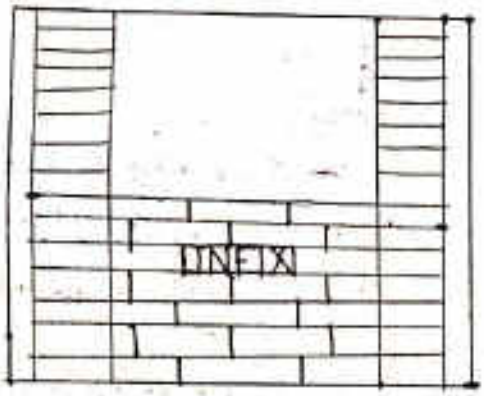
Limitation :- → Some columns in the frame are subjected to large axial tensile forces, which may exceed the capacity.

→ A strong masonry infill may result in a failure of the columns of existing frame.

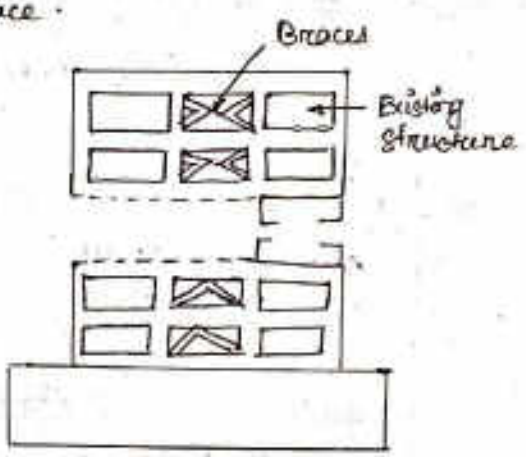
(iii) Adding Steel bracing :- Higher strength stiffness can be proved. Opening for natural light can be made easily.

Limitation :- A moderate to high level of skilled labour is necessary.
→ Lack of information about the seismic behaviour of the added bracing.
→ Undesirable changes takes place.

(iii)



(Adding Infill wall)



(Adding steel Bracing)

(iv) Mass Reduction :- It can be an effective retrofitting technique for some existing buildings by reducing effective mass. If the vibration period of the structure is shortened, the initial forces are reduced and displacement demands are reduced. Mass reduction can be achieved by removing heavy non-structural elements.

(v) Mass Dampers / Supplemental Damping :- Mass dampers absorbs the energy of the motion & convert it to heat. Thus damping effect the structures that are rigidly attached to the ground in addition to adding energy dissipation capacity to the structure. Supplementary damping can reduce the displacement and acceleration demand within the structure.

(vi) Base isolation :- It is a collection of structural elements of building that should isolate from the shaking ground thus protecting the buildings integrity and enhancing its seismic performance. Hence normally excavations are made around the building & the building is separated from the foundation steel or reinforced concrete beam, replace the connection to the foundation while under these the isolating pads or base isolation are provided.

2. Local or Member level Retrofitting

→ Local retrofittings are typically used either when the retrofit objectives are limited or direct treatment of the vulnerable components is needed.

→ The most popular & frequently used method in local retrofitting is jacketing or confinement by the jackets of R.C, steel, fibre reinforced polymer (FRP), carbon fibre etc.

→ Jacketing around the existing members increases its lateral load capacity of the structure in a uniformly distributed way with a minimal increase in loading on any single foundations with no alternative in the basic geometry of the building.

(i) **Jacketing :-** → Jacketing is the most popularly used materials for strengthening of building columns.

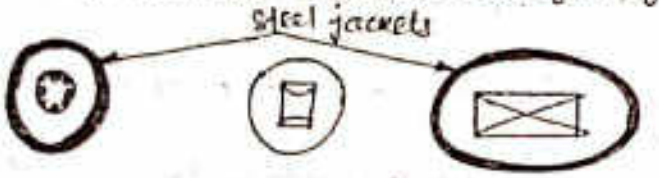
→ The most common types are steel jackets, RC jackets, fibre reinforced polymer composite jacket, Jacket with high tension materials like carbon fibre, glass fibre etc.

Purpose :-

→ To increase concrete confinement by transverse fibre / reinforcement, especially for circular cross-sectional columns.

→ To increase shear strength by transverse reinforcement.

→ To increase flexural strength by longitudinal fibre.



(ii) **FRP Jacketing**

→ Carbon fibre is flexible and can be made to contact the surface tightly for a high degree of confinement.

→ Confinement is of high degree because carbon fibre is of high strength and high modulus of elasticity.

→ It has light weight and resisting does not occure.

(carbon fibre winding)

viii. Sources of weakness in RC frame Buildings

Earthquake engineering is not a pure science rather it has been developed through the observation of failure of structure during earthquake. Damage survey reports of past earthquakes reveal the following main sources of weakness in reinforced concrete moment resisting frame buildings:

1. discontinuous load path
2. Lack of deformation compatibility of structural members.
3. Quality of workmanship and poor quality of materials.

(i) Structural damage due to discontinuous load path :

→ Every structure must have two load resisting systems :-

(a) vertical load resisting system for transferring the vertical load to the ground.

(b) Horizontal load resisting system for transferring the horizontal load at the vertical load system.

→ It is imperative that the seismic forces should be properly collected by the horizontal framing system and properly transferred into vertical lateral resisting system. Any discontinuity in this load path or load transfer may cause one of the major contributions to structural damage during strong earthquakes.

→ 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.

(ii) Structural damage due to lack of deformation :

→ The main problems in the structural members of moment resisting frame building are the limited amount of ductility and the inability to redistribute load in order to safely with stand the deformations imposed upon in response to seismic loads.

→ The regions of failure may be in columns beams walls and beam column joints.

→ It is important to consider the consequences of member failure of structural performance.

→ Inadequate strength and ductility of the structural member can and will result in local or complete failure of the system.

(iii) Quality of workmanship & Materials :

→ There are numerous instances where faulty construction practices and lack of quality control have contributed to damage.

→ The faulty construction practices may be like, lack of amount and detailing of reinforcement as per requirement of code particularly when the end of lateral reinforcement is not bent by 135 degrees as the code specified.

→ Many buildings have been damaged due to poor quality control of design material strength as specified, spalling of concrete by the corrosion of embedded reinforcing bars, porous concrete, age of concrete, proper maintenance etc.

Ventilation -

The Process of supplying fresh air and removing contaminated air by nature mechanical means to from a room is known as ventilation.

Proper ventilation and temperature in a building is very essential for health efficiency and hygienic condition.

Necessity of ventilation -

- To create air movement.
- To Prevent accumulation of carbon dioxide (CO_2) and moisture.
- To Prevent depletion on oxygen (O_2) containing air.
- To Prevent flammable concentration of gass vapour and dust.

System of ventilation -

The system of ventilation may be devided into 2- Catagories.

1. Natural ventilation
2. Mechanical or artificial ventilation.

(1) Natural ventilation -

→ Natural system of ventilation is considered and not suitable for small houses suitable for big houses government offices, theater, assembly hall, auditorium and

→ This system of ventilation largely depends on the scientific location of doors, windows, ventilators and other opening.

→ The rate of ventilation by natural means through doors, or windows and other opening depends on.

(a) wind effect
(b) Stack effect

(a) Wind effect

ventilation by wind effect is affected by the direction and velocity of outside wind and size and position of openings and Pressure difference. when it blows against a building causes a positive Pressure on windward side suction on the leeward side this Pressure difference causes the wind blow through the building and cause air change it Proper openings are Provided. This effect action is known as wind effect or wind action.

(b) Stack Effect-

Fresh admitted air inside the building is cool and heavy. This air becomes hot after some time and is letted up. Letted up air is escaped through ventilations and opening the roof. Fresh air again comes in the building and gets letted up by heating and again escape through openings Provided

This effect cause flow of wind in upward direction and is known as stack effect.

(2) Mechanical or artificial ventilation-

→ The system of ventilation in which some mechanical arrangement are made to Provide adequate ventilation in the room is known as mechanical ventilation and.

→ The mechanical ventilation is Prominance only recently because it Provides better comfort than natural condition. It can classified into 4- catagories.

Extract or Exhaust system
Supply or Plenum
Balancing
Air conditioning.

(a) Extract or Exhaust system -

In this system the partial vaccum is developed inside the room by extracting contaminated air by fixing fan, the blower and the outlet. The Pressure inside the room beinglow the fresh air from outside forces in through the door windows and every available openings.

This system is used for extracting smoke, odur, dust etc from kitchen, industrial plant the system can be installed for one room also.

(b) Supply and Plenum system:-

This system is reverse of exhaust system. Fresh air is forced with the help of input fans or blowers into the rooms and Polluted air is allowed to leave the room by it self. In this case the Pressure inside the room is greater than the atmosphere. This system is not used in case of cinema hall, auditorium, resturants etc. It is mainly used in factories.

(c) Balancing system -

This system uses fans to supply and extract air. It enables full control over air movements and conditions to be obtain and should be use where accurate performance is required. Some difference is usually maintained bet^n the rate of air supply and extraction. In most cases it is desirable to extract only about 75% of the quantity of air supply. recirculation of air is possible in this system.

(d) Air conditioning system -

The process of creating, controlling and maintaing indoor best suited to the requirements of men or to the needs of industry. Is known as air conditioning. This process consist of conditioning air with respect to humidity, temp., bacteria contain, dust contain and air movement so that the comfortable condition maintain there room.

Mechanical Services-

Elevator

→ A cage, car or platform raised or lowered vertically in permanent gide or rails and including operating mechanism used to transport person or material is known as elevator.

→ There are 3 types of elevator :

1- Hydraulic Elevator
2- Cable lift Elevator
3- Pneumatic Elevator

1- Hydraulic Elevator

Hydraulic model pushes the kept cab through the hoistway from below and is regulated by hydraulic oil filling chamber.

Cable lift Elevator-

This types of elevator is more common for home and commercial model. and the cab is lifted up through the hoist way by a series of Pully and cables.

Pneumatic Elevator

This types of elevator is muck vaccum and the cab is sucked up through ut hoistway to different floors. When it is locked up in place. Pneumatic and hydraulic elevation are based for smaller buildings and residents.

Escalator -

→ It is a moving staircase. A conver transPor device for carrying bet^{n} people bet^{y} floors of a building.

→ The device consist of a moter driven chain of individual linked steps that moves up or down on track allowing the treades to remain in horizontal.

→ There are many type of Escalation with the moving staircase are that we see in mples and airports being the most common.

→ The max^{m} angle of inclination of an escalator to the floor level is 30° with a standard rise upto 18m.

Uses -

→ Those are use to move pedestrial traffic in place where elevator would not be Practical.

→ It has the capacity to move a large number of people.

→ They can be placed in same physical space where one might install on staircase.

→ They have no waiting intervals.

A. Cold water system in high rise building -

Before designing a cold water system for a building it is essential to know the requirements of water authority.

There are two distinct system of cold water supply in high rise building.

① Direct system

② Indirect system

① Direct system -

→ This system is used mostly in areas where large level of Preservoir Provide a good main supply and in this system all sanitary are supplied with cold water directly from the main and the cold water feed cistern is required only to feed

the hot water storage cylinder.

→ The capacity in liters of the feed system is required to be at list equal to the capacity in lit. of hot water cylinder.

→ The water regulation requires a cistern of 114 lit. minimum capacity and is therefore small enough to be accomodated in the top of an airing cupboard, thus saving lagging of the cistern and pipe work.

→ For efficient operation a high Pressure water supply is essential particularly at a period of peak demand.

→ Pipe work is minimum and the storage system supplying hot water need to have only 115 lit. capacity cylinder.

(2) Indirect system -

→ In this system all the sanitary fitting except drinking water drawn off at sink and fountains are supplied indirectly from a cold water storage system.

→ Since the system supplies cold water to both basins shower etc. also feed the hot water cylinder, its capacity in lit. will be approximately double of that required for the direct system.

→ The water regulation required a cistern of 227 lit. minimum capacity and therefore will be accomodated in the roof space.

→ An indirect system supplies at sanitary appliances and basins, shower, bath and water feed from a storage tank.

→ Main water for drinking is available at the kitchen tap only. This can also supply washing machine and gardening tape.

→ The advance of a indirect system include tank feed water being at low pressure reducing noise and leakage.

→ If they do occur then these produce less water and damage than high Pressure system and there is less wear and tears on valbs and washes.

→ Soil and waste water installation in high rise building.

c. Soil and waste installation in high rise building.

A lot of soil and waste water is produced daily by, toilets, bath tub, showers, dish washers, washing machine etc. It all has to be drained from the buildings and transported to the sewage facilities. There are various material which are to be used in the soil and waste water installation in high rise building.

	Material	Application
(1)	Cast iron	– 50mm and above vent and discharge stage
(2)	Galvanized steel	– waste pipe
(3)	Copper	– waste pipes and traps
(4)	Lead	– waste pipe and discharge stack.
(5)	Plasticized Pvc	– upto 50mm waste and vent pipe.

System -

→ The system use for soil and waste water installation in high-rise building for the better discharge of soil and waste water akavent system.

→ If a single discharge pipe would be used, that is just capable of draining the maximum amount of waste (water) large pressure fluctuations would result in sucking dry or blowing out all water traps giving access for bad odours to enter the living space.

→ In order to keep the pressure fluctuation low, the system has to be ventilated an additional ventilation stack can also do the job but is more complicated in construction, costing considerably more and takes up more valuable space in building shafts. A special device called as dearant system and a large pipe of diameter about 110 – 160 mm are used.

→ When fluid is transported in pipe system at a low discharge rate relative to the maximum rate of pipe system, a special device called as dearant system and a large pipe of dia up to so called annular flow will occur in the vertical pipe. In the centre of the pipe the core of air will occur. If the vertical stack sticks through the roof and is

open, the core of air will always remain at approximately atmospheric Pressure.

→ This in contact to a clog blow that can block the air Path at any location in the Pipe system. In front of the Plug of the water that cuts of the open air path and a pressure Peak will occur. where a vaccum behind the Plug is will Present.

The Pressure Peak in the front will also entre the side branch and Possible blow out of the water traps

→ To keep the water traps in Planes the Pressure has to to kept at approximately atm. level in the side branch also. To manage this the air in the branch have to be in contact with the core air of the stack at all times. This is where the special billing, the akavent is brought into Place.

→ The system is all about keeping the air Pressure in the system near atmospheric in order to keep the water traps in Place. For this Purpose a large stack of dia (110-160mm) and special billings "Akavent" must be choosen

as well as a special Precaution at the vent at the bottom to Prevent the hydraulic jump from blocking the ventilation of the system are used.

B. Hot water supply In Building -

Hot water is required in houses and buildings for bathing and washing of cloth, utensils etc. Higher temperature melt oil from Pot and Pans make the cleaning work easier. Bathing with hot water opens body Pores for washing dirt and sweat easily and giving a sense of freshness especially in winter.

The requirement of hot water is very much essential. In order to meet the requirement of hot water, hot water system are designed and installed in accordance with the requirement of Particular building.

Sl No.	Type of building	Avg daily hot water demand (Lit/head/day)
(1)	**Residence**	
	(a) Residence with shower and trap	– 15
	(b) Residence with bath tub	– 135
(2)	**Factories**	
	(a) Factories with shower	– 90
	(b) Factories with tap only	– 30-45
(3)	**Hospital**	
	(a) Patient cleaning up station.	– 180
	(b) Staff, doctors and nurses	– 90
	(c) Visitors	– 10
(4)	(a) Offices, schools, Colleges	– 145
	(b) Hostels	– 135
(5)	Laundries	– 20/kg of laundry

(1) Electric Geyser -

→ It generates hot water using electrical heating element. LPG may be used in gas's water heater. Electrical geyser have now a days become very applyns of our modern life and even in our developing countries.

→ Geyser are now a days being used in houses even in smaller town and some advance villages where electricity is available.

(2) Instaneous electrical geyser -

These geysers are designed for direct connection to the water tank and electric heating element switched on after the flow of water is established. Such as applying requires heating element which binds around a pipe which heats the water to a specify temperature matching the rate of flow.

③ Storage geyser -

It is of two types -

(a) Pressure type.

(b) Non - Pressure type.

(a) Pressure type -

In Pressure type geyser these are not connected to the direct mah supply which may stop or suck back the water from the geyser. If the check valve fails to function the inlet is not blocked and its stop cock even if provided for convenious of connection is always kept open. The outlet stop cock is usually cap open and hot water be drawn by opening the hot water tank.

(b) Non-Pressure type -

In non-Pressure type geyser where hot water is not being drawn to the supply to such a geyser (either direct or from over head tank) will be caused by closing the inlet stop cock and hence they will get no water Pressure on the geyser. when supply is open equal amounts of hot water will get out of geyser. In such type of geyser is known as non Pressure type geyser.

Centralised hot water system -

Individual geyser proved to be useful in small installation such as house hostel etc. However a large installation in hotels, high rise building involving large number of supply point and hence installing individual geysers in such building may prove to be uneconomical and trouble some. Therefore centralised hot water system is installed in high rise building etc. The various factors which are consider in its design are

1. ### Ambient Temperature -

The temperature of hot water to be supplied is usually kept between 55 - 80°c depending upon the requirements and climatic condition of the place. The heat required in the boiler to achive the desired temp. will depend upon the temp. of incoming cold water.

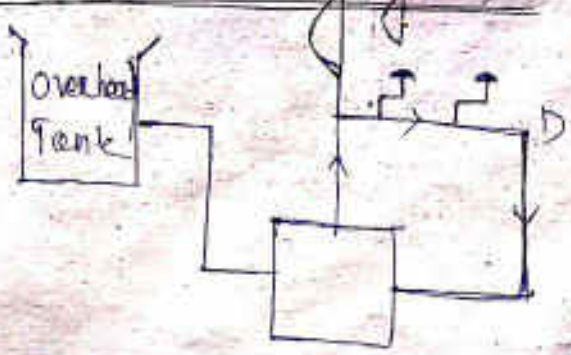
2- Pressure in the system -

Pressure in the hot water taps should be the same as in cold water pressure in the system taps unequal Pressure may result in the back flow of water from one system to another when hot and cold mixtures are used.

3- Hot water storage and generation -

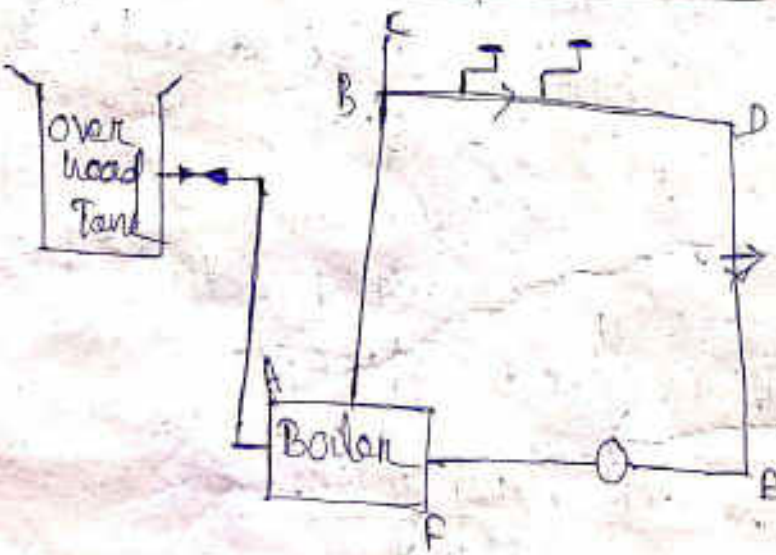
If a boiler is not able to generate hot water at the same rate, the Peak demand in the system that evidently required, no storage of hot water. However by Providing a storage tank for hot water the hot water can be stored. According to boiler capacity the large storage tank for hot water can be reduced and generally avoided due to availability of limited space.

4- Hot water Piping system -



The hot water generated to the should be supplied to the various supply Point without excessive loss of temperature and Pressure. If the length of supply pipe from boiler to the supply point. If the length of is long, lots of heat from the water will decept even if the Pipes are insulated. If suddenly if there are no recirculation of it the distribution system. Then hot water from a tap will come out only after initial delivery of called water from 1 to 5 minutes.

5. Piping system with forced circulation-



since the natural thermosphonic circulating Pressure is usually low, it become necessary in large installation to generate additional Pressure within the system to force the circulation by means of pumps. This helps in using reduce pipe size. and in all parts of the distribution system for quick drop in the hot water.

Solar water Heater -

Now a days water heater has become quite cost effective and save fossile fuel or electricity which are scarce. solar water heater have therefore gained Popularity in countries like Japan, Israle Australia and USA where water heater are required mostly.

The designe of solar water heater and Particularly the area of observer unit is Primarily governed by solar energy available at the Place of installation of the solar heater.

A solar water heater is occupy unit of

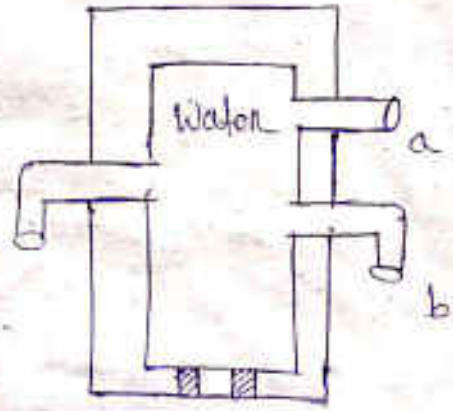
(a) A solar energy collector or connection unit.

(b) Storage tank.

(a) Collection unit -

The main function of a collection unit is to absorb solar radiation and transfer them. This heat energy to the cold water for heating is usually a black and Plate in such a copy that channels are form through which water can flow and circulate.

(b) Storage tank -



Since the hot water may have to be stored over night for use the next morning, the tank must be well insulated and weather proof. It should have double valves having a sandwitch of at least 10cm of fibre glass or mineral wool for similar insulation. The hot water from the collection unit is usually allow to enter the tank at a depth of about 30cm below the water level in the tank.

D. Fuse -

Fuse is strip of metal that melts when current reach a shorter value. The fuse is rated by the maximum number amperes they than can carry without melting. Fuse allow a small over load current for a short time.

Purpose of Fuse -

The fuse is a safety device used for the purpose of protecting a circuit against excess current. In the event of excessive current the fuse element melts and open up the circuit thereby protective it from damage.

Types of Fuse -

Following are the type of fuse.

① Rewirable Type (upto 200 A)

The fuse element in this type of fuse consist of a wire which may be replaced when necessary. These fuses are simple in construction and the initial cost as well as renewal cost is very low.

2- Cart - Ridge fuse

Cart - ridge fuse are developed disadvantages of rewerable fuse due to high temp. Prolonged used and oxidation rewirable fuse deterates and interrupted the supply even when carrying normal current as cart - ridge fuse element are enclosed in air tight chamber, the deterioration does not take place.

3- Ferrule - contact cart - ridge fused -

This is used for protecting electrical and electronic circuit. These are available in 25, 50, 100, 200, 250 MAMP and also in 1, 2, 5, 6, 10, 16 and 32 Amp. capacity. Its body is made up glass and fuse wire is connected between two metalic caps.

4- Diazed screw type cart - ridge fuses -

This type of fuse is commonly used in domestic and industrial electrical installation in many country.

5- High rupturing capacity fuses

- They are cylindrical in shape and are made up ceramic body filled in with a chemicaly treated filling Powder or silica to quench the acting quickly without any fire hazard.

Earthing:

Earthing is a Process of creating and alternative Path for the flow of fault, slash, excessive current safely into the ground in the Presence of minimal resistance or Impedance.

Uses of Earthing

→ Earthing is done for Personnel and equipment Protection Purpose. Earting Provides the Coducting Path for fault current to the current.

→ It Protects the human from electrical shock and equipment also.

→ Earthing is nothing but it use to remove unwanted ~~slash~~ harmful current/voltage by sending it to earth Pit.

→ It is use to Prevent shock from fault current.

Wiring-

① Cleat wiring

In this type of wiring, insulated conductors (usually vulcanized Indian rubber) are supported wooden cleat. The cleats have 2 halves one base and the other is cap. The cables are placed in the grooves provided in the base and then the cap is placed. Both are fixed sequently on the walls by 40mm long screw. This wiring is suitable for temporary installation where cost is the main criteria but not the appearance.

Advantage

→ Easy installation.
→ Material can be retright for used.
→ Flexibility provided for inspection, modification and expansion.
→ Relatively economical.
→ Skilled man power is not required.

Disadvantage

→ Appearence is not good.
→ Open system of wiring is required in regular cleaning.
→ Higher risk of material injury.

(2) Cable tyre sheathed (CTS) / Tough Rubber sheathed (TRS) wiring

→ In this wiring system wires sheathed in top rubbers tyre used are used which are quite flexible. They are clad on wooden Patteans with brass clips and fixed on the walls or ceiling by flat head screw. These cables are moisture and chemical Proof. TRs wiring is suitable for light in load voltage installation.

Advantages

→ Easy installation and durable.
→ Low risk of short circuit.
→ Cheaper then casing and caping system of wiring.
→ Gives a good appearance.

Disadvantages

→ Dangerous of mechanical injury.
→ Dangerous of fire hazard.
→ should not exposed to direct sun light.
→ skilled work manship is required.

③ Metal sheathed wiring // Lead sheathed wiring -

The wiring is similar to that of CTS but the conductors (2 or 3) are individually insulated and covered with a common outer lead alluminium alloy sheathe. Protects the cable against dampness, atmospheric extremities and mechanical damage. The sheathe is earthed at every junction to provide a path to ground for the leakage of current.

Advantages

- Easy installation and is aesthetic in appearance
- Highly durable.
- Suitable in adverse climatic conditions.

Disadvantages

- Requires skilled labour.
- Very expensive.
- Unsuitable for chemical industries.

④ Casing and capping

Insulated conductors laid inside rectangular teak wood or Pvc box having grooves inside it. A rectangular strip of wood called capping having same width as that of casing is fixed over it. Both the casing and capping are screwed together at every 15cm.

Advantages

→ Cheaper than lead sheathed conduit wiring.

→ Provides good insulation as the conductors are placed apart reducing risk of short-circuit.

→ Easily accesible for inspection and repairs.

→ Since the wire are not exposed to atmosphere, the insulation is less effected by dust, dirt and climatic variation.

Disadvantages

→ Highly inflamable.

→ Use of unseasoned wood get damage by termed.

→ Skilled workmanship is required.

(5) Conduit Wiring.

Pvc or VIR cables are used through rec. Pvc Pipes Providing good Protection agai mechanical injury and fire due to short circuit. They are embedd inside the walls & known as consild wiring or teased on the surface called as surface conduit wiring.

Advantages.

→ No risk of fire and good Protection against mechanical injury.

→ The lead and return wires can be carried in the same tube.

→ Earthing and continuity is assured.

→ Water Proofing and travel shooting is easy.

Disadvantages

→ Very expensive system of wiring.

→ Required skilled workmanship.

→ Erection is quit complecated and is time consuming.

→ Risk of short circuit under excess wet condition.

Lift-

→ Lifts are known as vertical transportation.

→ A lift is defined as an applying design to transport persons or material between two or more level in a vertical direction by means of a guided car or Platform.

→ The first safety lift is designed by "Otis" in 1853.

→ The development of lift was felt necessary to encourage the construction of tall buildings.

→ Since lifts are possible sources of accident of a building, special care should be taken while designing, maintaining and installing in good working condition.

→ The different types of lifts are Passenger lift, bed lift, freight lift, dumb waiters.

Construction & Earth Moving Equipments

Part - D

(a) Planning & selection of construction equipments

→ Most of construction operations can be performed by more than one kind of equipment or combination of equipments.

→ The best choice of equipment for a given job is the one that can complete the work, according to the plans & specifications within the time ~~allowed~~ for and least total cost.

→ The equipment selected must satisfy several constraints imposed by the job and ~~assumed~~ the contractual obligations. The constraints or factors include the following :-

i. Specific construction operations.
ii. Job specification requirements.
iii. Condition of the job site.
iv. Location of the job site.
v. Time allowed to do the job.
vi. Balance of independent equipment.
vii. Monthly requirement of the equipment.
viii. ~~Versatility~~ Versatility of the equipment.

→ A feasible solution to the equipment selection problem for actual field condition requires a number of these factors to be considered. In fact this would be unusual construction if the choice made is dependent on only one factor.

(b) Various types of earthmoving equipments

1. Excavators :- The excavators can be used on wheels or treads. They are mainly used to shovel dirt & lift heavy pieces of machinery. It is easy to identify an excavator based on its long bucket arm that is attached to the pivoting cab. The excavators are operated by an operator who is in the cab & has high visibility over the work area.

2. Backhoe loaders :- The backhoe loaders are mounted on tires & are great for use in sub-urban areas. They have many things in common with the tractors. The major difference is that they have a shovel in front that can be adjusted and a bucket at the rear that is used for digging. These loaders are best choice for small jobs that have to be completed in a confined space. The backhoe loaders help to shift dirt, shovel, trenchers and position pipes in place.

3. Bulldozers :- Bulldozers are considered to be the heaviest equipments available. They are very strong and the best choice for shifting a large amount of dirt on sites where there are large open spaces where grinding and rough grading of rocks takes place. The bulldozers can easily be identified with a huge blade at the front which is controlled using hydraulic pistons.

4. Skid Steer Loaders :- The skid steer loaders can be used for many purposes. It is an equipment that can be operated easily as it is on wheels & has a very tight turning range. Skid steer loaders are a good option for smaller sites. They help lower soil compaction & work well in difficult conditions such as mud & snow. Also the skid steer loaders have a limited impact on finished zones because of their tread system.

5. Trenchers :- Generally trenchers are used to dig trenches before the pipes are laid down. A range of trenchers are available including small sized trenchers, walk-behind modules & heavy equipment used to trench firmer grounds. Trenchers are highly versatile and they use alternating digging options based on the requirement of the job.

(c) Various compacting Equipments

1. Smooth wheel rollers

→ Smooth wheeled rollers are of 2 types :- * Static smooth wheeled rollers
* Vibrating smooth wheeled rollers.

→ The most suitable soils for these rollers are well graded sand, gravel crushed rock, asphalt etc. where crushing is required. These are used on soils which doesnot require great pressure for compaction. These rollers are generally used for finishing the upper surface of the soil. These rollers are not used for compaction of uniform sands.

→ The performance of smooth wheeled rollers depends on load per cm width it transfers to the soil and diameter of the drum. The load per cm width is derived from the gross weight of the drum.

→ The smooth wheeled roller consists of a large steel drum in front of two steel drums on the rear. The gross weight of these rollers is the range of 8-10 tonnes ranges from 18000 - 22000 lbs. The other types of smooth wheeled roller is called Tandem roller which weighs between (6-8 tonnes) 13000 to 18000 lbs.

→ The performance of these rollers can be increased by increasing the weight of the drum by ballasting the inside of drums with wet sand or water. Steel sections can also be used to increase the load of the drum by mounting the steel frame attached with axle.

→ The desirable speed and number of passes for appropriate compaction of soil depends on the type of soil and varies from location to location. About 8 passes are adequate for compacting 20cm layer. A speed of 3-6 kmph is considered appropriate for smooth wheel rollers.

2. Vibrating Compactors

The vibrating compactors are used for compaction of cohesive soils. These compactors are used because the vibration creates impact forces which results greater compacting energy than equivalent static load and thus can be able to free the inter-locked circular particles of cohesionless soils.

(d) Owning & operating cost

→ Ownership cost is the total cost associated with the construction equipment for owning it, irrespective of the equipment is employed or not in the project. The ownership cost consists of the following :-

1. Initial cost :- It is the capital investment required to own the equipment. It includes purchase cost, sales tax, transportation cost (or freight charges) to bring the equipment to company's storage yard or construction site and cost of assembly and installation of the equipment. If the equipment is mounted on rubber tires (pneumatic tires) then the tire cost is deducted from initial cost for calculating ownership cost.

2. Salvage value :- Salvage value represents the expected cash inflow that will be received by disposing of equipment at the end of its useful life. The estimation of expected salvage value of equipment can be carried out by referring to the data obtained from past projects where in same equipment was used or information obtained from other relevant sources.

3. Interest cost on cost of capital Investment :- It is the annual cost of interest charged on the borrowed money or that of capital investment to acquire the ownership of the equipment. If the equipment is purchased by borrowing the money from a lender, then interest cost is the interest charged on the borrowed amount. On the other hand if the equipment is purchased using construction firm's own fund, then cost of capital investment is the interest charged on capital investment at interest rate equal to construction firm's rate of return. Even though the construction firm uses its own funds to purchase the equipment, cost of capital investment is charged as part of the ownership cost because the construction firm could have invested the fund elsewhere to earn the return instead of purchasing the equipment.

4. Taxes :- It represents the property taxes to be paid to the state or central government. It depends on the value of the equipment owned & the applicable tax rate for a given location. Generally it ranges from 2% - 5% of the average annual investment or book value of equipment.

5. Insurance cost :- It represents the annual premium to be paid to the insurance companies to cover the cost incurred due to accident, fire, theft etc. for the construction equipment. In other words it represents

the cost that protects the owner of the equipment against these damages. It is generally about 1% - 3% of the average annual investment or book value of equipment.

6. Storage Cost :- It is the cost of keeping the equipment in storage yards when it is not operating at work site. Storage cost includes the rental & maintenance charges of storage yards, wages of security guards and wages of workers employed for bringing it in and out of the storage yards. It is around 0.5% - 1.5% of the average annual investment or book value of the equipment.

#70 (Soil Reinforcing Techniques)

(7.1) Soil Reinforcing

→ Soil reinforcement is defined as the technique to improve the engg. characteristics of soil. In this way, using natural fibres to reinforce soil is an old and ancient idea.

→ Soil reinforcement is the act of improving soil strength to enable it to support or carry more load. Two common examples are :-

(1) Mixing a soil amendment such as lime into weak clayey soil and recompacting to improve soil bearing capacity, often done under road base in highway construction.

(2) Installing plastic or composite webbing layers called as geogrid materials, alternating with compacted soil to produce a stronger sloped soil structure, often done on steep roadway embankments to improve strength and stability.

(7.2) Wire Mesh

Welded wire mesh or welded wire fabric or weldmesh is an electric fusion welded prefabricated joined grid consisting of a series of longitudinal wires with accurate spacing welded to cross wires at the required spacing. Machines are used to produce the mesh with precise dimensional control.

Geosynthetics

Geosynthetics are synthetic products used to stabilize terrain. They are generally polymeric products used to solve civil engg. problems. This include 8 main product categories :- geotextiles, geo-grids, geonets geomembranes, geosynthetic clay liners, geofoam, geocells & geocomposites.

Uses of wire mesh & geosynthetics in soil reinforcing techniques

Use of wiremesh :- Wire mesh fencing is one of the most basic types of fencing. It can either be made from galvanized steel or stainless steel. Wiremesh fencing has a lot of uses from residential to industrial purposes. Over the years it has slowly taken over chain link fences as users see it to be more durable.

1. **Security fencing :-** One of the main uses of wire fencing is for security purpose. This type of fencing is often used as a industrial, commercial or residential installation. Most homes use this type of fencing to secure their area as well as provide an aesthetic look to their exterior fencing. This type of wire mesh ~~fencing~~ used for security fencing comes in different sized holes from 5mm holes to 6mm holes. The type of wire mesh fencing you need depends on your preference and requirement.

2. **Animal fencing :-** Another common use of wire mesh fencing is to fence animals. Since this type of fencing comes in different hole sizes, you can choose to have a small holed or big-holed fencing to accomodate the type of animal you could like to fence in. This type of fencing is often used in chicken coops, rabbit fencing and horse fencing. Since wire mesh fences do not have any sharp edges, it is also deemed as safe fencing for animals.

3. **Garden fencing :-** Wire mesh fencing is also best used for garden fencing. It can be surrounding the entire garden area or it can also be installed around certain areas of the garden. Garden fencing can add a certain look into your garden since it can also comes in several colours. This type of fencing is also used as an alternative to wires for climbing trees. They are more durable and take the weight of these types of plants without having to make repairs regularly.

4. **Window Screens :-** This type of fencing can also be used as an alternative to window screens. Just like security fences wire mesh fencing provides a durable option for window screens on structures or buildings that requires extra security. Window bars, storage facilities and stock rooms are often installed with wire mesh fencing. It prevents accidents from entering the facility through the window.

5. **Highway & railway fencing :-** Wire mesh fencing is also commonly used in industrial applications. One of the main industrial uses of this type of fencing is for highway and railway fencing. Wire mesh fencing is commonly used as sort of security fencing for highways and railways. It is used to prevent animals and people from trying to cross the rail tracks & highway roads. Wire mesh fencing for a railways and highways ~~for railways and~~ are also often used to prevent and minimize damages on the tracks.

Slope Stabilization

Slope stability is the potential of soil covered slopes to withstand and undergo movement. Stability is determined by the balance of shear stress and shear strength. A previously stable slope may be initially affected by preparatory factors, making the slope conditionally unstable.