GOVERNMENT POLYTECHNIC
KENDRAPARA

DEPARTMENT
OF
CIVIL ENGINEERING

LECTURE NOTES

Year & Semester: 3rd Year, 6th Semester

Subject code/Name -Th-3, Advanced Construction Techniques & Equipment

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CHAPTER-1 Advanced Construction Materials

Fibres as a Construction Material and its Types:

- Fibres is a class of material which are having continuous filaments or which have elongated pieces similar to the length of thread.
- Animal body and plants also contains fibres for holding tissue together.
- Fibres can be made into filaments or ropes which can be used as raw material of papers etc
- Fibres can be natural or synthetic.
- Natural fibres are cotton, wools, jute etc
- Synthetic fibres can be produced very cheaply and in a large amount as compared to the natural fibre.
  eg. Asbestos, glass wool, steel fibres, Carbon fibres etc.

General Uses of Fibres:

- Fibres are used for packing and making fabrics and felts.
- Glass wool made of very fine fibres of glass is used for making acid proof and fire-proof fabrics.
- Glass wool is used as packing material for heat, sound and electric insulation. It is commonly used in a solar water system.
- Lead wool prepared from fine fibres of lead is used in water pipe joints to stop leakage of water. Natural jute fibres are extensively used in plumbing work to stop leakage of water.

Types of fibres: There are mainly three types of fibres which are commonly used as a construction materials.

(1) Steel fibers
(2) Carbon fibers
(3) Glass fibers

(1) Steel fibers :

(a)

- Steel fibers are made from the cold drawn steel wire with low content of carbon or made from stainless steel.
- They are manufactured in various types such as hooked steel fibres, undulated or flat steel fibers according to the need required in the construction project.
- These fibers are used in the construction for concrete reinforcement.
- Steel fiber reinforced concrete is less expensive than hand tied bars
- Steel fibers can be used on surfaces to avoid corrosion and rust.
- 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.

(b) Properties of steel fibers :

- It increases the tensile strength of concrete.
- It is more trough and hard.
- It avoids corrosion and rust stains.
- They are more elastic in nature.
- steel fibers are available in various standards
- Steel fibers have a tensile strength of 1.1 N/mm^2
- They are available in the shapes like flat, hooked and undulated.

(c) Applications of steel fibers :

- Steel fibers are highly used in tunnel linning work.
- Mostly used in airport runways constructions and in highway pavements.
- Most commonly used in precast concrete so as to increase the tensile strength.
- They are used in shotcrete.
- Used in construction of parking
- It is used in anti-seismic buildings.

(2) Carbon Fibers :

(a). Carbon fiber is a material consisting of extremely thin fibers about 0.005mm to 0.10mm in diameter. It is mostly composed of carbon atoms.

- Carbon fibers are also called as "Graphite fibers".
- The carbon atoms are bonded together in microscopic crystals which are more or less aligned parallel to the long axis of the fiber.
- A number of carbon fibers are twisted together so as to form a Yarn which can be used as it exist or woven into fabric.
- It can be combined with a plastic resin and moulded to form composite materials like carbon fiber reinforced plastic to provide a high strength material.
- The atoms of carbon fiber are arranged in a regular hexagonal pattern.

(b) Properties of Carbon fibers :

- It has a high tensile strength, low weight and low in thermal expansion.

- They are rigid materials which are resistant to stretching and compression.
- It is chemically non-reactive material.
- They are resistant to corrosion.
- Fibers contained about 85% carbon has excellent flexural strength.

(c) Application of carbon fibers :

- Carbon fiber is mostly used to reinforce composite material.
- Reinforce carbon-carbon (RCC) consists of carbon fiber reinforced graphite and is used structurally in high temperature application.
- It increases the tensile strength as well as the compressive strength of concrete.
- It has high tensile strength, low weight and low thermal expansion. Therefore it is used in aerospace military, motorsports equipments.
- Used in race bicycle industry.
- Used in tennis rackets.
- Used in musical instruments for its weather resistance and ability to recreate the tone of guitars.

(3) Glass fibers :

- It is also called as fiber glass. It is made from extremely fine fibers of glass.
- There are two main type of glass fiber product.
- First fiber is made either from a direct melt process or a marble remelt process.
- Glass fiber is always made of platinum alloy with

rhodium for better durability.

- Platinum is used because the glass melt has a natural tendency to wet.
- Thin fibers are most strong because they have more ductility.

(b) Properties of glass fiber :

- It has high ratio of surface area to weight.
- Good thermal insulation.
- It has high tensile strength but has no strength against compression.
- Compression strength is increased by reinforcing it with plastic, then it can resist both tension and compression.
- It is resistant to corrosion.
- It is resistant to chemical reaction. However, if its surface area is increased, it makes them more susceptible to chemical attack.

(c) Application of Glass fibers :

- Corrugated fiber glass panels are used for outdoor canopy or greenhouse construction.
- It is used as a reinforcing agent for polyme which are used in tubes and pipes of water supply system and sewer system.
- Used as mats, insulators, sound absorption, heat resistance fabrics, corrosion resistant fabric and high strength fabrics.
- Used in roofs, doors, window canopies, chimney coping system, sills etc.
- The glass fibres with polymer and plastic is commonly used in fire water system, cooling wate

systems, sewage systems, waste water system, gas system etc.

PLASTICS

* Plastics are a group of materials, either synthetic or naturally occuring, that may be shaped when soft and then hardened to retain the given shape.

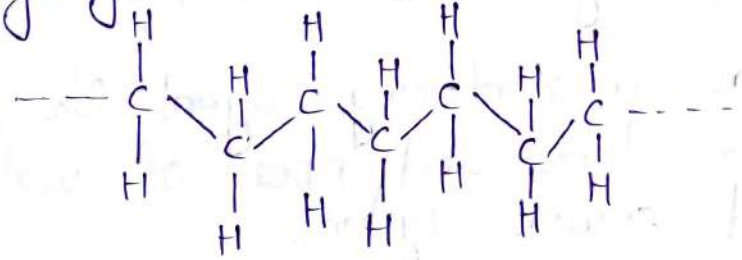
→ Plastics are polymers. A polymer is a substance made of many repeating units. A polymer can be thought of as a chain in which each link is a single unit. The chain is made by joining, or polymerizing atleast 1000 links together.

→ Polymerization can be understood by making a chain using paper clips.

→ Natually occuring polymers are :- Animal horn, shellac, amber etc.

→ Synthetic polymers include ~~polyethene~~ polyethylene, polypropylene, polyvinyl chloride (PVC) etc.

Polyethylene structure :-



Type of plastics :

(1) PET (Polyethylene terephthalate):

• When the plastic is made out of polyethylene terephthalate

→ It is mostly used for food and drink packaging purposes due to its strong ability to prevent oxygen

from getting in and spoiling the product inside.

→ It is the most widely recycled plastic in the world.

(2) HDPE (High Density Polyethylene):

→ It is an incredible resistant resin used for grocery bags, milk jugs, recycling bins, agricultural pipe, play ground equipment, lids, cosmetic bottles, etc.

→ It is made with long unbranched polymer chains. It is much stronger and thicker than PET.

→ It is relatively hard and resistant to impact and can be subjected to temperature of upto 120°C, without being affected.

→ HDPE is accepted at most recycling centers in the world, as it is one of the easiest plastic polymers to recycle.

(3) PVC : (Polyvinyl Chloride):

→ It is the world's third most widely produced synthetic plastic polymer.

→ It comes in two basic forms: rigid and flexible.

→ In its rigid form, PVC is largely used in the building and construction industry to produce doors and window and pipes etc.

→ When it is mixed with other substances, it can be made softer and more flexible and applied to plumbing, wiring, electrical cable, insulation, flooring etc.

→ PVC is now replacing traditional building materials like wood, metal, concrete, rubber, ceramic etc in various application.

→ PVC is not easily recyclable. Therefore, it should be avoided, whenever possible.

(4) LDPE: (Low Density ~~Polyethene~~ Polyethylene):

→ It has a low-density molecules, giving this resin thinner and more flexible design.

→ It has the simplest structure of all the plastics, which makes it easy and cheap to produce.

→ It is used in plastic bags, various containers, dispensing bottles and ~~most~~ plastic wraps.

→ It is not often recycled.

(5) RPVC: (Rigid Polyvinyl Chloride):

→ Rigid PVC is a tough, rigid, economical plastic that is easy to make and paste with adhesives or solvents.

→ It is nonflammable, weather resistant material

→ RPVC is mixed with other suitable substances, and it can be stabilized against UV rays to resist sunlight.

→ It is an excellent water resistant. Thus, often used in water pipes, sewage pipes, irrigation pipes.

→ It is ~~fire~~ ~~fire~~ fireproof and weather resistant.

(6) FRP: (Fiber-Reinforced Plastic):

→ It is a composite material made up of polymers that is supported with fibers for added strength.

→ FRP is produced using a wide range of fibers depending on the final usage requirement.

→ Fibers can be sourced from glass, carbon, other sources.

→ It is commonly used in industries such as

aerospace, construction and marine to build structures that require added resistance to force in order to prevent deformation.

→ It can resist corrosion.

(7) GRP (Glass Reinforced Plastic):

→ It is also called as "Fiberglass composite plastic".

→ It is strong, extremely light weight

→ GRP is made from strands of glass.

These are very fine fibers that are woven together to create a flexible fabric.

→ These are thermal insulator, does not melt easily, chemical resistance, corrosion resistance, sound insulator, weather resistance.

→ It is used in water pipes, drain coverings, electronic equipment, sport equipment, helicopter rotor blades and wind turbine blades etc.

(8) PP (Polypropylene):

→ It is the 2nd most widely produced plastic.

→ It is hard and sturdy, it can bear high temp.

→ It is used in tupperwares, car parts, yogurt containers, baby diapers.

(9) Polystyrene (PS):

→ It can be solid or foamed.

→ It is very cheap, easy to produce, for these reasons it can be found everywhere.

→ It is used in beverage cups, egg cartons, insulation packing materials, disposable dinnerware etc.

→ It is commercially known as "Styrofoam".

→ It is highly inflammable, can produce harmful chemical when heated.

Use of plastic as Construction material

→ Many construction companies are using plastic materials. It includes plastic nut bolts, hinges to bigger plastic parts as flooring, wall covering, water proofing, electric wiring etc.

→ Plastic is used for the following reasons:

(a) Durability : Plastic is strong, corrosion resistant, it can survive outside weather conditions.

(b) Cost effectiveness : Plastic is cheaper than metal so it is economical.

(c) Recycling : Plastic can be recycled without losing any chemical properties and hence can be used over and over again.

(d) Energy saving : Plastic consumes less heat than metal. The insulating effects of plastic can also decrease pollution level.

(e) Safety : Plastic materials are typically much lighter than metals. The lightness of material makes it easier to carry and lift into place.

(f) Easy to install : The light weight of plastic materials allows for quick and easy installation.

(g) Chemical resistance : Plastic offer great resistance against chemicals.

(h) Electric insulation : Plastics are good electric insulators. So they are used as linings for electric cables and for electronic tools.

(i) Fire resistance : Plastics like PVC made plastics do not catch fire easily. Some plastics are fire proof. eg. Phenol formaldehyde; Urea formaldehyde

(j) Moisture resistance: PVC plastic offers great moisture resistance.

(k) Thermal Property: Thermal conductivity of plastics is very low and is similar to wood. Hence it can be used as thermal insulator.

Use of plastic

- **Flooring**: Plastics like PVC (Polyvinyl chloride) and polyethylene are used to make flooring less prone to wear and tear. It also decreases the sound pollution level and can be cleaned easily.
- **Roofing**: • Plastic sheets are used for roof covering such as PVC, RPVC, FRP, Polyester.
  - To protect the outer surface of the roof from damage, two layers of plastic materials are used.
  - The upper part is made of coloured thermoplastic vinyl and lower part consists of polyurethane foam which consumes less energy and keeps the interior of a house cooler.
- **Walls**: A structural insulated panel (SIP) is a sandwich of expanded polystyrene (PS) between two layers of strand board. This type of composite wall boards can be pre-fabricated and can be transferred to work place easily for a particular task. It provides good support to column.
- **Pipes**:
  - Pipes are made up of Polyvinyl chloride (PVC), CPVC (chlorinated Polyvinyl chloride), Polystyrene (PS), polyethylene (PE) etc.

- They are flexible and light weight. Therefore they are easy to install.
- They are highly chemical and water resistant, which is suitable for extreme environmental condition.

- **Windows:**
  - Polycarbonate plastic is used to manufacture building windows. This plastic is strong, clear and very light weight.
  - Polycarbonate windows are considered more burglar-proof than glass windows.
  - PVC and glass fibers are used to produce window frames.
- **Doors:**
  - Some construction projects use doors made from a stiff polyurethane foam core with a fiber reinforced plastic (FRP) coating. This sandwich structure of these doors makes them incredibly strong.

Artificial Timbers :

- Artificial timber is made of enhanced, modified and thermoplastic material that is filled with wood fibers and plant fibre. It has a combining advantages of timber and plastics.

→ It is good in corrosion resistance, warp free, convenience in maintenance and looks similar to woods etc.

→ It is also called as "Industrial timbers".

→ They have desired shape, appearance, strength and durability.

eg. Plywood, fibreboard, flush door, block boards etc.

* Artificial wood may be defined as the man-made product used in building industry, also refered to as composite or synthetic. ~~artifical~~

Properties of Artificial timbers

→ It is insect resistant.

→ It needs low maintenance. It can be washed with water.

→ It is durable.

→ It is less expensive than natural wood.

→ They are water resistent.

→ It is free from warping and shrinking.

Types of Artificial timbers (Available in market)

- **Veneers** : It is thin layers of wood which is obtained by cutting the wood with sharp knife in rotary cutter.

→ These thin sheets are dried in kilns and finally veneers are obtained.

→ Veneers are used to manufacture different wood products like plywood, block boards etc.

- **Plywood**

- Ply means thin.

→ Plywood is a board obtained by addition of thin layers of wood or veneers on one above each other. The joining of successive layers is done by suitable adhesive

→ The layers are glued and pressed with some pressure either in hot or cold condition.

→ In hot conditions 150 to 200°c temperature is maintained and hydraulic press is used to press the layers.

→ In cold conditions, room temp is maintained and 0.7 to 1.4 N/mm² pressure is applied.

→ Plywood is used in doors, partition walls, ceilings, paneling walls, formwork for concrete etc.

→ Plywood has decorative appearance, It is used for buildings like theatres, auditorium, temples, churches, restaurants etc in architectural purpose.

• Fibes Boards :

• Fibes boards are made of wood fibess, vegetable fibers etc.

→ They are rigid boards and called as reconstructed wood.

→ The collected fibess are boiled in hot water and then transferred into closed vessel. Steam with low pressure is pumped into the vessel and pressure increased suddenly.

→ Due to sudden increment of pressure, the wood fibess explode and natural adhesive gets separated from the fibess. Then they are cleaned and spread on wire screen in the form of loose sheets.

→ This matter is pressed in between steel plates and finally fibes boards are obtained.

→ Fibes boards are used for wall, paneling, ceilings, partitions, flush doors, flooring materials. They are also used as sound insulating material.

• Impreg Timber

• Impreg timber is a timber covered fully or partly with resin.

→ Thin layers of wood or veneers are taken and dipped in resin solution. Generally used resin is phenol formaldehyde.

→ The resin solution fills up the voids in the wood and consolidated mass occurs.

→ Then it is heated at 150 to 160°c and finally impreg timber develops. This is available in market with different names such as "surgloss", "sunmica", "Formica" etc.

→ Impreg timbers has good resistance against moisture, weathering, acids and electricity.
→ It is strong, durable and provides beautiful appearance. It is used to form wood molds, furniture decorative products etc.

• Compreg Timbers:

→ It is similar to impreg timbers but in this case, the timber is cured under pressure conditions.
→ So it is more strengthened than impreg timbers.
→ It is used for decorative products.

• Hard Boards

• Hard boards is usually 3mm thick and made from wood pulp
→ Wood pulp is compressed with some pressure and made into solid boards.
→ The top surface of board is smooth and hard while bottom surface is rough.

• Glulam :

• Glulam means glued and laminated wood.
→ solid wood veneers are glued to form sheets and then laminated with suitable resins.
→ This type of sheet is very much suitable in the construction of chemical factories, long span roofs in sports stadium, indoor swimming pool etc.

• Chip Board:

• Chip boards are made of wood particles or rice husk ash or bagasse. (sugar cane skin)
→ These are dissolved in resins for some time and heated.

→ After then it is pressed with some pressure and boards are made.
→ These are also called particle boards

• Block Board

→ Block board is a board containing core made of wood strips
→ The wood strips are generally obtained from the leftovers from solid timbers
→ These strips are glued and made into solid form.
→ Block boards are generally used for partitions, paneling, marine and river crafts, railway carriages etc.

Acoustics Materials :

- When the sound intensity is more, then it gives the great trouble and irritation to the particular area like auditorium, cinema hall, studio, recreation centre, entertainment hall, college libraries. Hence it is very important to make that area or room to be sound proof by using a suitable material called as "Acoustic Material".
- Acoustic material is provided so as to control the outside as well as inside sound of various buildings until such that the sound will be audible without any disturbance.
- Types of Acoustic Material are
  - Acoustic plaster
  - Acoustic tile
  - Perforated plywood
  - Fibrous plaster
  - Straw board
  - Pulp board
  - Compressed fibre board
  - Thermocol - coal
  - Foam plastic
  - Chip boards
  - Acoustic foam

  etc.

Properties of Acoustic Material :

→ Sound energy is captured and absorbed.
→ It has a low reflection and high absorption of sound.
→ Higher density improves the sound absorption efficiency at lower frequencies.
→ Higher density material help to maintain a low flammability performance. Hence it should have higher density.

→ It controls the sound and noise level from machinery and other sources for environmental noise disturbance.

→ Acoustic material reduces the energy of sound waves as they pass through.

→ It suppresses echoes reflection of sound.

Uses of Acoustic Materials

→ Acoustic materials can be used for noise reduction and noise absorption.

→ It makes the sound more audible, clear, without any disturbance.

→ A vinyl acoustic barrier block controls street traffic noises, music, voices from passing through a wall ceiling or floor.

→ Acoustic foam and acoustic ceiling tiles absorb sound so as to minimize echo within a room.

→ Sound proof doors and windows are designed to reduce the transmission of sound.

→ Building techniques such as double wall construction or cavity wall construction can improve the sound proofing of a room.

Wall Claddings

→ Wall cladding is also called as "siding".
→ Wall cladding is the protective material attached to the exterior side of a wall of a building.
→ It forms the first line of defense against the sun, rain, snow, heat and cold. Thus creating a stable, more comfortable environment on the interior side.
→ Wall cladding increases the beauty of building.
→ Most of the wall cladding consists of pieces of weather resistant material. They are smaller than the wall they cover, to allow the expansion and contraction of material due to moisture and temperature.
→ Example of wall claddings:

- Stone cladding
- Vinyl cladding
- Aluminium cladding
- Wooden cladding
- Brick cladding
- Fiber cement cladding
- stainless steel cladding

Properties of wall cladding

→ It increases the mechanical strength of a structure.
→ It protects the underlying structure as well as provides beauty to the structure.
→ It improves thermal insulation.
→ It serves as decorative covers.
→ It improves the resistance to cracking when the temperature is increased.
→ It reduces water absorption.
→ It provides resistance to sunlight.
→ It provides safe guards against air and chemical pollution

→ It provide the right acoustic for sound insulation or absorption.

• Types of Wall Cladding and their uses :

1. Stone cladding : Stone cladding is regarded as most natural and fresh looking cladding. It can be installed over a surface either made of concrete or steel. Stone cladding is ~~a~~ mainly used in living rooms, indoor gardens and bathroom walls. Stone cladding is very ~~dea~~ durable but is really costly to install.

2. Vinyl Cladding :

It is used for exterior walls of buildings. It is applied for small apartments, decoration and for weatherproofing. It is low in cost. But not of ~~good~~ better quality as compared to wood cladding or Aluminium cladding.

3. Aluminium cladding :

It is costly compared to other types. But it is more durable. It requires less maintenance or replacement. It is used mainly for basement and storage walls of a building. It is also used for large commercial buildings and structures

4. Wooden cladding :

• Wooden cladding is a quality option. It is stronger than Aluminium and vinyl cladding. Wooden cladding looks attractive, that is why, wooden cladding is used for aesthetic appearance. It is costly to install. Maintenance price is very high.

5. Brick cladding:
It provides a lovely decorative look to the walls. Installation of Brick cladding is difficult and costly. But maintenance price is low compared to wood cladding

6. Fibre Cement cladding:
It has a beautiful appearance, strong, high strength. It is easy to install and less costly.

7. stainless steel cladding: It is very durable. It is highy resistance to environmental effect. It provides a protecting coating against corrosion. Hence widely used for exterior walls.

PLASTER BOARDS: (Properties and uses)

- Plaster Boards are also called as Drywalls, or wallboards or gypsum board or gypsum panel or custard boards.

→ It is a panel made of Gypsum ($CaSO_4$).
→ It is used for interior walls and ceilings.
→ It is used for fire protection, acoustic insulation, & sound proofing, thermal efficiency, weather resistant
→ It helps to control moisture damage in high humidity areas.
→ It can be used for hospital, school, shop or residential buildings.
→ It gives decorative look and it is lightweight, easy to install.
→ Plaster boards are 100% recyclable. Hence it is a environmental foiendly product.

• Micro silica : (Property and Use)

→ It is also called as silica fume.

→ It is a non-crystalline polymorph of silicon dioxide (SiO_2, known as silica).

→ It is a very fine powder collected as a by product of silicon and ferrosilicon alloy production.

→ It has spherical particles of average size of 150 nano metre.

→ It is mainly used as a pozzolanic material for high performance concrete.

→ Microsilica in concrete improves its strength and durability.

→ It provides a uniform distribution to concrete and it decreases the average size of pores in the cement paste.

→ Microsilica comes in 3 forms
- Powdered microsilica
- Condensed microsilica
- Slurry microsilica

→ Microsilica reduces the segregation of concrete, reduces bleeding.

→ It improves the compressive strength and tensile strength of concrete.

→ It reduces abrasion, permeability of concrete.

→ It make the concrete sulphate resistance, heat reduction, chemical resistance.

→ It is cheap, therefore cost effective.

Artificial Sand : (properties and Uses)

• Artificial sand, also called crushed sand or mechanical sand, refers to rocks, mine tailings or industrial waste granules with a particle size of less than 4.75mm. It is processed by mechanical crushing and sieving.

Availability of

→ * Natural sand is decreasing day-by-day as the demand is ~~by~~ huge. The natural sand resources require hundreds of thousands of years to form.

→ As a result, natural sand costs are getting higher and higher and cannot meet the increasing market demand. In this case, the artificial sand came into use.

→ As this type of sand is artificially made, the quality can be adjusted and controlled.

→ Artificial sand particle gradation is stable. The grain shape can be improved.

→ Artificial sand industries are stable entities. They have mining licenses, fixed business location, which is easy to trace. So it reduces any illegal activities.

→ It reduces the waste production from mine, tailings,

→ Artificial sand has cubical shape.

→ Artificial sand has higher compressive strength than that of natural sand.

→ It has higher flexural strength.

→ It has less impurities like seaweed, bones, shells, mica, silt.

→ Artificial sand is used for construction works like concrete making, plastering etc.

Bonding Agents (Properties And Uses)

→ Bonding Agent is a natural or synthetic materials used to join individual members of a structure without mechanical fasteners.

→ The bonding agents are often used in different repair applications, such as bonding of new concrete to old concrete, as sprayed concrete at construction joint or as sand cement repair mortar

→ Generally bonding agents are used in concrete where there is a requirement to join the old and the new concrete surfaces. It is also used to join the surfaces between the successive concrete layers.

→ The cement within a concrete mix does not have any natural bonding agent. Hence, when fresh concrete is poured on top of an existing layer of concrete, the two concrete layers do not join together. They will not create a strong bond between the two successive layers. Thus it affects the performance and strength of structure.

→ Therefore, a bonding agent is needed to be applied on the old concrete surface so as to ensure the new concrete gets joined to old one.

Properties of Bonding Agent :

* It provides greater adhesion and workability.

→ It increases the tensile strength, flexural strength and bond strength of concrete as well as the

mortar.

→ It reduces the permeability of concrete
→ It reduces the risk of cracking.
→ It increases the resistance against frost and various other chemical.
→ It enables easy use and application.

* Example of bonding agents are
  - Acrylic latex
  - Styrene Butadiene (SBR)
  - Polyvinyl Acetate (PVA)
  - Epoxy Resin etc.
  - Latex Emulsion

• Adhesives (Properties and Uses)

→ Adhesives are defined as non-metallic materials capable of joining permanently ~~to~~ surfaces by an adhesive process.
→ They have ability to bind different materials together, distribute the stress uniformly.
→ Adhesives are abrasion resistant.
→ They are creep and fatigue resistant
→ They have great hardness and strength.
→ They ~~have~~ have low shrinkage.
→ They are vibration resistant, impact resistant and shock resistant.
→ Types of adhesives used in construction are
  - Polymer adhesive
  - Acrylic adhesive
  - Hot melt adhesive
  - Resin adhesive
  - Plastisol adhesive
  - Anaerobic adhesive
  - Pressure adhesive
  - Reactive Adhesive etc.

• Hot melt Adhesives :

• A hot melt adhesive (HMA) is a thermoplastic adhesive. It is sold as cylindrical sticks of various diameter.

→ The sticks are designed to place on a hot glue gun.

→ It is They are used in laminating application of woodworks, installation of electronic devices, fixing wires.

• Acrylic Adhesive :

→ These are resin-based adhesive.

→ These are extremely strong

→ They are resistance to sun and rainfall.

→ They are mainly used for carpentry works.

• Epoxy resin adhesive :

→ They have high mechanical strength, chemical resistance and they are affordable.

→ They are used for bonding steels, non-ferrous metals, aluminium, fiber-reinforced composites, ceramics, bricks, glasses and woods.

• Anaerobic Adhesive :

→ They contains "dimethacrylate monomers" and it cures only when oxygen is absent.

→ They are less toxic, non-corrosive to metals.

• Pressure Adhesive :

• In this type of adhesive, pressure is applied between adhesive and the surface of attachment.

• It is commonly used on stickers.

CHAPTER : 2

PREFABRICATION

→ Prefabrication is the practice of assembling components of a structure in a factory or other manufacturing site. Then transporting complete assembly to the construction site where the structure is to be located.

→ In traditional method of building a house is to transport bricks, timber, cement, sand, steel, aggregate etc to the site and to construct the house on site from these materials.
But, in prefabricated construction, only the foundation is constructed in traditional way, while sections of walls, floors and roof are prefabricated in a factory, transported to the site, lifted into place by a crane and bolted together.

→ Prefabrication is also used in the manufacture of ships, aircraft and all kinds of vehicles and machines.

Necessity And Scope of prefabrication

→ Prefabrication saves a lot of time and cost as compared to the traditional method.

→ Prefabrication is applicable where the structure is composed of repeating units, or where multiple copies of the same basic structure are being constructed.

→ Prefabrication is necessary when tempory housing is required for a large no. of people.

→ Steel sections need to be transported and cut and welded. Prefabrication in factories reduces any hazard linked to the process.

→ It can be difficult to construct the formwork required to mould concrete components on site and delivering wet concrete to site before it starts to set requires very accurate time management. In case case prefabricated concrete is useful.

→ Prefabricated houses become a necessity during the time of natural disaster or war time when many residential buildings are destroyed and a quick fixation of shelter houses are needed in a large numbers.

→ To decrease the labour requirements

→ To improve the quality of construction with low cost

→ To improve performance of structure with less need of maintenance.

→ To increase productivity.

→ To increase proper usage of space.

→ To increase the strength and stability of structure.

→ To provide better aesthetic or attractive finish of buildings.

History of prefabrication

→ Prefabrication has been used since ancient times.

→ The oldest known prefabricated structure in "the Sweet track" roadway in England, constructed in 3800BC. Here prefabricated timber sections are brought to the site rather than assembled on-site.

→ "Singhalese" kings of ancient Sri Lanka have used prefabricated building technology 2000 years before to make gaint structure, where some sections were prepared separately and fitted together.

→ After the great "Lisbon earthquake of 1755," the cities of Portuguese capital (Baixa distict), was rebuilt by using prefabrication on a large scale. They have introduced anti-seismic design features and many prefabrication method. Multi story buildings were entirely manufactured outside the city, then transported in pieces and joint on the site.

→ In Portugal, the town of "Vila Real de Santo António" was founded on 30 december 1773, was quickly erected through the use of prefabricated materials. The entire town was built from March 1774 to May 1776.

→ In 19th century Australia a large number of prefabricated houses were imported from the United Kingdom.

→ Prefabrication is widely used in 20th century for housing. During the time of "World War II"

many houses were destroyed and families become ho
Temporary housings for thousands of urban families
are made at that time.

→ "The Crystal Palace" was made in London in 1851 where iron and glass are prefabricated. Then "Oxford Rawley Road railway station" was made in the same technique.

→ Prefabricated cargo ships were designed during World War II to quickly replace ships sunk by Nazi boats. At that time, the production was over 2000 units. On an average 3 ships/day was made

CURRENT USES OF PREFABRICATION

① The most widely used form of prefabrication in building and civil engineering is the use of prefabricated concrete and prefabricated steel sections in structures where a particular part or form is repeated many times.

② Prefabrication techniques are used in the construction of apartment blocks and housing developments with repeated housing units.

③ The technique is used in office blocks, warehouses and factory buildings.

④ Prefabricated steel and glass sections are widely used for the exterior of large buildings.

(5) Detached houses, cottages, log cabins etc are sold with prefabricated elements.

(6) Prefabricated modular walls elements are used with facilities of thermal insulation, window frame components etc which improves the quality construction.

(7) Radio towers for mobile phone and others services often consist of multiple prefabricated sections. Modern lattice towers are assembled of prefabricated elements.

(8) Prefabrication has become widely used in the assembly of aircraft and spacecraft with components such as wings sections are manufactured in different countries or states.

(9) Prefabricated bridge systems are used. They are cost effective, and safe for environment.

TYPES OF PREFABRICATED SYSTEMS

1. Panelized wood framing :

It is used for roofs, these are long pieces of frames built from laminated timber, covered either by a plywood or some board roof deck. Panelized frames can be upto 72 feet long, these roof panels can save construction time and make roof construction a much safer activity.

2. Sandwich Panels :

It is made from a thin facings of materials like concrete, plywood, or stainless steels. The outer facings are then stuck to an inner core. Inner core are always insulating materials like foam, paper, cloth or rubber.

3. Steel Framing:

Steel framing are used to create prefa-bricated panels which can be used to construct buil

4. Timber framing:

Timber framings are built in factories and then used in erecting timber homes. Timber framing panels are very popular in other countries where wooden homes are common.

5. Concrete system:

→ Concrete components are prefabricated in factories. They can be modified as desired and save time. Concrete panels are heavier than other building components. But they are stronger and looks beautiful.

6. Modular Systems:

These systems use all prefabrication styles and create a whole building structure. The buildings are transported to the final construction site and then simply connected to a prepared foundation.

Classification of prefabrication:

- **Small prefabrication:** Here, the small elements like bricks are precasted. The degree of precast element is very low.
- **Medium Prefabrication:** If the elements like roofing system are prefabricated, those constructio are called as medium prefabrication. Here the degree of prefabrication is moderate.
- **Large Prefabrication:**

In large prefabrication, most of the members like wall panels, roofing system, flooring system,

beams and columns are prefabricated. Here degree of precast elements are high.

- **Cast-in-site prefabrication : (or Off-site factory prefabrication)**

. Prefabricated elements are needed to be transported. So, the mode of transport, vehicles affect the time and cost of prefabrication. Therefore, in such prefabrication, elements are joints on the site of construction.

- **Open prefabrication system :**

In this type of prefabrication system, single unit or section of space frames are fabricated and assembled at the site. Wall fittings or other fixings are also done at site. This type of construction system is called as open prefabrication system.

- Open prefabrication system is classified based on degree of fabrication used in the construction.

(i) Partial prefabrication system
(ii) Full / Total prefabrication system

(i) Partial prefabrication system :

This system is more important for roofing and flooring and some prefabricated components such as lintels, sunshade, kitchen sinks. This system is mainly adopted for long span structure such as industry or factory.

(ii) Full prefabrication system: All types of structural components are fabricated by using this system and the bricks are used as ~~fillers~~ fillers. This system is more effective and applicable for all type of construction.

. Total prefabrication system is based on
  - equipment availability
  - transportation
  - space availability
  - connection between structural elements.

- **Closed prefabrication system :**

In this type of system, whole part of structural components are fabricated along with fitting provisions and erected in their position.

- **Factory prefabrication system :**

- Factory prefabrication is done in the manufacturing or production units for the fabrication of structural components under controlled condition. It takes a long period of time.
- Fabrication work is done over a year under covered condition using machines to avoid the bad effect of climate condition.
- It is high in transportation cost.

Advantages of prefabrication :

→ Component of prefabrication structures are readymade. So there is no need of shutting or formwork.

→ Less consumption of energy, time, wages, space and materials.

→ Prefabrication structures are mainly used in hilly areas, due to the less availability of construction material.

→ High skilled labours, engineers, architects are needed for prefabrication. So the structure becomes high in quality.

→ Construction speed is increased because, there is no

need of curing time.
→ Prefabricated structures are highly resistant to adverse climatic condition, fire and moisture.
→ Easy to handle, recycle and join the structural components.
→ Accuracy of structural components is very high and they possess high degree of safety.
→ Quality and performance of structural components are very high.
→ Onsite construction cost are minimized.
→ Construction waste are less and can be recycle.
→ Prefabrication components are mainly used for apartment blocks, office blocks, warehouses and factory buildings.
→ Prefabricated steel and glass sections are used for exterior of building structure for providing attractive look.
→ Prefab. components are used construction of aircraft or spacecraft.
→ Environmentally friendly buildings are developed by less use of materials, less production of noise and dust, use of recycled materials.

Disadvantages of prefabrication

- Leakage of pre-fabricated structures occurs at the joints.
→ Cost of construction and packaging is very high.
→ Prefabricated structures are not applicable for disaster prone areas.

→ High skilled labours, engineers and architects are required.

→ Large section of prefabricated structural components requires heavy duty crane which requires accurate measurement and placing of structural components.

→ A prefabricated structure requires better handling of components such as glass panels, wall panels and so on.

→ More attention is provided for production of prefabricated section joint in order to reduce the failure of structures.

→ Employment of local labours is minimized due to the development of prefabrication technique.

Process in Prefabrication

Various process involved in prefabrication are

(i) Main process
(ii) Auxillary Process (সহায়ক)

Main process involved :

- Assembling of moulds
- Positioning of reinforcement cage for reinforced concrete work.
- Installation of fitting and tubes.
- Placing of fresh concrete into the mould
- Vibrating fresh concrete moulds
- Demoulding
- Curing
- Stacking of precast units.

Auxillary process involves :

- Mixing and making of fresh concrete in casting unit
- Casting of reinforcement cage in workshop by using prefabrication process
- Production of fitting and fixtures
- Finishing of prefab. elements
- Testing of prefab. elements.

• Theory of prefabrication :

→ The theory behind the method is that time and cost is saved if similar construction tasks can be grouped, and assembly line techniques can be employed in prefabrication at a location where skilled labour is available, while congestion at the assembly site, which waste times, can be reduced.

→ The method is applicable when the structure is made of repeating units or form. Where multiple copies of same basic structure are constructed.

→ Prefab. avoids the need to transport so many skilled workers to the construction site.

→ Prefab. process avoids restricting conditions such as lack of electric power, lack of water, bad weather conditions, toxic environmental conditions etc.

→ Main disadvantages of the prefab process is cost of transporting prefabricated sections and lifting them into position as they are usually larger, more fragile and more difficult to handle.

Design principle of prefabricated system:

→ Economy growth of large-scale construction with more repetition units of structures.
→ Special attention is provided for the better outlook finish of pref. structures.
→ Compatibility of quality control in structural component
→ Speedy construction because there is no need of curing period of structural components.
→ Space and environmental restriction.
→ Local labour employment are affected
→ Large Building consist of repeated units of pref section produce dull and tedious look.
→ There is a limitation of resource availability such as construction material, electric power etc.
→ Simple and standardized connection details for prefab components
→ Minimized usage of materials.
→ Design usage of recyclable materials.
→ Quickly arranged fittings are selected to increase speed of construction.
→ Improved quality and safely construction.
→ Reduced usage of money, time, energy, wages and et
→ Design of construction using the locally available material which are light weight, easy workability, etc

Types of prefabricated elements :

The important elements of prefab are

- Roofing or flooring
- Slab
- Joist
- Beam
- Wall panels
- Columns etc.

(1) Roofing or flooring :

Prefab. roofing consists of reinforced concrete planks and joists. These parts are fabricated with standard size and attached with reinforced cement concrete joist which are provided at regular interval. RCC joists are connected by using bolts.

(2) Slab :

Prefab. slabs are : Hollow core sections types, Double tee section, Channel sections, light weight concrete slab, solid rectangular planks.

- Width and length of prefab slab ranges from 0.5m to 5m.

(3) Joist :

Joists are commonly act as a beam which is used to carry the loads acting on planks. It is then transferred to the main beam.

(4) Beam :

Beams are fabricated bet^n the columns. Beams are may be rectangular, L-shaped, inverted tee-beam etc.

(5) Wall panels :

Wall panels are manufactured with necessary fittings such as doors, windows, frames, ventilators and so on. The wall panels are generally non-load bearing member. Prefab. wall panels are generally sandwich type of

concrete blocks of thickness of about 75mm and it is covered by reinforced cement concrete of grade M25 with thickness of about 37.5mm on each side. The inner core is filled with any type of light weight or low cost material such as bricks, concrete etc.

6) Column :

Columns are fabricated with necessary grooves provided on each side, to achieve strength and stability of structure or to keep the structure safety.

Modular Co-ordination (for prefabrication)

→ Modular coordination means the inter-dependent arrangement of a dimension, based on a primary value accepted as a module.

→ Some strict rules of modular co-ordination are followed. They are

(i) Assembly of single components into large components

(ii) Fewest possible different type of components.

(iii) Minimum wastage of cutting is needed.

→ Modular co-ordination is the basis for a standard of a mass production of component. A set of rules are required for prefabricated construction.

→ Modular co-ordination is a concept of coordination of dimension and space, in which buildings and components are dimensioned and positioned in a term of a basic unit or "Module" known as "1M" which is equivalent to 100 mm.

→ The rules adopted for prefab are :

(a) The planning grid in both directions of

the horizontal plan shall be
- 3M for residential and institutional buildings.
  (3M = 3x100 = 300mm)
- For industrial buildings,
  15M for spans upto 12m.
  30M for spans of 12m to 18m.
  60M for spans above 18m.

→ The centre lines of load bearing walls shall coincide with the grid lines.

→ In case of external walls the grid lines should coincide with the centre line of the wall.

→ The planning module in the vertical direction shall be 1M upto a height of ~~2.8M~~ 2.8metre.

→ Increments for sill, doors, windows etc shall be 1M.

→ In case of internal column the grid line should coincide with centre line of columns.

Application of Modular co-ordination:

- Modular co-ordination ~~shall be~~ is applied to the design, manufacture and assembly of buildings, components, their assemblies and installation.
- Modular coordination ensures proper fitting of the components relative to the position and the dimension with reduced material wastages and on site modification.
- Modular co-ordination is applied to prefab technologies, and traditional building methods.
- M. co-ordination is used for columns, beams, slabs etc prefabricated elements.

Indian standard recommendation for modular planning

- Indian standards used for recommendation for modular co-ordination in building industry is IS 1361 : 19

— This standard recommends the rules for practical application of the modular co-ordination in building industry for fixing location of structural walls and floor, slabs.

→ Other important Indian standards relating to modular co-ordination are IS : 7921 : 1987
IS : 7922 : 1987
IS : 6820 : 1978

→ IS : 6820 : 1978 : This standard deals with application of modular co-ordination in planning and design of buildings and manufacture and assembly of building components.

Lateral Load Resisting Structures :

- The tall buildings need a lateral load resisting system to maintain the structure stability when lateral loads are applied to them. Wind and Earthquakes are mainly applied as the lateral load.

→ The effect of lateral load becomes more severe with the increase of height of structure.

→ Different structural systems are used depending on the nature of buildings to resist the lateral loads.

→ The methods/Elements are

- Frame
- Bracings
- Shear walls
- Wall frame interaction.

(i) Frame :

- Frame structures exist in the majority of the buildings.
- Beam and columns connected together to create the frame. When the connection of beam and column is rigid, the frame can transfer the lateral loads to the foundation.
- Rigid frames considered as a lateral load resisting system. Beam column frame structure can be used upto 15-20 stories building as a lateral load resisting system.

(ii) Bracings :

- Bracings are used mostly in steel structures to improve the lateral load resisting capacity.
- Bracings are used in concrete buildings to improve

the lateral load resistivity.

- Bracings are used in steel buildings.
  (a) Single diagonals
  (b) Cross bracing
  (c) K - bracing
  (d) V bracing.

(iii) Shear Wall:

→ A concrete wall constructed from the base level to the top of the building is considered as a shear wall. It carries the lateral loads and vertical loads applied by the structural elements connected to it.

→ The shear wall alone can resist the lateral load of buildings upto 20 stories. Beyond that the frames are also needed.

→ Shear walls should be fixed at the base level in order to carry the lateral load effectively.

(iv) Wall Frame Interaction:

→ Beyond a certain level, we need some other supporting method along with shear wall to have load resisting capacity.

→ When the tall buildings have both shear wall and frame to resist lateral load, it is called as Wall-frame interaction.

→ The shear wall-frame interaction for lateral load resistance, deflects primarily in bending mode.

Building Characteristics (for Earthquake Resistant Construction)

(1) Quality of soil :

→ Soil quality should be enough to withstand the pressure of the earthquake. The soil should have good flexibility and capability.

→ Soil which is soft, sandy, clayey loose are not suitable for construction.

→ Soils which have coarse components like clayey soils, sandy gravels and consolidated solids are prefered.

→ Soils which have steep slopes, dispersive clays and organic fillings are avoided.

2. Foundation :

→ With the help of foundation, the structure transmit the weight to the nearby land and distribute them.

→ The best foundations are those which are, larger than the structure which they will be supporting.

→ Reinforced foundations are prefered.

→ Pile foundations or deep foundations are prefered.

3. Height of Structure :

→ The number of storeys and the height of the building is major factor in determining the load produced which has to be carried by foundation and soil.

4. Distribution of load and symmetry :

→ A structure should be symmetrical. This helps in maintaining a constant balanced and proper distribution of load over the foundation.

5. Structural design :

→ A structure should have the capacity of bearing dynamic as well as static forces.

→ A structure should be flexible enough to absorb the load easily.

→ Buildings that do not have flexibility and are rigid have high chances of breaking and cracking during earthquake.

→ A greater number of structural elements are provided at base, on the first floor, on column and on girders to ensure the stability and resistance of buildings against the seismic movement.

6. Quality of building material :

→ Materials of high grade and certified help in absorbing the energy generated during earthquake and prevent the damage in best way.

→ Use of steel with concrete is always prefered. This combination gives strength and flexibility to the structure.

→ High quality steels should be used.

→ Mechanical test should be done for every materials to determine their strength for creating seismic resistant structures.

7. Authorization And procedures :

→ There are National and state building regulation as well as Municipal Building law needs to be follow for any earthquake resistant structure.

→ Laws, regulations, rules & must be followed during the construction.

8. Maintenance after construction : It is important to take care of any structure after construction

→ Maintenance includes checking of internal and external leakage, checking of cracks and deformation, repairement of any damages.

Effect of Structural Irregularities

(a) Vertical irregularities :

→ After any earthquake damage, it has been shown that a major amount of structural failures are due to the presence of vertical irregularities.

→ Vertical irregularity refers to structures with irregular lateral stiffness distribution, irregular mass distribution, discontinuity of vertical lateral force resisting members or the sudden change of the bearing capacity of the floor.

→ Vertical irregularities are characterized by vertical discontinuities in the distribution of mass, stiffness and strength.

→ These irregularities increase the displacement of storey of structures which leads to increase of seismic resistance demands. As a result, it leads to a significant reduction in the ductility of local vertical members.

→ A vertical irregularity has a negative impact on the response of structures to seismic action.

→ Some vital requirement for earthquake resistant structures are ductility demand, deformation demand energy dissipation demand etc.

→ Ductility is the capability of a material to undergo deformation after its initial yield without any significant reduction in strength.

→ Ductility demand becomes very complicated to estimate in case of irregular structures.

→ When an earthquake occurs, the acceleration of the ground causes the buildings to move sideways at the base causing a lateral load on the building.

→ The resistance against the lateral load depend on the mass and stiffness of structure.

→ The force is transmitted through the structure to the foundation acc^n to the mass and stiffness distribution.

→ If a gap or discontinuity exists along the members, the force transmission path is altered. This creates weak points in the structures.

→ It creates greater stress concentration, or plastic deformation etc. Which leads to severe damage of structures.

(b) Plan configuration problem :

→ Usually the plan and shape is often decided by site of structure, or other requirements which are not in the control of an engineer.

→ Engineers are advised to provide a regular configuration and uniform shape such as rectangular or trapezoidal shape when possible.

→ Plan configurations such as "Plus shape",

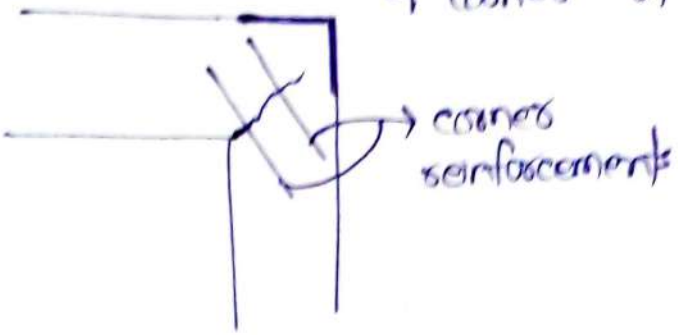
L - shape, H - shape, E - shape, T - shape, C - shape suffer more lateral displacements as compared to regular shape.

→ short buildings can adjust more easily to the earthquake waves and can resist the lateral load. Long buildings are more likely experience torsion during the movement of ground.

Additional Strengthening measures in masonry buildings

(1) Corner reinforcement :

Corner reinforcements are used at wall intersections or near corners of square or rectangular opening in walls, slabs or beams, or around the 4 corners of walls



→ It is used to reduce the cracking due to shrinkage.

→ A strip of metal-lath bent to form 90° angle used in an inside corner of plaster wall, ceiling etc. to prevent cracking.

(2) RCC Bands

- RCC bands in be load bearing structure are reinforced concrete runner provided in the walls to tie them together and to impart horizontal bending strength in them.

→ They ~~read~~ make the masonry walls a stronger unit.

→ RCC bands in load bearing structures are known as horizontal seismic bands.

→ There are five types of bands.

Gable band • Roof band • Lintel band • Sill band • Plinth band

- Gable band : It is a horizontal member which is placed at the top of the ridge of the sloping slab to support the ends of the rafters and transferring loads to gable end walls.

- Roof band : It is a load bearing member of a roof at the roof level. Sometimes roof band is not required because the roof slab of load bearing wall masonry also plays the role of a band. Roof beams are generally provided in the building with flat timber.

- Lintel band :

It is a horizontal member which is placed at the top of the openings like door and window to support the portion of the supported wall above it, continuously throughout the length of wall.

- Sill band :

It is a horizontal member which is placed at the bottom of the opening to support the load of the window frame. It is discontinued at the door opening.

- Plinth band :

It is a horizontal member present at the plinth level to tie the wall at plinth level.

- All these bands and corner reinforcement sustain the shaking of earthquake and hence minimize the damage to the load bearing masonry building.

→ They provide ductility and crack proofing to the structures

(3) RC Jackets (Reinforced concrete) :

→ It is used for strengthening the masonry structure more strongers.

→ The RC jackets are reinforcement mesh.

→ They are provided on one side or on both sides of a wall, connected with the help of steel anchors.

→ 30mm to 100mm thick RC jackets are provided, depending on the method of application of concrete layers.

RETROFITTING OF STRUCTURES

- Retrofitting is the method of modifying or repairing something after it has been manufactured.
- Retrofitting work includes changing or repairing the structure system of a building after its construction. It increases the safety and durability of the structure.
- Retrofitting of buildings is required for homes that are affected by failures and damage by earthquake force.

Imp

- Retrofitting of structure means making changes to an existing building to protect it from flooding or winds or earthquakes.

Need / Purposes of Retrofitting:

- To make the building safer
- For repairing of damaged buildings
- For public safety
- For protection of earthquake - vulnerable buildings
-

Sources of weakness in RC frame Buildings:

(i) Discontinuous load path / interrupted load path / irregular load path

(ii) Lack of deformation compatibility of structural members

(iii) Quality of workmanship and poor quality of material

(i) Discontinuous load path :

- Seismic forces should be properly collected by the horizontal framing system and properly transferred into vertical lateral resisting system.
- Discontinuity/ irregularity in the load path as load transfers may cause structural damage during strong earthquakes.

(ii) Lack of deformation compatibility :

- Limited amount of ductility and inability to redistribute load to safety withstand the deformations damage the whole structure.

(iii) Quality of workmanship and poor quality of material :

- Faulty construction practice like lack of amount of reinforcement as of IS codes.
- Lack of material strength, porous concrete, age of concrete disintegration of concrete, improper maintenance to over all weakness of structure.

Classification of Retrofitting techniques And their uses

1. Retrofitting of reinforced concrete structures
2. Retrofitting of masonry structures.

1. Retrofitting of Reinforced concrete structures:

a. Concrete Jacketing:

- By placing reinfocing steel bars around its periphery, concreting is widely adopted, called concrete jacketing.
- It is for the enlargement of existing structural members like columns and beams.
- This method increases the member stiffness and its size.

b. Steel Jacketing: With steel angles, channels and bands, jacketing of columns and beams is done

c. FRP Jacketing: (Fiber Reinforced polymer jacketing):

- Materials likes carbon fibers and glass fibers reinforced polymers are high-strength sheets.
- Retrofitting is done using these sheets.

d. Addition of Extra structural members:

- This method requires minor disturbance in the existing building, and in this method, only a shear wall is added right from the foundation level.

e. Addition of Energy dissipation device:

- The energy devices like shock absorbers, this method is highly effective approach in seismic retrofitting.

2. Retrofitting of masonry structures:

a. Addition of shear walls:

For ~~retroffin~~ retrofitting of non-ductile reinforced concrete frame buildings and at the exterior of the buildings, new features are placed. It is not preferred in the interior of structure.

b. Addition of steel bracing:

. It is an effective solution in the retrofitting of building when large openings are required.

. It gives strength and stiffness to the structures.

c. Base Isolation: For the passive buildings, vibration control is the most powerful tool.

. Isolation of superstructure from the foundation is known as base isolation.

. When building isolates from the ground it causes lesser seismic loads, hence lesser damage to the structures and minimum repair of super-structure.

. This method is not suitable for high rise buildings and buildings rested on soft soils.

d. Mass reduction technique:

. Removing one or more stories reduces the mass of structures, that leads to increase of strength

e. Wall thickness technique:

. Addition of bricks to existing walls of a building increases the weight of wall. It can bear more vertical and horizontal loads.

CHAPTER : 5 BUILDING SERVICES

Building Services :

Cold Water Distribution in high-rise Buildings :

- The normal water pressure from the public water main is normally inadequate to serve high rise buildings. There are 3 type of water distribution system used for that.

(a) Overhead tank system :

- Water is pumped into a large tank on top of building and distributed to the fixtures by means of gravity.

Advantages : • Water is not affected by peak load hour.
- Not affected by electric power interruption.
- Time needed to replace parts will not affected the regular water supply.

Disadvantages : • Water is subjected to contamination
- It is high maintenance system
- Tanks occupy valuable space.
- It requires stronger foundation and other structure to carry additional load of tank and water.

(b) Hydro - Pneumatic system

- When pressure supplied is not strong enough, compressed air is used to raise and push water into the distribution pipes

Advantages: • It is protected from bacteria due to air tight water chamber
- It is cost effective.

- Less initial construction and maintenance cost.

Disadvantages: Wates supply is affected by loss of pressure inside the tank in case of power interruption.

(C) Direct Pumping system

→ It is an innovation of air pressurized wates distribution used on tall buildings. ~~that could not~~.

→ Pumps are installed to operate in sequence accor the vol of demand.

Advantages: It eliminates the construction of a large house wates tank.

- It is low in construction price.
- It eliminates the periodic cleaning of tank.

Disadvantages: It depends on power supply.