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Advance Construction Technique & Equipment

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Fiber as construction material

Fibers are considered as a construction material the flexural and tensile strength and as a binder that cloud combine Portland cement in bonding with cement matrice. Fiber is such a reinforcing material. Fibers are small pieces of reinforcing material processing certain characteristics and properties. Fibers are usually used in concrete to control cracking due to plastic shrinkage and drying shrinkage.

Types:-

Glass Fiber :

Different types of glass exist, with various colours chemical compositions and characteristics. Glass fibres have great mechanical properties and excel in terms of strength thermal properties durability and have good interfacial bonding to the matrix. Glass fibers are most frequently used as reinforcement in resins and composites as they have amazing properties in strengthening composites.

Glass fibers are generally used to reinforce polypropylene systems. A composite is formed between the elements to form an excellent material. The resulting composite is cost effective, easy to procure and possesses the strength and toughness characteristics of glass fiber.

Steel Fibers:

Similar to tradition steel reinforcement the key characteristic of steel fibers is their high tensile capacity. Steel fibers have been broadly studied in concrete applications, hence they are commonly used to improve the mechanical properties of concrete.

Research has shown that when steel fibres are used to reinforce concrete structures there are many improvements in the overall properties. Steel fibers help improve to fatigue and impact and blast loading. Further more strength, properties such as tensile strength compressive strength and flexural strength are increased

for the parent material. This strength increase is due to the steel fibers characteristics of absorbing energy and controlling cracks. Steel fibers can be an ideal additive to specific applications as they possess good electric, magnetic, and heat conductivity.

Carbon Fibers:

Carbon fibers have been added in materials to form composite with improved properties. The addition of carbon fibers creates a composite that has outstanding mechanical properties, performs well in high temperature environments, and possesses the benefit of durability. Although carbon fibers are quite brittle, with careful consideration in the design stage, carbon fiber reinforced composite have excellent properties. The disadvantages of carbon fibers is high and the bonding between the fibres and material matrix may be difficult to achieve.

Similar to glass fibres, although there are many positives and benefits to carbon fibers, the production of carbon fibres leads to concerns for the environment and questionable sustainability. The problem of the disposal of carbon fibre composites at the end of life phase is also known. For most carbon fibre composites, recycling could be a possibility, however most products are simply burnt or buried, which is not good for the environment.

Properties:

→ High tensile strength and modulus of elasticity
→ High resistance to weather and acidic environments and some alkali resistance
→ Good thermal properties and stability and can tolerate and perform well in high temperature environments
→ Good electric, electromagnetic and sound insulation properties
→ Good resistance and stability against corrosion, chemical attack, impact load, and fire
→ Good adhesion and abrasion properties with the ability to mix well with matrix materials.

→ Nonreactive and noncombustible
→ Low absorption of moisture/water and thermal conductivity.
→ Absorb sound and vibration isolation
→ Resistant to radiation and UV light.
→ strong, hard and rigid
→ Improved strain failure Basalts fibers are also.
→ Easy to produce and process.
→ Cost-efficient/inexpensive
→ Used to form lightweight composites with excellent properties.
→ Can be recycled for reuse.
→ Require no chemicals or additive
→ Natural
→ Biodegradable
→ Ecologically clean, easy to handle, and non-toxic
→ can be used in diverse range of application.
→ Tailed as green.

Plastic as a Construction Material:

Plastic is a general name given to a wide range of synthetic materials that are based on polymers. The construction industry uses plastic for a wide range of applications because of its versatility, strength to weight ratio, durability, corrosion resistance and so on

Plastic can be manufactured into forms such as, pipes, cables coverings, panels, films, sheets and so on, and can be formed or expanded to create low-density materials and be dissolved in solvents

Some of these plastics main uses in the construction industry are: cladding panels, cables, pipes and gutters, Windows and doors shutterings, wall linings, floor covering, ceiling panels, Roof coverings, sinks, basins, baths and showers.

: The advantages of using plastic in construction are that it is light weight yet strong which makes it easier to transport and shift around site. It is also resistant to rot and corrosion and has strong weather ability due to it being capable of achieving tight seals

: The disadvantages of plastic are that it has a high embodied energy content and a low modulus of elasticity, meaning that it is generally unsuitable for loadbearing applications

Properties :

Typically, construction professionals select plastic materials based on the following criteria

1. Durability 2. Cost effectiveness, 3. Recycling, 4. Energy saving 5. Safety 6. Easy to install.

Use of plastics in different aspects of the construction industry

1. Flooring: Plastic materials like Polyvinyl chloride (PVC) 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.

2. Roofing :- To protect the outer surface of the roof from damage, two layers of different plastic materials are required. The upper part is made of colored thermoplastic olefin or vinyl while the lower part consistency. Polyurethane foam ~~is also popular because it is polyurethane insulation performs as an air barrier, resulting in significant energy savings.~~ which consumes less energy and keeps the interior of a house cooler.

3. Insulation: Polyurethane spray is frequently used for insulation when constructing green or low energy buildings. Rigid polyurethane foam is known for its high thermal resistance which promotes temperature consistency. Polyurethane foam is also popular because it is lightweight chemical resistant, and flame retardant. Due to its closed cell nature polyurethane insulation performs as an air barrier, resulting in significant energy savings.

4. Wall :- A structural insulated panel (SIP) is a sandwich of expanded polystyrene amidst two slim layers of oriented strand board. This type of pre-fab, composite wall board can be transferred to the work place easily for a particular task and provide good support to columns and other associated essentials during renovation.

5. Pipes: Commonly made up of polyvinyl chloride (PVC), CPVC, acrylonitrile butadiene styrene (ABS) or polyethylene, plastics ~~materials~~ pipes are flexible and very light in weight, making them easy to install. All of these plastic materials are also highly chemical and water resistant, making them suitable for many extreme environments.

6. Windows: Polycarbonate is used to manufacture building windows. This plastic material is strong clear and very light in weight. Polycarbonate windows are considered more burglar-proof than regular glass windows. Two plastic materials, vinyl and fiberglass are used commonly in the production of window frames. Fiberglass is extremely strong while vinyl is quite durable and also inexpensive.

7. Doors: Some construction projects use doors made from a stiff polyurethane foam core with a fiber reinforced plastic (FRP) coating. The sandwich structure of these doors makes them incredibly strong.

Types:

PVC: Polyvinyl chloride (PVC), a synthetic resin made from the polymerization of vinyl chloride. Second only to polyethylene among the plastics in production and consumption. PVC is used in an enormous range of domestic and industrial products, from raincoats and shower curtains to window frames and indoor plumbing. A lightweight, rigid plastic in its pure form, it is also manufactured in a flexible "plasticized" form.

RPVC: RPVC means Rigid Polyvinyl chloride which comes from PVC. Polyvinyl chloride (PVC), also known as vinyl, is a common plastic polymer (a polymer being a large molecule). It comes in two basic forms: flexible and rigid (RPVC) RPVC is used in construction (especially pipes), packaging etc. RPVC pipes with high impact strength & load bearing capacity.

HDPE: High density polyethylene (HDPE) piping systems have been used for municipal and industrial water applications for over 50 years. Within Building & construction Division HDPE pipes are used for ground source geothermal application also known as earth energy or geoexchange system.

FRP: Fibre reinforced plastic (FRP) also called fiber-reinforced polymer). FRP bars are used as internal reinforcement for concrete

structures. FRP bars, sheets and strips are used for strengthening of various structures constructed from concrete, masonry, timber and even steel. Fibers reinforcement polymers are used in the construction of special structures requiring electrical neutrality.

GRP:- GRP stands for 'Glass Reinforced plastic' a material made from a polyster resin, which is reinforced by chopped strand mat glass fibers to form a GRP laminate. It is a very popular composite material to use because not only is it very strong but also suprising light.

Coloured plastic sheets:

Plastic film is a thin continuous polymeric material. Thicker plastic material is often called a 'sheet' plastic sheets are generally low cost, easy to manufacture, durable, strong for their weight, electrically and thermally insulative and resistant to shock, corrosion, chemical and water

ARTIFICIAL TIMBER:-

Reduction of moisture content along with improving some qualities before the use of woods is called seasoning of timber. By seasoning, generally the moisture is reduced to about 15% where new cut woods ~~are~~ bears about 50%.

Reason for seasoning:- Seasoning of timber is done to fulfill some specific requirement. Following are the reasons to perform timber seasoning.

1. To change and improve the properties of wood,
2. To make a correct percentage of shrinkage of woods
3. To make a confident use of woods
4. To reduce the adverse behaviour of woods.

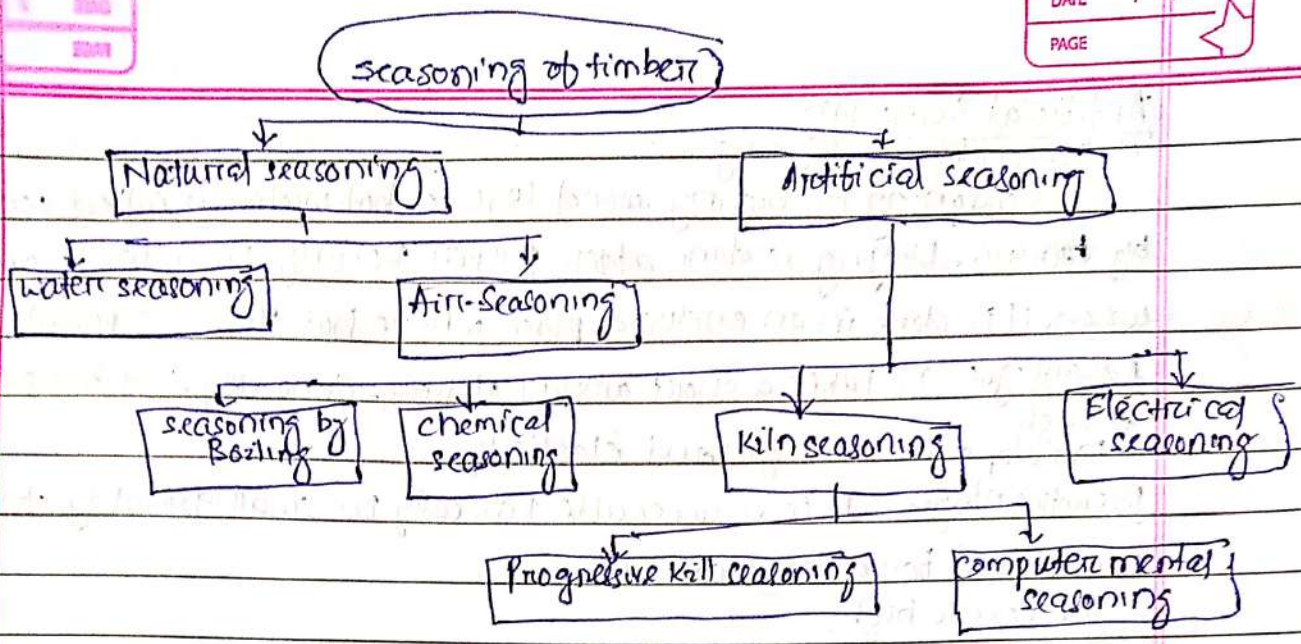
Methods of seasonings of timber

There are mainly two methods of seasoning of timber. There are

A) Natural seasoning

B) Artificial seasoning

Following tree diagram can be used to illustrate all the methods of timber seasoning.



Natural seasoning

Seasoning of woods or timbers using natural elements is called natural seasoning e.g. water and air seasoning.

(a) Water seasoning:- Removal of wood sap immersing logs into water flows is called water seasoning. It is carried out on the banks of the river while thicker ends are kept towards upstream. After that, the logs are allowed to dry. Disadvantages: It is time consuming such as 2 to 4 weeks generally.

(b) Air seasoning:- Exposing the woods to air for seasoning. At first, a platform is required that is built on the ground at 300mm height above the ground.

Secondly, the arrangement of woods in layers. Air circulation is maintained between logs because it helps to reduce the moisture which is important for seasoning. The environment for this need to maintain some condition. A clean, shady, dry, cool place is preferred. Sometimes logs are coated by the impermeable substance to reduce extreme moisture. To improve the quality oil coating, thick paint coating is maintained. To prevent fungal infection logs are treated with petrol or gasoline.

Advantages:

Good quality of seasoned wood
A large amount is convenient in this process
Well seasoned timbers is formed

Disadvantages:-

It is slow process

Artificial Seasoning

a. Seasoning by Boiling

Seasoning by boiling wood logs in hot water is called seasoning by boiling. Drying is done after proper boiling. For a large amount of wood, it is done in an enclosed place where hot steam is passed.

Advantages: It takes a short amount of time. Generally, 3 4 hours is good enough.

Develops the strength and elasticity.

Disadvantages: It is serviceable basically for small quantity of wood, not convenient for a large amount.

The cost is high.

b. chemical seasoning :

Reduction of moisture using salt solution is called chemical seasoning. After the absorption of water by the solution logs are let to dry

Advantages

→ It increases the strength of the timber

→ It is less time-consuming

Disadvantages

chemical reagents can sometimes reduce strength.

It can cause a problem in gluing or finishing or corrosion while using.

c. Kiln seasoning

Seasoning of wood by using a large chamber or oven where there is a good process for the circulation of hot air.

Advantage:- Most effective and economic seasoning

Kiln seasoning can be done by 2 processes such as

1. Progressive kiln seasoning:- Wood log is entered through the kiln of the temperature and humidity differentials are maintained throughout the length of the kiln to maintain proper drying

2. Compartmental seasoning:- Its maintained by enclosed containers or buildings

Advantage: It accelerates the process because external energy is used

d. Electrical seasoning :- Dry wood is non-conductor of electricity while green timber is a conductor, so, can pass alternating currents. Thus in this

method alternating current is used for. The resistance of timber against electricity is measured at every interval time. When the required resistance is reached seasoning process is stopped because resistance of timber increases by reducing moisture content in it. It is also called as rapid seasoning and it is uneconomical

Miscellaneous materials:-
A category of asbestos-containing building material comprised mostly of non friable asbestos products and materials such as ceiling tiles, floor tiles, roofing felt, transit pipes and panels, exterior siding, fabrics and sheetrock systems.

Acoustic Material:
When the sound intensity is more, then it gives the great trouble or nuisance to the particular area like auditorium, cinema hall, studio, recreation centre, entertainment hall, college reading hall. Hence it is very important to make that area or room to be sound proof by using a suitable material called as "Acoustic material". It is measured in decibles (db)

Properties of Acoustic Material
1. Sound energy is captured and adsorbed
2. It has a low reflection and high absorption of sound.
3. Higher density improves the sound absorption efficiency at lower frequencies.
4. Higher density material help to maintain a low flammability performance. Hence accoustic material should have higher density.
5. It controls the sound and noise levels from machinery and other sources for environmental amelioration and regulatory compliance.
6. Acoustic material reduces the energy of sound waves as they pass through.
7. It suppresses echoes, reverberation, resonance and reflection

Uses of Acoustic Material:-
1. Acoustic materials can be used for noise reduction and noise absorption. It makes the sound more audiable which is clear to listen without any disturbances.
2. It suppresses echoes, reverboration, reflection and resonance.
3. Important specifications for noise reduction and noise absorption produc include noise attenuation and noise reduction coefficient.

4. A vinyl acoustic barrier blocks controls airborne noise (street traffic, voices, music) from passing through a wall ceiling or floor.
5. Acoustic foam and acoustic ceiling tiles absorb sound so as to minimize echo and reverberation within a room.
6. Sound proof doors and windows are designed to reduce the transmission of sound.
7. A sound proof wall (treated by a accuricate material) can incorporate sound proofing and acoustic materials to meet desired sound transmission class (STC) values.

Wall cladding:-

Wall cladding is a type of decorative covering intended to make a wall look like it is made of a different sort of material than it actually is. Some of the most common examples are on the outside of buildings, but cladding can also be an artistic element in interior decorating.

The most common types of cladding are stone cladding, Brick cladding, Timber cladding, Metal cladding, Concrete cladding, Glass claddings.

Plasterboard:-

Plasterboard is a panel made of calcium sulfate dihydrate (gypsum) usually pressed between a facer and a backer. It is used to make interior walls and ceilings. This 'Drywall' construction became popular as a quicker alternative to traditional lath application.

Microsilica:-

Microsilica or silica fume is an excellent admixture for concrete as it leads to better engineering properties. It reduces thermal cracking, improves durability, and increases strength. Silicafume concrete has a number of construction

applications.

Artificial sand:-

Artificial sand, also called crushed sand or mechanical sand refers to rocks, mine tailings or industrial waste granules which a particle size of less than 4.75mm, which are processed by mechanical crushing and sieving but does not include soft and weathered granules.

Bonding Agents:-

Bonding agents are natural, compounded or synthetic materials used to enhance the joining of individual members of a structure without employing mechanical fasteners. The most commonly used types of bonding agents are generally made from natural rubber, synthetic rubber or from any other organic polymers. The polymers include polyvinylchloride, polyvinyl acetate or. With the addition of bonding agent in repair mortar or concrete, the reduced water-cement ratio can be adopted for the same workability thereby reducing drying shrinkage.

Adhesive:-

Construction adhesive is a general purpose adhesive used for attaching drywall, ~~the~~ tile molding and fixtures to walls, ceilings and floors. It is most commonly available in tubes intended for use

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Prefabrication:-

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 term is used to distinguish this process from the more conventional construction practice of transporting the basic materials to the construction site where all assembly is carried out.

The term prefabrication also applies to the manufacturing of things other than structures at a fixed site. It is frequently

used when fabrication of a section of a machine or any movable structure is shifted from the main manufacturing site to another location, and the section is supplied assembled and ready to fit. It is not generally used to refer to electrical or electronic components of a machine, or mechanical parts such as pumps, gearboxes and compressors which are usually supplied as separate items, but to sections of the body of the machine which in the past were fabricated with the whole machine. Prefabricated parts of the body of the machine may be called 'sub-assemblies' to distinguish them from the other components.

History:-

Prefabrication has been used since ancient times. For example, it is claimed that the world's oldest known engineered roadway, the Sweet Track constructed in England around 3800 BC, employed prefabricated timber sections brought to the site rather than assembled on-site. [citation needed].

Sinhalese Kings of ancient Sri Lanka have used prefabricated building technology to erect giant structures, which dates back as far as 2000 years, where some section were prepared separately and then fitted together, specially in the Kingdom of Anuradhapura and Kingdom of Polonnaruwa.

After the great Lisbon earthquake of 1755, the Portuguese capital, especially the Baixa district, was rebuilt by using prefabrication on an unprecedented scale. Under the guidance of Sabastião José de Carvalho e Melo, popularly known as the Marquis de Pombal, the most powerful royal ministers of D. José I, a new Pombaline style of architecture and urban planning arose, which introduced early anti-seismic design features and innovative prefabricated construction methods, according to which large multistory buildings were entirely manufactured outside the city, transported in pieces and then assembled on site. The process, which lasted into the nineteenth century, lodged the city's residents in

safe new structures unheard of before the quake.

Also in Portugal, the town of Vila Real de Santo Antonio in the Algarve, founded on 30 December 1773, was quickly erected through the use of prefabricated materials en masse. The first of the prefabricated stones was laid in March 1774. By 13 may 1776, the centre of the town had been finished and was officially opened.

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

The method was widely used in the construction of prefabricated housing in the 20th century such as in the United Kingdom as temporary housing for thousands of urban families "bombed out" during World War II. Assembling sections in factories saved time on-site and the lightness of the panels reduced the cost of foundations and assembly on site. Coloured concrete grey and with flat roofs, prefab houses were uninsulated and cold and life in a prefab acquired a certain stigma, but some London Prefabs were occupied for much longer than the projected 10 years.

The Crystal Palace, erected in London in 1851, was a highly visible example of iron and glass prefabricated construction it was followed on a smaller scale by Oxford Rewly Road railway station.

Scope of prefabrication:

Prefabrication is more efficient, low cost, Time saver, Reduce the wastage, Reduce the Manpower, Maintenance is less and can be reused in the material stream.

First prefabrication in India:

→ Prefabrication in India began with the emergence of the Hindustan Housing Factory.

→ The company was developed by the first Prime Minister of India, Pandit Jawaharlal Nehru, from West Pakistan in 1950s.

→ The Hindustan Housing Factory produce the prestressed concrete railway sleepers to replace dilapidated wooden sleepers on Indian

Railways
→ Then, the company changed its name known as the Hindustan Prefab Limited or HPL.

Necessity of pre fabrication:
→ Higher quality products for clients
→ Maintenance cost is low
→ Improved productivity and profitability for contractors
→ Environmental benefits associated with its use:
→ Prefabrication System provides satisfactory results to the construction Industry.
→ It found that wastage generation can reduce up to 100% after adopting prefabrication, in which up to 84.7% can be saved as wastage reduction.

Current uses:
A house being built with prefabricated concrete panels
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. It can be difficult to construct the formwork required to mould concrete components on site, and delivering wet concrete to the site before it starts to set requires precise time management. Pouring concrete sections in a factory brings the advantages of being able to re-use moulds and the concrete can be mixed on the spot without having to be transported to and pumped wet on a congested construction site. Prefabricating steel sections reduces on-site cutting and welding costs as well as the associated hazards.

Prefabrication techniques are used in the construction of apartment blocks, and housing developments with repeated housing units. The quality of prefabricated housing units had increased to the point that may not be distinguishable from traditionally built units to those that live in them. The technique steel and glass sections are widely used for the exterior of large buildings.

Detached houses, cottages, log cabin, saunas, etc. are also sold with prefabricated elements. Prefabrication of modular wall elements allows building of complex thermal insulation, window frame components etc. on an assembly line, which tends to improve quality over on-site construction of each individual wall or frame. Wood construction in particular benefits from the improved quality. However, tradition often favours building by hand in many countries and the image of prefab as a 'cheap' method only slows its adoption. However, current practice already allows the modifying the floor plan according to the customer's requirements and selecting the surfacing material e.g. a personalized brick facade can be masoned even if the load-support elements are timber.

Transportation of prefabricated Airbus wing assembly

Prefabrication saves engineering time on the construction site in civil engineering projects. This can be vital to the success of projects such as bridges and avalanche galleries, where weather conditions may only allow brief periods of construction. Prefabricated bridge elements and systems offer bridge designers and contractors significant advantages in terms of construction time, safety, environmental impact, constructibility and cost. Prefabrication can also help ~~reduce~~ minimize the impact on traffic from bridge building. Additionally, small commonly used structures such as concrete pylons are in most cases prefabricated.

Radio towers for mobile phone and other services often consist of multiple prefabricated sections. Modern lattice towers and guyed masts are also commonly assembled of prefabricated elements.

Prefabrication has become widely used in the assembly of aircraft and spacecraft, with components such as wings and fuselage sections often being manufactured in different countries or states from the final assembly site. However, this is sometimes for practical rather than commercial reasons, such as for Airbus

Process and theory

An example of a house-building illustrates the process of prefabrication. The conventional method of building a house is to transport bricks, timber, cement, sand, steel and construction aggregate, etc. to the site and to construct the house onsite from these materials. In prefabricated construction, only the foundations are constructed in this way, while sections of walls, floors and roofs are prefabricated (assembled) in a factory (possibly with sheathing, window and door frames included), transported to the site, lifted into place by a crane and bolted together.

Prefabrication is used in the manufacture of ships, aircraft and all kinds of vehicles and machines where sections previously assembled at the final point of manufacture are assembled elsewhere instead, before being delivered for final assembly.

The theory behind the methods is that time and cost is saved if similar construction tasks can be grouped, and assembly line techniques can be employed in prefabrication of a location where skilled labour is available, while congestion at the assembly site, which wastes time, can be reduced. The method finds application particularly where the structure is composed of repeating units or forms or where multiple copies of the same basic structure are being constructed. Prefabrication avoids the need to transport so many skilled workers to the construction site, and other restricting conditions such as a lack of power, lack of water, exposure to harsh weather or a hazardous environments are avoided. Against these advantages must be weighed cost of transporting prefabricated sections and lifting them into position as they will usually be larger, more fragile and more difficult to handle than the materials and components of which they are made.

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Types of Prefabricated systems:

There are two main types of prefabrication, namely volumetric (often referred to as 'modular') and panelised. Both of these types of construction can be acheived in timber, steel and concrete and can also be mixed within the same scheme.

Steel systems for housing are usually light gauge galvanised steel. Timber systems can be relatively traditional in that the construction mirrors that might be produced on site using components such as timber studs and sheating. It can make use of timber Ibeams which give longer spans with a relatively lightweight beam. A third option is structural Insulated Panel systems, which use veneer studs and rely in part on the bond between rigid insulation core and outer sheating materials for strength.

One factors that differentiate all prefabricated timber systems from what might be termed traditional timber frame is the amount of work undertaken in the factory.

While there does not appear to be a ~~panel~~ formal definition separating the two, the prefabricated panel might include any insulation material, the sheating boards and possibly some services.

~~Advantages~~

Prefabrication Elements:

→ Flooring/Roofing system.
→ Precast beams
→ Precast columns
→ Precast wall panels
→ Precast slabs

Classification of Prefabrication:

The prefabrication is classified as follow from the view of degree of Precast construction.

1. Small Prefabrication, 2. Medium Prefabrication, 3. Large prefabrication
4. Cast in site prefabrication, 5. off site (or) factory Prefabrication.

→ Open system of prefabrication.
→ closed system of prefabrication
→ Partial prefabrication
→ Total prefabrication

1) Small Prefabrication :-

The bove 3 types are mainly classified according to their degree of precast.

Element using in that construction for eg: brick is a small unit precast and used in building.

This is called as small prefabrication. That the degree of precast element is very small.

2) Medium Prefabrication :-

Suppose the roofing systems and horizontal members are provided with pretested elements those construction are known as medium prefabricated construction here the degree of precast elements are moderate.

3) Large Prefabrication :-

In large prefabrication most of the members like wall panels, roofing/flooring systems, beams and columns are prefabricated Here degree of precast elements are high.

4) Cast in-site prefabrication: OFF-site (factory) prefabrication :-

One of the main factor which affect the factory prefabricate is transport. The width of road walls, mode of transport, vehicles are the factors which prefabrication is to be done on site or factory.

Suppose the factory situated at a long distance from the construction site and the vehicle have to cross a congested traffic with heavy weighted elements the cost in side prefabrications preferred even though the same ~~direction~~ condition are the cast in site prefabrication is preferred only when number of houses and more over small elements the conveyance is carried with normal type of lorry and trailers. Therefore we can

adopt factory (or) OFF site prefabrication for this type of construction

5) Open system of prefabrication:

In the total prefabrication system, the space frames are casted as a single unit and erected at the site. The wall fitting and other fixing are done on site. This type of construction is known as open system of prefabrication.

6) closed system of prefabrication:

In this system the whole things are casted with frames and erected on their position.

7) Partial prefabrication:

In this method of construction the building element (mostly horizontal) required are precast and then erected. Since the casting of horizontal elements (roof/floor) often take there time due to erection of formwork, the completion of the building is delayed and hence this method is restored. In most of the building sites, this method is popular more. Seen in industrial buildings where the elements have longer spans. Use of double tees, channel unit, cured slabs, slabs, hyperboloid shall etc. are some of the horizontal elements.

This method is efficient when the elements are readily available when the building reached the roof level. The delay caused due to erection of formwork, delay due to removal eliminated completely in this method of construction. Suitable for any type of building provided lifting and erection equipments are available.

Advantages:-

1. Moving partial assemblies from a factory often costs less than moving preproduction resources to each site.
2. Deploying resources on-site can add costs; prefabricating assemblies can save costs by reducing on-site work.
3. Factory tools - jigs, cranes, conveyors, etc. - can make production faster and more precise.
4. Factory tools - shake tables, hydraulic testers, etc. - can offer added quality assurance.

5. Consistent indoor environments of factories eliminate mo impacts of weather on production.
6. Higher precision Cranes and reusable factory tools can aid more controlled movement of building heat and air, for lower energy consum and healthier buildings.
7. Cranes and reusable factory supports can allow shapes an sequences without expensive on site-falsework.
8. Factory production can facilitate more optimal material usage, recycling, noise capture, dust capture, etc.
9. Machine-mediated parts movement and freedom from wind and 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 and precision measurement and handling to place in position.

Design Principal of Prefabrication:

The Main reasons to choose Precast Construction method over conventional in methods:

1. Economy is large scale project with higher degree of repetition in work construction.
2. Special requirement in finishing
3. Consistency in structural quality control
4. Fast speed of construction
5. Constraints in availability of site resources (e.g. material & Labour)
6. Other spaces & environmental constraints.
7. Overall assessment of some or all of the above factors which points to the superiority of adopting precast construction over convention method.

The following details gives the most implication of precast construction & conventional in situ method

5. Large groups of buildings from the same type of prefabricated elements tend to look drab and monotonus.

1. Local Jobs are lost.

The main reasons to choose Precast construction method over conventional in-situ method.

1. Economy in large scale project with high degree of repetation in work execution.
2. Special architectural requirement in finishing
3. Consistency in structural quality control.
4. Fast speed of construction.
5. Constraints in availability of site resources e.g. materials & labour etc.
6. Other space & environmental constraints.
7. Overall assessment of some or all of the above factors which points to the superiority of adopting precast construction over conventional method.

~~The following details gives the cost implications of precast construction & conventional in situ method.~~

Modular Coordination:

Modular coordination is a concept for coordinating dimension and space for which building components are positioned. Basic unit of MC is module 1M which is equal to 100mm. MC is internationally accepted by the International Standard of Organization (ISO) The introduction of MC in building facilitate proper planning, design construction and assembly of building components. The principle objective of implementation of MC is to improve productivity, more flexibility in design and construction action.

Modular co-ordination Grid:

Structural Grid: It is used to locate the structural components such as beam and columns.

Planning Grid: It is used for locating the space for building components like rooms.

Controlling Grid: It is used for locating internal walls. Modular

coordinated grid is used for locating the building components and the grids can be available in both horizontal and vertical planes. The grids are generated by measurement in modules.

Dimensional Grid:- Modular coordinated grid network defines the space available for placing the components. An important factor is that the component must always undersized to grid size for providing space for joint space. Manufactured length of unit nominal length 11½ inch grid size would be 12 inch because of units were designed to be placed with ½ inch joint.

In modular coordination system, in place of geometric series, a different system of preferred dimensions is used. For larger dimensions it is represented in modules like 1M = 0.1m, for smaller dimensions sub modular increments 50mm or 25mm are used.

Modular coordination system provides:

1. Defining coordinating spaces for building elements and component.
2. Rules for maintaining the component size while manufacturing
3. Rules for selecting the component size and providing the required grid size in building.
4. The MC system allows standardization in design of building components. It encourages manufacturers and assemblers to enter in open market.
5. It is difficult to manufacture the component in ±1 unit mm tolerance. But it is easier for manufacturer to make the module tolerance system.

Advantages of Modular Coordination:

1. Facilitate cooperation between building designers, manufacturers, traders, contractors.
2. Improves freedom in design and permits flexibility
3. Encourage the possibility of interchanging the component
4. Simplifies positioning and placing of components
5. Ensures dimensional coordination between component with the rest of the building.

6. It's possibles to get maximum economy in the production of components.
7. Reduces the need for making special sizes.
8. Increase the number of choices of components because of interchangeability
9. Improves quality and productivity of construction
10. Wastage in production and time taken for installation of components is reduced
11. It helps to acheive the responsibility in constructing the building.

Design principal of prefabrication:

The Main reasons to choose Precast Construction method over conventional in method.

1. Economy in large scale project with high degree of repetition in work construction.
2. Special requirement in finishing.
3. Consistency in structural quality control.
4. Fast speed of construction
5. Constraints in availability of site resources (e.g. materials & Labourites)
6. Other space & environmental constraints.
7. Overall assessment of some or all of the above factors which points to the superiority of adopting precast construction over conventional method.
8. Large groups of buildings from the same type of prefabricated element tend to look drab and monotonus.
9. Local Jobs are lost

The main reasons to choose Precast Construction method over conventional in situ methods

1. Economy in large scale project with high degree of repetition in work execution.
2. Special architectural requirement in finishing.
3. Consistency in structural quality control.
4. Fast speed of construction

5. Constraints in availability of site resources e.g. materials & labour.
6. Other space & environmental constraints.
7. Overall assessment of some or all of the above factors which points to the superiority of adopting precast construction over conventional method.

The following details gives the cost implications of precast construction & conventional in situ method.

Indian Standard Recommendation for modular planning (IS 7921 1988)

(A) Preferred horizontal dimensions:

→ The preferred horizontal dimensions for building components and buildings are such multiples of 3M which are preferred against other multiples are basic module.

→ The values of the multimodule for horizontal co-ordination dimensions in modular co-ordination shall be 3M, 9M, 15M, 21M, 27M, 33M, 39M & 45M.

(B) Modular room dimensions:

In the perfect modular designs all room dimensions shall be modular.

→ The modular room dimensions shall be designed and that modular fixtures fittings & partitions shall fit into them without shaping on site. This shall only be achieved when all building components are made available in modular dimensions for the modular planning.

(C) Axial planning:

Modular room dimension becomes $nxM + 10$ mm with plaster and $nxM + 30$mm without plaster.

(D) 5-mm Rule:

Horizontal dimensions in design of the buildings are controlled by the planning module 3M.

(E) Residential buildings:

Horizontal preferred dimensions for residential building shall be multiple of 3M.

Module - III

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Earthquake Resistance Construction:

Building configuration:

The second step of seismo~~graph~~ resistance construction is the configuration of load resisting system of buildings. IS 1893-(part-1): 2002 has recommended building configuration in sec^n 7 for the better performance of building during earthquake.

An important features in building configurations is its regularity and symmetry in horizontal and vertical plane. seismic behaviour of irregular shape plans are differe from regular shape.

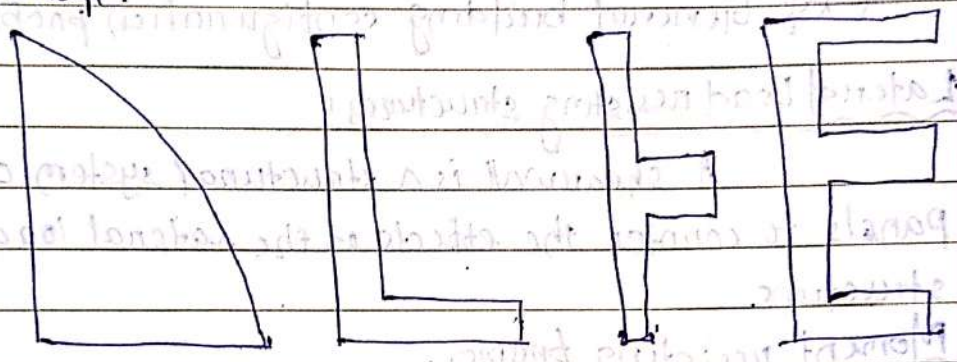


fig. example of plan irregularity.

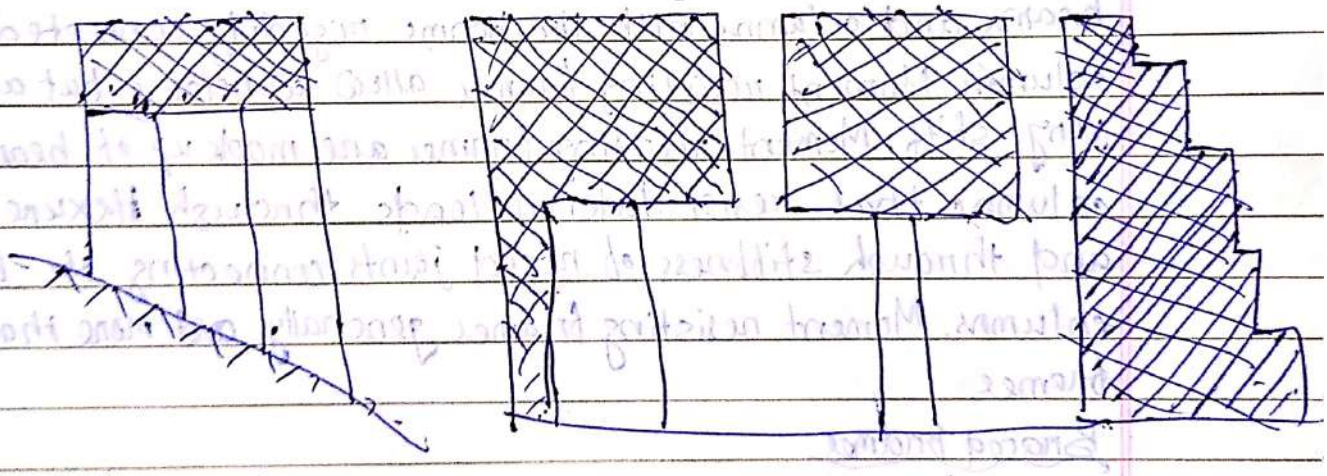


fig. example of vertical irregularity

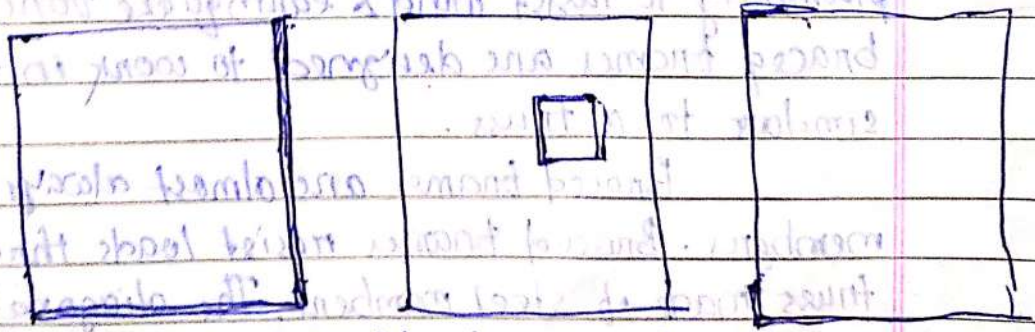


fig. example of highly torsional configuration

fig. example of short column

(fig. General building configuration problem)

Lateral load resisting structures:

A shearwall is a structural system composed of braced panels to counter the effects of the lateral load acting on a structure.

Moment resisting frames:

Moment resisting frame is a rectilinear assemblage of beams and columns with the beams rigidly connected to the columns Moment resisting frames allow windows but are not very stiff. Moment resisting frames are made up of beams and columns that resist lateral loads through flexure member and through stiffness of riged joints connecting the beams and columns. Moment resisting frames generally cost more than braced frames.

Braced frames:

A braced frame is a structural system which is designed primarily to resist wind & earthquake forces. Members in a braced frames are designed to work in tension & compression similar to a truss.

Braced frames are almost always composed of steel members. Braced frames resist loads through a series of trusses made of steel members. The diagonal member of the trusses resist lateral load in the form of axial stresses

by either tension or compression.

Shear walls or (bearing wall system).

In structural engineering a shear wall is a structural system composed of braced panels to counter the effects of the lateral load acting on a structure. The wind & seismic loads are the most common loads that shear walls are designed to carry. Shear walls no option for windows but very stiff.

Shear wall also provide resistance to lateral forces by cantilever beam action through shear & bending.

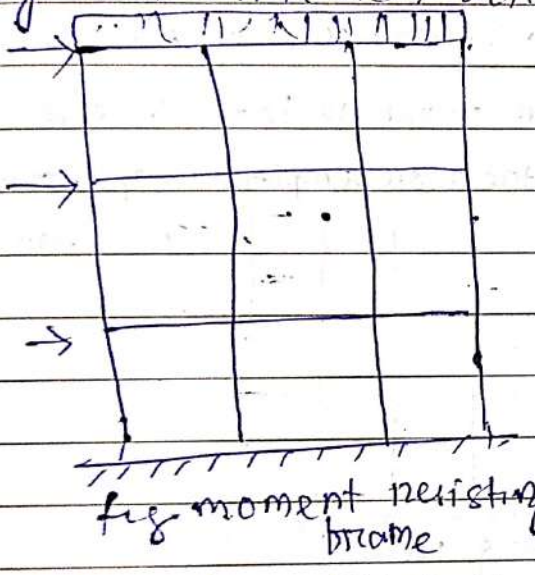
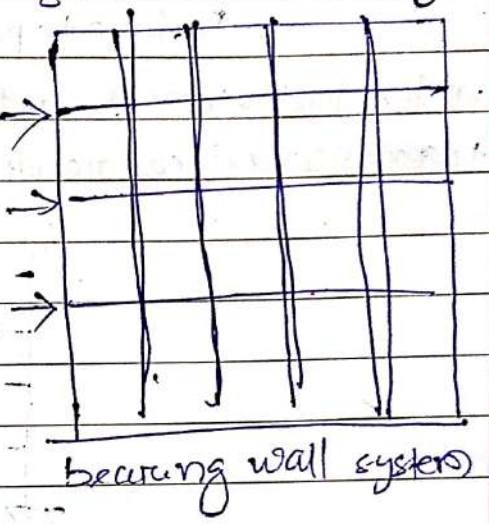


fig moment resisting frame



bearing wall system

Building characteristics: The seismic forces entered on a building are not extremely developed forces like wind instead they are the response of cyclic motions at the base of a building causing acceleration and hence inertia force, The response is the therefore essentially dynamic in nature

The dynamic properties of the structure such as natural period damping & mode shape play a crucial role in determining the response of building. Besides other characteristics of building system also affect the seismic response such as ductility, building foundation response of non-structural elements etc. The effect of building characteristics on its seismic performance are

- → Mode shape is fundamental period
- → Building frequency & grace period
- → Damping, → Ductility, → Seismic weight
- → Hyperstaticity / Redundancy

-> Non structural elements

-> Foundation soil / liquifaction

Effect of structural irregularities :-

① Vertical discontinuities in load path :- One of the major contributors to structural damage in structure during strong earthquake is the discontinuities irregularities in the load path or load transfer.

The structure should contain a continue load path for transfer of the seismic force, which develop due to acceleration is individual elements to the ground.

Failure to provide adequate strength & toughness of individual elements in the system or failure to tie individual elements to ground. can result in distress or complete collapse of the system

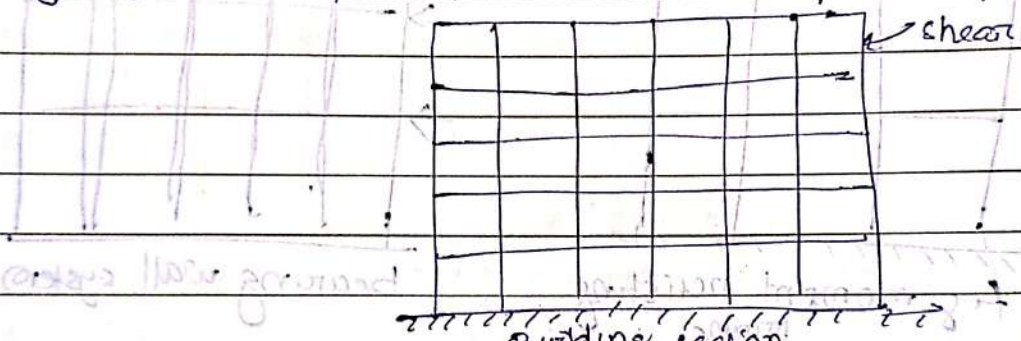


fig. discontinuous shear wall

② Irregularities on strength & stiffness :- A weak storey is defined as one in which the storeys lateral strength is less than 80% of that in the above storey.

The storey's lateral strength is the total strength of all seismic resisting elements shearing the story shear for the direct under consideration.

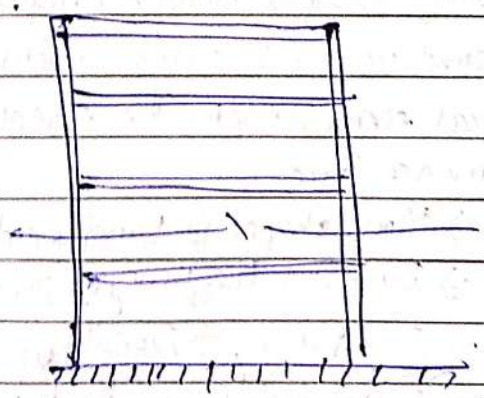
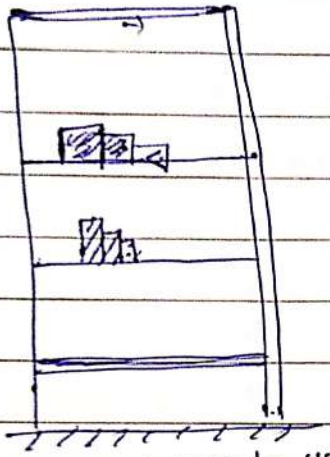


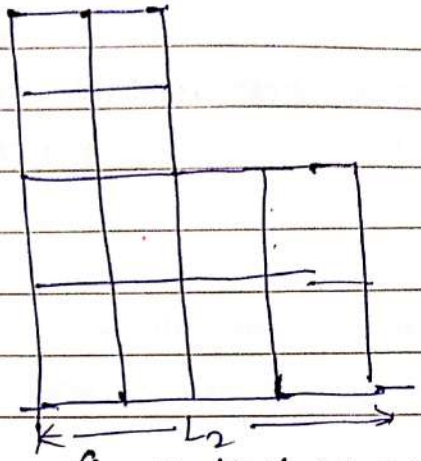
fig stiffness irregularities - soft storey

③ Mass irregularities :- Mass irregularities are considered to exist where the effective mass of any storey is more than 200% of the effective mass of an adjacent storey.

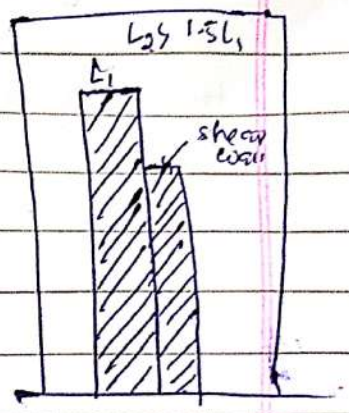
The effective mass is the real mass consisting of the dead weight of the floor plus the actual weight of partition & equipment.



(Fig. mass irregularities in building)



(Fig. vertical geometric irregularity)



→ Proximity of adjacent building

Pounding damage is caused by 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 character.~~

Plan configuration problem :

Torsional irregularities : Torsion irregularities shall be considered when floor diaphragms are rigid in their own plan in relation to the vertical structure elements that resist the lateral forces.

Torsion irregularity is considered to exit when the ~~design~~ maximum storey drift computed with design eccentricity at one end of the structure transverse to an axis more than 1.2 times of avg. of the storey drift at the two ends of the structure.

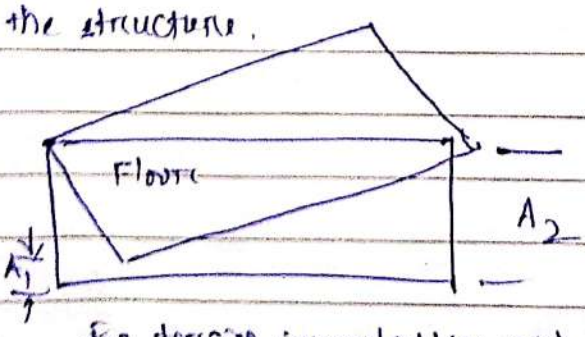


Fig torsion irregularities with stiff diaphragm

Re-entrant corners :- The re-entrant lack of continuity or inside corner is the common characteristics of overall building configuration that in plan, plan configuration of a structure and its lateral force resisting system which contain re-entrant corners, where both projection of the structure beyond the re-entrant corner are greater than 15% of its plan dimension in the given direction.

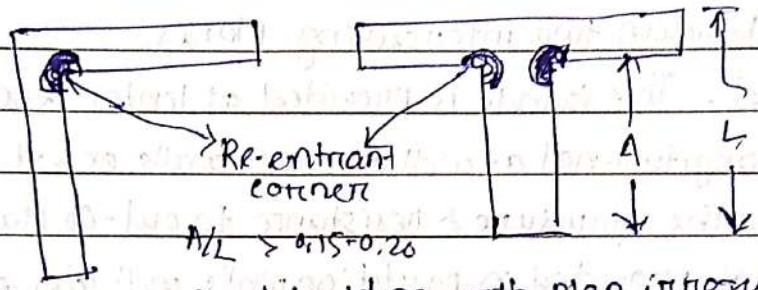


Fig:- example of building with plan irregularities

Non-parallel system :- The vertical load resisting elements are not parallel or symmetrical about the major orthogonal axis of the lateral force resisting frame system.

This problem is often exaggerated in the triangular or wedge shape buildings resulting from street intersection at an acute angle.

Safety Consideration during additional construction and alternation of existing building :-

Existing buildings often undergo alteration during their life to change, modify or improve their performance or the nature of their use.

Common examples of alterations include

-> Total or partial change of use
-> Extension, -> Partial demolition, -> Linking or separating spaces
-> Making or closing openings
-> Retrofitting a new component or feature
-> Maintenance, -> Decoration
-> Renovating an existing component or feature

Some alteration may require planning permission other alteration may be considered permitted developments for which

planning permission is not required.

Additional strengthening measures in masonry building:

Corner reinforcement:- Corner reinforcement uses at wall intersection or near corners of square or rectangular opening in walls, slabs or beams.

Metal reinforcement for plaster at restraint corners to provide continuity between two intersecting planes.

Lintel band:- This bands is provided at lintel level on all internal & external longitudinal as well as cross walls except partition wall. It provide integrity to the structure & resistance to out-of plane wall bending. The lintel band of provided in partition walls will also enhance their stability. The purpose of lintel and roof band is to prevent the collapse of roof.

Sill band:- This band is similar to lintel band but it is provided at sill level. This band reduces the effective height of masonry piers between openings. This is expected to reduce shear cracking in piers. It has not been recommended so far in codes.

Plinth band:- This band is provided at the plinth level ~~on all internal & external longitudinal as well as cross walls except~~ of walls on the top of the foundation, which is useful in sustaining differential settlements particularly when foundation soil is soft or has uneven properties.

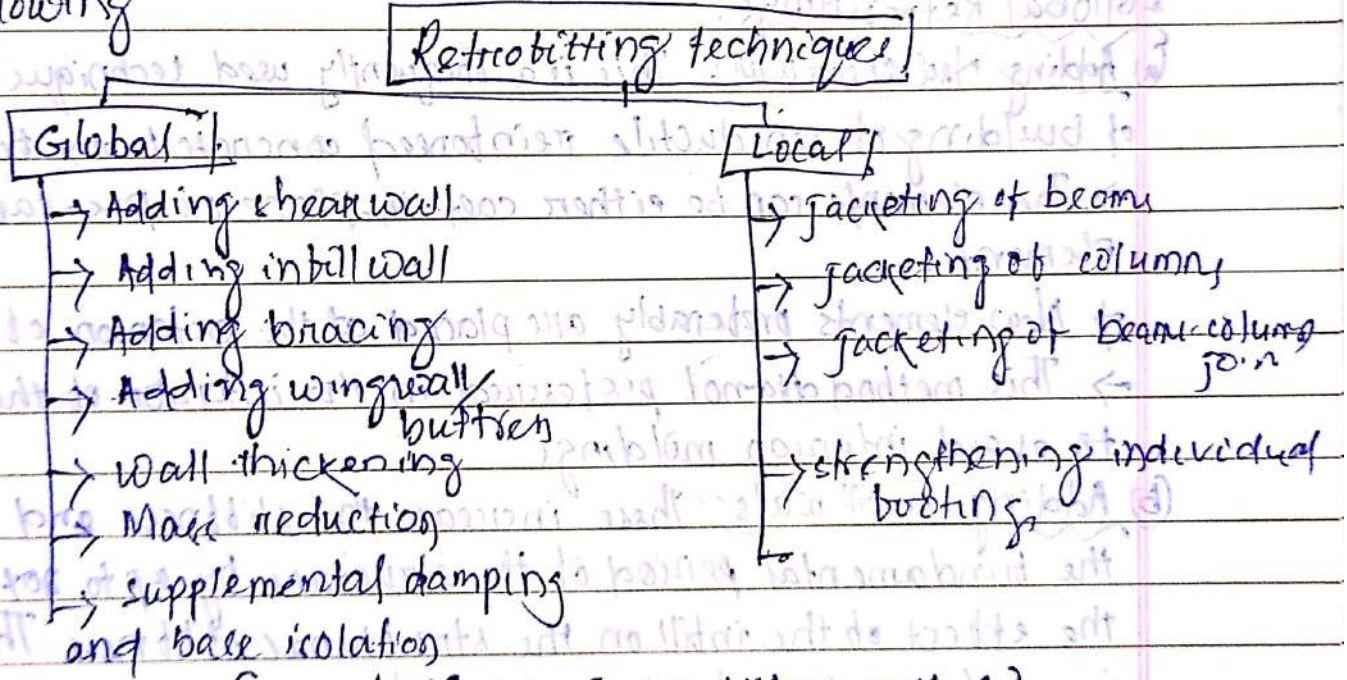
Roof band:- Roof band is similar to lintel band but it is provided ~~also~~ below the roof or floors. It improves the in-plane rigidity of horizontal floor diaphragm. Such bond need not be provided in case of rigid diaphragm.

Gable band:- Gable band is provided at the top of the gable masonry below the purline. This band shall be made continuous with the roof band at the eave level. It restricts the out-of-plane feature of gable walls, which is susceptible to earthquake forces.

Retrofitting: It is the process of addition of new features to older buildings, heritage structures, bridges etc. Retrofitting reduces the vulnerability of damage of an existing structure during a near future seismic activity.

Classification of retrofitting technique & their uses:

There are two ways to enhance the seismic capacity of existing structures. The first is a structural level approaches of retrofitting which involves global modifications to the structural system. The second is a member level approach of retrofitting or local retrofitting which deals with an increase of the ductility of components with adequate capacities of satisfy their specific limit states. Based on the above concept the available technique of retrofitting of reinforced concrete building may be classified as following



(Fig. Global & local retrofitting methods)

Generally structural level retrofitting are applied when the entire structure load resisting system is deemed to be deficient, employed to increase stiffness & strength with limited ductility.

Achieving desired ratio between the additional stiffening & strengthening is the aim of seismic retrofitting. The most common modification include the infill walls, base isolations or supplemental energy dissipation devices.

Jacketing :-

It is a technique used to increase the strength of existing structural members (e.g. columns, Beams etc.) by providing a jacketing of additional material around the existing member. The additional material can be of several types e.g. concrete, steel or FRP etc.

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 confinement by the jacket of reinforced concrete.

The addition of new reinforced concrete shearwall is the most often practised device which has to proved to be effective for controlling global lateral drifts and for reducing damage in frame members.

1 Global Retrofittings:

(a) Adding new shear wall :- This is a frequently used technique for retrofitting of building of non-ductile reinforced concrete frame buildings.

→ The elements can be either cast-in-place or pre-cast concrete elements.

→ New elements preferably are placed at the exterior of the building.

→ This method did not preferred in the interior of the structure to avoid interior moldings.

(b) Adding infill walls :- These increase the stiffness and reduces the fundamental period of the structure by up to 20% indicating the effect of the infill on the structural stiffness. This method is mostly used in short steel buildings.

(c) Adding steel Bracing :- steel bracing is an effective solution in the retrofitting of building when large openings are required.

→ Potential advantages due to higher strength and stiffness and opening for natural light can be provided.

→ The amount of work is also less so foundation cost may be minimized and adds much less weight to the existing structure.

(d) Adding wing wall/buttress :- To increase lateral strength and stiffness of a building.
→ Usually the shear walls are placed within bounding columns. whereas wing walls are placed adjacent to column.
→ And the buttress walls are placed on the exterior sides of an existing frame.
→ For a buttress wall, the new foundation should be adequate to resist the overturning moment or uplift pressure

(e) Wall thickening :- Thickening is the sixth technology comes under global category this method is used to increase the dimensions of the existing member in this the structural elements thickness is increased for example if the wall is having 230mm for old building by using thickening we can increase that to 300mm. By increase in the thickness the lateral loading effect will be reduces in structure. This method is also important in strengthening of building now a days using.

(f) Mass Reduction :- The mass reduction is the seventh method used in retrofitting of building in this method reduction of storey is made in order to reduce the loading condition. For example if the building is G+5 with higher amount of loading condition system we need to make than to G+4 or G+3 to level the strength of the building.

(g) Base Isolation :- The base isolation system is the last technology comes under global retrofitting, this method reduces the oscillation effect. Under this base isolation systems the methods like rubber base isolation and friction pendulum isolation stems are taken in the earthquake resistant construction. The isolations are placed at the support condition system only and whether the oscillations and deflections which are applied only to the structure below the support condition.

2. Local Retrofitting (Jacketing of beam) :- Jacketing of the beam come under the first method in local retrofitting. The extra reinforcements bars are provided for the existing beam member to increase the strength by providing extra reinforcement the lateral loading condition of the structure decreases and this is the advanced method in strengthening

of buildings.

(b) Jacketing of column:- Column jacketing is also similar to beam jacketing in this the vertical member like column section reinforcement increa. The jacketing of column consisting ~~the~~ of the adding the longitudinal reinforcement bars as extra reinforcement in building. This method frequently used now a days for strengthening the old building under certain condition and limitations only.

(c) Jacketing of beam-column joint :- The jacketing of beam column joint come under local retrofitting technology in this the weak joints are determined initially for existing system by applying lateral loads in three dimensional analysis software like STAAD, ETABS or SAP. After determining the weak joints by the retrofitting is made for increasing the strength of that respected joint

(d) Strengthening individual footing :- This is the last method in local retrofitting this is used for old buildings by increasing the size of the footing and reinforcement bars in existing building. The jacketing of bars in existing building. The jacketing of bars is properly made to the existing footing and anchored to the column section in order to transfer the loading. But this method is not advisable in building construction.

Seismic Retrofitting of reinforced concrete buildings

Seismic Retrofitting Techniques are required for concrete constructions which are vulnerable to damage and failures by seismic forces. In the past thirty years, moderate to severe earthquake occurs around the world every year. Such events lead to damage to the concrete structures as well as failures

Thus the aim is to Focus on a few specific procedures which may improve the practice for the evaluation of seismic vulnerability of existing reinforced concrete buildings of more importance concrete building of more importance and for their seismic retrofitting by means of various innovative techniques such as base isolation and mass reduction.

So, seismic Retrobilting is a collection of mitigation technique for Earthquake engineering. It is of utmost importance for historic moments areas prone to severe earthquake and fall on expensive structures.

Seismic Retrobilting of Concrete structures is the modification of existing structures to make them more resistant to seismic activity ground motion, or soil bailure due to earthquake.

The retrobit techniques are also applicable for other natural hazards such as tropical cyclones, tolenadoes, and severe winds from thunderstorms.

Source of weakness in RC frame building:

Earthquake structure is not a pure science, rather it ~~must have two load resisting system~~ has been developed through the observation of bailure of structure during earthquake.

The following main sources of weakness in reinforced concrete moment resisting frame building

(i) discontinuous load path/intercepted load path/irregular load path
(ii) Lack of deformation compatibility of structural member
(iii) quality of workmanship & poor quality of material.

Structural damage due to discontinuous load path:

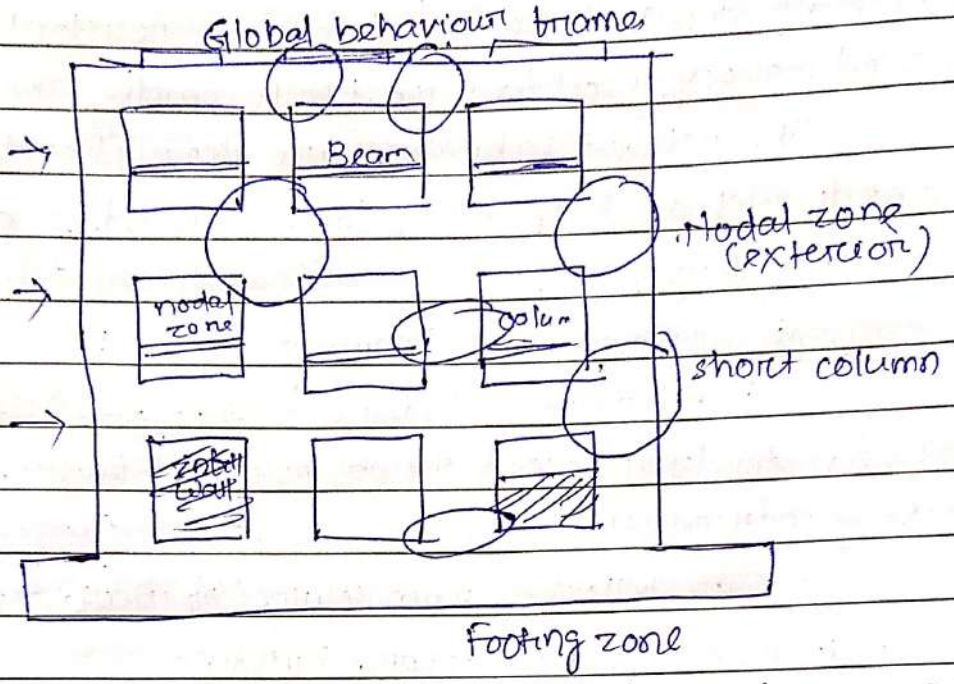
Every structure must have two load resisting system
(a) vertical load resisting system for transferring the vertical load to the ground &
(b) horizontal load resisting system for transferring the horizontal load to the vertical load system.

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

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 withstands the deformations imposed upon in respon to seismic loads.

The most common region of failure in an existing reinforced concrete frame are shown in given fig.



The region of failure may be in columns, beams, walls and beam-column joints. It is important to conside the consequences of member failure on structural performance.

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

Quality of workmanship & materials. There are numerous instance where faculty practices and lack of quality control have contributed to the 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° as the code specified.

Many building 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.

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(CH-5) {Building services}

Building Services: Building service are the systems installed in building to make them comfortable, functional, efficient and safe.

Cold water distribution in high rise building:

The cold water distribution system are three type.

(A) By normal water pressure
(B) By overhead feed system
(C) By air pressure system

(A) By normal water pressure :- The normal water pressure from the public water main is normally inadequate to serve high rise buildings. The alternative solution is either by overhead feed system or by air pressure system.

(B) By over head feed system :- Water is pumped into a large tank on top of the building and is distributed to the fixtures by means of gravity.

Advantages: Water is not affected by peak load hours
→ Not affected by power interruptions
→ Time needed to replace parts will not affect the regular supply of water.

Disadvantage: → water is subjected to contamination
→ High maintenance cost
→ Occupies valuable spaces

(C) Direct up feed system :- It is an annovation of the air pressurized water distribution system used to all building that could not be served adequately by street. It is installed to operate in sequence according to the volume of demand

Installation & layouts:

Two basic types of supply systems used in buildings are
→ Up feed system → Down feed system

The application of these depends on the project and its individuals needs & specification.

Some basic principles must however be followed for efficient and economical design.

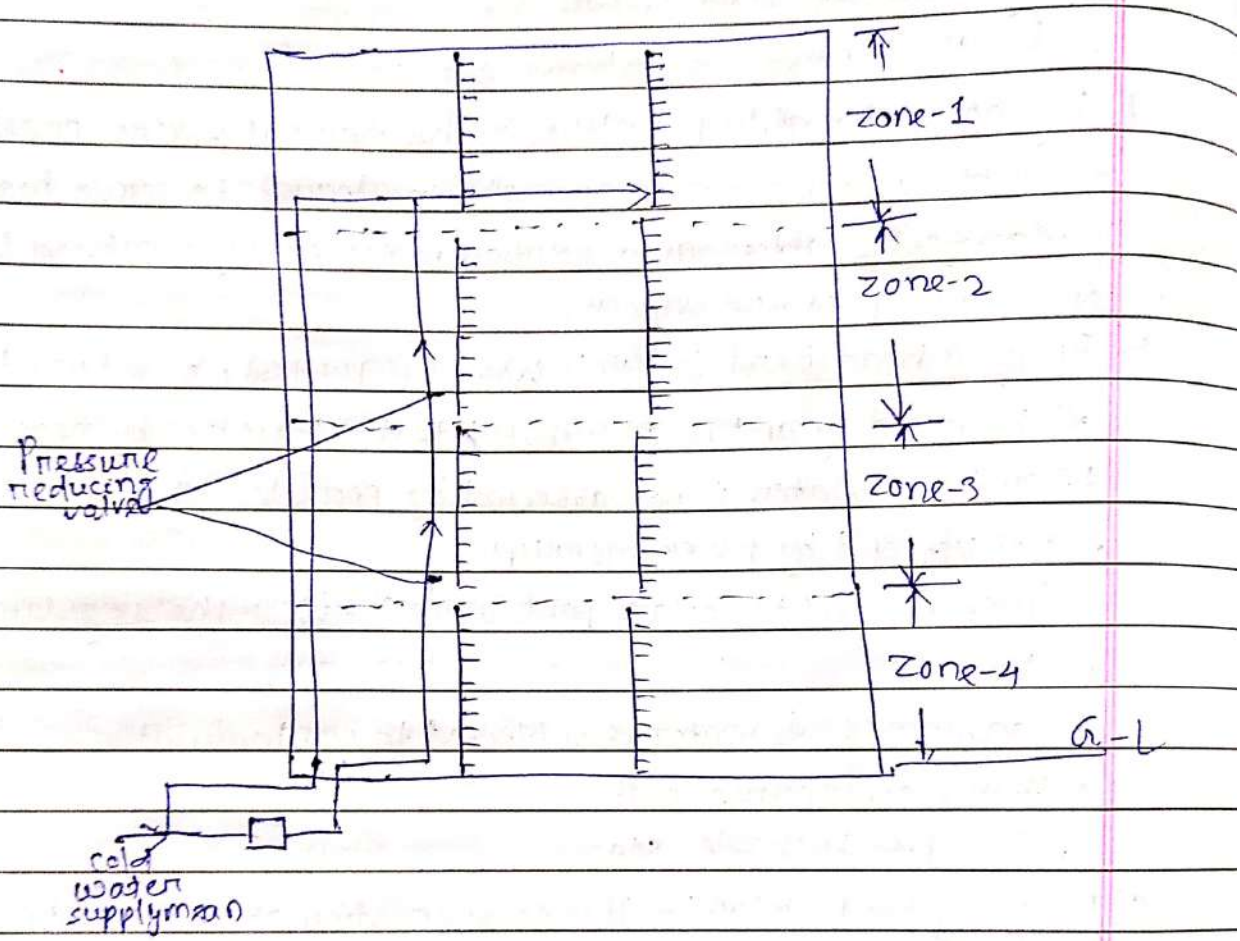
Up feed system: An up feed system uses pressure in a water

main to directly supply fixtures

1- limit 40'- 60'

2- supply from city main is 40 to 80 psi

Pressure must be sufficient to overcome friction in pipes, fittings, meter & static head, but still have enough pressure to fixtures.



The upfeed arrangement produces the largest pr. at the bottom and as the water moves to the top zones, energy is expended in friction losses as the water passes through the pipe and fittings

Downfeed system:

When a building is too tall for an upfeed system, a downfeed system is used, here the water is first pumped to upper level storage tanks & then flows by gravity to the fixtures.

Hot water installation: The plumbing for hot water is in principle the same as for cold, but there are certain additional factors that apply to hot water systems i.e. → diameter of pipe

→ insulation → safety devices

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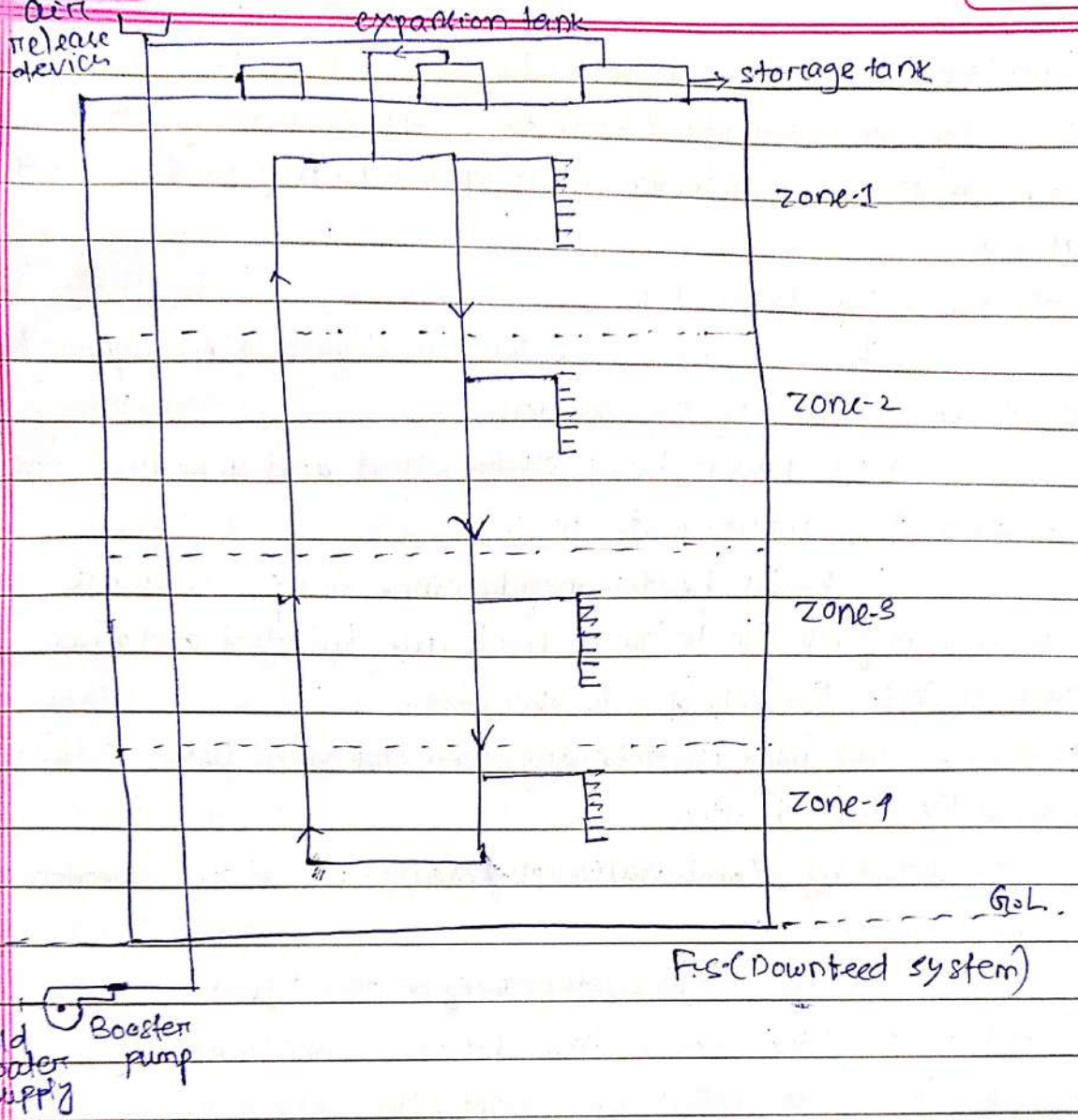
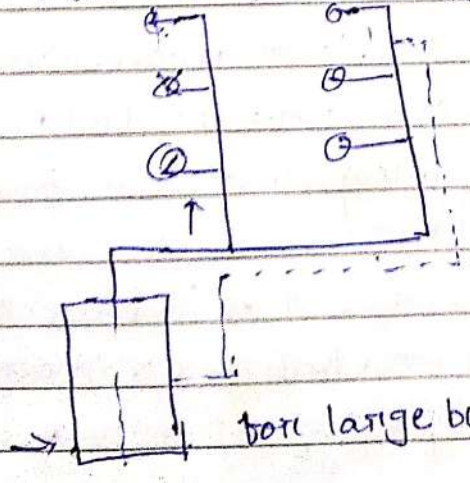


F.s-(Downfeed system)

Hot water storage tanks:

All hot water storage tanks must be well insulated to keep the water hot during the night. Heat loss depends on many factors (temperature, wind, season) & will be approximately 0.5 to 1 °C/h during the night.

The hot water storage tanks are made for low pressure use only. They can withstand a pr. of approx. 30 mtr. head.



Central plants

for large buildings only

Connection of collectors of hot water storage tanks :-

→ Surface of a standard collector is approximately 1.4 m^2

→ Per m^2 of such a collector, count approximately 50 ltr. of hot water at 50K.

Collector & circulation pipe

The side of the collector closed with a A1 cap can be opened for flushing & cleaning the collector.

In the tower head sludge, sand and dirt may accumulate.

Connection to drinking water mains:

Water heater may be connected to the drinking water mainline only, if the following points are fulfilled and where sufficient pressure from the supply side available.

Caution :- There must never be any other stop valve between the non-return valve & the water heater.

Electric boosting: Combination of solar & wood stove heater may use

Sanitation :-

The drainage system may be two types -

① Waste water is from shower, bath, kitchen sinks, washing machines and the like. This is also called grey water. Normally a minimum of 75 mm dia pipes are used for drainage of waste water.

② Soil water or sewage is from WCs and urinal. This is also called black water. Minimum of 100mm diameter pipes are used for waste water when run horizontally, soil water pipes should be run at a steeper slopes such as 1:40 as they have solids. These can be of cast iron or of PVC.

Electrical Services :

① Requirement in high rise buildings :- The requirements of the planning & execution of electrical works of an ordinary building having ground plus one or two floors housing are quite different from those of a multi storeyed or high rise building.

A building is classified as highrise if it has more than 4 floors (G+3) or height more than 15 mtr. It can be regarded as a miniature township requiring entire range of civic services

such as electric power from the electricity board, stand/emergency power from diesel generators, water supplies for various applications fire fighting system, elevators services, sanitation recreation facilities swimming pool, lighting for apartments as well as common areas etc.

(ii) Layout of wiring - types of wiring:

Wiring (a process of connecting various accessories for distribution of electrical energy from suppliers meter board to home appliance such as lamps, fans & other domestic appliances is known as electrical wiring) can be done using two methods which are

1- joint box system or Tee system)

2- Loop-in system)

Fuse:- A fuse or an electric fuse is an electrical/electronic device that protects the circuit from different electrical faults can be considered as a sacrificial element in the circuit as they act as a weak link in the entire circuit as they act as a weak link in the entire circuit.

Types of fuses:

The fuses are the following types

(a) AC fuses, (b) DC fuses

DC fuses:- The DC fuse opens or breaks the circuit when the excessive current flows through it. The only difficulty with the DC fuse is that the arc produced by the direct current is very difficult to extinct because there are no zero current flows in the circuit.

AC fuse:- The AC fuses are categorized into two types they are the low voltage fuses & the high voltage fuses. The frequency of the AC fuses changes its amplitude from 0° to 60° in very one second. Thus the arc extinction in the AC circuit can be done easily as compared to the DC circuit.

Earthing:- Earthing is the method of transmitting the instant electricity discharge directly to the ground through low resistance wires or electrical cables. This is one of the significant features of electrical network. Because it builds the most eagerly accessible and hazardous power source much secure to utilize.

Uses: The main intention of electrical earthing the instant electrical is to keep always from the danger of from ground through the not preferred path as well as to make sure that the potential of a conductor does not include increase with respect to the ground than its planned insulation.

The main benefits of grounding include protection from over voltage stabilization of voltage and prevention from injury, damage & death.

Lighting:- Lighting is a major end use of energy in most multi-storey non-residential buildings, Design strategies that reduce electric lighting requirements should there by reduce annual electrical consumption and peak electrical loads and may also lower HVAC loads.

Improved lighting design strategies specification of new, efficient lighting hardware and improved operation & maintenance of lighting systems all promise substantial energy savings.

measurement of light intensity:- The fundamental light intensity unit is the candela, nominally the light given off by one candle or more precisely a source that emits monochromatic radiation of frequency 540x1012 hertz and that has a radiant intensity in that direction of 1/683 watt per steradian.

Ventilation:- Ventilation moves outdoor air into a building or a room & distributions the air within the building or room.

The general purpose of ventilation in building is to provide healthy air for breathing by both diluting the pollutants originating in the building and removing the pollutants from it.

Methods of Ventilation

Nature ventilation:- If well installed and maintained there are several advantage of a natural, ventilation system, compared with artificial ventilation system

(a) Natural ventilation systems can generally provide a high ventilation rate more economically, due to the use of natural forces and large openings.

(b) Natural ventilation can be more energy efficient, particularly if heating is not required.

(c) Well-designed natural ventilation could be used to access higher levels of day light.

Artificial Ventilation:-

(a) Mechanical fans device artificial ventilation. Fans can either be installed directly in windows or walls or installed in air ducts for supplying air into or exhausting air from a room.

(b) The types of artificial ventilation used depends upon climate.

System of ventilation. The following are the different system of ventilation which are

→ Exhaust ventilation system
→ Supply ventilation system
→ Balanced ventilation system
→ Energy recovery system

Problems on ventilation:

→ Intermittent airflow
→ Distribution of air
→ proportion of out door air
→ Building supply & exhaust location.
→ Periods of operation
→ Maintenance

Mechanical Services:

Lift:- A vertical transport equipment that efficiently moves people between floors of a building or other structure.

Generally powered by electric motor that drive by traction cable & counter weight system like a hoist or hydraulic pump.

Types:

→ stone lift → institution lift, → hospital lift,
→ lift of cars, → residence lift

Elevators:- An elevator is a type of vertical transport equipment. Elevators are generally powered by electric motor.

Types: The common types of elevator.

(1) traction elevator
(2) Hydraulic elevator
(3) Traction-Hydraulic elevator

Escelator :- An escelator is a moving staircase a conveyor device transport device for carrying people between floors of a building.

types: The common types of escelator are

→ Parallel → Multiple parallel → Criss cross.

CH-6

Construction and earth moving Equipments

Planning & selection of construction equipments:

Construction planning is required for completion of the project well within the stipulated time, incorporating the laid down specification at the lowest practical cost. For this an engineer must study each major/minor item of construction to determine the possibility of completing ~~time~~ the project at the earliest with incurring the least expenditure while utilizing all adequate resources/ manpower/equipment.

The construction planning of a project may be divided into three parts and they are

① Material ② Labour (manpower)

③ Finance required (money)

planning is necessary both prior to & during the actual construction as an engineered project. Such planning is necessary in order to construct the project within cost and on time. Items which need to be adequately planned include:

① The identification of specific activities of work required and the inter relationships between those items.

② The proper sequencing of the specific activities of work so as to complete the project in the optimum amount of time.

③ The time for delivery of material & installed equipment.

④ The types, quantities and duration of construction plant & equipment.

⑤ The classification & number of workers needed & the periods of time they will be needed.

⑥ The amount of timing of financial assistance that is needed.

Factors affecting the selection of construction equipment are:
① standard type of equipment
② special equipment
③ Replacement of parts
④ Cost of owning & operating construction equipment.
⑤ Economic life of construction equipment
⑥ Sources of construction equipment.

Study on earth moving equipment:

Dragline: A dragline excavator is a piece of heavy equipment used in civil engineering and surface mining. These are used for road, port construction, pond & canal dredging and as pile driving range.

The dragline is designed to excavate below the level of machine The size of dragline is indicated by the size of the bucket expressed in cubic yards.

Components of dragline:-
→ Hoist rope → dragline bucket → Hoist coupler → Drag coupler
→ Drag rope

Bulldozer: A bulldozer is a crawler equipped with a substance that metal plate used to push large quantities of soil, Sand, rubble or other such material during construction or conversion works & typically equipped at the rear with a claw-like device (known as ripper) to loosen densely computed materials.

types The bulldozer may be of following types
→ Crawler mounted bull dozer
→ wheel mounted bulldozer
→ mini bulldozer

Tractor: It is an engineering vehicle specifically design to deliver a high tractive effort at slow speeds for the purpose of hauling a trailer or machinery such as that used in agriculture or construction.

Most commonly the term is used to describe a farm vehicle that provides the power & traction to mechanize agricultural tasks

Power shovel :- A power shovel is a bucket-equipped machine usually electrically powered used for digging & loading earth or fragmented rock & for mineral extraction.

Power shovels are used principally for excavation, and usually removal of overburden in open-cut mining operations through it may include loading of minerals such as coal. They are the modern equivalent of steam shovels and operate a similar fashion.

Compacting Equipments :-

Tamping rollers: These are also called sheeps foot roller.

→ The most common type is the one having two drums 1.22 mts wide and 1.06 either as tapper foot or club foot rollers according to the shape of feet.

→ The coverage area is about 8 to 12 t.

→ The thickness of compacting layer is kept about 5 cm more than the length of each foot.

→ The density of the consolidated soil should be about 1.48 kg/cm².

Smooth wheel rollers :-

→ The ground pressure exerted by tandem roller is about 10 to 17 kg/

→ Performance of the smooth wheel roller depend upon if load per cm width and diameter of the roll.

→ The maximum grade a road roller can climb is 1 in 5.

→ Some rollers are made with its prime mover or engine as a separate unit which is a tractor.

→ The optimum working speed has bound to 3 to 6 km/h.

Pneumatic tyred rollers:

→ The coverage area is about 80 t.

→ Tyre pressure maybe upto about 7 kg/cm²

→ It provided uniform pressure throughout the width.

→ This type of roller consists of a heavily loaded wagon with several rows of 4 to 6 closely spaced tyres.

→ They are particularly efficient when used to finish of the embankment compacted by sheep foot roller or loose sandy soils.

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Vibrating Compactors:

→ This type of roller is fitted with one or two smooth surfaced steel wheels 0.9m to 1.5m in diameter and 1.2m to 1.8 m wide.
→ self propelled vibrating rollers are now available weighing from 4 to 6 tonnes.
→ Vibration are generated by the rotating of an eccentric shaft inside.
→ A vibratory roller is used for compacting granular base course. It is sometimes used for asphaltic concrete work.

Owning & Operating cost:-

Owning cost:- It is made up of the following cost:
① Investment cost
② Depriciation cost
③ Major repair cost

① Investment cost:- It's a kind of fixed cost and continues to be incured whether the equipment is used or not. The investment cost comprises the following
→ Procured of equipment
→ taxes on equipment
→ ~~insurance expanses~~

② Depreciation cost:-

Whenever any machine or equipments performs useful work the wear & tear is bound to occur. This can be minimize upto some extent by proper care & maintenance but can not be totally its efficiency also reduces with the lapse of time and at one time it becomes uneconomic to be used to and need replacement by new units. This amount is deducted yearly from sufficient money for replacement at end of useful life

③ Major repair cost:

While minor or field repair are corrected out during the day to day working of the equipment the major repairs are carried out after the substantial use of equipment major repair and overhauls are the replacement of major parts of the equipment because of excessive was through a long period of use. Since these repairs requires a heavy amount of expenditure they are met from repair cost is spread out during the entire lifespan of equipment.

Operating cost :- It consist of following

① cost of fuel (on power)
② cost of lubricants
③ Servicing + maintenance cost
④ Labour cost
⑤ cost of field repairs
⑥ Various other overheads

Example-1

A power shovel with a diesel engine rated at 160 pulp. When used to load trench, the engine may operate at a max power while hoisting the dipper, requiring 5 sec, out of a cycle time of 20 sec, during the other 15 sec the engine may operate at not more than one half of its related power, assume that the shovels operate ~~at not more than one half of its~~ 50 mins per hour. Calculate the diesel consumed per hour.

Soln Engine factor :

Following the dipper = $5/20 \times 1 = 0.250$

Rest of cycle = $15/20 \times \frac{1}{2} = 0.375$

Total engine factor = 0.625

Time factor = $50/60 = 0.833$

operating factor = 0.625×0.833

$= 0.520$

Fuel consumed per hour = operating factor x engine hphp x engine type factor

$= 0.520 \times 160 \times 0.04 = 3.33$ gal/hr

C-lubricating oil

$$q = \frac{hp \times t \times 0.006 \times lb/hp.hr}{7.4\ lb/gal} + \frac{c}{t}$$

q : quantity assumed : gal/hr.

hp = rated horse power for engine

c = capacity of crankcase, gal

t = operating factor

t = no. of hours betn changes

The above formula based on ...

An operating factor of 60%.

Quantity of six consumed per rated horsepower hour between charges will be 0.006 lb.

Example.2

Engine = 100 hp
crankcase capacity = 4 gal
operating factor = 60%.

No. of hours between changes = 100 hr

$$q = \frac{100 \times 0.6 \times 0.006 \text{ lb/hp.hr}}{7.4 \text{ lb/gal}} + \frac{4}{100}$$

$$= 0.049 + 0.04 = 0.089 \text{ gal/hr.}$$

Example-3 Determine the probable cost per hour for owning & operating 25 cuyd. heaped capacity bottom dumb wagon within six rubber tires. the following information will apply.

Engine 250 hp, diesel
crankcase capacity 14 gallon
Time between oil changes · 8 hr
Operating factor = 60%.
useful lifts 5 year = 2000 hr/yr with no salvage value.
life of tires 5,000 hr.

Repair of tires 15% of tire depreciation cost delivered including freight & taxes Rs. Rs. 92,623.00
cost of tires = Rs. 12,113.00

M & R = 50% of depreciation
investment rate = 15%.

(A) Fuel consumed per hour
= 250 × 0.6 × 04 = 60 gal

(B) Lubricating oil consumed per hr.

$$q = \frac{250 \times 0.6 \times 0.006 \text{ lb/g'hr}}{7.4 \text{ lb/gal}} + \frac{14}{60}$$

$$= 0.3 \text{ gal/hr.}$$

(C) Cost of owner.

cost delivered including freight, taxes = Rs. 92,623.00
less cost of tires = Rs. 12,113.00
Net cost less Total tires = Rs. 80,510
Avg. cost per = $p(n+1)/2n$ = 92,623(.511)/2x5 = Rs. 55744.00

④ Annual cost: Depreciation = (80,510 - 50)/5
= Rs. 16,102

maintenance & repair = 50% x 15,102 = Rs. 8,057.00

Investment = 15% x par = Rs. 8362.00

Total annual fixed costs = Rs. 32,515.00

⑤ Hourly cost:

Fixed cost = 32,575/2000 hr = Rs. 16.26

Tire depreciation = 12,113/5,000 = Rs. 02.42

Tire repairs = 0.15 x 2.42 = Rs. 00.36

fuel = Rs. 4 x 6 gal = Rs. 24.00

lubricating oil = 0.3 x Rs. 15 = 0.04.50

Total cost per hr excluding labour = Rs. 47.50

→ x → x → * → x →

CH 4

Soil Reinforcing Techniques

Necessity of soil reinforcing:- Soil reinforcement is necessity on land where

→ bearing capacity is low
→ loose soil
→ chances of erosion are high

Soil reinforcement is performed by placing tensile element on the soil to enhance its natural stability & strength.

Wire-mesh: Wire mesh can offer benefits is when a poor or weak subgrade exists may be expected to move or settle wire mesh can offer tensile strength to the soil.

Geo-synthetics: Geo-synthetics are considered necessary and indispensible for an economical solution in multiple function, such as reinforcement, separation, filtration, drainage, barrier erosion control, containment and protection.

Geo-synthetic materials are nothing but planar, polymeric materials used in contact with soil/rock/or any other geotechnical material, for filtration, protection, sealing & packing.

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Types of geosynthetics

Following are the types of geo-synthetic used in civil engineering.

1. Geotextiles
2. Geogrids
3. Geonets
4. Geocomposites
5. Geocell
6. Geomembranes
7. Geo-synthetic clay liner

Strengthening of embankments :-

Geotextiles and geogrids have been widely employed in embankment construction to reduce subgrade settlement & improve embankment stability.

However these geosynthetic materials are generally applied in new materials are generally applied in are difficult to utilize in existing embankments and need relatively large deformation on slope along the fabric-soil interfaces to mobilize their reinforcement effects.

Reinforced soil slopes and embankments

A reinforced slope is defined as a compacted fill embankment that incorporates the use of horizontally placed geosynthetic reinforcement to enhance the stability of the soil structure. The different following application are

- → Reinforced steep slopes
- → Surficial stability of embankments
- → Embankments constructed over weak soils
- → Temporary walls
- → Pressure Relief walls

Soil Reinforcement techniques :- It can be divided into two major categories

1. In situ soil reinforcement
2. Constructed soil reinforcement

In the in-situ reinforcement technique the reinforcement is placed in an undisturbed soil to form a reinforced soil structure This includes the techniques of soil-nailing & soil doweling The reinforcement used for insitu structure is usually linear owning to the method of installation.

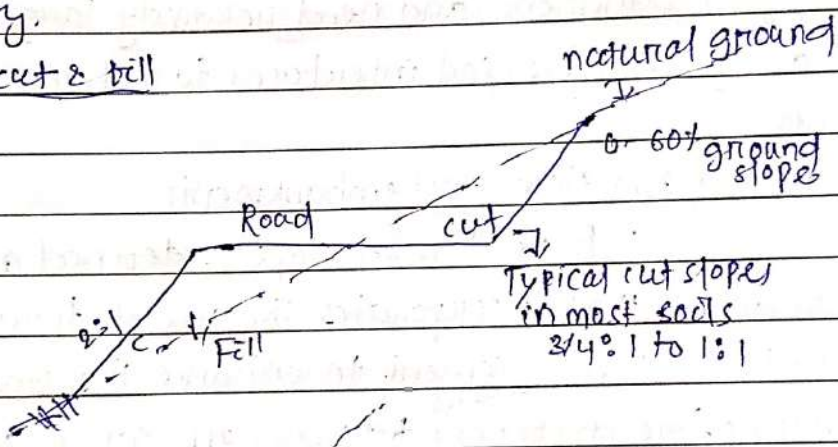
① open excavation using soil nails
② constructed soil reinforcement technique

Application of soil reinforcement:

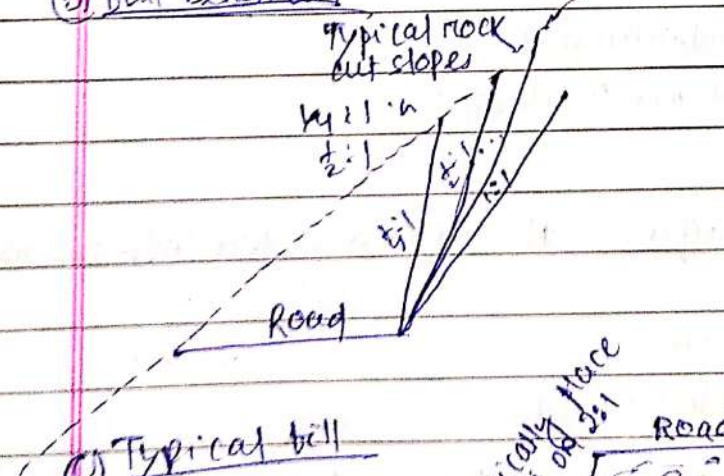
① slope failure repairs
② slope cutting ~~embankments~~ repairs
③ steep slopes - embankments & bunds
④ Widening of slope crest
⑤ Bridge abutment & wing walls
⑥ Soils retaining structures
   - → Face walls
   - → counter scrap walls
   - → Retaining walls
⑦ Road & railway embankment

A wide range of slope stabilization measures is available to solve slope stability.

② Balanced cut & fill



③ Full bench cut



④ Typical fill