C.V. RAMAN POLYTECHNIC, BHUBANESWAR

C.V.Raman Polytechnic

Quality Education for the New Millenium

LECTURE NOTE

ADVANCED CONSTRUCTION TECHNIQUES & EQUIPMENT (TH.3)

SEM-6TH

BRANCH-CIVIL ENGINEERING

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Ch-1 Advance construction Material

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Fibers and Plastics:-

(a) Fibers as construction Material :-

→ Fibers are consider as a construction material to enhance the flexutural and tensile strength and as a binder that could combine portland cement in bonding with cement matrices.

→ Fibers is such as raintorcing material small pieces of ~~transtorcing~~ raintorcing processing suddern characterlstics and properties.

→ Fibers are usually used in concrete to control craeking due to plastic shrinkage and drying shrinkage.

(b) Types of tibers :-

(1) Glass tibers :-

→ Different types of glass exbit with vanious colour chemical composition and characteristic.

→ Glass tiber have grade mechanical properties and exel in terms of strength. thermal properties and have good interfacial bonding to the matrics.

→ Glass tibers are generally used to raintorce polypropylen system.

→ A composite is formed between the element to form an exellent material.

→ The resulting composite is cost effective easy to Procuere and possess and toughness characteristic to glass fiber.

(b) Steel fiber :-

→ similar to traditional steel reinforcement the key characteristic of steel fiber is they are high tensile capacity.

→ Steel fibers have been broadly studied in concrete application hence they are commonly used to improve the mechanical properties of concrete.

→ Steel fibers help in improving the concrete behaviour in terms of cracking, shrinkage, ductility, toughness, impact and blast loading.

→ The strength increase is due to the steel fibers characteristic of absorbing energy and of controlling crack.

→ Steel fibers can be an ideal aditive to specific application as they possess good electric, Magnet and heat conductivity.

(c) carbon fiber :- (carbon content in carbon fiber 93-95%.)

→ carbon fiber having added in materials to form composite with improve properties.

→ The addition of carbon fiber create a composite that has outstanding mechanical Properties Perform well in high temperature environment

and possesses the benifit of durability.

→ The disadvantage of carbon fiber are that due to their excellent properties the expense of manufacturing carbon fiber is high.

→ Similar to glass fiber although there are many positives and benitits to carbon fiber the production of carbon fiber leads to concern for the environment and possible sustanability.

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Properties of fibers:-

→ High tensile strength and Modules of elasticity.

→ High resistance to weather, acidic environment and some alkali resistance.

→ Good thermal properties and stability can tollered and perform well in high temperature environment.

→ Good electric, electric management and sound insulation property.

→ Good resistance and stability against corrosion, chemical attack, impact load and time.

Non reactive and Non-combustible:-

→ Low absorbtion and thermal conductivity

→ Absorb sound, vibration and isolation.

→ Resistant to radiation UV light.

→ Strong, hard and rigid.

→ Easy to produce and process.

→ cost efficient.

→ Use to form light wave composite with accelent properties.
→ Require no chemical aditives.
→ Natural and bio-degreedable.
→ Ecologically clean easy to handle and non toxic.

Use or Application :-

→ Improve characteristic and properties such as strength toughness, durability, rigidity and ductility.

→ Improve resistance and Pertomance in different environment and against physical and chemical corrosion and other attach.

→ Improve stability, thermal properties and operating temprature.

→ Reduction of heat conductivity.
→ Reduction of the specific weight and density resulting in a light weight product that is both energy and cost efficient.

→ Reduction and lower cost of design and installation, each fiber can replace traditional reinforcement method.

→ Prevent the occurance of shrinkage cracks and swelling.

→ Improved environmental ⟶ Friendliness.

→ Economic efficiency and sustainability.

Plastic as construction material :-

→ Plastic is a general name given to a wide range of synthetic materials that are based on polymers.

→ The construction industry use plastic for a wide range of application because of its versatility, strength to weight ratio, durability, corrosion resistance and show on.

→ Plastic can be manufactured in to formed such as pipes, cables, coverings, tunnel sheet etc. 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.
→ Shuttering.
→ Wall linings.
→ Floor covering
→ ceiling panels.
→ Roof covering.
→ 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 sites. It is also resistante 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 load bearing 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 consists of polyurethane foam 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 light weight, chemical resistant. Due to its closed cell nature polyurethane insulation performs as an 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. thin 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 plastic 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. poly carbonate windows are considered more burglar-proof commonly 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 light weight, 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 and 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 and construction division, HDPE pipes are used for ground source geothermal applications, also known as earth energy or geoexchange systems.

FRP :-

→ Fibre-reinforced plastic (FRP) (also called fiber-

reinforced polymer). FRP bars are used as internal reinforcement for concrete structure. FRP bars, sheets and strips are used for strengthening of various structures constructed from concrete masonry, timber and even steel. Fibre reinforced polymers are used in the construction of special structures requiring electrical neutrality.

GRP :-

→ GRP stands for "Glass Reinforced Plastic". A material made from a polyester resin, which is reinforced by chopped strand mat glass fibres to form a GRP laminate. It is a very popular composite material to use because not only is it very strong but also surprisingly 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 insulative, and resistant to shock, corrosion, chemicals and water.

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Artificial timber :-

→ Reduction of moisture content along with improving some some quantities before the use of wood is called seasoning of timber. By seasoning, generally

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the moisture is reduced to about 15-1. Where new cut woods bear about 50-1.

Reasons for seasoning :-

→ Seasoning of timber is done to fulfill some specific requirement. followings are the reasons to perform timber seasoning.

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

Methods of seasoning 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. eg:- water and air seasoning

a. Water seasoning :-

→ Removal of wood sap immersing logs in to water flow 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. Disadvantage : 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 conditions. 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 fugel infection logs are treated with petrol or gasoline.

Advantage :-

→ Good quality of seasoned wood.
→ A large amount is convenient in this process.
→ Well - seasoned timber is formed.

Disadvantage :-
→ It's a 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 a 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 left to dry.

Advantage :-

→ It increases the strength of the timber.
→ It is less time - consuming.

Disadvantage :-

→ 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 a process such as :-

$CaSO_4 \cdot 2H_2O$ (Gypsum)

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

2. Compartmental seasoning :- it is maintained by enclosed container 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 current. Thus in this method alternating current is used for the resistance of timber against electricity is measured at every interval of 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 Material :-

→ A category of asbestos containing building materials comprised mostly of non-sewable asbestos products and materials such as ceiling, tiles, floor tiles, roofing felt, transit pipe and panels, cement sheeting, fabrics etc.

✓ Acoustics Material :-

→ When the sound intensity is more than it gives the great troubles to the particular area like auditorium, cinema hall, studio, entertenment hall college, reading hall etc.

→ Hence it is very important to make that area or room to be sound Proof by using a suitable Material called as acoustics material.

Properties of acoustics material :-

→ sound energy is capture and absorbed.
→ It has a low reflection and high absorbtion of sound.
→ Higher density improves the sound absorbtion efficiency at lower frequency.
→ Acoustics material reduces the energy of sound ways as they passed through.
→ It suppresses echos, riverberation and reflection.

Uses of Acoustic materials :-
→ Acoustic material can be used for noise reduction and noise absorbtion.
→ It makes the sound more audiable which is clear to listen without any disturbances.
→ A vinyl acoustic barrier block controls

air borne noise like street traffic, voice, music from passing through a wall ceiling or floor.

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

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

Adhesive :-

→ construction of adhesive is a general-purpose adhesive use for attaching dry-wall tile, Molding and fixtures to walls, ceilings and floors. it is most commonly available in tubes intended for use.

→ 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 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 cladding.

Plaster board :-

→ Plaster board 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 "Dry wall" 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. Silica fume concrete has a number of construction application

Artificial sand :-

→ 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, which are processed by mechanical crushing and sieving but does not include soft and weathered granules.

Bonding Agents :-

→ Bolding agents are natural or compounded or synthetic materials used to enhance the joining of individual members of a structure without employing mechanical fasteners. the most common

Used types of bonding agents are generally made from natural rubber, synthetic rubber or from any other organic polymers. The polymers include polyvinyl chloride, polyvinyl acetate etc. 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.

~ 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, reverberation, reflection and resonance.

3. Important specifications for noise reduction and noise absorbtion products include noise attenuation and noise reduction co-efficient.

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.

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6. Sound Proof doors and windows are designed to reduce the transmission of sound

7. A sound Proof wall (treated by a accurate Material) can incorporate sound proofing and acoustic materials to meet desired sound transmission class (STC) values.

MODULE-2

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 part 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 employs prefabricated timber sections brought to the site rather than assembled on-site [citation needed]

→ Sinhalese kings of ancient Sri Lanka have used prefabricated buildings technology to erect giant structures, which dates back as far as 2000 years where some sections 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 Sebastião 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

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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.

Current use :-

→ 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 form work required to mould concrete components on site and delivering wet 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 on the construction of apartment blocks and housing developments with repeated housing units. The quality of prefabricated housing units had increased to the point that they may not be distinguishable from traditionally built units to those that live

in them. the techniqee is also ceed in office block warehouses and factory buildings. Pretabricated steel and glass sections are widely used for the exterior of large buildings.

⇒ Detached houses, cottages, log cabin, saunas etc. are also sold with pretabricated elements. Pretabrication 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 on frame wood construction in particular benefits from the improved quality. However tradition often favors building by hand in many countries and the image of Pretab as a "cheap" method only shows its adoption. However, current practice already allows the modifying the floor plan according to the customers requirements and selecting the cladding material e.g. a personalized brick facade can be planned even if the load supporting elements are timber.

Transportation of Pretabricated 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 allows brief periods of construction. Prefabricated bridge elements and system often bridge designers and contractors significant

advantages in terms of construction time safety, environmental impact constructibility, and cost. prefabrication can also help 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 political rather than commercial reasons such as for airbus.

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Types of Prefabricated System:-

→ There are two main type of prefabrication mainly volumetric or modular and panellised.

→ Both of these type of construction can be achieved in timber, steel and concrete.

→ Steel system for housing are usually light gauge galvanised steel.

→ Timber system can be relatively traditional which might be produced on site using components such as timber stud.

→ It can make use of timber beams which gives longe life span with a relatively light weight beam

→ A third option is structural insulated panel system which use tower stud and rely in part on the bond between rigid insulation core and outer sheaphing material for strength

→ One factor that differentiate all Prefabricated timber system from what might be traditional timber frame is the amount of work undertaken in the factory.'

Classification of Pre fabrication:-

(A) Small Pre fabrication.
(B) Medium Pre fabrication.
(C) Large Pre fabrication.
(D) Partial Pre fabrication.
(E) Open system Pre fabrication.
(F) Close system Pre fabrication.
(G) Total pre fabrication.
(H) Cast inside the fabrication.
(I) OFF side Pre fabrication.

Classification of Pre fabricated construction system:-

1. Smaller degree fabrication: (Here the fabrication is done in the smaller scale).

2. Medium degree Pre fabrication:- (Hence the Prefabrication is done in the moderate shape.)

3. Large degree Pre fabrication:- (Hence the Prefabrication is done in the large scale).

Advantages:-

→ Moving partial assemblies from a factory often cost less than moving Pre-production resources to each side.

→ Deploying resources on side can add cost, Prefabricating assemblies can save cost by reducing on side work.

→ Factory tools like cranes, conveyors etc. can make production faster and more precise.

→ Factory tools like shape table hydraulic testers can offer added quality assurance.

→ consistent indoor environment of factories eliminate most impact of weather on production.

→ Crane and reusable factories supports can allow shape and sequences without expensive

on side tasse work:

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

Disadvantage:-

→ Transportation cost may be higher for voluminous Pre fabricated section than for their constituent materials.

→ Large Prefabricated section may require heavy duty and precision measurement and handling to place in position.

Process and theory:-

→ An example from 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 on site from these materials. In prefabricated construction, only the foundations are constructed in this way, while section of walls, floors and roof are prefabricated (assembled) in a factory (possibly with 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 Manufacture are assembled elsewhere instead, before delivered for final assembly

→ The theory behind the method is that time and cos is saved, if similar construction tasks can be gro and assembly assembly techniques can be employed in prefabrication at a location where skilled labo is available while congestion at the assembly p which waster time can be reduced :

→ Prefabrication avoids the need to transport so ma skilled workers to the construction site, and oth restricting conditions such as a lack of power, lack water, exposure to harsh weather or a hazardo environment are avoided. Against these advantages must be weighed the cost of transporting

→ Prefabricated sections and lifting them into positio as they will usually be larger, more fragile an more difficult to handle than the materia and components of which they are made

Design principle of Prefabrication :—

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

1. Economy in large scale project with high degree repetition in work construction.

2. Special requirement in finishing

3. consistency in structural quality control.

4. Fast speed of construction.
5. consistency in availability of site resources (eg materials and labour)
6. ~~fast speed of construction.~~
- other space and 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.

→ superiority of adopting precast construction over convention method.

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

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

1. Local jobs are lost.

→ The main reasons to choose precast construction method over conventional in site method.

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. eg

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materials and labour etc.
6. other space and 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 and conventional site method.

Prefabrication Elements :—
1. Flooring / Roofing system.
2. precast beams.
3. precast columns.
4. precast Wall panels.
5. precast stairs.

Classification :—
→ 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 on site Prefabrication.
5. off-site (or) factory Prefabrication
6. open system of prefabrication.
7. closed system of Prefabrication.
8. partial Prefabrication.
9. total Prefabrication.

Small Prefabrication :-

→ The three type are mainly classified according to their degree of precast.

→ Elements 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 positive.

Medium prefabrication :-

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

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.

Cast-In-site Prefabrication : off-site (factory) prefabrication :

→ one of the main factor which affect the factory prefabrication is transport. The width of road, Mode of transport, vehicles are the factors which prefabrication is to be done on site or on factory.

→ Suppose the factory situated at a long distance

from the construction site and the vehicle have to cross a congested traffic which heavy weighed elements the cost inside prefabrication is preferred even through the same condition are the cost inside prefabrication is preferred only when number of houses and more for small elements the conveyance or carrier with normal type of lorry and trailers. Therefore we can adopt factory (or) off site prefabrication for this type of construction

Open system of Prefabrication:-

→ In the total prefabrication systems, 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.

Closed system of Prefabrication:-

→ In this system the whole things are casted with fixings and erected on their position

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 from works the completion of the building is delayed and hence this method is restored in most of the building

Sites this method is popular more so in industrial buildings. Where the elements have longer spans. Use of double tees, channel units, cored slabs, slabs, hyperboloid shell 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 form work, delay due to removal eliminated completely in this method of construction suitable for any type of building. Provided lifting and erection equipments are available.

Total Prefabrication :-

→ very high speed can be achieved by using this method of construction. The method can be employed for frame type of construction or for panel type of or the total ~~structure~~ Prefabrication can be on site or off site. The choice of these two methods depends on the situations. When the factory produced elements are transported and erected site we call it off-site Prefabrication. If this method is adopted then we have a very good transportation of the products to site. If the elements are cast near the building site and erected, the transportation of elements can be eliminated but we have consider the space availability for establish such facilities through it is temporary. The choice of the method of construction also depends on the following :-

1. Type of equipment available for erection and transpo

2. Type of structural scheme (linear elements or panel).
3. Type of connections between elements.
4. Special equipment devised for special method construction.

Modular co-ordination:—

→ Modular co-ordination is a concept for co-ordinating dimensions and space for which building components are positioned. Basic unit of MC is Module 1 M which is equal to 100m. 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 activities.

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 external walls modular co-ordinated 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 co-ordinated 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 11 1/2 inch grid size would be 12 inch because of units were designed to be placed with 1/2 inch joints.

→ In modular co-ordination system, in place of geometric series, a different system of prefered dimensions is used. for larger dimensions. It is represented in modules like 1 m = 0.1 m, for smaller dimensions sub modular increments 50mm or 25 mm are used.

✓ Advantages of modular co-ordination:-
1. Facilitate co-operation between building designer, manufacturers, traders, contractors.
2. Improves freedom in design and permits flexibility
3. Encourages the possibility of interchanging the components.
4. Simplifies Positioning and placing of components.
5. Ensures dimensional co-ordination between components with the rest of the building.
6. It is possible to get maximum economy in the production of components.
7. Reduces the need for making special sizes.
8. Increases the number of choices of components.

because of interchangeability
9. Improves quality and productivity of a construction.
10. Wastage in production and time taken for installation of components is reduced.
11. It helps to achieve the responsibility in constructing the building

Earthquake resistant construction

Unit:- Building configuration

→ Buildings having simple regular Geometry and uniformly distributed mass and stiffness in plan as well as in elevation suffer much less damaged is known as building configuration.

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

→ The ~~form configuration~~ formation should generally be based on hard and uniform ground

→ The members resisting horizontal forces should be arrange show that the torsional deformation is not produced structure of building should be dynamically simple and definite the frame of building structure should have adequate ductility in addition to required strength.

⇒ The building shaped like a box such as rectangular in both plan and elevation is inherently

Stronger than one that is U-shaped ex:- A building with wings:

→ The effect gives origin to undesired stresses concentration in some resisting members of the building.

~ Lateral load Resisting structure:-

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

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

→ BIS has approved three measured types of lateral resisting system such as
(1) Moment resisting frame.
(2) Bearing wall system.
(3) Dual system.

Building characteristics in earthquake resistant construction:-

→ ~~Building characteristics~~ The following assumption shall be made in ~~a~~ earthquake resistant design of structure:-

→ Earthquake causes impulsive ground Motion which are complex and irregular in character changing in period and amplitude each lasting for a small duration. Therefore resonance of the type as visualized under a mild stay sinusoidal

excitation will not occur as it would need to built of such amplitude.

→ Earthquake is not likely to occur symaltaneously with wind on maximum flood or maximum sea wave.

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

Structural irregularity in building:-

→ A building that lacks symmetry and has discontinuity in Geometry mass or load resisting element is called irregular.

→ The irregularities may caused interaction of force flow and stress concentration a symmetrical arrangement of mass and stiffness of element may caused a large torsional coarse. the irregularities may be classified as:- (a) Horizontal irregularities or plan configuration Problem.

(b) Vertical irregularities

Horizontal irregularities:-

→ Refers to sudden change of strength stiffness

Geometry and Mass which results in irregular distribution of forces and deformation over the height of building. they are also known as plan configuration problem. and they are follows:-

(i) Torsion irregularities:- Torsion irregularity is considered when the floor diphargm are rigid in their own plan in relation to vertical structural element that resist the lateral force.

(ii) Diphargm discontinuity

→ Discontinuity in diphargm stiffness lead to plan irregularity the diphargm is a horizontal resistant element that is responsible for transferring forces bet^n vertical resistance elements.

(iii) Re entrant corners:-

→ The re entrant or inward cutting corners is a common irregularity in overall building configuration that in plant assume the shape of L TH or combination of these shapes resulting lack of tensile capacity and force concentration.

→ The reentrant corner of the buildings are subjected to two types of problem the first is that they tend to produced variations of rigidity and hence differential motions bet^n different

part of the building resulting in a local stress concentration at the notch of the reentrant corners.

→ The second problem is torsion the magnitude of the induced forces depends upon mass of the building structural system length of the wings they are height and they are height depth ratio.

(D) Projection :—

→ All projections (vertical and horizontal) are most vulnerable to damage during earthquake. as they are basically cantilevers there is hardly any ductility at their junction with the main structure.

(E) Non Parallel systems :—

→ In this case the vertical load resisting elements are not parallel or symmetrical about the measure orthogonal axis of the lateral force resisting system.

→ The narrower portion of the building will tend to be more flexible than the wider ones which increases the tendency of torsion. in the design of such type of building special care must be taken to reduced the effect of torsion.

Vertical irregularities:-

→ Refer to suddern change of strength stiffness geometry and mass which results in irregular distribution of force and deformation over the height of building. Following are the vertical irregularities.

Vertical discontinuities in load path:-

→ one of the major causes to structural damage in structures during strong earthquake is the discontinuities or irregularities in the load path or load transfer it is desirable that the structure should contain a continuous load path for transfer of the seismic forces that develops due to acceleration of individual element together can result in distress or complete collapse of the system. therefore all structural or non-structural elements must be adequately tied to the structural system to act as a unit. the load path must be complete and sufficiently strong. the sequence of genera load path ~~must be complete and~~ is as follows:-

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

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

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

Irregularities in strength and stiffness:-

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

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

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

1. First is the reduction in spectral acceleration and base shear due to increase of natural period of vibration of the structure as on a base isolated

structure. But the advantage of this force reduction is nullified by an increase in structural displacement and inter-storey drift which is a threat to stability of the structure.

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

→ The failure of reinforced concrete buildings due to soft-storeys have reinforced the main reason in past earthquake. Undoubtedly it is recognised that this type of failure results from the combination of several other unfavourable reasons such as tension excessive mass in upper floors, P-Δ effects and lack of ductility. In the bottom storey, these factors lead to local stress concentration accompanied by large plastic deformation therefore the soft storeys observe a special consideration in analysis design and it is not always necessary that all first storeys of the building are soft storey. If the column of the first storey have been designed on the basis of capacity of ductility

Mass irregularity :-

→ Mass irregularity is induced by the presence of a heavy mass on a floor like swimming pool. As per IS 1893, mass irregularities are considered to exist where the effective mass

of any storey or floor is more than twice the effective mass of adjacent storey or floor. However NEHRP is when the weight exceeds 150% of that of the adjacent floor/storey.

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

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

Vertical Geometric irregularity:-

→ All buildings with vertical offsets fall in this categories. Here a building may have no apparent

offset but its lateral load carrying elements may have irregularity It is considered when the horizontal dimensions of the lateral force resisting systems in any storey more than 150% of that in an adjacent storey. for instance shear wall length may be suddenly reduced. Also when a building has such larger dimension above the smaller dimension it acts as an inverted pyramid and is considerable.

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

Out of plane offset :-

→ This is a very serious irregularity where in there is an out of plane offset of vertical element that carries the lateral loads such an offset imposes vertical and lateral load effects on horizontal elements which are difficult to design for adequately in this case shear walls are not obvious.

Proximity of adjacent buildings :-

→ pounding damage is likely to be caused by mutual hitting of two buildings constructed in close proximity with each other pounding may result in irregular response of adjacent buildings of different heights due to different dynamic characteristics several examples of building failure have been observed

due to pounding during earthquakes.

→ This problem arises when buildings are built without separation right up to property lines in order to make maximum use of the space when floor of these buildings are constructed at the same height the damage due to pounding actually is not serious if this is not the case there may be two problems: damage due to pounding can be minimized by drift control building separation and aligning floors of adjacent buildings.

Safety consideration during additional construction and alteration of existing buildings:-

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

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

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

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

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

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

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

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

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

Additional strengthening measures in masonry buildings

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

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

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

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

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

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

Chapter-4

Retrofitting of Structures

→ It is the process of increasing resistance of damage on weak building by appropriate technique. Retrofitting proves to be a better economic considerate and immediate shelter to problems rather than replacement of building.

'or'

→ It is the modification of existing structures to make them more durable and resistant to ground motion or soil failure due to earthquake. the retrofitting technics are also applicable for other natural hazard that is tropical cyclone, tornado and severe wind from thunder storms.

Classification of retrofitting techniques

- Global
  - ↦ Adding shear wall.
  - ↦ Adding infill wall.
  - ↦ Adding bearing.
  - ↦ Adding wing wall.
  - ↦ Member thickness
  - ↦ mass reduction
  - ↦ base isolation
- Local
  - ↦ Jacketing of beams.
  - ↦ Jacketing of columns.
  - ↦ Jacketing of beam and column joint.
  - ↦ Strengthening individual members

Need for seismic retrofitting :-

→ To ensure the safety and security of a building, employee, structure, functionality, machinery and inventory.

→ Essential to reduce hazard and losses from non structural element.

→ Important buildings must be strengthed whose services are assumed to be essential just after an earthquake like hospital.

→ There are two way to enhance the seismic capacity of existing structure the first is a structural lable of approach of retrofitting which involves global modification to the structural system.

→ The second is a member lable approach or local retrofitting which deals with an increase of the ductility of components with adequate capacity to satisfy their specific limit state.

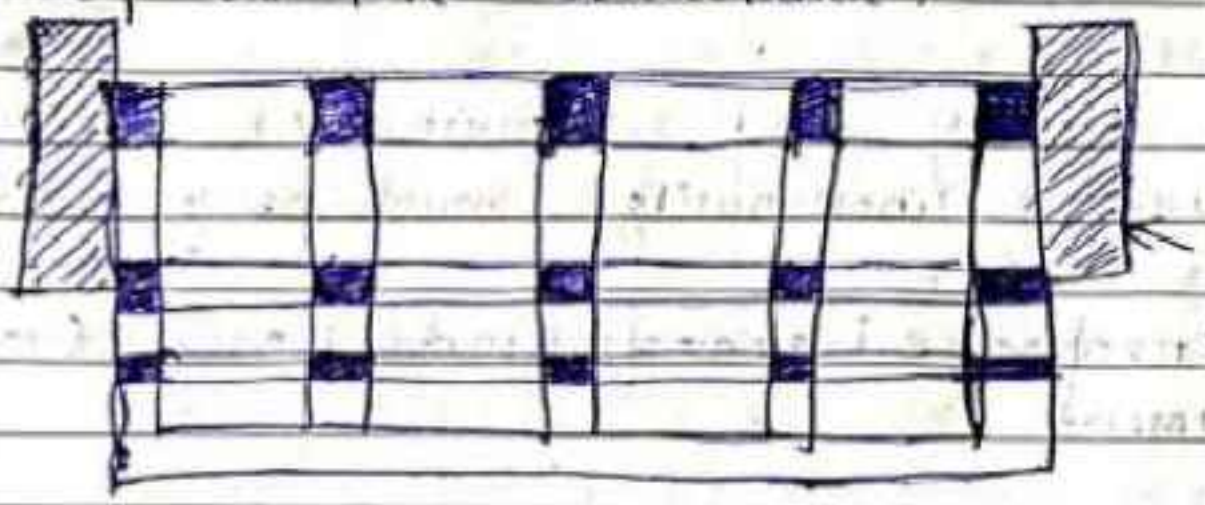
Structural level or global level retrofitting :-

(i) Adding shear walls :-

→ one of the most common methods to increase the lateral strength of the R.C buildings. It is the last simple method.

Limitations :- increase in lateral resistance but it is concentrated at a few places and increases the dead

load of the structure.



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

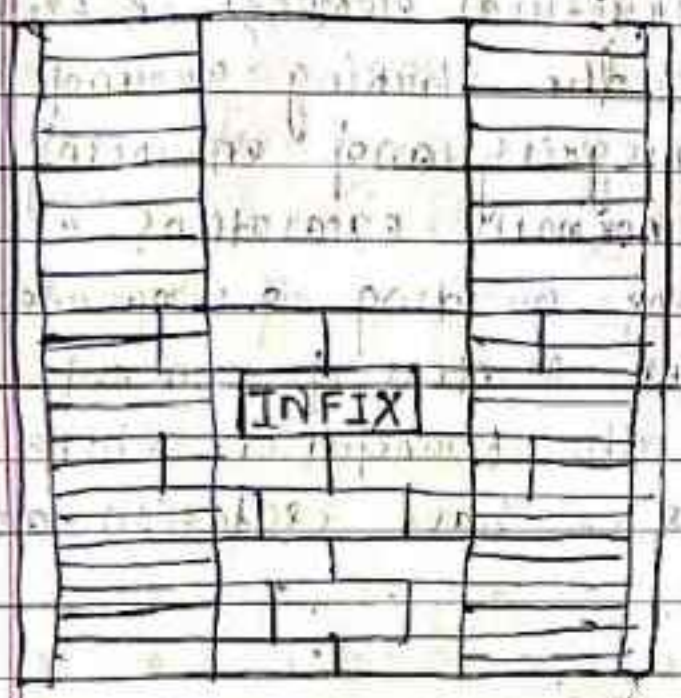
Limitation :-
→ some columns in the frame are subjected to large axial tensile forces, which may exceed the capacity.

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

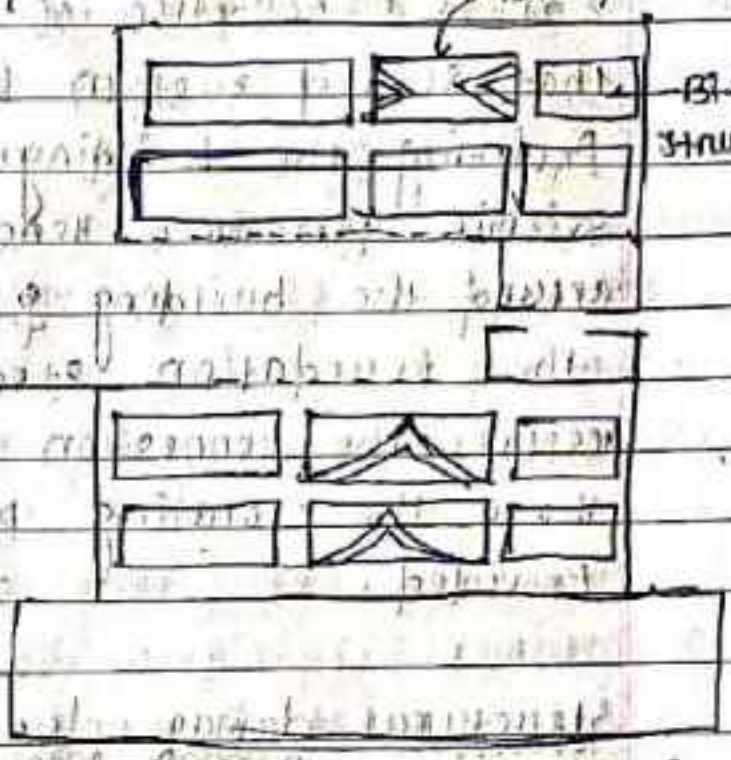
(iii) Adding steel bracing :-
→ Higher strength, stiffness can be proved, opening for natural light can be made easily

Limitations :-
→ A moderate to high level of skilled labour is necessary
→ Lack of information about the seismic behaviour of the added bracing

→ Undesirable changes takes place.



(Adding infill wall)



(Adding steel bracing)

(iv) Mass reduction:-

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

(v) Mass dampers supplemental damping:-

→ Mass dampers absorbs the energy of the motion and convert in to heat. Thus damping effect the structure that are rigidly attached to the ground in addition to adding energy dissipation capacity to the structure supplemental damping can reduce the displacement and acceleration demand within the structure.

(vi) Base isolation :-

→ It is a collection of structural elements of building that should sustain from the shaking ground thus Protecting the buildings integrity and enhancing its seismic performance - Hence normally excavations are made around the building & the building is separated from the foundation steel or reinforced concrete pedestal replace the connection to the foundation while using these the isolating pads or base isolation are provided.

Structural damage due to discontinuous load path :-

→ Every structure must have two load resisting system :-

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

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

→ Therefore, all the structural and non-structural elements must have sufficient strength and ductility and should be well connected to the structural system so that the load path must be complete and sufficiently strong

(ii) Structural damage due to lack of deformation:-

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

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

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

→ In adequate strength and ductility of the structural member can and will result in total or complete failure of the system.

Quality of workmanship & materials:-

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

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

→ Many buildings have been damaged due to poor quality control of design materials strength as specified spalling of concrete by the corrosion of embedded

reinforcing bars, porous concrete, age of concrete, proper maintenance etc.

2. Local or Member level Retrofitting :—

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

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

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

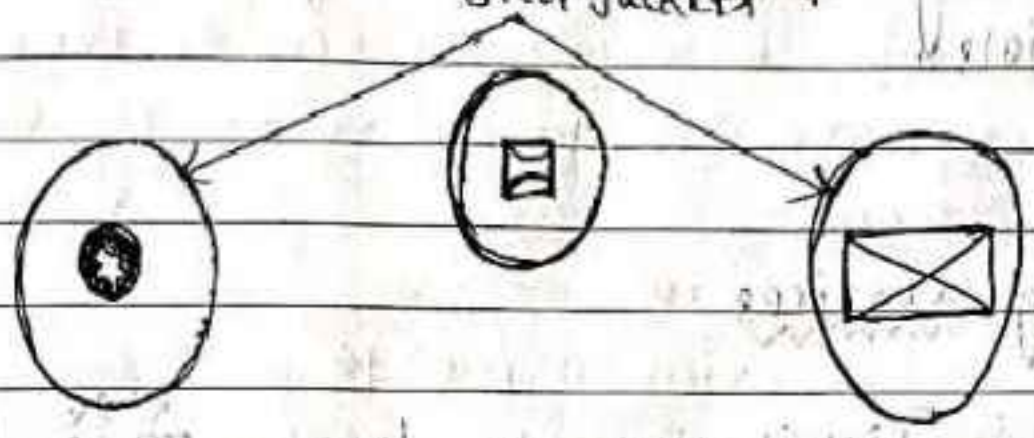
(ii) Jacketing :— Jacketing is the most popularly used materials for strengthening of building columns.

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

Purpose :— → To increase concrete confinement by transverse rebar / reinforcement especially for circular cross-sectional columns.

→ To increase shear strength by transverse reinforcement
→ To increase flexural strength by longitudinal fibre ~~steel jackets~~.

Steel jackets :

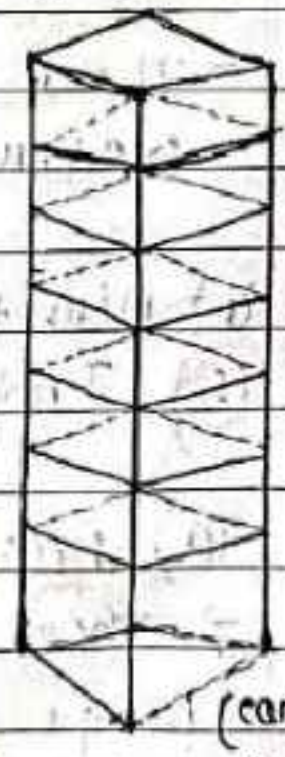


(ii) F.R.P Jacketing :-

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

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

→ It has light weight and reloading does not occure.



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

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

chapter-5

Building Services

cold water distribution in high rise building

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

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

(a) Direct system.
(b) Indirect system

(a) Direct system:-

→ This system is used mostly in areas where large level of reservoir provide a good main supply and in the system all sanitary are supply with called water directly from the main supply.

→ The capacity in litre of the feed system is required to be at least equal to the capacity of hot water cylinder.

→ The Water regulation requires a system of 114 litre minimum capacity and is therefore small enough to be accomodated in the top of an airing cupboard, thus saving plugging of the system and pipe work.

→ For efficient operation a high pressure water supply is especial particularly at a period of peak demand

(ii) Indirect systems:-

→ In the system all the sanitary fittings accept drinking water drawn off at a ring and fountain are supplied indirectly from a cold water storage system.

→ since the system supplies cold water to both basins shower etc also feed the hot water cylinder whose capacity in litre will be approximately double that of required for the direct system.

→ The water regulation required ~~the~~ system of ~~200 to~~ 227 litre minimum capacity and thereto it will be accomodated in the roof space.

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

→ main water for drinking is available at the kitchen top only, this can also supply

Washing machine, gardening tape

Hot water supply in building :-

→ Hot water is required in houses in building for bathing, washing of cloth utensils, etc.

→ Higher temprature melts oil from pot and pane make the cleaning work easier. bathing with hot water opens body pores ~~the environment~~ washing dirt and sweat easily and giving a sense of freshness, obidiently in winolow.

→ The requirement of hot water is very much essential in order meat the requirement of hot water these systems are design and installed in accordance with the requirement of particular building

Sl No.	Type of building	avg daily hot water demand (lit / head / day)
1.	Residence	
	(a) With shower and Tape	45
	(b) With bath tub	135
2.	Factories	
	(a) with shower	90
	(b) With tape only	30–45
3.	Hospital	
	(a) Patient cleaning of station	180

(b) Staff doctor and nurses — 90
(c) Visitors — 10

4.
(a) office, school, college — 145
(b) Hostels — 135

5. Laundries. ——— 20 per kg of Laundries.
(a) 20.

Soil and waste water installation in high rise building :-

→ A lot of soil and waste water is produced daily a top of water, shower, dish washer, washing machine etc.

→ It all has to be trained from the buildings and transported to the sewage.

→ There are various materials which are to be used in the soil and waste water installation in high rise building.

Material — Application.
(1) Cast Iron - 50 mm & above, vent & discharge stage.
(2) Galvanized steel - Waste pipe.
(3) copper - waste pipe & traps
(4) Lead - waste pipe & discharge stage.
(5) Plasticized PVC - up to 50mm, waste & vent pipe.

Ventilation :-

→ The process of supplying fresh air and removing confined air by natural or mechanical process from a room is known as ventilation.

→ Proper ventilation in a building is very essential for health efficiency and hygenic condition.

Necessity of ventilation :—

→ To create air movement.
→ To prevent accumulation of carbon dioxide and moisture.
→ To prevent flameable concentration of gas vapour and dust.

System of ventilation :—

→ The system of ventilation may be devided in two catagories

(1) Natural ventilation.
(2) Mechanical or artificial ventilation.

(1) Natural ventilation :—

→ Natural system of ventilation is suitable for small houses and not suitable for big houses, govt, office, theater, assembly hall, auditorium etc.

→ This system of ventilation largely depends on the scientific location of door, window, ventilator

and other openings.

→ The rate of ventilation by natural means through door window and other opening depends on

(a) Wind effect
(b) stack effect

(a) Wind effect :-

→ ventilation by wind effect is affected by the direction and velocity of outside wind, size and positions of openings, and pressure difference.

→ When it blows against a building cause a the pressure windward side over the lowerward side, this pressure difference causes the wind blow through the building and cause air change if proper openings are provided.

(b) Stack effect :-

→ Fresh admitted air inside the building is cool and heavy.

→ This air becomes hot, after some times and is lifted up.

→ This lifted air is escaped through ventilators and openings.

→ Fresh air again comes in the building and gets lifted up by heating and again escape through openings provided.

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

(B) Mechanical or artificial ventilation :—

→ This system of ventilation in which some mechanical arrangement are made to provide adequate ventilation in the room is know as Mechanical or artificial ventilation.

→ The mechanical ventilation is prominent because it provides better content than natural condition.

→ It can be classified in to 4 categories
  a) Extracted or exhaust system.
  b) Supply & phenum system.
  c) Balancing system.
  d) Air conditioning system.

(a) Extracted or exhaust system :—

→ In this system the partial vaccume is developed inside the room by extracting contaminated air by fixing fan blower and the outlet.

→ The pressure inside the room being low, the fresh air from outside forced through the door, window and every available openings.

→ This system is used for extracting smoke, odour dust etc. from kitchen, industrial plant etc

(b) Supply and Plenum system :-

→ This system is reverse of at exhaust system.
→ Fresh air is forced with the help of input fans and blower in to the rooms and polluted air is allow to leave the room by itself.

→ In this case the pressure inside the room is greater than the atmospheric pressure.
→ the system is mainly used in factories.

(c) Balancing system :-

→ This system uses both to supply and abstract air.
→ It enable full control over air movement and should be used where accurate performance is required.

→ some differences is usually maintain bet the rate of air supply and extraction.

→ In most cases it is desirable to extract only about 15 % of the quantity of air supply.

→ Recirculation of air is possible in this system

Air condisening system :-

→ the process of creating, controlling and maintaining indore based requirement or needs of industry is known as air condisening.

→ This process consists of conditioning air with respect to humidity temperature, bacteria content dust content and air movement so the comfortable condition maintain there in room.

Mechanical Services :—

(a) Elevator :— A cage, car or platform rises or lower vertically in Permanent guide rails including operating Mechanism used to transport portion or material is known as elevator.

There are three type of elevator.

(1) Hydraulic elevator.
(2) cable lift elevator.
(3) pneumetic elevator.

(1) Hydraulic elevators :—

→ Hydraulic Model conveyer the elevator in upward direction from the bottom way from below and is regulated by hydraulic oil filling chamber.

(2) cable lift elevator :—

→ This type of elevator is common for residential and commercial model.

→ The cab is lifted up through the hoist way by the help of a pulli and cables.

(3) Pneumatic elevator:-

→ A pneumatic elevator is a self supporting elevator fully enclosed room elevator.

→ It is simply rest on the existing ground floor and don't require pre construction shaft or machine room to operate.

Excalater:-

→ It is a moving stair case a transport device for carrying people betn floors of a building.

→ The device consist of a motor driven chain of individual linked step that waves it on down on track allowing the treads to remain in horizontal.

→ There are many type of excalater with the moving stair, case that we see in Mohls and airports being the most common.

→ The max^m angle of inclination of an excalater to the floor level is 30° with a standard rise up to 18° Meter.

Uses:- There are used to move pedestrial traffic in place where elevator could not be practical.

→ It has the capacity to move a large no of people at same time.

→ They can be placed in same physical space where one stair case might be installed.

→ They have no weighting intervals.

Wearing :-

→ Cleat Wearing :- In this type of wearing insulated conductors are supported Wooden cleat.

→ The cleats have two halves, one is base and other is cap. the cables are placed in the groups provided in the base and then the cap is placed.

→ Both are fixed with securely on the walls by 40mm long screw. this wearing is suitable for temporary installation where cost reduce is main criteria.

Advantage :-

→ Easy installation.
→ material can be recued.
→ Flexibility on provision for inspection, modification and expansion.

→ Relatively economical.
→ Skilled man power is not required.

Disadvantage;—
→ Appearence is not good.
→ open system of wearing is required regular cleaning.
→ Higher possibility of material injury.
→ cable type sheathed (CTS / Tough rubber sheathed (TRS) wearing:-
→ on this type of wearing system wire sheathed in tough class rubber which are quite flexible.
→ They are created on wooden pattens we brass fixed on the wall.
→ These cables are moisture and chemical proof.
→ TRS wearing is suitable for lite in low voltage installation.

Advantages;—
→ Easy installation and durable.
→ Low risk of short circuit cheaper then casing and capping system of wearing gives a good appearence.

Disadvantage:-

→ Dangerous for mechanical injury
→ Dangerous for fire hazards.
→ Should not exposed to direct sunlight
→ Skilled workmanship is required.
→ metal ship wearing or lead ship wearing the wearing is similar to that of CTS but the conductors are individually insulated and covered with common lead aluminium.
→ the sheathed is done every section to provide a path to ground for the leakage of current.

Advantages:-

→ Easy installation and aethetic in appearence.
→ Highly durable.
→ Suitable in adverse climatic condition.
→

Disadvantages:-

→ Required skilled labour very expensive unsuitable for chemical industry.
→ casing and coring:-

→ Insulated conductors laid inside rectangular teak wood or PVC box having roots inside it.

→ A rectangular strip of wood called caping having same width as that of casing is fixed over it.

→ Both the casing and caping are skew together at every 15 c.m

Advantages:—

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

→ Easily accessible for inspection and repairs.

→ Since the wire are not exposed to atmosphere the insulation is place affected, dust, oil and climatic variation.

Disadvantages:—

→ Highly inflammable use of unseasoned wood get damaged by termed.

→ Skill workmanship is required.

→ Conduit Wearing:—

→ In this Wearing PVC cables are used PVC pipes

Providing good protection against mechanical injury and fire from short circuit.

→ They are embeded inside the walls known as conduit wearing or fixed on the surface called as surface conduit wearing.

Advantages :—

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

→ Earthing is assured the lead and return type wire can be carried in the same tube.

→ Water proofing is easy.

Disadvantage :—

→ very expensive system of wearing

→ Required skilled workmanship, risk of short circuit under weight condition

Centralised Hot Water System

→ Individual geyser proved to be useful in small installation such as house hostel etc. However a large installation in hotels, high

rise building involving large number of supply point and hence installing individual geysers in such building may prove to be uneconomical and trouble some. Therefore centralised hot water system is installed in high rise building etc. the various factor which are consider in its design are.

Ambient temperature

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

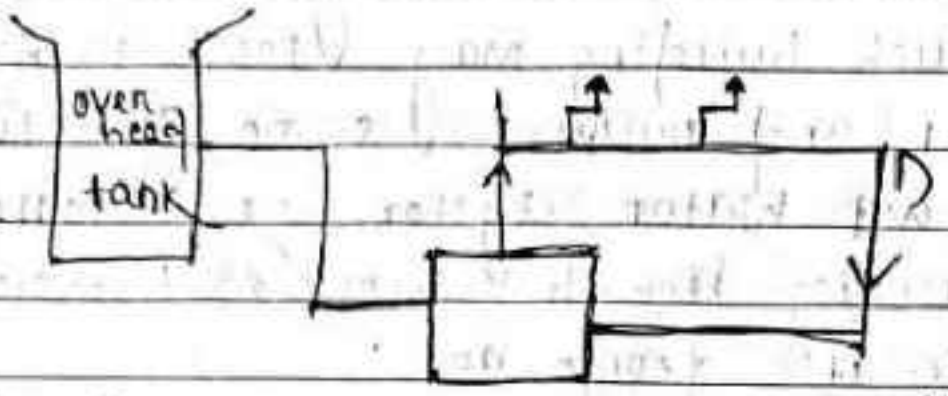
Pressure in the System :—

→ Pressure in the hot water taps should be the same as pressure in the system col of water taps unequal pressure may result in the back krow of water from one system to another when hot and col of mixture are used.

Hot water storage and generation :—

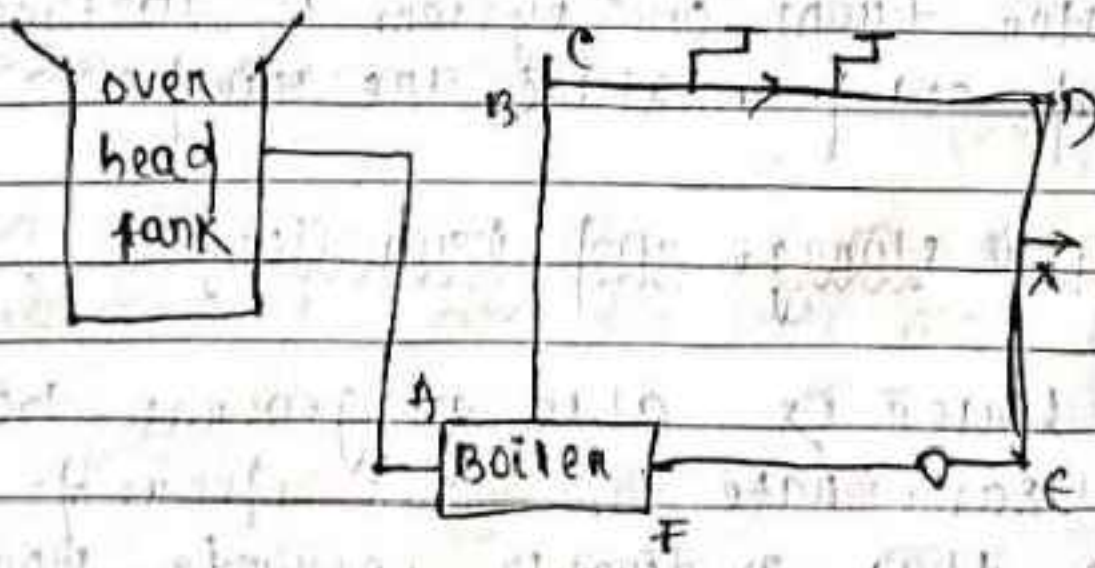
→ If a boiler is able to generate hot water at the same rate the PCK demand in the system that evidiently required storage of hot water. However by providing a storage tank for hot water can be reduced and generally avoided due to availability of limited space.

Hot Water Piping system



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

Piping system with forced circulation;-



Since the natural thermosphonic circulating pressure is usually low it become necessary in large installation to generate additional pressure

in the system to force the circulation by means of pumps.

This helps in using reduce pipe size and in all parts of the distribution system for quick drop in the hot water.

Solar Water Heater;—

→ Now a day water heater has become quite cost effective and save fossile fuel or electricity which are scrace. solar water heater have therefore gained popularity in countries like Japan.

→ Israle. Australia and USA where water heater are required mostly

→ The designes of solar water heater and particularly the area of observer unit is primarily governed by solar energy available at the place of installation of the solar heater.

A solar water heater is occupy unit of

(a) A solar energy collecton or connection unit
(b) storage tank.

Fuse;—
Fuse is strip of metal melts when current reach a shorter value. The fuse is rated by the maximum number amperes than can carry without

without melting fuse allow a small overload current for a short time.

Purpose of fuse :-

→ It fuse is a safety device used for the purpose of protecting a circuit against accessive current. In the event of excessive current the fuse element melts and open up the circuit their by protective it from damage

Types of fuse :-

Following are the types of fuse

(1) Rewirable type (up to 200A)

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

(2) Cart-ridge fuse :-

→ cart ridge fuse are developed disadvantages of rewirable fuse due to high temp. prolonged used and oxidation rewirable fuse detoriates and interrupted the supply even when carrying normal current a cart ridge fuse element are enclosed in air tight chamber the detriation does not take place

3. Ferrule - contact cart - ridge fuses :-

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

4. Dazed screw type cart-ridge fuses :-

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

5. High - rupturing capacity fuses :-

→ they are cylindrical in shape and are made up ceramic body filled in with a chemicaly treated filling powder or silica to quench the acting quickly without any fire hazard

Earthing :-

Earthing is a process of creating and alternative path for the flow of fault, slash, excessive current safely in to the ground in the Presence of minimal resistance or impedance.

Uses of earthing :-

→ Earthing is done for personal and Equipment Protection Purpose. Earthing provides the conducting

path for fault current to the current.

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

→ Earthing is nothing but it use to remove an wanted harmful current / voltage by sending it to earth pit.

→ It is use to prevent shock from fault current.

Construction and Earth Moving Equipment

Planning and selection of construction equipment :-

→ most of construction operation can be perform by more than one kind of equipment or combination of equipments.

→ The best choice of equipment for a given job is the one that can complete the work, according to the plan and specification within the time and least total cost.

→ The equipment selected must satisfy several constraints imposed by the job and the contractual obligation.

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⇒ The constraints or factors include the following:

(a) Specific construction and operation.
(b) Job specification requirements.
(c) condition of the job site.
(d) Location of the job site.
(e) Time allowed to do the job.
(f) Balance of independent equipment.
(g) Monthly requirement of the equipment.
(h) Versatility of the equipment.

→ A feasible solution to the equipment selection became problem for actual field condition it may requires a no of these factors to be considered inter this would be unusual construction if the choice made is dependent on only one factor.

Various types of earth Moving equipment:-

(a) Excavator:-

→ The excavator can be used on wheels or tracks they are mainly used to shovel dirt and lift heavy pices of machinery.

→ It is easy to identify an excavator based on its long bucket arm that is attached to the pivoting cab.

→ The excavators are operated by an operator

who is in the cab has high visibility over the work area.

(b) backhoe loader :-

⇒ The back hoe loaders are mounted on tire and are great for use, sub-urban areas.

⇒ . The equipment have a shovel in front that can be adjusted and a bucket at the rear that is use for digging.

⇒ These loaders are best choice for small job that have to be completed in a confined space.

⇒ The backhoe loaders help to shift, dig, shovel trenches and position pipes in place.

(c) Bulldozer :-

→ Bulldozers are considered to be the heavyist equipment available.

⇒ They are very strong and the best choice for shifting a large amount of dirt on sites where there are large open stage where grinding and rough grading of rocks takes place.

⇒ The bulldozer can easily be identified with a huge blade at the front which is controlled using hydraulic piston system.

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

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

(c) Various compacting Equipments:
1. smooth wheel rollers.
→ Smooth Wheeled rollers are of 2 types * static smooth Wheeled rollers
* vibrating smooth Wheeled rollers.

→ The most suitable soils for these rollers are well graded sand, gravel crushed rock, asphalt etc. Where crushing is required. These are used on rollers are generally used for finishing the upper surface of the soil. These rollers are not used for

compaction of uniform sands.

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

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

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

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

2. Vibrating compactors:-

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

(d) owning & operating cost :-

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

1- Initial cost :-

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

2. Salvage value :-

→ Salvage value represents the expected cash inflow that will be received by disposing of equipment at the end of its useful life. The estimation of expected salvage value of equipment can be carried out by referring to the data obtained from past projects where on same equipment was used on

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information obtained from other relevant sources

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

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

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

It is generally about 1%–3% of the average annual investment on book value of equipment.

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

✓ Pneumatic tyred roller :-

→ This type of roller consist of a box mounted on two excel. the rear has one wheel and are spaced in such a manner these travel over the surface between the front wheels to produce complete coverage of the surface.

→ Generally they are 4 (four) wheels in the front and five in the rear weights in the range of 12 to 45 tons are common.

→ These rollers are suitable for compacting non plastics soil and silty soils.

→ The layer thickness of soil should be 10 to 20 cm when compacted by these rollers.

✓ Sheep foot roller :-

→ This type of rollers consist of hollow circular steel drum with steel projection in the form of sheeps foot.

→ These Projection are called tamping feet.

→ The steel drum is 1.2 to 1.5 M long and 0.9 to 1.2M in diameter.

→ The tamping feet on the drums are staggered in rows the length of the feet should be at least sufficient to pass through 3-4 of the thickness of the loose layer and is usually 150 to 200 mm.

→ They are generally towed by tractors a tractor of 45hp can cooled a single drum and 70 to 90hp tractor can cooled double drum

→ These rollers are suitable for co-hesive soils the no of passes of sheeps foot rollers depends upon the type of soil and density desired.

Dragline excavater :-

→ A dragline excavater is a piece of heavy equipment used in construction and surface mining.

→ It is used to strip the over burden from the lower seams.

→ They are large pieces of equipment and require large lable areas from which to work.

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Power shovel :—
⇒ A power shovel is a bucket equip machine usually electrically power used for digging and loading earth and fragmented rock and for mineral excavation.

Chapter:1 Soil reinforcement techniques

Soil reinforcement :-
⇒ It is defined as the technique to improve the engineering characteristic of soil in this way using natural fibers to reinforce soil is an old and ancient idea.

⇒ Soil reinforcement is the act of improving soil strength to enable it to support or carry more load two examples are
1. Mixing a soil amendment such as lime in to weak clayey soil and recompacting to improve soil bearing capacity, often done under road base in highway construction.

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

Wiremesh :—
⇒ Welded wiremesh or welded wire fabric or weldmesh is an electric fusion welded prefabricated joint grid consisting of series of parallel

longitudinal wires with accurate spacing welded to cross wires at the required spacing.

→ Machines are used to produce the mesh with precise dimensional control.

2 marks V.V

Geosynthetics :-

→ Geosynthetics are synthetic products used to stabilized terrain. they are generally polymeric product used to solve civil engineering problems. this includes 8 main Product categories. Geotextiles, Geogrids, Geonet, Geomembranes, Geosynthetic clay liners, Geofoam, Geocells, Geocomposite.

Uses of Wiremesh and Geosynthetics in soil reinforcing techniques

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Uses of Wiremesh :-

→ Wiremesh fencing is one of the most basic type of fencing.

→ It can either be made from galvanize steel or stainless steel. Wiremesh fencing has a lot of uses from residential to industrial purposes over the years. It has slowly taken over chainlink fences as users see it to be more durable.

(1) Security fencing :-

→ one of the Main uses of Wire fencing is for security Purpose this type of fencing is often used as a industrial commercial or residential installation. most homes used this type of fencing to secure their area aswell as Provide an, asthetic look to their exterion fencing

→ This type of wireness used for security fencing comes in 5mm whole to 6mm whole diameter.

→ The type of wireness fencing depends on Preferance and requirement.

2. Animal fencing :-

→ Another common use of wireness fencing used to fair animals since this type of fencing comes in different hole sizes. it is easy to choose to have a small holed or big holed fencing to accomodate the type of animal like to fence in.

→ This type of fencing is often used in chicken coops, Rabit fencing and horse fencing since wireness fences dont have any sharp edges (t is also trained as safe fencing for animals.

3. Garden fencing :-

→ Wireness fencing is also based used for garden fencing.

→ It can be surrounded the entire garden area or it can also be installed around sloped area of the garden. Garden fencing can add a certain blue in to the garden since it can also comes in several colours.

→ They are more durable and take the weight of these type of plants without having repairs regularly

4. Windows Screen:-

→ These type of fencing can also be used as an alternative two window screen. Just like security fences wireness fencing provides a durable option for window screen on structures or buildings that require extra security it prevents outsiders from entering the facility through the window.

5. Highway and Railway fencing:-

→ Wireness fencing these also commonly used in industrial application one of the main industrial uses of this type of fencing is for highway and railway fencing.

→ It is use to prevent animal and people from trying to cross the railtrack and high roads. also used to prevent and minimize damaged on the tracks.

Use of Geosynthetics :-

1. For improving ground stabilization.
2. pavement roads parking bay runways improvement.
3. Heavy duty pavements like ports and harbours.
4. For railways.
5. For erosion control.
6. For returing wall and bridge abutments.
7. For building foundation improvements.

Slope stabilization :-

→ Slope stability is the potential of soil covered slopes to which stand and undergo movement.

→ Stability is determined by the balance of shear stress and shear strain a previously stable slope may be initially affected preparatory factors making the slope conditionally unstable.

Light intensity

→ Intensity of light is like brightness and is measured as the rate at which light energy is delivered to a unit of surface or energy per unit time per unit area.

→ The unit of Measurement of intensity of light is flux.

1 flux = 1 lumen / M^2