LECTURE NOTES
OF
ADVANCE CONSTRUCTION
TECHNIQUE & EQUIPMENT

PREPARED

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CONTENT

CHEPTER-1:-ADVANCED CONSTRUCTION MATERIALS

FIBER AS CONSTRUCTION MATERIAL-

Fibers are considered as a construction material to enhance the flexural and tensile strength and as a binder that cloud combine Portland cement in bonding with cement matrices. 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 Fibres-

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 fibres are.most frequently used as reinforcement in resins and composites as they have amazing properties in strengthening composites.

Glass fibres 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 Fibres-

Similar to traditional steel reinforcement, the key characteristic of steel fibres is their high tensile capacity . Steel fibres 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 fibres help improve the concrete behaviour in terms of cracking, shrinkage , ductility, toughness, resistance to fatigue, and impact and blast loading . Furthermore, 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 fibres' characteristics of absorbing energy and controlling cracks. Steel fibres can be an ideal additive to specific applications as they possess good electric, magnetic, and heat conductivity.

Carbon Fibres-

Carbon fibres have been added in materials to form composites with improved properties . The addition of carbon fibres creates a composite that has outstanding mechanical properties , performs well in high temperature environments , and possesses the benefit of durability . Although carbon fibres are quite brittle , with careful consideration in the design stage, carbon fibre-reinforced composites have excellent properties . The disadvantages of carbon fibres are that due to their excellent properties the expense of manufacturing carbon fibres 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 fibres, 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 well 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 –

1. High tensile strength and modulus of elasticity.
2. High resistance to weather and acidic environments, and some alkali resistance.
3. Good thermal properties and stability, and can tolerate and perform well in high temperature environments .
4. Good electric, electromagnetic, and sound insulation properties.
5. Good resistance and stability against corrosion, chemical attack, impact load, and fire
6. Good adhesion and abrasion properties with the ability to mix well with matrix materials.
7. Nonreactive and noncombustible.
8. Low absorption of moisture/water and thermal conductivity.
9. Absorb sound and vibration isolation.
10. Resistant to radiation and UV light.
11. Strong, hard, and rigid.
12. Improved strain failure Basalt fibres are also:
13. Easy to produce and process.
14. Cost-efficient/inexpensive.
15. Used to form lightweight composites with excellent properties.
16. Can be recycled for reuse.
17. Require no chemicals or additive.
18. Natural.
19. Biodegradable.
20. Ecologically clean, easy to handle, and non-toxic.
21. Can be used in a diverse range of applications .
22. Titled as green.

USE OR APPLICATION-

- Improved characteristics and properties, such as strength, toughness, durability, rigidity, and ductility.
- Improved resistance and performance in different environments, and against physical and chemical corrosion and other attacks.
- Improved stability.
- Improved thermal properties and operating temperature.
- Reduction of heat conductivity.
- Reduction of the specific weight and density resulting in a lightweight product that is both energy and cost-efficient.
- Reduction and lower cost of design and installation , as fibres can replace traditional reinforcement methods.
- Reduction of the volume of landfill and saving of energy if a waste product is utilised.
- Prevents the occurrence of shrinkage, cracks, spalling, and swelling.
- Improved environmental-friendliness, economic efficiency, and sustainability [3], particularly if natural, energy efficient, or waste fibre is used.

(A) 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 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,Shuttering,
Wall linings,Floor covering,Ceiling panels. Roof coverings.Sinks, basins, baths, and showers

The advantages of using plastic in construction are that it is lightweight yet strong which makes it easier to transport and shift around sites. 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 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 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, 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. Polycarbonate windows are considered more burglar-proof than regular glass windows. Two plastics 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 Poly-Vinyl 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 applications, also known as earth energy or geo-exchange systems.

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. 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 and thermally insulative, and resistant to shock, corrosion, chemicals, and water.

(B) 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 bear about 50%.

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 woods. 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. These 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 into 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 fungal 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 let 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 2 processes such as:-

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

2. Compartmental Seasoning: Its 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 Materials.

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

Acoustics 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 acoustic 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 products 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.

1. Acoustic foam and acoustic ceiling tiles absorb sound so as to minimize echo and reverboration within a room.
2. Sound proof doors and windows are designed to reduce the transmission of sound.
3. sound proof wall (treated by a accurate 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 Cladding.

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. Silica fume 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 with a particle size of less than 4.75 mm, 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 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

Adhesive

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

CHEPTER-2 :-PREFABRICATION

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 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 minister of D. Jose 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 António 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 Rewley Road railway station.

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 they may not be distinguishable from traditionally built units to those that live in them. The technique is also used in office blocks, warehouses and factory buildings. Prefabricated 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 favors 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-supporting 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 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.

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 sections 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 of manufacture are assembled elsewhere instead, before being delivered for final assembly.

The theory behind the method is that time and cost is saved if similar construction tasks can be grouped, and assembly line techniques can be employed in prefabrication at a location where skilled labour is available, while congestion at the assembly site, which 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 environment are avoided. Against these advantages must be weighed the 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.

Types of prefabricated systems

There are two main types of prefabrication, namely volumetric (often referred to as 'modular') and panellised. Both of these types of construction can be achieved 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 what might be produced on site using

components such as timber studs and sheathing. 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 fewer studs and rely in part on the bond between rigid insulation core and outer sheathing materials for strength.

One factor that differentiates 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 formal definition separating the two, the prefabricated panel might include any insulation material, the sheathing boards and possibly some services.

Classification of prefabrication

Classification of prefabricated construction system

Smaller degree Prefabrication: Here the prefabrication is done in the smaller scale. precast brick

Medium degree Prefabrication: Here the prefabrication is done in the moderate scale. Large degree

Prefabrication : Here the prefabrication is done in the large scale.

Advantages

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

2. Deploying resources on-site can add costs; 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. on-site falsework

5. Higher-precision factory tools can aid more controlled movement of building heat and air, for lower energy consumption and healthier buildings

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

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

8. Cranes and reusable factory supports can allow shapes and sequences without expensive

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

10. 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 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 & Laborites)
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 convention method.

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

Large groups of buildings from the same type of prefabricated elements tend to v look drab and monotonous. v Local Jobs are last. The main reasons to choose. Precast Construction method over conventional in situ method.

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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 in 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 first 3 types are mainly classified according to their degree of precastElements 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 position

Medium Prefabrication :
Suppose the roofing systems and horizontal members are provided with pretested elements those construction are known as medium prefabricated construction here th 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 mad walls, mode of transport, vehicles are the factors which prefabrication is to be done on site on factory.

Suppose the factory situated at a long distance from the construction site and the vehicle have to cross a congested traffic with heavy weighed elements the cost in side prefabrication is preferred even though the same condition are the cast in site prefabrication is preferred only when number of houses and more for small elements the conveyance is easier 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 framers 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 costing of horizontal elements (roof / floor) often take their time due to erection of from work the completion of the building is delayed and hence this method is restored. In most of the building sites this method is popular more. Son in industrial buildings where the elements have longer spans. Use of double tees, channel units, cored stabs, 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.

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 prefabrication can be on site or off-site. The choice of these two methods depend on the situations when the factory produced elements are transported and erected site we call if off-site prefabrication. If this method is to be 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 though it is temporary. The choice of the method of construction also depends on the following;

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

Modular coordination

Modular coordination is a concept for coordinating dimensions 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 activities.

Modular co-ordination Grid:

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

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

3. 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.

4. 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 11 ½ inch grid size would be 12 inch because of units were designed to be placed with ½ inch joints.
In modular coordination system, in place of geometric serious, 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 components.

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 SI unit mm tolerance. But it is easier for manufacturer to make in module tolerance system.

Advantages of Modular Coordination:

1. Facilitate cooperation between building designer, manufacturer, 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 coordination between component 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 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.

CHEPTER-3:-EARTHQUAKE RESISTANT CONSTRUCTION

EARTHQUAKE

Earthquake is a natural phenomenon occurring with all uncertainties . During the earthquake, ground motions occur in a random fashion, both horizontally and vertically, in all directions radiating from epicentre . These cause structures to vibrate and induce inertia forces on them.

CLASSIFICATION OF EARTHQUAKE

Slight: Magnitude up to 4.9 on the Richter Scale
Moderate: Magnitude 5.0 to 6.9
High: Magnitude 7.0 to 7.9
Very High: Magnitude 8.0 and above

CAUSES OF EARTHQUAKE DAMAGE

1. Heavy dead weight and very stiff buildings, attracting large seismic inertia forces.
2. Very low tensile and shear strength, particularly with poor mortars.
3. Brittle behaviour in tension as well as compression.
4. Weak connection between wall and wall & roof and wall.
5. Stress concentration at corners of doors and windows.
6. Overall un-symmetry in plan and elevation of the building Un-symmetry due to imbalance in the sizes and positions of openings in the wall.
7. Defects in construction, such as use of substandard materials, unfilled joints between bricks

PRINCIPLE OF EARTHQUAKE-RESISTANT DESIGN

The building shall withstand with almost no damage to moderate earthquake which have probability of occurring several times during life of a building. The building shall not collapse or harm human lives during severe earthquake motions, which have a probability of occurring less than once during the life of the building.
Earthquake-resistant designs typically incorporate ductility (the ability of a building to bend, sway, and deform without collapsing) within the structure and its structural members, Concrete buildings, which are normally brittle (relatively easy to break), can be made ductile by adding steel reinforcement.

RULES FOR BUILDING DESIGN

1. The configuration of the building (Plan and elevation)should be as simple as possible.
2. The formation should generally be based on hard anduniform ground.
3. The members resisting horizontal forces should bearranged so that torsional deformation is not produced.
4. The structure of the building should be dynamically simple and definite.
5. The frame of the building structure should have adequate ductility in addition to required strength.

LATERAL LOAD RESISTING STRUCTURE

Lateral loads are live loads that are applied parallel to the ground; that is, they are horizontal forces acting on a structure. They are different to gravity loads for example which are vertical, downward forces.
The most common types are:

- Wind load.
- Seismic load.
- Water and earth pressure

Different structural systems are introduced depending on the nature of the buildings to resist the lateral loads. out of those methods, the following methods are widely used in buildings.

- Frame
- Bracings
- Shear Walls
- Wall Frame Interaction

Frame

If there is a building, there will be a frame in the structure most of the time. Frame structures exist in the majority of the buildings.Beams and columns connected together create the frame. When the connection of the beam and column is rigid, the frame can transfer the lateral loads to the foundations.Therefore, rigid frames considered as a lateral load resisting system. Beam column frame structure can be used up to 15-20 stories as a lateral load resisting system.

Bracings

Bracings are used mostly in steel structures to improve the lateral load resisting capacity. Further, they are constructed in the concrete buildings also to improve the lateral load resistivity.The following types of bracings are used in steel buildings.

- Single diagonals
- Cross bracings
- K-bracings
- V-bracings

Lateral loads applied by wind, seismic loads, and national loads are resisted by these types of bracings.

Shear Wall

A concrete wall constructed from the based level to the top of the building is considered as a shear wall. It carries the lateral loads and the vertical loads applied by the structural element connected to it. The shear wall along can resist the lateral load of buildings having about 20 stories. Beyond that, the contribution of the frame could also be considered. Shear walls need to the fixed at the base level in order to carry the lateral loads effectively. Stiffness of the shear wall is the key factor affecting the lateral load resistivity of the wall. Length and the width of the wall are the key factors affecting the stiffness of the walls.

Wall Frame Interaction

Shear Wall along can resist the lateral loads up to some extent as discussed above. Beyond a certain level, we need some other supporting method to have the load resisting capacity. Due to the restrictions on the floors, we cannot continue the shear walls as we wish to have the required stiffness. Prime important task of building a structure to have the required services. Therefore, designers have to find alternatives to improve structural capacities. Consideration of the wall frame interaction is one of the best options that we using the inherent capacity of the structural systems. Consideration of this interaction improves the structural capacity significantly than that of considering the shear wall along.

BUILDING CHARACTERISTICS

The points which should be kept in mind while designing and constructing a house, which will be resistant to earthquakes. Try reinforcing these during the process of building right from scratch.

The quality of the soil is important-

Even before you start designing a construction which will be earthquake resistant, the first thing to consider is the soil quality which will be able to withstand the pressure of the earthquake. The soil should have good flexibility and capability.Look for soils which have coarse components like argillaceous sands, sandy gravels and consolidated soils. These soils are usually exposed to compact, hard and natural phenomena and are great for seismic resistant structures. Refrain from soils which are soft, sandy, clayey, loose as these are not appropriate for construction. Also add plastic soils in this list as they tend to lose their mechanical capacity and strength and become deformed after receiving water. As a result, they are in no way suitable for construction. Also refrain from steep slopes, dispersive clays and soils with organic fillings.

Foundation matters-

The foundation of a building is one of the most important things to be kept into consideration, particularly while building a seismic resistant structure. In case there are unsuitable features in the soil, try replacing a section of the soil. Another option is designing special foundations for the structure. With the proper foundation, the structure can transmit the charges and weights to the nearby land and distribute them. This prevents damage to the main building. Preferably the foundation should be made of reinforced steel and concrete.Thereare many structures which require very deep support or where large load needs to be taken by the structure. For such structures, foundations in piles, well or in piles and cylinders are the preferred choices.

Height of the structure-

The numbers of storeys in the building and the height of the building will be a major factor in determining the load that will be borne by the foundation and the soil. Proper calculation should be done in this regard before making the design and planning of the structure

Distribution of load and symmetry

There should be symmetry in the structural designing of the building. This not only helps in proper distribution of the load over the foundation but also helps in maintaining a constant balance.

Structural design

Structures should have the capacity of withstanding dynamic as well as static forces and be flexible enough to absorb them easily. This is applicable right from the foundation to enclosures, from load walls to delays etc. Buildings that lack flexibility and are rigid have high chances of breaking and cracking during earthquakes. It is also important to have greater numbers of structural elements right at the base, on the first floor, on columns and girders, etc.

Quality of building materials

The quality of building materials used in the construction of the structure is an important thing to consider for establishing strength and toughness in a building. Materials which are certified help in absorbing the energy generated during an earthquake and prevent damage to the building in the best manner. The ideal combination is use of reinforced steel with concrete.

Maintenance post construction

After the construction of the structure, it is important that it should be maintained and taken care of well. After an earthquake, it is possible to understand how well the structure has been maintained. Maintenance includes things like reinforcement of columns and gutters in case of detachments and separations, checking deck slabs, insulation restoration in walls, roofs and foundations, checking internal and external leakages etc.

IRREGULARITIES IN A BUILDING

Irregularities are categorized in two types

- Vertical irregularities - referring to sudden change to strength, stiffness, geometry and mass results in irregular distribution of forces and deformation over the height of building
- Horizontal irregularities - which refer to asymmetrical plan shapes or discontinuities in the horizontal resisting elements such as large openings, re-entrant corners and abrupt changes resulting in torsion, diaphragm deformation

Vertical Irregularities are mainly of five types:

1. Stiffness Irregularity –

a. Soft Story- A soft story is one in which the lateral stiffness is less than 70 per-cent of the story above or less than 80 per-cent of the average lateral stiffness of the three stories above.

b. Extreme Soft Story- It is one in which the lateral stiffness is less than 60 per-cent of that in the story above or less than 70 per-cent of the average stiffness of the three Story's above.

2. Mass Irregularity- When the weight of any story is more than 200 percent of the adjacent story,then it considered as mass irregularity.
3. Vertical Geometric Irregularity- A structure is considered to be Vertical geometric irregular when the horizontal dimension of the lateral force resisting system in any story is more than 150 percent of that in its adjacent story.
4. In-Plane Discontinuity in Vertical Elements Resisting Lateral Force-An in-plane offset of the lateral force resisting elements greater than the length of those elements.
5. Discontinuity in Capacity-Weak Story-A weak story is one in which the story lateral strength is less than 80 per-cent of that in the story above.

ALTERNATION OF EXISTING BUILDING

An addition is adding to an existing building and alteration is a change to an existing building.An alteration is defined as a limited construction project for an existing building that comprises the modification or replacement of one or a number of existing building systems or components. Alterations are less than total building modernizations. Renovation refers to the process carried out to upgrade an existing structure to improve performance by either altering the scope of structure, providing additional facilities or improving existing facilities.Event to modify existing buildings are usually referred as alterations and additions .Examples of alterations and additions works are:

- constructing a new extension block to an existing building;
- adding floors to an existing building, whether on the top or not;
- constructing a swimming pool;
- linking two or more floors by removal of parts of the floor slab and/or adding internal staircases;

Three fundamental methods of renovation are distinguished in practice, as well as in the field of an investigation:
1. The reinforcement of damaged parts,
2. The strengthening of weakened constructional wholes,
3. The replacement of damaged components.

These repairs involve on structure:

- Patching up of defects such as cracks and fall of plaster;
- Repairing doors, windows, replacement of glass panels;
- Checking and repairing electric conduits/ wiring;
- Checking and repairing gas pipes, water pipes and plumbingservices;
- Re-building non-structural walls, smoke chimneys, parapet walls, etc;
- Re-plastering of walls as required;
- Rearranging disturbed roofing tiles;
- Relaying cracked flooring at ground level;
- Redecoration — whitewashing, painting, etc.

strengthening measurements
corner reinforcement-

Corner reinforcement are also called as torsional reinforcement. Torsional reinforcement shall be provided at corner of two way slab. The torsional moment are high near the corner therefore, torsional reinforcement is essential to prevent corner slab from lifting and prevents cracks.
For earthquake safety in seismic zone V reinforcing bars have to be embedded in brick masonry at the comers of all the rooms and the side of the door openings. Window openings larger than 60 cm in width will also need such reinforcing bars . The diameter of the bar depends upon the number of storey in the building. The recommendations are given in Table-2. Providing the vertical bars in the brickwork and concrete blocks requires special techniques which could be easily learnt by the supervising engineers and masons will need to be trained. These vertical bars have to be started from the foundation concrete, will pass through all seismic bands where they will be tied to the band reinforcements using binding wire and embedded to the ceiling band/roof slab as the case may be using a 300 mm 90° bend. Sometimes the vertical bars will not be made in one full length. In that case the extension of the vertical reinforcement bars are required, an overlap of minimum of 50 times the bar diameter should be provided. The two overlapped reinforcement bars should be tied together by using the binding wires.

Lintel Band-

As the name tells these are horizontal bands provided at the lintel level. And it is provided in almost all buildings. Under the action of earthquake ground motion, the lintel band is subjected to constant bending as well as pulling Hence the construction of lintel band has to done with special care and supervision.
During earthquake shaking, the lintel band undergoes bending and pulling actions . To resist these actions, the construction of lintel band requires special attention. Bands can be made of wood (including bamboo splits) or of reinforced concrete (RC) ; the RC bands are the best. The straight lengths of the band must be properly connected at the wall corners. This will allow the band to support walls loaded in their weak direction by walls loaded in their strong direction. Small lengths of wood spacers (in wooden bands) or steel links (in RC bands) are used to make the straight lengths of wood runners or steel bars act together. In wooden bands, proper nailing of straight lengths with spacers is important. Likewise, in RC bands, adequate anchoring of steel links with steel bars is necessary.

Sill band-

Basically sill is known as the horizontal bed of the mortar which is usually as wide as the wall provided below windows or other openings. Therefore sill supports the windows. And lintel is made up of reinforced concrete or cement mortar . Therefore lintel support the wall above the openings

Plinth Band
This type of horizontal bands is essential in those areas where the soil on which the building has to be constructed is weak. The soil will be soft with uneven properties. This problem is mainly found

in soils found in hilly areas. This band is hence not necessary if we have a stronger soil and substructure.

roof band-

These bands are mainly employed in buildings with roofs made of flat timber or CGI sheets. If the building roof is made of reinforced concrete slabs or brick roofs as mentioned before, there is no need of these bands. As R.C slabs itself behave as a horizontal band.

Gable Band-

Those buildings that have sloped roof i.e. truss construction, gable bands are necessary. Now the incorporation of Gable band is not shown in the figure as the building have a flat roof. When the roof construction is by using a truss, the requirement of gable band comes into play.
The recommendations on the design of horizontal bands are provided by IS:4326-1996 Code of practice. This is applicable for the buildings from brick or concrete block walls and also those with RC flat slab roofs. The dimension of the horizontal band and the reinforcement details depend upon the length of the walls which is between the perpendicular cross walls. The details of the dimension of the band and its reinforcement details with respect to the wall thickness for buildings with different functionality is shown in table-1. These recommendations are for buildings located in Zone 5, as per Indian code

Internal length of wall	**Buildings of all types i.e., Residential buildings & Public Buildings** (Schools, Hospitals, Meeting Halls, Anganwadis, etc.)		
	Size of the band	No. of Bars	Dia (mm)
5 m or, less	10 cm x wall width	2	10
6 m	10 cm x wall width	2	12
7 m	15 cm x wall width	4	10
8 m	15 cm x wall width	4	12

CHEPTER-4:- Retrofitting of Structures

Retrofitting

Retrofitting is the process by which we add new features to existing structures, such as heritage sites, older buildings, and bridges, etc. Retrofitting helps in reducing the vulnerability of damage to an existing structure in case of any natural disaster or seismic activity.

Retrofitting is described as the procedure of change of existing structures such as Residential buildings, bridges, and historical buildings to make them impervious against seismic action like Earthquakes, Volcanic Eruptions, and other natural disasters that include landslides, tsunamis, floods, thunderstorms. Retrofitting of RCC structural members is done so that the deteriorated concrete element structure regains its strength. It also helps to prevent further distress in concrete elements.

The deficiency in the strength of the concrete element could be because of design errors or poor workmanship. There could be another reason too for the deterioration such as the aggression of harmful agents. Once the proper technique of retrofitting is implemented and specified, the required capacity to the structure could be regained and it totally depends on the severity of the damage caused.

There are various techniques that are used in the process of retrofitting such as external plate bonding, grouting, external post-tensioning, section enlargement, and fibre reinforced polymer composites.

The need for strengthening and repair of buildings and engineering works might arise once they are broken in such a way that they are not appropriate for general use. In such cases, The structure cannot afford, with accepted reliability, a further sequence of the same action or other accidental actions and consequently, the chance of lives and therefore the risk of any structural and content damage would be unacceptable. A strengthening change that can regain a sufficient level of safety and protection against such actions is described as retrofitting.

Purpose of Retrofitting

As time passes many environmental factors going on around impact the structure. Out of all these factors, the most damaging is an earthquake that disturbs the internal structure of the building, and thus gradually building starts losing its strength and stability. As a result, the structure becomes unsafe for future use and might cause massive loss.
The level of deterioration caused to the concrete element structure is occurring at an alarming rate. It has been confirmed that even if all the specific building code is followed still there is a high risk of deterioration of concrete element and corrosion of reinforcement.

Steel corrosion is considered as one of the severe cause behind the deterioration of reinforced concrete element and this could create cracks or reduce the effective area of the reinforcement, spalls the concrete cover, and might lead to collapse.
There are a variety of cases when dealing with damages. In case of any private or public sector like any office or house if the structure is damaged to an extreme level. Civil Engineers prefer demolishing the building and reconstruct it. But in the case of important and heritage buildings demolishing them is not an option. Now, here comes the phenomenon of Retrofitting.

Retrofitting has come to the frontline as a component of the drive to make structures warmer proficient and practical. This can help cut fossil fuel byproducts, make it less expensive and simpler to run structures, and can add to beating helpless ventilation and moist issues, therefore improving the whole situation. It can likewise expand building versatility, solidness, and flexibility.

Importance of Retrofitting

Presently a-days retrofitting is extending its legs on the planet out of control, as a considerable lot of the recorded, public, and private significant designs get genuine old and become feeble because of passing time. Retrofitting is perhaps the most ideal alternative to make an existing lacking structure protected against future dangers or other natural powers.

Retrofitting is the cycle of expansion of new highlights to more established structures, legacy structures, spans, and so on Retrofitting diminishes the weakness of harm of an existing design during a not-so-distant future seismic movement.

It is the alteration of existing designs to make them more impervious to seismic activity, movement of the ground, and disappointment of soil because of seismic tremors or other characteristic cataclysms, for example, twisters, typhoons, and winds with high velocity caused by tempest, snowfall, hailstorms.

A few designs are significant considering public, social, or past significance. Retrofitting serves to enhance strength, resistivity.

Objective to Retrofitting of Structure:

The basic objective behind retrofitting or repair works is to extend the service life, enhance the performance of the structure or increase the load-bearing capacity. The rational approach to any retrofitting work is to keep into consideration the main cause of the deterioration along with the symptoms. Only treating the symptoms without proper understanding of the main cause of the problems leads to camouflaged defects identification beneath the finished work. It is said that repair of the retrofitting work should be avoided and for that, we need to follow the below-mentioned steps.

- Preparation of drawings and specifications
- Condition Evaluation
- Selection of materials and repair methods
- Determination of the main cause behind the deterioration
- Execution process
- Maintenance after completion of the retrofitting work
- Appropriate quality control measures

Problems that needs to be addressed

- Evaluation models and damage assessment
- Design and analysis of suitable repair methods and techniques
- Bridge rehabilitation

- Seismic retrofitting
- Strengthening and refurbishment techniques
- Materials for repair, protection, and rehabilitation
- Durability Considerations
- Performance monitoring and distress diagnostics, Non- Destructive test
- Structural Condition assessment

The two important methods of retrofitting that are carried out to improve concrete element structures are Strengthening of structural components and Surface repairs.

Under the Strengthening of the structural components, enlargement and composite construction is done whereas in Surface repairs spalling and disintegration along with the work to repair cracks is done.

Types and techniques of retrofitting

1. Sealing with Epoxies
2. Stitching
3. Blanketing
4. Routing and Sealing
5. External Stressing
6. Autogenous Healing
7. Overlays
8. Grouting

Sealing with Epoxies: Cracks in the concrete element could be sealed with the help of epoxy by injecting them with pressure.

Stitching: With the help of iron or steel dogs a cracked concrete part could be retrofitted by stitching in the same manner as we stitch clothes.

Blanketing: This technique of retrofitting is used on a large scale to seal the dormant as well as active cracks.

Routing and Sealing: Under this method of retrofitting the cracks along the affected surfaces are first enlarged and then a suitable material is used to seal them and fill them up such as Hot-Tar used on road pavements.

External Stressing: This process of retrofitting involves the process of counteracting the stress due to which the crack has been caused. It provides a residual compression and overcomes the tension, applied using rods and pressing wires.

Autogenous Healing: The unique ability of concrete elements to heal cracks by itself is known as Autogenous Healing. Basically used to seal dormant cracks such as cracks in water tanks or cracks caused due to temporary loading.

Overlays: These are types of retrofitting used to improve load-bearing capacity, drainage, rideability or to protect underlying concrete elements from aggressive environments.
Grouting: This process of retrofitting is similar to that of sealing with epoxies. It is basically a mortar paste that is mixed with adhesives to help increase the bonding properties.
There are two major strategies behind the retrofitting of structures, the first one is active strengthening and the second one is passive strengthening.

Active strengthening is a situation when additional deformation is not used and the repair done should be ready for immediate use. In the case of passive strengthening, the repair work does not share a load by the time an additional load is applied.

Types of Retrofitting

There are following two types of retrofitting:

1. **Local Retrofitting**
- Jacketing of beams
- jacketing of beam-column joints
- Strengthening individual footings
- Jacketing of Columns

2. **Global Retrofitting**
- Adding shear wall
- Adding infill wall
- Mass Reduction
- Wall Thickening
- Adding Braces

Reinforced Concrete Structures

Two important methods that can be carried on improving concrete structures are these: –

- Adding New Structural Elements
- Strengthening Existing Elements

Masonry Structure

Other methods include Retrofitting through roofs, doors, and windows.

Advantages of Retrofitting

1. Increases the life of the building.
2. Is economical.
3. It is pocket friendly
4. Helps in increasing stability and sustainability
5. Prepares the building to bear different weather conditions
6. Helps in strengthening and enhancement of the structure.

Disadvantages of Retrofitting

1. Small irresponsibility can cause further damage.
2. Chances are that it can damage historical buildings.
3. Need critical and expert analysis before Retrofitting.
4. Requires expert analysis before proceeding to retrofit
5. High risk of causing damage to Heritage Sites
6. Normal negligence could cause major damage
7. Manpower involved needs to be of good expertise.

TRADITIONAL METHODS OF SEISMIC RETROFITTING

Traditional methods of seismic retrofitting fall essentially into two categories, one based on the classical principles of structural design which requires an increase of strength and stiffness, and the other based on mass reduction. Thus the first one tends to satisfy the design inequality by an increase of the capacity while the second one achieves the same result by a reduction of the demand. Since seismic design is different from ordinary design, both techniques may turn out to be quite ineffective.

INNOVATIVE APPROACHES TO SEISMIC RETROFITTING

The main innovative methods of seismic retrofitting may be grouped into the following classes:
Stiffness reduction

- Ductility increase
- Damage controlled structures
- Composite materials
- Any suitable combination of the above methods
- Active control

For equal mass the ‘stiffness reduction’ produces a period elongation and a consequent reduction of the seismic action and therefore of the seismic strength demand. The stiffness reduction may be achieved by the principle of springs in series whereby the equivalent stiffness of two springs in series is smaller than either of the single springs . In general it may be assumed that base isolation is a special case of the stiffness reduction approach.

Cold & Hot Water Distribution In High Rise Building

Hot and Cold Water Main Lines

The hot and cold water main lines are usually hung from the basement ceiling or in the crawl space of the home and are attached to the water meter and hot water tank on one side and the fixture supply risers on the other. These pipes should be installed neatly and should be supported by pipe hangers or straps of sufficient strength and number to prevent sagging. Older homes that have copper pipe with soldered pipes can pose a lead poisoning risk, particularly to children. The water should be tested to determine the presence or level of lead in the water. Until such tests can be conducted, the water should be run for about 2 minutes in the morning to flush any such material from the line. Hot and cold water lines should be approximately 6 inches apart unless the hot water line is insulated. This is to ensure that the cold water line does not pick up heat from the hot water line.

The supply mains should have a drain valve stop and waste valve to remove water from the system for repairs. These valves should be on the low end of the line or on the end of each fixture riser.
The fixture risers start at the basement main and rise vertically to the fixtures on the upper floors. In a one-family dwelling, riser branches will usually proceed from the main riser to each fixture grouping. In any event, the fixture risers should not depend on the branch risers for support, but should be supported with a pipe bracket.

The size of basement mains and risers depends on the number of fixtures supplied. However, a ¾-inch pipe is usually the minimum size used. This allows for deposits on the pipe due to hardness in the water and will usually give satisfactory volume and pressure.

In homes without basements, the water lines are preferably located in the crawl space or under the slab. The water lines are sometimes placed in the attic; however, because of freezing, condensation, or leaks, this placement can result in major water damage to the home. In two-story or multistory homes, the water line placement for the second floor is typically between the studs and, then, for the shortest distance to the fixture, between the joists of the upper floors.

Hot and Cold Water Piping Materials

Care must be taken when choosing the piping materials. Some state and local plumbing codes prohibit using some of the materials listed below in water distribution systems.

Polyvinyl Chloride (PVC).- PVC is used to make plastic pipe. PVC piping has several applications in and around homes such as in underground sprinkler systems, piping for swimming pool pumping systems, and low-pressure drain systems PVC piping is also used for water service between the meter and building . PVC, or polyvinyl chloride, is one of the most commonly used materials in the marketplace. It is in packaging, construction and automotive material, toys, and medical equipment.

Chlorinated PVC.- CPVC is a slightly yellow plastic pipe used inside homes. It has a long service life, but is not quite as tough as copper. Some areas with corrosive water will benefit by using chlorinated PVC piping. CPVC piping is designed and recommended for use in hot and cold potable water distribution systems.

Copper.- Copper comes in three grades:

- M for thin wall pipe (used mainly inside homes);
- L for thicker wall pipe (used mainly outside for water services); and
- K, the thickest (used mainly between water mains and the water meter).

Copper lasts a long time, is durable, and connects well to valves. It should not be installed if the water has a pH of 6.5 or less. Most public utilities supply water at a pH between 7.2 and 8.0. Many utilities that have source water with a pH below 6.5 treat the water to raise the pH. Private well water systems often have a pH below 6.5. When this is the case, installing a treatment system to make the water less acidic is a good idea.

Galvanized Steel.- Galvanized pipe corrodes rather easily. The typical life of this piping is about 40 years. One of the primary problems with galvanized steel is that, in saturated water, the pipe will become severely restricted by corrosion that eventually fills the pipe completely. Another problem is that the mismatch of metals between the brass valves and the steel results in corrosion. Whenever steel pipe meets copper or brass, the steel pipe will rapidly corrode. Dielectric unions can be used between copper and steel pipes; however, these unions will close off flow in a short time. The problem with dielectric unions is that they break the grounding effect if a live electrical wire comes in contact with a pipe. Some cities require the two pipes to be bonded electrically to maintain the safety of grounded pipes.

PEX. -PEX is an acronym for a cross-formulated polyethylene. "PE" refers to the raw material used to make PEX (polyethylene), and "X" refers to the cross-linking of the polyethylene across its molecular chains. The molecular chains are linked into a three-dimensional network that makes PEX remarkably durable within a wide range of temperatures, pressures, and chemicals.

PEX is flexible and can be installed with fewer fittings than rigid plumbing systems. It is a good choice for repiping and for new homes and works well for corrosive water conditions. PEX stretches to accommodate the expansion of freezing water and then returns to its original size when water thaws. Although it is highly freeze-resistant, no material is freeze-proof.

Kitec.- Kitec is a multipurpose pressure pipe that uniquely unites the advantages of both metal and plastic. It is made of an aluminum tube laminated to interior and exterior layers of plastic. Kitec provides a composite piping system for a wide range of applications, often beyond the scope of metal or plastic alone. Unlike copper and steel materials, Kitec is noncorroding and resists most acids, salt solutions, alkalis, fats, and oils.

Poly.- Poly pipe is a soft plastic pipe that comes in coils and is used for cold water. It can crack with age or wear through from rocks. Other weak points can be the stainless steel clamps or galvanized couplings.

Polybutylene.- Polybutylene pipe is a soft plastic pipe. This material is no longer recommended because of early chemical breakdown. Individuals with a house, mobile home, or other structure that has polybutylene piping with acetal plastic fittings may be eligible for financial relief if they have replaced that plumbing system.

Hot Water Safety-

In the United States, more than 112,000 people enter a hospital emergency room each year with scald burns. Of these, 6,700 (6%), have to be hospitalized. Almost 3,000 of these scald burns come from tap water in the home. The three high risk groups are children under the age of 5 years, the handicapped, and adults over the age of 65 years. It only takes 1 second to get a serious third-degree burn from water that is 156ºF (69ºC). Tap water is too hot if instant coffee granules melt in it.

Young children, some handicapped individuals, and elderly people are particularly vulnerable to tap water burns. Children cannot always tell the hot water faucets from the cold water faucets. Children have delicate skin and often cannot get out of hot water quickly, so they suffer hot water burns most frequently. Elderly and handicapped persons are less agile and more prone to falls in the bath tub. They also may have diseases, such as diabetes, that make them unable to feel heat in some regions of the body, such as the hands and feet. Third-degree burns can occur quickly—in 1 second at 156ºF (69ºC), in 2 seconds at 149ºF (65ºC), in 5 seconds at 140ºF (60ºC), and in 15 seconds at 133ºF (56ºC).

A tap-water temperature of 120ºF–130ºF (49ºC–54ºC) is hot enough for washing clothes, bedding, and dishes. Even at 130ºF (54ºC), water takes only a few minutes of constant contact to produce a third-degree burn. Few people bathe at temperatures above 110ºF (43ºC), nor should they. Water heater thermostats should be set at about 120ºF (49ºC) for safety and to save 18% of the energy used at 140ºF (60ºC). Antiscald devices for faucets and showerheads to regulate water temperature can help prevent burns. A plumber should install and calibrate these devices. Most hot water tank installations now require an expansion tank to reduce pressure fluctuations and a heat trap to keep hot water from escaping up pipes.

Types of Water Flow Controls

It is essential that valves be used in a water system to allow the system to be controlled in a safe and efficient manner. The number, type, and size of valves required will depend on the size and complexity of the system. Most valves can be purchased in sizes and types to match the pipe sizes used in water system installations. Listed below are some of the more commonly encountered valves with a description of their basic functions.

Shutoff Valves. Shutoff valves should be installed between the pump and the pressure tank and between the pressure tank and service entry to a building. Globe, gate, and ball valves are common shutoff valves. Gate and ball valves cause less friction loss than do globe valves; ball valves last longer and leak less than do gate valves. Shutoff valves allow servicing of parts of the system without draining the entire system.

Flow-control Valves. Flow-control valves provide uniform flow at varying pressures. They are sometimes needed to regulate or limit the use of water because of limited water flow from low-yielding wells or an inadequate pumping system. They also may be needed with some treatment equipment. These valves are often used to limit flow to a fixture. Orifices, mechanical valves, or diaphragm valves are used to restrict the flow to any one service line or complete system and to assure a minimum flow rate to all outlets.

Relief Valves. Relief valves permit water or air to escape from the system to relieve excess pressure. They are spring-controlled and are usually adjustable to relieve varying pressures, generally above 60 psi. Relief valves should be installed in systems that may develop pressures exceeding the rated limits of the pressure tank or distribution system. Positive displacement and submersible pumps and water heaters can develop these excessive pressures. The relief valve should be installed between the pump and the first shutoff valve and must be capable of discharging the flow rate of the pump. A combined pressure and temperature relief valve is needed on all water heaters. Combination pressure and vacuum relief valves also should be installed to prevent vacuum damage to the system.

Pressure-reducing Valves. A pressure-reducing valve is used to reduce line pressure. On main lines, this allows the use of thinner walled pipe and protects house plumbing. Sometimes these valves are installed on individual services to protect plumbing.

Altitude Valves. Often an altitude valve is installed at the base of a hot water tank to prevent it from overflowing. Altitude valves sense the tank level through a pressure line to the tank. An adjustable spring allows setting the level so that the valve closes and prevents more inflow when the tank becomes full.

Foot Valves. A foot valve is a special type of check valve installed at the end of a suction pipe or below the jet in a well to prevent backflow and loss of prime. The valve should be of good quality and cause little friction loss.

Check Valves. Check valves have a function similar to foot valves. They permit water flow in only one direction through a pipe. A submersible pump may use several check valves. One is located at the top of the pump to prevent backflow from causing back spin of the impellers. Some systems use another check valve and a snifter valve. They will be in the drop pipe or pitless unit in the well casing and allow a weep hole located between the two valves to drain part of the pipe. When the pump is started, it will force the air from the drained part of the pipe into the pressure tank, thus recharging the pressure tank.

Frost-proof Faucets. Frost-proof faucets are installed outside a house with the shutoff valve extending into the heated house to prevent freezing. After each use, the water between the valve and outlet drains, provided the hose is disconnected, so water is not left to freeze.

Frost-proof Hydrants. Frost-proof hydrants make outdoor water service possible during cold weather without the danger of freezing. The shutoff valve is buried below the frost line. To avoid submerging it, which might result in contamination and back siphoning, the stop-and-waste valve must drain freely into a rock bed. These hydrants are sometimes prohibited by local or state health authorities.

Float Valves. Float valves respond to a high water level to close an inlet pipe, as in a tank-type toilet.

Miscellaneous Switches. Float switches respond to a high and/or low water level as with an intermediate storage tank. Pressure switches with a low-pressure cutoff stop the pump motor if the line pressure drops to the cutoff point. Low-flow cutoff switches are used with submersible pumps to stop the pump if the water discharge falls below a predetermined minimum operating pressure. High-pressure cut-off switches are used to stop pumps if the system pressure rises above a predetermined maximum. Paddle-type flow switches detect flow by means of a paddle placed in the pipe that operates a mechanical switch when flow in the pipe pushes the paddle.

The inadvertent contamination of a public water supply as a result of incorrectly installing plumbing fixtures is a potential public health problem in all communities. Continuous surveillance by environmental health personnel is necessary to know whether such public health hazards have developed as a result of additions or alterations to an approved system. All environmental health specialists should learn to recognize the three general types of defects found in potable water supply systems: backflow, back siphonage, and overhead leakage into open potable water containers. If identified, these conditions should be corrected immediately to prevent the spread of disease or poisoning from high concentrations of organic or inorganic chemicals in the water.

TYPES OF WASTE WATER

YELLOW WATER: This is basically urine collected with specific channels and not contaminated with either blackwater or graywater.

GRAY WATER: Origin- non-toilet and food fixtures (i.e. bathroom sinks, laundry machines, spas, bathtubs and so on. Technically it is sewage that does not contain human excreta. Graywater is treated very differently from Blackwater and is usually suitable for re-use.

BLACK WATER: Origin- toilet fixtures, dishwashers, and food preparation sinks It includes human excreta, toilet paper and wipes; body cleaning liquids, anal cleansing water and so on. They are known to be highly contaminated with dissolved chemicals, particulate matter and is very pathogenic.

SOURCES OF WASTE WATER

NON- SEWAGE: These include water from floods (stormwater), runoff (rainwater running through cracks in the ground and into gutters), water from swimming pools, water from car garages and cleaning centers. They also include laundromats, beauty salons, commercial kitchens, energy generation plants and so on.

DOMESTIC SEWAGE: This includes all wastewater generated by home dwellings, public restrooms, hotels, restaurants, motels, resorts, schools, places of worship, sports stadiums, hospitals and other health centers, apartments and the like. They all produce high volumes of wastewater. For residential buildings, water requirement per head per day: 135 litres (90 litres for domestic purposes and rest 45 litres comes under flushing requirements.

HOUSE DRAINAGE-

The arrangemnet provided in a house or building, for collecting and conveying waste water through drain pipes, by gravity, to join either a public sewer or a domestic septic tank, is termed as house drainage or building drainage.

AIMS OF HOUSE DRAINAGE

To collect and remove waste matters systematically.
To facilitate quick removal of foul matter (e.g. human excreta).
To avoid the entry of foul gases from the sewer or the septic tank.
To dispose off waste water as early and quickly as possible.
To maintain healthy conditions in the building.

PRINCIPLES OF HOUSE DRAINAGE

• House Drainage should be preferable laid by side of the building to facilitate easy repair and better maintenance.
• House sewer joints should be leek proof because any leekage shall create an odour problem and leaked wastewater shall infilterate in the ground and shall reduce bearing capacity of soil below foundation, which is not desirable.
• The sewage or sullage should flow under the force of gravity.
• The house sewer should always be straight.
• The entire system should be well ventilated from start to the end.
• The house sewer should be connected to the manhole such that the invert level is sufficiently higher to avoid back flow of sewage in house sewer.
• Where ever there is change in direction of sewer line in the premises, provide inspection chamber at the junction.
• Rain water from roofs or open courtyards should not be allowed to flow through the house sewers.
• Siphonage action can never be permitted and therefore adequate ventilation systems should be installed.

TYPES OF PIPES

• Soil Pipe: Pipe through which human excreta flows.
• Waste Pipe: Pipe which carries only the liquid waste & does not carry human excreta.
• Vent Pipe: Pipe which is provided for the purpose of the ventilation of the system. A vent pipe is open at top and bottom, to facilitate exit of foul gases. It is carried at least 1 m higher than the roof level.
• Rain Water Pipe: Pipe which carries only the rain water.
• Anti-siphonage Pipe: Pipe which is installed in the house drainage to preserve the water seal of traps. Type Size (in mm) Soil Pipe 100 Waste Pipe (horizontal) 30 - 50 Waste Pipe (Vertical) 75 Vent Pipe 50 Rain water pipe 75 Anti-siphonage pipe 50

TRAPS AND THEIR TYPES

• A trap is depressed or bent fitting that, when provided in a drainage system, always remains full of water, thus maintaining water seal.
• It prevents the passage of foul air or gas through it, though it allows the sewage or waste water to flow through it.
• The depth of water seal is the vertical distance between the crown and dip of a trap. The depth of water seal represents its strength or effectiveness.
• Greater the depth of water seal more effective is the trap. The depth of water seal varies from 25mm to 75mm.
• According to Use:
• Floor trap (Nahani trap)
• Gully trap • Intercepting trap
• Grease and oil traps
• Silt traps

According to Shape:

• P trap
• Q trap
• S trap

ONE PIPE SYSTEM

• A Separate vent p i p e is provided in this system. It is clear from the study of sketch that in comparision to single stack system:
• This system is costly and difficult to construct
• Ventilation is provided to sullage pipe and soil pipe too.
• Arrangement of pipe work is difficult.

TWO PIPE SYSTEM

• Following are the features of this system.
• Water closets, bath traps, kitchen traps and wash basin traps all are connected to vent pipes.
• Separate soil pipe and waste pipes are provided.
• Two vent pipes are provided.
• There are four stakes in this system
• It is efficient system but costlier than other systems.

SINGLE STACK SYSTEM

• From the figure it is clear that only single pipe acts as soil pipe waste pipe and ventilation pipe.
• This is poorly ventilated system
• It is simple system and easy to construct.
• Risk of water seal breaking in the trap is high because of induced siponage.
• Waste or air of the waste pipe may be forced up due to back pressure.

Electrical Wiring

Electrical Wiring is a process of connecting cables and wires to the related devices such as fuse, switches, sockets, lights, fans etc to the main distribution board is a specific structure to the utility pole for continues power supply.

Methods of Electrical Wiring Systems

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

- Joint box system or Tee system
- Loop – in system

Different Types of Electrical Wiring Systems

The types of internal wiring usually used are

- Cleat wiring
- Wooden casing and capping wiring
- CTS or TRS or PVC sheath wiring
- Lead sheathed or metal sheathed wiring
- Conduit wiring

There are additional types of conduit wiring according to Pipes installation (Where steel and PVC pipes are used for wiring connection and installation).

- Surface or open Conduit type
- Recessed or concealed or underground type Conduit

Ventilation

Ventilation is the intentional introduction of outdoor air into a space. Ventilation is mainly used to control indoor air quality by diluting and displacing indoor pollutants; it can also be used to control indoor

temperature, humidity, and air motion to benefit thermal comfort, satisfaction with other aspects of indoor environment, or other objectives.

The intentional introduction of outdoor air is usually categorized as either mechanical ventilation, natural ventilation, or mixed-mode ventilation (hybrid ventilation).

- **Mechanical ventilation** – It is the intentional fan driven flow of outdoor air into a building. Mechanical ventilation systems may include supply fans (which push outdoor air into a building), exhaust fans (which draw air out of building and thereby cause equal ventilation flow into a building), or a combination of both. Mechanical ventilation is often provided by equipment that is also used to heat and cool a space.
- **Natural ventilation**- It is the intentional passive flow of outdoor air into a building through planned openings (such as louvers, doors, and windows). Natural ventilation does not require mechanical systems to move outdoor air. Instead, it relies entirely on passive physical phenomena, such as wind pressure, or the stack effect. Natural ventilation openings may be fixed, or adjustable. Adjustable openings may be controlled automatically (automated), controlled by occupants (operable), or a combination of both.
- **Mixed-mode ventilation systems** – It uses in both mechanical and natural processes. The mechanical and natural components may be used at the same time, or at different times of day, or in different seasons of the year. Since natural ventilation flow depends on environmental conditions, it may not always provide an appropriate amount of ventilation. In this case, mechanical systems may be used to supplement or regulate the naturally driven flow.

CHEPTER-6:- CONSTRUCTION AND EARTH MOVING EQUIPMENTS

PROPER PLANNING

Modern highway construction projects are complex in nature and success of a project depends greatly on proper and scientific planning. Before starting any project its planning is done with great care, as the efficiency of the whole project largely depends upon its planning. While planning each and every detail should be worked out in anticipation and should be considered carefully. Planning of a construction project involves deciding about the extent of mechanization, equipment planning, and execution planning etc. while planning a highway project equipment manager should be carefully decided the extent of mechanization so as to minimize the cost of project.

SELECTION

Proper selection of equipment for a highway construction project is of vital importance for its speedy and economical completion. Problem of equipment selection has become more complicated, because large variety of equipments are being manufactured now-a-days. For selection of equipment, a considerable experience in the operation and maintenance in the field is essential. Records kept for operation, maintenance and actual output obtained under comparable conditions of previous projects will greatly help in taking decision for equipment selection. With the undertaking of new projects and the retirement of old machinery and equipment, it becomes necessary to acquire new construction equipment. In this stage, sufficient knowledge base of current brands and products is necessary. It is also important to determine what sort of equipment and capacity is needed.

Dragline excavator

Dragline excavator is used for civil engineering projects and surface mining. Dragline is the largest equipment ever built on this planet. It has the ability to excavate very deep down the earth. Word drag is used because it has the ability to drag material at far distance from the machine. Dragline consists of drag rope, large bucket, boom, hoist rope and driving motors. A large bucket is attached with dragline boom (it is truss like structure). Bucket is controlled with the help of number of ropes and chains. There are two separate function ropes are attached with bucket.

These are;

1. Hoist rope
2. Drag rope

Hoist rope is controlled with the help of electric motor and it supports the hoist-coupler assembly and the bucket from the boom. The second one i.e., drag rope is used for drawing of bucket horizontally towards the machine.

Uses Of Dragline

Dragline is used for;

1. Road excavation
2. Deep down pile driving
3. Construction of ports, harbor etc.
4. Surface mining
5. Deep down excavation
6. Under water excavation

TYPES OF DRAGLINE

There are three types of dragline;

1. Wheel mounted dragline
2. Crawler type dragline
3. Truck mounted dragline/portable dragline.

TRACTOR

A tractor is a versatile earth moving equipment that finds many uses at a construction site. While its primary purpose is to pull or push loads, it is also used as a mount for many types of accessories, such as front-end shovels, bulldozers and others. There are types and sizes to fit almost any job for which they are usable.

Types of Tractors

Tractors may be divided into two major types: Crawler Tractors and Wheel Tractors.

Crawler Tractor

Crawler tractors are usually rated by size or weight and power. The weight is important on many projects because the maximum tractive effort that a unit can provide is limited to the product of weight times the coefficient of traction for the unit and the particular road surface, regardless of the power supplied by the engine.

Wheel Tractor

Wheel tractors are either two-wheel or four-wheel. One of the primary advantages of a wheel tractor compared with a crawler tractor is the higher speed that may exceed (50 km/hr). However, in order to attain a higher speed, a wheel tractor must sacrifice pulling effort.

Difference between Wheel and Crawler Tractors

Wheel Tractors	Crawler Tractors
1. It can travel fast	1. Travel slowly
2. Not more powerful and hence used for light duty jobs.	2. Very powerful and hence used for powerful jobs.
3. Less costly	3. Costly due to use of chains
4. Less operation and maintenance cost	4. More operation and maintenance cost
5. Require less skill for their operation because of wheels.	5. Requires more skill for their operation
6. Can be used for roads or pavements.	6. Used for rough ground conditions
7. Self-driven for longer distance hence transportation is easy.	7. Transportation for longer distance required with trailers.
8. Does not have better stability during working	8. Does have better stability during working.

BULLDOZER

The bulldozer is a very powerful crawler that is equipped with a blade. The term bulldozer is often used to mean any type of heavy machinery, although the term actually refers to a tractor that is fitted with a dozer blade. Often times, bulldozers are large and extremely powerful tracked vehicles. The tracks give them amazing ground mobility and hold through very rough terrain. Wide tracks on the other hand, help to distribute the weight of the dozer over large areas, therefore preventing it from sinking into sandy or muddy ground.

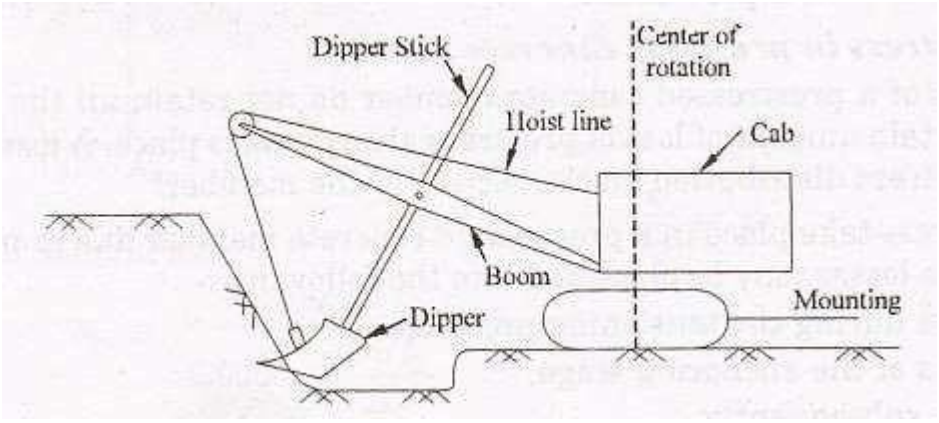
Bulldozers have great ground hold and a torque divider that's designed to convert the power of the engine into dragging ability, which allows it to use its own weight to push heavy objects and even remove things from the ground. Take the Caterpillar D9 for example, it can easily tow tanks that weight more than 70 tons. Due to these attributes, bulldozers are used to clear obstacles, shrubbery and remains of structures and buildings.

The blade on a bulldozer is the heavy piece of metal plate that is installed on the front. The blade pushes things around. Normally, the blade comes in 3 varieties:
1. A straight blade that is short and has no lateral curve, no side wings, and can be used only for fine grading.
2. A universal blade, or U blade, which is tall and very curved, and features large side wings to carry more material around.
3. A combination blade that is shorter,offers less curvature, and smaller side wings.

Power shovel
Power shovel is construction equipment whose value is to excavate the earth and load it into the trucks or other hauling equipment waiting nearby. They are capable of excavating all classes of earth, except the solid rock without prior loosening.

Basic Parts and Operation of Power Shovel:

The basic parts of a power shovel consists of the mounting (crawler track or rubber tyred wheel), cab, boom, dipper stick, dipper and hoist line.



Suitability in the field condition:

The following job conditions should be looked into while selecting the size of a showel.

i. For large lifts to dump earth from basement into tracks will require long boom of a large shovel.

ii. For excavating blasted rocks, large size dipper will easily handle bigger sizes.

iii. For excavating hard and tough bed of soil, the dipper of large shovel which can exert greater downward pressure will be more suitable.

iv. If the project time is such that it needs high hourly output, large shovel should be used.

COMPACTING EQUIPMENTS

Effective compaction of material is an essential part of construction engineering operations concerned with foundations, construction and maintenance of the roads, airports, dams etc. The equipment required for these work range from the smallest vibrating rammers to the largest rollers of vibrating type.

Compaction is the process whereby material particles are constrained to pack more closely together through a reduction of air void content, generally by mechanical means.Compaction can also be defined as the process of densifying or increasing the unit weight of a soil mass through the application of static or dynamic force, with the resulting expulsion of air and, in some cases, moisture.

Types Of Compactors- (Rollers)

Today's compaction equipment are represented by many large, highly responsive, and versatile self-propelled units. These compactors and rollers can be divided into following major classes :

- Static Smooth Wheeled Rollers.
- Sheep Foot or Pad Foot Rollers.
- Pneumatic Tyred Rollers
- Vibratory Rollers.

Smooth Wheeled Rollers.

These are rollers used with or without ballast and may be 3 wheeled or tandem type (two rolls of equal width). These are the conventional rollers used for almost all types of rolling. It is not effective on uniformly graded sand, gravel or silt and on over moist cohesive soil due to poor traction.Diesel powered rollers with modern technology of hydrostatic transmission rollers have replaced the traditional steam rollers which were first introduced 100 years ago. The dead weight rollers (static rollers are sometimes called by this name) rely on weight alone to compact the material over which they pass. The units of 8 to 10 tonnes imparting pressure of 20 to 40 kg per linear cm are generally used. For light works, lighter rollers of weight upto 1 ton are also available.

Sheep Foot or Pad Foot Rollers.

These may be self driven or tractor driven and are suitable on cohesive soils specially when water content is on the higher side. The inherent dynamic beat developed by these tamping pads or feet in many cases produce a high degree of compaction at a faster rate.

Pneumatic-Tyred Rollers.

These are used for compaction both the earthwork and bituminous road construction. Because of the oscillating axle layout they produce more even compaction across the rolling width than a wide steel wheel smooth rollers, which sometimes bridge the material leaving uncompacted areas of fill.On bituminous wear courses, it can eliminate surface cracking and material crushing caused by steel rolls – the tyres fold and knead the material to produce an almost total sealed finish. These rollers are available in weighing range from 6 to 30 tonnes with 500 to 4000 kg per tyre and tyre pressure from 2 to 8 kg/sq.cm.

Vibratory Rollers.

Different types and sizes of vibratory rollers to suit specific conditions are available like :

1. Rollers with large vibrating drum infront with 2 steel or pneumatic tyred rear driving wheels. Pneumatic tyres offer better traction on gradients and in over moist soil. These may be articulated or non articulated type.

2. Roller with tandem smooth wheels, either one wheel vibrating and driven or both wheel vibrating and driven.
3. Single roll pedestrian vibrators rollers weighing nearly 400 kg are used for compacting small areas such as pavements, foundations etc.
4. Towed vibrating rollers weighing 5000 to 11000 kg. are aged for mass earthworks, base constructions embankments, rockfill dams etc.

Vibrations are produced by rotating eccentric weights within the rolls at high speed. These roll thus hitting the material to be compacted at high frequency. The vibration reduces the friction between the particles of material which are brought closer together as air voids are eliminated. Thus binding the material into denser state. Further. compaction results from the dynamic forces applied by vibrating roll onto the material being compacted.Vibrating rollers are very effective on free draining type soil and granular base course. These are not effective on uniform graded sand, gravel or silt. Rollers with high amplitude are preferable for soil and granular base course. At high amplitude vibrations the effective pressure on the compacting materials is around twice the static weight of the roller.

CHEPTER-7:- SOIL REINFORCING TECHNIQUES

Soil reinforcement

Soil reinforcement is a technique which is used to improve the strength and stiffness of soil. Different engineering techniques are used to enhance the strength of soil, like geogrid and geotextile. It is a combination of earth fill and reinforcing strips. They are capable of bearing large tensile strength. Soil reinforcement is a modern technique which is employed in various projects to prevent the failure of slopes of soil and it improves the bearing capacity of the soil.

Objectives of Soil Reinforcement

- Reinforcement of soil is performed by placing tensile elements in the soil to enhance the stability and strength of the soil.
- Soil reinforcement is a cost-effective technique which is used to improve tensile and bearing strength of the soil.
- It is opted to improve the engineering and mechanical properties of soil.
- Reinforced soil bed increase the bearing capacity of the soil and reduce the differential settlement of soil bed.
- To reduce the quantity of earth fill. Steeper embankment slopes reduce the land take required.

Types of Soil reinforcement

Strip Reinforcement

Strips are the flexible linear elements. Their breadth is greater than their thickness.
Commonly strips are used of metals, such as – galvanized steel, aluminium – magnesium alloy, chrome stainless steel. Some other types of strips are bamboo strips, polymer strips and glass fibre reinforced plastic strips. The thickness of strips reinforcement may vary from 3 to 9 mm and its breadth ranges between 40 to 120 mm.

Grids Reinforcement

The grid can be made from plain or galvanized steel wire mesh.When reinforcement is provided to resist tensile force geogrids are used. Geogrids are geosynthetic material which is made from polymers.
Raw materials used in geogrids are polypropylene, polyester or polystyrene.Using geogrids in civil engineering the amount of usable land on a site is increased. It enables the construction of steep slopes or walls, construction of roads over poor ground conditions, decrease the thickness of landfill required for road construction.

Sheet Reinforcement

Sheet reinforcement can be made from galvanized steel, fabric or expanded metal which can not be in the criteria of the grid. Use of geosynthetic sheet instead of steel strips has cost-efficient. It has greater corrosion resistance than strips commonly used sheet type reinforcement are geo fabric. Geo fabric is a porous fabric which is manufactured from synthetic material, such as – polyester, polyamide, polyethene, polypropylene and glass fibre. The thickness of the sheet may range between 0.125 to 7.5 mm.

Effects of Soil reinforcement

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

Slope stabilization in cutting and embankments by soil reinforcing techniques.

Soil Reinforcement

- Geosynthetic Reinforced Soil Slopes
- In-situ Soil reinforcement – soil nailing
- MSE Walls

Reinforced Soil in a Nutshell

- Soil: Strong in compression, weak in tension
- Reinforcement can carry tensile stresses
- Soil + Reinforcement ⇒ Structure strong under both compression and tension
- Analogous to reinforced concrete

MSEW / RSS Components

- Reinforced fill material (soil)
- Reinforcement • Facing
- Joint Materials
- Leveling Pads
- Coping
- Drainage
- Membrane (salts)

Major Components

- Connections
- Traffic Barrier
- Ground Improvement (if needed) Common Facing Systems
- Precast concrete panels (wet cast)
- Modular blocks (dry cast)
- Gabions
- Welded wire mesh
- Cast-in-place
- Timber
- Shotcrete
- Vegetation
- Geosynthetic: wrap around, geocells

THE ADVANTAGES OF SOIL NAILING

- Incorporation of temporary support in final structure
- Reduction in cut excavation
- Potential reduction in right-of-way
- Rapid construction
- Cost effective What are the

DISADVANTAGES OF SOIL NAILING

• Permanent underground easements may be required
• Difficult to construct wall with high groundwater
• Utility conflicts
• Nail capacity may not be economical in highly plastic clays
• Ground displacements
• Durability of shotcrete with respect to freeze thaw
• Soil face must exhibit sufficient stand up time