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CHAPTER-1. PART-A

ADVANCED CONSTRUCTION MATERIALS

FIBERS: →

(1) Fibers is a class of material which are having continuous filaments or having discrete elongated pieces similar to the length of thread.

(2) Fibers are very important in the biology of plants and animals for holding tissue together.

(3) They are often used in the manufacture of other materials.

(4) Fibers can be spun into filaments or string or rope which can be used as a component of composite material or melted into sheets so as to make the products like paper or felt.

(5) Fibers are inorganic, or organic, natural or synthetic

(6) Synthetic fibers can be produced very cheaply and in large amounts as compared to natural fibers.

(7) Rayon and nylon are organic synthetic fibers.

(8) Burlap is a coarse jute or hemp which is a natural fiber.

(9) Hessian is a jute fabric.

(10) Silk and cotton are produced from natural fibers.

(11) Glass wool, lead wool and asbestos are mineral fibers

of which glass wool and lead wool are synthetic fibers.

(12) Steel fiber, carbon fiber and glass fiber are the new and recent trends used in the construction work.

TYPES OF FIBERS :→

There are mainly three types of fibers which are commonly used as a construction materials.

1. Steel fiber :→

★ Steel fiber are made from the cold drawn steel wire with low content of carbon or stainless steel wire.

★ They are manufactured in various types such as hooked steel fibers, insulated or flat steel fibers according to the need required in the construction project.

★ These fibers are used in the construction for concrete reinforcement.

★ Steel fiber reinforced concrete is less expensive than hand tied re-bar shape, dimensions and length of the fiber are more important because it increases the tensile strength of the concrete.

★ Steel fibers can only be used on surfaces so as to avoid corrosion and rust stains.

★ fiber - reinforced normal concrete is mostly used for on-ground floors and pavements and also used for the construction parts such as beams, pillars, foundation etc.

⇒ **Properties of Steel Fibers :→**

★ It increases the tensile strength of concrete.
★ It is more tough and hard.
★ It avoids corrosion and rust stains.
★ They are more elastic in nature.
★ Steel fibers are available with standards as ASTM 820/96, ASTMC 1116/95 and DIN 1045.
★ It has a tensile strength of 1.100 N/mm².
★ They are available in the shapes like flat, hooked and undulated.

⇒ **Applications of Steel fibers on field :→**

★ Steel fibers are highly used in tunnel lining work.
★ It is mostly used in the construction of airport runways and highways pavements.
★ Most commonly used in precast concrete as so to increase the tensile strength.
★ They are used in shortcrete.
★ Used in the construction of parking.
★ It is used in anti-seismic buildings.

2. **Carbon fibers :→**

★ Carbon fiber is a material consisting of extremely thin fibers about 0.005mm to 0.010 mm in diameter and mostly composed of carbon atoms.
★ Carbon fiber is alternately called graphite fiber.

★ The carbon atoms are bonded together in microscop crystals which are more or less aligned parallel to the long axis of the fiber.

★ The crystal alignment makes size of fiber more strong.

★ Number of carbon fibers are twisted together so as to form a yarn which can be used as it exist or weaven into a fabric.

★ It can be combined with a plastic resin and wound or moulded to form composite material like carb fiber reinforced plastic to provide a high strength to weight ratio of the material.

★ The atomic structure of carbon fiber is similar to that of graphite consisting of sheets of carbon atoms arranged in a regular hexagonal patt

★ Carbon fibers shows the no. of properties very close to the properties of asbestos.

★ Each carbon filament thread is an bundle of many thousand carbon filaments.
A single such filament is a thin tube with a diameter of (5-8 nm micrometer) and consists of almost exclusively of carbon.

→ Properties of Carbon fibers:→

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

★ They are rigid materials which are resistant to stretching and compression.

★ It is chemically inert or unreactive materials. The are resistant to corrosion.

★ Fibers contained about 85% carbon it has excellent flex

ural strength.

→ Application of Carbon fibers: →

★ Carbon fiber is mostly used to reinforce composite material
★ Reinforced carbon-Carbon (CCC) consists of carbon fiber reinforced graphite and is used structurally in high temperature applications.
★ It increases the tensile as well as compressive strength of concrete.
★ Due to high tensile strength, low weight and low thermal expansion it makes the carbon fiber very popular in aerospace, military & motorsports along with other competition sports.
★ Carbon fiber is extensively used in the bicycle industry, especially for high-performance racing bikes.
★ It is also used in some tennis rackets.
★ It is now being used in musical instruments for its weather resilience and ability to recreate the tone of guitars.

⑤ Glass fibers: →

→ It is also called as fiber glass.
→ Glass fiber is the material made from extremely fine fibres of glass.
→ It was invented in 1938 by Russell Games Slayter.
→ In 1893, Edward Drummond Libbey exhibited a dress at the World's Columbian Exposition incorporating glass fibers with the diameter and texture of silk fibers.
→ This dress first worn by the well known and popular stage actress of the time Georgia Cayvan

There are two main types of glass fiber manufac-ture and two main types of glass fiber product

① First fiber is made either from a direct melt process or a marble remelt process.
② Both start with the raw materials in solid form. It is almost and always made of plantinum alloyed with rhodium for better durability.
③ It is almost and always made plantinum is used because the glass melt has a natural affinity for wetting it.
④ The fresh and thin fibers are more strong because the thinner fibers are more ductile.

→ **Properties of Glass fibers:** →

★ It has high ratio of surface area to weight. They have good thermal insulation.
★ It has a good tensile strength but has no strength against compression.
★ Compressive strength is weak but can be increased by reinforcing it with plastic.
★ When the glass fiber is reinforced with plastic then reinforced material can resists both compressive and tensile forces as well.
★ (It is resistant to chemical attack). However, if its surface area is increased, then it makes them more susceptible to chemical attack. (They are corrosion resistant.)

Application of Glass fibers: →

★ Corrugated fiber glass panels are widely used for outdoor canopy or green house construction.

★ It is used as a reinforcing agent for many polymer products like FRP and GRP which uses tubs, pipes for drinking water and 'screen' office plant containers and flat roof systems etc.

★ It is reinforced with plastic material so as to increase tensile strength.

★ Uses of regular fiber glass are mats, insulation reinforcement sound absorption, heat resistance fabrics, corrosion resistant fabrics and high strength fabrics.

Glass fiber reinforced plastics are used in the house building market for the production of roofing, laminate, door surrounds, over-door, canopies, window canopies and dormers, chimney coping system, heads with keystone and still etc.

The reinforced glass fiber with polymer and plastic is commonly used in fire water systems, cooling water systems, sewage, waste water systems, gas systems etc.

General Uses of fibers: →

→ fibers are used for packing and making fabrics and felts.

→ Glass wool made of very fine fibers of glass is used for making acid-proof and fire-proof fabrics.

→ Glass wool is also used as packing material for heat, sound and electric insulation. It is commonly used in a solar water system.

→ Lead wool prepared from fine fibers of lead is

used in water pipe joints to stop leakage of water. Natural jute fibers are extensively used in plumbing work to stop leakage of water.

Different types of plastic that are used in construction industry are described below :→

1. POLYETHLENE PLASTIC (PE) : →

→ Polyethylene plastic is made from the polymerized vinyle monomers.

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

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

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

2. POLYVINYL CHLORIDE PLASTIC (PVC) :→

Polyvinyl chloride plastic is a kind of common building plastic made from the polymerized vinyl chloride monomer. Polyvinyl chloride plastic has better chemical stability and aging resistance, but poor heat resistance. It may decompose and metamorphose if the temperature exceeds 100°c. Usually, it should be used at temperature of below 60-80°c. By adding different amounts of plastizer, hard & soft polyvinyl chloride plastic can be made.

3. POLYSTYRENE PLASTIC (PS) :→

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

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

4. POLYPROPYLENE PLASTIC (PP) :→

→ Polypropylene plastic is made from the polymerized acrylic monomer. It has the properties of light weight (density 0.90g/cm²), strong heat resistance (100-120°c), regular ductility and water resistance.

→ The weak points are that it has poor stifness in low temperature; and poor air resistance.

→ Therefore, polypropelene plastic is fit to be used in
Recent years have seen the rapid development of
polypropylene.

→ Polypropylene, together with polyethylene and poly
vinyl chloride, has become the main varieties of
building plastic.

5. POLYR.METHYL METHACRYLATE (PMMA) :→
Thermoplastic resin, also called organic glass, can be
made from the polymerized polymethyl methacrylat
It has the advantages of good light transmitta
high strength at low temperature, low water ab
orption, better heat resistance, better aging resis
tance, and easy to be processed. However, it has
the disadvantages of poor abrasive resistance and
high price.

6. POLYESTER RESIN (PR) :→
Polyester resin is made by condensing diatomic or
polybasic alcohol and diatomic or polybasic acid
Polyester resin has the properties of good build
capacity, elasticity, better colourability, flexi
bility, heat resistance and water resistance.

7. PHENOLIC RESIN: (PF) →
Phenolic resin is made by polymerizing phenol and
aldehyde under the influence of acid catalyst
or alkaline catalyst. Phenolic resin has better
cohesion strength, light resistance, water resi
tance, heat resistance, corrosion resistance and

and electrical insulation. However, it has poor stiffness. Phenolic resin, added by filling material & curing agent, can be made into phenolic plastic. Phenolic plastic is smooth, strong, durable and cheap. It has become a type of commonly used plastic.

8. ORGANIC SILICON RESIN (SI) :→

→ Organic silicon resin is made by hydrolysing of one or more types of organic silicon, monomer. Organic silicon resin has the properties of heat resistance, cold resistance, water resistance, and corrosion resistance.

→ However, it is poor in mechanical performance and cohesive ~~load~~ force. These two weak points can be improved by adding synthetic resin (phenolic aldehyde, epoxy, and polyester), glass fiber and asbestos, etc.

1.3 DEFINITION OF ARTIFICIAL / INDUSTRIAL TIMBER :→

→ Industrial timber is nothing but timber product manufactured scientifically in factories. Because of its scientific nature, it is stronger and durable than ordinary timber materials.

→ It also contains desired shape and size.

Different Types of Industrial Timber

following are the different form of industrial timber

① Veneers
② Plywood
③ fiber boards
④ Impreg timbers
⑤ Compreg timbers
⑥ Hard boards
⑦ Glulam
⑧ Chip board
⑨ Block board
⑩ Flush door shutters.

① Veneers :→

→ Veneers are nothing but thin layers of wood which are obtained by cutting the wood with sharp knife in rotary cutter.

→ In rotary cutter, the wood log is rotated against the sharp knife or saw and cuts it into thin sheets. These thin sheets are dried in kilns and finally veneers are obtained.

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

② Plywood :→

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

→ The layers are glued and pressed with some pressure either in hot or cold condition. In hot condition 150 to 200 °C temperature is maintained and hydraulic press is used to press the layers. In cold conditions, room temperature is maintained and 0.7 to 1.4 N/mm² pressure is applied.

→ Plywood has so many use. It is used for doors, partition walls, ceilings, paneling walls, formwork for concrete etc.

→ Due to its decorative appearance, it is used for buildings like theatres, auditoriums, temples, churches, resturants etc in architectural purpose.

③ Fiber Boards: →

→ Fiber boards are made of wood fibers, vegetable fibers etc. They are rigid boards and called as reconstructed wood.

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

→ Due to sudden increment of pressure, the wood fibers explode and natural adhesive gets separated from the fibers. Then they are cleaned and spread on wire screen in the form of loose sheets. This matter is pressed in between steel plants and finally fiber boards are obtained.

→ Fiber boards are used for several purposes in construction industry such as for wall paneling, ceilings partitions, flush doors, flooring material etc. They are also used as sound insulating material.

④ Impreg Timbers: →

→ Impreg timber is a timber covered fully or partly with resin. Thin layers of wood or veneers are taken and dipped in resin solution. Generally used resin is phenol formaldehyde.

→ The resin solutions fills up the voids in the wood and consolidated mass occurs. Then it is heated at 150 to 160°C and finally impreg timber develops. This is available in market with different names such as Sunglass, sunmica, formica etc.

(5) Compreg Timber: →

It is similar to impreg timber but in this case, the timber is cured under pressure conditions. So, it is more strengthened than impreg timber. Its specific gravity lies from 1.30 to 1.35.

(6) Hard Boards: →

Hard Boards is usually 8mm thick and made from wood pulp. Wood pulp is compressed with some pressure and made into solid boards. The top surface of board is smooth and hard while the bottom surface is rough. Hard boards are generally classified as three types as follows:

Types	Density (kg/m³)	Available thickness (mm)
Mediam	480-800	6, 8, 10, 12
Normal	800-1200	3, 4, 5, 6, 9, 12
Tempered	>1200	3, 4, 5, 6, 9, 12

(7) Glulam: →

Glulam means glued and laminated wood. Solid wood veneers are glued to form sheets and then laminated with suitable resins.

This type of sheet is very much suitable in the construction of chemical factories, long span roofs in sports stadium, indoor swimming pools etc. Curved wood structures can also be constructed using glulam sheets.

⑧ Chip Board:→

Chip boards are another type of industrial timber which are made of wood particles or rice husk ash or bagasse. These are dissolved in resins for some time and heated. After then it is pressed with some pressure and boards are made. These are also called particle boards.

⑨ Block Board:→

→ Block board is a board containing core made of wood strips. The wood strips are generally obtained from the leftovers from solid timber conversion etc. These strips are glued and made into solid form.

→ Veeneers are used as faces to cover this solid core. The width of core ~~solid~~ should not exceed 25mm. If the width of core is less than 1mm then it is called as Lamin board.

→ Block boards are generally used for partitions, paneling, marine and river crafts, railway carriages etc.

⑩ Flush Door Shutters:→

Flush door shutters made in factories are widely using nowadays. They are generally available with

25mm, 30mm or 35mm thicknesses. Factory made flush board shutters are of different types such as cellular core, hollow core, block board, core etc.

Properties of Timber →

The quality of timber must be ensured before using it for a purpose. The quality can be ensured by investigating the properties of timber. Here we have discussed both physical and ~~medical~~ mechanical properties of timber which affects timber quality.

Followings are the physical and mechanical properties of timber :→

1. Colour
2. Appearance
3. Hardness
4. Specific Gravity
5. Moisture Content
6. Grain
7. Shrinkage and Swelling.
8. Strength
9. Density
10. Toughness
11. Elasticity
12. Warping
13. Durability
14. Defectless
15. Workability
16. Soundness
17. Free of abrasion.

⇒ COLOUR: →

★ Colour is a uniform property by which most trees are characterized as they show variation from tree to tree. Light color indicates weak timber. For example, freshly cut teak, Deodar, and walnut have a golden yellow whitish and dark brown shades respectively.

⇒ APPEARANCE: →

★ Smell is a good property as timbers for few plants as they can be identified by their characteristic aroma. Fresh cut timbers have a good smell. for example resinous smell from pine.

⇒ HARDNESS: →

★ For the resistance of any kind of damage, hardness is an obivious property.

⇒ SPECIFIC GRAVITY: →

★ Variation of timber is specific gravity (0.3-0.9) is found. It depends on pores present inside timber. The specific gravity of this light material is less than that of water (<1). But in case of compact wood where pores are almost absent and become heavier, their specific gravity increases up to 1.5.

⇒ MOISTURE CONTENT: →

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

→ GRAIN: →

★ Several types of grain arrangement found. On the grain structure quality of timber varies. Grains remain closely related.

⇒ STRAIGHT GRAIN: →

Arrangement of vascular tissue (xylem and phoem) is important which grow parallel to the length of the timber that is termed as straight grain.

★ Coare greain: → vascular tissue and fibre arrange broadly and widely.

★ Interlocked grain: → Instead of parallel arrangement twisted, a spiral arrangement may be found.

Shrinkage and Swelling: →

The percentage of shrinkage and swelling varies fr plant to plant. Some give higher percentage after drying. Shrinkage starts when cell walls of timber start to release water. In moisture atmosphere timber swells when cell walls absorb water. Good quality timber swell less. Timbers having thicker wall swell more than a thinner core.

⇒ STRENGTH: →

★ Best quality timbers have the highest strength. Strength means capable to bear loads. Anisotrophi material like timber has different structure at the different portion. So, the strength of timber is different at different points. Grain structure determines the strength of the timber. Some types of strength are:

* Compressive Strength – 500 kg/cm² to 700 kg/cm² load is enough to test timbers strength. Tensile strength: When timber is enough strong to the tensile force. If perpendicular force is made then timber is weaker 500-2000 kg/cm² is the range of tensile strength load.
* Transverse strength – Enough bending strength indicates good quality timber.

⇒ DENSITY: →

* Timber having higher density have a thicker wall. An important property that quality of timber. Moisture content: Presence of defects: There may be some of the natural and artificial defects in timber such as cross-grain, knots and shakes, etc. All of them cause a decrease in the strength of the timber.

⇒ TOUGHNESS: →

* Timber has to have the capability to bear shocks, jerk. Anti-bending and ant splitting characteristics is needed. Old timbers have annual rings which indicate their age is a good indication.

⇒ ELASTICITY: →

* Another property elasticity means timber should attain its own shape after use. Because of this quality, it is used in sports bat.

⇒ WARPING: →

* Environmental change with season can't effect good quality timber.

⇒ DURABILITY: →

★ A good quality timber has the property to resist the attack the infection of fungus or other insects. This resistance quality makes timber better.

⇒ DEFECTLESS: ★This property is gained if the timber is from a sound tree. ★ defectless tree is free from sap, shakes and dead knots. To know more about timber defects read: Defects in Timber.

⇒ WORKABILITY: →

★ ★good timber is always easy to work on it. Easy to drag using saw on good timber. The finishing can be done well.

⇒ SOUNDNESS: →

★ A good quality timber gives good sound.

⇒ TEXTURE: →

★ The texture of good timber is fine and even.

⇒ FREE OF ABRASION: →

★ Timber should not be damaged by the external environment. It has to gain the ability to protect its skin.

Used for the following works: →

1. For heavy construction works like columns, truss piles.
2. For light construction works like doors, windows flooring and roofing.

3. for other permanent works like for railway sleepers, fencing poles, electric poles and gates.
4. for temporary works in construction like scaffoleding, centering, shoring and strutting, packing of materials.
5. for decorative works like showcases and furnitures.
6. for body works of buses, lorries, trains and boats.
7. for industrial uses like pulps. (used in making papers) card boards, wall papers.
8. for making sports goods and musical instruments.

STRENGTH OF TIMBER :→

① The strength of Timber is measured by its resistance to yielding under the influence of external force applied in any form. Timbers may be so located with reference to the load they sustain as to be strained in tension, or in compression, or in shear, or by bending, and in each case the maximum resistance which can be offered by a piece of wood will have a different value. The maximum resistance also depends upon the direction of the grain relative to the direction in which the load is applied. In general, knotty and cross-gained wood is not so strong as clear & straight-grained pieces of the same materials. Large timbers usually contain more imperfections in grain than small ones which might be cut from the large bulk, and hence, large timbers are likely to be relatively weaker than small ones. In general, the heavier woods are the stronger.

STRENGTH OF TENSION :→

(A) Strength of tension is measured by the resistance which is offered to a force drawing in the direction of length. For a piece of wood, this is the sum of the resistance of all the separate fibers making up the crosse section. Long-leaved yellow pine and Washington fir will withstand about 12,000 pounds for each square inch of cross section, while oak, Canadian white pine, and red fir withstand about 10,000 pounds, cypress, and chestnut, from 6000 to 9000 pounds. These values are remarkably large when one considers the lightness of the materials involved.

STRENGTH OF COMPRESSION :→

(B) Strength of compression is the resistance offered to a force which tends to reduce the dimension of a material in the direction in which the force is applied. Columns stand upon a foundation or base of any sort, and bear a load upon the top, are in compression. In this case the individual fibers act as so many hollow columns firmly bound together. Failure under compression occurs when the fibers, by separating into small bodies and sliding over each other, cease to act as a solid mass. This section is obviously assisted by the presence of the smallest knot or the slightest irregularity in grain. When tested in the form of short columns in which the grain runs lengthwise, the common woods withstand loads in compression of from

5000 to 8000 pounds per square inch of cross-section.

1.3 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.

PROPERTIES :→

1. It is a good heat, sound, and electric insulator.
2. It has no definite crystalline structure.
3. It is extremely brittle.
4. It can take up high polish.
5. It reflects, absorbs and transmits light.
6. It has no sharp melting point. It varies between 14000 - 15000 C
7. It is resistant to most of the chemicals.
8. It can be needled but difficult to be cast into large pieces.

USES OF ACOUSTICS MATERIALS :→

Acoustical materials are a variety of foams, fabrics, metals etc. used to quiet workplaces, homes, automobiles, and so forth to increase the comfort and safety of their inhabitants by reducing noise generated both inside and outside of those spaces.

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.

PLASTER BOARD :→

Plasterboard is a panel made of calcium sulfate dihydrate (gypsum) usually pressed between a facer and a backer. It is used to make interio walls and ceilings. This 'Drywall' construction walls and ceilings became popular as a quicker alternatives to tradition al lath and plaster.

MICROSILICA :→

Microsilica or silica fume is an excellent admixtur for concrete as it leads to better engineering pro perties. It reduces thermal cracking, improves durability, and increases strength. Silica fume concrete has a number of construction applicatio

ARTIFICIAL SAND :→

Sand manufactured by Vertical Shaft Impacter is of cubical shape. Such sand can be used for all types of construction work, concreting, Pla stering etc and is better substitute to river sand V.S.I. Crushers is a most economical machine for Crushing Stone in Cubical shape and manufacturing artificial sand.

BONDING AGENTS :→

Bonding agents are natural, compounded or synthetic materials used to enhance the joinin of individual members of a structure neithai employing mechanical fasteners.

CONSTRUCTION ADHESIVE :-

Construction adhesive is a general purpose adhesive used for attaching drywall, tile, molding and fixtures to walls, ceiling and floors. It is most commonly available tubes intended for use with a caulking gun.

CHAPTER-2.

PREFABRICATION

→ Introduction:→ 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.

→ *Necessity of prefabrication: →

(i) Shortage of skilled labour.
(ii) Need for increased construction quality at lower cost.
(iii) Need to improve construction productivity.
(iv) Need for more sustainable solution.

→ * Scope of prefabrication of building: →

- Prefabrication is more efficient, low cost, time saver, reduce the wastage, reduce the manpower.
- Maintanance is less and can be reused in the material stream.

→ * History of prefabrication: →

- It has been used since ancient times. for example it is claimed that the world's oldest known engineered road way. the Sweet track constructed in England around 3800 BC. employed prefabricated timber sections brought to the site rather than assembled on site.

→ *Current uses of prefabrication: →

- The most widely used from 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.

- The technique is also used in office blocks, wearehouse and factory buildings.

→* Theory and process of prefabrication: →

- The process and theory of 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.

→* Types of prefabricated system: →

- Prefabrication is the practice of assembling components of a structure in a factory or other manufacturing site and transporting the complete assemblies or sub-assemblies to the construction site where the structure is to be located.

Different types of prefabricated systems: →

Used typically for roofs these are long pieces of frames built from laminated timber (a) covered either by a plywood or some board roof deck.

(a) Sandwich panels
(b) Steel framing
(c) Timber framing
(d) Concrete systems
(e) Modular systems.

→* Classification of prefabrication: →

→ Small prefabrication
→ Medium prefabrication
→ Large prefabrication
→ Partial prefabrication
→ Open system prefabrication

→ Closed system prefabrication.
→ Total prefabrication.
→ Cast-in-site prefabrication.
→ Off-site prefabrication.

★ Advantages and disadvantages of prefabricati

→ Advantages: →

(i) There is a trend of designing majority of buildi consisting of part and components manufactur with a high degree of prefabrication at mech anized plants.

(ii) The partial prefabrication (prefab) units requi technological effectness is design and utilization of prefabrication components and their joints involving use of minimum amount of material and manpower for their manufacture and creation.

(iii) In fully prefabricated construction, there is a shift from using smaller prefabrication uni larger ones, using light weight materials employing more effecient designs. For ex, use of room blocks instead of single layer wall panels.

(iv) As prefab elements grow larger and full prefabrication makes possible speedier construction. Building organization need sophisticated mobile crane of higher load lifting capacities and other auxilliary device

(v) Prefab structures are generally cast in factor site and delivered to work site without allowing handling and erected, sometimes directly from the transport vehicle.

→ Disadvantages : →

(i) Design need to be complete before casting commence.
(ii) Last minute alterations to the structure are impossible.
(iii) It is costlier than in-site work, especially for small scale works.
(iv) Unsuitable if structural alteration might be need in the future.
(v) Units require care and protection while in storage, during transparent and while handling on site, all of which involves cost.
(vi) If units are produced in the sequence of erection to save time, damage to one elements can create havoc with the creation program.
(vii) Prestressed floor panels or beams can create problems with uneven camber in different units.
(viii) Unsuitable in case of structure which cannot be satisfactorily broken into small components for transportations and erection.
(ix) Precast component may require excessively larger site handling, hoisting equipment.
(x) Limited site access may make mobilization - demobilization of machinery difficult, hence causing difficulties and delay.
(xi) Especially in developing countries, prefabrication and precasting techniques may require many prerequisites.

DESIGN CONSIDERATIONS :→

* final position and loads
* Transportation requirements - self loads and position during transportation

* Storing requirements - self load and position during storing - (carried or store in the same position as it transported / built in).
* Lifting loads - Distribution of lifting points - optimal way of lifting (selection of lifting and rigging tools).
* Vulnerable points (e.g. edges) - reduction of risk (e.g. rounded edges).

PREFABRICATION PRINCIPLES :→

* To give safely in structed system.
* To design the building as an aesthetic one.
* To effect economy in cost.
* To improve in quality as the components can be manufactured under controlled conditions.
* To speed up construction since no curing is necessary.
* To use locally available materials with required characteristics.
* To use the materials which posses their inna characteristics like light weight, easy workability, thermal insulation and combustibility etc.

TYPES OF PREFABRICATED ELEMENTS :→

Prefabrication, the assembly of buildings or their components at a location other than the building site. Prefabricated units may include doors, stairs, window walls, wall panels, floor panels, roof trusses, room sized components and even entire buildings.

MODULAR COORDINATION OF PREFABRICATION :→

It provides the easy grasped layout of the positioning of the building components in relation to each other and to the building and faciliate collaboration between planners, manufactures, distributors and contractors.

MODULAR COORDINATION (1) :→

* Modular coordination is a concept of coordination of dimension and space in which buildings and components are dimensioned and positioned in terms of basic unit or module.
* The basic module is known as 1M which equivalent to 100mm.
* It is intermentionally accepted by the International Standard Organisation and many other countries including Malaysia.

BACKGROUND :→

* Modular coordination was first explored as an aid to design shortly after the introduction of prefabrication in the construction industry in the industralization. It was conceived as a further step in the development of systematic design and construction of the building.
* The subject has been discussed and attempted in an actual building experiment in practically every developed country.
* Modular coordination was first studied in Singapore in the early seventies. The housing and development board implemented the conce

in 1973 in the new generation flats.

* Prefabrication and standard components were subsequently introduced. Modular blocks and bricks were introduced in 1983. There are merits to extend the use of modular coordination in other components as well.

AIMS AND OBJECTIVES OF MODULAR COORDINATION

* The principle objectives of modular system are to provide practical and coherent solutions for coordination of the position and dimensions and elements, components and space in building design.
* This process can contribute to increase design freedom and improved balance between quality and cost in manufacture and construction.

BASICS PRINCIPLE OF MODULAR COORDINATION:

* The main purpose of Modular coordination is to achieve the Dimensional Compatibility between the Building Dimensions, Spaces and the size of components and Equipments by using related Modular Dimension.
* Modular coordination generally provides the easy and grasped layout of the positioning of the building components in relations to each other and to the building and facilities collaboration between planners, manufacturer, distributors and contractors.

STANDARD RULES ON MODULAR COORDINATION :-

* Modular coordination is essentially based on the use of modulus (basic module and multi-modules) and a reference system to define coordinating spaces and zones for building elements and for the components which form.

:- - Rules for sizing building components in order to determine their work sizes;
- Rules for defining preferred sizes for building components and coordinating dimensions for building.
- IS 1922-1987 - Recommendations for Modular coordination in Building Industry.

PURPOSE OF MODULAR COORDINATION :→

* To reduce the component size produced.
* To allow the building designer of greater flexibility in the arrangement of components.

CHAPTER-3

EARTHQUAKE RESISTANT CONSTRUCTION

① BUILDING CONFIGURATION

Building configuration is defined in the initial design phases, when it is possible to evaluate the regularity of a structure and observe the influence of the proposed design solution onto the structural treatment (structure analysis dimensioning, and modelling.

② LATERAL LOAD RESISTING STRUCTURES

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... Seismic load · water and earth pressure. Lateral load-resisting system consists of horizontal and vertical elements connected together so as to transfer lateral forces from the top of a building to the foundations.

③ BUILDING CHARACTERISTICS

→ Sustainable design with a proper balance of aesthet accessibility, cost-effectiveness, safety, and secur
→ Superior indoor air quality, based on the spefic requirements of the space.
→ Energy efficient design and performance.
→ Reduced greenhouse gas emissions.

④ EFFECT OF STRUCTURAL IRREGULARITIES - VERTICAL IRREGULARITIES, PLAN CONFIGURATION PROBLEMS.

✱ VERTICAL IRREGULARITIES

ⓐ Stiffness Irregularity

→ Soft storey : A soft storey is one in which the lateral stiffness is less than 70% of that in the storey above or less than 80% of the average lateral stiffness of the three storeys above.

→ Extreme Soft storey : An extreme soft storey is one in which the lateral stiffness is less than 60% of that in the storey above or less than 70% of the average stiffness of the three storeys above. For example, buildings on stilts will fall under this category.

ⓑ Mass Irregularity

→ Mass irregularities are considered to exist where the effective mass of any storey is more than 150% of effective mass of an adjacent storey.

ⓒ Vertical Geometric Irregularity.

→ Geometric irregularity exists, when the horizontal dimension of the lateral force resisting system in any storey is more than 150% of that in adjacent storey.

ⓓ Discontinuity in capacity - Weak Storey

→ A weak storey is one in which the storey lateral strength is less than 80% of that in the storey above, the storey ~~is more than 150% of that in an adjacent storey.~~ lateral strength of all seismic force resisting elements sharing the storey shears in the considered direction.

Ⓐ

(e) In-Plane Discontinuity in Vertical Elements Resiting Lateral Force

→ An-in-plane offset of the lateral force resisting elements greater than the length of those elements.

* PLAN IRREGULARITIES

(a) Torsion Irregularity

Torsional irregularity to be considered to exist when the maximum storey drift, computed with design eccentricity, at one end of the structure transverse to an axis is more than 1.2 times the average of the storey drifts at the two ends of the structure.

(b) Re-entrant Corners

Plan configuration of a structure and its lateral force resisting system contain re-entrant corners, where both projections of the structure beyond the re-entrant corner are greater than 15 percent of its plan dimension in the given direction.

(c) Diaphragm Discontinuity

Diaphragm with abrupt discontinuities or variations in stiffness, including those having cut-out or open areas greater than 50 percent of the gross enclosed diaphragm area, or changes in effective diaphragm stiffness of more than 50 percent from one storey to the next.

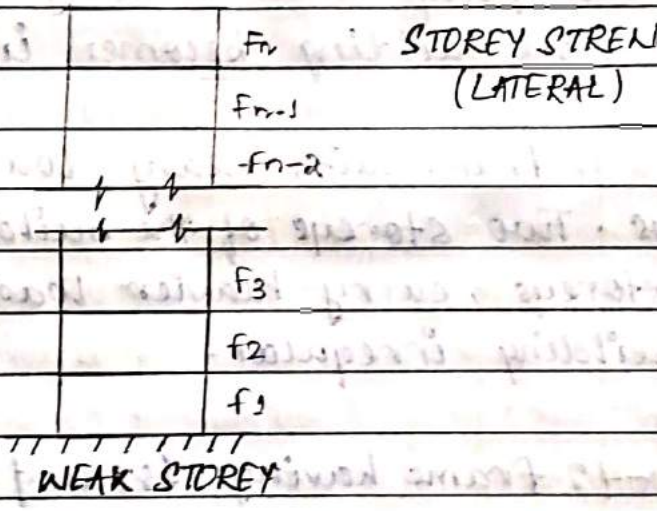
(d) Out-of-Plane Offsets

Discontinuities in a lateral force resistance path, such as out-of-plane offsets of vertical elements.

(e) Non-parallel Systems

The vertical elements resisting and lateral force are not parallel to or symmetric about the major orthogonal axes or the lateral force resisting elements.

INTERNATIONAL JOURNAL OF MODERN TRENDS IN ENGINEERING AND RESEARCH



The problem considered for the study is taken from one of the existing plans. This 10-storey building frame is considered with two different irregularity as taken from IS: 1893 (part 1): 2002. Thus, we have five frames including the base frame. These five frames have been analysed using equivalent Static method of IS 1893-part 1:2002 while assuming seismic zone IV, and importance factor 1.5. Analysis has been carried out using CSI-ETABS program. Configuration of frames is as given below

and shown:

Frame-1: This is the regular plan of the building with no irregularities and ten storeys, with a storey height of 3m. The specifications of the building are:

Dimensions of the beam = 0.45m × 0.25m; Column size 0.30m × 0.30m., Column length = 3m, Load combination = DL + LL + EQL, Dead Load = 8.5 KN/m, Live load = 10 KN/m.

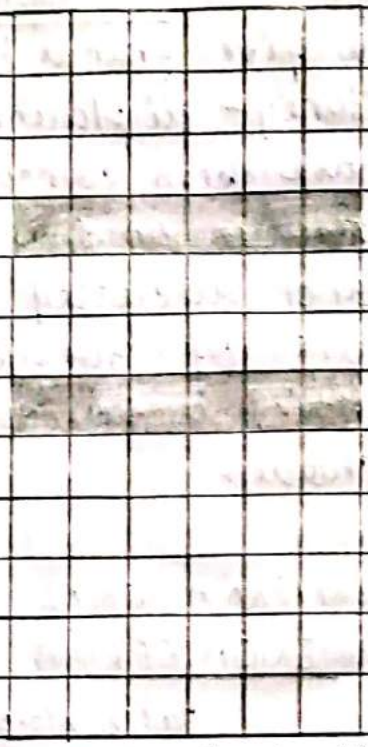
Frame-2: This frame carries heavier loading on the top storey, e.g, in the top storey swimming pool has been introduced hence making the top storey heavy, and the building becomes irregular.

Frame-3: frame with heavy loading on 4th and 7th storeys. Two storeys of the building i.e 4th and 7th storeys, carry heavier loads, hence making the building irregular.

Frame-4: frame having 1st and 2nd storeys soft. No floor slab has been provided which makes these two storeys less stiff i.e softer.

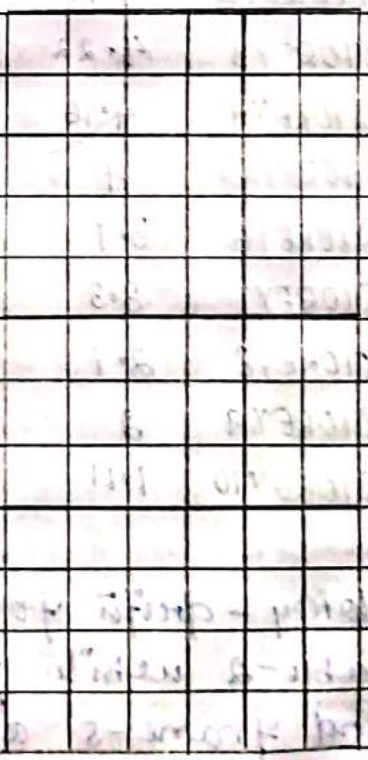
Frame-5: This frame has its 4th and 5th storeys soft. No floor slabs have been provided which makes these two storeys soft.

(a) Heavy load at top level (mass irregularity).



(b) Heavy load at 4th & 7th storey (mass irregularity)

(c) 1st & 2nd storey soft



(d) 4th and 5th storeys soft.

ANALYSIS RESULTS

The five frames have been analyzed and their lateral storey-displacements, storey drifts and base shears have been computed to study the effects of irregularities on the frames. The results are presented and discussed hereafter. Table-1 shows displacement of storeys of various frames in X-direction which is horizontal. These have been plotted & shown.

Table No.1 Displacement in X (mm)

STOREY	frame 1	frame 2	frame 3	Frame 4	frame 5
STOREY1	3.2	5.113	9.74	6.99	3.128
STOREY2	4.17	6.56	11.99	8.93	4.01
STOREY3	4.22	6.69	4.43	8.9	4.03
STOREY4	4.16	6.69	4.05	7.2	4.54
STOREY5	4	6.62	3.91	0.09	11.33
STOREY6	3.7	6.49	3.64	5.75	10.88
STOREY7	3.3	6.2	3.25	5.601	3.602
STOREY8	2.7	5.8	2.71	0.108	2.75
STOREY9	2	4.51	2.06	1.76	2.212
STOREY10	1.11	0.15	0.75	1.18	0.765

Storey-drifts for all the frames are presented in Table-2 while plotted as fig.f. Frame 3, Frame 4 and frame-5 are seen to exhibit abrupt change in storey drifts, which is highly undesirable.

Table No 1 Displacement in X(mm)

STOREY	frame 1	frame 2	frame 3	frame 4	frame 5
STOREY 1	3·2694	5·8	9·74	6·2545	3·45
STOREY 2	7·441	11·2	21·151	15·16	7·156
STOREY 3	11·6717	18·523	26·325	24·454	11·15
STOREY 4	15·83	25·879	30·25	32·11	15·974
STOREY 5	19·84	31·23	34·9894	32·2654	27·6445
STOREY 6	23·58	38·256	37·545	38·3115	37·654
STOREY 7	26·92	44·21	41·246	43·651	41·581
STOREY 8	29·7106	50·17	43·9465	43·546	42·3545
STOREY 9	31·77	54·68	45·825	45·9789	46·755
STOREY 10	32·8944	54·7926	46·3259	46·21	47·75

(5) SAFETY CONSIDERATION DURING ADDITIONAL CONSTRUCTION AND ~~Add~~ ALTERATION OF EXISTING BUILDINGS

→ Survey and assessment
A competent person should do a through structural survey and assessment beforeany potentially load-bearing parts of a structure are altered.

→ The structural survey should consider:
The age of the structure;
Previous use;
Type of construction; and
any nearby buildings or structures. This information should be used to determine the steps required to prevent any collapse.

→ Preventing structural collapse:
A competent person should decide the method and

design of temporary supports. Temporary support provided must be designed, installed and maintained to withstand foreseeable loads and structure should never be overloaded.

→ Arrangements for demolition:
Demolition or dismantling arrangements should be written down before the work begins. This safe system of work may be in the begins. ~~This safe~~ form of a safety method statement identifying the sequence required to prevent accidental collapse of the structure.

→ In additional to the design and method of temporary supports a safe system of work may include

- Establishing exclusion zones and hard-hat areas clearly marked and with barriers or hoardings covered walkways; using high-reach machines reinforcing machine cabs so that drivers are not injured; and training and supervising site workers. Consulting building and control departments. You should consult the building control department of the local authority in the area where a building is located before any structural alterations are made to a building.

The local authority is the reinforcing body for building regulations.

6 ① CORNER REINFORCEMENT

It is a device used to shape and reinforce the corners and prevent cracking in a plaster wall system.

② LINTEL BAND

Lintel band also provides support to chhajja, and sill band support the load of the window frame. During an earthquake, bands sustain the shaking & hence minimize damage to load-bearing masonry building. They provide ductility and crack proof masonry building, as masonry buildings are as such brittle structure

③ SILL BAND

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

④ PLINTH BAND

A plinth band is a horizontal member which is positioned at the plinth level to tie the wall at plinth level.

⑤ GABLE BAND

Gable band is basically a kind of horizontal band used in the buildings with sloped roofs. It is a band which is employed in the triangular upper portion of the roof. It is used in masonry buildings.

EARTHQUAKE CODE

IS: 1893 (Part 1) : 2002

EARTHQUAKE : when earthquake is a sudden shaking of moment of the earth crust occeur in naturally at or below the surface of the earth.

SEISMOLOGY : The study of earthquake is known as seismology.

SEISMOGRAPHY: It is an instrument for recording & measuring the strength of earthquake.

SIZE OF THE EARTHQUAKE: Earth quake intensity is measure by Richter's scale.

$$M_L = \log_{10} A - \log_{10} A_0$$

where A_0 = Amplitude for zero magnitude

A = Recorded magnitude

M_L = Richer's magnitude scale.

Seismic waves are 2 types

1- Body wave

2- Surface wave

1- **BODY WAVE**

It travels in all direction and depth of propagation of wave.

2- **SURFACE WAVE**

It travels only in structure of the rock

Body weave are 2 types
① Primary weave (P weave)
② Secondary weave (S weave)

→ PRIMARY WAVE: P weave travels in the direction of propogation & its velocity equal to the velocity of sound.

→ SECONDARY WAVE: It travels in the direction ⊥ to the particle motion.

Earthquake resistant construction.
It is believe that structural analysis is itself is not sufficient to ensure the seismic resistant stability of the building.

Lateral load resisting system
The 1st system in architectural planing of a building is to select the lateral load resisting system. The load resisting system must be of closed loops.
So, that it is able to the transfer the all forces acting either vertically or horizontally the ground.
→ According to code IS 1893 Part (1) : 2002. There are 8 measure types of lateral force resisting system.
→ There consist at 1- Moment resisting frame
2- Bearing wall system
3- Dual system.

→ Respone reeduction factor (R) is basically an indicator of the performance of the structure in earth quake.

MOMENT RESISTING FRAME

It is a frame in which members of its are capable of resisting forces primarily by flexture.

→ The system is generally report by Architects because there relatively suitable as compare there shear walls.

① Shear wall

It is a wall designed to resist lateral force acting in its own plane.

→ Slab column frames are not recommended as a lateral load resisting system.

② Bearing wall system

This system supports all or most of the gravity loads as well as lateral loads.

→ In general a bearing wall, system has a comparably lower value for 'R' (Response - reduction) Since the system focus redundancy has a poor in elastic response capacity.

→ This system is not much preferred by the architect.

③ Dual system

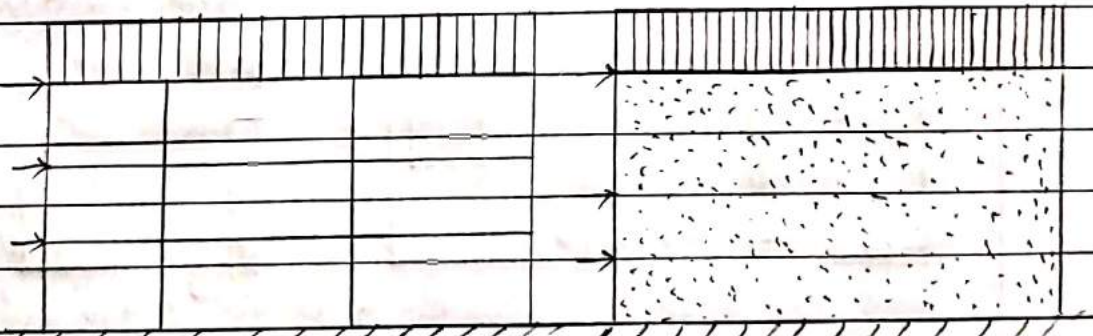
This system consist of shear wall & moment resisting frame such that -

(i) The two systems are design to resist the total design force in preparation to their lateral stiffness considering the interaction of the dual system at all floor levels.

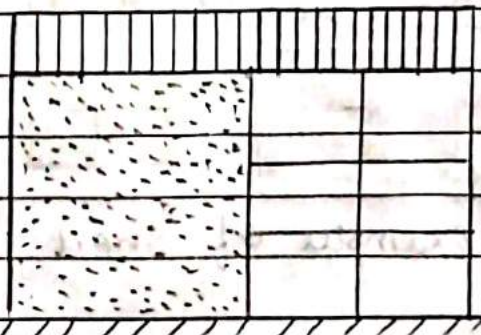
(ii) The moment resisting frames are designed to independently resist at least 25% of design seismic base shear.

→ In general a dual system comparably has a higher value of are. Since a secondary, lateral strength support system is available to assist the primary non-bearing lateral support system.

→ This system is some what less restrictive architecturaley.



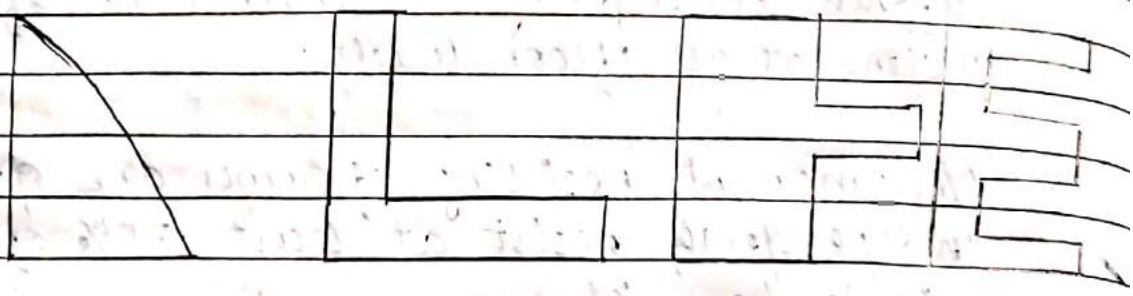
(a) (Moment resisting frame) (b) Bearing wall system
(Beam - column)



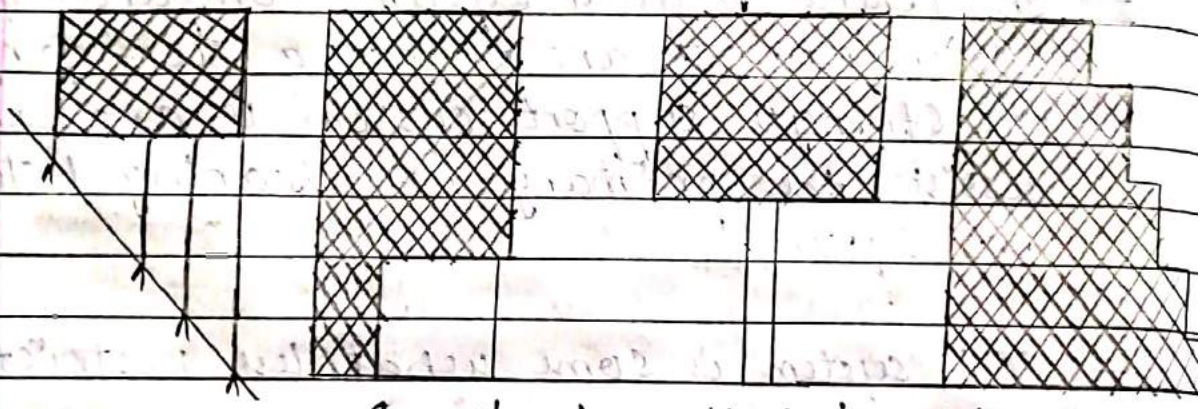
(c) Building with dual system.

DIAGRAMS

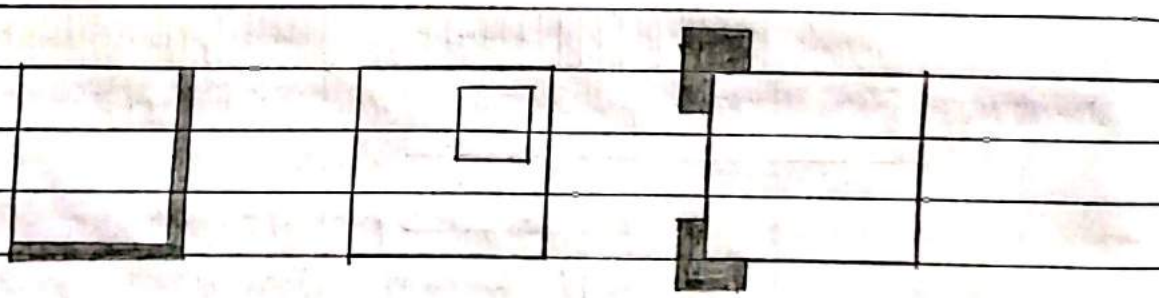
BUILDING CONFIGURATION



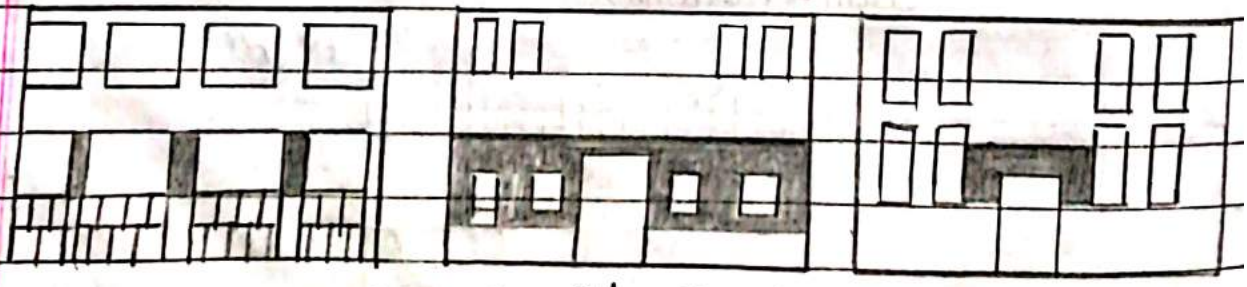
[e.g of plan irregularity]



Example of vertical irregularity

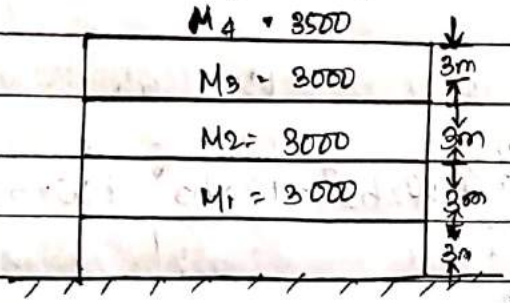


Examples of highly torsional configuration



Examples of short columns.

A four - storyed reinforcement can frame building as shown in fig. is situated reduce the ht betn the floor is 3mt & total height of the building is 12mt the dead load & normal live load is lumped the soil below the foundation is assumed to be hard mark. Assume building intended to be used as hospital. Determing the total base shear as per IS 1893 (part-1) 2002 & distribute the base shear along the height of building.



Petn of base shear

$V_B = A_n W$

When = A_n = Design horizontal acc spectrum waters in determined by.

$$A_n = \frac{Z}{2} = \frac{I}{R} = \frac{S_a}{g}$$

$Z = 0.24$

I = Importance facture = 1.5

$R = 5$

$T_a = 0.07h$ - 0.75 RC building frame.

$= 0.085h$ - steel frame building

$= 0.075 \times (12)^{0.75}$

$= 0.484$ KN.

$S_a/g = 1/T = 1/0.484 = 2.06$

$A_n = Z/2 \cdot I/R \; S_a/g$

$$\frac{0.24 \times 150}{2 \times 5} \times 2.06 = 0.074$$

$W = 3 \times 3000 + 2500 = 11500$

$V_B = A_m W = 0.074 \times 11500 = 851\,kN$

Vertical distribution of base shear to different

floor level :-

$$= V_B \left(\frac{w_1 h_1^2}{w_1 h_1^2 + w_2 h_2^2 + w_3 h_3^2 + w_4 h_4^2} \right)$$

$$= \frac{w_1 h_1^2}{A}$$

$$\Sigma_{j=1} w_i h_i^2$$

$$= 851 \left(\frac{3000 \times (3)^2}{3000 \times (3)^2 + 3000 \times (6)^2 + 3000 (9)^2 + 2700 \times 12^2} \right)$$

$$= 31.18\,kN$$

$$Q_2 = V_B \times \left(\frac{w_2 h_2^2}{w_1 h_1^2 + w_2 h_2^2 + w_3 h_3^2 + w_4 h_4^2} \right)$$

$$= 851 \times \left(\frac{3000 \times (6)^2}{3000 \times (3)^2 + 3000 \times (6)^2 + 3000 \times (9)^2 + 2700 \times 12^2} \right)$$

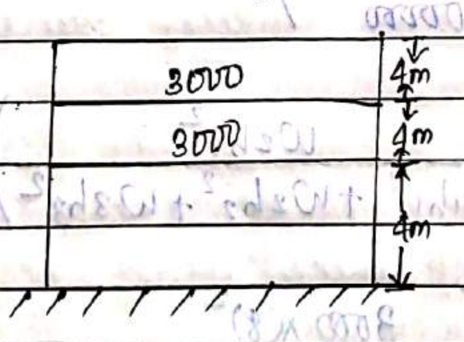
$$= 124.53\,kN$$

$$Q_3 = V_B \left(\frac{w_3 h_3^2}{w_1 h_1^2 + w_2 h_2^2 + w_3 h_3^2 + w_4 h_4^2} \right)$$

$$= 851 \left(\frac{3000 \times (9)^2}{3000 \times (3)^2 + 3000 \times (6)^2 + 3000 \times (9)^2 + 2500 \times (12)^2} \right)$$

$$= 415.08 \text{ kN}$$

Q 3 strayed steel plane with eccentric brances building as shown in fig. is situated at ctc the height betn the floors is 4mt the height of building is 12mt the dead load are normal live load P is pumped as respective floor. The soil below the foundation assumed to be medium salt. Assumed building is intended to be used as an assembly hall. Determined the total bar shear as per IS 1893 (part 1) 2002. Distribute the base shear along the height of building 2500.



Defn of base shear

$V_B = A_h w$

Where A_h - Design horizontal accomodation specimen.

Volm & is determined by

$$A_h = \frac{Z}{2} = \frac{I}{R} \times \frac{S_a}{g}$$

Scanned with CamScanner

$Z = 0.16$ $I = 1.5$ $R = 5$

$T_a = 0.075 h = 0.075 \times 2 = 0.483$

$1/T_a = 2.070$ (Sa/g)

$A_h = Z/2 \cdot I/R \cdot Sa/g = 0.16/2 \times 1.5/5 \times 2.070$

$= 0.049$

$W = 2 \times 3000 + 2500 = 8500$

$V_B = A_h W = 0.049 \times 8500 = 416.5W$

$$Q_1 = V_B \left(\frac{w_1 h_1^2}{w_1 h_1^2 + w_2 h_2^2 + w_3 h_3^2} \right)$$

$$= 416.5 \left(\frac{3000 \times (4)^2}{3000 \times (4)^2 + 2000 \times (8)^2 + 250 \times (12)^2} \right)$$

$$= 416.5 \left(\frac{3000 \times (4)^2}{600000} \right) = 33.32 \text{ KN}$$

$$Q_2 = V_B \left(\frac{w_2 h_2^2}{w_1 h_1^2 + w_2 h_2^2 + w_3 h_3^2} \right)$$

$$= 416.5 \left(\frac{3000 \times (8)^2}{3000 \times (4)^2 + 3000 \times (8)^2 + 3000 \times (1)^2} \right)$$

$= 133.28$ KN

$$Q_3 = V_B \left(\frac{w_3 h_3^2}{w_1 h_1^2 + w_2 h_2^2 + w_3 h_3^2} \right)$$

$$= 416.5 \left(\frac{2500 \times (1)^2}{3000 \times (4)^2 + 3000 \times (8)^2 + 3000 \times (12)^2} \right)$$

$= 249.9$ KN.

CHAPTER-4

RETROFITTING OF STRUCTURES

RETROFITTING

Often retrofit involves modifications to existing commercial buildings that may improve energy efficiency or decrease energy demand. In addition, retrofits are often used as opportune time to install distributed generation to a building.

SEISMIC RETROFITTING TECNIQUES FOR CONCRETE STRUCTURES

→ The Constructor Logo
→ Search Shop Merchandise
→ Home/ Concrete Technology / Seismic Retrofitting Techniques for Concrete Structures.
→ Posted in Concrete Technology. How To Guide, Repair/ Protection Guide.
→ Seismic Retrofitting Techniques for Concrete Structures.

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

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

So, Seismic Retrofitting is a collection of mitigation techniques for Earthquake engineering. It is of utmost importance for historic monuments, areas prone to severe earthquakes and tall or expensive structures.

1. Introduction to Seismic Retrofitting Techniques

Earthquake creates great devastation in terms of life, money and failures of structures. Upgrading of certain building systems (existing structures) to make them more resistant to seismic activity (earthquake resistance) is really of more importance. Structures can be (a) Earthquake damaged, (b) Earthquake vulnerable. Retrofitting proves to be a better economic consideration and immediate shelter to problems rather than replacement of building.

1.1 Seismic Retrofitting of Concrete Structures.

It is the modification of existing structures to make them more resistant to seismic activity, ground motion, or soil failure due to earthquakes.

The retrofit techniques are also applicable for other natural hazards such as tropical cyclones, tornadoes, and severe winds from the under storm.

2. Need for Seismic Retrofitting Keywords

Retrofitting
Base Isolation
Retrofitting Techniques
Jacketing
Earthquake Resistance.

3. Need for Seismic Retrofitting

→ To ensure the safety and security of a building employees, structures functionality, machinery and inventory.

→ Essential to reduce hazard and losses from non-structural elements predominately concerned with structural improvement to reduce seismic hazard. Important buildings must be strengthened whose services are assumed to be essential just after an earthquake like hospitals.

4. Problems faced by structural engineers are

Lack of standards for retrofitting methods- effectiveness of each methods varies a lot depending upon parameters like type of structures, material condition, account of damage etc.

Basic Concept of Retrofitting.

The aim is at→

Upgradation of lateral strength of the structure. Increase in the ductility of the structure. Increase in strength and ductility.

SOURCES OF WEAKNESS IN RC FRAME BUILDINGS

Deaths from earthquakes result from the collapse of buildings and falling objects in them, fires and tsunamis. The type of construction that causes the most fatal injuries in earthquakes is unreinforced brick, stone or concrete buildings that tent not to be flexible and to collapse when shaken.

What is reinforced concrete frame buildings consists

REINFORCED CONCRETE FRAME BUILDINGS

Reinforced concrete (RC) frame consists of horizontal elements (beams) and vertical elements (columns) connected by rigid joints. These structures are cast monolithically - that is, beams and columns are cast in a single operation in order to act in union. Deaths from earthquakes result from the collapse of buildings and falling objects in them, fires, and tsunamis. The type of construction that causes the most fatal injuries in earthquakes is unreinforced brick, stone, or concrete buildings that tend not to be flexible and to collapse when shaken.

CLASSIFICATION OF RETROFITTING TECHNIQUES.

RETROFITTING TECHNIQUES.

GLOBAL	LOCAL
→ Adding Shear Wall	→ Jacketting of Beams
→ Adding Infill Wall	
→ Adding Bracing	→ Jacketting of Columns
→ Adding ruling Wall	
→ Wall Thickening	→ Jacketting of Beam-Column Joints
→ Mass Reduction	
→ Base Isolation	→ Strengthening of Individual Footings.
→ Mass Dampers.	

2.1 Adding New Shear Walls:

→ Frequently used for retrofitting of non ductile reinforced concrete frame buildings.

→ The added elements can be either cast? in? place or precast concrete elements.

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

→ Not preferred in the interior of the structure to avoid interior moulding.

2.2 Adding Steel Bracings:

→ An effective solution when large openings are required.

→ Potential advantages due to higher strength and stiffness opening for natural light can be provided, amount of work is less since foundation cost may be minimized and adds much less weight to the existing structure. Adding STEEL Bracings:

. RC Building retrofitted by steel bracing.

2.3 Jacketing (Local Retrofitting Techniques).

This is the most popular method for strengthing of building columns.

Types of Jacketing:

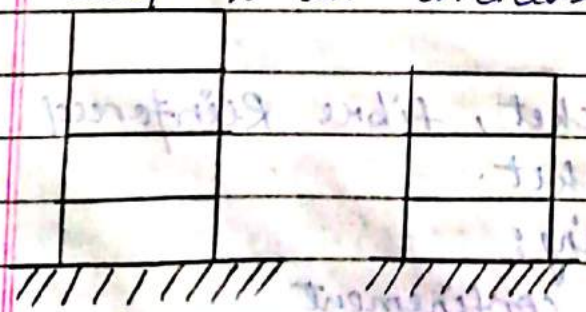
1. Steel jacket,
2. Reinforced Concrete jacket, fibre Reinforced Polymer
3. Composite (FRPC) jacket.
4. Purpose for jacketing:
5. To increase concrete confinement
6. To increase shear strength
7. To increase flexural strength.

Base Isolation: Isolation of superstructure from the foundation is known as base isolation. It is the most powerful tool for passive structu vibration control technique.

Advantage of Base Isolation
Isolates Building from ground motion.
- Lesser seismic loads, hence lesser damage to the structure - Minimal repair of superstructure.
- Building can remain serviceable throughout construction.
- Does not involve major intrusion upon exist superstructure.

2.4. Disadvantages Of Base Isolation Expensive.
Cannot be applied partially to structures unlike other retrofitting.
Challenging to implement in an efficient manne

2.5 Mass Reduction Technique of Retrofitting. This may be achieved, for instance, by removal of one or more storey's. For this case it is evident that the removal of the mass will lead to a decrease in the period, which will lead to an increase in the required strength



Seismic Retrofitting by Mass reduction (removal of storey).

2.6 Wall Thickening Technique of Retrofitting: The existing walls of a building are added certain thickness by adding bricks, concrete and steel aligned at certain places as reinforcement, such that the weight of wall increases and it can bear more vertical and horizontal loads, and also its designed under special conditions that the transverse loads does not cause sudden failure of the wall.

CHAPTER-5 PART-C

BUILDING SERVICES.

(A) Cold water enters the building from a rising main and is stored in an intermediate cold water tank. The cold water is fed from the tank by gravity to the points of use without recirculation.

System Layout :-

In the design process, the layout of the plumbing system will largely follow room layout. Nonetheless, there are many things to consider which relate to code compliance, building users, comfort and sustainability.

When planning a water supply layout the following must be considered.

→ Pipe runs and lengths - Keep pipe runs as short as possible. Pass pipe close to fixtures to minimise the no. of branches and unnecessary elbows, tees and joints. Having longer pipe runs and more fixtures will reduce flow rate, increase heat losses, and increase use of materials.

→ Point of entry into the building - This should be into a utility space such as garage / laundry and include an accessible isolating valve, line strainer and pressure limiting valve.

(B) **Central hot water production :-**

If a central hot water production is used, the hot water is distributed from the central hot water tank to the apartments with a hot water pipe and a hot water circulation

pipe. The general principles as follows are applicable.

→ Avoid installing the circulation pipe in the apartments, use only supply pipes for the users.
→ The maximum pressure in the distribution system is 600 kPa.
→ The user pressure for each apartment has a minimum of 200 kPa.
→ The maximum pressure for the hot water system. Its not possible to locate the hot water storage tanks in the basement because of the high static pressure. This hot water concept provides space on the floors near the apartments.

(e) Sanitation :-

Plumbing and sanitary items used in building construction. The plumbing water supply system consists of water supply and distribution pipes, taps, valves, storage tanks etc, while plumbing drainage system consists of wash basins, water closets, urcinals, traps, soil-waste pipes, vent pipes, septic tanks etc.

(D)(i) Electrical services :-

An electrical system, within the context of a building is a network of conductors and equipments designed to carry, distribute and convert electrical power safely from the point of delivery or generation to the various loads around the building that consume the electrical energy.

(ii) Wiring:-

It is the network of wires used in an electrical system, device, or circuit. The circuit breaker works as a protection whenever electrical wiring in a building has too much current flowing through it. Wiring is the network of wires used in an electrical system, device or circuit.

Types of wiring:-

→ Cleat wiring
→ Wooden casing and capping wiring.
→ CTs or TRS or PVC sheath wiring.
→ Lead sheathed or metal sheathed wiring.
→ Conduit wiring.

(iv) ~~Fuses~~ Wiring Layout

A wiring layout diagram is a simple visual representation of the physical connections & physical layout of an electrical system or circuit. It shows how the electrical wires are interconnected and can also show where fixtures and components may be connected to the system.

(iii) Fuses:-

fuses are used for the prevention of home appliances from the short circuit and clamp by overload or high current etc. If we don't use fuses, electrical faults occur in the wiring and may starts fire at home

Types of fuses:-

① DC fuses - DC fuses have larger in size. DC supply has constant value above 0V so it is hard to neglect and turn off the circuit and there is a chance of an electric are between melted wires. To overcome this, electrodes placed at larger distances and because of this the size of DC fuses get increased.

② AC fuses - AC fuses are smaller in size. They oscillated 50-60 times in every second from minimum to maximum. So there is no chance of Arc between the melted wires. Hence they can be packed in small size.

④ Earthing :-

Earthing is used to protect you from an electric shock. It does this by providing a ~~both~~ path for a fault current to flow to earth. It also causes the protective device to switch off the electric current to the circuit that has the fault.

Uses of earthing :-

The neutral earthing is also called the system earthing. Such type of earthing is mostly provided to the system which has star winding. For example, the neutral earthing is provided in the generator, transformer motor etc.

(E) Requirements of lighting system:-

→ Sufficiency
→ Distribution
→ Absence of glare.
→ Absence of sharp shadows.
→ Steadiness.
→ Color of light
→ Surroundings
→ Angle of light

Light intensity measurement Goniophotometer

(F) VENTILATION:

Ventilation may be simply defined as a process of removing or supplying air by natural or mechanical means two & from a air spaces or any space.

(i) Methods of ventilation :-

1- Natural ventilation or acceration.
2- Mechanical ventilation or artificial ventilation

NATURAL VENTILATION :-

In this system of ventilation the outside air supplied into a building through windows doors ventilators an other opening due to wind outside & convation effect a rising from temperature or vaipour pressure difference or both between the side & outside of the building.

→ Natural ventilation is usually considered suitable for houses & flats it can't be adopted for big offices, assembly halls theaters auditorium, large factory, work shops etc.

ARTIFICIAL VENTILATION :-

It means of assisting or stimulating respiration, a metabolic process referring to the overall exchange of gasses in the body by pulmonary ventilation, external respiration and internal respiration.

SYSTEM OF VENTILATION :-

All of the fans, vents and ventilation equipment in a home work together as a "ventilation system" to exchange indoor and outdoor air without wasting energy. Ventilation systems can be categorized as one of four types: exhaust, supply, balanced, and heat - recovery.

PROBLEMS OF VENTILATION :-

In fact, buildings with high ventilation rates may suffer indoor air problems due to an uneven distribution of air, or insufficient exhaust ventilation.

MECHANICAL SERVICES :-

→ LIFTS : A lift is a form of vertical transportation between building floors, levels or decks, commonly used in offices, public buildings &

Other types of multi-storey building.

★USES★

These are used to transport both people and goods from one floor to another.

TYPES

→ CAPSULE LIFT
→ HYDRAULIC LIFT
→ PNEUMATIC LIFT
→ RESIDENTIAL LIFT

→ ESCALATORS:- It is used for vertical transportation & requirees the least and of horizontal space & providing the fast service at the least cost.

★USES★ Escalators are found installed in stores & other places where transportation facilities are necessary however they have not found in more use in industry in India.

TYPES

→ By normal width
→ By speed in mt/min
→ Riser. The upright part of a step
→ Driving Roller.

→ ELEVATORS:-

Elevators are mainly machine intended for raising load in guide ways.

→ Large elevators are intended exclusively per vertical lifting of material & passangers in a cage which moves reiged guide rails.
→ Electrically driven elevators are the most popular.

COMPONENTS OF ELEVATORS :-

An electric elevators compaireses the following main parts.

1- Cages (for passengers and goods)
2- Car (for concrete mixes).
3- Steel formed structures.

TYPES :-

→ Traction with a machine room.
→ Machine - room - less traction.
→ Hydraulic.

CHAPTER-6 PART-D

CONSTRUCTION AND EARTH MOVING EQUIPMENTS

(a) Planning and selection of equipments:-
For speady & economic construction of a project proper choice of equipment is primary importance selection of equipment is possible by following general consideration. This includes -

1- Use of available equipments.
2- Suitability for job conditions.
3- Uniformility of type.
4- Size of equipment.
5- Use of standard equipment.
6- Unit cost of procoduction.
7- Country or origine.
8- Availability spare parts.
9- Versatility
10- Selection of manufacture
11- Suitability of local labour.
12- Adoptability for future use.

(b) DRAGLINE

It is used to excavate earth and loads it into haul unit such as trucks or tractor pulled wagons, or to deposite it on spoil banks & embankment near the place from where it is excavated.

Types of dragline:-
→ Crawler mounted.
→ Wheel mounted.
→ Truck mounted.

Uses of dragline :-

It is used for the excavation of canal, ditches, trenches & under water soil.

→ It is used for sloping and shallowing grading
→ It is used for haul unit & loading into hopper

Main parts of dragline :-

→ Hoist cable
→ Hoist chain
→ Drag chain
→ Drag cable
→ Dump cable.

★ TRACTOR

→ It is an important equipment for earth moment.
→ It converts engine energy for to treactive energy.
→ It is usually work by diesel engine having horse power ranging from 2HP - 200 HP.
→ They are either ① Crowller
② - wheel or premulatic.
→ They crowler type moves on an endless chain.
→ They are slower in steel than wheel type.
→ Generally they are the speed of about 12 kmph.
→ They are used for uneven and rough ground.
→ It based operate on gravel or earth.
→ wheel tractors move on Pneumatic tyres & have a speed of about 50 km/ph.
→ They operate based on smooth roads.
→ It used to pull or push other equipments. Here they are provided with various attachment such as dozers, scrappers & plough etc.

* BULL DOZER,

It is broadly used to include both a bulldozer and an angle dozers. These machinery further be classified into

1- Crawler - tractor - mounted.
2- Wheel - tractor - mounted.

Classification :-

→ Based on the method of raising & lowering the blade a bulldozer may be 2 types.
1- Cable controlled.
2- Hydraulically - control.

Uses of bulldozers :-

→ Clearing land of timber & stumps.
→ Opening of pilot roads through mountains & rough areas.
→ Moving earth for the haul distances of to about 100 mts.
→ Helping load tractors.
→ Spreading earth fill.
→ Backfilling trenches.
→ Clearing construction sites of debries.
→ Maintaining haul roads.

* POWER SHOVEL

Power shovels are used mainly to excavate earth and load into trucks or tractor drawen wagons.

→ They can excavate all types of earth except

solid rim.

→ It consist of 6 basic part.

1- Boom
2- Cabin
3- Diper stick
4- Hoist line
5- Mounting
6- Power system & controls.

→ There are 2 types of power shovels.

1- Crawler mounted
2- Wheel mounted.

Uses of power shovels :-

1- It is used for digging & embakment.
2- It is used for dressing slopes.
3- It is used for digging shallow not trenches side-casting & loading haul unit.

(c) ★ TAMPING ROLLERS

→ Temping rollers are high speed self propelled non-vibratory rollers.

→ These rollers usually have four sted-padded wheels and can be equipped with a small blade to help level of left.

→ The pads are tappered with an oval or rectangular face.

→ As a tamping roller moves over the surface the feat penitrate the soil to produce a kneeding action & a pressure to mix & compact the soil from bottom to the top of the layer with repeated passage of the roller over the surface the penitration of fact decreases until the roller is said to walk out of the fill.

→ The working speed for those rollers is in the 8-12 mph range.

→ Generally 2-3 passes overal 8-12 in lift will achieve density. But this is depended on the size of the rollers. 4 passes may be necessary in poorly graded plastic silt or varying clay.

→ A tamping foot roller is effective on all soils except pure sand.

★ SMOOTH WHEEL ROLLERS

Three wheeled or macadam rollers & tendors rollers are the typical examples smooth wheeled rollers.

→ These rollers have either two or 3 rollers in lying behind eachr other.

→ The rocks actually hollow steel drums which can be filled up with water and dam sand to obtain the desired pressure.

→ These rollers are most suitable for compacting gravels, sand & such materials where crushing obtain is needed.

→ The depth or layer which can be satisfactory compacted depends on the type of soil the wt of the rollers and purpose of the work.

→ In general compacted thickness varies from about 150 m for subgrade & to about 15cm for material used in embankment.

★ PNEUMATIC TYRED ROLLERS

→ This type of roller consist of a box-mounted one, two axels.

→ The front axles has less than the rear axles
→ They are usually divided into 3 types
① Popularly known as medium, heavy, super heavy of the medium class includes both towards type & are proposed with upto 12 to 15 ton rolling capacity.
② These rollers are suitable for moderately cohesive silty soils, clayey, gravelly & clean sands of close gradation.
③ The compaction should be done in layer less than 15 cm thickness.

VIBRATOR COMPACTORS

This consist of a vibrating unit of either the of balance out type or pull setting hydraulic type mounted on screed plate or roller in such a way that not affect is and up & down vibratory moment of the compactor. These compactors are most effective for course grained soil.

(d) OWNING AND OPERATING COST PROBLEMS

The cost of owning or ownership cumulative record of these cost flows an owner experiences whether or not the machine is productively employed on a job.

Elements of operating cost :-

Operating cost is the sum of those expences an owner experiences by working a machine on a project.

Typical expenses include
1- Fuel
2- Lubricants, filters & grease
3- Repairs
4- Tires
5- Replacement of high wears items.

The factors which effect the cost of owning & operating equipment as follows.
1- Cost of equipment deliver to the owner
2- Demand of such equipment at the end of its used life which will affect the salvage value
3- No. of hours it is used per year.
4- Severity of the condition under which it is used.
5- No of year it is used.
6- State of maintance & repairs etc.

* Salvage value
Salvage value is the case in flow a firm receives if a machine still has value at the time of its disposal. This receive will accure at a future date.
following cost should be consider for arrived at the cost of owning & operating equipment.
1- Investment charges of one year.
2- Depreciation of one year.
3- Maintance & repairs of one year.
4- Operating cost which include cost of fuel & cost of oil.

CHAPTER-7

SOIL REINFORCING TECHNIQUES

NECESSITY OF SOIL REINFORCING

Soil reinforcement is necessary in lands where chances of erosion are high. It is particularly useful in areas with soft soil as it cannot provide adequate support to any construction or building.

GEOSYNTHESIS

→ Soil reinforcement is the act of improving soil strength to enable it support or carry more loads.
→ Soil reinforce is necessary in lands where chances of erosion are high.
→ It is particularly useful in areas where soft soil cannot provide adequate support to any construction or building.

Geosynthesis are man-made products. They are flexible & planar. They are manufacture from synthetic ~~from natural material~~ polymeric material and some times from natural material.

It is categories 5 groups
→ Geotextiles
→ Geomembrane
→ Geogrids
→ Geonets
→ Geo composite

STRENGTHERING SOIL EMBANKMENTS

Generally, the proposed PRDs can Improve the confining pressures and hence is able to effectively improve the shear strength, bearing capacity,

ability to resist elastic and plastic soil deforma
tion, critical dynamic stress, and dynamic shea
r modulus of the embankment soil.

SLOPE STABILIZATION TECHNIQUES

* DEFINITION - A system of permanent design measure
used alone or in combination to minimize erosion
from disturbed surfaces.

* PURPOSE - To stabilize the soil, to reduce raindrop
impact, to reduce the velocity & surface runoff,
and to prevent erosion.

* APPLICABILITY - Applicable to cleared, graded, dis-
turbed slopes, or where vegetation alone does not
provide adequate erosion protection.

* ADVANTAGES -
(1) Stabilizes the soil
(2) Absorbs raindrop impact.
(3) Reduces velocity of surface runoff
(4) Improves infiltration.
(5) Prevents erosion.

* DIS-ADVANTAGES -
(1) Rock slope protection can be considered unattractive
(2) Availability of much material within or near the
Lake Tahoe Basin may be limited.

* EFFECTIVENESS - Along with retaining structures discussed in the

chapter slope stabilization techniques can be used to limit erosion and mass movement conditurbed hill slopes, offering effective source control.

SOIL REINFORCEMENT TECHNIQUES

In simple terms, soil reinforcement is a technique used to improve the stiffness and strength of soil using geo-engineering methods. A long time ago natural fibres were used to reinforce the soil. This old techniques did not have a high yield and required a lot of time for the soil to recover.