ADVANCED CONSTRUCTION MATERIAL & CONSTRUCTION AND EARTH MOVING EQUIPMENTS

LECTURE NOTE

Based on New syllabus (2020-21) circulated by SCTE&VT, Odisha for 6th Semester Diploma in Civil Engineering courses approved by AICTE, New Delhi

PREPARED BY

JYOTIRMAYEE SABAR

Senior Lecturer (Civil), Department of Civil Engineering

Govt. Polytechnic Kalahandi

ACTE (Part-D)

* Planning and Selection of construction equipments :-

Proper planning, selection, procurement, installation, operation, maintenance and equipment replacement policy plays an important role in equipment management for the successful completion of the projects.

⇒ Construction Equipment Planning :

The efficiency of the whole project largely depends upon its planning and it should be done before starting every project and is done with great care.

→ Planning involves deciding about the extent of mechanisation, equipment planning, execution planning etc.

→ Planning also involves to carefully decide about the extent of use of construction equipments, because on major construction projects mechanisation is indispensable, while for middle & minor construction projects a compromise between manual & mechanical means have to be made.

⇒ Selection of Construction Equipment :

Proper selection of equipment for a construction project is of vital importance for its speedy and

economical completion. Following are the main points which should be considered in the process of equipment selection:

→ Suitability for Job Conditions : The equipment must meet the requirement of the work, climate and working conditions.

→ Size of the Equipment : Size of equipment should be such that it must be able to be used with other matching units.

→ Standardisation : It is better to have same type & size of equipments in the project, so that it will be easy for the operators to understand it, mechanics will be able to maintain and repair better as they become expert by handling similar type of equipment.

→ Availability of Equipment : Easily available in the market, equipments should be purchased. It should also be ensured that the equipment is reputed and likely to be continued to be manufactured in future also.

→ Availability of spare parts : While selecting a particular type or make of equipment, it should be ensured that the spare parts will be available at reasonable price throughout the working life of the equipment.

→ The Economic Aspects : While selecting the equipment, it should be considered that the cost of unit production should be minimum.

→ Service Support : Service support should be available in the area of project where the equipment shall be used.

→ Operating Requirements : Equipment should be easy to operate & maintain and should have lesser fuel consumption.

→ Past Performance : If the equipment being purchased is of new make and model, it is desirable to enquire about its performance from other users.

→ Warranty or guarantee offered by manufacturer should be checked.

→ Use of standard components in the equipment to be ensured.

→ Versatility of the equipment should be given due priority, i.e. the machine can be used for many jobs.

* Compaction Equipment :-

Compaction : It is the process whereby material particles are constrained to pack more closely together through a reduction of air void content, generally by mechanical means.

* There are different types of Compactors, vibrators and rollers used for Compaction.

* Types of Compactors :

⇒ Static 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 overmoist cohesive soil due to poor traction.
→ Diesel powered rollers with modern technology of hydrostatic transmission rollers have replaced the traditional steam rollers.
→ Static rollers rely on weight alone to compact the material over which they pass.

⇒ Pneumatic-Tyred Rollers :

→ These are used for compaction both in earthwork and bituminous road construction.
→ They have oscillating axle layout, because of which they produce more even compaction across the rolling width than 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 weights ranging from 6 to 30 tonnes with 500 to 4000 Kg per tyre and tyre pressure from 2 to 8 Kg/sq.cm.

⇒ Vibratory Rollers :

→ These are very effective on free draining type soil and granular base course.

→ Vibrations are produced by rotating eccentric weights within the rolls at high speed, the 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.

→ Rollers with large vibrating drum in front with 2 steel or pneumatic tyred rear driving wheels offer better traction on gradients and in overmoist soil.

→ Single roll pedestrian vibratory rollers weighing nearly 400 kg are used for compacting small areas such as pavements, foundations etc.

→ Towed vibrating rollers weighing 5000 to 11000 kg are used for mass earthworks, base constructions, embankments, rockfill dams etc.

⇒ Tampers and vibrating Plates:

→ Tampers with small vibrating feet are used to tamp footings, trench bottoms, position posts, lay paving slabs or in any small area where high care and skill is required.

→ These can also be used on small road repair jobs, footpath construction and compacting trench bottoms for pipe laying.

→ Operational weights fall in range upto approximately 80 kg for tampers and as much as 300 kg for vibrating plates.

→ Tampers can deliver from 800 to 4500 blow per min and are generally powered by engine.

* Vibratory Compaction Equipment :

Vibratory compactors can be divided into following groups:

i) Tandem Vibratory Compactors.
ii) Towed Vibratory Compactors
iii) Towed sheepfoot and tamping foot vibratory Compactors
iv) Self-propelled Vibratory Compactors
v) Handguided Vibratory Compactors.

i) Tandem Vibratory Compactors :

→ These are available with dual (all wheel) drive or single axle drive.
→ They are available in two types, namely single drum vibrating or both drum vibrating.
→ In double vibrating drum compactors, two tandem wheels are provided with separately controlled vibrators in the front and rear rolls.
→ The double drum vibratory compactors can be used, either with both vibrating drum operating or one vibratory drum operating.

ii) Towed Vibratory Compactors :

→ These are mainly used for the compaction of cohesive soils, fine and coarse grained mixed soil, and rocky materials.
→ The heavy towed vibratory compactors are used for the compaction of extremely thick layers.

→ These have larger amplitude and therefore show a 'tamping' motion (Impact motion).

iii) Towed Sheepfoot or Tamping foot Vibratory Compactors :

→ These are mainly used for the compaction of highly cohesive soils, and soft rock.

→ The Kneading and crushing effect of the feet improves the compaction performance.

→ Sheepfoot rolls are having cylindrically shaped feet with relatively small contact areas.

→ Tampingfoot rolls have feet with larger contact areas and are designed so that the actual contact area increases with the penetration of the foot into the soil.

iv) Self-propelled Vibratory Compactors :

→ These are available in large varieties mostly around 8 to 12 tons dead weight range, to suit the requirement of the job condition.

→ Large vibratory steel roll in the front and two rubber ~~type~~ tyres in the rear.

→ Vibratory steel roll in the front and two static steel rolls in the rear for multipurpose works.

v) Handguided Vibratory Compactors :

→ These may be either (i) Single drum which vibrates with the operator guiding it from behind, (ii) duplex having

either one or both drum vibrating.

→ These are used for compacting trenches, slopes, parking lots, small repair jobs, sport centres, insides building and other confined spaces, and preparing foot and bicycle paths.

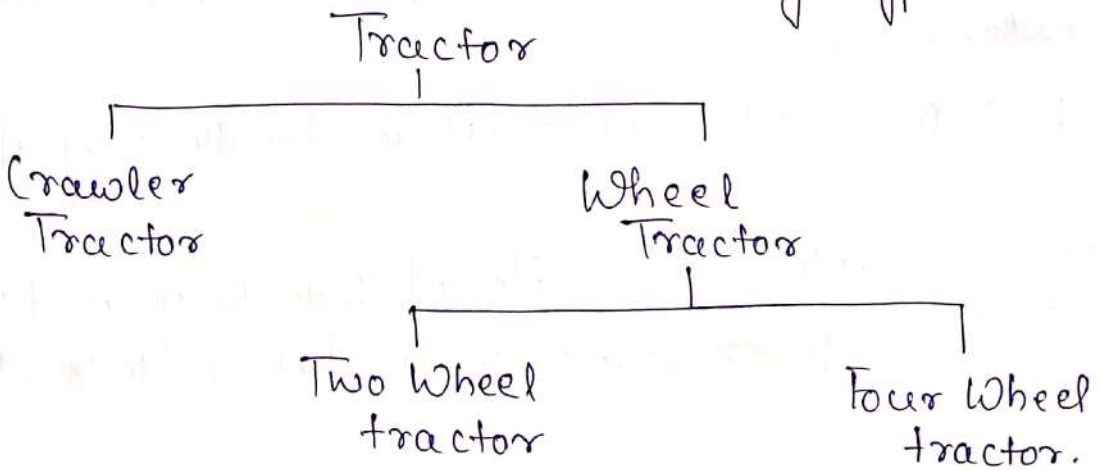
* Earth Moving Equipments :

The primary purpose of earth moving equipments are to pull or push loads and it may be used for excavating and transporting of equipments. Some of the earth moving equipments are discussed here.

Tractor :

It is regarded as one of the most important equipments and is indispensable on most of the construction projects whether small or big.

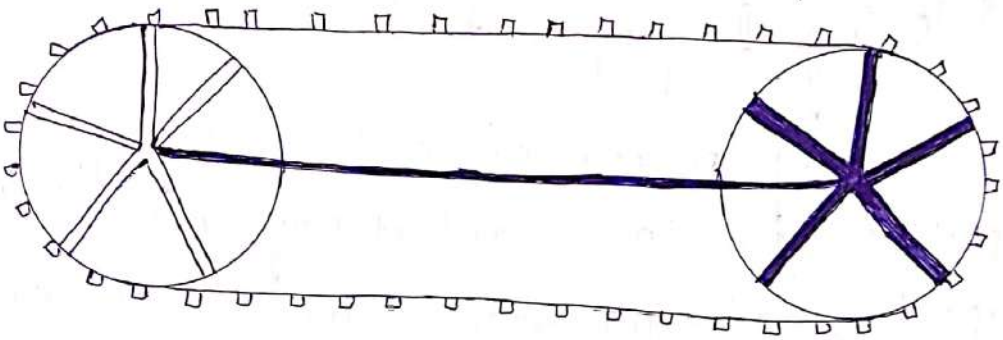
→ Tractors are divided into following types:



* Crawler Tractor :

→ If a tractor is mounted on crawler, it is called crawler tractor.

→ A crawler track is an endless, chain consisting of steel links made of steel plates connected together by pins and bushings as shown in fig:



→ It is used for moving heavy units on rough surface having poor traction.

→ Having more tractive effort it can operate on soft footing such as loose or muddy soil.

→ It can operate in rocky formation where rubber tyres may be seriously damaged.

→ It has greater floatation because of lower pressure under the tracks.

→ Being compact and powerful, it can handle very difficult jobs.

→ A crawler tractor has a life of 8 to 12 years depending upon its horse power which varies from 100 to 300 HP.

* Wheel Tractor :

→ It can travel at higher speed on the job or more from one job to another.
→ It can give greater output where considerable travelling is necessary.
→ It can travel over paved highways without damaging the surfaces.
→ It can operate easily which makes the operator less fatigue.
→ A wheel tractor is very useful for long push distance, fast return, loose soil - little or no rock, level or downhill work.
→ Its useful life lies between 8 to 10 years depending upon on its horsepower which is generally more than 75 HP.

Bulldozer :

→ These are very efficient excavating tools for short haul applications up to 100 m and as auxiliary machine to other construction equipments.
→ In many projects they may be used from the start to the completion of projects for various operations such as : Clearing land of trees and vegetation, Opening of temporary roads through rocky areas.
→ These are also used for moving earth for haul distance upto 100m and helping load tractor pulled scrapers.

→ These are also used for spreading and levelling earth fills, back filling trenches, clearing the construction sites of debris and rubbish and many more.

→ According to the direction of blades, the bulldozer is classified as bulldozer and angledozer.

→ According to the control of blade, it is classified as Cable controlled bulldozer and hydraulic controlled bulldozer.

→ According to the mountings of a bulldozer, it is classified as Crawler mounted bulldozer and wheel-mounted bulldozer.

→ At the time of purchasing a bulldozer, the engine horsepower at the fly wheel, speed range, blade type and size, turning radius, fuel tank capacities, number and size of tyres, ground clearance etc., should be verified.

Power Shovel :

→ It is a construction equipment whose purpose is to excavate the earth and load it into the trucks or other hauling equipment waiting nearby.

→ If a power shovel is mounted on crawler track, it is called crawler-mounted power shovel, and if it is mounted on rubber tyred wheels it is referred as wheel-mounted power shovel.

→ Size of power shovel is indicated by the size of dipper generally expressed in cubic meters and are available in size 3/8, 1/2, 3/4, 1, 1 1/4, 1 1/2, 2 & 2 1/2 Cubic meter.

→ The basic parts of a power shovel consist the mounting, cab, boom, dipper stick, dipper & hoist line.

→ The output of power shovel is expressed in cubic meter per hour based on bank-measure volume.

Drag line :

→ As the basic character of the machine is dragging the bucket against the material to be dug, it is called dragline.

→ It is used to excavate the earth and load it into hauling units or to deposit it into dams/embankments or soil banks near the pit from which it is excavated.

→ It usually does not have to go into a pit or hole for excavating the earth. It may operate on natural firm ground.

→ It is excellent for excavating trenches without shoring.

→ It is of 3 types such as – crawler mounted dragline, wheel mounted dragline and truck mounted dragline.

→ The output of a dragline is expressed in cubic meter per hour bank measure.

→ The factors that affect the output of dragline are, class of material, depth of cut, angle of swing, size & type of bucket, length of boom etc.

* Note: Hourly working rate of construction equipment comprises of the components such as – Owning cost and Operating cost.

* Owning and Operating Cost:

⇒ Owning cost is made up of the following costs:
i) Investment cost
ii) Depreciation cost.
iii) Major Repair cost.

⇒ Operating cost includes the following cost:
i) Cost of fuel (or power)
ii) Cost of lubricants
iii) Servicing & maintenance cost.
iv) Labour cost.
v) Cost of field repairs
vi) Various other overheads.

→ The cost of possession of an equipment is called cost of owning to which can be added the cost of fuel for running the equipment is called the cost of operating.

→ The following factors affect the cost of owning and operating:

i) Initial cost of the equipment which consists the price of equipment, transportation cost, loading and unloading charge and installation cost.

ii) Severity of service condition under which it is to be used.

iii) No. of hours it is used per year.

iv) The care with which it is maintained & repaired.

v) The demand for equipment after its useful period i.e. the salvage value.

vi) Useful life of equipment in years.

ACTE - PART- A

* Artificial Timber :

The timber which is prepared scientifically in a factory is termed as the "artificial timber" or industrial timber and such timber posseses desired shape, appearance, strength etc.

* Types of artificial timber :

There are varieties of artificial timber available in market and are as follows :

i) Veneers
ii) Plywoods
iii) Fibreboards
iv) Impreg timbers
v) Compreg timbers
vi) Block board & laminboard
vii) Glulam
viii) Flushdoor shutters
ix) Particle board or Chip board
x) Hardboard.

i) Veneers :

→ These are thin sheets or slices of wood of superior quality, having a thickness of 0.40mm to 6mm or more.

→ The veneers after being removed are dried in Kilns to remove moisture.

→ The edges of veneers are joined and sheets of decorative designs are prepared.

→ The Indian timbers which are suitable for veneers are mahogany, oak, rosewood, sissoo, teak etc.
→ The veneers are used to produce plywoods, battenboards and laminboards.
→ The veneers may be glued with suitable adhesives on the surface of interior wood. The appearance of interior wood is then considerably improved.

ii) Plywoods :

→ The meaning of term ply is a thin layer and the plywoods are boards which are prepared from thin layers of wood or veneers.
→ Three or more veneers in odd numbers are placed one above the other with the direction of grains of successive layers at right angles to each other. They are held in position by applying adhesives.
→ The plywoods are used for various purposes such as ceilings, doors, furniture, partitions, panelling walls, packing cases, formwork for concrete etc.
→ The plywoods are available in different commercial forms such as battenboard, laminboard, metal faced plywood, multiply, three-ply, veneered plywood, etc.
→ They are elastic and hence they are not liable to split or crack due to changes in atmosphere.

→ They do not split in an axial direction.
→ They make use of rare and valuable timbers in a quite economical way.
→ They possess uniform tensile strength in all directions.

iii) Fibreboards :

→ These are rigid boards and they are also known as the pressed wood or reconstructed wood.
→ They are available in lengths varying from 3m to 4.50m and in widths varying from 1.20m to 1.80m and the thickness varies from 3mm to 12mm.
→ The weight of fibreboards depends on the pressure applied during manufacture, the maximum and minimum limits of weights are respectively 9600 N/m³ and 500 to 600 N/m³.
→ Depending upon their form and composition, these are classified as insulating boards, medium hard boards, hardboards, superhard boards and laminated boards.
→ These form an ideal base for practically all types of decorative finishes such as distemper, oil paint, etc.
→ Fibreboards are used for internal finish of rooms such as wall panelling, suspended ceilings, etc, to construct partition, to prepare flush doors, tops of tables, etc.

→ These are also used to construct formwork for cement concrete i.e. to retain cement concrete in position when it is wet.

→ It is also used to provide an insulating material of heat and sound, and to work as paving or flooring material.

iv) Impreg timbers :

→ The timber which is fully or partly covered with resin is known as the impreg timber.

→ The usual resin employed is phenol formaldehyde which is soluble in water.

→ The veneers or thin strips of woods are taken and they are immersed in resin, the resin fills the space between wood cells and by chemical reaction a consolidated mass develops.

→ These are used for moulds, furniture, decorative articles, etc.

→ These type of timbers are not affected by moisture and weather conditions, they are strong & durable.

→ It possesses more electrical insulation, it presents a decent appearance and it resists the acidic effects.

v) Compreg timbers :

→ The process of preparing compreg timbers is same as that of impreg timbers except that curing is

Carried out under pressure.

→ The strength and durability of compreg timbers are more as compared to the impreg timbers.

→ The specific gravity of compreg timbers is about 1.30 to 1.35.

vi) Block boards and Lamin boards :

→ Block boards are boards having a core made up of strips of wood, each not exceeding 25mm in width.

→ The edges are glued together to form a solid sheet, which is then finished with one or two cross bonded veneers on each face.

→ When the thickness of core strips does not exceed 7mm, such boards are known as lamin boards.

→ These boards are extensively used for railway carriages, bus bodies, marine and river crafts, for furniture, partitions, panelling, prefabricated houses, etc.

vii) Gluelam :

→ It means glued and laminated wood.

→ It is not made of veneers but with solid wood, as it is glued to large sections.

→ Gluelam sheets are mainly used for supporting long span roofs in sports stadium, indoor swimming pools, sheds for chemical factories, etc. where other materials like steel cannot last long.

→ They can be used as beams of many shapes including curved members.

viii) Flush door shutters :

→ These days, factory-made flush door shutters have become more popular for interior work.

→ They are available in thickness of 25 mm, 30 mm or 35 mm.

→ Different types of flush door shutters are available in the market such as — Cellular core type, Hollow core type, Block board core type and Particle or MDF board core type.

ix) Particle boards or Chip board :

→ These boards are made of wood particles or rice husk or bagasse (remains of sugarcane after crushing), embedded in resin and subjected to heat with pressure.

→ These boards are manufactured by extrusion pressing or by pressing in parallel plates.

→ Particle boards are heavier than solid wood plywood.

→ They provide broad and stable panels of reasonable strength, they can be sawn like wood and are mainly used for furniture making.

X) Hardboards :

→ Hardboard is made from wood pulp which is compressed to make sheet usually of 3mm thick.

→ Its face surface is made smooth and hard while back surface is made rough with pattern or cross lines.

→ Its width is usually 1.2m and length varies from 1.2m to 5.5 m.

* Uses of timber :

There is hardly any material other than timber which can be used as an all round substitute in construction work and its uses are as follows :

→ It is used for door and window frames, shutters of doors, roofing materials, etc.

→ It is used for formwork of cement concrete, centering of an arch, scaffolding etc.

→ It is used for making railway coach wagons, railway sleepers, packing cases etc.

→ It is used for making toys, engraving work, matches, etc.

Miscellaneous Materials

* Acoustics Materials :

When the sound intensity is more, then it gives the great trouble to the particular area like auditorium, cinema hall, studio, recreation center, entertainment hall, reading hall etc. Hence it is very important to make that area or room to be sound proof by using a suitable material called as 'Acoustic Material'.

→ The acoustics treatment is provided so as to control the outsides as well as inside sound of the various building until such that the sound will be audiable without any nuisance or disturbance.

Types of Acoustic Material :

There are various types of acoustic material used in construction and are as follows :

→ Acoustic Plaster
→ Acoustic tiles
→ Perforated Plywood
→ Fibrous Plaster
→ Straw board
→ Pulp board
→ Hair felt
→ Compressed fibre board
→ Cork board slabs
→ Foam glass
→ Asbestos Cement boards
→ Thermocoal
→ Foam plastic
→ Chip boards.

Properties of Acoustic Material :

→ Sound energy is captured and adsorbed.
→ It has a low reflection and high absorption of sound.
→ Higher density improves the sound absorption efficiency at lower frequencies.
→ It controls the sound and noise levels from machinery and other sources for environmental amelioration and regulatory compliance.
→ Acoustic material reduces the energy of sound waves as they pass through.
→ It suppresses echoes, reverberation, resonance and reflection.

Uses of Acoustic Material :

→ It makes the sound more audible which is clear to listen without any disturbances.
→ A vinyl acoustic barrier blocks controls airborne noise from passing through a wall ceiling or floor.
→ Acoustic foam and acoustic ceiling tiles absorb sound so as to minimize echo and reverberation within a room.
→ Sound proof doors and windows are designed to reduce the transmission of sound.

* Wall Claddings :

→ Cladding is the application of one material over another to provide a skin or layer. In construction, cladding is used to provide a degree of thermal insulation and weather resistance, and to improve the appearance of buildings.

→ Cladding can be made of any of a wide range of materials including wood, metal, brick, vinyl and composite materials that can include aluminium, wood, blends of cement and recycled polystyrene, wheat/ rice straw fibres.

Properties and Uses of Wall Claddings :

→ Cladding itself is not a waterproof material, but a control element: it may serve only to direct water or wind safely away in order to control run-off and prevents its infiltration into the building structure.

→ It can also be a control element for noise, either entering or escaping.

→ Rainscreen cladding is a form of weather cladding designed to protect against the elements, but also offers thermal insulation.

→ Between the cladding and the wall there is a cavity where rain can run down.

→ It provides protection from rough weather conditions like snow, rain, heat and wind, and at the same time, adds some value and elegance to the property.

* Plaster Boards :

→ They are made from a large sheet of gypsum plaster faced on both sides with stout paper as a reinforcement.

→ They are available in thickness varying from 9.5 mm to 12.5 mm.

→ There are two types of plaster boards depending upon the nature of facing plaster:
i) Gypsum lath board ii) Plaster wall board.

→ It has good insulating properties, and are mainly used for partition walls, internal lining of walls and for partition walls.

→ It is used to help builders and designers meet building regulations for fire protection, acoustic insulation and thermal efficiency.

→ It can also help to control condensation and potential damage in areas of high humidity.

* Micro-Silica :

→ Microsilica, also known as silica fume or condensed silica fume, is a mineral admixture composed of very fine solid glassy spheres of silicon dioxide.

→ Microsilica in concrete improves its strength and durability as it provides more uniform distribution and a greater volume of hydration products, and decreases the average size of pores in the cement paste.

→ As a result, microsilica concrete is able to strongly protect reinforcement and embedments from aggressive agents.

Types of Microsilica :

Microsilica comes in three forms which are :

i) Powdered Microsilica
ii) Condensed Microsilica
iii) Slurry Microsilica.

Properties of Microsilica :

→ It is a grey ; nearly white to nearly black powder.

→ It has spherical particles less than 1mm in diameter.

→ Its bulk density is based on the degree of densification and varies from 130 to 600 kg/m^3.

→ The specific gravity of microsilica range between 2.2 to 2.3.

Uses of Microsilica:

→ It reduces thermal cracking caused by the heat of cement hydration.

→ It improves durability to attack by sulphate and acidic waters.

→ It reduces the early age temperature rise.

→ Silica fume is cheap; therefore it is cost-effective.

→ It is used in elastomeric, polymer, refractory, ceramic and rubber applications.

* Bonding Agents:

→ The development of construction technique has posed the problem of providing durability in the joints between different engineering materials such as aluminium, concrete, glass, marble, masonry wall, steel and stone.

→ Concrete bonding agents are natural or synthetic materials used to join the old and new concrete surfaces.

→ This agent can also be used to join the successive concrete layers. This chemical helps to allow different concrete surfaces to behave like a single unit.

→ Different types of concrete bonding agents used in construction are as follows:

i) Epoxy Bonding Agents.
ii) Acrylic Latex Bonding Agents.
iii) Polyvinyl Acetate (PVA).

Properties of Bonding Agents:

→ Bonding agents are easy to use and apply.
→ They reduce cracks formed in shrinkage.
→ The permeability of concrete is reduced.
→ The use of bonding agents improves adhesion between the layer of concrete.
→ The tensile, flexural and bond strength of the concrete or mortar are increased.
→ Bonding agents have high resistance against frost and chemical actions.

Uses of Bonding Agents:

→ These are used as an ideal resin for high performance and lightweight concrete parts.

→ They are not only used to bond concrete layers but also to join concrete and steel.

→ This agent is primarily used to bond fresh concrete with a surface of old concrete.

→ This agent is also used for the repair works in concrete as its offers great water resistance, ultraviolet stability and aging characteristics.

* Adhesives :

→ An adhesive is a substance which is used to join two or more parts so as to form a single unit. The application of adhesive has ~~more~~ advantages over the conventional methods of bolting, riveting and welding.

→ There are various types of adhesives such as:

i) Albumin glues
ii) Animal protein glues
iii) Glues from natural resin
iv) Glues from synthetic resins
ix) Vegetable glues.
v) Nitrocellulose glues
vi) Rubber glues
vii) Special glues
viii) Starch glues

Properties and uses of Adhesives :

→ It should have a higher degree or intensity of sticking, higher durability and higher resistance

to heat.

→ It should have a good strength of bond developed after drying or setting.

→ Using adhesives a wide variety of combinations in joining is possible.

→ It can be used for bonding the surfaces of glass, metal, plastics and wood.

→ It is possible to prevent corrosion between different metals joined by adhesive.

→ The process of applying adhesive is easy, economical and speedy.

* Fibres :

Fibres are used as an advanced construction material. Fibre reinforced concrete can be defined as a composite material consisting of mixtures of Cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibres.

→ Fiber is a small piece of reinforcing material possessing certain characteristics properties.

→ Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity.

Types of Fibers :

Following are the different type of fibres generally used in the construction industries.

i) Steel Fiber Reinforced Concrete.
ii) Glass Fiber Reinforced Concrete.
iii) Carbon fibers
iv) Asbestos fibres
v) Organic fibres
vi) Polypropylene Fiber Reinforced (PFR) Cement mortar & Concrete.

i) Steel Fiber Reinforced Concrete :

→ A number of steel fiber types are available as reinforcement.

→ Round steel fiber the commonly used type are produced by cutting round wire in to short length. The typical diameter lies in the range of 0.25 to 0.75 mm.

→ Steel fibers having a rectangular sections are produced by slitting the sheets about 0.25 mm thick.

→ Fiber made from mild steel drawn wire, Conforming to IS:280-1976 with the diameter of wire varying from 0.3 to 0.5 mm have been practically used in India.

→ Deformed fiber, which are loosely bounded with water-soluble glue in the form of a bundle are also available.

→ Since individual fibers tend to cluster together, their uniform distribution in the matrix is often difficult. This may be avoided by adding fibers bundle, which separate during the mixing process.

ii) Glass Fiber Reinforced Concrete :

→ Glass fiber is made up from 200-400 individual filaments which are lightly bonded to make up a strand.

→ These strands can be chopped into various lengths, or combined to make cloth mat or tape. Using the conventional mixing techniques for normal concrete it is not possible to mix more than about 2% of fibers of a length of 25 mm.

→ The major appliance of glass fiber has been in reinforcing the cement or mortar matrices used in the production of thin sheet products.

→ The commonly used varieties of glass fibers are e-glass used in the reinforced of plastics and AR glass. E-glass has inadequate resistance to alkalis present in Portland cement cohere AR-glass has improved alkali resistant characteristics.

→ Sometimes polymers are also added in the mixes to improve some physical properties such as moisture movement.

(iii) Carbon Fibers :

→ Carbon fibers form the most recent and probability the most spectacular addition to the range of fiber available for commercial use.

→ Carbon fiber comes under the very high modulus of elasticity and flexural strength. These are expansive.

→ Their strength and stiffness characteristics have been found to be superior even to those of steel.

→ These are more vulnerable to damage than even glass fiber, and hence are generally treated with resin coating.

Properties of fibers :

→ It increases the tensile strength of the concrete.

→ It reduce the air voids and water voids than inherent porosity of gel.

→ It increases the durability of the concrete.

→ Fibres such as graphite and glass have excellent resistance to creep.

→ It itself is a composite material, where the reinforcement act as the strengthening fact.

12/3/19

Ratro fitting of structures :-

→ It is the modification of existing structure to make them more resistant to seismic activity, ground motion, soil failure due to earthquake.

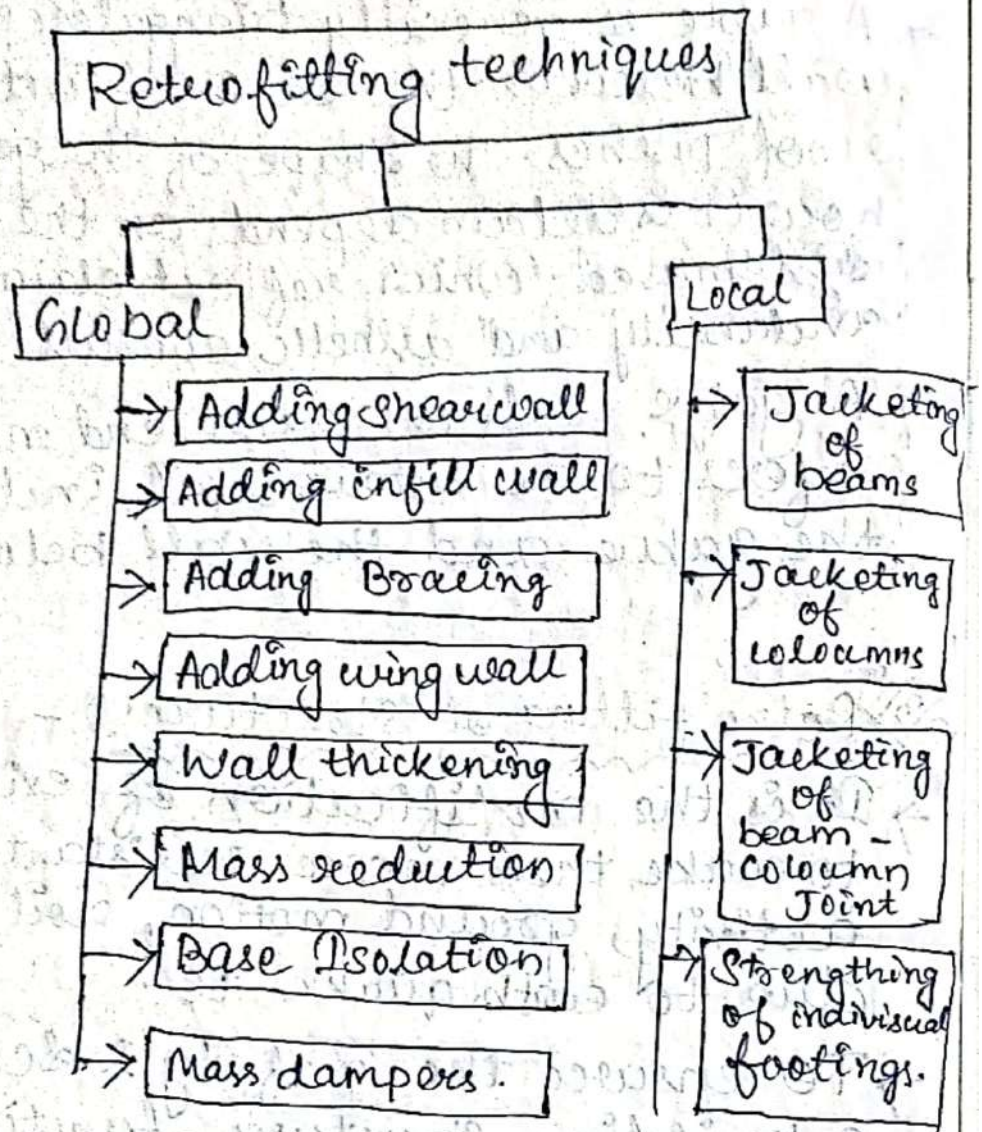
→ To ensure the safety & security of a building structure functionality machinery and inventory.

→ Assential to reduce hazards and losses from non structural element.

→ Lake of standard for ratro fetting method effectiveness of is method varies a lot depending upon parameters like type of structure material condition, amount of damage etc.

→ The main aim is upgradation of stength of the structure, increase in the ductility of the structure.

Classification of retrofitting techniques



Adding new Shear wall :—

→ Frequently used for retrofitting of non-ductile reinforced concrete frame buildings.
→ New elements preferably be placed at the exterior of the building, not preferred in the interior of the structure to avoid interior modeling.

Adding steel bracing :—

An effective solution when large openings are required.
Potential advantages due to higher

Strength and stiffness openings for natural light can be provided amount of work is less. Since foundation cost may be minimize and add much less weight to the existing structure.

Base Isolation :→

→ Isolation of super structure from the foundation is known as base isolation.

→ It is the most powerfull tool. Basic structural vaibration control technique

→ Isolates building from ground motion lesser seismic load hence lesser damage to the structure.

→ Building can remain surviceable throughout construction, minimal repair of super structure, does not involve major instruction of an existing superstructure.

→ But it is expensive, can't be applied Partially to structure unlike other retro fitting, challangeing to implendent in an affective manner.

Mass reduction :—

This may be achive for instance by removal of one or more storey in this case it is evident that the removable of mass will lead to decrease in the period which will lead to increase in

required strength.

Wall thickening :-

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

4/3/19

Jacketing :-

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

Types of jacketing :-

(i) Steel jacket
(ii) Rein forced concrete jacket
(iii) Fiber reinforced polymer composite jacket.

Purposes of jacketing :-

(i) To increase concrete confinement
(ii) To increase shear strength
(iii) To increase flexural strength.

Seismic retro fitting techniques for concrete structure :—

i) Seismic retro fitting is a suitable technology for protection of a variety of structures.

ii) It has material in the recent year to a highly reliable technology.

iii) But the expertse needed is not avilable in the basis level.

iv) The main challange is to achive a desired performance level at a minimum cost which can be achived through a detain non linear analysis.

v) Optimition technique are needed to know the most efficient retrofit for a particular structure.

vi) Proper design course are needed to be published as code of pratices for professionals related to this field.

———— o ————

Chapter-4

1/3/19

Earthquake resistant construction

Building configuration :-

Building have in simple regular geometric and uniformly distributed load or mass and stiffness in plan as well as in elevation suffers much less damage is known as building configuration.

Q. State different plan configuration problem?

A→ To perform well in an earthquake a building should possess ~~if~~ four main attributes namely simple and regular configeration and adequate lateral strength, stiffness and ductility.

(i) A building shall be considered as irregular for the purpose of this Standard if at list one of the conditions given is applicable.

(ii) Plan configeration of a structure and its lateral force resisting system contain reentrant corners. Where both of the projection of the structure beyond the corner are greaterthen 15% of its plan dimension in the given direction.

(iii) This continuous in a lateral force resistance path such as out of plan offset of vertical

elements.

(iv) In plan offset of the lateral force resisting elements greater than the length of those elements.

7/3/19

Q. Described different building characteristics from seismic performance point of view?

A→ Following are the different building characteristics from seismic point of view.

(i) The seismic weight of the whole building is the sum of seismic weight of all flows

(ii) Any weight supported in between storey shall be distributed to the flows above and below in inverse propation to its distance from the floors.

(iii) For calculation the design seismic forces of the structure the imposed load on roof need not to considered.

(iv) The seismic weight of each floor is full dead load appropriate amount of imposed load.

(v) While computing the seismic weight of each floor the weight of column and walls in any storey shall be equally distributed on effect above and below the storey.

Q. What is lateral load resisting system?

A→ The first step in architechtural planning of a building is to dillay the lateral load resisting system. The load resisting system must be of floor loops so that it is able to transfer all the forces acting either vertically or horizontally to the ground.

Q. Enunerate safety consideration during additional construction and ulteration of existing building?

A→ If sufficient precautions w.r.t safety of work are not taken there are changes of serious accidents involving heavy loss of man and materials. Sum of the safety rules to be observe during the erection process of structures are as follows.

(i) All guys and encourages are should be closely viewed regularly so as to ascertain their bearing capacity of floor.

(ii) Suitable parking pieces must be poovided at the required point of so as to avoid the sleeping of road the chain should not be draw from a height but should be low at gradually.

(iv) The equipment and devices employed in the erection poblem should never be over loaded.

(v) The legs of chains should not be open out to such as angle so as to enditure

the stability of work.

(vi) The levels of pannel point of the falls work should be maintained as per desired camber for trucks to avoid straight and distruction during assembly.

(vii) The lifting device and mechanizm should be maintainence in perfect learning order so as to avoid their sudden failure with out notice.

(viii) The lifting should be carried out smoothly with sudden shocks.

8/3/19

Lintel :-

(i) A lintel is a horizontal member which is plaid across an opening to support the portion of the structure above it. The function of a lintel is just the same as that of an arch or a beam.

(ii) In general it should be seen that the bearing of lintel that is the distance of to which it is incerted in the supporting wall should be the minimum of the following 3 considireation.

(i) 100mm or

(ii) Height of lintel or

(iii) $\frac{1}{10}$ to $\frac{1}{12}$ of the span of lintel.

Materials for lintels :-

The common materials used in the construction of lintels are as follows.

(i) Wood or timber lintels.
(ii) Stone lintels
(iii) Brick lintels
(iv) Steel lintels
(v) Reinforced cement concrete lintels

Sill band :-

→ Window sills are provided between the bottom of window frame and above the top of the wall below.

→ Window sills are nessary because they are a part of buildings structure. Their serve as the framing of the window to keep in plaie with out a window sill the opening of that window wood sway and sweep as the foundation sattles the window sill act as a braie to reinforced the wall.

→ Anarage depth for manufactured window sill range from two to eight inches.

11/3/19

Plinth Band :-

→ Plinth bands are primarly used when there is consult about un even settlement of foundation soil.

The lintel band ties the wall together and creat it support for walls

loaded along weak direction from walls loaded in strong direction.

→ Plinth beams are structural elements which are going to hold wall and acts as element where the walls can rest i.e to separate the wall from directly laying it on the ground.

→ A plinth beam is generally provided at natural ground level or ground floor level. The void between the foundation & plinth level is field with compacted soil.

→ Brick or stone masonary is usually constructed below the plinth beam. The plinth beam needs to be strong but need to be made of reinforce cement concrete all the time.

Functions & objectives :→

(i) It saves building by diffential settlement which is cause by partial failure of sub structure or by the failure of soil on which building constructed.

(ii) It provides uniformity to building at plinth level

(iii) Distributed super structure load uniformly to soil via sub structure.

(iv) Also plinth beam provides confination to column of the structure.

Roof Band :—

(i) A roof is defind as the upper most path of a building which is constructed in the form of a frame work to give protection to the building against rain, heat, snow, wind etc.

(ii) A roof basically consist of structural elements provided at the top of building for the support of roof covering.

Requirements of a good roof :—

(i) It should be durable against the adverse affect of various agencies such as wind, rain, sun etc.

(ii) It should grant the discable insulation against sound and heat.

(iii) It should be structurally stable and sound and it should be capable of taking the loads likely to come over it.

(iv) It should be well drained.

(v) It should have efficient water proofing arrangement.

(vi) It should be fair resistant.

(vii) The roofs are classified into the following 3 categories.

(a) Pitched or slope roof
(b) Flat or terraced roof
(c) Curve roof

Gable band :-

→ A gable is generally triangular portion of a wall between the edges of intersecting roof pitches. The shape of the gable and how it is detain depends on the structural system used. which reflect climate material availability and aesthetic consult.

→ A gable wall or gable end more commonly refers to the entair wall including the gable and the wall below it.

Retro fitting of structures :-

→ It is the modification of existing structure to make them more resistant to seismic activity, ground motion, soil failure due to earthquake.

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

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

→ Lake of standard for retro fitting method effectiveness of is method varies a lot depending upon parameters like type of structure material condition, amount of damage etc.

→ The main aim is up gradation of strength of the structure, increase in the ductility of the structure.

Lintel :-

→ A lintel is a beam placed across the opening like doors, windows etc. in building to support the load from the structure above.

→ The width of lintel beam is equal to the width of wall. & end of it is built into the wall.

→ Lintel are classified based on their material of construction.

Bearing of Lintel :-

The bearing should be provided minimum of the following 3 cases :- (i) 10cm ii) Height of beam iii) $\frac{1}{10}$ th or $\frac{1}{12}$ th span of lintel

Types of Lintel used in building construction :-

1. Timber lintel :-

→ The main advantages with timber are more cost & less & less durable & vulnerable to fire.

→ If the length of opening is more then it's provided by joining multiple no. of wooden pieces with help of steel bolt, In case of wider walls, it is composed of two wooden pieces kept at a distance with the help of packing pieces made of wood.

2. Stone lintel :- They are the most common type, especially where stone is abundantly available. The thickness of these are most imp factor of its design. These are also provided over the openings in brick walls.

→ Stone lintel is provided in the form of either one single piece or more than one piece.

→ The depth of this type is kept equal to 10cm/m of span. with min value of 15 cm.

3. Brick lintel :- These are used when the opening is less than 1m & lesser loads are acting. Its depth varies from 10cm to 20cm.

→ Bricks with frogs are more suitable than a normal bricks because frogs when filled with mortar gives more shear resistance of end joints which is known as Jogged brick lintel.

4. Reinforcement brick lintel :-

→ These are used when loads are heavy & span is greater than 1m. The depth should be equal to 10 & 15cm

→ The bricks are so arranged that 2 or 3cm wide space is left length wise between adjacent bricks for the insertion of mild steel bars as reinforcement 1:3 cement mortar is used to fill up the gapes.

→ Vertical stirrups of 6mm dia are provided in every 3rd vertical joints. Main reinforcement is provided at the bottom consists of 8 to 10mm dia bars, which are cranked up at the ends.

5. Steel lintel :-

→ These are used when the superimposed load are heavy & opening are large. These consist of channel sections or rolled steel joists.

→ Reinforcement cement concrete lintel :-

The lintel made up of reinforced concrete are widely used to span the openings for door, windows in a structure because of their strength, rigidity

Fire resistance, economy.

→ These are suitable for all the locals & for any span. The width is equal to width of wall & depth depend on length of span.

→ Main reinforcement is provided at the bottom & half of these bars are cranked at the ends.

Horizantal band :-

The horizantal band can be defined as method of reinforcing the masonary building by providing band with higher tension strength.

→ This is enabled in areas where two structural elements of a building meet, so that a connection is formed all together & they would behave like a single unit.

→ It's also called as Seismic bands which consist of reinforced concrete running flat throughout all the external & internal masonary wall elements.

Location :-

1. At the plinth level of building
2. At the levels of lintels.
3. At the ceiling level

Based on the area where a horizantal band is provided can be classified as :-

1. plinth band :- This types of horizantal band is essential in those areas where the soil on which the building has to be con is weak.

→ the soil will be soft & uneven properties.
The problem is arises particullary in hilly areas.

2. Lintel Band :—
These are the horizontal band provided at lintel level. under the action of earthquake ground motion.

Roof band :—
These bands are mainly implemented in building with roof made of flat timber or CGI sheet.

→ If the building roof is made up RC slab or brick roofs as there is no need of these band.

Gable Band :—
Those buildings that have sloped roof i.e trusses and gable bands are necessary.

→ When the roof can is by using a truss, the requirement of gable band comes into play.

Corner 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 & prevent cracks.

Sill band :—
A sill band is a horizontal member which is place at the bottom of opening to support the load of window frame. It's discontinued at door opening.