ARYAN SCHOOL OF ENGINEERING & ECHNOLOGY

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LECTURE NOTE

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Advanced construction Technique & Equipments.

ACTE

ch-1

Fibers & plastics

Fibers

Fiber is such a reinforcing materials. Fibers are small pieces of reinforcing material possessing certain characteristics & properties.

types of fibers

The different common types of fibers which are generally used in construction are

(a) Steel fibers
(b) carbon fibers
(c) glass fibers.

Steel fibers

Steel fiber is a metal reinforcement. Steel fiber for reinforcing concrete is defined as short, discrete lengths of steel fibers with as aspect ratio from about 20 to 100.

A certain amount of steel fiber in concrete can be cause qualitative changes in concrete's physical property, greatly increasing resistance to cracking impact, fatigue & bending, tenacity, durability, and other properties.

carbon fibers

carbon fibers can be defined as fibers with a carbon content of 90%.

or above. they are produced by thermal conversion of organic fibers with a lower carbon content such as polyacrylonitrile (PAN) containing several thousand filaments with diameter between 5 & 10 μm.

Types

The common types of carbon fiber are

(a) PAN type carbon fiber
(b) pitch type carbon fiber.

Glass fibers

Glass fibers are a very versatile class of materials. they are used to extensively as an reinforcement fibers for polymeric resins such as epoxy & unsaturated polyster.

The stiffness of the glass fiber is lower than that of the other reinforcement fibers, but it possesses the distinct advantages of combining a very high strength with low density and most of all, a very reasonable cost. Glass fiber will continue to be used as a major reinforcement fiber well into the future.

Types

The common types of glass fibers are

(a) A glass
(b) AR glass
(c) C glass
(d) D glass
(e) E glass
(f) ECR glass
(g) R glass
(h) S glass
(i) S-2 glass

Use of fiber as a construction material

In a wide range of industries including the construction industry, the application of fiber material within composites has constantly expanded. Such positive include are

(a) improve characteristics & properties such as strength, toughness, durability rigidity & ductility.

(b) improved resistance & performance

(c) corrosion & other attacks.

(d) improved stability

(e) improved thermal properties & operating temparature.

(f) Reduction & lower cost of design & installation.

properties of fiber

(a) High tensile strength & modulus of elasticity.

(b) High resistance to weather & acidic environments.

(c). Good thermal properties & stability

(d) good electric, electromagnetic & sound installation properties.

(e) improved stress failure

(f) Strong, hard & riged

(g) Resistance to radiation & uv light

(h) Absorb sound and vibration isolation.

Plastics

The plastic is a synthetic material that are based on polymers, the construction industry uses plastic for a wide range of application because of its versality, strength to weight ratio, durability, corrosion resistance & so on.

Types

The different common types of plastic used in construction are
PVC, RPVC, HDPE, FRP, GRP.

PVC

Polyvinyl chloride plastic is a kind of common building plastic made from polymerized vinyl chloride monomer.

It has better chemical stability and ageing resistance, but poor heat resistance. It may decompose & metamorphose, if the temp^r exceeds 100°C. Usually it should be used at temp^r of below 60-80°C. By adding different types of plasticizer, hard & soft polyvinyl chloride plastic can be made.

RPVC:-

Rigid PVC is a strong, stiff, low cost plastic material that is easy to fabricate and easy to bond using adhesives or solvents, it is also easy to weld using thermo plastic welding equipment.

Rigid polyvinyl chloride (RPVC) is a non-flammable material that is resistant to weathering. With the proper additives, RPVC can be UV stabilized so that it with stands sun light. Because PVC has an excellent resistance to aqueous sol^n, it is frequently used in application that

come on contact with water, include doorways, windows pipes & even extruded wire covering.

HDPE: (High density poly ethylene)

It is a thermo plastic polymer made from petroleum. As one of the most versatile plastic materials around,

HDPE plastic is used in a wide variety of applications, including plastic bottles, milk jugs, shampoo bottles, bleach bottles, cutting boards, and piping.

known for its outstanding tensile strength and large strength-to-density ratio. HDPE plastic has a high impact resistance and melting point.

Besides its use for food applications, it can be found in unusual places, including

-> wood plastic composites
-> plastic surgery.
-> snow boards,
-> shoe lasts
-> 3-D printing filament.
-> Food & beverage containers.

FRP

Fiber reinforced plastic is a composite material made of polymer matrix reinforced with fibers. The fibers are usually glass, carbon, aramid, or basalt. Rarely other fibers such as paper, wood or asbestos have been used. The polymer is usually an epoxy vinyl ester, or polyester thermosetting plastic, though

phenol formaldehyde resins are still in use.

FRPs are commonly used in the aerospace automotive, marine, and construction industries. they are commonly found in ballistic armor as well.

GRP

Glass fiber reinforced plastic is a composite material that consist of a polymer matrix and glass fiber, the polymer matrix is usually an epoxy, vinylester, or polyster thermosetting resin.

The beams bring the environmental & chemical resistance to the product is the border for the fibers in the structural laminate & define the forms of a GRP part.

- the glass fiber add strength to the composite. they may be randomly arranged or conveniently oriented.

the most common types of glass fiber used for GRP is E-glass, which is alumino-borosilicate glass. E-CR glass is also commonly used in applications that require particularly high protection against acid corrosion.

Properties of plastic

Each plastic material has its own peculiar properties to suit its particular uses, the success of plastic as an engineering material well depends up on the stretch of variety of plastic.

Following are the general properties of plastic

- → Appearance
- → chemical resistance
- → Ductility
- → Durability

→ Dimensional stability
→ Electric insulation
→ fire resistance
→ Hemidity
→ maintenance
→ optical property
→ Sound absorption
→ weather resistance
→ finishing
→ firing
→ Melting point
→ Recycling
→ Strength
→ thermal property
→ weight.

Uses of plastic:-

A wide range of application of plastics on the buildings are

→ uses of plastics in facade panels, exterior covering, carpentry etc.

→ Uses of plastics in interior covering, floors, walls, ceiling, Doors, partition etc.

→ Uses of plastics in Roof coverings, Tightners, Domes & lighting elements.

→ Uses of plastics in sanitary equipment & piping.

Artificial timbers

The timber which is converted in a factory by some mechanical processes is termed as artificial timber or industrial timber. And such timber possesses desired shape, apperance, strength & durability.

Types

Following are the some varieties of artificial timbers.

- → Veneers
- → Plywood
- → Feber board
- → Impreg timbers
- → Compreg timber
- → Hard board
- → Glulam
- → Chip board
- → Block board
- → Flush door shutters.

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.

Followings are the physical & mechanical properties of timber.

- → colour
- → Appearance
- → Hardness
- → specific gravity
- → moisture content
- → Grain
- → Strength
- → Density
- → Free of abrasion
- → Shrinkage & Swelling
- → Toughness
- → Elasticity
- → warping
- → Durability
- → Defectless
- → workability
- → Sourness

While selecting timbers, for use, one must check these properties to ensure the quality. At the same time, it is also essential to ensure that the timber is defectless.

Strength of timber

The best quality timbers have the highest strength, strength means capable to bear loads. Anisotropic material like timber has different structure of 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.

Acoustics material

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

Acoustic material play a vital role in the various area of building construction.

Properties of acoustic material

(A) Sound energy is captured & absorbed
(B) It has a low reflect & high absorption of sound.
(C) Higher density improves the sound absorption efficiency at low frequency.
(D) It reduces the energy of sound waves as they pass through.
(E) High density material help to maintain a low flammability performance.
(F) It controls the sound & noise level.

Uses of acoustic material

→ It can be used for noise reduction & noise absorption
→ It makes the sound more audible which is clear to listen without any disturbance.
→ It suppresses echos, reverberation, reflection and resonance.
→ Imp. specification for noise reduction & noise absorption
→ A vinyl acoustic barrier blocks controls airborne noise
→ Sound proof door & windows are designed to reduce the transmission sound.
→ A sound proof material can incorporate sound proofing.

wall cladding

wall cladding is the application of one material over the wall for aesthetic purpose, once the wall is clad it will appear that the wall is made up of some other material than it actually is.

In construction cladding is used to provide a degree of thermal insulation and weather resistance, and to improve the apperance of buildings.

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

Types of wall cladding

wall claddings are available in several types of forms, some of the common wall cladding are

- -> Stone cladding
- -> vinyl cladding
- -> Aluminium cladding
- -> wooden cladding
- -> Brick cladding
- -> Fiber cement cladding
- -> stainless steel cladding.

Plaster board

It is a panel made of calcium sulphate dehydrate (gypsum usually pressed between a facer and a backer.

It is used to make interior wall or ceiling.

plaster board is used to help builders and designers meet building regulation for fire protection, acoustic insulation and thermal efficiency. It can also help to control condensation & potential damage in areas of high humidity.

plaster board categorised based on performance

- fire performance
- sound "
- thermal "
- acoustic "
- impact resistance
- control, vapour, moisture & water
- weather defence.

Micro-silica

Micro silica in concrete improves its strength and durability as it provides more uniform distribution and a greater volume of hydration products, & decreases the avg. size of pores in the cement paste.

Micro silica, is also known as silica fume, is a mineral admixture composed of very fine solid glassy spheres of silicon oxide. It is usually found as a by-product in the industrial manufacture of ferrosilicon

and metallic silicon in high temp electric arc furnaces.

types of micro silica

micro silica comes in 3 forms which are

- powdered micro-silica
- condensed "
- slurry "

properties of micro silica

- It is grey, nearly white to nearly black powder.
- spherical particles less than 1mm in diameter.
- the bulk density of micro-silica is based on the degree of densification & varies from 130 to 600 kg/m³
- the specific gravity ranges bet 2.2 to 2.3.

Artificial sand

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

Difference bet artificial sand & Natural sand.

artificial Sand	Natural Sand
→ Manufactured in factory	→ Natural available on river banks.
→ Higher concrete strength	→ lesser concrete strength.
→ passing upto 1.5T.	→ passing upto 3T.

Bonding agent

Adhesive bonding is used to fasten two surfaces together, usually producing a smooth bond. This joining technique involves glues, epoxies or various plastic agents that bond by evaporation of solvent or by curing a bonding agent with heat, pressure or time. ~~History~~.

Historically glues have produced relatively weak bonds. However the recent use of plastic based agent such as the new super-glues that set cure with heat has allowed adhesion with a strength approaching that of the bonding material themselves.

Ch-2

Prefabricated

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

Need of pre-fabrication of buildings

(1) prefabricated structures are used for sites which are not suitable for normal construction method such as hilly region and also when normal construction materials are not easily available.

(2) prefabrication facilities can also be created at near a site as is done to make concrete blocks used on a plane of conventional brick.

(3) Structures which are used repeatedly and can be standardized such as mass housing storage sheds, godowns, shelter, bus stand, security cabins, site offices, Foot over bridges, road bridges, Tubular structure, concrete building block etc, are prefabricated structures.

History of prefabrication

The practice of prefabricated construction have not be evolved recently but it exists from ancient times although there have been modification.

on its perception and execution as per the local material available and the environmental conditions. there has been a direct impact of the local customs, traditions and beliefs on the technique as well.

the prefabrication technique in the very early civilisation may be analyzed by categorizing them as follows.

→ sweet track constructed in england around 3000 BC.

→ ancient srilanka in the kingdom of Anuradhapura & polonnaruwa.

current uses of prefabrication

the most widely used form of prefabrication in building and civil engg. is the use of prefabricated concrete & prefabricated steel sections in structure where a particular part or forms is repeated many times. It can be difficult to construct the form work required to mould concrete components on site, and delivering wet concrete to the site before it starts to set requires precise time management.

prefabrication techniques are used in the construction of apartment blocks, and housing development with repeated housing units.

the quality of prefabricated

housing units had increased to the point that they may not be distinguishable from traditionally built units to those that live in them. The technique also used in office blocks, ware houses and factory building. pre fabricated steel and glass sections are widely used for the exterior of the large buildings.

Theory & process of prefabrication

An example from house building illustrate the process of prefabrication. The conventional method of building a house is to transport brick, timber, cement, sand, steel and construction aggregate etc to the site and to construct the house on site from these materials.

In prefabricated construction only the foundations are constructed in this way, while section of walls, floors & roof are prefabricated in a factory, transported to the site, lifted into place by a crane & bolted together.

The theory behind the method is that time & cost is saved if similar construction tasks can be grouped & assembly line techniques can be employed in prefabrication at a location where skilled labour is available, while congestion at the assembly

site which waste time, can be reduced. the method find application particularly where the structure is composed of repeating units or forms or where multiple copies of the same basic structure are being constructed.

classification of prefabricated system

classification according to their degree of precast elements used in the construction.

(a) medium construction

suppose the roofing systems and horizontal members are provided with precasted elements. these constructions are known as medium prefabricated construction.

Here the degree of precast element is moderate.

(b) Large prefabrication

In large prefabrication most of the members like wall panels, roofing/flooring systems, beams and columns are pre-fabricated.

Here the degree of precast element is high.

one of the main factors which affect the theory of prefabrication is transport.

(c) open system of prefabrication

In the total prefabrication system the space frames are casted as a single unit and erected at the site.

the wall fitting and other fixing are done on site. This type of construction is known as open system of prefabrication.

(d) Closed system of prefabrication

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

(e) partial prefabrication

In this method of construction the building elements required are precast and then erected. Since the casting of the horizontal elements often take more time due to erection of frame work, the completion of the building is delayed & hence this method is restored.

(f) Total prefabrication

very high speed can be achieved by using this method of construction. The method can be employed for frame type of construction or for panel type; the total prefabrication is done on-site or off-site. The choice of the two methods depend on the situation when the factory produced elements are transported and erected on site, we call it off-site prefabrication.

Types of prefabricated systems

The word system is referred to a particular method of construction of buildings using prefabricated components which are inter-related in function and are produced to a set of instruction with certain constraints. Several plans are possible using the same set of components. The degree of flexibility varies from system to system.

The various prefabrication systems are

(1) Small prefabrication
(2) Medium prefabrication
(3) Large prefabrication
(4) Open prefabrication
    - (a) → partial prefabrication open system
    - (b) → Full prefabrication open system.
(5) Large panel prefabrication system.
(6) Wall system
    - → cross wall system
    - → longitudinal wall system
(7) Floor system
(8) Staircase system
(9) Box type system.

Advantages of prefabrication

→ Self supporting ready made components are used, shuttering & scaffolding is greatly reduced.
→ on-site construction and condition is minimized.
→ Less waste may occur.
→ construction time is reduced & buildings are completed sooner.
→ prefabrication can be located where skilled labour is more readily available.
→ Saving in cost, material, time & man power.

Disadvantages

→ Local jobs are lost
→ Similarly leaks can from at joints in prefabricated components.
→ careful handling of prefabricated components such as concrete panels, steel and glass panels is reduced.
→ Transportation cost may be higher for voluminous prefabricated sections.
→ Large group of buildings from the same type of prefabricated elements tend to look drab & monotonous.

Modular co-ordination

Modular co-ordination means the interdependent arrangement of a dimension based on a primary value accepted as a module. The strict observance of rules of modular co-ordination facilitated.

(1) Assembly of single components into large components.

(2) Fewest possible different types of component.

(3) Minimum wastage of cutting needed.

Modular co-ordination is the basis for a standardisation of a mass production of component.

A set of rules would be adequate for meeting the requirements of conventional and prefabricated construction. These rules are adaptable for

(a) the planning grid in both direction of the horizontal plan shall be

(1) 3M for residential & institutional buildings.

(2). For industrial buildings

15M for spans up to 12m

30M for spans bet^n 12m & 18m

60M for spans over 18m

(b) In case of external walls the grid lines shall coincide with the centre line

of the wall or a line on the wall 5cm from the external face of the wall.

(c) The planning module in the vertical direction shall be 1M up to & including a height of 28M.

(d) Preferred increments of a still height doors, windows and other fenestration shall be 1M.

Principle of prefabrication

The main reason to choose precast construction method over conventional method.

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

(2) special requirement in finishing.

(3) consistency in structural quality control.

(4) Fast speed of construction.

(5) constraints in availability of site resources.

(6) other space & environmental constraints.

(7) overall assessment of some or all of the above factors which points to be superiority of adopting precast construction over convention method.

(8) large groups of building from the same type of prefabricated elements tend to drab and monotonous.

The following details gives the cost implication of precast construction & conventional or site method.

* prefabrication elements
  1. Flooring/Roofing System.
  2. ~~precast beams~~ precast beam.
  3. precast column
  4. precast wall panels.
  5. precast slabs.

~~* classification:~~

Prefabricated elements

The prefabrication structural components are
- -> Based on the area (or) size of prefabricates
- -> Based on weight of prefabricates
- -> Based on the function
- -> Based on the shape
- -> Based on the material

Indian standard recommendation for modular planning (IS 7921-1987)

* Preferred horizontal dimensions
  - -> The preferred horizontal dimensions for building components and building are such multiples of 3M which are preferred against other multiples of basic module.

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

(B) modular room dimensions :-

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

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

(C) Axial planning

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

(D) 5-mm Rule

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

(E) Residential buildings

Horizontal preferred dimensions for residential buildings shall be multiple of 3M

Ch-3 Earthquake Resistant construction

Building configuration :-

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

An important feature in building configuration is its regularity and symmetry in horizontal and vertical plane. Seismic behaviour of irregular shape plans are differ from regular shape.

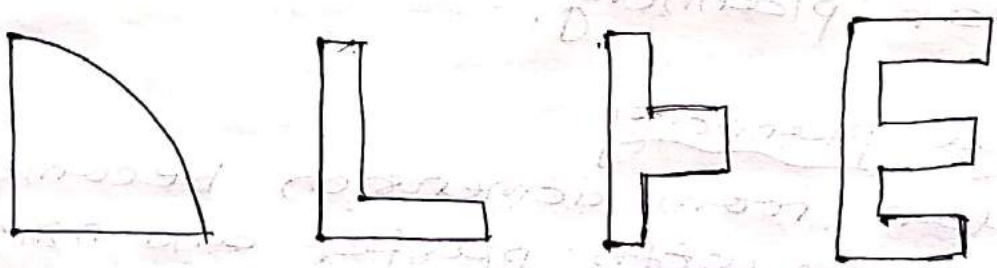


fig- Example of plan irregularity.

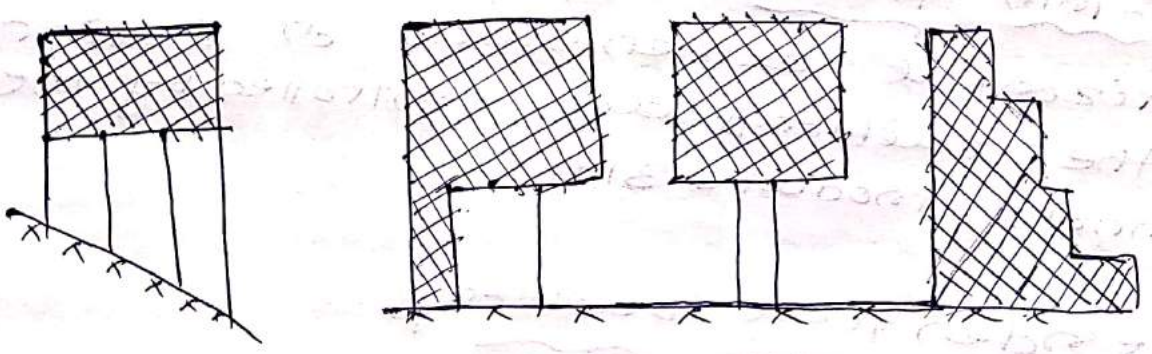


fig- example of vertical irregularity

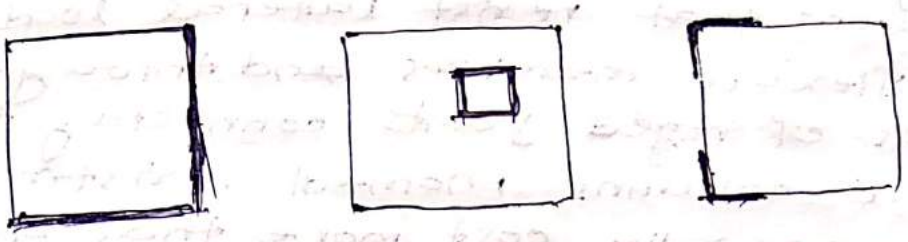


fig - Example of highly torsional configuration

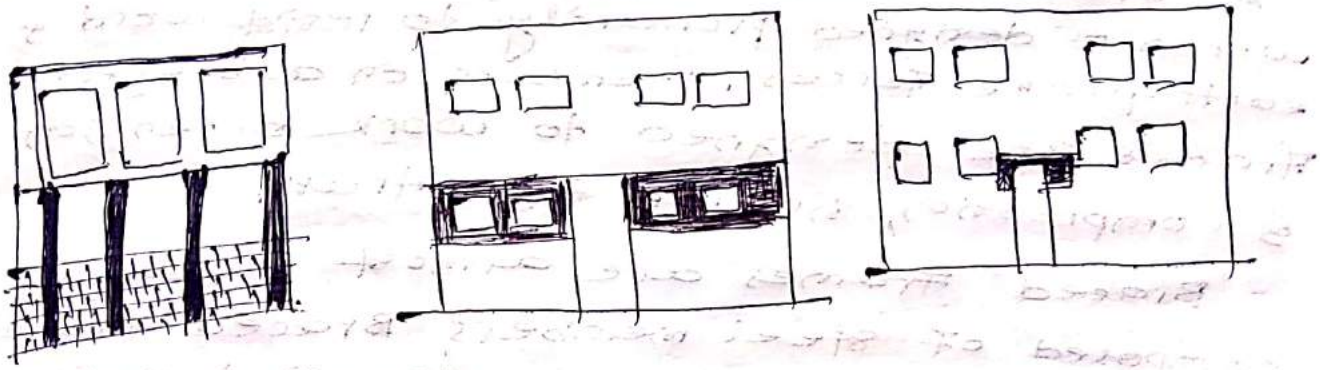


fig - Example of short column,

(fig. General building configuration problem)

Lateral load resisting structures

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

moment resisting frames

Moment resisting frame is a rectilinear assemblage of beams and columns with the beams rigidly connected to the columns. Moment resisting frames allow windows but are not very stiff. Moment

resisting frames are made up of beams and columns that resist lateral loads through flexure members and through stiffness of rigid joints connecting the beams and columns. Moment resisting frames generally cost more than braced frames.

Braced frames

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

Braced frames are almost always composed of steel members, Braced frames resist loads through a series of trees made of steel members, the diagonal member of the trusses resist lateral load in the form of axial stresses, by either tension or compression

Shear walls or (bearing wall system)

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

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

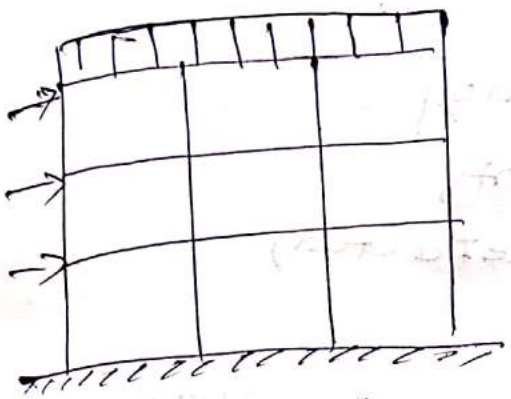
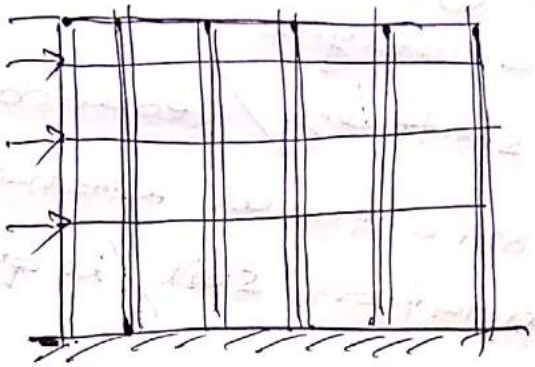


fig- moment resisting frame



bearing wall system,

Building characteristics

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

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

→ mode shapes & fundamental period

→ Building frequency & ground period

→ Damping
→ Ductility
→ Seismic weight
→ Hyperstaticity / Redundancy
→ Non-structural elements
→ Foundation soil / liquefaction

Effect of structural irregularities

→ vertical discontinuities in load path

one of the major contributors to structural damage in structure during strong earthquake is the discontinuities/ irregularities in the load path or load transfer.

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

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

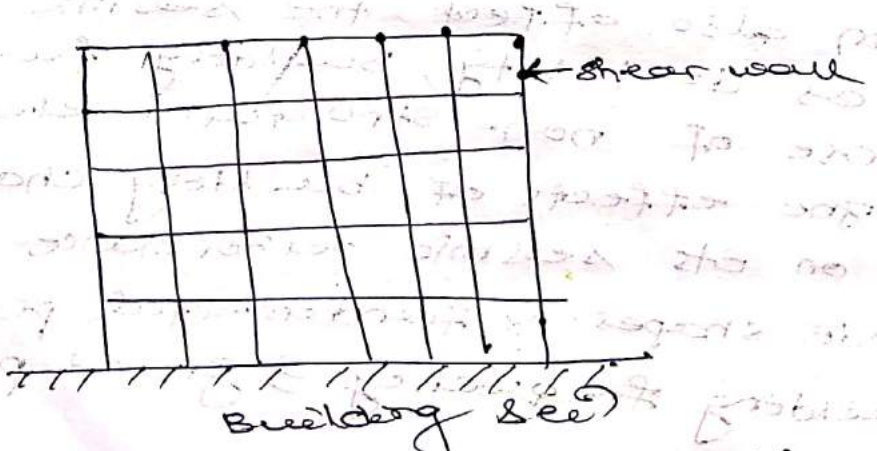
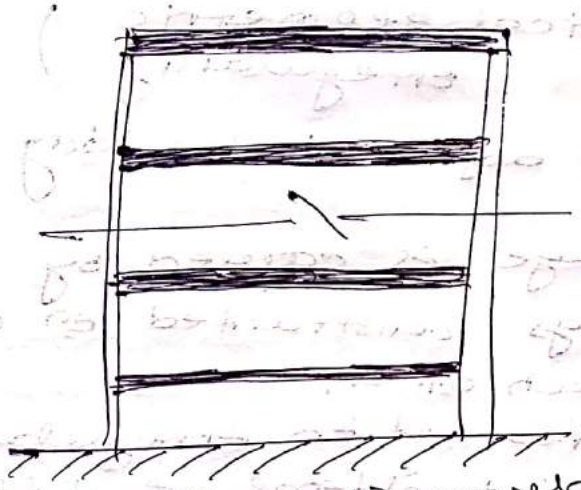


fig- discontinuous shear wall.

→ Irregularity in strength & stiffness

A weak storey is defined as one in which the storey's lateral strength is less than 80 %. of that in the above storey.

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

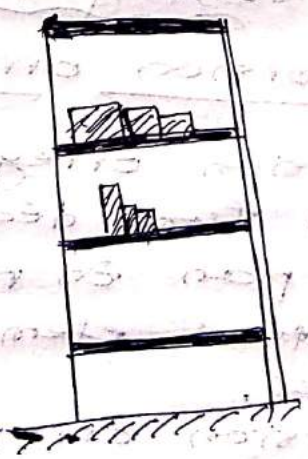


Eg- stiffness irregularities, - soft storey.

→ Mass irregularities

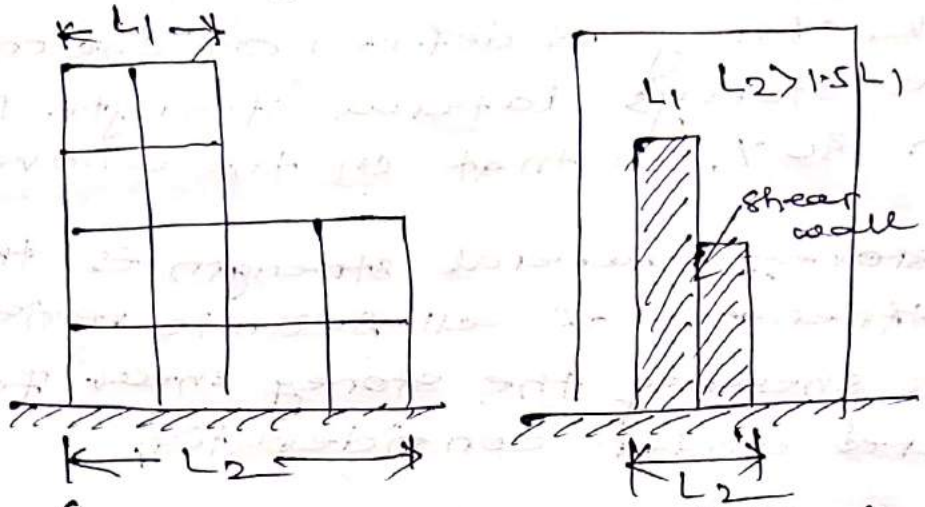
Mass irregularities are considered to exist where the effective mass of any storey is more than 200% of the effective mass of an adjacent storey.

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



Eg- mass irregularities in buildings

→ vertical geometric irregularities



(fig. vertical geometric irregularity)

→ proximity of adjacent buildings

Pounding damage is caused by hitting of two buildings constructed on close proximity with each other.

Pounding may result in irregular response of adjacent buildings of different heights due to different dynamic characteristics.

Plan configuration problems

→ Torsion irregularities.

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

Torsion irregularity is considered to exist when the max^m storey drift, computed with design eccentricity at one end of the structure transverse to an axis more than 1.2 times of avg. of the storey

drifts at the two ends of the structure.

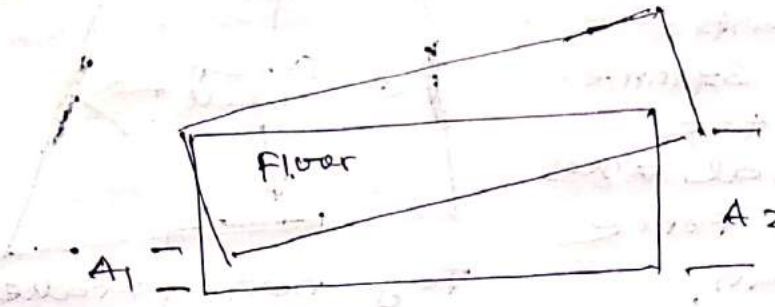


fig- torsion irregularities with stiff diaphragm.

→ Re-entrant corners

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

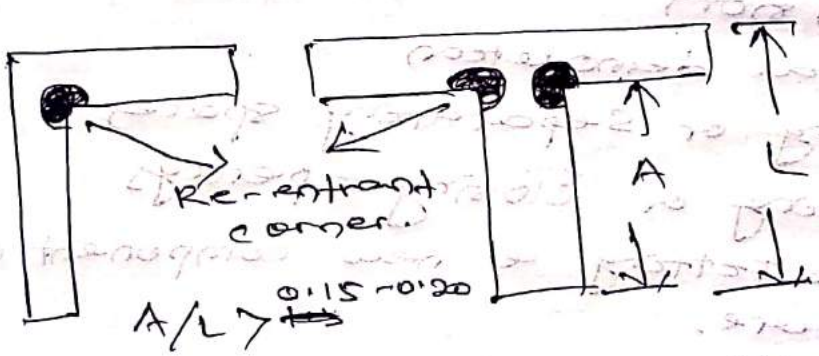


fig- example of building with plan irregularities.

→ Non-parallel System

The vertical load resisting elements are not parallel or symmetrical about the major orthogonal axes of the lateral force resisting system.

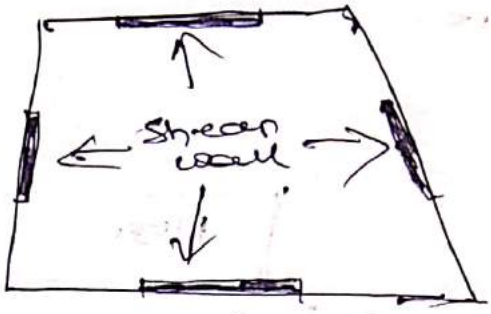


fig- non-parallel system.

This problem is often exaggerated in the triangular or wedge shaped buildings resulting from street inter-sect at an acute angle.

Safety consideration during additional construction and alteration of existing buildings

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

common examples of alterations include

→ Total or partial change of use
→ Extension
→ partial demolition
→ Linking or separating spaces
→ making or closing openings
→ Retro fitting a new component or feature.
→ maintenance
→ Decoration
→ Renovating an existing component or feature.

some alteration may require planning permission. other alteration may be considered permitted developments for which planning permission is not required.

Additional strengthening measures in masonry building -

corner reinforcement:

corner reinforcement used at wall intersections or near corners of square or rectangular openings in walls, slabs or beams.

metal reinforcement for plaster of restraint corners to provide continuity between two intersecting planes.

Lintel band:

this band is provided at lintel level on all internal & external longitudinal as well as cross walls except partition walls. it provides integrity to the structure & resistance to out-of plane wall bending. the lintel band if provided in partition walls will also enhance their stability. the purpose of lintel and roof band is to prevent the collapse of roof.

Sill band

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

plinth band:-

This band is provided at the plinth level of walls on the top of the foundation, which is useful in sustaining differential settlements particularly when foundation soil is soft or has uneven properties.

roof band:-

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

Gable band:-

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

Ch-4 Retrofitting of Structures

Sources of weakness in RC frame building:

Earthquake engineering is not a pure science, rather it has been developed through the observation of failure of structure during earthquake.

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

(i) Discontinuous load path/interrupted load path/Irregular load path,

(ii) Lack of deformation compatibility of structural members,

(iii) quality of workmanship & poor quality of materials.

Structural damage due to discontinuous load path:

Every structure must have two load resisting systems (a)

(a) vertical load resisting system for transferring the vertical load to the ground &

(b) horizontal load resisting system for transferring the horizontal load to the vertical load system.

It is imperative that the seismic forces should be properly collected by the horizontal framing system & properly transferred onto vertical lateral

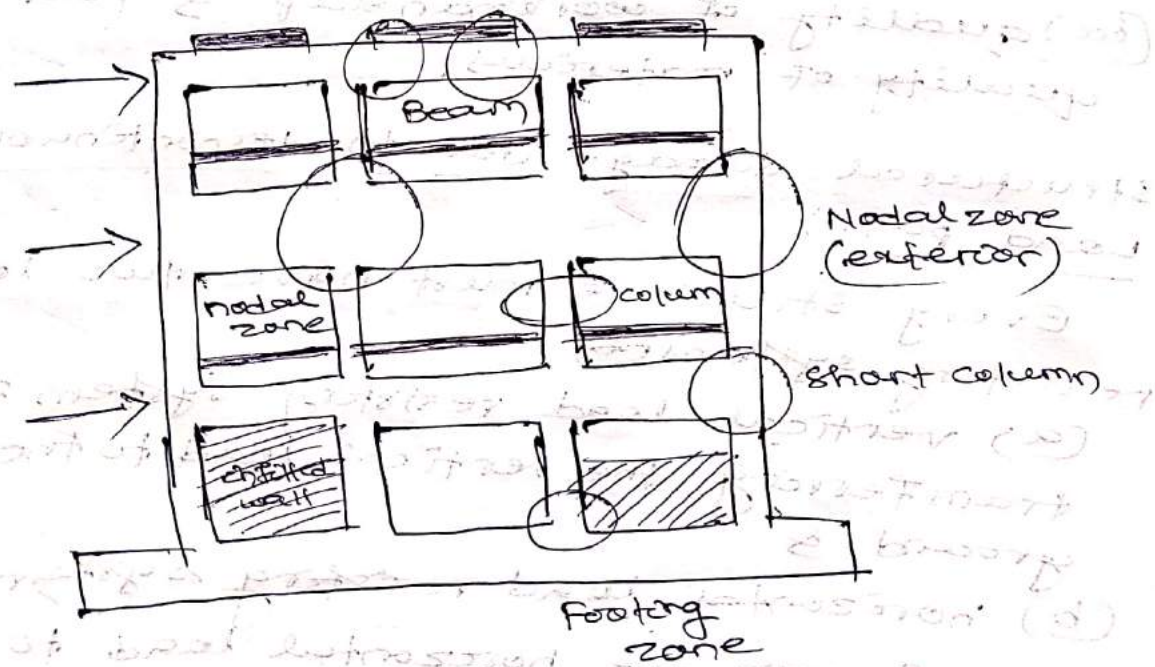
resisting system, Any discontinuity irregularity in the load path or load transfer may cause one of the major contributions to structural damage during strong earthquake.

Structural damage due to lack of deformation:-

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

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

Global behaviour frames



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

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

→ Quality of workmanship & materials:

there are numerous instances where faulty practices and lack of quality control have contributed to the damage. The faulty construction practices may be like, lack of amount and detailing of reinforcement as per requirement of code particularly when the end of lateral reinforcement is not bent by 135 degrees as the code specified.

Many buildings have been damaged due to poor quality control of design material strength as specified, spalling of concrete by the corrosion of embedded reinforcing bars, porous concrete, age of concrete, proper maintenance etc.

classification of retrofitting technique & their uses:

there are two ways to enhance the seismic capacity of existing structures. The first is a structural level approach of retrofitting which involves global modifications to the structural system. The second is a member level approach of retrofitting or local retrofitting which deals with an increase of the ductility of components with adequate

capacities to satisfy their specific limit states. Based on the above concept the available technique of retrofitting of reinforced concrete building may be classified as follows.

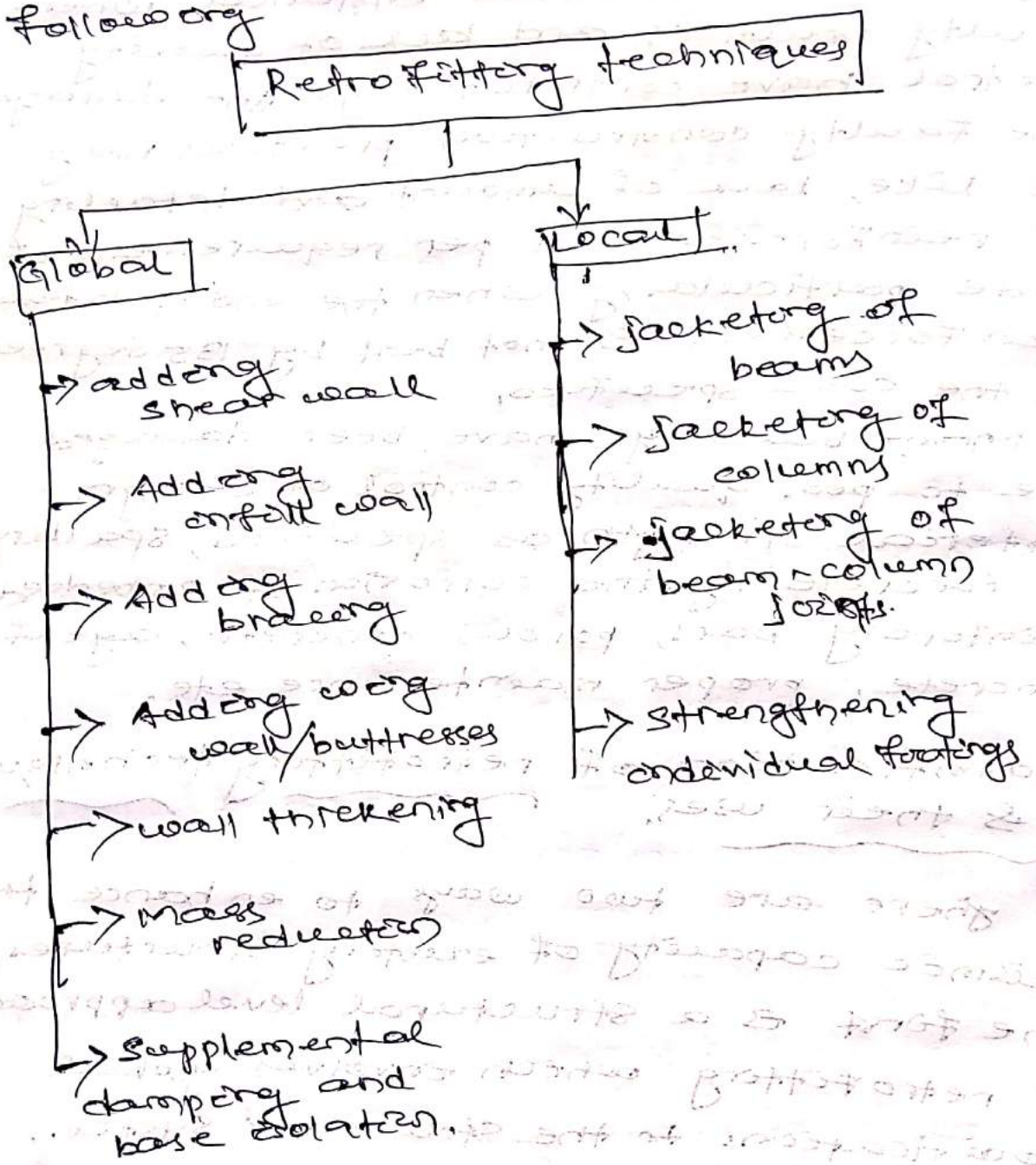


fig- Global & local retrofitting methods

Generally structural level retrofittings are applied when the entire structural load resisting system is deemed to be deficient. common approaches in this regard are employed to increase stiffness & strength with limited ductility.

Achieving desired ratio bet the additional stiffening & strengthening is the art of seismic retrofitting. the most common modifications include the addition of structural walls, steel braces, infill walls, base isolators or supplemental energy dissipation devices.

Local retrofittings are typically used either when the retrofit objectives are limited or direct treatment of the vulnerable components is needed. the most popular & frequently used method in local retrofitting is jacketing or confinement by the jackets or reinforced concrete.

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

Ch-5 Building Services

cold water distribution on high rise building

The cold water distribution system are three types

(A) By normal water pressure
(B) By over head feed system
(C) By air pressure system.

(A) By normal water pressure:-

The normal water pressure from the public water main is normally inadequate to serve high rise buildings. The alternative solution is either by over head feed system or by air pressure system.

(B) By over head feed system:-

Water is pumped into a large tank on top of the building and is distributed to the fixtures by means of gravity.

Advantages:-

- water is not affected by peak load hour.
- Not affected by power interruptions.
- Time needed to replace parts will not affect the regular supply of water.

Disadvantages:-
-> water is subjected to contamination.
-> High maintenance cost
-> occupies valuable spaces

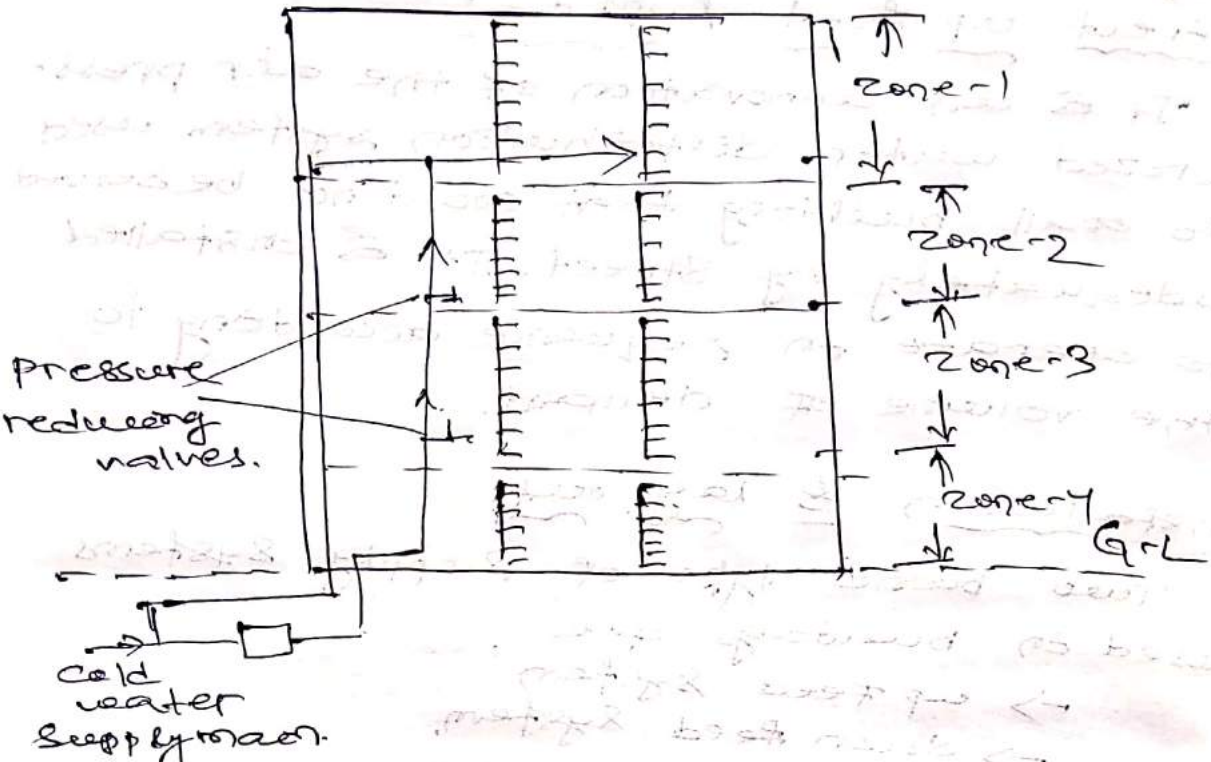
(c) Direct up feed system:-
It is an innovation of the air pressurized water distribution system used to dall building that could not be served adequately by street. It is installed to operate in sequence according to the volume of demand.

Installation & layout
Two basic types of supply systems used in buildings are
-> up feed system
-> down feed system.

The application of these depends on the project and its individuals needs & specification.
Some basic principles must however be followed for efficient and economical design.

upfeed system:
An upfeed system uses pressure in a water main to directly supply fixtures
1- Direct - 40' - 60'
2- Supply from city main of 40 to 80 psi.

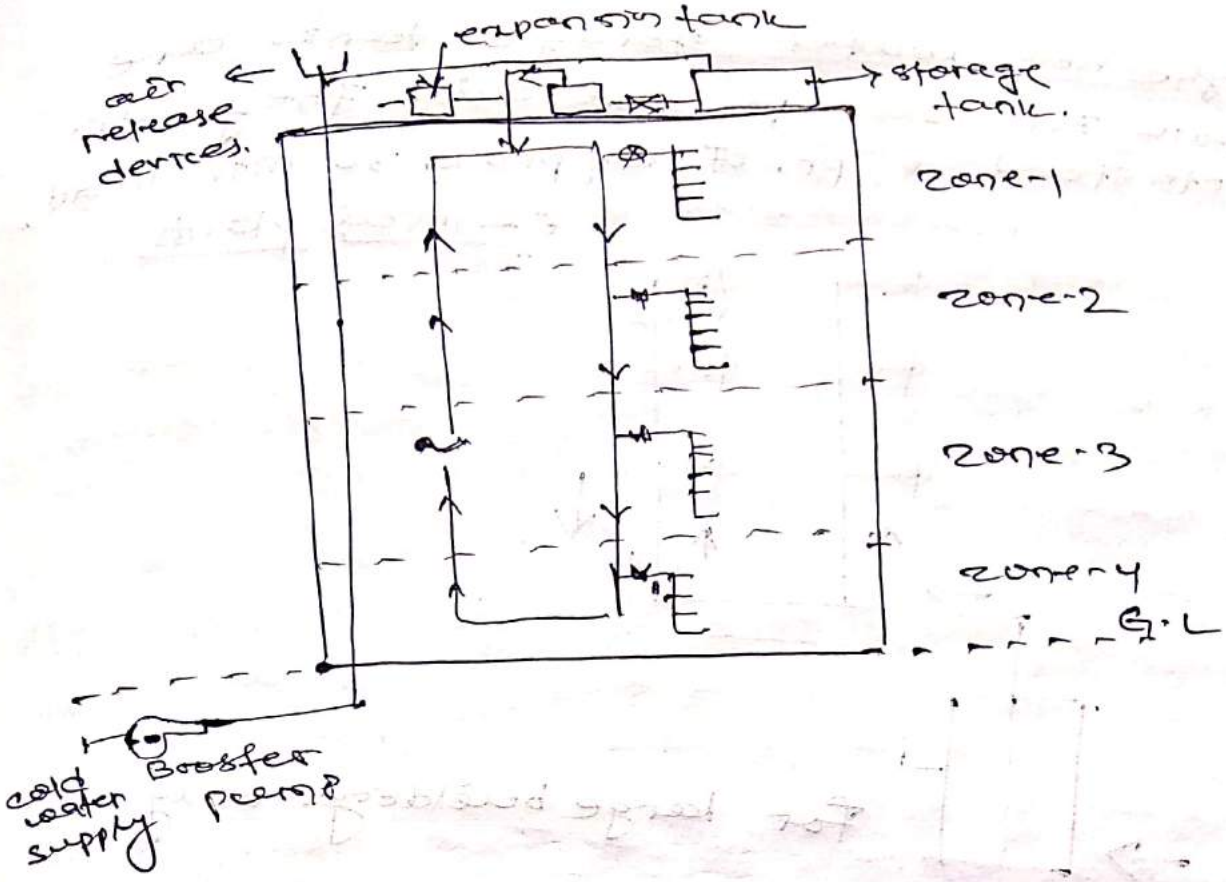
pressure must be sufficient to overcome friction on pipes, fittings, meter & static head, but still have enough pressure to fixtures.



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

Down feed System

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



Hot water installation

The plumbing for hot water is in principle the same as for cold, but there are certain additional factors that apply to hot water systems. i.e.

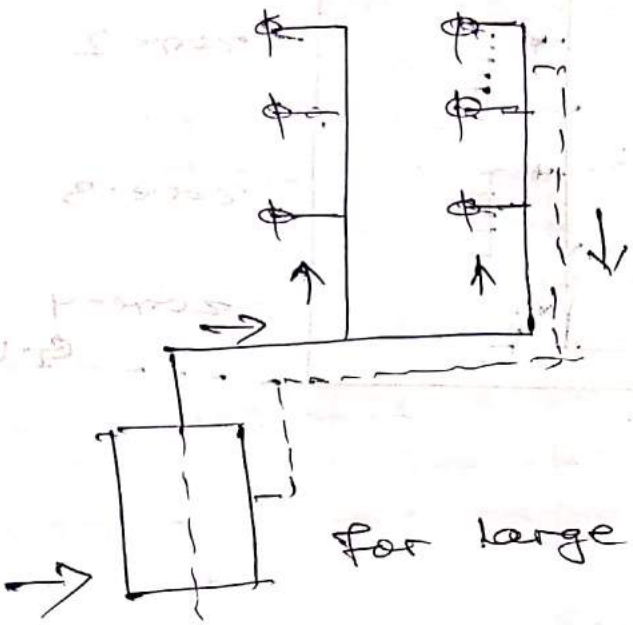
- → diameter of pipe
- → insulation
- → safety devices.

hot water storage tanks :-

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

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

central plants



for large buildings only.

connection of collectors of hot water storage tanks :-

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

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

collector & circulation pipe

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

In the lower head sludge, sand and dirt may accumulate

connection to drinking water mains

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

caution: there must never be any other stop valve bet^n the non-return valve & the water heater.

→ Electric boosting:

→ combination of solar, & wood stove heater, may used.

Sanitation

the drainage system may be two types.

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

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

Electrical Services

(i) Requirement of high rise buildings

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

A building is classified as high-rise, if it has more than 4 floors (G+3) or height more than 15 mtrs, it can be regarded as a miniature township requiring entire range of civic services such as electric power from the electricity board, stand/emergency power from diesel generator, water supplies for various applications, fire fighting system, elevator services, sanitation, recreation facilities, swimming pool, lighting for apartments as well as common areas etc.

(ii) Layout of wiring - types of wiring

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

1- Joint box system or Tee system

2- Loop - in system

Fuse

A fuse or an electric fuse is an electrical/electronic device that protects the circuit from different electrical faults like over current & over load. Fuses can be considered as a sacrificial element in the circuit as they act as a weak link in the entire circuit.

Types of fuses

The fuses are the following types.

(a) DC fuses

(b) AC fuses.

DC fuse

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

AC fuse

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

Earthing

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

Uses

The main intention of electrical earthing is to keep away from the danger of electric shock due to the out flow of current from ground through the not preferred path as well as to make sure that the potential of a conductor does not increase with respect to the ground than its planned insulation.

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

Lighting

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

Improved lighting design strategies, specification of new, efficient lighting hardware, and improved operation &

maentenance of leghteng systems all promise substaeatal energy savings.

measurement of light entensity:

The fendamental leght entensity unet es the candela, nomenally the leght geven off by one candle, or more precisely "a source that emets monochromatic radeaton of freqeency 540 x 1012 hertz and that has a radeant entensity en that dereaton of 1/683 watt per steradeon.

ventilaton

Ventèlaton moves outdoor aer ento a bueldeng or a room, & destrcbutes the aer weth en the bueldeng or room.

The general purpose of ventèlaton en bueldegs es to provide healthy aer for breatheng by both dèlueteng the pollutants orgenateng en the bueldeng and removing the pollutants from et.

methods of ventèlaton:

Nateral ventèlaton:

If well enstalled and maentained, there are several advantage of a nateral ventèlaton syeten, compared weth artificeal ventèlaton systems.

(a) Nateral ventèlaton can generally provide a negh ventèlaton rate more economically, due to the use of nateral forces and large openegs.

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

(c) well-designed natural ventilation could be used to access higher levels of daylight.

Artificial ventilation :-

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

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

System of ventilation

The following are the different system of ventilation which are

→ exhaust ventilation system
→ Supply ventilation system
→ Balanced ventilation system
→ Energy recovery system.

problems on ventilation

→ Intermittent air flow
→ Distribution of air
→ proportion of out door air
→ Building supply & exhaust location.
→ periods of operation
→ maintenance.

Mechanical Services

Lift:-

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

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

types

- → store lift
- → hospital lift
- → residential lift
- → construction lift
- → lift of cars.

Elevators:-

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

types

- → traction elevator
- → Hydraulic elevator
- → Traction - Hydraulic elevator

Escalator:-

An escalator is a moving staircase a conveyor device, transport device for carrying people between floors of a building.

types

The common types of escalator are

- → parallel
- → multiple parallel
- → criss cross.

Ch-6

construction & earth moving equipment

planning & selection of construction equipment:-

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

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

1. material
2. Labour (man power)
3. Finance required (money)

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

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

(2) the proper sequencing of the specific activities of work so as to complete the project in the optimum amount of time.
(3) the time for delivery of material & installed equipment.
(4) the types, quantities, and duration of construction plant & equipment.
(5) the classification & number of workers needed & the periods of time they will be needed.
(6) the amount of timing of financial assistance that is needed.

~~study on earth moving equipment~~

~~dragline~~:

Factors affecting the selection of construction equipment are -

(1) standard type of equipment
(2) special equipment
(3) Replacement of parts
(4) cost of owning & operating construction equipment.
(5) Economic life of construction equipment.
(6) Sources of construction equipment.

Study on earth moving equipments

drag line:-

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

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

components of drag line

-> Hoist rope
-> drag line bucket
-> Hoist coupler
-> Drag coupler
-> Drag rope

Bull dozer:-

A bull dozer is a crawler equipped with a substantial metal plate used to push large quantities of soil, sand, rubble or other such material during construction or conversion work & typically equipped at the rear with a claw-like device (known as ripper) to loosen densely compacted materials.

types
The bull dozer may be of following types
-> crawler mounted bull dozer
-> wheel mounted "
-> mini bull dozer.

Tractor:-
It is an engineering vehicle specifically design to deliver a high tractive effort at slow speeds, for the purpose of hauling a trailer or machinery such as that used in agriculture or construction.
Most commonly, the term is used to describe a farm vehicle that provides the power & traction to mechanize agricultural tasks.

Power shovel:-
A power shovel is a bucket-equipped machine, usually electrically powered, used for digging & loading earth or fragmented rock & for mineral extraction.
Power shovels are used principally for excavation and removal of overburden in open-cut mining operations, though it may include loading of minerals, such as coal. They are the modern equivalent of steam shovels, and operate a similar fashion.

compacting equipments

Tampering rollers :-

→ these are also called sheeps foot roller
→ the most common type is the one having two drums 1.22 mts wide and 1.06 either as taper-foot or club-foot rollers according to the shape of feet.
→ the coverage area is about 8 to 12 Y.
→ the thickness of compacting layer is kept about 5 cm more than the length of each foot.
→ the density of the consolidated soil should be about 1.48 kg/cm².

Smooth wheel rollers :-

→ the ground pressure exerted by tandem rollers is about 10 to 14 kg/cm².
→ performance of the smooth wheel roller depend upon it load per cm width and diameter of the roll.
→ the max grade a road roller can climb is 1 in 5.
→ some rollers are made with its prime mover or engine as a separate unit which is a tractor.
→ the optimum working speed has found to 3 to 6 km/h.

Pneumatic tyred rollers:-

-> The coverage area is about 80.
-> Tyre pressure may be upto 7 kg/cm².
-> It provided uniform pressure throughout the width.
-> This type of roller consists of a heavily loaded wagon with several rows of 4 to 6 closely spaced tyres.
-> They are particularly efficient when used to finish of the embankment compacted by sheep foot roller or on loose sandy soils.

Vibratory compactors:-

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

Owning & operating cost :-

Owning cost :-

It is made up of the following cost:

(1) Investment cost
(2) Depreciation cost
(3) major repair cost

(1) Investment cost :-

It is a kind of fixed cost and continues to be incurred whether the equipment is used or not. The investment cost comprises the following:

-> procured of equipment
-> taxes on equipment
-> insurance expances

(2) Depriciation cost :-

whenever any machine or equipment performs useful work its wear & tear is bound to occur. This can be minimize up to some extent by proper care & maintenance but can not be totally pre. Its efficiency also reduces with the lapse of time and at one time it becomes uneconomical to be used to and need replacement by new units. This amount is deducted yearly from the profits & kept separately to have sufficient money for replacement at end of useful life.

(3) major repair cost :-

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

operating cost :

It consist of following:

(1) cost of fuel (or power)
(2) cost of lubricants
(3) Servicing & maintenance cost
(4) Labour cost
(5) cost of field repairs
(6) various other overheads.

Example -)

A power shovel with a diesel engine rated at 160 hp. when used to load truck, the engine may operate at a max power while filling the dipper, requiring 5 sec, out of a cycle time of 20 sec, during the other 15 sec, the engine may operate at not more than one half of its rated power, assume that the

shovels operate 50 min per hour. calculate the diesel consumed per hour.

Sol)

Engine factor:

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

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

Total engine factor = 0.625

Time factor = $50/60 = 0.833$

operating factor = 0.625×0.833

$= 0.520$

Fuel consumper per hour

= operating factor x engine hp x engine type factor

$= 0.520 \times 160 \times 0.04$

$= 3.33$ gal/hr.

c- lubricating oil

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

q = quantity consumed, gal/hr.

hp = rated horse-power for engine

c = capacity of crankcase, gal

f = operating factor

t = no. of hours. bet changes.

The above formula based on:

An operating factor of 60%.

Quantity of oil consumed per rated

horse power hour, belt changes, will be 0.006 lb.

Example -2

Engine = 100 hp.
crankcase capacity = 4 gal.
operating factor = 60%.
No. of hour belt changes = 100 hr.

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

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

Example -3

Determine the probable cost per hour for owning & operating 25 cu. yd heaped capacity bottom dumb wagon with six rubber tires, the following information will apply.

Engine 250 hp, diesel
crankcase capacity 14 gallon
Time belt oil changes ~~50~~ 50 hr.
operating factor 60%.
useful life 5 year - 2000 hr/yr - with no salvage value.
Life of tires 5,000 hr.
Repair of tires 15% of tire depreciation cost delivered including freight & taxes Rs = Rs 92,623.00
cost of tires = Rs 12,113.00

M & R = 50% of depreciation

investment rate = 15%.

① Fuel consumped per hour

$= 250 \times 0.6 \times 0.04 = 6.0$ gal

② Lubricating oil consumped per hr.

$$q = \frac{250 \times 0.6 \times 0.006 \text{ lb/hp.hr}}{7.4 \text{ lb/gal}} + \frac{14}{80}$$

$= 0.3$ gal/hr.

③ cost of owner:

cost delivered including freight & taxes = Rs 92,623.00

Less cost of tires = Rs 12,113.00

Net cost less tires = Rs 80,510

Avg. cost per

$= P(n+1)/2n$

$= 92,623 (5+1)/2 \times 5 =$ Rs 55,744.00

④ Annual cost:

Depreciation $= (80,510 - 3\%)/5$

= Rs 16,102

maintenance & repairs

= 50% × 15,102 = Rs 8,051.00

Investment = 15% × pav = Rs 8,362.00

Total annual fixed costs = Rs 32,515.00

(5) Hourly cost :-

Fixed cost = 32,515/2000 hr = Rs 16.26

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

Tire repairs = 0.15 × 2.42 = Rs 00.36

fuel = Rs 4 × 6 gal. = Rs 24.00

lubricatory oil = 0.3 × Rs 15 = 04.50

Total cost per hr excluding labour = Rs 47.50.

Ch-7 Soil reinforcing techniques

Necessity of soil reinforcing:-

Soil reinforcement is necessary on lands where

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

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

Wire-mesh:-

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

Geo-Synthetics:-

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

Geo-Synthetics materials are nothing but planar, polymeric materials

used in contact with soil / rock / or any other geotechnical material, for filtration, drainage, separation, Reinforcement, protection, Sealing & packing.

Types of geosynthetics

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

1. Geo textiles
2. Geo grids
3. Geonets
4. Geo cells
5. Geo membranes
6. Geo-synthetic clay liner
7. Geo composites.

strengthening of embankments

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

However these geosynthetic materials are generally applied in new built embankments layer by layer, are difficult to utilize in existing embankments, and need relatively large deformation or slips along the fabric-soil interfaces to mobilize their reinforcement effects.

Reinforced soil slopes and embankments

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

-> Reinforced steep slopes
->Surficial stability of embankments.
-> Embankments constructed over weak soils
-> Temporary walls
-> pressure Relief walls.

Soil reinforcement techniques

Soil reinforcing techniques can be devided into two major categories

(1) In site soil reinforcement
(2) constructed soil reinforcement.

In the 'in site reinforcement technique the reinforcement is placed in an undisturbed soil to form a reinforced soil structure. This includes the technique of soil nailing & soil dowelling. The reinforcement

used for onsite structure is usually linear owing to the method of installation.

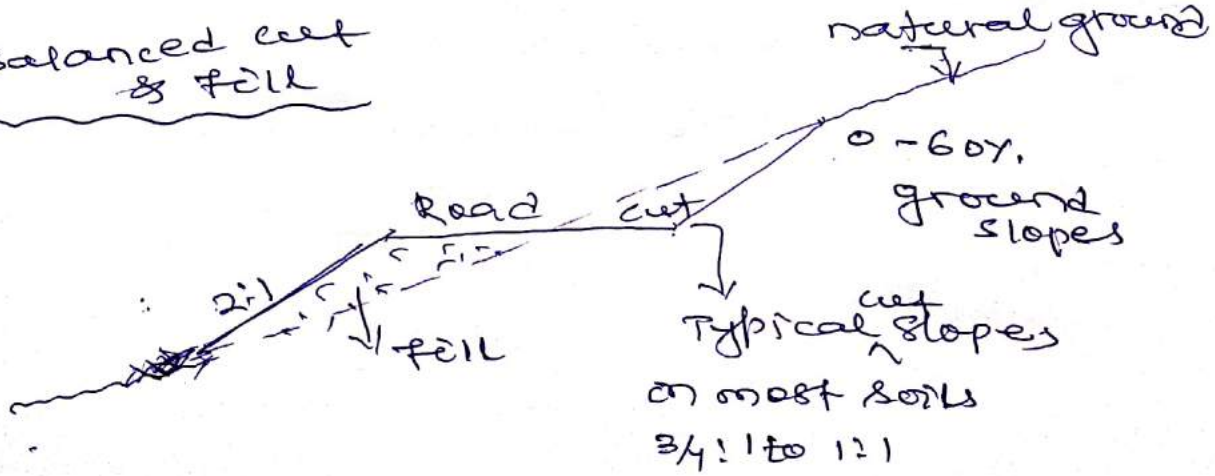
(1) open excavation using soil nails
(2) constructed soil reinforcement techneque.

Application of soil reinforcement:-

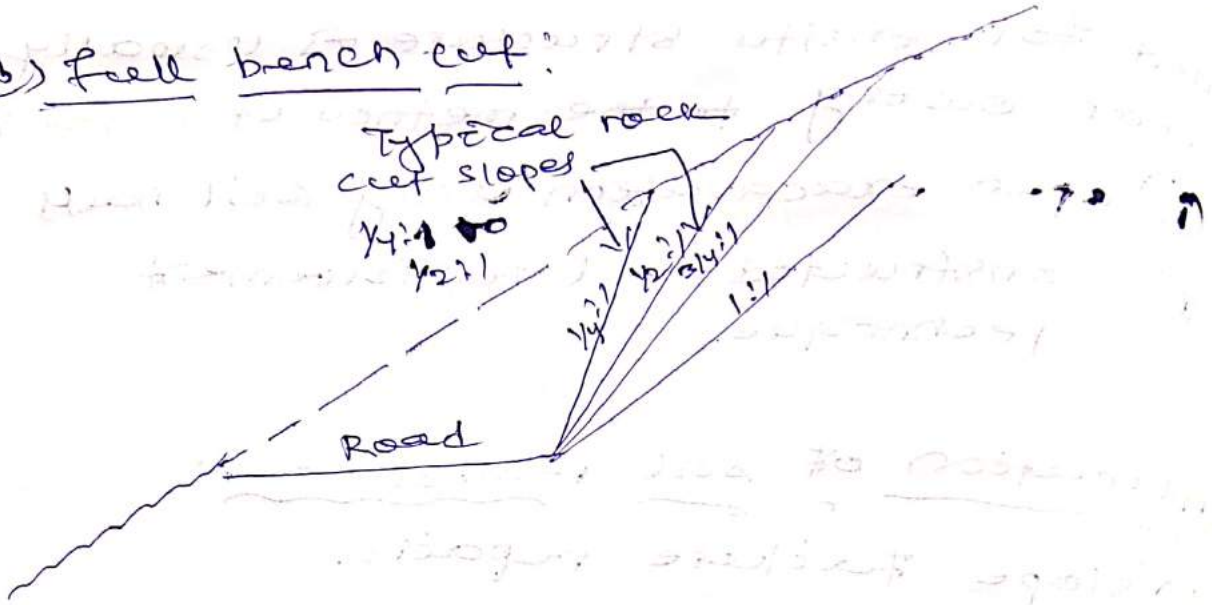
(1) slope failure repairs.
(2) slope cutting repairs.
(3) steep slopes embankments & bunds
(4) widening of slope crest
(5) Bridge abutment & wing walls
(6) soil retaining structures
   - -> Face walls
   - -> counter scarp walls
   - -> Retaining walls
(7) Road & railway embankment

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

(2) Balanced cut & fill



(b) Full bench cut:



(c) Typical fill:-