LECTURE NOTE

ON

ADVANCED CONSTRUCTION TECHNIQUES & EQUIPMENTS (TH.3)

6TH SEMESTER IN CIVIL ENGG.

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Advanced construction Materials :-

Fibres :-

→ The fibre is a filament or thread like piece of any material. This term sometimes also refer to a raw material that can be drawn into threads.

→ Fibre is a small piece of reinforcing material processing certain characteristic properties. It is a long and thin material, can be circular or flat.

→ Fibre is described by a parameter called 'Aspect ratio'. It is the ratio of length of fibre to its diameter or least lateral diameter in case of flat fibres. It ranges from 30 to 150. Generally 1 % of fibre is used in concrete.

Following are the various types of fibres.
(1) Steel fibres (2) Carbon fibres (3) Glass fibres
(4) plastic fibres (5) Asbestos fibres (6) Jute fibres.
(7) san (8) coir (9) Cellulose fibres.

(1) Steel fibres :-

→ It is one of the most commonly used fibres. Generally round fibres are used. The diameter may vary from 0.25 to 0.75 mm.

→ It is likely to get rusted and lose some of its strength.

→ It has high tensile strength i.e 280 to 440 N/mm² as well ~~has~~ as high Young's Modulus. It improves the flexural, impact & fatigue strength of concrete.

Properties :-

→ These are more tough and hard.

→ They are more elastic in nature and avoid corrosion and rust strains.

→ They increase the tensile strength of concrete.

USES :-

→ It is used in shortcrete.
→ They are used in precast concrete construction
→ They are used in tunnel lining work.
→ This fibre has been extensively used in various types of structures, particularly for overlays of roads, airfield pavements and bridge decks.

(2) Carbon fibres :-

→ These have very high tensile strength 2110 to 2815 N/mm^2 and Young's modulus. Chopped Carbon fibres with random array may be used. These are very costly.

Properties :-

→ These are chemically inert and are resistant to corrosion.
→ They have high tensile strength
→ They are available in low weight
→ It has low thermal expansion and the fibres content about 85 % carbon has good flexural strength

USES :-

→ The use of carbon fibre for structures like cladding, panels and shells will have promising future
→ These are most commonly used to reinforce composite materials.
→ These are used in reinforced carbon concrete, in which they increase tensile as well as compressive strength of concrete.

(3) Glass fibres :-

→ They may be softened and drawn mechanically into thread or glass wool that is finer than silk. A glass stand composed of 60 filaments. Each filament having a diameter of 0.0036 mm possesses the tensile strength of approximate 17500 Kg/m^2. However glass fibre may have a tensile strength approaching 70,000 kg/m^2

→ A stand glass fibres may be 1/15 of the diameter of human hair but have a tensile strength of steel.

Properties :-

→ It has good thermal insulation.
→ It has excellent corrosion resistance and moisture resistant.
→ It has good tensile strength.

USES :-

→ The glass reinforced plastic is used in the manufacturing of corrugated sheeting, mainly used for roof lights and also used for interior paneling and decoration.
→ It is also used for sound deadening and thermal insulation in walls, floors and ceilings.
→ Natural jute fibres are used in plumbing works.
→ The glass fibres are used for packing and making fabrics and felts.

PLASTICS :

→ A plastic can be broadly defined as any non-metallic material that can be moulded to desired shape.
→ Plastics are natural or synthetic resins or their compounds, which can be moulded, extruded, cast or used as films or coatings.
→ Constituents of plastics are, Binders (resins), Fillers, plasticizers (e.g - vegetable oil, camphor), Colouring matter (mineral pigments), Lubricants. (Metallic soaps) and Catalysts.

Properties :-

→ It is very light in weight.
→ It have low electrical conductivity.
→ It have low thermal conductivity

Miscellaneous Matereials

Acoustic Matereial :-

→ Acoustics is the science of sound, including its production, transmission and effects. Acoustics is a board field which embraces music radio, sound reproduction and other fields.

Properties :-

→ It has low reflection and high absorption of sound.

→ It controls the sound and noise levels from the machinery and other sources.

→ It suppresses reverberation, echoes, resonances and reflection.

→ It has capacity to capture and absorb the sound energy.

→ It reduces the sound energy waves.

Types :-

(a) Soft Matereial :- These have sufficient porosity and are good sound absorbers. Hairfelt, asbestos, rock wool, glass silk fall in this catagory.

(b) Semi-hard Matereial :- These are stiff enough to stand rough handling and can also serve as building panels, Mineral wool boards, cane fibre are include under this catagory.

(c) Hard Material :- These are hard material which have been made porous during the manufacture. They also serve as protective surfaces, porous tiles of masonry are commonly employed for this purpose.

1. Acoustical tiles
2. Acoustic pulp
3. Fibrous plaster
4. Straw board
5. Unifil acoustical plaster
6. Acoustical boards / tiles
7. Limpet asbestos.

Wall Claddings:-

→ Wall cladding or tiling is a process of finishing the surface with tiles. They are fixed upto a height of 1.25m above the floor level or upto ceiling, in passages, bathrooms, swimming pools, kitchens, staircases, boiler rooms, fire places and sometimes on exterior of building for decorative effect or protection from atmospheric agents.

→ They make the wall non-absorbent and easy to clean. The tiles used are either terra cotta, faience, china clay, natural stones like marble. Faience is similar to terra cotta but is twice fired.

→ These tiles are available in variety of colours and thickness. They are rectangular, square, rounded or corner type.

→ For cladding, the surface of the wall is first plastered with cement mortar in usual manner and then the tiles, which are immersed in water at least one hour are placed over the plaster surface by cement paste.

Plaster Boards:-

→ These are large sheets of gypsum plaster faced on both sides with stout paper as reinforcement. Plaster boards are made by mixing gypsum plaster with fine cinders or wood chips and sufficient water to form a thin consistency.

→ They are most economical and easy to work due to light in weight. Though the plaster forms best covering on external walls but the use of plastering is not favoured due to following reasons or objections:-

(a) Plaster does not stick well to the wood work.

(b) The cracks are formed on plastered surface due to extreme temperature variations.

(c) It required sufficient time for setting and drying.

PREFABRICATION

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

→ It is used in the manufacture of ships, aircraft and all kinds of vehicles and machines where sections previously assembled at the final point of manufacture are assembled elsewhere instead, before being delivered for final assembly.

History of Prefabrication:

→ Prefabrication has been used since ancient times. For example, it is claimed that the world's oldest known engineered roadway, the Sweet Track constructed in England around 3800 BC, employed prefabricated timber sections bought to the site rather than assembled on-site.

→ Sinhalese kings of ancient Sri Lanka have used prefabricated buildings technology to erect giant structures, which dates back as far as 2000 years where some sections were prepared separately and then fitted together, specially in the Kingdom of Anuradhapura and Kingdom of Polonnaruwa.

→ After the great Lisbon earthquake of 1755, the Portuguese capital, especially the Baixa district was rebuilt by using prefabrication on an unprecedented scale.

→ Also in Portugal, the town of Vila Real de Santo Antonio in the Algarve, founded on 30 December in 1773, was quickly erected through the use of prefabricated materials en masse.

→ The crystal Palace, erected in London in 1851, was a highly visible example of iron and glass prefabricated construction.

→ The method was widely used in the construction of prefabricated housing in the 20th century such as in the United Kingdom as temporary housing for thousands of urban families bombed out during World War II.

Current Uses of Prefabrication :-

→ The most widely used form of prefabrication in building and civil engineering is the use of prefabricated concrete and prefabricated steel sections in structures where a particular part or form is repeated many times.

→ This technique is used in the construction of apartment blocks and housing developements with repeated housing units.

→ It is also used in office blocks, warehouses and factory buildings.

→ Prefabricated steel and glass sections are widely used for the exterior of large buildings.

→ Radio towers for mobile phone and other services often consist of multiple prefabricated sections.

→ It is widely used in the assembly of aircraft and spacecraft, with components such as wings and fuselage sections often being manufactured in different countries or states from the final assembly site.

Theory and Process of Prefabrication :-

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

→ The method finds application particularly where the structure is composed of repeating units or forms, or where multiple copies of the same basic structure are being constructed.

→ It avoids the need to transport so many skilled workers to the construction site, and other restriction conditions such as a lack of power, lack of water, exposure to harsh weather or a hazardous environment are avoided.

→ The conventional method of building a house is to transport bricks, timber, cement, sand, steel and construction aggregate, etc. to the site and to construct the house on site from these materials.

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

→ It is used in the manufacture of ships, aircraft and all kinds of vehicles and machines where sections previously assembled at the final point of manufacture are assembled elsewhere instead, before being delivered for final assembly.

Earthquake Resistant Construction

Building configuration :-

The behaviour of a building during earthquake depends on its shape, size & geometry. A good building configuration can result in less damage during earthquake. The various components of building configuration are explained below :-

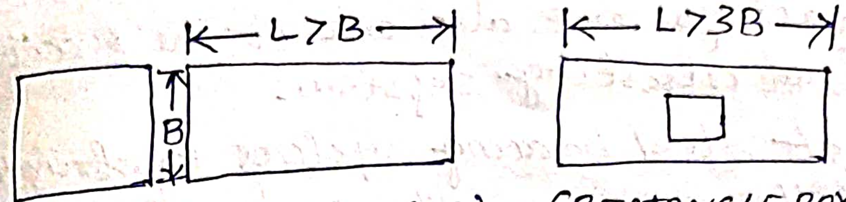
(1) Symmetry :- The building as a whole or its various blocks should be kept symmetrical about both the axes. The asymmetrical buildings are subjected to twist or torsion during earthquakes. This twist make different portions at the same floor level to move horizontally by different amounts. If asymmetry is not avoidable than the additional forces due to torsion should be taken while designing the structures.

(2) Simplicity & Regularity :- The building should have a simple rectangular plan. It is seen that simple shapes behave better during earthquake than complex shapes like L, T, E, H, U & Y, etc.

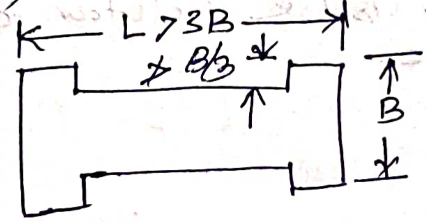
(3) Simple Building without much projections & Suspended Parts behave well during earthquake :- Long cornices, vertical or horizontal projection, facia stones, etc should be avoided and are dangerous during earthquake. To avoid this, they should be reinforced properly and tied firmly to the main structure.

(4) Size of Building :- In tall buildings, the horizontal movement of the floors during ground shaking is large. Building with one of their dimension much larger or smaller than the other two do not perform well during earthquake. The building length should not be longer three times its width.

If longer length are needed, two separate blocks with separation should be provided.

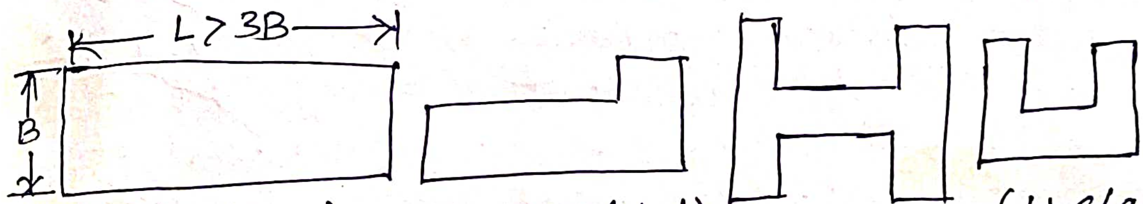


(SQUARE) (RECTANGLE) (RECTANGLE BOX)



(WITH SMALL PROJECTIONS)

(Symmetrical desirable plans)



Long rectangle (Unsymmetrical) (I-With Long Projection) (U-Shape)

(Long / Unsymmetrical undesirable plans)

(5) Enclosed Area :- A small building with properly interconnected walls acts like a rigid box and more earthquake resistant. Therefore it is advisable to have separate small rooms than one long room.

Lateral Load Resisting Structures :-

→ For Seismic resistance for high rise structures it is important to provide exclusive Lateral load Resisting system which will supplement the behaviour of moment resisting frames in resisting the lateral load.

→ The dual structural system consisting of special moment resisting frame and concrete

Effect of structural irregularities:-

Irregularity is mainly of two types-
i) Vertical irregularity
ii) plan irregularity

→ Both plan and vertical irregularity makes structures vulnerable under seismic loading.
→ Torsional irregularity, overturning moment can raise abruptly having irregularity in a structure.
→ Hence effect of irregularity is a very important issue to be considered during building design.

i) Vertical irregularity:-

These irregularities are as a result of sudden change of strength stiffness, geometry and mass over the height of the building.

a) Vertical Discontinuities in Load Path:-

The structure should contain a continuous load path for transfer of the seismic forces which develops 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. The load path must be complete and sufficiently strong.

b) Irregularity in strength & Stiffness:-

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

(iii) Damping :- The degree of structural amplification of the ground motion at the base of the building is limited by structural damping. The more damping a building possess, the sooner it will stop vibrating - which of course is highly desirable from standpoint of ~~eq~~ earthquake performance.

(iv) Ductility :- It is defined as the capacity of building of materials, systems, or structure to absorb energy by deforming in the inelastic range. The ductility of a structure depends on the type of material used and also the structural characteristics of the assembly. It is possible to build ductile structure with reinforced concrete if care is taken during designing to provide the joints with sufficient abutments that can adequately confine the concrete, thus permitting it to perform plastically without breaking.

(v) Seismic weight :-

Seismic forces are proportional to the building weight and increases along the height of the building. Weight reduction can be obtained by using lighter materials or by relocation of heavy weight such as file racks, libraries, swimming pools, etc at lower levels.

(vi) Hyperstaticity / Redundancy :-

Hyperstatic (statically indeterminate) structure have advantage because if primary system yields or fails, the lateral force can be redistributed to secondary elements or system to prevent progressive failure hyperstaticity of the structure causes the formation of plastic hinges that can absorb considerable energy without depriving the structure of its stability. Therefore the redundancy of hyperstatic structure is highly desirable characteristic for earthquake resistant design.

(vii) Non-Structural Elements :-

This problem is particularly difficult to deal with because the nonstructural components that are subjected to seismic forces are not normally within the design scope of the structural engineer, whose responsibility is to provide the seismic safety of building. non-structural components - such as partition walls - are often added after the initial building design, and original architect. on an architect at all, is often not involved.

(viii) foundation soil / Liquefaction :-

Problems related to foundation soil can be classified mainly in two groups:

a) influence of subsoil on the characteristics of seismic movement, landslides and loss of soil resistance (liquefaction), these problems are not significantly affected by structure and their foundations.

b) Problems caused ~~due~~ by the loads transmitted to the soil by foundation and the settling of the foundation under static and seismic loads.

The liquefaction of soil is most common feature of earthquake. This phenomenon of loss of resistance is generally occured

Lintel Band

→ During earthquake shaking, the lintel band undergo bending and pulling actions.
→ To resist this actions, the construction of lintel band requires special attention.
→ Lintel band ties the walls together and creates a support for walls loaded along weak direction from walls loaded in strong direction.

Roof Band :-

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

Gable Band :-

→ Those buildings that have sloped roof i.e. truss construction, gable bands are necessary.
→ When the roof construction is by using a truss, the requirement of gable band comes into play.

Plinth Band :-

→ This type of horizontal bands is essential in those areas where the soil on which the buildings has to be constructed is weak. The soil will be soft with uneven properties.
→ This problem is mainly found in soils found in hilly areas.
→ This band is hence not necessary if we have a stronger soil and substructure.

Corenere Reinforcement :-

→ Corenere reeinforcement aree also known as topsional reeinforcement.

→ ~~It~~ ~~it~~ These aree provided at corenere of two way slab.

→ The toresional moment aree high neare the corenere therefore, tonsional reinforcement is essential to prevent corenere slab from lifting and prevents cracks.

Sill Band :

→ It is a horizontal member which is place at the bottom of the opening to support the load of the window frame.

→ It is discontinued at the doore openings.

→ It protects the junction of the window and provides additional support and stability for the window.

* The height between the base of the window and ~~a~~ floore level is known as sill height.