

DEPARTMENT OF CIVIL ENGINEERING

QUESTION BANK

UNIT II - PREFABRICATED COMPONENTS

Behavior of structural components – Large panel constructions – Construction of roof and floor Slabs – Wall panels – Columns – Shear walls.

PART – A

1. What is Shear wall?

(AUC Nov/Dec 2012 & 2013)

These are simple type and these shear walls under forces and horizontal shear along its length are subjected to bending and shear. To resist these forces, the uniform distribution of steel along its length is used in simple shear walls.

2. What are the types of prefabricated structural components?(AUC Nov/Dec & May/June 2012)

- 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.

3. What is the classification of precast large panel?

(AUC May /June2013)

- Cross wall system
- Longitudinal wall system
- Two-way system

4. What are types of Cross wall system?

- Longitudinal wall system
- Homogeneous walls
- Non-Homogeneous walls

5. What are the prefabricated structural units?

- Walls and columns
- Lintels
- Doors and window frames
- Roofing and flooring elements
- Stairs

6. What is meant by box type construction?

In this system room size units are prefabricated and site. Toilet and kitchen blocks could also be similarly prefabricated and erected at site.

This system derives its stability and stiffness from the box units which are formed by four adjacent walls. Walls are jointed to make rigid connections among themselves. The box units rest on plinth foundation which be of conventional type or precast.

7. Write briefly about Types of Wall Panels?

The single way of classification of precast wall panel is based on their size or the materials of which they are made. They can be classified. According to size, as small and large, or as narrow vertical stirrups or as broad horizontal bands.

The material that are used for precast wall panel are bricks, hollow clay blocks, normal density concrete, light – weight metal, gypsum, plastic, and timber.

8. What is the classification of precast concrete walls?

- Based on size
- Based on materials used
- Based on function
- Based on location
- Based on cross section
- Based on stressing

9. What are the types of precast floors?

- Depending up on the composition of units, precast flooring units could be homogeneous or non-homogeneous.
- Homogeneous floors could be solid slabs, ribbed or waffle slabs.
- Non homogeneous floors could be multi layered ones with combinations of light weight concrete or reinforced / prestressed concrete with filler blocks.

10. Write about Prefabricated Roofing and flooring elements.

- Prefabricated reinforced concrete battens and plain concrete tiles can be used for roofing and flooring for flat, instead of wooden section and brick tiles.
- For sloping roof, precast reinforced and prestressed concrete triangulation trusses can be used.
- Plain concrete or lightly reinforced concrete can be used in the form of precast shells for roofing.

11. Define Long Wall System?

The main beam (or) load bearing wall are placed to the long axis of building. It is applied to the building with large prefabricated and similar to traditional brickwork. The longitudinal wall crosses the floor load must possess not only thermal.

12. How are roofing members in prefabricates classified?

- Small roofing members.
- Large roofing members.
- Reinforced planks (or) ties.
- Light weight concrete roofing members.
- Small reinforced concrete roofing members.
- Purlins.

13. What is the space bordering?

These members are used to give spaces like walls both load carrying and partition walls. This may (or) may not contain doors and windows the provision for the same is as per the requirement.

Another example for the space bordering member is floor slab.

14. What is the meant by surface forming members?

In the case of surface forming members, the load carrying and surface bordering are united and a uniform load carrying surface is found loaded by complex forces and economic shapes.

Example: Shell structures folded plates structures etc.

15. Differentiate between synclastic and Anticlastic?

In the case the synclastic the curve of the shell in the same side (e.g.: hemispherical shell) whereas in the case of anticlastic the curvature of the shell is in opposite direction (e.g.: hyperbolic shell (saddle shell)).

16. Write a short on dome structure?

A dome is a space structure covering a more (or) less square (or) irregular area. The best known example is the dome of revolution, and it is one of the earliest of the shell structure.

Excellent examples are still its existence that were built in Roman times.

17. Different classification of shear walls.

- Plain rectangular shear wall
- Bar bell type
- Framed shear wall
- Coupled shear wall
- Core type

18. What is ring system?

Load bearing walls and beams are placed in both ways longitudinally and transversely. In the building with ring system of support floors are normally supported on all four edges and span in two directions. In skeleton construction these floors are placed directly on columns.

19. Give the classification of floor slabs.

- Precast RC Panels
- Prefabricated brick panels

- Precast RB curved panel
- Precast RC channel roofing
- Precast hollow slabs
- L panel roofing
- Trapezon panel roofing
- Un reinforced pyramidal brick roof
- Precast concrete panel

20. Explain the term lift – slab construction.

(AUC May/June 2012)

- In the lift-slab system, the load bearing structure consists of precast reinforced concrete column and slab.
- Reinforced concrete slab are poured on the ground in forms one on top of the other.
- Precast concrete floor slab are lifted from the ground up to the final height by lifting cranes.
- The slab panel are lifted to the top of the column and then moved downwards to the final position.

21. What is necessity of dimensional tolerances?

(AUC May /June2013)

- It is almost impossible (and sometimes uneconomical) to maintain the strict degree of accuracy as listed on a plan.
- To accommodate this, it is normal to display measurements with a plus or minus (+/-) tolerance which allows for some margin of error.
- Care needs to be taken however when determining such (+/-) tolerance, particularly where there are mating parts.

22. What are the lateral loads in a building?

- Live load
- Wind load
- Earthquake load

23. What are the lateral load resisting elements in a building? (AUC Nov/Dec 2013)

- Vertical Elements
 - Moment
 - Resisting Frames
 - Walls
 - Bearing walls / Shear Walls / Structural Walls
 - Gravity Frame + Walls
 - “Dual” System (Frame + Wall)
 - Vertical Truss
 - Tube System
 - Bundled
 - Tube System
- Floor/Diaphragm
- Foundation

PART – B

1. Explain the behavior of large panel construction with suitable sketches. (AUC Nov/Dec 2013)

Large panel structure

All the main part of a building, including exterior wall and interior wall, floor slab, roofs, and staircase, may be made up from large panel structure are used in two main design schemes, frame-panel and panel building. In frame-panel building, all the base loads are borne by the building's frame, and as enclosure element. Frameless buildings are assembled from panels that perform the load bearing and enclosing functions simultaneously.

- Large panel structure for Exterior wall
- Large panel structure for Interior wall.
- Large panel structure for floor slab
- Large panel structure for Roof element.

a) Large panel structure for Exterior wall;

- Large panel structure for exterior walls consist of panel one or two stories in height and one or two rooms in width. The panel may be blind (without openings) or with window or door openings.
- In terms of design, the wall panels may be single layer (solid) and multilayer(sand witch) Solid panels are manufactured from materials that have insulating properties and at the same time can perform supporting functions for example, light weight concrete, cellular concrete, and hollow ceramic stone.
- Sandwich wall panels are made with two or three layers: their thickness depends on the climate conditions of the regions and the physicotchnical properties of the materials used for the insulating layer and for the exterior layer.
- The surface of exterior wall panels is covered with decorative mortar or is faced with ceramic or other finishing tiles.
- After assembly, the joints between panel are filled with mortar or with lightweight or ordinary concrete and then sealed with packing and special mastics.

b) Large panel structure for Interior walls:

- The large panel structure of interior walls may be non load bearing or load bearing.
- In the first case, they are made from gypsum slag concrete or from other materials that act as enclosures. In the case of load bearing structure, the wall panels, which combine enclosing and load bearing function, are made from heavy or lightweight, silicate or cellular concrete, or vibration set brick or ceramic work.
- The dimensions of the panels are determined by the dimensions of the rooms (in apartment houses), their height is equal to the height of a story, the width is equal to the depth or width of

a room, and the thickness of the walls between rooms is usually 10-14 cm (between apartment 14-18 cm)

c) Large panel structure for floor slab:

- The large panel structure of floor slabs are usually made from reinforced concrete, the area of the floor slabs in apartment buildings usually equals the area of one room and be as great as 30 sq.m.
- Flagging panels have an area of 5-8 sq m. The large panel floor slabs of housing public, and administrative building are of both the solid and sandwich types in the latter, provision is made for a sound insulation layer to reduce air and impact noise.
- Composite floor panels, consisting of a load bearing reinforced concrete panel combined with a floor or ceiling panel and soundproofing, insulating, and other layer, are often used in housing construction.

d) Large panel structure for Roof Element:

- The large panel roof elements are used in housing and public buildings mainly in the form of combined articles roofs, and in industrial buildings the roof panels have a span of up to 12 m.
- The weight of large panel structure depends on the method of dividing the building into prefabricated element; it is usually 1.5-7.5 tons.
- Large panel structure of a high rise apartment building consist of (1) foundation slab,(2) exterior wall panel,(3) interior wall panel, (4) floor slab,(5) deck ,(6) exterior panel in the process of installation
- At the joints, the panels have to which steel connecting pieces are welded, thus linking together all the panels and providing general stability of the building.
- Large panel structures are used in the construction of high rise building.

2. Explain the behavior of roof and floor slabs construction with suitable sketches.

(AUC Nov/Dec 2012 & 2013)

Behavior of roof and floor slabs:

- The roofing / flooring system consist of RC planks and joists.
- The planks are casted to a standard size and they are connected with RCC joists which are provided at a regular interval.
- The loads from planks are transmitted to RCC joists and then to main beams.
- The main beams are provided with channel sections 10cm projections on the necessary side with the spacing of joist.
- The joists are seated in the channel and bolted together.
- The loads from slabs to the main beam will come as point loads.
- The roofing / flooring slabs system consists of planks which are supported over RCC joist.

- The planks can be made in any one of the following form with or without prestressing. According to the span and loads.
- The usual width of these of slabs is 0.5m and spanning to the requirement upto a maximum limit of 5m without prestressing.
- The thicknesses of planks are casted in two steps with different mould to access monolithic action with adjacent slab by putting necessary reinforcement and concreting.

3. Explain the methods of construction of roof and floor slab. Also explain the precautions taken during the manufacturing process. (AUC May/June 2012)

In Floor and Roof:

- Structural floor / roof account for substantial cost of a building in normal situation. Therefore, any saving achieved in floor/roof considerably reduce the cost of building.
- Use of standardized and optimized roofing components where shuttering is avoided prove to be economical, fast and better in quality.
- Some of the prefabricated roofing/flooring components found suitable in many low-cost housing projects are
 - Precast RC planks
 - Prefabricated brick panels.
 - Precast RB curved panels.
 - Precast RC channel roofing.
 - L panel roofing.
 - Trapezon panel roofing
 - Unreinforced pyramidal brick roof.
 - Precast concrete panels.

Precast RC planks:

- This system consists of precast RC planks supporting over partially precast joist. RC planks are made with thickness party varying between 3 cm and 6 cm.
- There are haunches in the planks which are tapered.
- When the plank is put in between the joists, the space above 3 cm thickness is filled with in-situ concrete to get tee-beam effect of the joists.
- The planks are made in module width of 30 cm with maximum length of 150 cm and the maximum weight of the dry panel is 50 kg.
- Precast joists are rectangular in shape, 15 cm wide and the precast portion is 15cm deep.
- The main reinforcement of the overhang provided at the top in the in-situ concrete attains sufficient strength.
- The savings achieved in practical implementations compared with conventional RCC slab about 25%.

Prefabricated brick panel:

- The prefabricated brick panel roofing system consist of is made of first class brick reinforced with two MS bars of 6mm dia and joists filled with either 1:3 cement mortar or M15 concrete.
- A panel of 90cm length requires 16 bricks and a panel of 120cm requires 19 bricks.
- Partially precast joist it is a rectangular shaped joist 13cm wide and 10cm to 12.5cm deep.
- The overall depth of joist with in-situ concrete becomes 21cm to 23.5cm, it is designed as composite tee-beam with 3.5cm thick flange.
- The partially precast RC joist, is designed as simply supporting tee-beam with 3,5cm thick flange.

Precast curved brick arch panel:

- This roofing is same as RB panel roofing except that the panels do not have any reinforcement.
- A panel while casting is given a rise in the centre and thus an arching action is created.
- An overall economy of 30% has been achieved in single storeyed building and 20% in two or three storeyed building.

Precast RC channel roofing:

- Precast panel channels are trough shaped with the outer side corrugated and grooved at the ends to provide shear key action and to transfer moments between adjacent units.
- The lengths of the units are adjusted to suit the span.
- The flange thickness is 30mm to 35mm.
- A savings of 14% has been achieved in actual implementation in various projects.

Precast hollow slabs roofing:

- Precast hollow slabs are panels in which voids are created by earthen kulars, without decreasing the stiffness or strength.
- These hollow slabs are lighter than solid slabs and thus save the cost of concrete, steel and the cost of walling and foundation too due to less weight.
- The width of the panel is 300mm and depth may vary from 100mm to 150mm as per the span.
- The outer sides are corrugated to provide transfer of shear between adjacent units.

L - Panel roofing:

- The precast full span RC panel is of section L.
- The L panels are supporting on parallel gable walls and are used for shaped roof of a building.
- L panel roofing is quite lighter in weight, economic in construction.
- It is panel sound performance and durability.

Trapezon panel roofing:

- Typical precast RC trapezon panel has trapezium section in orthogonal directions.
- The components are sound and can be manually handled with ease.

- These components are placed in position to from roof and haunch filling is done with in situ concrete to make a monolithic surface.

Unreinforced pyramidal brick roof:

- Unreinforced pyramidal brick roof construction system is suitable for low cost houses in cyclone affected and other coastal areas.
- Corrosion of reinforcement was found to be the major cause of failure of RCC structure in coastal area and a pyramidal roof with brick and cement concrete without reinforcement was therefore developed.
- The roofing is provided with peripheral RCC ring beam.

4. What is the necessity of providing shear walls in the precast structures? Also discuss the different types of shear walls. (AUC May/June 2013)

Necessity of shear wall:

- When shear walls are designed and constructed properly, and they will have the strength and stiffness to resist the horizontal forces.
- In building construction, a rigid vertical diaphragm capable of transferring lateral forces from exterior walls, floors, and roofs to the ground foundation in a direction parallel to their planes.
- Lateral forces caused by wind, earthquake and uneven settlement loads in addition to the weight of structure and occupants; create powerful twisting forces.
- These forces can literally tear a building apart reinforcing a frame by attaching or placing a rigid wall inside it maintains the shape of the frame and prevents rotation at the joints.
- Shear walls are especially important in high rise building subjected to lateral wind and seismic forces.
- Shear wall buildings are usually regular in plan and in elevation, in some building, lower floor are used for commercial purposes and the building are characterized with larger plan.

Types of shear walls based on materials:

- RC shear wall
- Plywood shear wall
- RC hollow concrete brick masonry wall
- Steel plate shear wall

RC shear wall:

- It consists of reinforced concrete wall and reinforced concrete slabs.
- Wall thickness varies from 140mm to 150mm, depending on the number of stories, building age, and thermal requirement.
- In general these walls are continuous throughout the building height however, some walls are discontinuous as the street front or basement level to allow for commercial or parking spaces.

Plywood shear wall:

- Plywood is the traditional material used in the construction of shear walls.
- The creation of prefabricated shear panels have made it possible to inject strong shear assemblies into small walls the fall at either side of a opening in a shear wall plywood shear wall consists of
 - Plywood to transfer shear force
 - Chords to resists tension / compression generated by the over turning moments.
 - Base connections to transfer shear to foundation.

RC hollow concrete block masonry walls:

- This walls are constructed by reinforced the hollow concrete block masonry, by taking advantage of hollow spaces and shape of the hollow blocks.
- It requires continuous steel rods both in the vertical and horizontal directions at structurally critical locations of the wall panels.
- RHCBM element are designing both as load bearing walls for gravity loads and also shear walls for lateral seismic loads to safety withstand earthquakes.

Steel plate shear wall:

- Steel plate shear wall system consists of a steel plate wall, boundary columns and horizontal floor beams.
- Together the steel plate girder, the column act as a vertical plate girder and steel plate wall act as its web.
- The horizontal floor beams act more or less as transverse stiffeners in a plate girder.
- The steel plate shear wall systems have been used in recent year in highly seismic areas to resists lateral loads.

5. Write briefly about types of wall panels.

(AUC May/June 2013)

Classifications of wall panels:

➤ Based on size:

- Large
- Small

➤ Based on materials:

- Bricks
- Hollow clay blocks
- Normal density concrete
- Light-weight metal
- Gypsum
- Plastic and
- Timber

6. Write briefly about precast concrete columns.

Precast concrete column:

- The precast concrete column elements are 1 to 3 stories high.
- The reinforced concrete floor slabs fit the clear span between columns.
- After erecting the slab and column of a story, the columns and floor slabs are prestressed by means of prestressing tendons that pass through ducts in the columns at the floor level and along the gaps left between adjacent slab are filled with in situ concrete and the tendons then become bonded with the spans.
- The prestressing slabs column system uses horizontal prestressing in two orthogonal directions to achieve continuity.
- Seismic loads are resisted mainly by the shear walls (precast or cast-in-place) positioned between the columns at appropriate locations.

7. Write about the structural behavior of precast structure.

(AUC May/June 2012)

Structural behavior of precast structure:

- The design load-carrying structure advantage from the viewpoint of prefabrication.
- Principles of structural analysis.
- Various specifications.
- Dimensioning of joists.
- Elimination of handling stresses.
- Redistribution of stresses in jointed structure.
- Calculation of reinforced concrete structure co-operating with strengthening concrete layer cast-in-situ.
- Influence of the sequence and the method of placing on the stress of the state of the structure.
- Stability of precast structural members.
- Quality of materials used for precast reinforced concrete structure.

8. Differentiate the behavior of frame in precast structures.

(AUC Nov/Dec 2012)

Roof and floor slabs:

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- The planks can be made in any one of the following form with or without prestressing. According to the span and loads.
- The usual widths of these of slabs are 0.5m and spanning to the requirement upto a maximum limit of 5m without prestressing.
- The thicknesses of planks are casted in two steps with different mould to access monolithic action with adjacent slab by putting necessary reinforcement and concreting.

Beams:

- All the main and secondary beams are the same size of 300 mm x 300 mm varies reinforcement are provided at various conditions according to the moments.
- The beams are casted for the clear distance between the columns.
- A square of 10 cm x 10 cm hole for a depth of 10 cm are provided on either sides to achieve the connection with other beam reinforcement or column reinforcement by proper welding.
- After welding the concrete has to be done at the column and beams, it is necessary to put site concreting.
- For the purpose the top ends of the beams are tapered so that it will give access to site concrete and for needle vibrators to get proper compaction.

Wall panels:

- The wall panels are casted with all fixing like door, ventilator, and window frames.
- These wall panel are non load bearing wall. Therefore neglect solid rectangular cross section wall panel with RCC from the view of thermal effects and safety the minimum of 150 mm is provided as wall thickness.
- This wall is a sandwich type that is cellular concrete blocks of 75 mm thick is sandwiched by RCC.
- M25 grade concrete to a thickness of 37.5 mm on either face with minimum reinforcement.
- Since, the walls are in steel moulds there will be no need for plastering on either face of wall. This is one of the advantages of precast wall panels.
- The main design factor is handling stresses in wall panels.

Columns:

- Many types of columns available in prefabricated system. Grooves are provided on the required faces to keeps the walls in position.
- This groove will act as a part of columns, and since the area of column has been increased due to tibs, will give addition moment carrying as well as load carrying capacity of columns.
- At the same time this grooves give a mild ornamental look to our building.