DEPARTMENT OF CIVIL ENGINEERING

QUESTION BANK

UNIT I - INTRODUCTION

Need for prefabrication – Principles – Materials – Modular coordination – Standardization – Systems – Production – Transportation – Erection.

PART – A

1. **What is meant by modular co-ordination? (AUC NOV/DEC 2012 & 2013)**

   Modular coordination is a concept for coordinating dimension and space for which building and component are dimensionally it used and positioned in basic units (or) modules. The standard specify that the module basic M = 100 mm. As the basic unit be used in a square of M.

2. **What are the production techniques? (AUC NOV/DEC 2013)**
   - The term production techniques describe a series of operation directly concerned in the process of making or more apply of molding precast units.
   - These techniques grouped into three basic methods of production.
     - The stand system
     - The conveyor belt or production line system
     - The aggregate system
3. **List out the limitations of prefabrication. (AUC NOV/DEC 2012)**
   - Extra reinforcement is required to take care of handling and erection stresses.
   - Temporary properties may be required in some cases before the un-site concrete joints achieve strength.
   - The cracks may develop at the joints between the precast in site concrete due to shrinkage and temperature stresses. To overcome them extra steel is required across joint.
4. **List the advantages and disadvantages of prefabricated system. (AUC MAY/JUNE 2012)**

   Advantages:
   - Self supporting readymade components are used, so the need for formwork, shuttering and scaffolding is greatly reduced.
   - On-site construction and condition is minimized.
   - Less waste may occur.

Disadvantages:

- Careful handling of prefabricated components such as concrete panels (or) steel and glass panels is reduced.
- Similarly leaks can form at joints is prefabricated component.

5. List the system for prefabrication. (AUC MAY/JUNE 2012)

- Large panel systems
- Frame systems
- Slab-column systems with walls
- Mixed systems

6. What are the methods for Manufacture of precast concrete elements (or) types of prefabrication? (AUC MAY/JUNE 2013)

- Factory prefabrication
- Site prefabrication

7. What are the classifications of prefabrication? (AUC MAY/JUNE 2013)

- Small prefabrication
- Medium prefabrication
- Large prefabrication
- Cast in – site prefabrication
- Off-site (or) factory prefabrication
- Open system of prefabrication
- Closed system of prefabrication
- Partial prefabrication
- Total prefabrication

8. What is the need for pre fabricates structures?

- Prefabricates structures are used for sites, which are not suitable for normal construction method.
- PFS facilities can also be created at near a site as is done to make concrete blocks used in plane of conventional brick.
- Structures which are used repeatedly and can be standardized.

9. What is the Production process?

The production of concrete blocks consists of four basic process. They are,

- Mixing
- Moulding
- Curing
- Cubing

10. Explain the conveyor belt or production line system in production technique?

The conveyor belt system of production splits the whole production process into a series of operation carried out at separate successive and permanent points, points to the next may be by means of conveyor belt, trolleys and cranes etc.

11. Explain the Erection procedure of PFS building?

- Before commencing erection, the setting out at the level concerned must be carefully checked with surveying instruments.
- At the same time, the working of cranes and the correct layout of the cranes track must be checked.
- Prefabricates buildings are erected in convenient section which correctly fixed, should be sufficiently rigid in all directions.

12. What are the aims of prefabrication?

- Prefabrication is used to affect economy in cost.
- This results in improvement in quality because components can be manufactured under controlled conditions.
- The spread of construction is increased since no curing period is necessary.

13. What are the characteristics of Materials used for construction of PFS?

- Easy availability.
- Light weight for easy handling and transport.
- Thermal insulation property.
- Easy workability.
- Durability in all weather conditions.
- Economy in cost.
- Sound insulation.

14. What are the Advantages of standardization?

- Easier design
- Easier manufacture
- Easier erection and completion

15. What are the Factors influencing the standardization?

- The most rational type of member for each element is selected from the point of production from the assembly serviceability and economy.
- The number of types of elements will be limited and they should be used in large quantities.
- To extent possible the largest size to be used which results in less number of joints.
- The size and the number of prefabricates is limited by the weight in overall dimension that can be handled by the transportation.

16. Define prefabrication.

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

17. Define the term Off-site fabrication.

Off-site fabrication is the process that incorporates prefabrication and preassembles the process involves the design and manufacture of units usually remote from the work site and the installation at the site to form the permanent work at the site.

18. List out the limitations of pre-fabrication?

- Extra reinforcement is required to take care of handling and erection stresses.
- Temporary properties may be required in some cases, before the un-site concrete joints achieve strength.
- The cracks may develop at the joints between the precast in –site concrete due to shrinkage and temperature stresses. To overcome them extra steel is required across joint.

19. What are all the Prefabrication materials?

- Structural insulated panels (SIPs).
- Insulating concrete forms (ICFS).
- Prefab foundation system.
- Steel framing.
- Concrete framing.
- Large - modular system

20. Write Insulating concrete forms?

Insulating concrete forms (ICE) are a prefab construction material consisting of hollow EPS foam blocks that are stacked and glued together on-site, creating the form that is filled with reinforcing bars and concrete.

21. Write short note on Principles of MC Concept?

- The basic module is small in terms of add size in order to provide design flexibility, yet large enough to promote simplification in the component variation in sizes.
- Industry friendly features that not only for manufacturing but also the transportation and assembly requirements.
- Internationally accepted to support international market.

22. What are the types of prefabricated construction systems?

- Open prefabricated system
- Partial prefabricated open system
- Full prefabricated open system
- Large panel prefabricated system

23. What are the design principles of prefabricated systems?

- Standardization
- Principle of structural design
- Connections

24. Distinguish between site prefabrication and plant prefabrication.

Site prefabrication:

- No transportation.
- The size limitation is depending on the elevation capacity only.
- Lower quality because directly affected by weather.
- Proper large free space required.

Plant prefabrication:

- Transportation and elevation capacity limits the size.
- Higher, industrialized quality – less affected by weather.
- No space requirement on the site for fabrication.
- Unlimited opportunities of architectural appearance.
- Option of standardized components.

PART – B

1. What are the principles of prefabrication techniques and explain in detail and also mention its advantages and disadvantages. (AUC NOV/DEC 2013)

Principles of prefabrication techniques:

- Design for prefabrication, preassembly and modular construction.
- Simplify and standardize connection details.
- Simplify and separate building systems.
- Consider worker safety during deconstruction.
- Minimize building components and materials.
- Select fittings, fasteners, adhesive and sealants that allow for quicker assembly and facilitate the removal of reusable materials.
- Design to accommodate deconstruction logistics.
- Reduce building complexity.
- Design for reusable materials.
- Design for flexibility and adaptability.

Advantages:

- Self supporting readymade components are used, so the need for formwork, shuttering and scaffolding is greatly reduced.

- On-site construction and condition is minimized.
- Less waste may occur.
- Construction time is reduced and buildings are completed sooner, allowing an earlier return of the capital invested.
- Quality control can be easier in a factory assembly line setting than a construction site setting.
- Prefabrication can be located where skilled labour is more readily available and costs of labour, power materials, space and overheads are lower.
- Time spoil in bad weather or hazardous environments at the construction site is minimized.
- Saving in cost, material, time & manpower.
- Shuttering and scaffolding is not necessary.
- Independent of weather condition.
- Components produced at close supervision. So quality is good.
- Possibility of alterations and reuse.
- Correct shape and dimensions and sharp edges are maintained.
- Very thin sections can be entirely precast with precision.

Disadvantages:

- Careful handling of prefabricated components such as concrete panels (or) steel and glass panels is reduced.
- Similarly leaks can form at joints is prefabricated components.
- Attention has to be paid to the strength and corrosion resistance of the joining of prefabricated sections to avoid failure of the joint.
- Transportation costs may be higher for voluminous prefabricated sections than for the materials of which they are made, which can often be packed more efficiently.
- Large prefabricated structures require heavy duty cranes and precision measurement and handling to place in position.
- Large group of buildings from the same type of prefabricated elements tend to look drab and monotonous.
- Local jobs are lost.

2. Explain the erection principles of precast members with suitable sketches.

(AUC NOV/DEC 2013)

1) Planning for precast installation:

- **Planning co-ordination:**

  It is important to have the precast erector or installer and builder working together to achieve best performance.

- **Site access and storage:**
    - Check for site accessibility and precast panels delivery to site especially low bed trailers.
    - Check whether adequate space for temporary storage before installation and ground conditions.
    - Uneven ground conditions will cause overstress and in cracking of the panels.
- **Planning crane arrangement:**
    - Plan the crane capacity and lifting gears based on position of panel location.
    - A boom lift and scissor lift for unhooking installed panels.
    - Lifting gears.
    - Skilled personnel, component crane operators, rigger and signaler.
- **General considerations for crane selection:**
    - Total lifting weight, crane model, swing radius and crane counter weight.
    - Lifting capacity must be 1.5 times the total weight. FOS is 1.5.

2) Installation process:

- **Installation of vertical components:**
- **Verification of delivered panels:**
    - Check the panels delivered for correct marking lifting hook and position.
    - Surface finishing condition.
    - Dimension compliance and reinforcement provision.
- **Setting out:**
    - Set the reference lines and grids.
    - Check starter bars for vertical components before hoisting for installation.
- **Setting out quality control points:**
    - Ensure correct offset line.
    - Check plate level at firm.
    - Rubber gasket properly secured.
    - Ensure panel vertically to correct plumb.
    - Check panel to panel gap connectivity.
- **Grouting works:**
    - Prepare and apply non shrink mortars to see gap.
    - Keep installed panels undisturbed for 24hrs.
    - Check joint widths are consistent before grout.
    - Grout used should be same grade of components and self compacting to prevent cracking.

- **Connecting joints:**
    - Install rebar's are required.
    - Set up for casting joints.
    - Do concreting.
    - Remove frames after sufficient strength.
    - For external connections sealant should be used.
- **Installation of horizontal elements:**
- **Setting out:**
    - Set reference line to required alignment with an level of slab during installation.
    - Put temporary properties to support the precast slab/beam elements.
    - Before hoisting check dimensions.
    - Check level and stability of shim during the erection process.
- **Hoisting and installation:**
    - Lift and rig the elements to designated location.
    - Align and check the level before placement.
    - The beams should support the properties at least two locations.
    - Check level of precast elements.
- **Connection / Jointing:**
    - Place the lap rebar's as required.
    - Set framework for casting joints.
    - Remove framework after concrete strength is achieved.
    - Supporting beams shall be designed to form part of framework joints.
    - Same grade of concrete should be used as that of the panels.

3. Explain the need for prefabrication systems. (AUC NOV/DEC 2012)

- Prefabricated structures are used for sites which are not suitable for normal construction methods such as hilly region and also when normal construction materials are not easily available.
- Prefabricated structure facilities can also be created at near a site as is done to make concrete blocks used in plane of conventional structures.
- Structures which are used repeatedly can be standardized such as mass housing, storage sheds, godowns, shelters, bus stand, security cabins, site offices, foot over bridges, road bridges, tubular structures, concrete building blocks etc, can be made of prefabricated structures.
- Speed in construction.
- Lack of space.

- Proper utilization of space.
- Control over material.
- Mass production.
- Difficult weather conditions.

4. Explain the production process of prefabricated structural elements. (AUC NOV/DEC 2012)

Precast fabrication can be divided into six steps, i.e. mold assembly, placement of reinforcement and all embedded parts, concrete casting, curing, mold stripping, and product finishing (Ko 2010), as shown in Figure 1. Different with production systems, precast elements are produced stationary instead of conveying by belts due to their huge volume and heavy weights. Therefore, fabrication works are completed by mobile crews. The mold assembly activity requires a specific dimension. In general, precast fabricators use steel molds for the purpose of reuse. Precast element primarily contains two kinds of materials, namely, concrete and steel bars. Reinforcements and embedded parts are put in their positions after the mold is formed. Embedded parts are used to connect and fix with other components or with the structure when the precast elements are erected. The concrete is cast when the embedded parts are in their positions. To enhance the chemistry solidifying concrete, steam curing is carried out. Otherwise, the concrete requires weeks to reach legal strength. Moving or erecting elements before reaching the legal strength could cause damage. The molds cannot be stripped until the concrete solidifies. Due to the cost of developing steel molds, fabricators reuse molds once they are stripped. Finally, production elements are finished. Defects such as scratches, peel-offs, and uneven surfaces are treated in this step. Afterwards, precast elements are shipped to the storage yard awaiting delivery to construction site (Ko 2010).

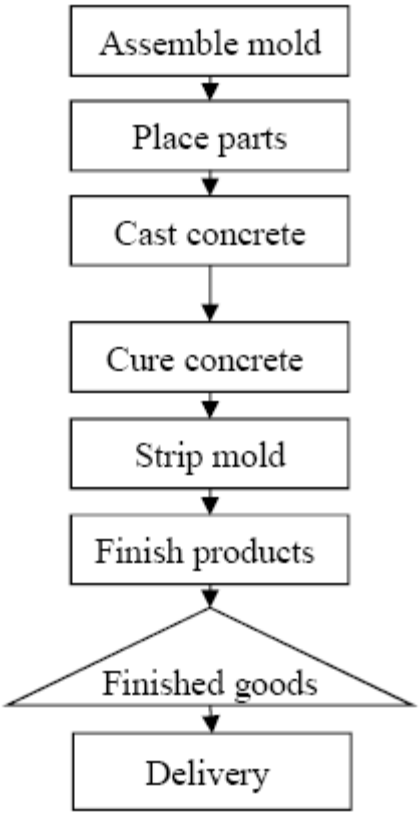


Figure 1: Precast production process

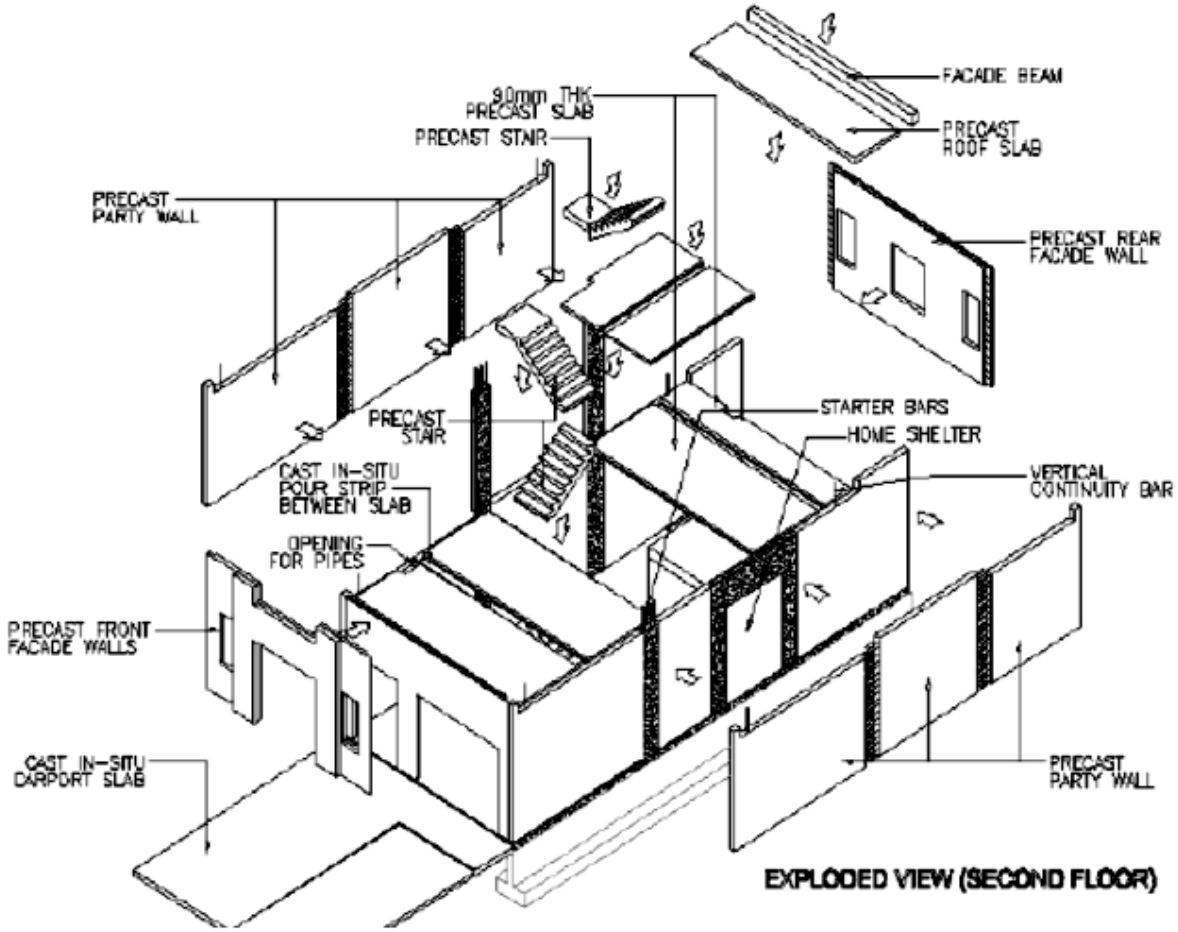
5. Discuss the concepts for precast concrete buildings. (AUC MAY/JUNE 2012)

The design concept of the precast buildings is based on the buildability, economy and standardization of precast components. In design of precast members and connections, all loading and restraint conditions from casting to end use of the structure should be considered. The stresses developed in precast elements during the period from casting to final connection may be more critical than the service load stresses. Special attention should be given to the methods of stripping, storing, transporting, and erecting precast elements.

When precast members are incorporated into a structural system, the forces and deformations occurring in and adjacent to connections (in adjoining members and in the entire structure) should be considered. The structural behavior of precast elements may differ substantially from that of similar members that are monolithically cast in place. Design of connections to transmit forces due to shrinkage, creep, temperature change, elastic deformation, wind forces, and earthquake forces require special attention. Details of such connections are especially important to insure adequate performance of precast structures.

Precast members and connections should be designed to meet tolerance requirements. The behavior of precast members and connections is sensitive to tolerances. Design should provide for the effects of adverse combinations of fabrication and erection tolerances. Tolerance

requirements should be listed on contract documents, and may be specified by reference to accepted standards. Tolerances that deviate from accepted standards should be so indicated.



All details of reinforcement, connections, bearing elements, inserts, anchors, concrete cover, openings and lifting devices, and specified strength of concrete at critical stages of fabrication and construction, should be shown on either the contract documents prepared by the architect/engineer of record or on the shop drawings furnished by the contractor. Whether this information is to be shown on the contract documents or shop drawings depends on the provisions of the contract documents. The shop drawings should show, as a minimum, all details of the precast concrete members and embedded items. The contract documents may specify that portions of connections exterior to the member are also to be shown on the shop drawings. The contract documents may also require the contractor to provide designs for the members and/or connections.

The contract documents should show the loads to be considered in design of the precast concrete elements of the structure, and they should indicate any special requirements or functions (for example: seismic loads, allowance for movements, etc.) that should be considered in design assigned to the contractor. In this case, the shop drawings should include complete details of the connections involved.

6. What are the classifications of prefabricated systems? (AUC MAY/JUNE 2012)

Small prefabrication:

The first three types are mainly classified according to their degree of precast elements used in the construction. For example brick is small unit of precasted material and used in buildings. This is called as small prefabrication and the degree of precast element is very low.

Medium prefabrication:

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 elements is moderate.

Large prefabrication:

In large prefabrication most of the members like wall panels, roofing / flooring systems, beams and columns are prefabricated. Here the degree of precast elements is high. One of the main factors which affect the factory prefabrication is transport. The width of the road, mode of transport vehicles are the factors which determines the prefabrication which is to be done on-site or in factory. Suppose the factory is situated far away from the construction site and the vehicle needs to cross congested traffic areas with heavy weighing elements the cast in-site prefabrication is preferred. Even though the same condition as the cast in site prefabrication is preferred only when numbers of houses are more for small elements the conveyance is easier with normal type of lorry and tractors. We can adopt factory or off-site prefabrication for this type of construction.

Open system of prefabrication:

In the total prefabrication systems, 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.

Closed system of prefabrication:

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

Partial prefabrication:

In this method of construction, the building elements required are precast and then erected. Since the casting of horizontal elements (roof / floor) often take more time due to erction of frame work, the completion of the building is delayed and hence this method is restored. In most of the building sites, this method is popular, so in industrial buildings where the elements have longer spans. Use of double tees, channel units, cored stabs, slabs, hyperboloid shells, etc, are some of the horizontal elements used.

This method is efficient when the elements are readily available and the building has reached the roof level. The delay caused due to erection of framework, delay due to removal of framework is eliminated completely in this method of construction suitable for any type of building provided lifting and erection equipments are available.

Total prefabrication:

Very high speeds 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 situations when the factory produced elements are transported and erected on site, we call it off-site prefabrication. If this method is to be adopted we should have a very good transportation facility for the products to be transported to the site of construction. If the elements are cast near the building site and erected, the transportation of elements can be eliminated, but we have to consider the space availability for establishing such facilities though it is temporary.

7. What is the process involved in manufacture of PFS? (AUC MAY/JUNE 2012)

The various processes involved in the manufacture of precast elements may be classified as follows.

1) Main process:

- Providing and assembling the moulds, placing reinforcement cage in position for reinforced concrete work and stressing the wires in the cases of prestressed elements.
- Fixing of inserts and tubes where necessary.
- Pouring the concrete.
- Vibrating the concrete into the moulds.
- Demoulding the forms and stacking the precast products.
- Curing (steam curing if necessary).

2) Auxiliary process:

- Process necessary for the successful complement of the processes covered by the main process.
- Mixing and manufacture of fresh concrete (done in a mixing station or by matching plants).
- Prefabrication of reinforcement cage (done in a steel yard or workshop).
- Manufacture of inserts and other finishing items to be incorporated in the main precast products.
- Finishing the precast products.
- Testing of products.

3) Subsidiary process:

- Storage of materials.
- Transport of cement and aggregate.
- Transport of green concrete and reinforced cages.
- Transport and stacking the precast elements.
- Repairs and maintenance of tools, tackles and machines.
- Generation of steam, etc.

For the manufacture of precast elements all the above processes shall be planned in a systematic way to achieve the following.

- A cycle technological method of working to bring in speed, an economy in manufacture.
- Mechanization of the process to increases productivity and to improve quality.
- The optimum production satisfying the quality requirements and to keep up the expected speed of construction aimed.
- Better working conditions for the people on the job.
- To minimize the effect of weather on the manufacturing schedule.

8. What are the methods for Manufacture of precast concrete elements and explain the factors influencing method of manufacturing.

The methods for Manufacture of precast concrete elements are stand method and flow method.

Stand method:

Here the moulds remain stationary at places when the various processes involved are carried out in a cyclic order at the same time.

Flow method:

Here the precast unit under consideration is in movement according to the various processes involved in the work are carried out in an assembly line method.

Factors influencing method of manufacturing:

- The size and the total number of elements to be produced.
    - Number of moulds required degree of mechanics.
    - Need for special curing method.
- Desired rate of output.
    - Number of moulds required degree of mechanics.
    - Need for special curing method.
- Shape type and construction features of elements.
    - Special shape (Curved or straight).
    - Required finish (single or multilayer).
- Facilities available in production setup.
    - Accelerated curing.
    - Overhead gantry crane.
- Economic aspects.
    - Minimized cost of production.
- Vertical moulding and horizontal moulding.
    - Types of moulds.
    - Wooden moulds.

- Steel moulds.
- Concrete moulds.
- Plastic moulds.

9. Explain the precasting methods and stages of work in precasting?

Precasting methods:

1) Individual mould method:

- Moulds which can be easily assembled.
- Easy to transport.
- Timber or steel.
- Needle or mould vibrates.
- It is used in beams, cranes and window panels.
- Any desired dimensions weight upto 200 m.

2) Battery form method:

- The shuttering panels may be adjusted into the form of battery at the required distances equal to the thickness of concrete members.
- It is used for interior wall panels, shell elements, roof and floor slabs.
- Length 18 m, breadth 3 m, weight 5 tonnes.
- Suitable for mass production of wall panels, shuttering cost reduced, autoclave or trench steam curing.

3) Stack method:

- For casting identical reinforced or prestressed panels one over the other with separating media interposed in between.
- Used for floor and roof slab panels.
- The dimensions are any desired length, breadth is 1 to 4 m, weight 5 tonnes.

4) Tilting mould method:

- Moulds can be filled using hydraulic jacks used for exterior wall panels where special finishes are required in one face.
- The dimensions are length 6m, breadth 4m, cover 5m.

5) Long line method:

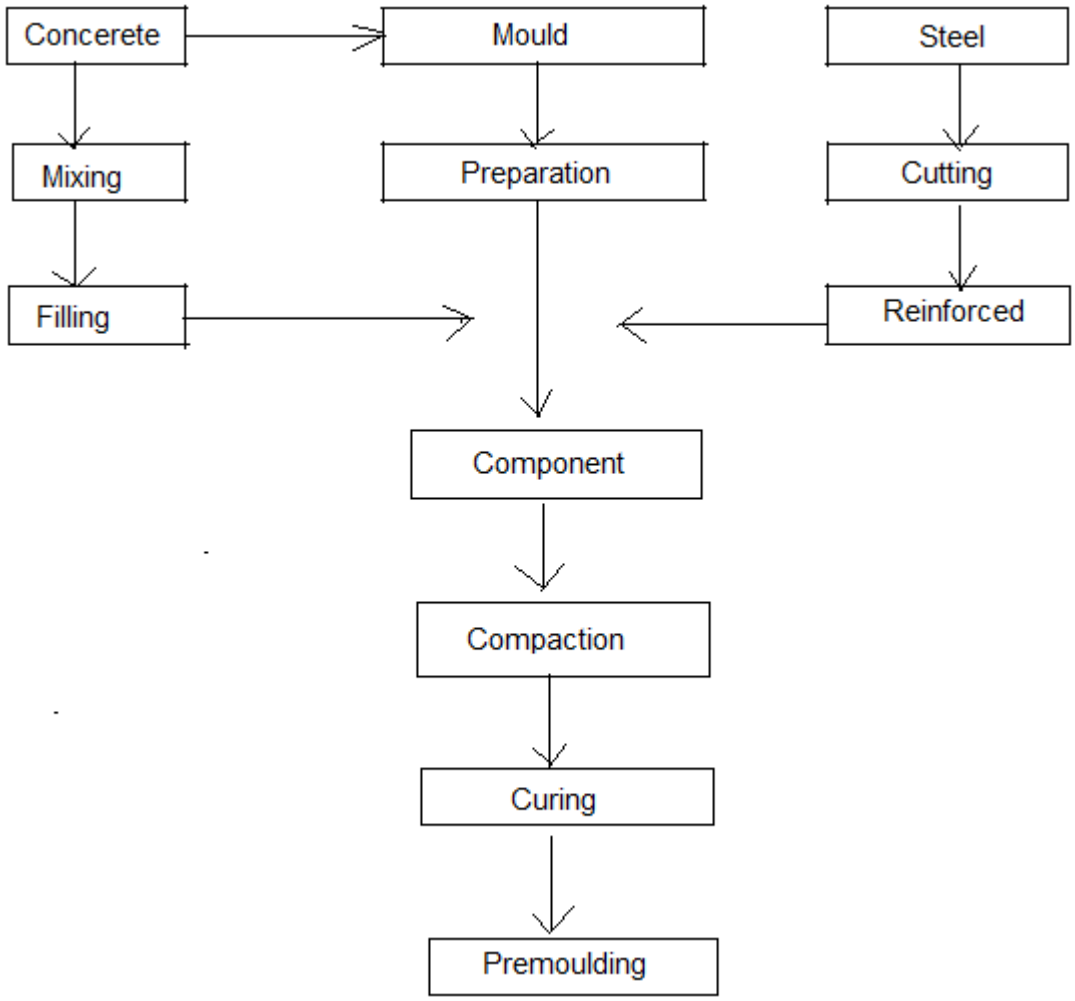
- Rib slabs, purlins, piles and beams.
- Length any desired, breadth 2m, lot upto 10 tonnes.
- Ideally suitable for pretensioned method.

6) Extrusion method:

- Long concrete mould with constant clearance concreting and vibration done automatically.
- Roof slabs, foam concrete, wall panels.
- Used for reinforced blocks, foam concrete panels.

- Used for unreinforced blocks, foam concrete panels.

Stages of working in precasting:



10. What are the importance aspects considered during hoisting, erection and transportation of precast element?

Casting:

Precast components are casted with controlled cement concrete in moulds of required shape and sizes. The vibrator is used to vibrate concrete and this removes any honeycombing inside the components.

Curing:

After 24 hours of casting, the casted components are released from the mould and transported to curing tanks. Certain special components like railway sleepers where high strength is required are steam cured.

Transportation and erection:

After complete curing is done the components are transported to the site with heavy trucks and erection will be done using cranes with skilled labour force.

11. Explain the standardization in detail and factors influencing the standardization.

For speedy construction we have to use repetitive use of building elements. Thus standardization of prefabrication elements becomes essential.

- It will facilitate quicker construction of similar elements, avoid duplication of effort.
- To adopt prefabrication in actual practice, it is necessary that the main parameters of the whole building are standardized.
- Each and every component that forms the buildings can be standardized.
- For each standard element, a limited number of types and sizes are established with a definite gradation in geometrical dimensions and reinforcement ratio.
- Flexural elements should retain their cross sectional dimensions with change in reinforcement ratio according to length, loading.
- Columns have constant dimension change in reinforced or if needed change in grade of concrete.
- If at all there is excessive use of concrete total cost of construction will be reduced through repeated use of the forms and unification of reinforcement mats and cages.
- Unchanging dimension of column from storey to storey, one type of floor beam supported by columns can be made (some column / beam joint with slight modification can be adopted).

Advantages:

- Easier design
- Easier manufacture
- Easier erection and completion

Factors influencing the standardization:

- The most rational type of member for each element is selected from the point of product from the assembly serviceability and economy.
- The number of types of elements will be limited and they should be used in large quantities.
- To the extent possible the largest size to be used which in less number of joints.
- The size and the number of prefabricates in limited by the weight in overall dimension that can be handled by the transportation.
- Hence it is preferable to have all prefabricated approximately of same weight very near to the lifting capacity of the equipment.

12. Explain erection and equipments required for erection.

Erection:

- Sequence of erection checking of precast elements availability.
- Precast element positions.
- Cleaning of elements and site for erection.
- Cleaning inserts before incorporation in the joints and grouting the joints.

- Crane capacity.
- Crane boom length for handling.
- Crane rotation radius.

Equipments required for erection:

- Machinery required for quarrying of coarse and fine aggregates.
- Conveying equipment such as belt conveyor, chain conveyors, screw conveyors, bucket elevator, hoists etc.
- Concrete mixers.
- Concrete vibrators.
- Erection equipment such as cranes, derricks, hoists, chain pulley blocks etc.
- Transport machinery such as tractor cum trailers, dumpers, lorries locomotive, motor boats and rarely even helicopters.
- Workshop machinery for fabricating and repairing steel and timber moulds.
- Bar straightening, bending and welding machines to make reinforcement cages.
- Minor tools and takes such as wheel barrows, concrete buckets etc.
- Steam generation plant for accelerated curing.

13. Discuss in detail the concept of modular coordination .State its significance in prefabricated structures.

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

1. Assembly of single components into large components.
2. Fewest possible different types of component.
3. Minimum wastage of cutting needed.

Modular coordination is the basis for a standardization 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 directions of the horizontal plan shall be
    1. 3m for residential and institutional buildings,
    2. For industrial buildings,
        - 15m for spans up to 12m
        - 30m for spans between 12m and 18m
        - 60m for spans over 18m

    The centre lines of load bearing walls shall coincide with the grid lines.

b. In case of external walls the grid lines shall coincide with the centre line of the wall or a line on the wall 5 cm from the internal face of the wall.

c. The planning module in the vertical direction shall be 1m up to and including a height of 2.8m.

d. Preferred increments for the still heights, doors, windows and other fenestration shall be 1m.

e. In case of internal columns the grid lines shall coincide with the centre lines of columns. In case of external columns, the grid lines shall coincide with the centre lines of the columns in the storey or a line in the column from the internal face of the column in the topmost storey.

A basic module can be represented as module andfor larger project modules are represented a Mp.

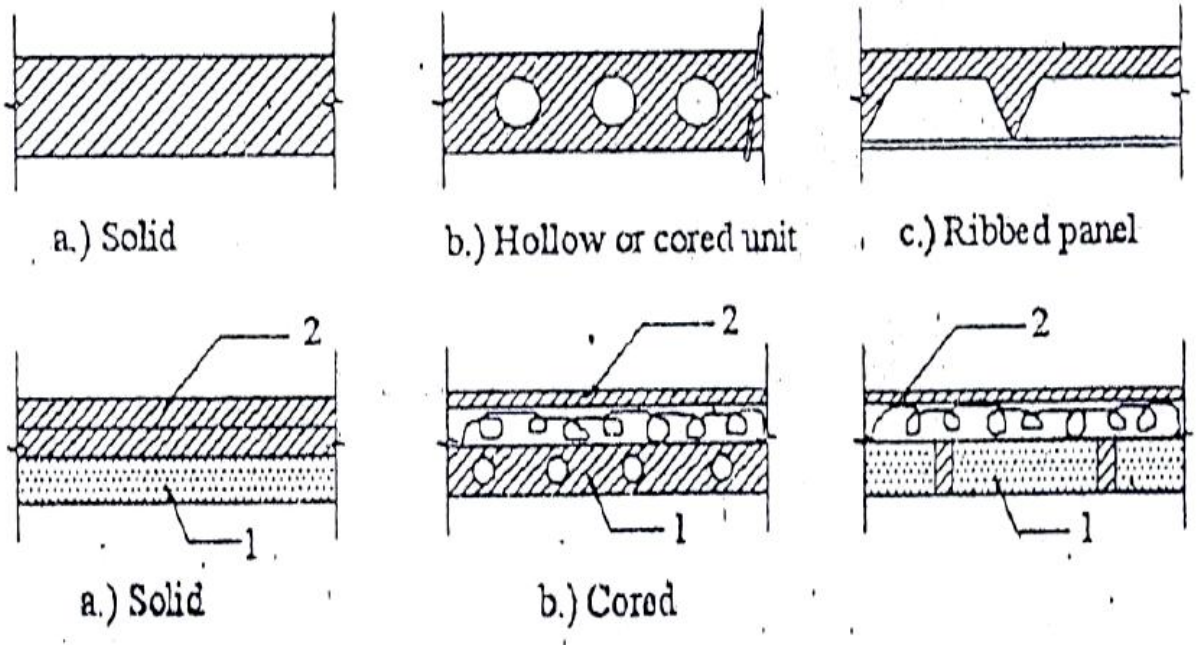
For eg: For a project module in horizontal coordination, the component can be of 30cm and for vertical component size be of 10cm.

The storey height is fixed between finished floor levels as 2.8m and if the thickness of slab is <15cm storey height is fixed as 2.7m. The centre distance between the load bearing walls can be chose from a set of modules. The use of other dimensions is not allowed.

In the design of a building, modular grid can be used consisting of parallel line spaced at a value of module M or Mp and a grid line chosen as a base for setting out a part of a building becomes a modular axis.

In the fig (a), a typical grid is chosen for load bearing walls without duct. The interior walls are placed so that their centerlines coincide with the modular axis. In the fig (b), a grid is shown for load bearing walls with hollow ducts in between. The centre line of the grid is found by deducting the size of duct.

Systems of prefabrication:



System is referred to a particular method of construction of buildings using the prefabricated components which are inter related in functions and are produced to a set of instructions. With certain constraints, several plans are possible; using the same set of components, the degree of flexibility varies from system to system. However in all the systems there is a certain order and discipline. The system of

prefabricated construction depends on the extend of the use of prefab components, their characteristics to be considered in devising a system:

- Intensified usage of spaces
- Straight and simple walling scheme
- Limited sizes and numbers of components
- Limited opening in bearing walls
- Regulated locations of partitions
- Standardized service and stair units
- Limited sizes of doors and windows with regulated positions
- Structural clarity and efficiency
- Suitability for adoption in low rise and high rise blocks
- Ease of manufacturing storing and transporting
- Speed and ease of erection
- Simple jointing system