CE6016 PREFABRICATED STRUCTURES NOTES - REGULATION 2013

OBJECTIVE
At the end of this course the student shall be able to appreciate modular construction, industrialised construction and shall be able to design some of the prefabricated elements and also have the knowledge of the construction methods using these elements.

UNIT I INTRODUCTION 9 Need for prefabrication – Principles – Materials – Modular coordination – Standarization – Systems – Production – Transportation – Erection.

UNIT II PREFABRICATED COMPONENTS 9 Behaviour of structural components – Large panel constructions – Construction of roof and floor slabs – Wall panels – Columns – Shear walls

UNIT III DESIGN PRINCIPLES 9
Disuniting of structures- Design of cross section based on efficiency of material used – Problems in design because of joint flexibility – Allowance for joint deformation.

UNIT IV JOINT IN STRUCTURAL MEMBERS 9
Joints for different structural connections – Dimensions and detailing – Design of expansion Joints

UNIT V DESIGN FOR ABNORMAL LOADS 9
Progressive collapse – Code provisions – Equivalent design loads for considering abnormal effects such as earthquakes, cyclones, etc., - Importance of avoidance of progressive collapse.

TOTAL: 45 PERIODS

TEXT BOOKS

1. CBRI, Building materials and components, India, 1990
2. Gerostiza C.Z., Hendrikson C. and Rehat D.R., Knowledge based process planning for construction and manufacturing, Academic Press Inc., 1994

REFERENCES
1. Koncz T., Manual of precast concrete construction, Vols. I, II and III, Bauverlag, GMBH, 1971.
2. Structural design manual, Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland Betor Verlag, 1978.

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UNIT-1

1.1 Introduction : Need for prefabrication - Principles Materials – Modular Co-Ordination Standarixation – System Production Importation Freedom.

- Defination :

  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.
- Process of Prefabrication :

  An example from house building illustrates the process of prefabrication. 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, roof are Prefabricated with window & door frames included).- transported to the site lifted into place by a crane and bolted together.

- **Uses of Prefabrication :**

1. The most widely used from of prefabrication in building and civil engineering is the use of Prefabricated Concrete & prefabricated steel sections in structures where a particulars part on form is repeated many line.
2. Pouring Concrete section in a factory brings the advantages of being able to re-use moulds and the concrete cab be mixed on the spot without having to be transported to and pumped wet on a congested construction site.
3. Prefabricating Steel sections reduces on site cutting and welding costs as well as the associated hazard's.
4. Prefabrication techniques are wood in the construction of apartment slacks and housing developments with repeated housing units.
5. The technique is also used in office blocks, warehouses and factory buildings.
6. Prefabricated Steel and glass sections are widely used for the exterior of large buildings.
7. Prefabricated bridge elements and systems offer bridge designers & Contractors significant advantages in terms of construction time, safety environmental impact construct liability and cost.
8. Prefabrication can also help minimize the impact from bridge building.
9. Radio bowers for mobile phone and other service often consist of multiple prefabricated sections.
10. Prefabricated has become widely used in the assembly of aircraft and space craft with component such as wings and fuselage sections after being manufactured in different countries or states from the final assembly site

❖ **Advantages of Prefabrication :**

- Self supporting readymade components are used. So. The need for work shuttering and scaffolding is greatly reduced.
- Construction time is reduced and buildings are completed sooner allowing an earlier return of the capital invested.
- On site construction and congestion is mini mixed.
- 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 spend in bad weather or hazardous environments at the construction site is minimized.

❖ **Disadvantages of Prefabrication :**

1. Careful handling of Prefabricated components such as concrete panels or steel and glass panels is required.
2. Attention has to be paid to the strength and corrosion-resistance of the joining of prefabricated sections to avoid failure of the joint.
3. Similarly, leaks can form at joints in prefabricated components.
4. Transportation costs may be higher for Voluminow. Prefabricated sections than for the materials of which they are made, which can often be packed more efficiently.
5. Large Prefabricated Structures require heavy-duty cranes & Precision measurement and handling to place in position.
6. Large group of buildings from the same type of Prefabricated elements tend to look drab and monotonous.
7. Local jobs are last.

1.2 Principles:

❖ **The Main reasons to choose Precast Construction method over conventional in 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(e.g. materials & Laborites)
6. Other space & environmental constraints.
7. Overall assessment of some or all of the above factors which points to the superiority of adopting precast construction over convention method.

   The following details gives. The cost implications of precast construction & conventional in situ method.

8. Large groups of buildings from the same type of prefabricated elements tend to

❖ look drab and monotonous.

1. Local Jobs are last.

❖ **The main reasons to choose. Precast Construction method over conventional in situ method.**

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The following details gives the cost implications of precast construction & conventional in situ method.

❖ **Prefabrication Elements :**

1. Flooring / Roofing system.
2. Priciest Beams
3. Precast Columns
4. Precast walk panels.
5. recast Stabs.

❖ **Classification :**

The Prefabrication is classified as follow from the view of degree of Precast construction.

1. Small prefabrication
2. Medium Prefabrication
3. Large Prefabrication
4. Cast in Site Prefabrication
5. Off-Site (or) factory Prefabrication
6. Open system of prefabrication
7. Closed system of prefabrication
8. Partial prefabrication
9. Total prefabrication

❖ **Small Prefabrication :**

The first 3 types are mainly classified according to their degree of precast

Elements using in that construction for eg.:brick is a small unit precast and used in building.

This is called as small prefabrication. That the degree of precast element is very low.

- Medium Prefabrication :

  Suppose the roofing systems and horizontal members are provided with pretested elements those construction are known as medium prefabricated construction here th degree of precast elements are moderate.
- Large Prefabrication :

  In large prefabrication most of the members like wall panels, roofing / flooring Systems, beams and columns are prefabricated. Here degree of precast elements are high.
- Cast – in – site prefabrication : OFF – site (factory) prefabrication :

  One of the main factor which affect the factory prefabrication is transport. The width of mad walls, mode of transport, vehicles are the factors which prefabrication is to be done on site on factory.

  Suppose the factory situated at a long distance from the construction site and the vehicle have to cross a congested traffic with heavy weighed elements the cost in side prefabrication is preferred even though the same condition are the cast in site prefabrication is preferred only when number of houses and more for small elements the conveyance is easier with normal type of lorry and trailers. Therefore we can adopt factory (or) OFF site prefabrication for this type of construction.
- Open system of prefabrication :

In the total prefabrication systems, the space framers 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 fixings and erected on their position.

- Partial prefabrication :

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

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

- 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 of or the total prefabrication can be on site or off-site. The choice of these two methods depend on the situations when the factory produced elements are transported and erected site we call if off-site prefabrication. If this method is to be adopted then we have a very good transportation of the products to site. If the elements are cast near the building site and erected, the transportation of elements can be eliminated, but we have consider the space availability for establish such facilities though it is temporary. The choice of the method of construction also depends on the following;

1. Type of equipment available for erection and transport.
2. Type of structural scheme (linear elements or panel)
3. Type of connections between elements.
4. Special equipment devised for special method construction.

1.3 Prefabricated Materials :

Prefabricated building materials are used for buildings that are manufactured off-site and shipped later to assemble at the final location same of the commonly used prefabricated building materials are aluminum steel, wood, fiberglass and concrete.

Prefabricated metal buildings use galvanized Steel and galvalume as s the chief materials for building. Galvalume is a form of Steel coated with aluminum Zinc. This is to protect the building against corrosion rust and fire. It also provides a sturdy and protective covering to the prefabricated building. Almost all the components of a metal building such as beams, frames, columns, walls & roofs are made of steel. Most prefabricated military buildings use steel or aluminum frames.

(Synthetic materials are used for the walls & roofs. To provide enhanced security a combination of both metal and cloth materials are used. Plastic flooring materials can be quickly assembled and are very durable)

Prefabricated, building materials used for small prefabricated buildings are steel, wood, fiberglass. Plastic or aluminum materials. These materials are cheaper than regular brick and concrete buildings. Materials like steel, fiberglass, wood and aluminum are used as prefabricated building materials for sports buildings. These materials provide flexibility and are preferred rfor making structures and accessories like stands and seats for stadium and gyms.

For making low cost housed, prefabricated materials like straw bale, Ferro cement calcium silicate. Products, campsites and other cheap wood based materials are currently being used calcium silicate bricks are strong and durable. Ferro cement consists of a cement matrix reinforced with a mesh of closely-spaced iron rods or wires. In this type of construction, the techniques used are simple & quick.

Using Prefabricated materials one can make durable water and fire resistant and cheap prefabricated buildings. Most of the prefabricated building materials are eco-friendly & affordable.

- **Precast structure Installation (Erection)**

The following steps to be followed to erect the precast structure :

5. Planning for precast installation
6. Installation process.
7. Installation using Big canopy
8. Installation construction Management.
9. Mishandling of precast panels.
10. Common defects in precast panels.
11. Precast failures.

- **Planning for precast installation.:**

1.1 Planning co-ordination. It is important to have the precaster erector / installer and builder working together to achieve best performances.

1.2 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 firm ground & leveled)
- Uneven ground will cause overstress & crack panels.

1.3 Planning crane Arrangement :

1. Plan the crane capacity and lifting gears based on
   1. Heavies weight of precast panels.
   2. Lifting heights.
   3. Working radius.
   4. Position of crane in relation to final location.

- **Plan other equipments**
  1. Boom lift and scissor lift for unhooking installed panels.
  2. Lifting gears.
- **Skilled personnel's :**
  1. Competent crane operators.
  2. Rigger
  3. Signaled etc.
- **General consideration for crane selection.**

1.Total lifting weight.
2.Crane Model
3. .Crane safe working load (SWL)

i.e. Based on 75% capacity build in F.O.S,1.33 – Lifting capacity must be 1.5 times the total weight i.e) F.O.S. 1.5

4. Lifting and swing radius.
5. Crane counter weight.
6. Crane boom length is relation to the vertical and horizontal clearance from the building.
7. Installation process.
8. Installation of vertical components.
9. Verification of delivered panels.
10. Check the panels delivered for correct marking liftinglook and position etc.
11. Surface finishing conditions.
12. Pc Dimension compliance.
13. Reinforcement provision
14. Architectural detail compliance.

- Setting out.

1. Check the panels delivered for marking lifting hook and condition.
2. Set the reference lines & grids.
3. Check starter bars for vertical components before hoisting for installation.

❖ **Setting out quality control points.:**

1. Ensure correct offset line.
2. Check 'Shim Pad'/plate level and firm.
3. Rubber gasket property secured.
4. For external wall / column place backer rod.

❖ **Hoisting, Rigging and installation :**

1. While tilting provide rubber pad to avoid chip off.
2. Lift and rig the panel to designated location.
3. Adjust the panel in position and secure.
4. Lifting of space adding items with balanced center of gravity.
5. Ensure horizontal alignment correct.
6. Ensure panel vertically to correct plumb.
7. Check panel to panel gap consistency.
8. Check stability of prop before releasing hoisting cable.

❖ **Grouting works :**

1. Prepare and apply non shrink mortars to seal gap
2. For corrugated pipe sleeve or splice sleeve pour NSGT or proprietary grouts into pipe sleep.
3. Keep installed panels undisturbed for 24 yrs.
4. Check joint widths are consistent before grouting.
5. Grout used should be same grade of components and self compacting to prevent cracking.
6. Collect test cube sample for testing for critical elements or load bearing elements.

❖ **Connecting joints :**

1. Cast in situ joints, install rebar's as required
2. Set up forms for casting joints.
3. Do connecting.
4. Remove forms after sufficient strength.
5. For external connections welding as required.

2.2 Installation of Horizontal Elements :

- Setting out :

1.Set reference line / offset line to required alignment and level of slab / beam during installation.

2.Put temporary prop to support the precast slab / bear elements.

3.Before hoisting check dimensions.

4.Check level and stability of shim.

5.Check protruding / starter bars are within the specified tolerance any obstruction

Specified colerance to prevent any obstruction during the erection process

Hoisting installation

1.Put temporary props to support slab or beam.

2.Lift and rig the elements to designated location

3.Align and check the level before placement

4.The beams shall prop atleast two locations

5. check level of precast elements

Connection and jointing

1.precast with cast-in0situ joints place the lap rebars as required.

2.Set formwork for casting joints

3.Remove formwork after concrete strength is achvieved

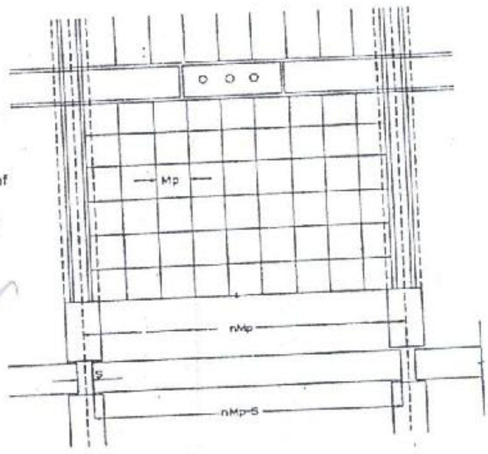
4.Supporting beams shall be designed to form part of formwork joints

5.The connecting or lapping rebars tied and secured

6.same grade of concrete to be used that of panel

1.4 Modular Coordination

Fig a. Typical layout of modular grid with ductters load bearing walls



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 ht of2.8M.

d. Preferred increments foa the still heights,doors,windows and other fenestration shall be1M.

e. In case of internal coluums 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.

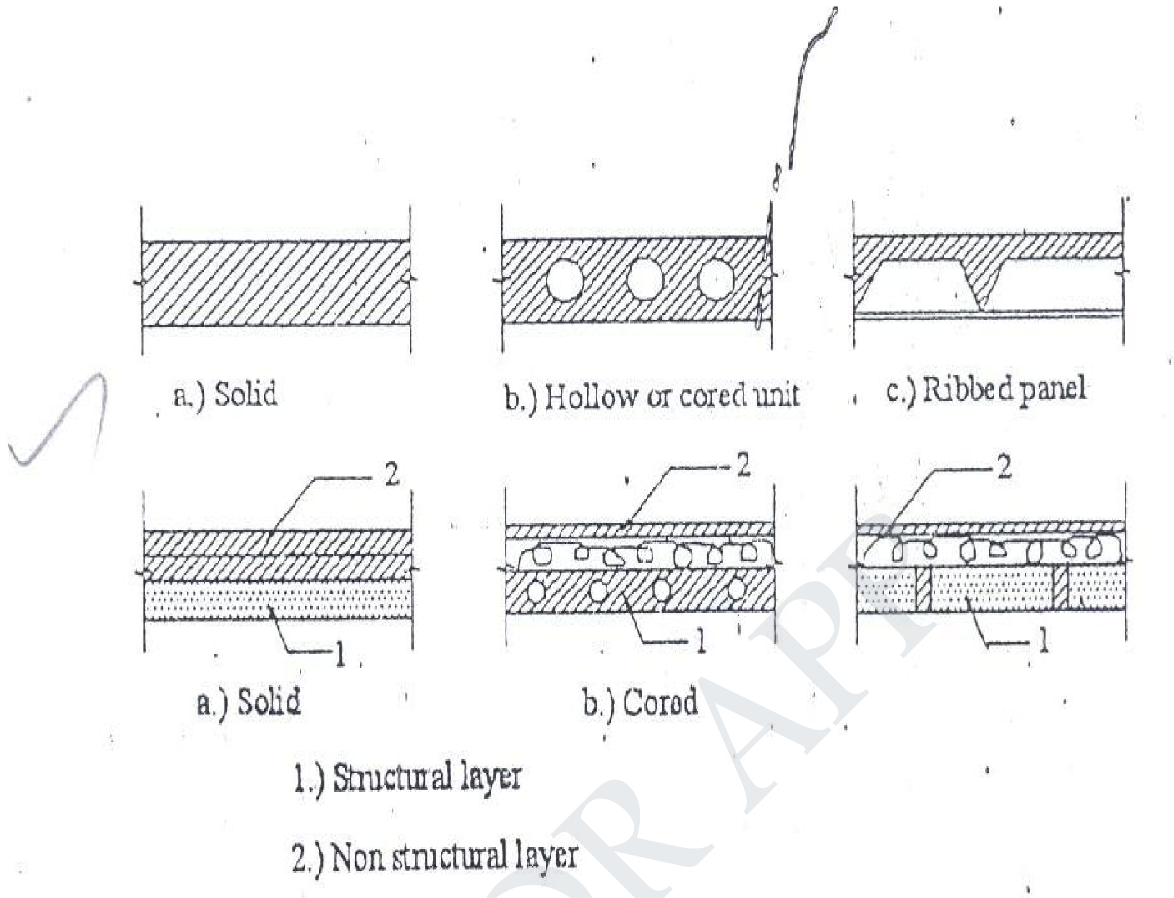
A basic module can be represented as module andfor larger project modules are represented aMp.

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 hollw ducts in between. The centre line of the grid is found by deducting the size of duct.

1.5 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 certin order and discipline. The system of prefabricated construction depends oon the extend of the use of prefab components, their characteristics to be considered in devising a system:

i. Intensified usage of spaces
ii. Straight and simple walling scheme
iii. Limited sizes and numbers of components
iv. Limited opening in bearing walls
v. Regulated locations of partitions
vi. Standardized service and stair units
vii. Limited sizes of doors and windows with regulated positions
viii. Stuctural clarity and efficiency
ix. Suitability for adoption in low rise and high rise blocks
x. Ease of manufacturing storing and transporting
xi. Speed and ease of errection
xii. Simple jointing system

a) Based on Disuniting of member b)
Based on the construction

Based on Disuniting of member:

1. System consisting of linear member disunited at joints
2. System for prefabricates of entire rigid frame
3. System consisting of I,T,U of straight members disunited at points of minimum moment.
4. Two hinged and three hinged arches

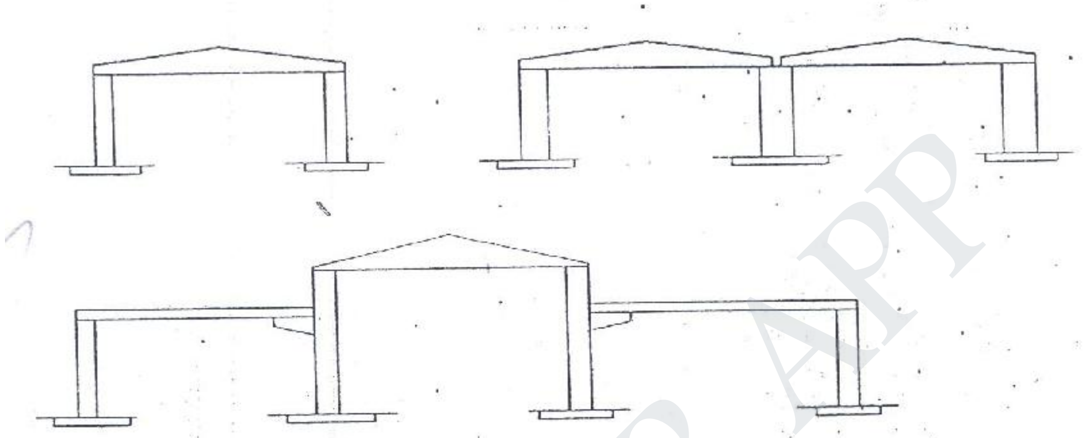


Fig 1.2.Members of frame disunited at the joints

System consisting of linear member disunited at joints:

Advantage:

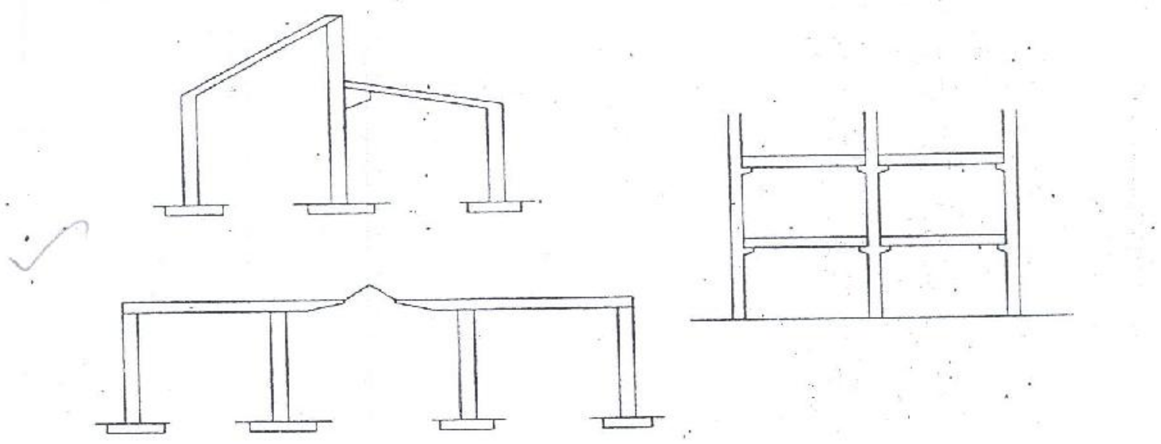
Disuniting at joints gives linear member. This means that a great advantage and facilitates from the view point manufacture and assembly.

Disadvantage:

1. Joints are at corners i.e. at points of maximum moment values, so forming the joint is difficult.
2. Joints must be over dimensioned to cope with insitu concreting. And one alternate solution to replace moment resistant joints by hinged connection.

System for prefabricates of entire rigid frame:

System for prefabricates of entire rigid frame:



In this system, to reduce the no of joints and to precast larger numbers I one piece leads to the prefabrication of entire frame. Production of the frames does not cause any particular trouble but the hoisting is more difficult and requires careful preparation.

The stress distribution of staright members during hoisting is in general statistically determinate.

Advantage:

1. It is ideal for site prefabrication.
2. Small number of joints so rapid prefabrication work is possible.
3. Suitable for long walls consisting of great number of uniform frames.

System consisting of I,T,U of straight members disunited at points of minimum moment:

System consisting of I, T, U of straight members disunited at points of minimum moment

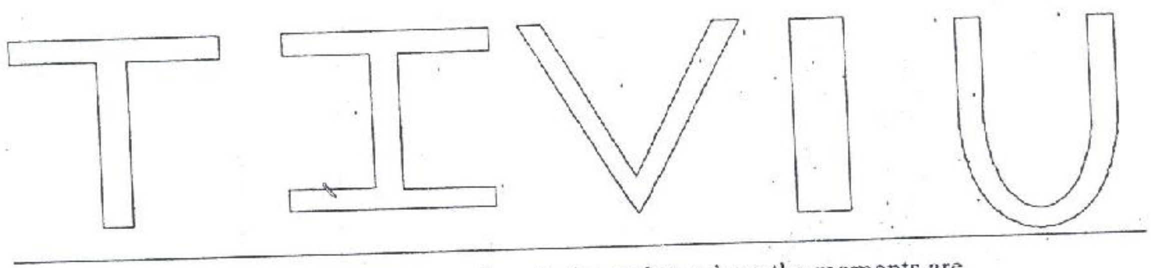


*Fig1.4*System consisting of Structures disunited at points where the moments are smallest Moments

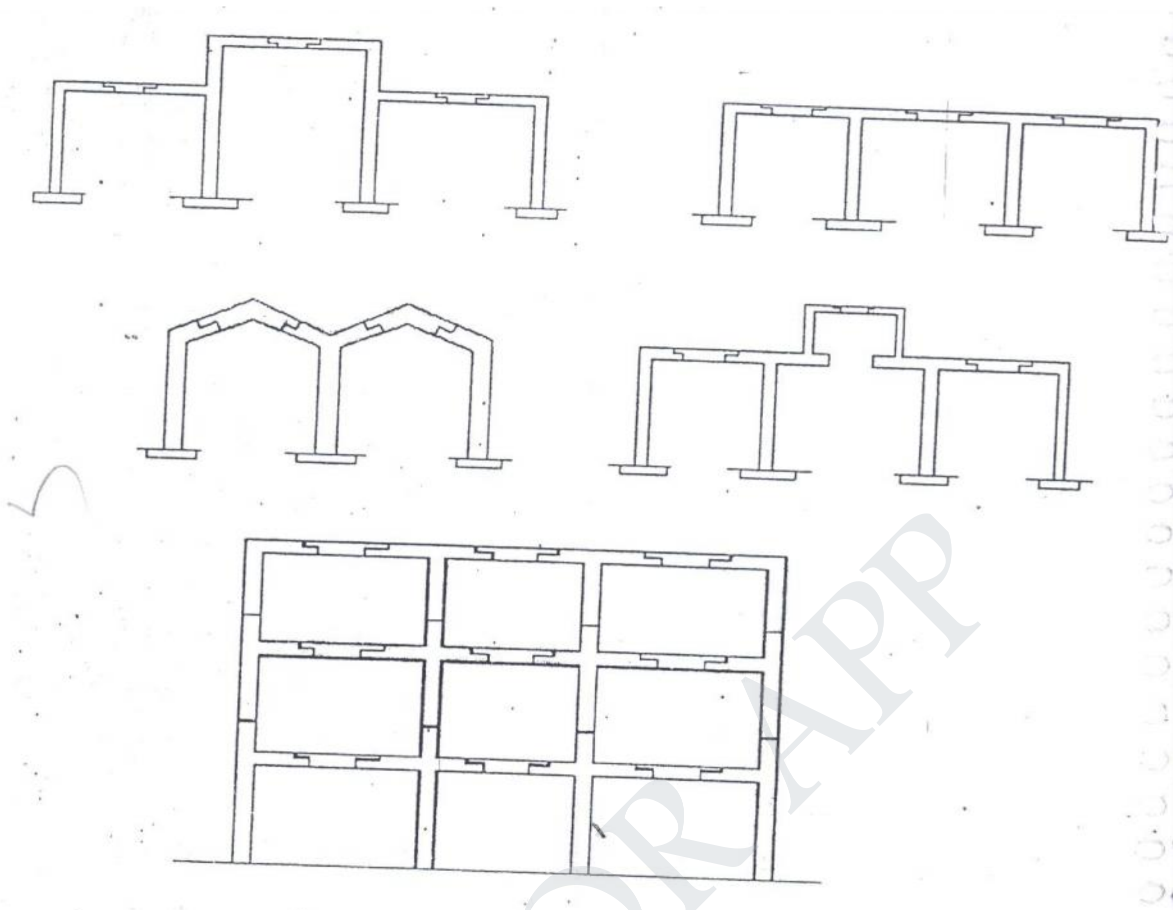


Fig 1.5 Structures disunited at points where the moments are smallest

Another method of disuniting of structures is by division into different membranes at points where the moments are thin or smallest. This method is called as lambda method. Using this method hinge joints are made.

Advantage:

1. Functions are made at points of minimum moments or at points of contra flexure.
2. Disuniting the main girder in this manner makes the application of different skylights possible.

Disadvantage:

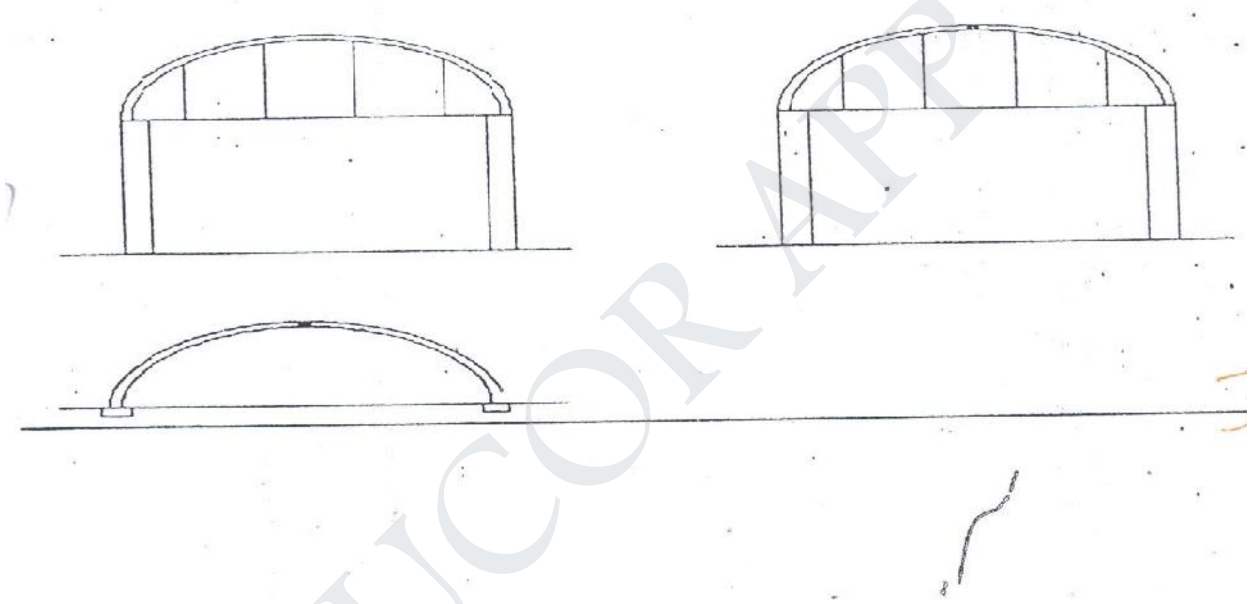
1. Hosting and temperature bracing of L joined asymmetric frame members is particularly complicated.
2. Temperature resting of frame member on each other necessaitates the use of canilevers having half depth and proper forming of this cause difficulty.

Two hinged and three hinged arches

Arched structures are normally two hinged and three hinged arches. Arched structures are normally used for bridging span more than 20-25m. Their production and placing is more difficult than straight members. Arch can be two hinged and three hinged but they can also be fixed at footings nd can be constructed with or without tie.

These members are generally precast and assembled in statistically determinant three hinged variance and middle hinge is only eliminated after placing is finished. The reinforcing bars protruding both sides are welded together and the joint between the members is filled in with insitu concrete.

Arch structure can be precast in either vertical or horizontal positions. In the first case, shuttering made of timber or concrete is required having the same curvature s the arch itself. The prefabrication of larger arches in theh horizontal position is found to be more economical The construction of arch trusses can be properly carried out in the horizontal position only.



1.6 Transportation and Hosting of refabricates:

Truck cranes

Gantry cranes

Mast cranes

Derrick cranes

Twinned mast cranes

Truck cranes:

Truck cranes consists of chasis includinig mortar and pivoting upper part. These cranes are mobile and an travel on their own needs. Different features are:

1. Weight of the crane while travelling is 31.8 tonnes
2. Maximum height of hoisting hook is 36.6m
3. Crane can rotate through 360º.

Disadvantage:

Needs firm and compact soil.

Gantry Cranes:

These cranes are used mainly to serve the operation of manufacturing and storing areas in prefabrication plants.

Capacity 5T, Total weight 4.5T

Horizontal distance between 2 tracks is 7.8m

Maximum height is up to 11m

Mast height 10.9m and it can hoist up to 20 tonnes in operation.

Mast Cranes:

These are wide spread hoisting devices,simple and cheap. Operation requires great skill and practice. Useful in hoisting prefabricates in vertical direction. Suspension load can be slightly moved forward by slackening the rear staying cable. Hoisting load is done by a winch.

Twinned mast cranes:

It is used for hoisting member to great height. It consists of two steel column assembled from sections and connected at top by bridging structure.

Hoisting capacity using two cranes each of 35-70T

Operation of the crane required minimum 16 workers.

The crane can be transferred but takes 1-2 days and is suitable fr high lifting but difficult to operate.

These are now a days replaced by 30T mast cranes hinged in 2 directions.

Derrick cranes:

Highly efficient lifting machines

It is stable or movable

Capacity 20-40T

Suitable for prefabrication halls

These cranes have booms which can move in horizontal directions.

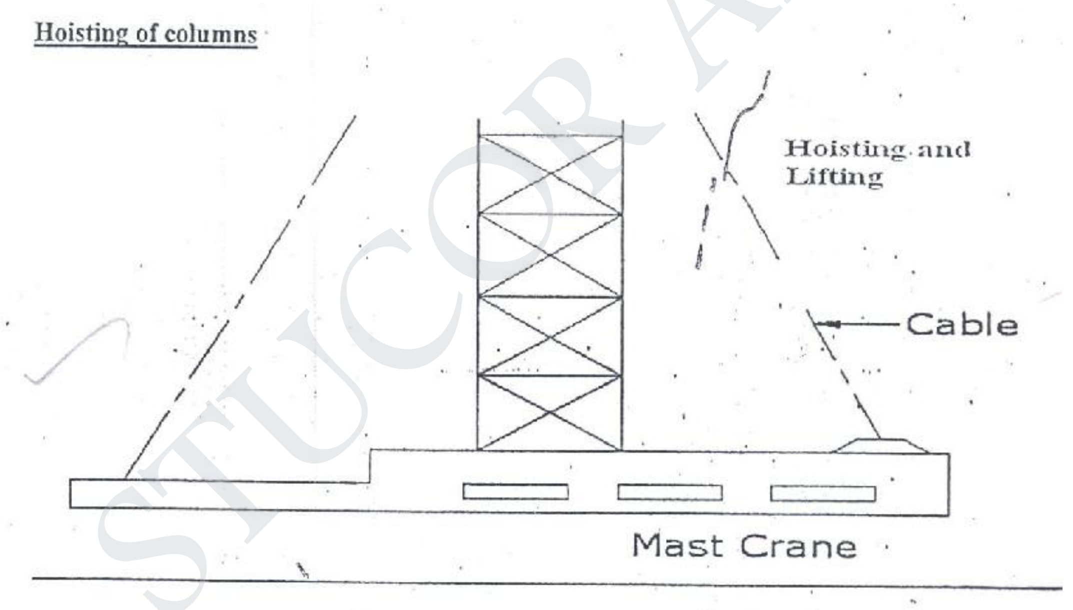
Prefabricated structurers are erected in coonvinient sections which when fixed correctly should be sufficiently rigid in all directions. Normal sequence of erection is

a. Structure units- external load bearing walls,columns,etc
b. Non structure units- internal walls,partition walls,etc
c. Floor panels, balconies, stair units
d. Specialized prefabricated units- chimney flumes. Ventilators, sanitary installation.

If the external walls are hand laid from small blocks or bricks, all necessary materials should be hoisted by crane and stacked near the ultimate position. The mansonry work is begun after the floor immediately above is laid.

The tolerances are comparatively strict and are normally coompliedwith the use of a skilled rection gang. The distance between the wals are measured with the steel tape and the thickness of joint with rule having mm scale.The accuracy is verified by means of surveying instruments after all joints are connected or erected.

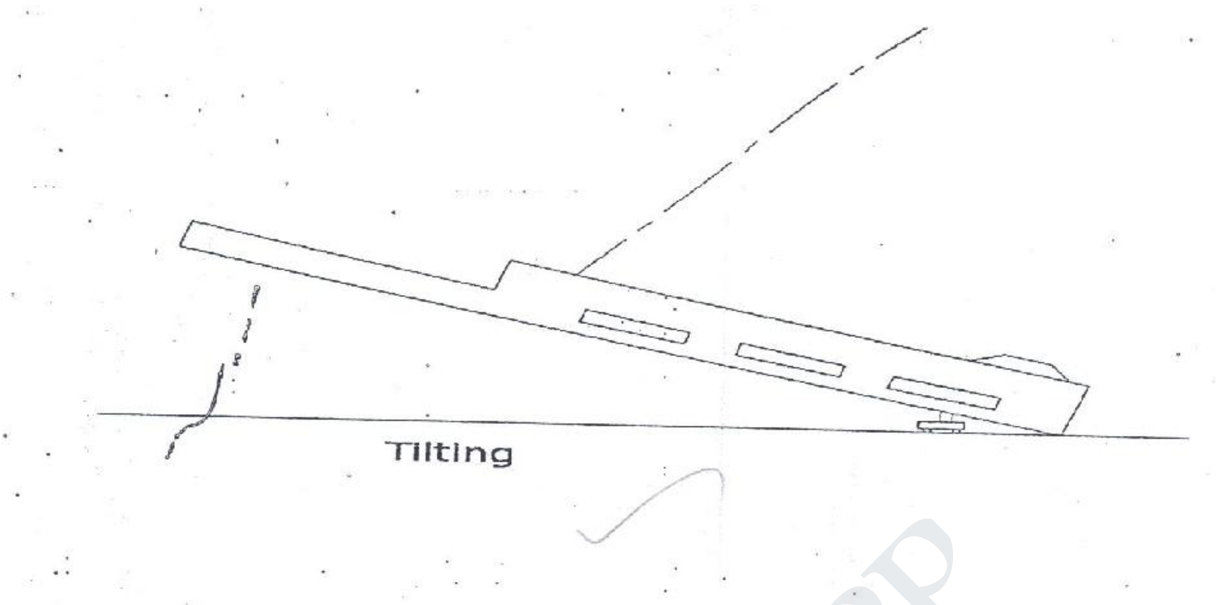
1.7 Hosting of Columns:



The hoisting machine for small column is less than five tones. First of all pick up gear must be assembled on to the column and the column is then under pinned.

Thereafter the column is lowered temporarily on to a sheep shoe assembled at the foot and the roller track is pushed under the shoe. When column is hoisted the pick up points moves vertically and bottom resting on the roller tracks shifts towards the footing. When the column is lifted to the required height, the retaining cable is used to decrease and finally stop the swinging motion of the column.

The hoisting and fixing up of the beams:



1. Pick up and hoisting
   Beams in general are liftedat two points depending on the weight and dimmensioons as well as the load bearing capacity of hoisting machines. The hoisting grider which is heavy to a great can be executed with hydraulic jacks. The jacks are lowered and the beam is placed to the required position to the column.

Suspension:

For lifting up of trusse and large beams of length 25-30m. care is taken to lift the rocker in uniform rate with two hoisting machines otherwise the beams would be subjected to distortion during the lifting leading to cracks.

5.Methods of prefabrication:

Site prefabrication- for large prefabricates

Plant prefabrication- large scale production

Site prefabrication:

1. The RC members are produced t the site in the open air chiefly in the open air or in the temporary sheds
2. The difficulties in construction in general are felt in this mechanization can case.
3. Mechanization can not be of such high degree as site PF is done for smaller duration of time.
4. When the pre fabricates are of large size it is difficult to transport the pre fabricates to the site.
5. In comparison with plant prefabrication transportation of the members are not needed. As large members are not transported the design and weight of the prefabricates are not limited.

Plant prefabrication

1. The members produced are to be transported t the place of costruction this accounts for about 10-15% of the cost of production and assembling.
2. Certain restriction is made in the dimension of prefabrication leading to restrainst in the design and development of prefabrication.
3. Prefabrication is appropriate for mass production for manufacture of standaridized members.
4. Needs costy materials for batching and production.
5. This method is most suited in the case of small prefabricates which are to be prefabricated in very large number.

Plantt prefabrication is done under permanent plant or factories. It is done under the covered roof so the effect of weather does not affect the work. So the quality and strength of the members can be improved considerably. Plant prefabrication reduces the cost of prefabrication if the number of prefabricate needed is more.

Dimensions of prefabricate:

There are 3 commonly known dimension for the prefabricates.

1. The design of the errectio dimension governing the dimensional coordination of the prefabricates.
2. Theoretical dimension
3. The actual dimension of the element when delivered the design dimension should be a multiple of abasic module size m or of a module lmp.

Production of prefabricates:

Production techniques involved are

1. Stand method
2. Conveyor method or line method
3. Aggregate method

Stand Method:

In this method, the prefabrication mature where they are moulded while the production teams moves to successive stands. The bed on whih prefabricates are cast may be fixed or movable. Tilting forms are often uused and in tthis method steam curing is generally done.

Conveyor belt method:

The whole production is split up in to series operations carried out at separate successive and permanent points served by specialized teams. The movement of the mould or prefabricate one point to other vary by means of conveyor belt trolleys.

The rigid steel forms are assembled at station 1 where they are mould oil to reduce the adhesion of concrete.The conveyor moves fron 1 to 2 where prestressing wires are fixed & in the next station anchoring of the wires is carried out. The prepared mould is then carried to the station 1ie casting station.After casting ,it is shifted to the vibrating table & finally stacked @ station 5 for setting.

After that,it is passed through tunnel autoclave for curing.After steam curing move too station 7 for demoulding & is finally stacked @ 8.

Aggregate method:

In the aggregate method,aggregate describes large complex permanently installed machines & mechanical appliances which carry out most of the separate operations involved in the casting of the concrete composition.The stand is operated by a permanent team & the only move the prefabricate makes is to the maturing point.

Aggregate method is used in the production of multi duct hollow floor pannel in Poland.At production point the reinforcement is fixed in the form & remote controlled aggregate(machine)inserts the duct formers,cast& vibrates the concrete,floats @ the top of the floor.The prepared prefabricate then move to the autoclave chamber in which hardening of concreteis accelerate.In many factories combined technology are employed when complex prefabricate are required.

Advantages:

1.The stand technique is the most flexible one.It is used in varying degrees of mechanization,in all kinds of prefabricate factories.

2.It is simple & less capital is required.It can be used for field prefabricate also.

3.Aggregate method is used for large scale productionin which case number of machineries is required.

UNIT 2 PREFABRICATED COMPONENTS

2.1 Behaviour of structural components

Displacement of grid or tartan grids.
Where there is a homogenous and repetitive between at least two basic increments.
E.g. 1M + 2M (or) 3/2 M + 3M
Interrupted grids (or) neutral zones

Where there are non modular interruptions of grids, neutral zones are created to cope with the economics of building design.

elements in building design

- ❖ Continuous grid
- ❖ Superimposed grid
- ❖ Displacement of grid (or) Tartan grids
- ❖ Interrupted grids as neutral zones.

Continuous grid

Where all dimensions in either direction are based on one increment only.

Superimposed grids

When the modular grid of 100 mm increment is superimposed on a multi-modular grid.

building components

encourages as far as possible the interchangeable components, whatever the material form or method of manufacture.

simplifies size operations by rationalizing selling out. Positioning and assembly of building components.

ensures dimensional coordination between installations equipment, storage units, other fitted furniture, etc) as well as with the rest of the building.

Modular Grid

A rectangular coordinate reference system in which the distance between consecutive lines is the basic module or a multimodule. This multimodule may differ for each of the two dimensions of the grid.

Types of Modular Grid

There are different types of grid patterns which are used to locate the positions and dimensions of building spaces, components and

Major Objective

The principal object of modular coordinate is to assist the building design, construction professional building industry and its associated manufacturing industries by standardization in such a way that building components fit with each other with other components and with building assembly on site thereby improving the economics of building.

Specific Objective

Modular Coordination thus

Facilitates cooperation between building designers manufacturers, distributors, contractors and authorities.

In the design work, enables buildings to be so dimensionally coordinated that they can be erected with standard components without undue restriction on freedom of design.

Permits a flexible type of standardization. Which encourages the use of a number of standardized building components for the construction of different types of buildings.

Optimize the number of standard sizes of multimodules will suit particular applications. However, if modular coordination is to be achieves the values of multimodules should not be chosen arbitrary and only standardized multimodules shall be used. By using multimodules, it is possible to achieved a substantial reduction in the number of modular sizes, particularly for components having at least one dimension equal to one of the dimensions of the functional element of which they are a part.

A further reduction in the number of modular sizes may be achieved by means of a general series of multimodular sizes based on selected multimodules. The international standardizes values of multimodules for horizontal coordinating dimensions are

3M, 6M, 12M, 80M & 60 M

The multimode 15M may also be used for special applications.

Aims of Modular co-ordination.

Major objective.

Specific objective.

Flexibility in the arrangement of components.

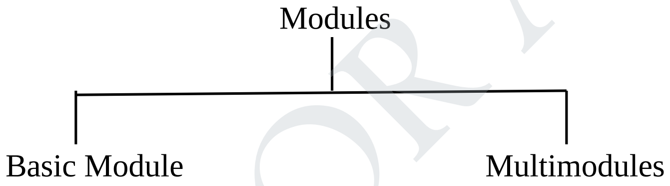
The modular coordination is defined as, the basic module is in adopted, the size of which is selected for general application to building and its components. The value of the basic module chosen in 100mm for maximum flexibility and convenience. The symbol used for basic module is M.

1M =100mm

100 mm = 1M = it is international standard value.

Modules

Modules is a standard unit of size used to coordinate the dimensions of buildings and components.



Multimodules

Multimodules are standardized selected whole multiples of the basic module different single beam has resulted the beam to fall 2 basement down.

The beam just placed for connection.

Need for prefabrication

1. Prefabricated structures are used for sites, which are not suitable for normal construction method such as hilly region, and also when normal construction material are not easily available.
2. PFS facilities can also be created at near a site as is done to make concrete blocks used in plane of conventional knick.
3. Structures which are used repeatedly and can be standardized such as housing storage sheds godowns, shelters, bus standard security cabins, site offices, fool over bridges, road bridges. Tubular structures, concrete building blocks etc., are prefabricated structures.

2.2 Characteristics of Materials

Easy availability

Light weight for easy handling and transport and to economics on sections and sizes of foundations.

- ❖ Thermal insulation property
- ❖ Easy workability
- ❖ Durability in all weather conditions
- ❖ Non Combustibility
- ❖ Economy in cost
- ❖ Sound insulations

Modular Coordination

Definitions

Basic Module

The fundamental module used in modular coordination the size of which is selected for general application to buildings and components.

Modular coordination

Dimensional coordination employing the basic module or a multimodule. The purposes of modular coordination are

(i) To reduce the variety of component size produced.
(ii) To allow the building designer greater.
(iii) Prefabricated components

2.2 Behaviour of Structured Components:-

Precast reinforced structures are many types, because almost all reinforced concrete structures can be prefabricated.

The members of structural components can be classified in to

- Lead-carrying structural members
- Space-bordering members
- Surface forming structural members

Load carrying structures generally act in their own plans.

Space bordering members have as a rule of plane surface. These also play a role in the carrying of loads, but this role is of a lower order. Thus.

Space-bordering members are

Load-carrying structures of a lower order, the load is transferred from the structures of lower order through the structures of higher order to the footings.

Load carrying structures can be classified in various ways from the view point of fabrication, load carrying structures can be divided in to main groups according to their disuniting in to members.

- of straight members
- of entire rigid frames
- of members joined at points of minimum moments
- of orched members limited in to two-hinged of three hinged arches.

Roofing slabs or corrugated asbestos cement sheets laid on purlins

These are the most popular forms of roof covering used in central Europe. This is not surprising considering the simplicity of manufacture of purlins and the availability from stock of factory made lightweight roofing slab and panels.

The structural system of the purlins may be

a) Freely supported beam b) The cantilever girder
c) The continuous girder.

The connection of the purlins over the support are designed only to absorb a limited BM. Normal purlins spans between 5 and 10m. The purlins are spaced at intervals of 2 to 3m.

Purlins:-

Purlins are usually solid web members. For long spans they may lattice girders or trussed beam.

Freely supported purlins are designed as let flanged or fish-belly members. Purlins designed as cantilever grilles (articulated griders) are usually llel flanged members.

The c/s feature depend on the spans of purlins & on the slope of the roof. The purlins for flat roofs are usually rectangular T-section or (prestressed concrete) T-Section members for steeply sloped roofs it the loaded also in biaxial bending L-Sections or channel sections are used.

Purlins section & the approximate spans associated with them for a purlins spacing of 3m are indicated for flat roofs. The dimensions relate to freely supported purlins.

Purlins sections with associated spans for a purlins spacing of about 1.25 M in the case of steeply sloped roofs with corrugated

professor von Halazz. They are convenient to manufacture with the legs of the channel upwards. whereby ray thin webs can be produced.

This type of purlins may be conventionally reinforced or by prestressed. Also they may be freely supported or be continuous over several spans. In case of L-shaped purlins usually only the flange of the section is supported.

The fishbelly girder is very favourable with regard to material requirements & the patterns of forces in the girder, but it has the disadvantages of being rather unsatisfactory from the point of view of architectural aesthetics. When it is used generally designed as a reinforced concrete purlins.

Structural connection to the main beams may be constructed as follows:-

a) By supporting the entire c/s of the purlins, the latter being secured to the beam by means of dowels, projections concreted on to the beam so-called shoes thickening the top flange of the beam with insist concrete or performed recesses in the beam.

b) The two last-mentioned methods are more particularly suitable for purlins of rectangular section. If the main beam is not provided with recesses to receive the ends of the purlins, it is desirable to apply an insite concrete topping to it, else there will be gap between its top flange & the roofing slabs, which not only looks rather unrightly but also aolds unutilisable, extra space to the enclosed volume of the buildings on the other hand, when recesses have to be formed in the top of the beams, concreting presents-difficulties Besides the recesses weaken the top flange unless it is possible the supports. Because of this local strengthening it is possible to reduce the depth of the purlin over the rod beam. There are too possibilities 1) The end of each purlins is reduced the depth to form a nib which rests on the beam. 2) The diaphragm on the top flanges of the roof beam is provided with nibs or corbels for supporting the purlins.

Purlins based on the principles of the cantilever girder. Provided with hinges which are so located as to ensures statical determining have not proved satisfactory. The reason for this are a) Halved joints:- The requirements of careful workmanship are more stringent than are normally considered acceptable in practice.

By large force will develop, more particularly in the purlins of long buildings, the failure of one member is liable to result in the collapse of the whole structure. This has indeed happened in a number of buildings.

The roofing slabs laid on the purlins of flat roofs are usually 0.5 TO 1.0m wide & have sparts of about 2.0 to 5.0m these slabs also comprise the thermal insulation and where necessary, also the cement mortar screed for the gravel roof.

The wt of slabs varies bet 10 & 150kg/m depending on the bulk density of the insulating materials and on the span.

a) Ordinary concrete : “Waffle” slabs with a shell thickness of only 1cm have been produced by the firm of press AG. The concrete bad a specified 28 days strength of 600kg /m^2.

b) layer, are manufactured on vibrating tables in Hungary the output per vibrating table is about 100 slabs per day. The slabs have standardized dimensions of 0.5 x 3.0m.

c) Roofing slabs can be produced in a simple manner from perforated bricks or fixed insulating clay. The reinforcement is passed through cavities. These slabs are 20cm wide & 8 to 10cm thik for spans upto 2.8 m.

d) I, perforated bricks or light wt bricks are used in conjunction with reinforced concrete ribs to form slabs 0.87 m wide & upt 3m span.

e) Pumice concrete slabs ("Planks") have been produced in germany for a good many gears, they are available in 3 forms slabs with circular cavities, "waffle" slabs comprising longitudinal and transverse ribs, & sold slabs-1.

f) Duris of roof slabs are used in many countries. The standard slabs are 50cm wide & 2 to 4 long. This concrete is not hygso scopic to that these slabs can also be used in damp surroundings without suffering any appreciable loss of Thermal insulating capacity.

g) Hebel aerated concrete roofing slabs used in Germany and Switzerland are likewise 50cm wide 2 to 6m long. They are reinforced & light wt concrete of with they are made has a compressive strength of 35 to 50kg/cm^2.

Large individual precast units are better able to fulfill the requirements of industrialized old than purlins & relatively small roofing slabs can they will therefore gradually suppressed the more conventional form of construction with roofing slabs & purlins. The advantages are

a. The number of units is substantially reduced
b. The slab & web of the unit are concrete as single monolithic whole with structural co-operation of the slab.
c. Window bracing for roof are dispensed with as it is readily possible to inter connect a number of large roof units.
d. Large roof units generally produce an aesthetically more pleasing result.

The requirements applicable to roof units may be summarized as follows.

1. The units should readily lend themselves to type standardization & to quantity production with the minimum of labour.
2. They should require the least possible quantities of material both in terms of concrete & of reinforcing steel.
3. They should be suitably transportable & capable of being conveniently stacked.
4. When joined together they should act as rigid diaphragms, so that no other form of wind bracings needed.

Countries they are reinforced & the light wt which is aerated concrete.

(k) Hollw prestressed concrete concrete slabs of the schater system are produced with light wt concrete core d are suitable for span up to 6.5 m.

Many other types of roofing slabs are manufactured from a variety of light wt materials.

How roofing slabs are supported on the purlins.

The standard specifications of some countries require that roofing slabs be designed as freely supported members without taking structural continuity into account. However it is normal practices always to install reinforcing bars in the longitudinal joints not as a means of establishing true continuity but merely to inter connect and locate the slab.

Structural continuity can be achieved by appropriate forms of construction with prince or other light wt concrete slabs. Tests have confirmed that the failure load is increased as a results of such arrangements.slabs.

2) Roof units with 3D structural action such as singly & doubly curved shells & fololed plate structures.

Hollow roofing slabs with rectangular cavities.

Slab type roof units are subdivided according whether they have structural longitudinal & transverse ribs or only structural longitudinal ribs.

2.3 Waffle Slabs:-

Recalled waffle slabs are characterized by having transverse ribs which perform a structural function & which may be so arranged as to form a series of approximately square panels with the longitudinal ribs or may alternatively be spaced close together. As a result of this arrangement the actual slabs can be made very thin. Thus they are actual slabs can be made very thin. Thus they are the lightest of in terms of material quantities the most economical type of roof unit. The width of the units ranges from 1 to 3m. The span range from 5 to 12 m, depth.

The longitudinal ribs are interconnected by welding or by means of grout & left projecting from the slabs.

It is rectangular cavities combine numberous advantages with regard to material requirements & wt they are significantly more favourable than roof units with circular cavities. The se box. Sections possess high torsional rigiolety & present a flat surface on the under side. Besides they can very suitable be pre stressed. The only drawback is that manufactured involving the removal of the cores for forming the cavities is somewhat more expensive than for ribbed slabs.Bearings for roof units

With regard to the bearings of slab-type roof units on the main beams a distinction must be made as to whether the unit is used for a flat roof or for a north light roof & as to whether or not the unit is provided with a transverse rib at the bearing.

The external wall constructed of precast components

Wall panel must

a) withstand without harmful deformations the loads that it is required to carry.
b) Permit or absorbs the movements due to temperature variations and differences without sustaining damages.
c) Have a good architectural effect.
d) Be resistant to climatic influences.
e) Require the least possible maintenance
f) Provide the requisite a caustic insulation and I fire protection
g) Fulfill the other basic requirements of prefab construction.

According to the perform the function of external wall panels are at following kinds.

a) Load-bearing b) Stiffening (Wind bracing)
b) Merely space-enclosing (curtain wall)

The c/s design of wall panels depends on the requirements

a) Single layer solid panels consisting of one material
E.g. Light wt concrete.
b) Multp-layer panels consisting of concrete and insulating materials.
C) Special -section slabs, which may be either of single-layer or multi layer constructions (sand which construction).

One of the most intricate and most difficult problems to be solved in both design & construction of structures assembled of prefab members as the joining.

It is highly important that the construction of the joints should be easy that unavoidable smaller in accuracies and deviations within dimensional tolerances should neither influence the designed stresses in a detrimental manner nor cause in admissible changes in the stress distribution of the structures.

The forming and construction of joints requires owing to their intricacy, greatly increased consist joints which cannot be inspected should be omitted.

When solving the problem of joints the properties of reinforced concrete must be taken into considerations. This means in other words, that the design & the construction of the joint should harmonize with the materials to be used. The properties of steel of timber are quite different from those of concrete and reinforced concrete. Therefore joints similar to those used in timber and steel construction are generally not appropriate for the purpose.

Joints of reinforced concrete structures which should be omitted are shown.

The joint to be seen in fig. This is s solution resembling a butt jointed with splayed table as used in timber construction. This does n't comply with the nature of the material & So is not good for this purpose. The limtating a joint used in steel construction, is not appropriate either. The steel structure -like joint as seen in which the component structural parts are coelded to the reinforcement is also not sufficiently adequate. The two halves of the steel structure forming the main constituents of the joints have to be concrete is to

the placing of the pins.

The joints can be rigid hinge like or shed.

Rigid joints are adequate in addition to the bearing the tensile, compressive & shear forces for resistances.

Design of c/s based an efficiency of the material used:-

The plastic concrete can be used for the subsequent concrete of joints & the fluid cement mortar last or pressed into the gaps lase part of their water during the settling time & shrisk, after setting the shrinkage of the insite concrete & mortar continue.

with respect to two phase of shrinkage same codes on reinforced concrete construction permit only reduced stresses for a subsequent insite concrete of a mortar casting. These are generally determined as a function of width of the joint on the gap to be concrete as cost.

Joints must be designed & executed so that compensation for the allowed dimensional tolerances is ensured or relative displacement of the jointed members should be impossible even as a result of a blow or of any other infavourable force effect. The length of the section determined for the transmission of forces should be as short as possible, but should excluded any excess of the permissible stress.

The joints can be regid hige like or shed. Regid joints are adequate in addition to the bearing of tensile, compressive & shear forces recover displacement and

like joints can transmit forces passing through the hinge itself and also allow a certain motion and rotation.

Rigid joints are generally used for the junction of column to footings, but they can also be applied for joining of individual groups with one another. The joints generally used in the construction with precast members are usually hinge like their execution is simpler and requires less working -lime than rigid joints “shodjoints” are only exceptionally used in industrial construction & are justified for a long span only. These joints are justified for chiefly used in bridge construction for a long span bridges depending on the necessity of insite concreting, two kinds of joinjts can be distinguished.

a. Dry joints - joint accomplished by simple placing of two members on each other & fasting.
b. Wet joints - joints require not only casting with cement mortar but also subsequent concreting.

2.4 Joints of different structural connections:-

a. jointing of column to footing
b. jointing of column to beams on top of column.
c. jointing of column to beam at an intermediate.
d.
e. jointing of beams

f. Forming of joints of arched structures
g. joining of joints of post tensioned structures.
h. joining of precast to monolithic reinforced concrete structures.

a. Joining column to footing:-

This joint is usually rigid but also can be hinge. A rigid joint can be made by placing the column into a calyx of the footing or by using a welded joint the figure shows the three variations of the this method.

a) Can be used for smaller b) for average and for large footings

The opening of the calyx is 6-10 cm greater in all directions than the c/s of the column. This is enable the vibrator to be operated while concreting at the bottom of the calyx & checked by leveling before concreting. A similar steel plate is also put on the lower end of the column when positioning the column. These two steel plates must be on each other. The dimensions of these steel plates are from 100 x 100 x 10 to 150 x 150 x 10mm an chored in to the concrete after the column is put in placed properly plumbed tow advantages of the calyx joint should be mentioned

1 The placing plumbing and fixing of the column as well as the subsequent filling of the calyx with concrete is far simpler and requires less time then in the case of a welded joint.
2 The method is least sensitive to inaccuracies occurring during the construction.

The disadvantages of the calyx Joint is more suitable for small columns. In the case of large columns requiring a calyx depth of which is greater than 1.0m.

One members of joining a merge like joint consists either of placing to beams on to as small cantilever protracting trans the column or of putting it on the bottom of an adequately shaped opening deft out of the column shaft. The beam rests temporarily on a tongue like extensist on a steel plate placed in this opening on the supporting surface the tongue is also furnished with a steel plate anchored in to the concrete. The other parts of the tongue are supported after the placing has been finished with concrete cast through an opening left for this purpose.

d. Lengthing of columns:-

Columns are usually lengthened at floor levels. An intermediate lengthening should be avoided it possible.

The lengthening of columns can be executed similarly to the joining with fooling, accordingly reinforcement are joined by overlapping looped steel bars a welding. Thereafter the stirrups have to be placed & finally the joint must be concreted.

e) Joining of Beams:-

The functions of beams can be affected either by overlapping the protracting steel bars or by welding them together.

Figure shows the tinge like joint of purlins. In this method the whole shear must be borm by both cantilever (i.e) by two separate structures therefore it is expedient to form this joint atleast for large girders.

The method illustrated in the fig presents a dry joint of beams which is called a bolted form. The advantages of this joint is immediate bearing capacity.

f) Forming of functions of arched structures:-

Precast arches are usually produced and assembled in the form of three hinged structures. When the constant load has already been applied the centre joint is frequently eliminated. The omission of the centre joint increases the rigidity of the structure. Naturally arched structures can also be precast in a piece i.e in the form of two hinged ones.

Hinges of arched structures can be made by using either steel shors are more expensive, but the centre transmission of forces is enhanced by their use.

Figure shows the centre hinge of a three hinged arch with a span of 12.5 m for this kind of each the joint can also be formed from the concrete itself. The latter method require exactly executed and adequately reinforced concave & convex surfaces with hear against one another.

The joining of a smaller hinged structure is show in below mentioned.

The arrangements the centre junction of the end hige of an arched structure. This method was used in the construction of the ball for the middle rolling train in D.O.Sayar. The structure was precast & assembled in the form of a three-hinged arched transformed later in to a two -hinged one.

g. Design of joints for post tensioned structures:-

Post tensioned structures can generally be joined for more simply then the usual reinforced concrete structures, By using post tensioning it can be ensured that in the entire structure. The joints included only compressive can develop consequently the problem of joining can be solved in a very easy manner namely by placing plane surfaces side by side and then filling the gaps with cement mortar.

precast member. Thus in post tensioned structures the forming of joints does not cause difficults.

Sketches solutions of principles relating to the joining of post tensioned structure are to be illustrated in the fig. All these joints are of course rigid and moment bearing. It is not permissible for the mortar which is to be poured into the gaps to follow in to the ducts of the stressing lables to arid this cable ducts are jointed by placing a shore piece of tube or rubber ring into the duct itself.

A regid point of their kind established between a columned two girders supported by the former after the casting of the gaps & hardening of the mortar, the short inserted cables are stressed and so rigid joint is established.

h) Joining of precast to monolithic reinforced concrete structures:-

If frequently occurs that a monolithic beam has to be joined to a precast column in this by placing the protruding from the column or into an opening formed in the column's shaft.

When making the joint, first of all a 2.5 cm deep cavity is chielled out of the side of the precast column. The bottom of this cavity should be roughened so as to attain a better bank between the concrete of the monolithic beam and the precast column.

1.Explain about Roofing members in etail.

Roofing members are classified as,

i.Reinforced planks.

ii.Light weight concrete members.

iii.Small reinforced roofing

members. iv.purlins

v.Large reinforced roofing

members. Reinforced planks:

Reinforced planks made of hollow tiles.The reinforced planks with longitudinal circular holes.Thickness of these tiles is 60mm,80mm & 100mm & the width is 200mm & length is vary from 360mm to 400mm. On the upper side one longitudinal groove is provided.

Reinforcement is placed into these grooves which are subsequently filled with cement mortar.In this way ,roofs of length 2 to 3m & thickness of 60 to 100mm & width 200mm can be constructed.

The end tiles resting on the support are provided with 3.11mm dia stirrups protruding from the tile.There are kept together over mortar of 40mm thickness & in further concreting of joint.the joint is completed.

Light weight concrete roofing members:

Light weight concrete roofing members play a role in addition to space bordering & load bearing in heat insulation.The thickness varies from 7.5 to 25cm for reinforcement of Light weight concrete roofing members.weiding nets is used.steel reinforcement is given additional coating to prevent any corrosion care is taken to give good bonding of reinforcement with concrete.

The unit weight of these members is 750kg/m3 & width of 50cm.Its varies from 1.75mm to 6m.precast members can be made either in usual way using light weight materials.sand as aggregate
& combination of high strength concrete.The top & bottom layer of about 2 to 3cm thickness iss provided with high strength concrete.Its consists of prestressed 2.5mm ddia embedded in these layers.The middle portion is made with light weight concrete.

Small reinforced concrete roofing members:

The Small reinforced concrete roofing members is essentially precast simply supported ribbed concrete slab width varying from 450 to 120cm & length varying from 2 to 4m.

Purlins:

Purlins are precast concrete beams supported by the main girders serving the purpose of bearing for the roof covering.The cross section of purlins iss generally rectangular but it can also have trapezoidal,T,L and I shape.

Precast purlins can be simply supported or cantilever beams & for the bearing of loads beyond these weight simply supported purlins can be transformed into continuous beams.It is very simple & easy to place.For cantilever purlins placing of hinges should be determined in a manner to develop positive & negative moments equal to each other.This can be arrived by placing the hinges @
0.1451 from the support where I is the spacing between the

supports. Large reinforced concrete roofing members:

Large reinforced concrete rest on the main girders.These are generally used for large hall structures & these are most advanced type of precast structures.Members are manufactured corresponding to spacing of the frame length of about 6 to 10m & width of 1.3 to 1.8m. As they are most supported on main girder purlins are not required.

Four kinds of members exist:

1.Normal members.

2.Intermediate members.

3.Members with cornice.

4.Members with gutter & eves border.

2.Write a detailed note on shear walls.

The types are classified as

1.Rectangular type or Bar bell type.

2.Coupled shear wall.

3.Framed shear type.

4.Core type shear wall.

When walls are to carry only compressive force,they can be designed as plain concrete,when walls are subjected to tensile forces(due to wind force)due to eccentric loading& earthquake load the walls are RC walls,shear walls are previously provided to resist the wind forces only.Hence became popylar & to prvide shear walls to resist EQ forces.

2.6 SHEAR WALLS:

These are simple type & these shea walls under forces & horizontal shear along its length are subjected to bending & shear.To resist the forces the uniform distribution of steel along its length is used in simple shear walls.In case of bar bell type 2 boundary elememts are provided on either side.Minimum steel is provided over the 0.7 to 0.8L & the remaining steel is placed steel is placed @
0.12 to 0.15L.These walls are designed in such a way that they never fail in shear but only by yielding of steel in bending.Shear failures are sudden & brittle.One disadvantage of this type of wall is that during EQ the shear walls attract all the earthquake forces & dissipates the forces in to the wall.The loss of energy by crackingof the wall iss difficult to repair .This can be eliminating by providing coupled shear wall.

Coupled shear wall:

If two straight walls are joined together by relatively short span beams they are called as Coupled shear wall.The stiffness of resultantwall increases in addition to the structure cqn dissipate most of the energy by yielding the coupling beams with no damage to the main walls.It is easy to repair the coupling beams than repairing the walls.

The action of the couping beams of the shear walls.The beams are displaced vertically they tend to bend in a double curvature.The consistent shear can reduce the axial force in the upwind wall by a large amount & reduce pressure can lower tne shear capacity of the wall.To take up for this force diagonal lateral steel is more effective.

The design should be taken care of to see that the system develop plastic hinges only in the coupling beams before shear failure & coupling beams should be designed to have good enrgy dissipation capacity.

Framed shear wall:

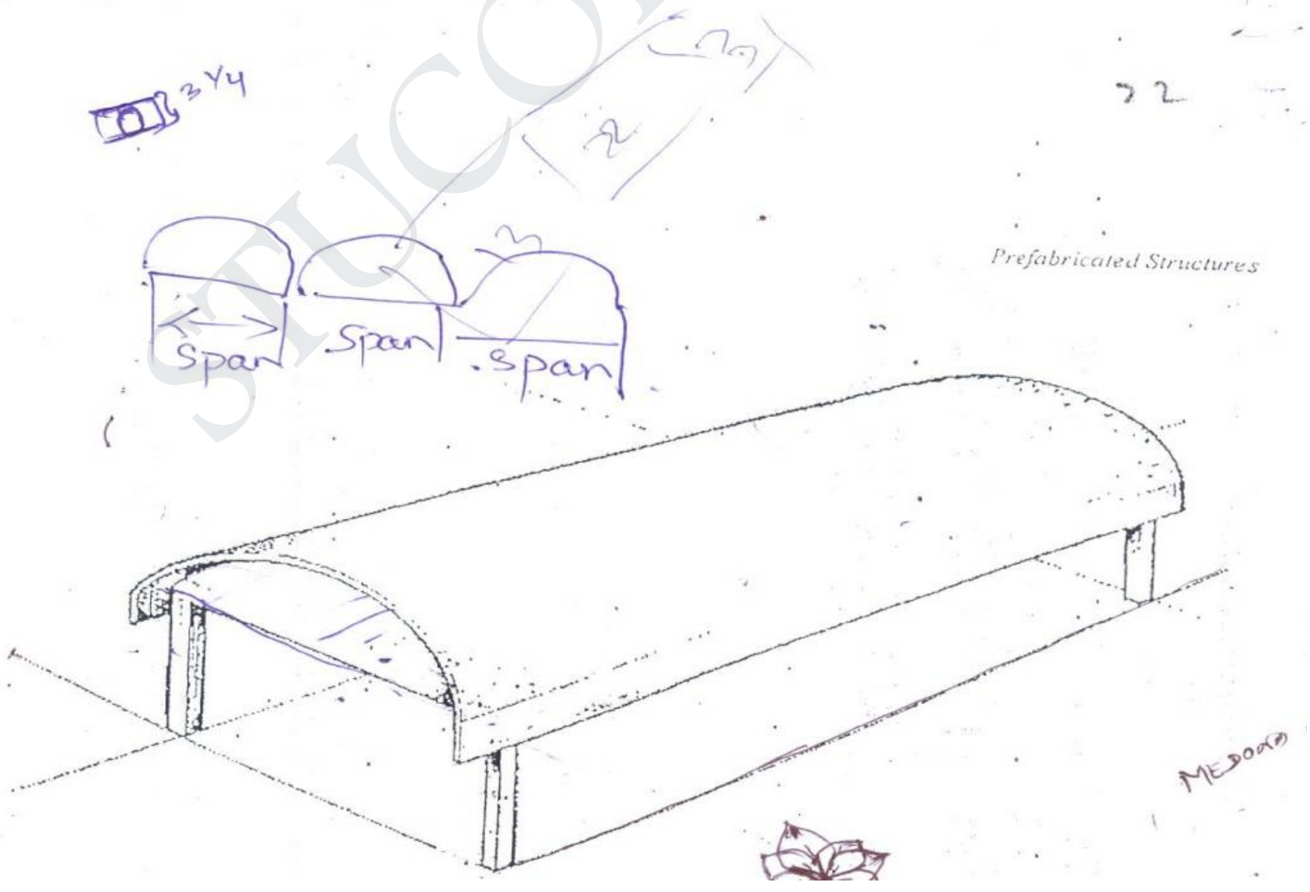
Framed shear walls can be provided with or without brick infills.

2.5 Construction of roof and floor walls.

These are load bearing structures having curved surface.The advantage of shells is that it provides large column free area for the monolithic construction.The cost of shuttering & scaffolding is very high but if manufactured in a precast factory in large scale.The production cosh can be considerably reduced.

The shell structure can have ribs in the centre & provided with curved membranelikee roof.The shells built of precast members used in the construction of industrial buildings are many.The thickness of shell varies from 2 to 10cm.Some precast shell,,s are produced with dimensions which are very difficult to transport.To avoid such difficulty large size shells are precast near to the restting or construction place.

The transportable or small size shell members can be precast in factories & these are transported to the site.Examples:Barrel shells,Saddle or hyperboloid shells.cupola or paraboloid shells.



Types:

a.Single barrel:

The structure above is a single barrel with edge beams.The shell has been allowed to project beyond the edge of the stiffener in order to show the shape of the shell.Stiffeners are required at columns.They do not necessarily have to be complete diaphragms but may be arches with a horizontal tie.The thickness is based on design of a slab element,the thickness of the barrel shell is usually based on the minimum thickness required for covering the steel for fireproofing,plus the space required for three layers of bars,plus some space for tolerance.If these bars are all half inch rounds,a practical minimum would be 3 ¼ inches.Near the supports the thickness may be greater for containing the larger longitudinal bars.

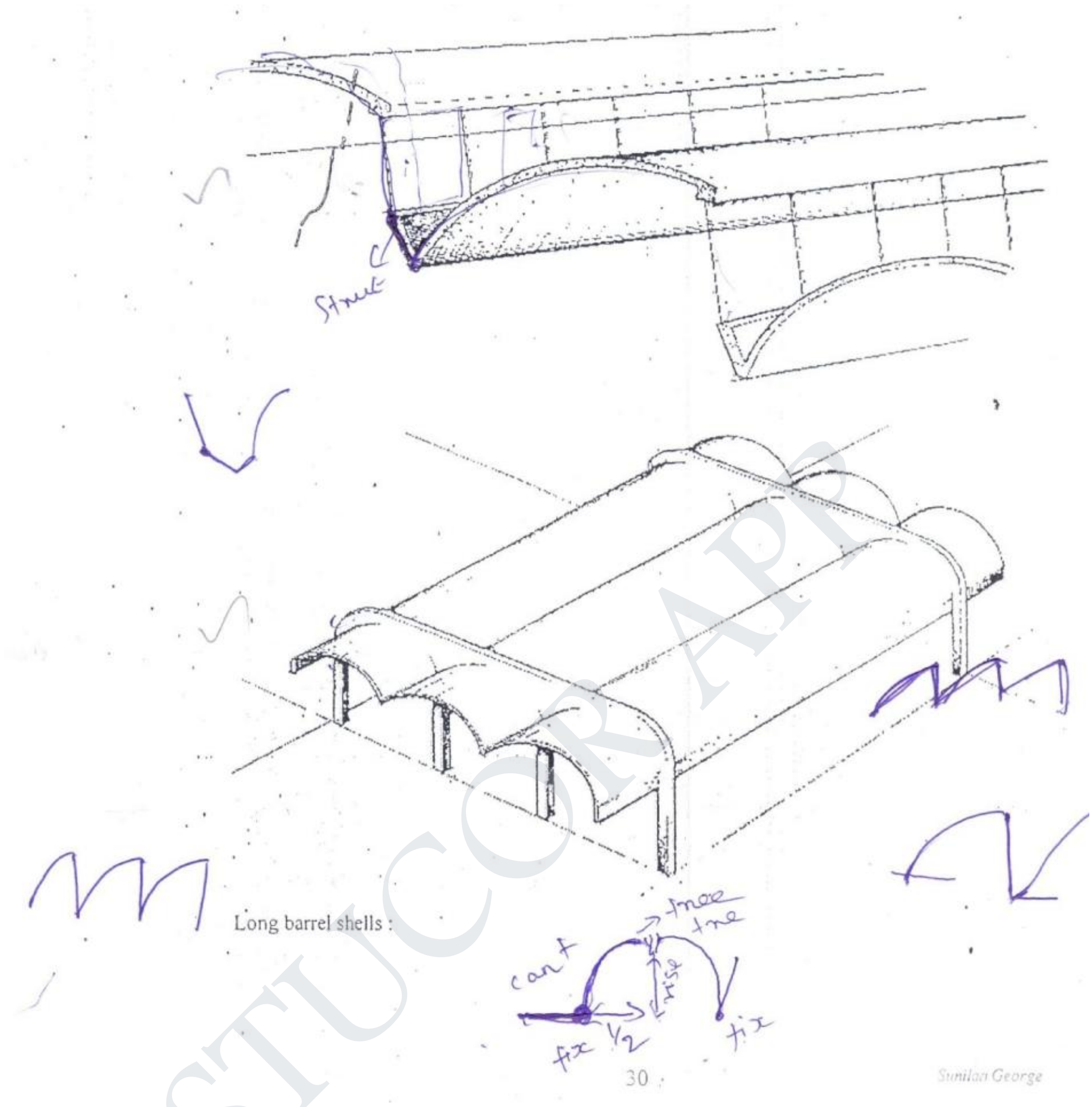
If more than one barrel is placed side by side,the structure is a multiple barrel structure & if more than one span,it is called as multiple

span structure. Multiple barrel structure:

This structure shows a multiple barrel with vertical edge beams at the outside edges.The stiffeners have been place over a roof.The advantage of having the stiffeners on top is that there are no interruptions to the space inside the shell so both the inside appearance & the utility are better.The movable formwork may be used which will slide with little decentering lengthwise of the shell.

The multiple span structure should have an occasional expansion joint to reduce shrinkage & thermal stresses.This can be accomplished by cantilevering half the span from eachadjacent stiffener.A small upturned rib placed oon each side of the joint & accordion type sheet metal flashing is arranged to prevent roof leakage.

The maximum spans for this type shell are again limited by the geometry off the cros section .Assuming the maximum width of barrel to be 50 feet & maximum end slope to be 45°,the rise would be about 14 feet,the maximum span would be in the order of 150 feet.

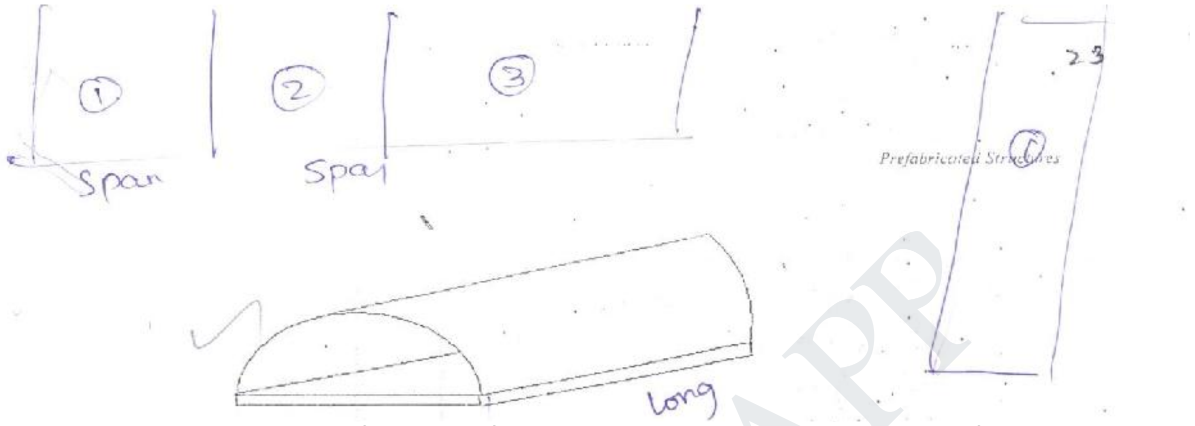


North light shells:

This type of shell structure is used to provide large areas of north light windows for factories requiring excellent natural lighting.The windows may be slanting or may be vertical.The member at the bottom forms a drainage trough with the curved shell & materially assists in stiffening the structure. The effective depth of the shell is not the vertical distance between the two ends but is morely represented b the depth if the shellis laid flat with the ends of the circle on the same horizontal line.The spans for the north light shell must be rather small in comparison to the vertical depth of construction.The edges of adjacent shalls should be tied together by concrete struts serving as mullions between the window glazing.

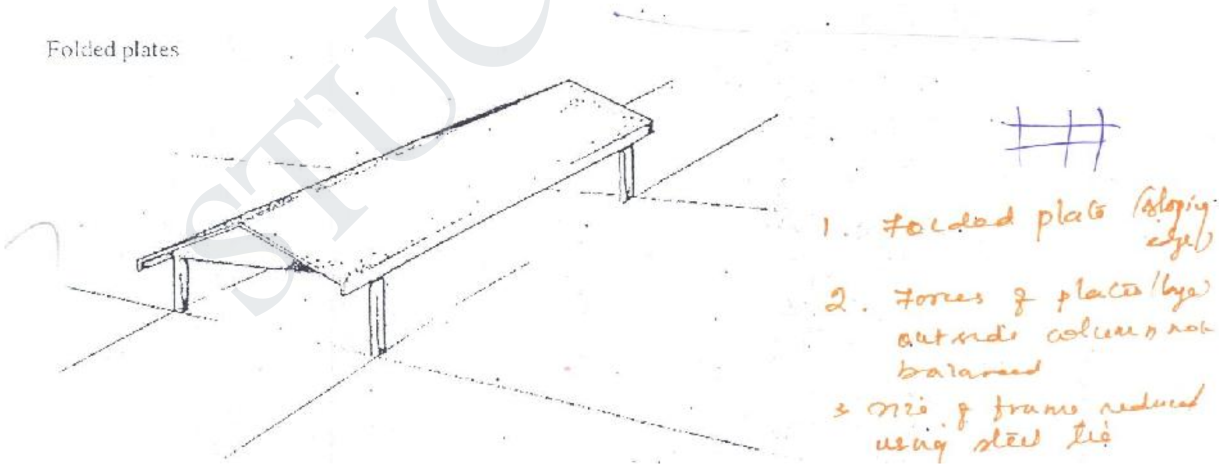
Long barrel shell:

Long barrel shell obtained hen the semicircle or a segment of same is translated along the longitudinal axis.



Generally used for shed for industrially purpose & buildings for large column free areas.Generally the prefabricated barrels off sizes 3.5 to 5m & 10m long with edge beams having thickness of 60mm.The thickness of the shell should not be more than 40mm.The dimension of these members were finally limited by the load carrying capacity of the available hoisting machines using the girder system built of precast prestressed trusses with parallel chords,areas having a span of even more than 15m can be covere with barrel shell

Folded plate:



A folded plate structure with 3 segments for each barrel.The forces from the reactions of the sloping plates on these rigid frames will be quire large and at an outside column they will not be balanced by thrusts from the adjacent plates.The size of the frames may be reduce by using a steel tie between the tops of the columns.The dimensions of the plate are dependent on both the with of the barrel & on the span.The depth of the shell should be about 0.10 timess the span & the maximum slope of a plate should not be greater than 40°.For example,assume that the span is 60feet & the baywidth is 24 feet.The depth of the shell should be about 6 feet & the horizontal width of each plate with a 3 segment plate should be about 8 feet.The lope of the plate is 6/8,which is about

37° & is satisfactory.The thickness of plate could be about 3 ½ inches.The principle components in a folded

plate consist of 1.inclined plate 2.edge plate which must be used to wide plate.3.Stiffeners to carry the loads to the supports & to hold the plate.4.Column to support the structure in the air.

4.Discuss about domes in detail.

Domes are construced with many planes so they ressemble the facets of a diamond.The structural problem in designing these shells is to provide enough angle between the planes so that an actual rib is formed which will be stiff enough to support the plane surface.Usually it is best to start with a spherical translation surface.

Folded plate dome:

This makes use of tapered folded plate slanting to the centre in the form of a tent.It can be built so that each of the triangular elements is self supporting during construction except for possibly a single shore at the crown.To obtain natural light the top may be cut off & a ring inserted with a sky light.The arch thrusts are taken through this ring & the difficult forming of the narrow plate at the crown is avoided.If the structure is large there would be very high bending stresses due to the curvature & the ring would be very large.

Multi facet dome:

There may be discontinuous in the layout of intersections which make or destroy the visual effect & make the structure more difficult to design.This dome can be of much greater span than the previous example because the span of the individual slab element is less.A dome hexagonal in plain can be made continuous with adjacent units if it is necessary to cover a large area.

Half sphere- vertical walls:

A half sphere for a dome of revolution does not require a thrust ring at the base so it can be placed on vertical walls & made continuous with a walls.This design is used for tanks because the roof becomes a part of the tank.The vertical portion of the sphere is not difficult to construct if pneumatically applied shotcrete or a similar process is used.The structure with arched openings an a plastic dome on the crown has a rather oriental feeling.The most serious problems in the architecture of dome is acoustics.In a domed ceiling the sound may reverberate as many as 20 times unless there is acoustical treatment.

Domes-Square in plan:

This structure is a spherical dome with portions sliced off to form a square or rectangle.Most areas to be covered are rectangular so a circular dome is not always a good solution to the planning requirements.This dome is supported by four rigid frame & would only be suitable for small span because the frame would get quire in large.For long spans it is necessary to place a tie between the knees of the frame.These ties can be made a part of the windows.Stresses in the shell are direct compression stresses except across the corner where there are direct tensile due to the outward spread of the forces.The arches or rigid frames pic up the shell forces by shear parallel to the arches which are zero at the top & maximum at the bottom.There is no component of force in the shell perpendicular to the arches.

Multiple Domes:

The domes is rectangular & is continuous with the adjacent domes.The edges of dome are supported by tied arches or brousing trusses.If windows are needed in these arches,the mullions may be made to serve as vertical hangers for the bottom chords of the arch.In constructing the shell,each one of the dome elements is an independent structural unit so the forms may be moved without shoring all or part of the dome already cast.The shell thickness of this type of dome does not need to be greater than a circular dome except at the triangular corners.Membrane action ceases to exists & the corner should be designed as a slab.

Translation domes:

This structure looks very much like the square dome.A translation shell is generated by a vertical curve sliding along another vertical curve.The curvs can be circles,ellipses or parabolas.Therefore the vertical sections are all identical as opposed to a circular dome in which all vertical sections vary in height.This is a big advantage in construction of the formwork.This method can provide a rectangular dome with the same height of arch on all sides,thus making a rectangular dome feasible.

Most of the load is carried by the side arches with some coming directly to the corners.A tie at the springing of the arches but usually this will be covered by the walls.Such shells are suitable for quite long spans with some interior lighting furnished by skylights in the shell.

5.Explain about Warped surface in detail.

Warped surfaces have a great advantage for shell structure because they may be formed from straight form boards eventhough they are surfaces of double curvature.There are two typeswhich are most useful:the conoid which as its name suggests is a portion of a cone& the hyperbolic paraboloid,a name for a particular mathematical surface.This type of shell structure can be built to what appears to be the ultimate in lightness of construction,minimum reinforcing & ease of moving forms.

Stresses in the hyperbolic paraboloid shell are almost entirely membrane(direct tension& compression)& all forces are delivered as shear parallel to the stiffening ribs.The shell thickness in structures is on &one half inches except for slight extra thickness at the intersection of the surface.This dimension is based on a cover of one centimeter on each side of two layers of bars & not an any structural requirement for strength.

6.Write a detailed note on Wall

system. Walls:

Generally classified based on the function as load bearing & non load bearing walls.Eg.partition wall.They taansfer self weight only & they are provided to create barriers that can be visual,thermal on acoustic.

Stiffening walls:

Provides 3 dimentional stiffness .The load bearing walls which are referred to as supported walls do not posses foundation o f their own but are either carried by beams or slabs or directly attached to load bearing walls. The supported walls can form on integral part of structure or remain as non structural depending on stiffness.

Depending on the orientation of the main beams or load bearing walls relative to long axis of the building. Prefabricated wall system are classified as,

Long wall system

Cross wall system

Ring or two way system

Long wall system:

The main beams are load bearing walls are placed parallel to the long axis of building. It is applied to the building with large prefabricates and is similar to traditional brick work technique . The longitudinal external walls which carry the floor loads must posses not only thermal properties but also sufficient load carrying capacity .

The long wall system construction is typical with large blocked structure and special pier blocks between the windows which carry loads from lintel and the walls above. The horizontal still blocks are not loaded . In some designs space between the piers is filled by prefabricated unit consisting of RC window frame complete with window.

The internal wall blocks are normally of full storey height subject to limitations imposed by lifting equipments available. Both internal and external walls are made of some materiel.

Cross wall system :

Load bearing walls and beams are placed at right angles to the longitudinal axis of the building . In this system the floor units are provided with two way structural units which distributes the to the cross walls and this system is more prominent. The internal walls are made of ordinary concrete for load bearing walls and the external walls and the external walls are made of light weight concrete to reduce the weight of the structure.

Generally the room size is nearly square in this

system. Ring system :

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

In this system, the floor slabs are designed to span in both direction and are loaded on to the supporting walls. For large load panels cross beams are hidden within the thickness of the panel.

UNIT 3 DESIGN PRINCIPLES

3.1 Disuniting of structures:-

The solution of problems connected with the transportation and placing of structures demands as a rule, their disuniting in to smaller members.

Construction of roof and floor slabs:-

Roofing members:-

Roofing members can be divided into two groups. short span and long span roofing members. The short span members rest on purlins. While long span one are directly supported by the main girders.

The short span roofing members the reinforced planks mode of porus hollow tiles, light weight concrete, roofing material and small reinforced concrete roofing members will be dealt with here.

Among the long span roofing members the reinforced concrete members are discussed.

(a) Reinforced planks mode of porous hollow tiles:-

These roofing members consist of porous tiles having longtidutional circular holes. The thickness placed in to these graces. Which are subsequently fined with cement mortar. In this way reinforced porous tile planks having a length of 2.3m, a thickness of 6-10 cm and a width of 20cm can be produced of these tiles, two kinds exist.

The first kind is heat insulating and has a unit weight of 750kg/m^3, the second kind is load bearing, its unit weight is 1100kg/m^3, this is used for production of reinforced planks.

The disadvantage of using the porous hollow tiles in question for roof covering is that the material of the latter is highly moisture absorbing, and therefore not frast resistant. Thus the roof cover should protected from moisture and hence it should be rough rendered with lime cement mortar.

The value of the limit moment is obtained from the following expression

$$M_{i=}0.9\left[Maco-\frac{3N}{N-1}S\right]$$

Where,

M_i = limit moment

Maco= arithmetic mean of the ultimate moment

m^i = Value of the ultimate moments belonging to the individual planks, where (i=1.............N)

N= Number of loading tests.

C=

$$S = \sqrt{\frac{\sum Maco - m_i^{2}}{N-1}}$$

An 8cm thik plank of porous hollow tiles and its reinforcement.

(b) Light weight concrete roofing members:-

Light weight concrete roofing members play a role. In additional to space brodering and load bearing. In heat insulating and so the application of a separate heat insulating layer is not necessary.

Light weight concrete roofing members can only be applied if there is a possibility of their reinforcement. It requires a bond between the steel and the light weight concrete for ensuring the transmission of the tensile force acting in steel bars to the concrete with the steel bars sliding, hence it is necessary to protect the reinforcement against corrosion.

From the view point of strength light weight concrete of the quality L_c 70 or L_c 1000 are quite suitable on the production of roofing members with a rectangular c/s and a thickness of in 25cm of 7.5=25cm and a length of 1.75-6.00m

Prefab roofing members can be produced of concrete mode in the usual way, using light weight materials on gravel and sand for aggregates. In the case of prefab structures the steel wires must be embedded in to a concrete the availity of which is at least C300.

b) Small Reinforced - concrete roofing members.

The small reinforced-concrete roofing member is essentially a pre cast simply supported, ribbed reinforced-concrete slab. The width of the member is 50-120 cm

The large reinforced-concrete roofing members resting directly on the main girders of structures represents a more advanced kind of pre cast roofing structure. These members are manufactured in a length corresponding to the spacing of the frames (6-10m) their width is 1.30-1.80m. They are directly supported by the main girders so that purlins are not required.

A large roofing member consist of two longitudinal edge ribs, cross, ribs and a slab having thickness of 2.5 -3.0 cm, and the two way reinforcement. These members connected to each other and to the frame girders form a unified continuous roofing structure.

Flooring members:-

In industrial buildings the us of prefab members, for floor consist of precast joints and flooring member.

The flooring member is designed for a span of 9m and for the bearing of a live load of 1000 kg/m^2. After the members are placed in final positions a longitudinal load bearing reinforcement and stirrups are placed in the trough formed between the longitudinal ribs of the adjacent member. A continuous mgh reinforcement is placed on the top of these members, there after a 5cm thick insist concrete layer is cast on the top of the members and the troughs between the longitudinal ribs are also filled u[p with concrete. In this way the slab is transformed in to a span of 6.0m & live load of 500kg/m^2 & a wt of 1450kg are widely used.

Flooring members to be used for smaller loads similarly to roofing members can also be made of lightweight concrete. These members are used chiefly in houses and public buildings.

The flooring members rest in general joists i.e. their cantilever like part.

The weight of flooring members should not exceed 5 tons otherwise the storage and transportation as well as the placing of these members using the presents available equipment would be difficult.

Flooring member spanning = 6.00m

P= 80-500 kg/M G=1450kg

1-Transverse rib at a spacing of 1.50m^2, -pre stressed reinforcement 12-20mm dia.

Shear walls:

Shear walls are the walls transmit then through the column of the frame work to the foundations their main load bearing direction is therefore horizontal as contrasted with vertically load-bearing wall panels for their reason these infilling wall panels or slabs are usually disposed horizontally (i.e) extending from column to column.

They arise from the basic conception that the overall stability of the supporting from work of a building can be ensured without additional bracing by means of components that are necessary any way thus the large roof panels serve as bracing for the roof, & the wall panels similarly provide the rigidity of the external walls. Industrial buildings not exceeding about 6m in height will not require such bracing at all since the horizontal force is in the longitudinal direction the more so as these forces may be distributed over a member of columns wall panels also as wind bracing is that it is necessary to provide flexurally rigid connections between the columns and these panels and such connections are difficult to establish without giring rise to cold bridges in the thermal insulation.

Shear walls in shed type industrial buildings:-

In the construction of shed type buildings for industrial purpose the horizontally placed panels are arranged are above the other. They span from column to column. They may contain. The widows, alternatively, the latter are accommodated in special panels. The cross-sectional shapes adopted for the wall, panels are generally similar to those of vertical load bearing wall panels except that now the direction of structural action. The direction of load transmission is different. The bracing panels or slabs are

a. ribbed slabs
b. hollow slabs
c. solid light weight concrete slabs.

are designed according to the same principles as are applied to [Load bearing wall] units of similarity type. Depending on the roof beam spacing the slabs may be up to 12m in length and may be as much as 4m wide transported in the upright position, however as a rule they seldom exceed 3m in width.

up to length of 6m light right concrete panels of the kinds also used for roof construction can suitably be employed (eg) siperex x tong Leca, aerated concrete etc, as they possess ladequate strength) to perform the function of bracing in important rule is to secure each panel individually.

3.3 Efficiency of material used:

In multi storey buildings the panels are either installed as spandrel panels between the columns or they may take the form of large panels which contain the windows the spendrel panels may also be supported by the floor slabs the bracing panel may be disposed horizontally or vertically in the later casting and should be so interconnected as not to go any relative movement.

replaced by reinforced concrete wall panels. The external surface of these panels is usually finished like a last stone facing. This giving them an attractive appearance.

Wall panels are adequate for resisting wind load which acts 1st to their own plane for bearing forces acting led to the longitudinal axis of the building. This ensures the rigidity of the building in the longitudinal direction without using any other bracing structures.

Wall panels can be made of light wt concrete reinforced concrete or partly of reinforced and partly light weight concrete when reinforced concrete is used a heat insultating layer it necessary is subsequently laid

Wall panels can be divided into two groups to first belong the panels which transfer their own weight or other vertical forms by same means to the column or flames. These are called horizontal wall panels.

The second group involves panels resting on and borne directly by the footing or footing beams. These panels don't transfer any vertical forces to the columns or frames and are called vertical (slanting) wall panels. In both groups solid windowed and must be distinguished.

Horizontal (lying) wall panels having a width of 0.6-2.00 m are self bearing between too adjacent frames and transfer their load directly to the columns.

A horizontal (lying) wall panel being a compound of light weight and reinforced concrete is to be seen in fig. The length of this panel is 5.98 m. The width is 1.18 m to the thickness is 0.2m. The outer surfaces is formed by a 2.5 cm thick reinforced concrete slab covered with a cast-stone like layer made of crushed limestone. The other parts of the panel are made of concrete using formed blast furnace slag and aggregate the quality of this concrete is LC too it also reinforced. The embedded paces for angles steel for foiling and for hoisting hooks however are made. The total weight is 33,000 kg the height up to the upper hinges is 41.55 m the gauge of the rail tracks is 12-14m for the same machine but with columns assembled of 4 sections the data are total weight of 20,000 kg height 20m, track gauge 9m. The maximum hosting capacity is in both cases 35 tons using two cranes to tons. The possible deviation of the hoisting by a mortar built into the structure of its permissible to move it in the unloaded state only. Hoisting is performed by a 27 HP mortar tilting by a 6HP are

The permitted tilting movements with the load on the crane, performed with motar power, are 50cm in the longitudinal and 70cm in the traverse direction both to the right and to the left of the basic position. These movements enable the hoisted member to be accurately placed.

The machine is operated by remote consist and must be reliability granded.

The crane is assembled on the ground with extended columns. Then gripped by the upper bridging part it is lifted by a 20 tons must crane to a height of about 15M. The wide flung columns are pulled toward each other by a winch. So bring the crane to a operational produced.

Wall panels used in the construction of the Tisza region chemical combine.

may be constructed by

a) Purlins with covering of roofing slabs or corrugated asbestos cement sheets

b) Large roofing units.

Roofing slabs or corrugated asbestos cement sheets laid on purlins

These are the most popular forms of roof covering used in central Europe. This is not surprising considering the simplicity of manufacture of purlins and the availability from stock of factory made lightweight roofing slab and panels.

The structural system of the purlins may be

a) Freely supported beam b) The cantilever girder

c) The continuous girder.

The connection of the purlins over the support are designed only to absorb a limited BM. Normal purlins spans between 5 and 10m. The purlins are spaced at intervals of 2 to 3m.

Purlins:-

Purlins are usually solid web members. For long spans they may lattice girders or trussed beam.

Freely supported purlins are designed as let flanged or fish-belly members. Purlins designed as cantilever grilles (articulated griders) are usually llel flanged members.

The c/s feature depend on the spans of purlins & on the slope of the roof. The purlins for flat roofs are usually rectangular T-section or (prestressed concrete) T-Section members for steeply sloped roofs it the loaded also in biaxial bending L-Sections or channel sections are used.

Purlins section & the approximate spans associated with them for a purlins spacing of 3m are indicated for flat roofs. The dimensions relate to freely supported purlins.

Purlins sections with associated spans for a purlins spacing of about 1.25 M in the case of steeply sloped roofs with corrugated professor von Halazz. They are convenient to manufacture with the legs of the channel upwards. whereby ray thin webs can be produced.

This type of purlins may be conventionally reinforced or by prestressed. Also they may be freely supported or be continuous over several spans. In case of L-shaped purlins usually only the flange of the section is supported.

The fishbelly girder is very favourable with regard to material requirements & the patterns of forces in the girder, but it has the disadvantages of being rather unsatisfactory from the point of view of architectural aesthetics. When it is used generally designed as a reinforced concrete purlins.

Structural connection to the main beams may be constructed as follows:-

a) By supporting the entire c/s of the purlins, the latter being secured to the beam by means of dowels, projections concreted on to the beam so-called shoes thickening the top flange of the beam with insist concrete or performed recesses in the beam.

b) The two last-mentioned methods are more particularly suitable for purlins of rectangular section. If the main beam is not provided with recesses to receive the ends of the purlins, it is desirable to apply an insite concrete topping to it, else there will be gap between its top flange & the roofing slabs, which not only looks rather unrightly but also aolds unutilisable, extra space to the enclosed volume of the buildings on the other hand, when recesses have to be formed in the top of the beams, concreting presents-difficulties Besides the recesses weaken the top flange unless it is possible

the supports. Because of this local strengthening it is possible to reduce the depth of the purlin over the rod beam. There are too possibilities 1) The end of each purlins is reduced the depth to form a nib which rests on the beam. 2) The diaphragm on the top flanges of the roof beam is provided with nibs or corbels for supporting the purlins.

Purlins based on the principles of the cantilever girder. Provided with hinges which are so located as to ensures statical determining have not proved satisfactory. The reason for this are a) Halved joints:- The requirements of careful workmanship are more stringent than are normally considered acceptable in practice.

By large force will develop, more particularly in the purlins of long buildings, the failure of one member is liable to result in the collapse of the whole structure. This has indeed happened in a number of buildings.

The roofing slabs laid on the purlins of flat roofs are usually 0.5 TO 1.0m wide & have sparts of about 2.0 to 5.0m these slabs also comprise the thermal insulation and where necessary, also the cement mortar screed for the gravel roof.

The wt of slabs varies bet 10 & 150kg/m depending on the bulk density of the insulating materials and on the span.

a) Ordinary concrete : “Waffle” slabs with a shell thickness of only 1cm have been produced by the firm of press AG. The concrete bad a specified 28 days strength of 600kg /m^2.

b) layer, are manufactured on vibrating tables in Hungary the output per vibrating table is about 100 slabs per day. The slabs have standardized dimensions of 0.5 x 3.0m.

c) Roofing slabs can be produced in a simple manner from perforated bricks or fixed insulating clay. The reinforcement is passed through cavities. These slabs are 20cm wide & 8 to 10cm thik for spans upto 2.8 m.

d) I, perforated bricks or light wt bricks are used in conjunction with reinforced concrete ribs to form slabs 0.87 m wide & upt 3m span.

e) Pumice concrete slabs ("Planks") have been produced in germany for a good many gears, they are available in 3 forms slabs with circular cavities, "waffle" slabs comprising longitudinal and transverse ribs, & sold slabs-1.

f) Duris of roof slabs are used in many countries. The standard slabs are 50cm wide & 2 to 4 long. This concrete is not hygso scopic to that these slabs can also be used in damp surroundings without suffering any appreciable loss of Thermal insulating capacity.

g) Hebel aerated concrete roofing slabs used in Germany and Switzerland are likewise 50cm wide 2 to 6m long. They are reinforced & light wt concrete of with they are made has a compressive strength of 35 to 50kg/cm^2.

Large individual precast units are better able to fulfill the requirements of industrialized old than purlins & relatively small roofing slabs can they will therefore gradually suppressed the more conventional form of construction with roofing slabs & purlins. The advantages are

a. The number of units is substantially reduced

b. The slab & web of the unit are concrete as single monolithic whole with structural co-operation of the slab.

c. Window bracing for roof are dispensed with as it is readily possible to inter connect a number of large roof units.

d. Large roof units generally produce an aesthetically more pleasing result.

The requirements applicable to roof units may be summarized as follows.

1. The units should readily lend themselves to type standardization & to quantity production with the minimum of labour.
2. They should require the least possible quantities of material both in terms of concrete & of reinforcing steel.
3. They should be suitably transportable & capable of being conveniently stacked.
4. When joined together they should act as rigid diaphragms, so that no other form of wind bracings needed.

Countries they are reinforced & the light wt which is aerated concrete.

(k) Hollw prestressed concrete concrete slabs of the schater system are produced with light wt concrete core d are suitable for span up to 6.5 m.

Many other types of roofing slabs are manufactured from a variety of light wt materials.

How roofing slabs are supported on the purlins.

The standard specifications of some countries require that roofing slabs be designed as freely supported members without taking structural continuity into account. However it is normal practices always to install reinforcing bars in the longitudinal joints not as a means of establishing true continuity but merely to inter connect and locate the slab.

Structural continuity can be achieved by appropriate forms of construction with prince or other light wt concrete slabs. Tests have confirmed that the failure load is increased as a results of such arrangements.slabs.

2) Roof units with 3D structural action such as singly & doubly curved shells & fololed plate structures.

Hollow roofing slabs with rectangular cavities.

Slab type roof units are subdivided according whether they have structural longitudinal & transverse ribs or only structural longitudinal ribs.

3.4 Waffle Slabs:-

Recalled waffle slabs are characterized by having transverse ribs which perform a structural function & which may be so arranged as to form a series of approximately square panels with the longitudinal ribs or may alternatively be spaced close together. As a result of this arrangement the actual slabs can be made very thin. Thus they are actual slabs can be made very thin. Thus they are the lightest of in terms of material quantities the most economical type of roof unit. The width of the units ranges from 1 to 3m. The span range from 5 to 12 m, depth.

The longitudinal ribs are interconnected by welding or by means of grout & left projecting from the slabs.

It is rectangular cavities combine numberous advantages with regard to material requirements & wt they are significantly more favourable than roof units with circular cavities. The se box. Sections possess high torsional rigiolety & present a flat surface on the under side. Besides they can very suitable be pre stressed. The only drawback is that manufactured involving the removal of the cores for forming the cavities is somewhat more expensive than for ribbed slabs.Bearings for roof units

With regard to the bearings of slab-type roof units on the main beams a distinction must be made as to whether the unit is used for a flat roof or for a north light roof & as to whether or not the unit is provided with a transverse rib at the bearing.

The external wall constructed of precast components

Wall panel must

a) withstand without harmful deformations the loads that it is required to carry.

b) Permit or absorbs the movements due to temperature variations and differences without sustaining damages.

c) Have a good architectural effect.

d) Be resistant to climatic influences.

e) Require the least possible maintenance

f) Provide the requisite a caustic insulation and I fire protection

g) Fulfill the other basic requirements of prefab construction.

According to the perform the function of external wall panels are at following kinds.

a) Load-bearing b) Stiffening (Wind bracing)

b) Merely space-enclosing (curtain wall)

The c/s design of wall panels depends on the requirements

a) Single layer solid panels consisting of one material

E.g. Light wt concrete.

b) Multp-layer panels consisting of concrete and insulating materials.

C) Special -section slabs, which may be either of single-layer or multi layer constructions (sand which construction).

One of the most intricate and most difficult problems to be solved in both design & construction of structures assembled of prefab members as the joining.

It is highly important that the construction of the joints should be easy that unavoidable smaller in accuracies and deviations within dimensional tolerances should neither influence the designed stresses in a detrimental manner nor cause in admissible changes in the stress distribution of the structures.

The forming and construction of joints requires owing to their intricacy, greatly increased consist joints which cannot be inspected should be omitted.

When solving the problem of joints the properties of reinforced concrete must be taken into considerations. This means in other words, that the design & the construction of the joint should harmonize with the materials to be used. The properties of steel of timber are quite different from those of concrete and reinforced concrete. Therefore joints similar to those used in timber and steel construction are generally not appropriate for the purpose.

Joints of reinforced concrete structures which should be omitted are shown.

The joint to be seen in fig. This is s solution resembling a butt jointed with splayed table as used in timber construction. This does n't comply with the nature of the material & So is not good for this purpose. The limtating a joint used in steel construction, is not appropriate either. The steel structure -like joint as seen in which the component structural parts are coelded to the reinforcement is also not sufficiently adequate. The two halves of the steel structure forming the main constituents of the joints have to be concrete is to

the placing of the pins.

The joints can be rigid hinge like or shed.

Rigid joints are adequate in addition to the bearing the tensile, compressive & shear forces for resistances.

Design of c/s based an efficiency of the material used:-

The plastic concrete can be used for the subsequent concrete of joints & the fluid cement mortar last or pressed into the gaps lase part of their water during the settling time & shrisk, after setting the shrinkage of the insite concrete & mortar continue.

with respect to two phase of shrinkage same codes on reinforced concrete construction permit only reduced stresses for a subsequent insite concrete of a mortar casting. These are generally determined as a function of width of the joint on the gap to be concrete as cost.

Joints must be designed & executed so that compensation for the allowed dimensional tolerances is ensured or relative displacement of the jointed members should be impossible even as a result of a blow or of any other infavourable force effect. The length of the section determined for the transmission of forces should be as short as possible, but should excluded any excess of the permissible stress.

The joints can be regid hige like or shed. Regid joints are adequate in addition to the bearing of tensile, compressive & shear forces recover displacement and like joints can transmit forces passing through the hinge itself and also allow a certain motion and rotation.

Rigid joints are generally used for the junction of column to footings, but they can also be applied for joining of individual groups with one another. The joints generally used in the construction with precast members are usually hinge like their execution is simpler and requires less working -lime than rigid joints “shodjoints” are only exceptionally used in industrial construction & are justified for a long span only. These joints are justified for chiefly used in bridge construction for a long span bridges depending on the necessity of insite concreting, two kinds of joinjts can be distinguished.

a. Dry joints - joint accomplished by simple placing of two members on each other & fasting.

b. Wet joints - joints require not only casting with cement mortar but also subsequent concreting.

3.5 Joints of different structural connections:-

a. jointing of column to footing

b. jointing of column to beams on top of column.

c. jointing of column to beam at an intermediate.

d.

e. jointing of beams

f. Forming of joints of arched structures

g. joining of joints of post tensioned structures.

h. joining of precast to monolithic reinforced concrete structures.

a. Joining column to footing:-

This joint is usually rigid but also can be hinge. A rigid joint can be made by placing the column into a calyx of the footing or by using a welded joint the figure shows the three variations of the this method.

a) Can be used for smaller b) for average and for large footings

The opening of the calyx is 6-10 cm greater in all directions than the c/s of the column. This is enable the vibrator to be operated while concreting at the bottom of the calyx & checked by leveling before concreting. A similar steel plate is also put on the lower end of the column when positioning the column. These two steel plates must be on each other. The dimensions of these steel plates are from 100 x 100 x 10 to 150 x 150 x 10mm an chored in to the concrete after the column is put in placed properly plumbed tow advantages of the calyx joint should be mentioned

1 The placing plumbing and fixing of the column as well as the subsequent filling of the calyx with concrete is far simpler and requires less time then in the case of a welded joint.

2 The method is least sensitive to inaccuracies occurring during the construction.

The disadvantages of the calyx Joint is more suitable for small columns. In the case of large columns requiring a calyx depth of which is greater than 1.0m.

One members of joining a merge like joint consists either of placing to beams on to as small cantilever protracting trans the column or of putting it on the bottom of an adequately shaped opening deft out of the column shaft. The beam rests temporarily on a tongue like extensist on a steel plate placed in this opening on the supporting surface the tongue is also furnished with a steel plate anchored in to the concrete. The other parts of the tongue are supported after the placing has been finished with concrete cast through an opening left for this purpose.

d. Lengthing of columns:-

Columns are usually lengthened at floor levels. An intermediate lengthening should be avoided it possible.

The lengthening of columns can be executed similarly to the joining with fooling, accordingly reinforcement are joined by overlapping looped steel bars a welding. Thereafter the stirrups have to be placed & finally the joint must be concreted.

e) Joining of Beams:-

The functions of beams can be affected either by overlapping the protracting steel bars or by welding them together.

Figure shows the tinge like joint of purlins. In this method the whole shear must be borm by both cantilever (i.e) by two separate structures therefore it is expedient to form this joint atleast for large girders.

The method illustrated in the fig presents a dry joint of beams which is called a bolted form. The advantages of this joint is immediate bearing capacity.

f) Forming of functions of arched structures:-

Precast arches are usually produced and assembled in the form of three hinged structures. When the constant load has already been applied the centre joint is frequently eliminated. The omission of the centre joint increases the rigidity of the structure. Naturally arched structures can also be precast in a piece i.e in the form of two hinged ones.

Hinges of arched structures can be made by using either steel shors are more expensive, but the centre transmission of forces is enhanced by their use.

Figure shows the centre hinge of a three hinged arch with a span of 12.5 m for this kind of each the joint can also be formed from the concrete itself. The latter method require exactly executed and adequately reinforced concave & convex surfaces with hear against one another.

The joining of a smaller hinged structure is show in below mentioned.

The arrangements the centre junction of the end hige of an arched structure. This method was used in the construction of the ball for the middle rolling train in D.O.Sayar. The structure was precast & assembled in the form of a three-hinged arched transformed later in to a two -hinged one.

g. Design of joints for post tensioned structures:-

Post tensioned structures can generally be joined for more simply then the usual reinforced concrete structures, By using post tensioning it can be ensured that in the entire structure. The joints included only compressive can develop consequently the problem of joining can be solved in a very easy manner namely by placing plane surfaces side by side and then filling the gaps with cement mortar.

precast member. Thus in post tensioned structures the forming of joints does not cause difficults.

Sketches solutions of principles relating to the joining of post tensioned structure are to be illustrated in the fig. All these joints are of course rigid and moment bearing. It is not permissible for the mortar which is to be poured into the gaps to follow in to the ducts of the stressing lables to arid this cable ducts are jointed by placing a shore piece of tube or rubber ring into the duct itself.

A regid point of their kind established between a columned two girders supported by the former after the casting of the gaps & hardening of the mortar, the short inserted cables are stressed and so rigid joint is established.

h) Joining of precast to monolithic reinforced concrete structures:-

If frequently occurs that a monolithic beam has to be joined to a precast column in this by placing the protruding from the column or into an opening formed in the column's shaft.

When making the joint, first of all a 2.5 cm deep cavity is chielled out of the side of the precast column. The bottom of this cavity should be roughened so as to attain a better bank between the concrete of the monolithic beam and the precast column.

Unit –IV

JOINT IN STRUCTURAL MEMBERS

4.1 Expansion Joints

An expansion joint is an assembly designed to safely absorb the heat-induced expansion and contraction of various construction materials. To absorb vibration, or to allow movement due to ground settlement or earthquakes. They are commonly found between sections of sidewalks, bridges, railway tracks, pipeing systems, and other structures.

Figure

Expansion joint design:

A design specification shall be prepared for each expansion joint application. Prior to writing the expansion joint design specification it is imperative that the system designer completely review the structural system layout, and other items which may affect the performance of the expansion joint. Particular attention shall be given to the following items.

The system should be reviewed to determine the location and type of expansion joint which is most suitable for the application. Both the EJMA Standards and most reliable expansion joint manufacturers'' catalogs provide numerous examples to assist the user in this effort. The availability of supporting structures for anchoring and guiding of the system, and the direction and magnitude of thermal movements to be absorbed must be considered when selecting the type and location of the expansion joint.

Conventional rubber expansion joint

Expansion joints are designed to provide stress relief in piping systems that are loaded by thermal movements and mechanical vibration. To deal with the various forces on the joint they require fibre reinforcement which guarantees both flexibility and strength. Conventional expansion joints are reinforced using prefabricated fibre plies. The use of these fabric plies makes it impossible to control the orientation of the fibres on complex shapes such as the bellow of an expansion joint. In both cases the inability to use the fibres in an optimal way leads to the following disadvantages:

High Material Cost:

- More fibres needed than necessary
- More rubber needed than necessary
- Additional parts such as metal reinforcement rings necessary with multiple bellows

Lower Performance

- High rubber wall thickness and fibre pack make product less flexible
- Undesired radial and axial expansion under pressure.

1) Introduction 2) Necessity 3) Advantages 4) Pre requisites 5) Types of prefabrications

Pre-fabrication means that the structure is disunited in its disunited in its members and these are precast in factor built and equipped particularly this purpose or in temporary plants establish on the site. Then the precast reinforced core members are shipped to the place where they used. Here they are hoisted set into their fix places and assembled in the form of a complete structure. The stages involved are

1) The structure is divided into no of units.
2) The different units are precast in permanent plants.

   Permanent prefabrications - plant prefabrication.

   Temporary plants (sheds) - Site prefabrication

3) Transported to the site
4) Hoisted and put into their places

   Prefabrications eliminates the use of scaffle.

Necessity:

Million houses in rural areas.

20 million houses in urban areas speedier construction.

Conventinal methods - time consuming

- The components are not a man power is not effectively.

Factors:

1) Cellular concrete plant at Madras
2) Hindustan Housing Factory at New
3) SIPOREX, India Limited at Poona
4) Key Jay Spirole private limited.

In New Delhi they are manufacturing -sleepers & poles.

Object or AIM :

1) To accelerate the building construction.
2) To increase the building activity.
3) To effectively utilize the man power.

Pre-Requisite:

1) Large demand of flats in a limired area
2) Availability of adequate funds & buildings materials

3) Prospective planning of building activities and long time orders.
4) Standardization allowing mass production
5) Adequate mechanization of production process.

Figure

Types of Fabrications

1. Permanent Plants	1. Temporary sheds
2. Work can be carried out throughout the year.	2. Weather conditions should be favourable
3. Highest degree of mechanization	3. Its mechanization is not possible
4. The produces will be cheap arid of a better quality.	4. Transportation cost is almost nil.
5. Transportation cost.	The elements can have any site.
6. Restriction on the size of the elements.	

4.2 Advantages of pre-fabrication over the monolithic methods of construction:-

1. Partial or total saving of material used for scaffolds.
2. Multiple use of structuring
3. Possibility of far more accurate and better work transits.
4. Cross sections more advantages from the new point of stream
5. Working time can be shortened.
6. Fewer expansion joints are required.
7. Interruptions in concreting can be omitted.
8. The work can be carried out with a high degree of mechanization.
9. Requirements in man power decrease.

10. Helps to avoid the seasonal character of the buildings industry.
11. Re use of the members. In pre fabrication scaffolding materials are needed as a temporary support.

    The single set of moulds can be used from 10 to times in case of small members. Only the lateral boards are made of timber and the other parts being usually of R.C. In case of plant prefabrication the moulds are made of steel. If they are made of timber. They are covered with steel steels. The same structuring can be used for casting both small and large members.

    Since the members are produced in easily accessible places on the ground better. Workmanship can be obtained the moulding assembly of the reinforcement and the concreting can be performed more precisely due to better workmanship and higher strength can be obtained.

    Since the permissible and limit stresses can be higher, cross sections can be decreased resulting in the decreases in dead load. The reduced deed load means less concrete and a decrease surface of structuring resulting in the reduction of prime and the use of cross sections which are structurally advantages namely an I profile or tresses does not cause particular difficulties in prefabrication. The application of such a cross section or a tress instead of a girder would be much more difficult in the case of monolithic structure. Even unreasonable because of the complicated shultering, reinforcement and concreting.

In the monolithic construction the separate builds spaces can be performed only in sequence namely the foundation. There the concrete, reinforcements, then the concreting of the structure. In the ease of prefabrication these constructional process namely the generally started,

beginning of the foundation work. The estimation that about 80% of the time is required for prefabrication and 20% for site works.

The greater part of shrinkage of precast concrete members occurs before their placings because of numerous joints the effect of temperature changes is also far less important and hence the spacing of expansion joints can be increased.

In monolithic structures it is the duty of the foreman to select palces where concreting can be interrupted. A matter not usually fore seen by the designers who does not deal with the problem on the other hand for pre-fabricated structures junctions must be carried out according to plans of later place specified and considered by the engineer.

In the fabrication since the work is carry out on mass scale we cane go in for mechanization instead of manual labour and thereby the quality is considerably improved.

In the case of prefabrication the application of industrial methods makes possible the employee me of hands adequately trained within a few weeks. The work is carried out throughout the year it is always easier to give labourers for works to be done in a permanent plant.

Plant prefabrication is absolutely independent the vagaries of the weather. In the case of site prefab the production of smaller members namely roofing members, wall panels, windows, purlins etc can be made in a covered place. In the case of large members the same is not possible but they can produced at an earlier date during favourable weather conditions. In the case of monolithic construction it is difficult to carryout the work during rainy seasons.

The dismantling of building constructed of precast members and the use of certain of these at other places is possible in the case of pre-fabrication such a thing is highly impossible with monolithic structures.

Production techniques in pre-fabrication

In Concreting : 1. Moulding the concrete to the require shape.

2. Hardening of concrete.

In prefabrication : 1. Refined methods of moulding

2. Accelerate the rate of hardening objectives in the manufacture of pre-fab compoenets are

1. Least amount of labour.

2. Specailist possible production.

3. Imporved quality

4.3 Types of Structue

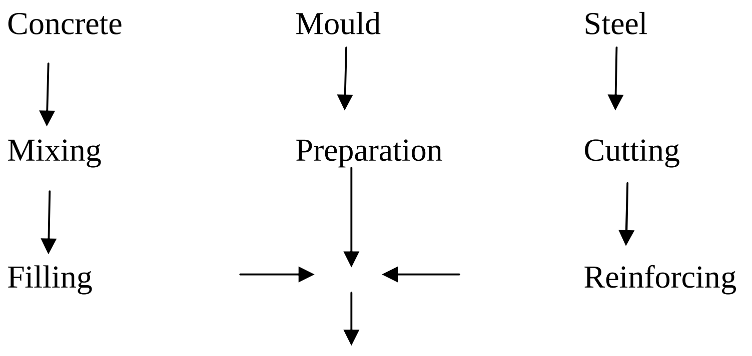
1. Fame less - large paneled

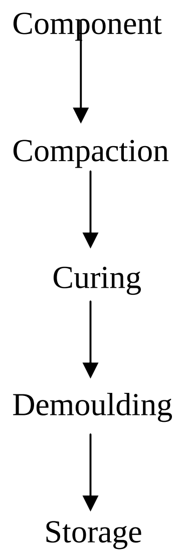
   structures - External and Internal

   wall panels - Floor and roof panels (of room single)

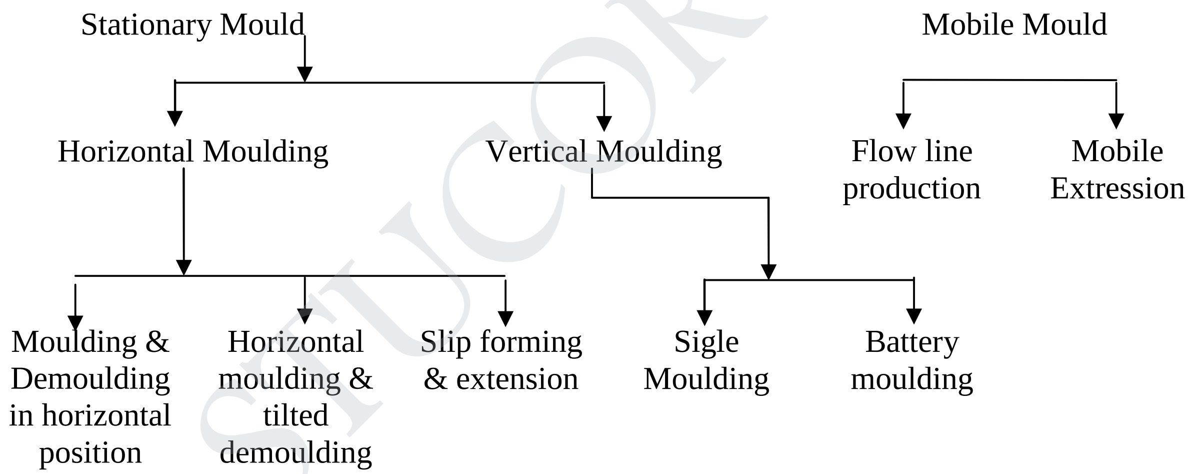
2. Framed buildings : Columns, beams & floor elements.

Stages of work in pre-casting





Methods of Manufacture:-



On -SITE : Open yard casting or covered but purely temporary or semi-permanent type of set-up with partly mechanized facilities.

Factors Influencing method of manufacture

The single and the total no of elements to be produced

1. The single of the element may decide the reinforcement of space for production as well as the capacity of the handling equipment is decided by the heorist element.

2. Desired rate of output: This will have direct bearing on the nf of moulds required degree of mechanization and need for accelerated method of curving.

3. Shape, type and construction features of these elements

   Features such as special shares, projected reinforcement, required finish on the surface on single layer or multi layer largely influence the design of the mould and technical castings.

   Horizontal casting techniques are favoured for curved elements, multi larged elements and element which require some particular finish vertical casting is favoured for single layer solid panel which require no special finish on their surfaces.

4. Facilities available in the production set u : An accelerated curing facility will result in quick turn over of mould which can be advantageously used. Machineries like over head gantry crane, will aid speedly production in handling.

5. Economic aspects : The cost of production should be minimum.

Both moulding and demoulding in horizontal position -External panel wall ; floor panes with protruded reinforcements, beams, columns, etc.

-Extra reinforcements to take ease of bending stresses.

Tilting Moulds :

Demoulding is carried out in almost vertical position. No extra reinforcement is necessary.

One end is hinged and the other end is lifted with the aid of a fack or lifting equipment.

Slip forming & Extrusion:

This method is achieved with a moving machine mould which forms the cross sectional shape of the element and the element hardening at the point where it is moulded. Precast pre stressed floor elements both solid & hollw are manufactured using this techniques.

Concrete laying - slips (Concrete buckets of various capacities)

Spreading - either manually or with a mechanical spreads.

Vibrating - with the help of shutter vibrates.

Screening - long & heavy wooden floats surface finishing - Travelling.

Figure

Figure

Figure

4.4 Mould for a pair of wall panels:

Vertical Moulding:-

Best suited for panels that require a smooth surface on both sides.

Advantages :

1. A large no of units can be produced in a small space.
2. Concreting the units proceeds fast.
3. No need to spread the concrete
4. Surface finishing not necessary due to smooth mould faces.
5. Heat of hydration developed is consersed and accelerates curing.

Single Moulds:

These are employed for casting volumetric elements such as sanitary units, ventilates shafts and refuse chuter. Battery moulds are employee for internal panel walls and floor panels. The swing down moulds are used for simultaneous manufacture of two wall panels.

Flow Line Production :

This is a travelling horizontal mould system in which the moulds are moved and the element from one position to the rest a series of stations, such as demoulding, mould cleaning and oiling, placing of reinforcements concreting vibration, surface finishing and curiving a stream chamber forms the part of the continuous travelling a chain and the chain can be in the horizontal plane or in the vertical plane.

Schematic diagram of flow line production:-

Moulds:-

1. They should have volumetric stability to ensure dimensional accuracy.
2. They can be reused a large no of times with minimum maintenance cost.
3. They should be easy to handle and close tightly so that no liquid can lead out.
4. They should not have adhesion to concrete and easy to clean.
5. They can be sued for various cross sections shapes of the components.

Wooden moulds:

1. Concrete sticks more easily. to prevent this, a coating of mould oil or wood lequer is given.
2. It can be used 30 to 40 times. The dimensions should be checked frequently.

3. They are used fro smaller production programmes.

Steel Moulds :

1. Because of the smooth surface demoulding is fairless easy.
2. Indiscreminate harmmering by workmen should be avoided.

Concrete moulds:

1. These are used in vertical battery moulding.
2. The workability is low
3. These moulds enable hish degree of dimensional accuracy, but are un-suitable for making modifications.
4. These moulds are stationary not often transported.
5. The surface of the mould must be absolutely smooth of otherwise excessive adherion may cause difficulties in demoulding.

Plastic Moulds:

1. Moulds made of glass fibre reinforce plastics are commonly used.
2. They have the advantage of freedom of shaping and low weight.
3. Demoulding is
4. They are easily transportable.
5. The same mould can be used 70 to 80 times without repair.

Manufacture Of Precast Elements:

1. Wall panels :-

Type of moulding depends upon the constructional features and the surface finish. In the case of internal panel wall-vertical battery wall. In the case of external panel wall-horizontal moulding is usually done.

2. Roof or Floor Elements:

Depends on the type of building we construct whether residential or public building with large span. In the case of residential building the entire roof or floor is cast as a single unit. In the case of public building where long spans are encountered. The elements are east in the form of hollow core floor slabs. Trough units and ribbed slabs which are normally of PSC.

3. Beams and Column :

Usually horizontal moulding is done. In the case of staircases vertical or horizontal moulding is done. In the case of sanitary units vertical moulding (as a single unit) is done.

Figure

Figure

1. Placing of concrete by strips slips
2. Spreading of concrete is done manually or mechanically.
3. Compaction by vibrators or by vacuum process or pressing.

In the case of vibration it is effected by means of internal vibrations and external vibrations. Internal vibrations in the form of immersion vibrators is used in places where we have conjusted reinforcements. External vibrators ae generally used with steel moulds. Vacuum process is suitable for components with large surface area or relatively thin elements. In the case of compaction by pressing. The freshly poured concrete is subjected to a pressure of about 70 ksc. It sequences out excessive water forming a cohesive slab which can be immediately remoulded.

Curing :-

Accelerated curing -1 cycle -	1. Preheating period -3hrs-35ºC
(Steam curring)	2. Temp Rise Period -2hrs -35 to 8.
	3. Period at max temp - 6hrs - 80ºC
	4. Cooling period - 3hrs - 80ºC-45ºC

Accelerated curing techniques are adopted for quicker turnover. It may be in the form of steam curing or heat treatment. Hot water or hot air. The duration of stream curing cycle is influenced by the factors like type of cement, water cement ratio, size of the members, the desired strength. With proper steam curing it is possible to achieve 60% of the moist curned 28 days strength of the concrete in 24 hours. In open casting yard for steam using specially made hoods are used which are insulated and sealed to prevent excessive loss of heat and moisture. In the case of flow line product.

The chamber is sufficiently long to ensure that the products remain wihin the chamber for the desired time.

Demoulding and storage:

The units are first demoulded from the sides and then from the bases and the earthwork required to separate the unit from the base is more than the weight of the unit to account the adhesion of the unit to the base. Wall element are stored vertically. Floor and roof elements are stacked horizontally with & wooden strips in between two elements.

Surface Finishing Techniques:

a) Surface formed in the mould.

b) Mechanical treatement of surface.

a) Textured surfaces are obtained by lining the mould with suitably patterned rubber linings, plastic steel or timber. Smooth surfaces are obtained by resin coated or plastic zined mould surfaces.

b) This can be applied by freshly cast concrete or by the hardened concrete. In the case of freshly cast concrete. It is done by hand travelling or by rolling with a smooth steel tube on the compact concrete or by tamping with the edge of long wooden floor. In the case of hardened concrete. It is done by point tooking or by grinding the surface when soft aggregate are used.

Production Tolerance:-

By production tolerance use mean the limiting value of admissible deviations in the actual dimensions. The deviations may be caused.

1.
2. Loose fitting of joints.
3. Joints and mould sides under pressure of concrete.

The limiting values are

1. Length ± 10mm
2. Width ± 3mm
3. Thickness ± 3mm
4. Flatness - 1/300 of the length.

Planning of precast concrete works:-

Requirement of space and facilities.

Space for production :

It is based on height and no moulds horizontal moulds -larger areas - vertical battery moulds -least amount of floor space. Height of the casting shed is based on space required. To lift and move one precast corpponent over another. The head room can be sufficiently decreased by having moulds in pits. Extra space must be provides for making the reinforcements stages cleaning and up the demoulded units.

Space for storage yard:

This depends on the daily output and the demand. The space must be sufficient to store minimum of 3 weeks production. The storage yard may be preferably aligned with the casting shed to facilitate movement of overhead cranes.

Space for facilities:

This depends on the type & single of ancillary facilities required namely storage of raw materials such as cement, coarse aggregate & fire aggregate, reinforcement steel. Conc batching plaint, fitters and joiness shop, Boiler and compress house. Laboratory & Office.

Modular co-ordination, standardization and Tolerance

Basic Dimensions :

This is the dimension between the axis defined by the dimensional grid. The dimensional grid is the two dimensional co-ordinate system of reference line defining the layout of the building.

Nominal or Theoretical Dimensions :

It is the planned dimension of the prefabricate arrived from its basic dimension and its joints.

Actual Dimensions :

It is the dimension of the prefabricated when produced and its differs from the nominal dimension by the production discrepancies which are unavoidable.

The tolerance is the sum of acceptable positive and negative discrepancies of actual dimensions from the theoretical one. The limits of tolerance are based on the manufacturing and erection requirements.

Modular Co-ordination :

If the inter dependent arrangements based on the Pre Fabrication and System Building

Definition

Pre-fabrication means that the structure is disunited in its members and these are precast either in factories built and equipped particularly for this purpose or in temporary plants established n the site. Then the precise reinforced concrete members are shifted to the place where they are to be used, here they are hoisted, set into their final places, and assembled to form a complete structure.

Stages involved in pre-fabrication

1. The structure divided into number of units.
2. The different units are precast in permanent factories (plant fabrication) or temporary plants (site prefabrication).
3. Transported to the site.
4. Hoisted set into their final places and assembled to

1. Partial or total saving of material used for scaffoldings.
2. Mulitple use of shuttering
3. Possibility of far more accurate and better work manship.
4. Working time can be shortened.
5. Fewer expansion joints are required.
6. Interruptions is connection can be omitted.
7. The work can be carried out with a high degree of mechanization.
8. Requriements in man power decrease.
9. Re use of the members.

4.5 Design of expansion joint:

1. Basic Dimensions

This is the dimension between the axes defined by the dimensional grid. The dimensional grid is the two dimensional co-ordinate system of reference line defining the layout of the buildings

2. Nominal or theoretical dimensions

It is the planned dimension of the prefabricate arrived from it's basic dimension and it's joints.

3. Actual dimensions

It is the dimension of the prefabricate when produced

If the interdependent arrangement of the basic dimensions of the building based on the primary unit accepted components so that they apply to any building that is laid out on the 10cm (4") modular basis without cutting or altering at the site.

5. Planning module (M_p)

It is a multiple of the basic module for specified applications. The planning module Mp = 3 cm is the common horizontal dimension or M_p= 1M is used for the vertical dimension, when M_p=60 cm for the length dimensions.

6. Modular grid

This is a particular case of the dimensional grid consisting of two dimensional co-ordinate system of reference lines (modular lines) at a distance equal to the basic module or the mult module (M_p). This multi module may be the same or different for each of the two dimensions of the reference system. The area between the modular lines is called the modular zone of the component. The dimensions of the prefabricates are fixed from the modular grid by fitting in the elements after taking into account their tolerances and dimensions of the joints.

The limits of tolerances are based on the manufacture and erection requirements.

Production tolerance (T)

The limits of deviation in the dimensions $(\Delta_S)T/2$ the shape of the prefabricates. This depends very much on the type of moduls, wooden, steel, concrete or plastic, the tolerance also depends on the nominal dimension, nature of prefabricate and its position during casting.

Degree of Accurancy	≤ 10cm	> 10 cm ≤ 30 cm	730 cm ≤ 3m	> 3m ≤ 9m	>9m
4	1mm	2mm	3mm	4mm	6mm
5	2mm	3	4	6	10
6	3mm	4	6	10	15
7	4mm	6	10	15	25
8	6mm	10	15	25	30

Erection tolerance

These are the limits of deviation of the positioning in the assembly of the prefabricates. The position tolerance are normally defined by five components namely, deviation in positioning of the prefabricates in x,y,z directions (Δx, Δy, Δ z) and deviation in positioning with respect to another prefabricate (Δp)and the deviation in the verticalioty of the

5	6mm	4mm	3mm
6	10	6	6
7	15	10	8
8	25	15	12

4.5 Standardization

The following are the advantages of standardization.

1. Easier desing

Elimiation of unnecessary choices.

2.Easier manufacture

Limited number of variants.

3.Easier erection and completion

Repeated use of sepcialised equipment.

4.6.Factors infuenceing standardization:-

1. The most rational type of member for each element is selected from the point of production from the assembly serviceability and economy.

2. The number of types of elements will be limited and they should be used in large quantities.

3. To the extent possible the largest size to be used which results in less no of joints.

4. The size and no of the prefabricates is limited by the weight in overall dimension that can be handled by the handling and erection equipment and by the limitation of transportation. Hence it is preferable to have all the and transporting complete assemblies or sub-assemblies to the construction site where the structure is to be located. The term is used to distinguish this process from the more conventional construction practices of transporting the basic materials to the construction site where all assembly is carried out.

The term prefabrication also applies to the manufacturing of things other than structure at a fixed site. It is frequently unused when fabrication of a section of a machine or any movable structure is shifted from the maid manufacturing site to another location, and the section is supplied assembled and ready to fit. It is not generally used to refer to electrical or electronic components of a machine, or mechanical parts such as pumps, gearboxes and compressors which are usually supplied as separate items, but to sections of the body of the machine which in the past were fabricated with the whole machine. Prefabricated parts of the body of the machine may be called ‘sub-assemblies” to distinguish them from the other components.

Contents

7. See also
8. External Links.

The process and theory of prefabrication

An example from house-building illustrates the process of prefabrication. The conventional method of buildings 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 and prefabricated (assembled) in a factory (possibly with window and door frames included), transported to the site, lifted into place by a crane and boiled together.

Prefabrication 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.

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. Prefabrication avoids the need to transport so many skilled workers to the construction site, and other restricting conditions such as a lack of power, lack of water, exposure to harsh weather or a hazardous envioronment are avoided. Against these advantages must be weighed the cost of transporting prefabricated sections and lifting them into position as they will usually be larger, more fragile and more difficult to handle than the materials and components of which they are made.

“Loren” Iron House, at Old Gipostown inMoe, Australia

Prefabrication has been used snce ancient times. For examples, it is claimed that the world’s oldest known engineered roadway, the Sweet Track constructed in England around 3800 BC, employed prefabricated timber sections brought 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 section were prepared separately and then fitted together, specially in the Kingdom of Anuradhapura and Kingdom of Polonnaruwa.

In 19th century Australia a large number of prefabricated houses were imported from the united Kingdom.

The method was widely used in the construction of prefabricated housing in the 20th century, such as in the United Kingdom to replace houses bombed during World war II. Assembling sections in factories saved time on-site and reduced cost. However the quality was low, and when such prefabricated housing was left in use for longer than its designed life, it acquired a certain stigma.

The Crystal palace, erected in London in 1851, was a highly visible example of iron and glass prefabricated construction, it was followed on a smaller scale by Oxford Road Railway station.

The most widely used form of prefabrication in building and civil engineering is the use of prefabricated concrete and prefabricated steel sections in structure where a particular part or form is repeted many times. It can be difficult to construct the formwork required to mould concrete components on site, and delivering wet concrete to the site before it starts to set requires precise time management. Pouring concrete sections in a factory brings the advantages of being able to re-use moulds and the concrete can be mixed on the spot without having to be transported to and pumped wet on a congested construction site. Prefabricating steel sections reduces on -site cutting and welding costs as well as the associated harards.

Prefabrication techniques are used in the construction of apartment blocks, and housing developments with repeated housing units. The quality of prefabricated housing units had increased to the point that they may not be distinguished from traditionally built units to those that live in them. The technique is also used in office blocks, warehouses and factory buildings. Prefabricated steel and glass sections are widely used for the exterior of large buildings.

Detached houses, cottages, log cabin, saunas, etc. are also sold with prefabricated elements

Unit -5 DESIGN FOR ABNORMAL LOADS

5.1 Equalent design loads for considering abnormal effects like earthquake and cyclones

hoisting & placing differ from those arising in their final position. Owing to this additional reinforcement would be required which after the placing is finished becomes unnecessary. The additional stresses as well as the reinforcement required to resist them should be eliminated. The methods will differ from each individual problem.

The most simple solution for the elimination of erection stresses & surplus reinforcement connected with the latter consists in the firm attachment of a steel beam to the member. The figure shows the hoisting of a framewhere ends of the steel beam are wedged to the stanchion while its middle is it down. In this way the developing BM due to the dead load is bome partly by the steel beam as marked in the figure & the remaining part can be bome by the stanchion itself without any additional reinforcement.

After the beam has been hoisted by 45", the temporary reinforcing steel beam becomes unnecessary & can be removed.

The same solution applied during hoisting a multi storyed frame. For large structures the above method, owing to great length & strong forces is no longer satisfactory & so here heavy latticed steel structures would be necessary. Erection stresses developing during hoisting in column & girders of high halls may be eliminated most suitably by post tensioning with cables.

The stressing cables applied on bothsides of the column are tensioned by gas threated jacks assembled to one end of the column by a tensioned of 25+25=50 MP

The tensioning force is controlled by measuring the reaction force developing above the hoisting pin using a manometer.

During hoisting the moment developing from post tensioning counter balances the moment arising from dead load. In the column not only a BM arises but also a centric compression which in the present case also exerts a beneficial effect. When the column has been hoisted the equipment used for post tensioning has to be dismantled before placing begins.

The same result might be achieved by a temporary post tensioning of a shorter section of the column. This method was used for post tensioning the column of power station at berente. Here the post tensioning extended only over the section affected by a positive moment during hoisting balancing the tensional force developing here.

The required tensioning force is provided by a hydraulic jack. Naturally the magnitude of this force must be measured.

Another solution for elimination of erection stresses in this case the stanchion of a frame to be transported are braced each other. During transportation. So lessening the moments arising at points which are supported by scattolds set up on the conveying trucks. The frames were precast in the upright position. To save the extra trucks for the conveying trucks, the latter were moved on the final sail tracks of the hall. This arrangement leads to the development of great bracing reduces these moments considerably.

Manufacture, transport & erection of wall panels:-

The manufacture of wall panels depends primarily upon the c/s design of upon the desired surface treatment. Hence it is perhaps the best procedure first to investigate the possibilities before deciding the manufacturing procedure.

These possibilities can be summarized as follows, according to the method of execution.

a) Surface which is formed by the pattern or texture of the mould

b) Surface finish produced by Mechanical treatment

c) Chemical treatment of the surface

d) Paints & Coatings.

a) Surface formed by Moulds:-

This method of producing the desired surface pattern or texture used when the outer face of the wall panel is downward in the mould. Initial case it will in general not be possible directly to produce a smooth interface, as it is not formed by moulding, but it merely given a float finish a higher degree of smoothness it will be necessary to apply an additional finish operation.

The following methods are best suited for producing a close-texture concrete surface free from pores or blow wholes.

a) Resin-coated mould surface

b) Plastic -lised mould

c) Moulds made of glass - fiber reinforced plastics.

Resin-coated & plastic -lined surfaces are most suitable for producing smooth concrete faces, while mould & made of plastics are good for producing patterned concrete.

a) Plywood located with resin or synthetic resing produce a smooth & dense concrete surface. As the mould has to be assembled from individual smaller panels, however the joints produce visible marks on the exposed concrete faces. concrete instead of oil. Colurless mould release pastes (grease) used which do not cause any staining of concrete.

b) Moulds lined with plastic sheeting : The sheets of plastic are smooth & are not difficult to fix to moulds. Difficulties are arise only when heat treatment is applied as adhesive used for fixing the sheeting lose their adhesive action at elevated temperature.

c) Glass fibre - reinforced moulds are very suitable for producing patterned surfaces as this material can be shaped into a almost any classic patter by casting or spraying it on to suitable Negative for the moulds too it is advisable to those mould oils or pastes as release agents.

d) Other patterns can be produced by lining the moulds with crude rubber or corrugated steel sheet or using rough faced timber moulds, or placing gravel on the bottom.

surface finish may be applied either:-

a) To the freshly cast concrete while it is still wet or

b) to the hardened concrete.

1 Mechanical treatment of freshly placed concrete:-

It is usually applied to sand which panels cast with outs deface upwards. The following form of treatment are available.

- ❖ Screeding the wet concrete with steel plates or cubes
- ❖ Float finishing
- ❖ Treating the surface with broons, brushes etc.

It is employed in industrial building construction. It is simple to apply, it gives attractive appearance but reduces the risk of cracking.

b) Mechanical treatment of hardened concrete comprises:

- ❖ Scrubbing or spraying to expose the aggregate
- ❖ Sand blasting to expose the aggregate.
- ❖ Looking (bush-hammering grinding etc).

The object of the scrubbed finish is to expose the aggregate particles by playing a jet of water on the surface or wire-brushing it at an appropriate length of tube after casting, whereby the cement & sand particles are removed. This is really an intermediate technique bet treatment of wet concrete & treatment applied after the concrete has fully hardened.

Good results can be achieved by the use of selting retarders which facilitate the removal of the fine particles by spraying. This is done sometimes after concreting usually 1 to 2 hours, depending on the prevailing temperature.

such process the 'O crat' treatment has the object of increasing the strength of concrete at the surface & at sametime making is resistant acid attack.

Facing & Coatings:-

In many cases it may be advantages to apply a decorative kind /or protective coating to hardened concrete. Attractive & durable surfaces can be obtained in this way.

E.g. with plastic coatings.

Erection :

An important requirement is that erection can be carried out without scat folding or false work on this respect it is advantageous to use vertical panels for low shed type building it the joints can be sealed by workman standing on the roof: with high buildings light suspended scat folds will be required for forming the joints. Alternatively, the panels may be installed form inside the b/d with the aid of stacker trucks or with winches & small trolleys.

The panels are suspended from the cranes by means of cast-in attachments (lifting, loops, screw-threaded sockets etc). some examples of such devices are illustrated.

Disuniting of Structures:-

The solution of problems connected with the transportation and placing of structures demands as a rule their disuniting into smaller members. One-by frames not exceeding 40 tons in weight, may represent an exception, because the problem of their hoisting and placing can be solved with the aid of modern available hoisting machines and equipment.

In spite of this these frames are frequently disunited as their corners or points of minimum moments into members, to make the hoisting of these smaller members possible, using much simpler equipments.

In general there is trend towards the use of larger members. This is justified by more then one reason. One is that the bearing of a certain moment can be solved more economically by using one large girder instead of two or more smaller beams together having the same bearing capacity indicates the moment bearing capacity of the girder. While the enlargement of the cross section led to an 11-fold dead load, the moment bearing capacity, increased 80-fold, However with regard to the load bearing capacity, the moment-bearing capacity is not one unique Decisive factor because the shear force that can be borne by a cross-section does not increase in the series ratio as does one moment.

In addition the hoisting of one larges member is as a rule, less expensive than that of two smaller members having the same combined weight. It is a direct consequence of the following circumstances: the assembling of the lifting tackle, the transfer of the hoisting machine, the hoisting, placing and plumbing must be done for each member separately, Independently of its weight.

into larger members means, lower costs of hoisting and placing as well as saving in joining costs.

In the first case the expenses of preparation and payments connected with the hire of the equipment may be higher, but the work itself is much less.

Naturally, if plant prefabrication is practiced, the greatest size of precast members is determined by the transportation and shipping cost.

But demands are not unlimited either so, members whose weight would exceed 60 tons cannot be found even in structures of the largest power stations.

Now a days, the hoisting capacity of derrick is 40 tons, while that of a pair of twinned-mast cranes reaches 70 tons.

In this case the members should be as large as possible within the limits of the available hoisting capacity.

5.2 Systems consisting of linear members Disunited @ joints:

Disuniting act joints gives linear members

The disadvantage of this system is that the joints are at the corners, i.e at places where the moments usually reach their maximal values, so the forming of the joints is difficult.

The quality of subsequent concreting executed in site is only exceptionally and at readily accessible places as good as the concrete quality of precast members. Therefore the joints must be over dimensioned.

(b) System for the prefabrication of Entire Rigid Frame:-

The trend to numbers of joints to precast larger members in one piece lands to the prefabrication of entire frames.

Properly carried out in the horizontal position only.

The prefabrication of larger arches in the horizontal position is found to be more economical using this method the arches must be tilted up and this involves the solution of an additional problem.

The construction of arched trusses can be properly carried out in the horizontal position only.

Prefabrication:-

Pre fabricated building is completely assembled and erected building of which the structural parts consist of pre fabricated individual units on assemblies.

Pre fabricated construction is a new technique and is desirable for the scale houring programmes.

Principles: (Aims)

1. To effect economy in cost.
2. To import in quality as the components can be manufactured under controlled conditions.
3. To speed up construction since no curing period is necessary.
4. To use locally available materials with required characteristics.

5. To use the materials which possesses their innate characteristics like light-weight easy workability.

- Materials for scaffolding is stored partly & in full and used.
- Availability of precise structure and expect workmanship.
- Work time is reduced
- Fewer expansion points are required.
- Interruption in connection can be omitted.
- Work is done with a better technology.
- Less workers are needed
- Members can be used again.

Materials used:-

The materials used a prefabricated components are many. The modern trend is to use concrete steel treated wood aluminum cellular concrete, light weight concrete ceramic products etc.

Which choosing the materials for pre fabrication the following special characteristics are to be considered and transported and to economic an sections and sizes of foundations.

- Thermal insulation property.
- Easy workability
- Durability in all weather conditions.
- Non-Combustibility
- Economy in cost
- Sound insulation.

Modular Co-ordination :-

Only basic modules to be adopted. Basic module is the fundamental module used in modular co-ordination. The size of basic module's selected for general applications for building and its components. The value of basic module chosening 100mm for maximum flexibility and convenience. The symbol used for basis module is M. After adopting this, further work is necessary to outline suitable range of multi module with greater increments, often referred to as preferred increments are adequate for meeting the requirements of conventional ad prefabricated construction. These rules relate to the following basic elements, refer to figure (4.1).

Modular co-ordination :-

1) The planning grid in both directions of the horizontal plan shall be:

a. 3m for residential and institutional buildings.

b. For industrial buildings :

15 M for spans up to 12 M.

30 M for spans between 12 M and 18 M and 60 M for spans over 18 M.

The Centre lines of load bearing walls shall concede with the grid lines.

2) In case of external walls, the grid lines shall coincide with the centre line of the wall of a line on the wall direction shall be 1M up to ad including a height of 2.8 m; above the height of 2.8 M it shall be 2M.

3)

4. Preferred increments for rill lights doors, windows etc. shall be 1 M.

5. In the case of internal columns the gridlines coincide with the centre lines of columns. In case of external columns ad columns near the lift and stairwells the grid lines shall coincide with centre lines of the column in the top most storey or a line in the column 50mm from the internal face of the column in the top most storey.

Advantages of standardization :-

The following are the advantages of standardization.

1) Easier in design as it eliminates unnecessary choices.

2) Easier in manufacture as there are limited number of variants.

3) makes repeated use of specialized equipments in erection ad completion easier ad quicker.

5.3 Factors influencing standardization:-

1) To select the most rational type of member for each element from the point of production, assembly, serviceability and economy.

2) To limit the number of types of elements and to use them in large quantities.

3)

4) preferred by the weight in overall dimension that can be handled by the handling and erection equipment and by the limitation of transportation.

5) To have all the pre fabricates approximately of same weight very near to the lifting capacity of the equipment.

Systems:-

The word system is referred to a particular method of construction of buildings by using 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.

a prefabrication system

The following characteristics among others, are to be considered in devising a system.

1. Intensified usage of spaces.
2. Straight and simple walling scheme.
3. Limited sizes and number of components.
4. Limited opening in bearing walls.
5. Regulated locations of partitions
6. Standardized service and stair units.
7. Limited sizes of doors and windows with regulated portions.
8. Structural clarity ad efficiency.
9. Suitability for adoption in law rise ad high rise blocks.
10. Ease of manufacturing, storing ad transporting.

Prefabricated construction system

The system of prefabricated construction depends in the extent of the use of prefab components, their material sizes and the technique adopted for their manufacture and use in build. The various prefabrication system are outlined below.

1. Open prefab system
    a. Partial prefab open system.
    b. Full prefab open system.
2. Large : panel prefab system
3. Wall system
    a. Cross wall system.
    b. Longitudinal wall system.
4. Floor system
5. Staircase system
6. Box type system

This system is based on the use of the basic structural elements to form whoe or part of a building. The standard prefab concrete components which can be used are,

1. Reinforced concrete channel units.
2. Hollw cost slabs
3. Hollow blocks ad patterns.
4. Precast plank and buttons.
5. Precast forsts ad tiles.
6. Cellular concrete slabs.
7. Prestressed / reinforced concrete slabs.
8. Reinforced / prestressed concrete beams.
9. Reinforced / pre stressed concrete columns.
10. Precast lintels ad sub standby.
11. Reinforced concrete waffle slabs /
12. concrete panels.
13. Reinforced / prestressed concrete walling elements.
14. Reinforced / prestressed concrete trusses.

The elements may be cost at the sit or off the site.

Foundation for the columns could be of prefabricated type of the conventional cast insites type depending upon the soil conditions and loads. The columns may have hinged of fixed base connections depending upon the type of components used ad the method of design adopted.

There are two categories of open prefabrication used in the construction as given below.

1. Partial prefab open system.
2. Full prefab open system.

The system basically emphaises the use of precast roofing ad flooring components and other minor elements like lintels, sunshades, kitchen sills in conventional building construction. The structural system could be in the form of insite frame work or load bearing walls.

5.4 Full prefab open system

In this system, almost all the structural components are prefabricated. The filter walls may be of bricks on of any other local materials.

This system is based on the use of large prefab components. The components used are precast concrete large panels for walls floors roofs balconies, staircases etc. The casting of the components could be at the sit on off the sit.

Depending upon the context of prefabrication, this system can also land itself to partial prefab system ad full prefab system.

Wall system

Structural scheme with precast large panel walls can be classified as

1. Cross wall system.

2. Longitudinal wall system.

Cross wall system:-

In this system the cross walls are load bearing walls. The façade walls are non-load bearing. This system's suitable.

In this system, cross walls are non-load bearing, longitudinal walls are load bearing. This system is suitable for low rise buildings.

A combination of the above systems with all load bearing walls can also be adopted.

Precast concrete walls could be :-

1. Homogenous walls.

2. Non-homogenous Walls.

Homogenous walls:-

The walls could be solid, hollow or ribbed.

Non-homogenous walls:-

Based on the structural functions of the walls. The walls could be classified as

c. Shear Walls.

Based on their locations and functional requirements the walls are further classified as.

i. External walls, which can be load bearing or non-load bearing depending upon the layout. They are usually non-homogenous walls of sandwiched type to impart better thermal comforts.

ii. Interla walls, which provides resistance against vertical loads, horizontal loads, fire etc. and are normally homogenous.

Types of precast floors:-

Depending upon the composition of units, precast flooring units could be homogenous or non-homogenous.

1. Homogenous foors could be solid slabs, cored slabs, ribbed or waffle slabs.
2. could be multilayered ones with combinations of light weight concrete or reinforced/ pre stressed concrete, with filled blocks.

Depending upon the way the loads are transferred the precast fllors could be classified as way or two way systems.

One way system:-

One way system transfers loads to the supporting members in one this direction only. The precast elements of this category are channel slabs.

Hollow core slabs, hollow blocks ad buttons plank system, channels and tiles system. light weight cellular concrete slat etc.

Transfer loads in both the directions imparting loads on the four edges. The precast element under thus category are room sized panels two way ribbed or waffle slab system etc.

Staircase system:-

Staircase system consists of single flights with in built risers and treads in the element only the flights are normally unidirectional, transferring the loads to supporting landing slbas or load bearing walls.

Box type system:-

In this system, room size units are prefabricated and erected at site. This system derives its stability and stiffness from the box make rigid connection among themselves.

The box unit rests on plinth foundation which may be of conventional type of precast type.

5.5 Design for abnormal loads

Definition Progressive Collapse:

- Progressive collapse occours when a key member or members of a structure fail.
- The isolated failure of this key member or section then initiates a sequences of events, causing failure of the entire structure.

Progressive collapse basics

Progressive collapse can be defined as collapse of all or a large part of a structure by failure or damage of a relatively small part of it. The general services Administration (GSA,2003b) offers a somewhat more specific description of the phenomenon: “Progressive collapse is a situation where local failure of a primary structural component leads to the collapse of adjoining members which, in turn, leads to additional collapse.

It has also been suggested that the degree of "Progressivity" in a collapse be defined as the ration of total collapsed area or volume to the area or volume damaged or destroyed directly by the triggering event.

Codes and standards

ASCE 7-02

The American Society of Civil Engineers Minimum Design Loads for Buildings and Other Structures shall be designed to sustain local damage with the structural system as a whole remaining stable and not being damaged to an extent disproportionate to the original local damage. This shall be achieved through an arrangement of the structural elements that provides stability to the entire structural System by transferring loads from any locally damaged region to adjacent regions capable of resisting those lads without collapse. This shall be accomplished by providing sufficient continuity, redundancy, or energy-dissipating capacity (ductility), or a combination thereof, in the members of the structure. "Clearly, the focus in the ASCE standard is on redundancy and alternate load paths over all other means of avoiding susceptibility to disproportionate collapse. But the degree of redundancy is not specified, and the requirements are entirely threat-independent.

ACI 318-02

The American Concrete Institute Building Code Requirements for Structural Concrete (ACI,2002) include extensive "Requirements for structural integrity" in the chapter on reinforcing steel details. Though the Commentary states that it "is the intent of this section... to improve... 6 redundancy" there is a explicit mention of redundancy or alternate load paths in the Code. The Code provisions include a general statement that "In the detailing of reinforcement and connections, members of a structure shall be effectively tied together to improve integrity of the overall strucute" and many specific prescriptive requirements for continuity of reinforcing steel and interconnection of components. There are additional requirements for the tying together of precast structural components. None of the ACI provisions are thereat-specific in any way.

GSA PBS Facilities Standards 2003

The 2003 edition of the GSA's Facilities Standards for the Public Buildings Service (GSA,2003a) retained the "Progressive Collaps" heading from the 200 edition.

GSA Progressive Collapse Guidelines 2003 The GSA Progressive Collapse Analysis and Design Guidelines for New Federal Office Buildings and Major Modernization Projects (GSA, 2003b) begins with a process for determining whether a building is exempt from progressive collapse considerations. Exemption is based on the type and size of the structure (for instance, any building of over ten stories is nonexempt) and is unrelated to the level of threat. Typical non-exempt buildings in steel or concrete have to be shown by analysis collapse. Considerable detail is provided regarding the features of the analysis and the acceptance criteria.

GSA Progressive Collapse Guidelines 2003

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Methods Of Avoiding Disproportionate Collapse

There are, in general, three alternative approaches to designing structures to reduce their susceptibility to disproportionate collapse:

- Redundancy or alternate load paths
- Local Resistance
- Interconnection or continuity.

5.6 Redundancy or Alternate Load Paths:

In this approach, the structure is designed such that if any one component fails, alternate paths are available for the load in that component and a general collapse does not occur. This approach has the benefit of simplicity and directness. In its most common application, design for redundancy requires that a building structure be able to tolerate loss of any one column without collapse. This is an objective, easily-understood performance requirement. The problem with the redundancy approach, as typically practiced, is that it does not account for differences in vulnerability. Clearly, one-column redundancy when each column is a W8 x 35 does not provide the same level of safety as when each column is a 2000 il/ft built -up section. Indeed, an explosion that could take out the 2000 lb/ft column would likely destroy several of the W8 columns, making one-column redundancy inadequate to prevent collapse in that case. And yet, codes and standards that mandate redundancy do not distinguish between the two situations; they treat every column as equally likely to be destroyed. In fact, since it is generally much easier to design for redundancy of a small and lightly-loaded column, redundancy requirements may have the unfortunate consequence of encouraging designs with many small (and vulnerable) columns rather than fewer larger columns. For safety against deliberate attacks (as opposed to random accidents), this may be a step in the wrong direction.

Local Resistance:

In this approach, susceptibility to progressive/ disproportionate collapse is reduced by providing critical components that might be subject to attack with additional resistance to such attacks. This requires some knowledge of the nature of potential attaks. And it is very difficult to codify in a simple and objective way.

Interconnection or Continuity

This is, strictly speaking, not a third approach separate from redundancy and local resistance, but a means of improving either redundancy or local resistance (or both),m studies of many recent building collapses have shown that the failure could have been avoided or at least reduced in scale, at farily small additional cost, if structural components had been interconnected more effectively. This is the basis of the "Structural integrity" requirements in the ACI 318 specification (ACI, 2002).

6.0 UNIT1.INTRODUCTION

PART- A

1.Define prefabrication.

The term prefab can apply to any construction method where the significant part of the construction takes place off site in a factory . That produces relatively large complex features that assembled at the site into the finished building .

2.What is meant by modular Coordination?

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 .

3.What are the characteristics of Modular concept .

I) 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 .

II) Industry friendly features that not only for manufacturing but also the transportation and assembly requirements .

III) Internationally accepted to support international market .

4. Write out the advantages & disadvantages of prefabrication ?

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

II) On-site construction and condition is minimized

. III) Less waste may occur .

Disadvantages :

I)Careful handling of prefabricated components such as concrete panels (or) steel and glass Panels is reduced .

II) Similarly leaks can form at joints is prefabricated component .

5) Define the term Off-site fabrication .

Off-site fabrication is the process that incorporates prefabrication and preassemble 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.

6) Write short note on Production process .

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

1) Mixing 2) Moulding 3) Curing 4) Cubing

7) List out the limitations of prefabrication .

I) Extra reinforcement is required to take care of handling and erection stresses .

II) Tempraray props may be required in some cases ,before the un-site concrete joints achieve strength .

III) The cracks may develop at the joints between the precart in –site concrete due to shrinkage and temperature stresses . To overcome them extra steel is required across joint.

8) What are all the Prefab materials ?

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

9) 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.

10) Write short note on Principles of MC Concept ?

The principle objective of implanting MC is to improve productivity through the reduction of wastages in the production ,installation process , to improve quality in the construction industry and to encourage an open system .

PART B

1.Explain Modular Coordination in detail

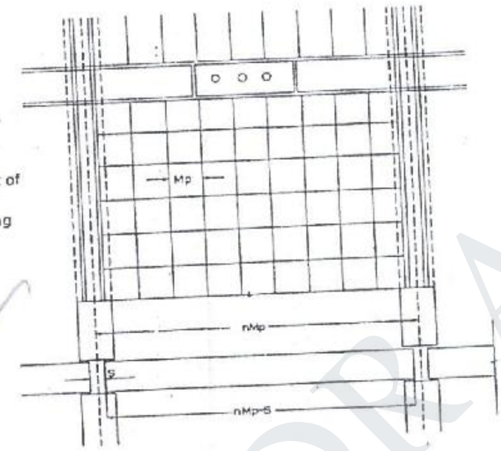


Fig a. Typical layout of modular grid with ductters load bearing walls

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 ht of 2.8 M.

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

e. In case of internal coluums 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.

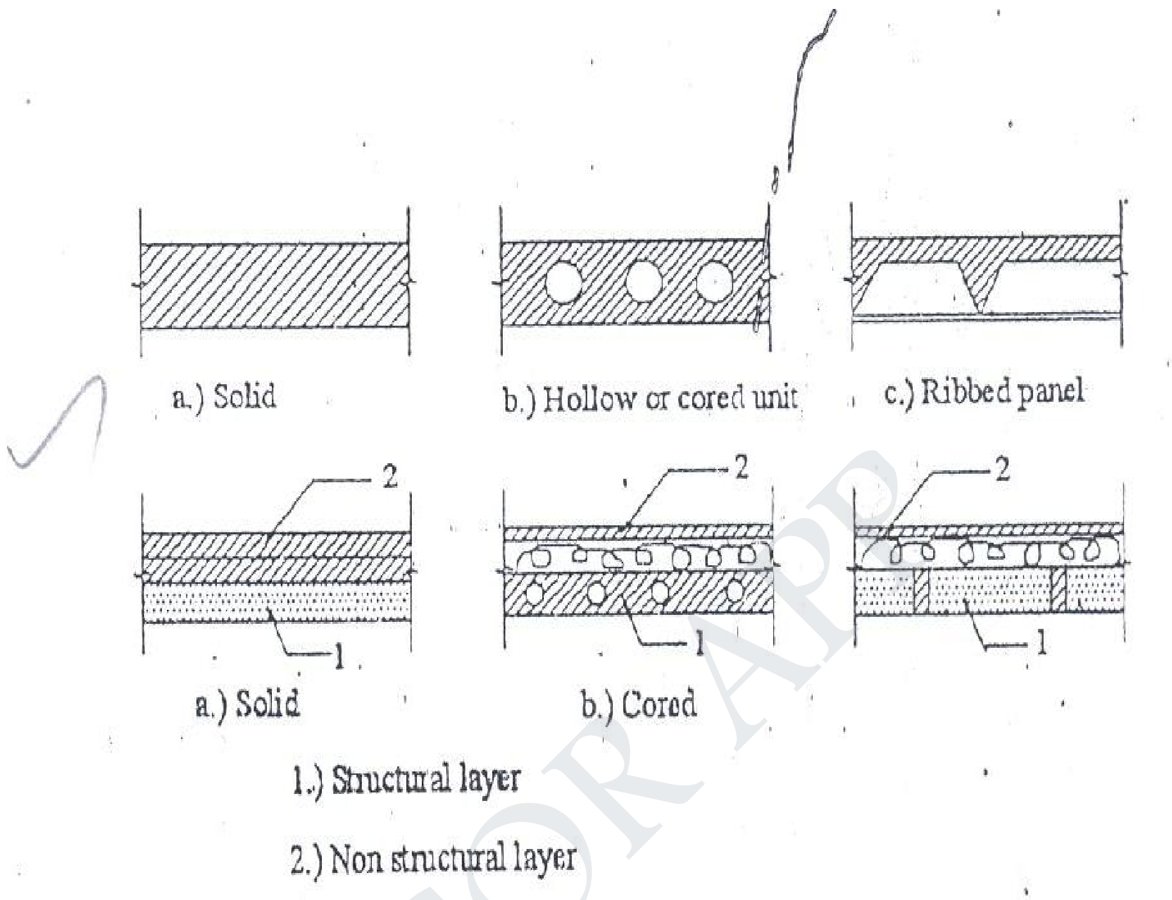
A basic module can be represented as module andfor larger project modules are represented a M p.

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 hollw ducts in between. The centre line of the grid is found by deducting the size of duct.

2.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 certin order and discipline. The system of prefabricated construction depends oon the extend of the use of prefab components, their characteristics to be considered in devising a system:

i. Intensified usage of spaces
ii. Straight and simple walling scheme
iii. Limited sizes and numbers of components iv. Limited opening in bearing walls
v. Regulated locations of partitions
vi. Standardized service and stair units
vii. Limited sizes of doors and windows with regulated positions viii. Stuctural clarity and efficiency
ix. Suitability for adoption in low rise and high rise blocks

x. Ease of manufacturing storing and transporting xi. Speed and ease of errection
xii. Simple jointing system
a) Based on Disuniting of member b) Based on the construction

Based on Disuniting of member:

1. System consisting of linear member disunited at joints
2. System for prefabricates of entire rigid frame
3. System consisting of I,T,U of straight members disunited at points of minimum moment.
4. Two hinged and three hinged arches

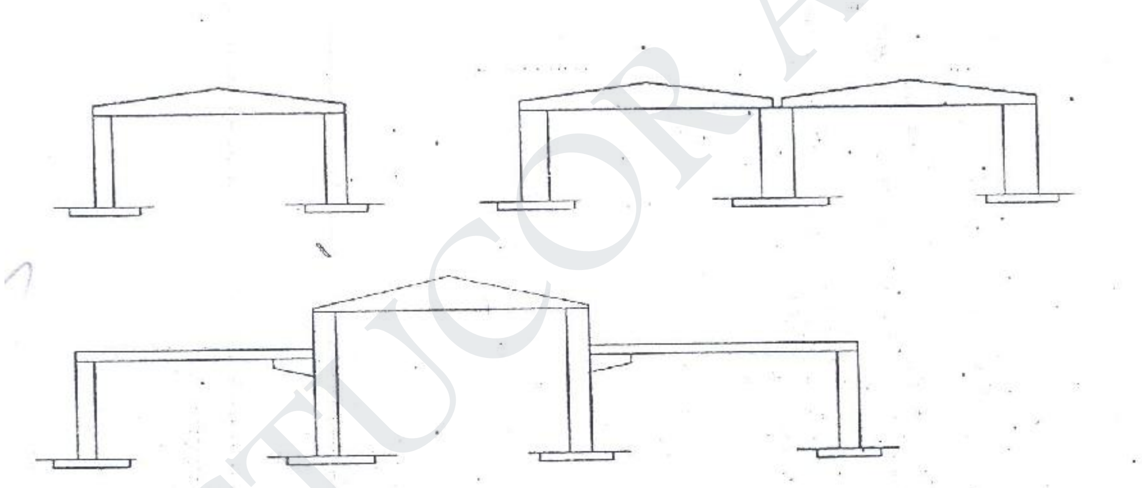


Fig 1.2.Members of frame disunited at the joints

System consisting of linear member disunited at

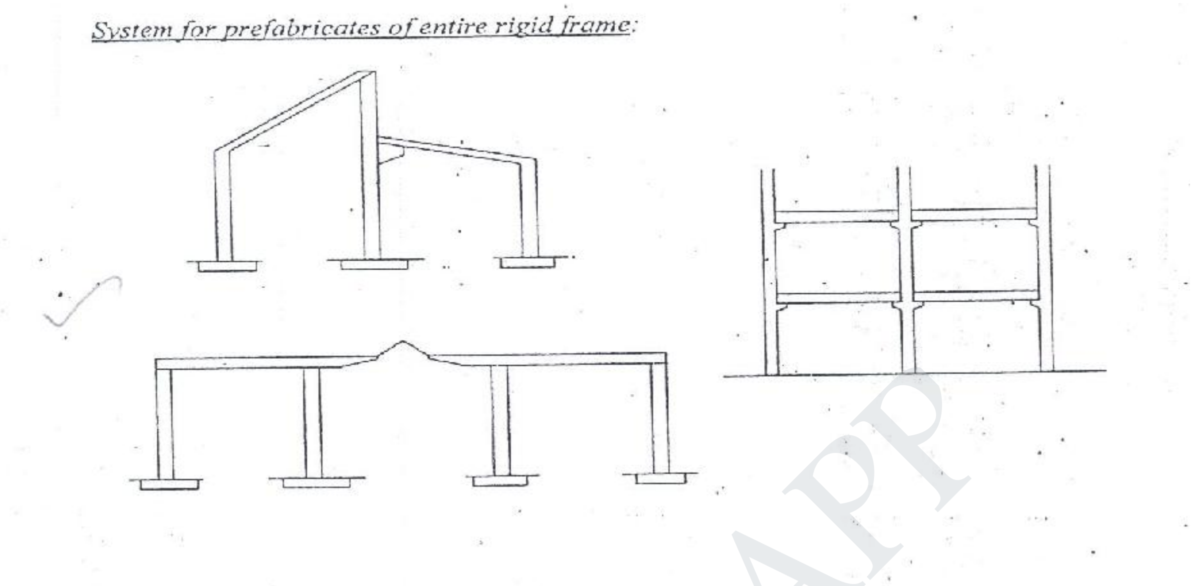
joints: Advantage:

Disuniting at joints gives linear member. This means that a great advantage and facilitates from the view point manufacture and assembly.

Disadvantage:

1. Joints are at corners i.e. at points of maximum moment values, so forming the joint is difficult.
2. Joints must be over dimensioned to cope with insitu concreting. And one alternate solution to replace moment resistant joints by hinged connection.

System for prefabricates of entire rigid frame:



In this system, to reduce the no of joints and to precast larger numbers I one piece leads to the prefabrication of entire frame. Production of the frames does not cause any particular trouble but the hoisting is more difficult and requires careful preparation.

The stress distribution of staright members during hoisting is in general statistically determinate.

Advanta ge:

1. It is ideal for site prefabrication.
2. Small number of joints so rapid prefabrication work is possible.
3. Suitable for long walls consisting of great number of uniform frames.

System consisting of I,T,U of straight members disunited at points of minimum moment:

3. Suitable for long ...

System consisting of I, T, U of straight members disunited at points of minimum moment

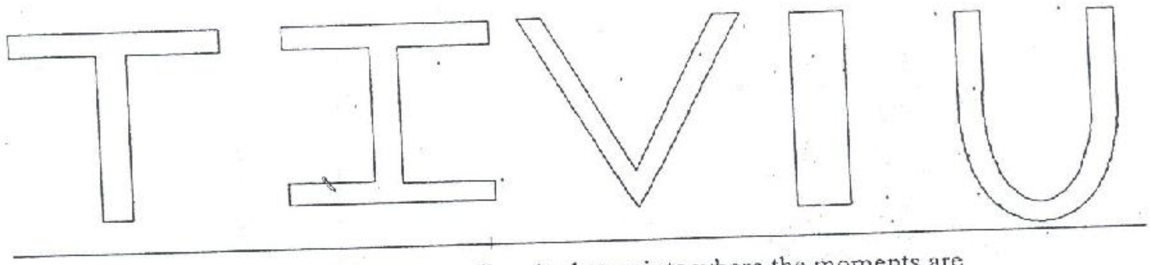


*Fig1.4*System consisting of Structures disunited at points where the moments are smallest Moments

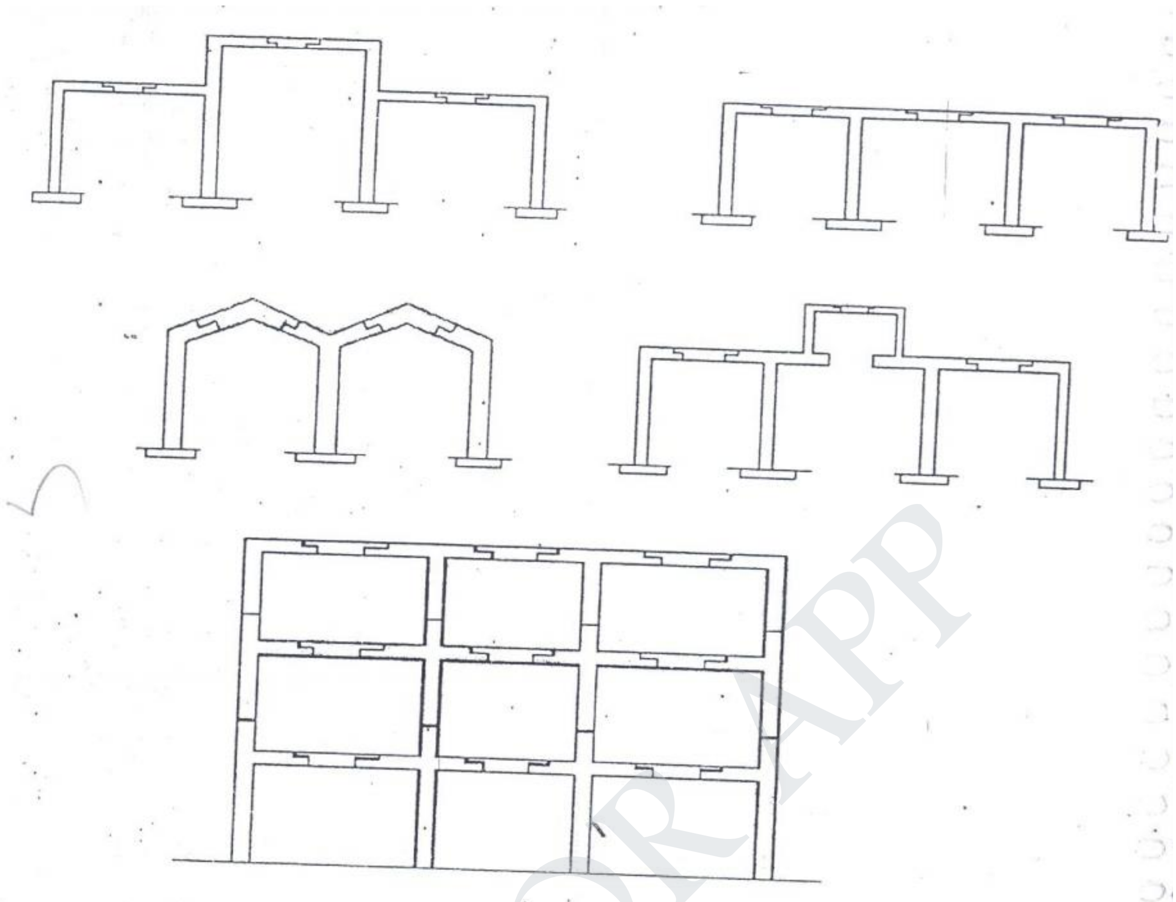


Fig 1.5 Structures disunited at points where the moments are smallest

Another method of disuniting of structures is by division into different membranes at points where the moments are thin or smallest. This method is called as lambda method. Using this method hinge joints are made.

Advantage:

1. Functions are made at points of minimum moments or at points of contra flexure.
2. Disuniting the main girder in this manner makes the application of different skylights possible.

Disadvantage:

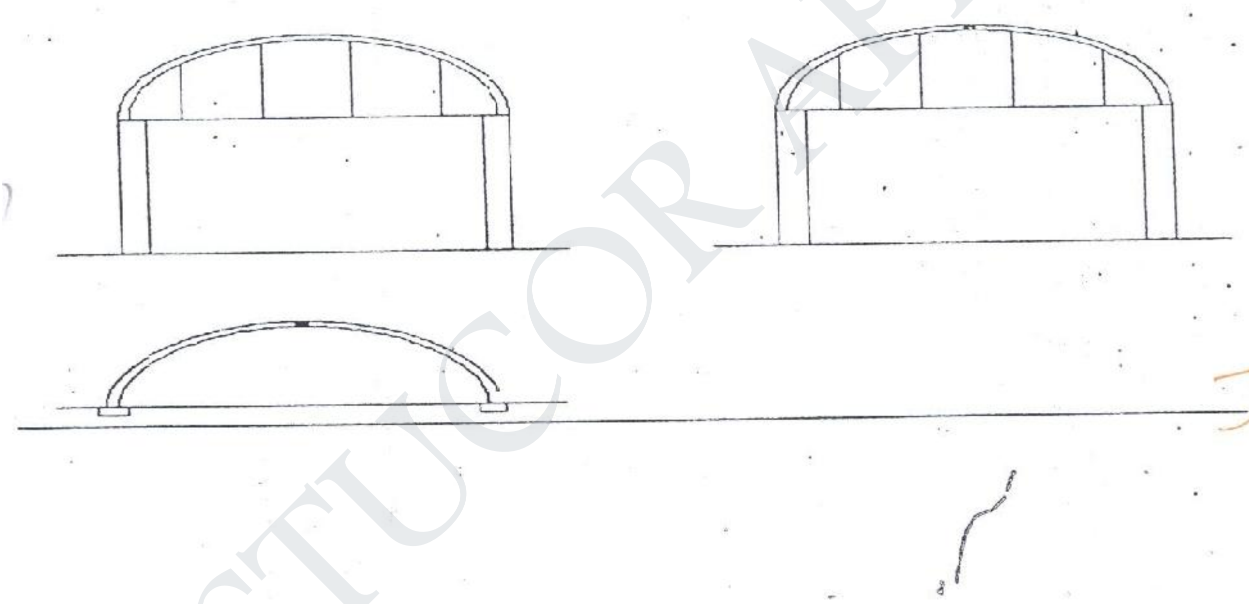
1. Hosting and temperature bracing of L joined asymmetric frame members is particularly complicated.
2. Temperature resting of frame member on each other necessaitates the use of canilevers having half depth and proper forming of this cause difficulty.

Two hinged and three hinged arches

Arched structures are normally two hinged and three hinged arches. Arched structures are normally used for bridging span more than 20-25m. Their production and placing is more difficult than straight members. Arch can be two hinged and three hinged but they can also be fixed at footings nd can be constructed with or without tie.

These members are generally precast and assembled in statistically determinant three hinged variance and middle hinge is only eliminated after placing is finished. The reinforcing bars protruding both sides are welded together and the joint between the members is filled in with insitu concrete.

Arch structure can be precast in either vertical or horizontal positions. In the first case, shuttering made of timber or concrete is required having the same curvature s the arch itself. The prefabrication of larger arches in theh horizontal position is found to be more economical The construction of arch trusses can be properly carried out in the horizontal position only.



3.Transportation and Hosting of Prefabricates:

Truck

cranes

Gantry

cranes

Mast

cranes

Derrick

cranes

Twinned mast cranes

Truck cranes:

Truck cranes consists of chasis includinig mortar and pivoting upper part. These cranes are mobile and an travel on their own needs. Different features are:

1. Weight of the crane while travelling is 31.8 tonnes
2. Maximum height of hoisting hook is 36.6m
3. Crane can rotate through 360º.

Disadvantage:

Needs firm and compact soil.

Gantry Cranes:

These cranes are used mainly to serve the operation of manufacturing and storing areas in prefabrication plants.

Capacity 5T, Total weight 4.5T

Horizontal distance between 2 tracks is 7.8m

Maximum height is up to 11m

Mast height 10.9m and it can hoist up to 20 tonnes in operation.

Mast Cranes:

These are wide spread hoisting devices,simple and cheap. Operation requires great skill and practice. Useful in hoisting prefabricates in vertical direction. Suspension load can be slightly moved forward by slackening the rear staying cable. Hoisting load is done by a winch.

Twinned mast cranes:

It is used for hoisting member to great height. It consists of two steel column assembled from sections and connected at top by bridging structure.

Hoisting capacity using two cranes each of 35-70T

Operation of the crane required minimum 16

workers.

The crane can be transferred but takes 1-2 days and is suitable fr high lifting but difficult to operate.

These are now a days replaced by 30T mast cranes hinged in 2 directions.

Derrick cranes:
Highly efficient lifting machines

It is stable or movable

Capacity 20-40T

Suitable for prefabrication halls

These cranes have booms which can move in horizontal directions.

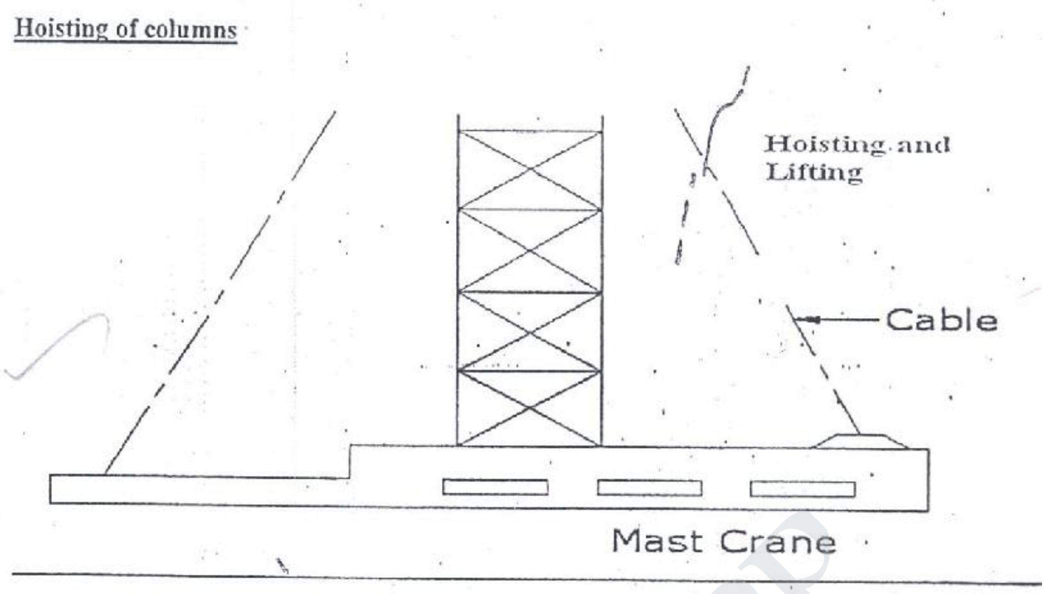
Prefabricated structurers are erected in coonvinient sections which when fixed correctly should be sufficiently rigid in all directions. Normal sequence of erection is

a. Structure units- external load bearing walls,columns,etc
b. Non structure units- internal walls,partition walls,etc
c. Floor panels, balconies, stair units
d. Specialized prefabricated units- chimney flumes. Ventilators, sanitary installation.

If the external walls are hand laid from small blocks or bricks, all necessary materials should be hoisted by crane and stacked near the ultimate position. The mansonry work is begun after the floor immediately above is laid.

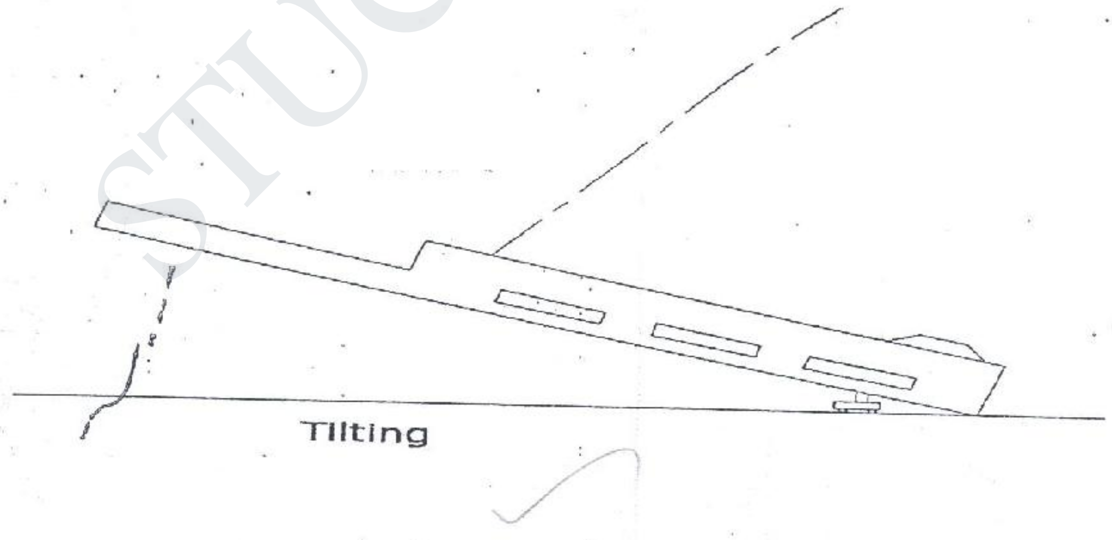
The tolerances are comparatively strict and are normally coompliedwith the use of a skilled rection gang. The distance between the wals are measured with the steel tape and the thickness of joint with rule having mm scale.The accuracy is verified by means of surveying instruments after all joints are connected or erected.

Hosting of Columns:



The hoisting machine for small column is less than five tones. First of all pick up gear must be assembled on to the column and the column is then under pinned.

Thereafter the column is lowered temporarily on to a sheep shoe assembled at the foot and the roller track is pushed under the shoe. When column is hoisted the pick up points moves vertically and bottom resting on the roller tracks shifts towards the footing. When the column is lifted to the required height, the retaining cable is used to decrease and finally stop the swinging motion of the column.



1. Pick up and hoisting
   Beams in general are liftedat two points depending on the weight and dimmensioons as well as the load bearing capacity of hoisting machines. The hoisting grider which is heavy to a great can be executed with hydraulic jacks.

The jacks are lowered and the beam is placed to the required position to the column.

Suspension:

For lifting up of trusse and large beams of length 25-30m. care is taken to lift the rocker in uniform rate with two hoisting machines otherwise the beams would be subjected to distortion during the lifting leading to cracks.

5.Methods of prefabrication:

Site prefabrication- for large

prefabricates Plant prefabrication-

large scale production **Site**

prefabrication:

1. The RC members are produced t the site in the open air chiefly in the open air or in the temporary sheds
2. The difficulties in construction in general are felt in this mechanization can case.
3. Mechanization can not be of such high degree as site PF is done for smaller duration of time.
4. When the pre fabricates are of large size it is difficult to transport the pre fabricates to the site.
5. In comparison with plant prefabrication transportation of the members are not needed.

   As large members are not transported the design and weight of the prefabricates are not limited.

Plant prefabrication

1. The members produced are to be transported t the place of costruction this accounts for about 10-15% of the cost of production and assembling.
2. Certain restriction is made in the dimension of prefabrication leading to restrainst in the design and development of prefabrication.
3. Prefabrication is appropriate for mass production for manufacture of standaridized members.
4. Needs costy materials for batching and production.
5. This method is most suited in the case of small prefabricates which are to be prefabricated in very large number.

Plantt prefabrication is done under permanent plant or factories. It is done under the covered roof so the effect of weather does not affect the work. So the quality and strength of the members can be improved considerably. Plant prefabrication reduces the cost of prefabrication if the number of prefabricate needed is more.

Dimensions of prefabricate:

There are 3 commonly known dimension for the prefabricates.

1. The design of the errectio dimension governing the dimensional coordination of the prefabricates.
2. Theoretical dimension
3. The actual dimension of the element when delivered the design dimension should be a multiple of abasic module size m or of a module lmp.

Production of prefabricates:

Production techniques involved are

1. Stand method
2. Conveyor method or line method
3. Aggregate method

Stand Method:

In this method, the prefabrication mature where they are moulded while the production teams moves to successive stands. The bed on whih prefabricates are cast may be fixed or movable. Tilting forms are often uused and in tthis method steam curing is generally done.

Conveyor belt method:

The whole production is split up in to series operations carried out at separate successive and permanent points served by specialized teams. The movement of the mould or prefabricate one point to other vary by means of conveyor belt trolleys.

The rigid steel forms are assembled at station 1 where they are mould oil to reduce the adhesion of concrete.The conveyor moves fron 1 to 2 where prestressing wires are fixed & in the next station anchoring of the wires is carried out. The prepared mould is then carried to the station 1ie casting station.After casting ,it is shifted to the vibrating table & finally stacked @ station 5 for setting.

After that,it is passed through tunnel autoclave for curing.After steam curing move too station 7 for demoulding & is finally stacked @ 8.

Aggregate method:

In the aggregate method,aggregate describes large complex permanently installed machines & mechanical appliances which carry out most of the separate operations involved in the casting of the concrete composition.The stand is operated by a permanent team & the only move the prefabricate makes is to the maturing point.

Aggregate method is used in the production of multi duct hollow floor pannel in Poland.At production point the reinforcement is fixed in the form & remote controlled aggregate(machine)inserts the duct formers,cast& vibrates the concrete,floats @ the top of the floor.The prepared prefabricate then move to the autoclave chamber in which hardening of concreteis accelerate.In many factories combined technology are employed when complex prefabricate are required.

Advantages:

1.The stand technique is the most flexible one.It is used in varying degrees of mechanization,in all kinds of prefabricate factories.

2.It is simple & less capital is required.It can be used for field prefabricate also.

3.Aggregate method is used for large scale productionin which case number of machineries is required.

UNITII.PREFABRICATED COMPONENTS.

PART A

1.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 posses not only thermal .

2. 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 .

3. How are the prefabricated component classified ?

a) Based on the area (or) size of prefabricates

. b) Based on weight of prefabricates .

c) Based on the

function . d) Based on

the shape .

e) Based on the material .

4. What are 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 are floor slabs .

5. 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.

6. differentiate between synclastic and Anticlastic .

In the case the synclastic the curve of the shell in the same side (eg : hemispherical shell) where as in the case of anticlastic the curvature of the shell is in opposite direction eg: hyperbolic shell (saddle shell).

7. 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 is existence that were built in Roman times .

8. Define shear wall .

These are simple type and these shear walls under forces and horizontal shear along its length are subjected to bending and shear walls.

To resist these forces , the uniform distribution of steel along its length is used in simple shear

9. Different classification of shear walls .

1) Plain rectangular shear wall

2) Bar bell type .

3) Framed shear wall .

4) Coupled shear wall.

5) Care type .

10). 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 is two direction .

In skeleton construction these floors are placed directly on columns .

PART B

1.Explain about Roofing members in

detail. Roofing members are classified

as,

i.Reinforced planks.

ii.Light weight concrete members.

iii.Small reinforced roofing

members. iv.purlins

v.Large reinforced roofing

members. Reinforced planks:

Reinforced planks made of hollow tiles.The reinforced planks with longitudinal circular holes.Thickness of these tiles is 60mm,80mm & 100mm & the width is 200mm & length is vary from
360mm to 400mm. On the upper side one longitudinal groove is provided.

Reinforcement is placed into these grooves which are subsequently filled with cement mortar.In this way ,roofs of length 2 to 3m & thickness of 60 to 100mm & width 200mm can be constructed.

The end tiles resting on the support are provided with 3.11mm dia stirrups protruding from the tile.There are kept together over mortar of 40mm thickness & in further concreting of joint.the joint is completed.

Light weight concrete roofing members:

Light weight concrete roofing members play a role in addition to space bordering & load bearing in heat insulation.The thickness varies from 7.5 to 25cm for reinforcement of Light weight concrete roofing members.weiding nets is used.steel reinforcement is given additional coating to prevent any corrosion care is taken to give good bonding of reinforcement with concrete.

The unit weight of these members is 750kg/m3 & width of 50cm.Its varies from 1.75mm to 6m.precast members can be made either in usual way using light weight materials.sand as aggregate & combination of high strength concrete.The top & bottom layer of about 2 to 3cm thickness iss provided with high strength concrete.Its consists of prestressed 2.5mm ddia embedded in these layers.The middle portion is made with light weight concrete.

Small reinforced concrete roofing members:

The Small reinforced concrete roofing members is essentially precast simply supported ribbed concrete slab width varying from 450 to 120cm & length varying from 2 to 4m.

Purlins:

Purlins are precast concrete beams supported by the main girders serving the purpose of bearing for the roof covering.The cross section of purlins iss generally rectangular but it can also have trapezoidal,T,L and I shape.

Precast purlins can be simply supported or cantilever beams & for the bearing of loads beyond these weight simply supported purlins can be transformed into continuous beams.It is very simple & easy to place.For cantilever purlins placing of hinges should be determined in a manner to develop positive & negative moments equal to each other.This can be arrived by placing the hinges @ 0.1451 from the support where I is the spacing between the supports. Large reinforced concrete roofing members:

Large reinforced concrete rest on the main girders.These are generally used for large hall structures & these are most advanced type of precast structures.Members are manufactured corresponding to spacing of the frame length of about 6 to 10m & width of 1.3 to 1.8m. As they are most supported on main girder purlins are not required.

Four kinds of members exist:

1.Normal members.

2.Intermediate members.

3.Members with

cornice.

4.Members with gutter & eves border.

2.Write a detailed note on shear walls.

The types are classified as

1.Rectangular type or Bar bell type.

2.Coupled shear wall.

3.Framed shear type.

4.Core type shear wall.

When walls are to carry only compressive force,they can be designed as plain concrete,when walls are subjected to tensile forces(due to wind force)due to eccentric loading& earthquake load the walls are RC walls,shear walls are previously provided to resist the wind forces only.Hence became popylar & to prvide shear walls to resist EQ forces.

SHEAR WALLS:

These are simple type & these shea walls under forces & horizontal shear along its length are subjected to bending & shear.To resist the forces the uniform distribution of steel along its length is used in simple shear walls.In case of bar bell type 2 boundary elememts are provided on either side.Minimum steel is provided over the 0.7 to 0.8L & the remaining steel is placed steel is placed @
0.12 to 0.15L.These walls are designed in such a way that they never fail in shear but only by yielding of steel in bending.Shear failures are sudden & brittle.One disadvantage of this type of wall is that during EQ the shear walls attract all the earthquake forces & dissipates the forces in to the wall.The loss of energy by crackingof the wall iss difficult to repair .This can be eliminating by providing coupled shear wall.

Coupled shear wall:

If two straight walls are joined together by relatively short span beams they are called as Coupled shear wall.The stiffness of resultantwall increases in addition to the structure cqn dissipate most of the energy by yielding the coupling beams with no damage to the main walls.It is easy to repair the coupling beams than repairing the walls.

The action of the couping beams of the shear walls.The beams are displaced vertically they tend to bend in a double curvature.The consistent shear can reduce the axial force in the upwind wall by a large amount & reduce pressure can lower tne shear capacity of the wall.To take up for this force diagonal lateral steel is more effective.

The design should be taken care of to see that the system develop plastic hinges only in the coupling beams before shear failure & coupling beams should be designed to have good enrgy dissipation capacity.

Framed shear wall:

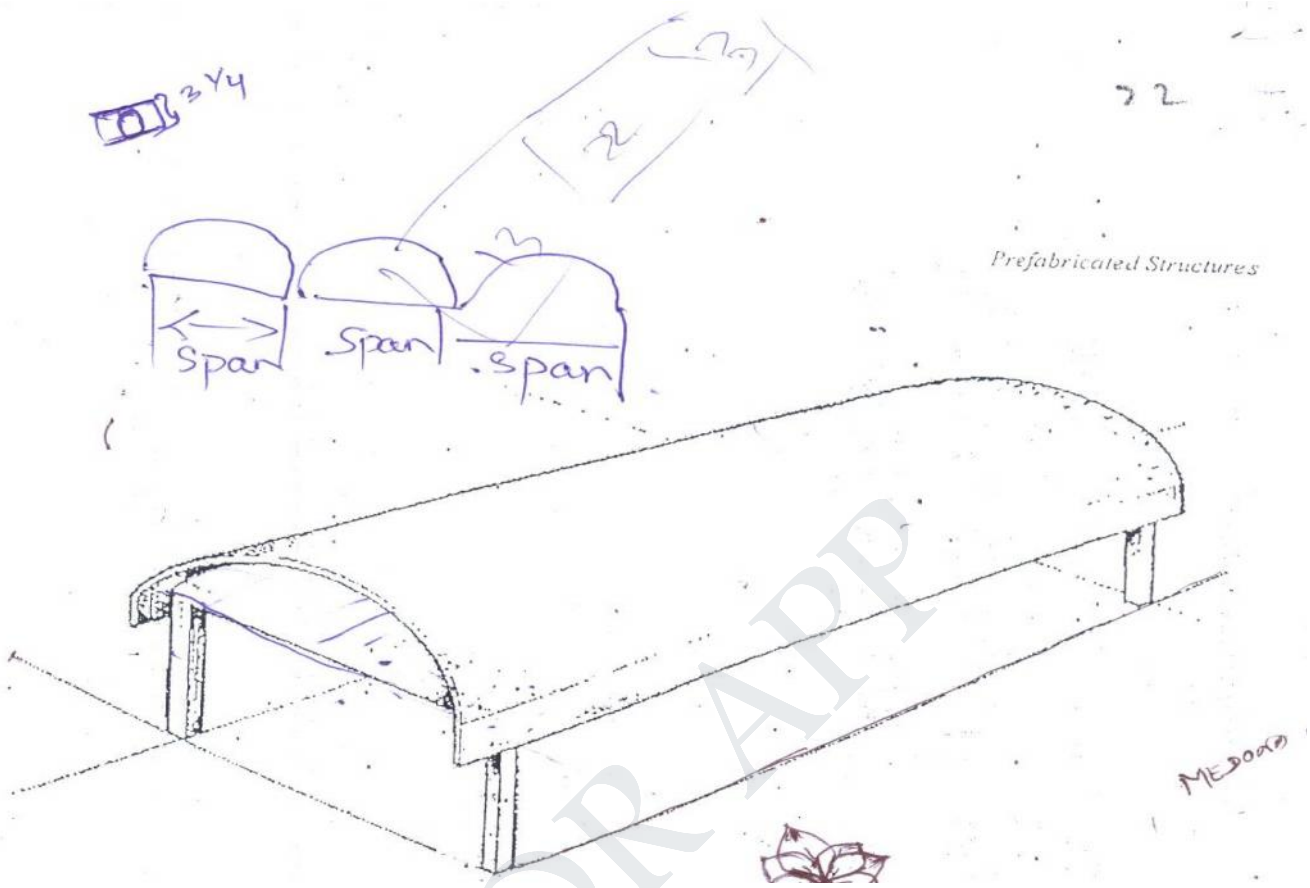
Framed shear walls can be provided with or without brick infills.

3.Write a brief note on shell structures.

These are load bearing structures having curved surface.The advantage of shells is that it provides large column free area for the monolithic construction.The cost of shuttering & scaffolding is very high but if manufactured in a precast factory in large scale.The production cosh can be considerably reduced.

The shell structure can have ribs in the centre & provided with curved membranelikee roof.The shells built of precast members used in the construction of industrial buildings are many.The thickness of shell varies from 2 to 10cm.Some precast shell,,s are produced with dimensions which are very difficult to transport.To avoid such difficulty large size shells are precast near to the restting or construction place.

The transportable or small size shell members can be precast in factories & these are transported to the site.Examples:Barrel shells,Saddle or hyperboloid shells.cupola or paraboloid shells.



Types:

a.Single barrel:

The structure above is a single barrel with edge beams.The shell has been allowed to project beyond the edge of the stiffener in order to show the shape of the shell.Stiffeners are required at columns.They do not necessarily have to be complete diaphragms but may be arches with a horizontal tie.The thickness is based on design of a slab element,the thickness of the barrel shell is usually based on the minimum thickness required for covering the steel for fireproofing,plus the space required for three layers of bars,plus some space for tolerance.If these bars are all half inch rounds,a practical minimum would be 3 ¼ inches.Near the supports the thickness may be greater for containing the larger longitudinal bars.

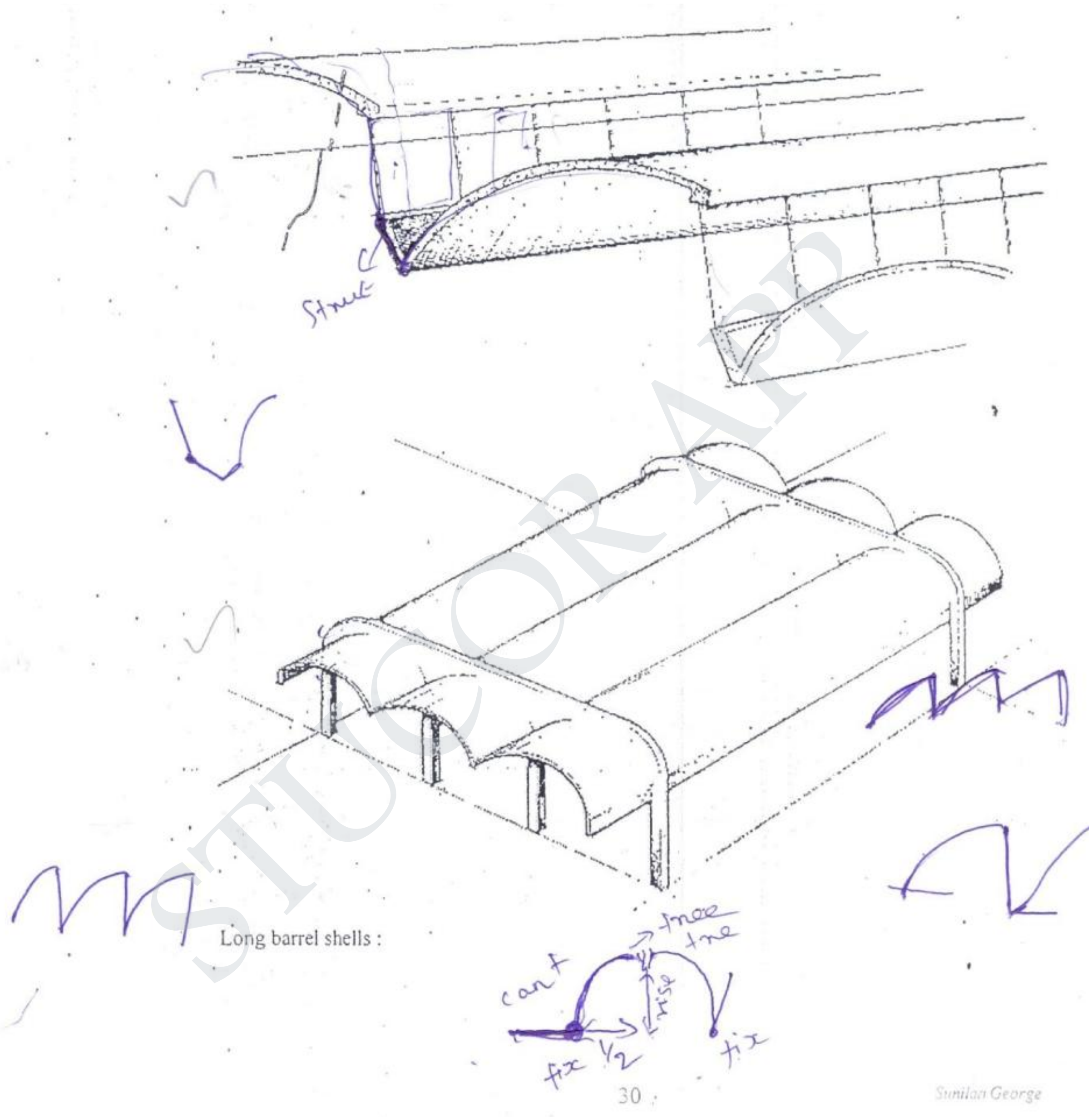
If more than one barrel is placed side by side,the structure is a multiple barrel structure
& if more than one span,it is called as multiple

span structure. Multiple barrel structure:

This structure shows a multiple barrel with vertical edge beams at the outside edges.The stiffeners have been place over a roof.The advantage of having the stiffeners on top is that there are no interruptions to the space inside the shell so both the inside appearance & the utility are better.The movable formwork may be used which will slide with little decentering lengthwise of the shell.

The multiple span structure should have an occasional expansion joint to reduce shrinkage & thermal stresses.This can be accomplished by cantilevering half the span from each adjacent stiffener.A small upturned rib placed oon each side of the joint & accordion type sheet metal flashing is arranged to prevent roof leakage.

The maximum spans for this type shell are again limited by the geometry off the cros section .Assuming the maximum width of barrel to be 50 feet & maximum end slope to be 45°,the rise would be about 14 feet,the maximum span would be in the order of 150 feet.



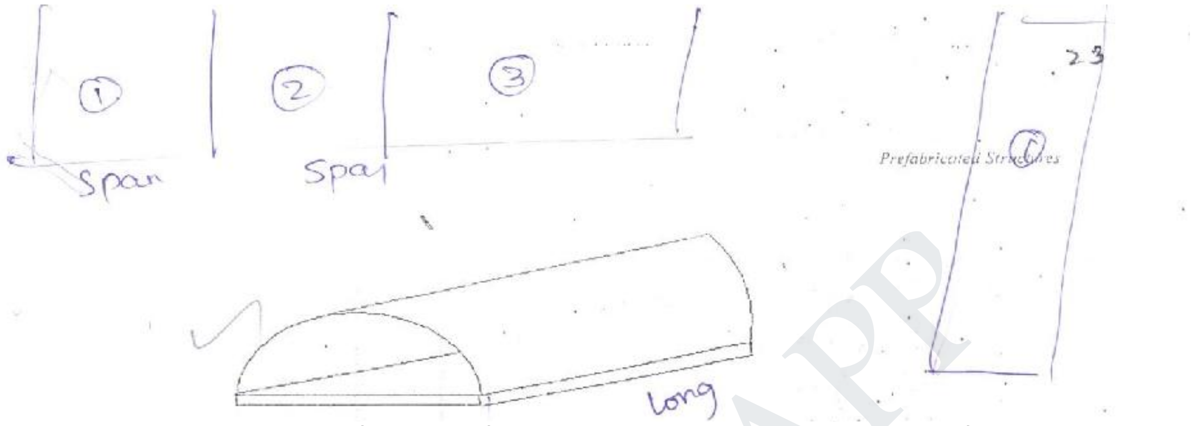
Long barrel shells :

North light shells:

This type of shell structure is used to provide large areas of north light windows for factories requiring excellent natural lighting.The windows may be slanting or may be vertical.The member at the bottom forms a drainage trough with the curved shell & materially assists in stiffening the structure. The effective depth of the shell is not the vertical distance between the two ends but is morely represented b the depth if the shellis laid flat with the ends of the circle on the same horizontal line.The spans for the north light shell must be rather small in comparison to the vertical depth of construction.The edges of adjacent shalls should be tied together by concrete struts serving as mullions between the window glazing.

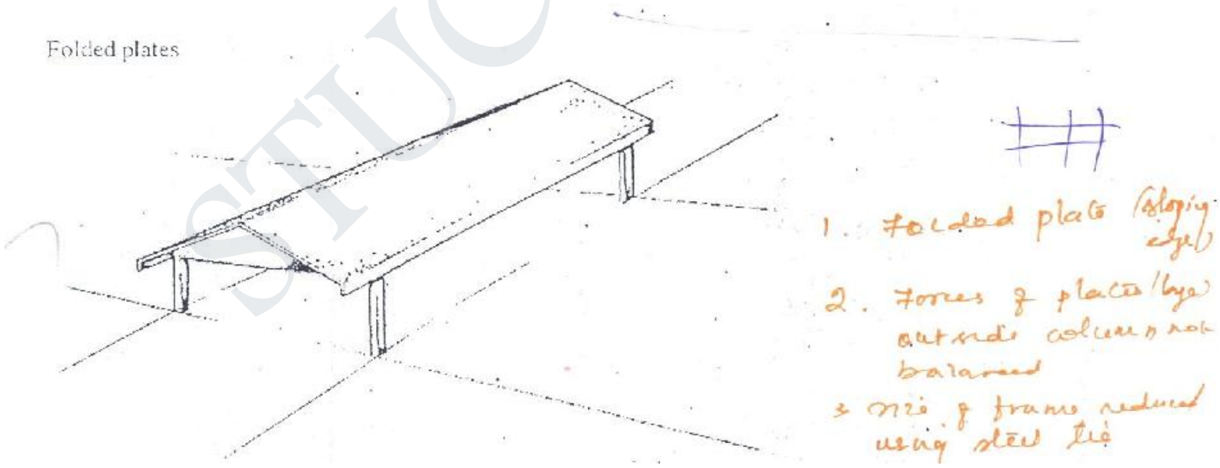
Long barrel shell:

Long barrel shell obtained hen the semicircle or a segment of same is translated along the longitudinal axis.



Generally used for shed for industrially purpose & buildings for large column free areas.Generally the prefabricated barrels off sizes 3.5 to 5m & 10m long with edge beams having thickness of 60mm.The thickness of the shell should not be more than 40mm.The dimension of these members were finally limited by the load carrying capacity of the available hoisting machines using the girder system built of precast prestressed trusses with parallel chords,areas having a span of even more than 15m can be covere with barrel shell

Folded plate:



A folded plate structure with 3 segments for each barrel.The forces from the reactions of the sloping plates on these rigid frames will be quire large and at an outside column they will not be balanced by thrusts from the adjacent plates.The size of the frames may be reduce by using a steel tie between the tops of the columns.The dimensions of the plate are dependent on both the with of the barrel & on the span.The depth of the shell should be about 0.10 timess the span & the maximum slope of a plate should not be greater than 40°.For example,assume that the span is 60feet & the baywidth is 24 feet.The depth of the shell should be about 6 feet & the horizontal width of each plate with a 3 segment plate should be about 8 feet.The lope of the plate is 6/8,which is about

37° & is satisfactory.The thickness of plate could be about 3 ½ inches.The principle components in a folded plate consist of 1.inclined plate 2.edge plate which must be used to wide plate.3.Stiffeners to carry the loads to the supports & to hold the plate.4.Column to support the structure in the air.

4.Discuss about domes in detail.

Domes are construced with many planes so they ressemble the facets of a diamond.The structural problem in designing these shells is to provide enough angle between the planes so that an actual rib is formed which will be stiff enough to support the plane surface.Usually it is best to start with a spherical translation surface.

Folded plate dome:

This makes use of tapered folded plate slanting to the centre in the form of a tent.It can be built so that each of the triangular elements is self supporting during construction except for possibly a single shore at the crown.To obtain natural light the top may be cut off & a ring inserted with a sky light.The arch thrusts are taken through this ring & the difficult forming of the narrow plate at the crown is avoided.If the structure is large there would be very high bending stresses due to the curvature & the ring would be very large.

Multi facet dome:

There may be discontinuous in the layout of intersections which make or destroy the visual effect & make the structure more difficult to design.This dome can be of much greater span than the previous example because the span of the individual slab element is less.A dome hexagonal in plain can be made continuous with adjacent units if it is necessary to cover a large area.

Half sphere- vertical walls:

A half sphere for a dome of revolution does not require a thrust ring at the base so it can be placed on vertical walls & made continuous with a walls.This design is used for tanks because the roof becomes a part of the tank.The vertical portion of the sphere is not difficult to construct if pneumatically applied shotcrete or a similar process is used.The structure with arched openings an a plastic dome on the crown has a rather oriental feeling.The most serious problems in the architecture of dome is acoustics.In a domed ceiling the sound may reverberate as many as 20 times unless there is acoustical treatment.

Domes-Square in plan:

This structure is a spherical dome with portions sliced off to form a square or rectangle.Most areas to be covered are rectangular so a circular dome is not always a good solution to the planning requirements.This dome is supported by four rigid frame & would only be suitable for small span because the frame would get quire in large.For long spans it is necessary to place a tie between the knees of the frame.These ties can be made a part of the windows.Stresses in the shell are direct compression stresses except across the corner where there are direct tensile due to the outward spread of the forces.The arches or rigid frames pic up the shell forces by shear parallel to the arches which are zero at the top & maximum at the bottom.There is no component of force in the shell perpendicular to the arches.

Multiple Domes:

The domes is rectangular & is continuous with the adjacent domes.The edges of dome are supported by tied arches or brousing trusses.If windows are needed in these arches,the mullions may be made to serve as vertical hangers for the bottom chords of the arch.In constructing the shell,each one of the dome elements is an independent structural unit so the forms may be moved without shoring all or part of the dome already cast.The shell thickness of this type of dome does not need to be greater than a circular dome except at the triangular corners.Membrane action ceases to exists & the corner should be designed as a slab.

Translation domes:

This structure looks very much like the square dome.A translation shell is generated by a vertical curve sliding along another vertical curve.The curvs can be circles,ellipses or parabolas.Therefore the vertical sections are all identical as opposed to a circular dome in which all vertical sections vary in height.This is a big advantage in construction of the formwork.This method can provide a rectangular dome with the same height of arch on all sides,thus making a rectangular dome feasible.

Most of the load is carried by the side arches with some coming directly to the corners.A tie at the springing of the arches but usually this will be covered by the walls.Such shells are suitable for quite long spans with some interior lighting furnished by skylights in the shell.

5.Explain about Warped surface in detail.

Warped surfaces have a great advantage for shell structure because they may be formed from straight form boards eventhough they are surfaces of double curvature.There are two typeswhich are most useful:the conoid which as its name suggests is a portion of a cone& the hyperbolic paraboloid,a name for a particular mathematical surface.This type of shell structure can be built to what appears to be the ultimate in lightness of construction,minimum reinforcing & ease of moving forms.

Stresses in the hyperbolic paraboloid shell are almost entirely membrane(direct tension& compression)& all forces are delivered as shear parallel to the stiffening ribs.The shell thickness in structures is on &one half inches except for slight extra thickness at the intersection of the surface.This dimension is based on a cover of one centimeter on each side of two layers of bars & not an any structural requirement for strength.

6.Write a detailed note on Wall

system. Walls:

Generally classified based on the function as load bearing & non load bearing walls.Eg.partition wall.They taansfer self weight only & they are provided to create barriers that can be visual,thermal on acoustic.

Stiffening walls:

Provides 3 dimentional stiffness .The load bearing walls which are referred to as supported walls do not posses foundation o f their own but are either carried by beams or slabs or directly attached to load bearing walls. The supported walls can form on integral part of structure or remain as non structural depending on stiffness.

Depending on the orientation of the main beams or load bearing walls relative to long axis of the building. Prefabricated wall system are classified as,

Long wall system

Cross wall system

Ring or two way system

Long wall system:

The main beams are load bearing walls are placed parallel to the long axis of building. It is applied to the building with large prefabricates and is similar to traditional brick work technique . The longitudinal external walls which carry the floor loads must posses not only thermal properties but also sufficient load carrying capacity .

The long wall system construction is typical with large blocked structure and special pier blocks between the windows which carry loads from lintel and the walls above. The horizontal still blocks are not loaded . In some designs space between the piers is filled by prefabricated unit consisting of RC window frame complete with window.

The internal wall blocks are normally of full storey height subject to limitations imposed by lifting equipments available. Both internal and external walls are made of some materiel.

Cross wall system :

Load bearing walls and beams are placed at right angles to the longitudinal axis of the building . In this system the floor units are provided with two way structural units which distributes the to the cross walls and this system is more prominent. The internal walls are made of ordinary concrete for load bearing walls and the external walls and the external walls are made of light weight concrete to reduce the weight of the structure.

Generally the room size is nearly square in this

system. Ring system :

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

In this system, the floor slabs are designed to span in both direction and are loaded on to the supporting walls. For large load panels cross beams are hidden within the thickness of the panel.

QUESTION BANK

UNIT I - INTRODUCTION

PART – A

1. Define prefabrication
2. What are the types of prefabricates based on i. Plan area ii Based on weight(MAY /JUNE 2012)&MAY/JUNE 2013
3. What are the types are of prefabricates based on shape? (MAY/JUNE 2012)
4. What is the need for pre fabricates structures
5. What are the Advantages of PFS? (MAY/JUNE 2012) &(MAY/JUNE 2009)& MAY/JUNE 2013
6. What are the disadvantages of PFS? (MAY/JUNE 2012)
7. What are the Production techniques?(NOV/DEC2012)
8. Explain the stand system Production technique
9. Explain the conveyor belt or production line system Production technique?
10. Explain the aggregate system production technique?
11. Explain the Erection procedure of PFS building?
12. What are the aims of prefabrication?
13. What are the characteristics of Materials used for construction of PFS?
14. What is meant by modular co-ordination? (NOV/DEC 2012)& NOV/DEC 2013
15. What are the Advantages of standardization?
16. What are the Factors influencing the standardization?
17. What are the Prefabrication systems?
18. What the Types of system are of prefabricate d construction systems? (MAY/JUNE2012)
19. What are the methods for Manufacture of precast concrete elements (or) types of pre fabrication? (MAY/JUNE 2013)
20. Write short note on Production process
21. Define the term Off-site fabrication
22. List out the limitations of pre-fabrication?

23. What are all the Prefab materials?
24. Write Insulating concrete forms?
25. Write short note on Principles of MC Concept?
26. What are erection stresses?
27. What are the different production techniques adopted in precast construction?
28. List out the precautions taken while erecting precast elements.
29. What are the types of prefabricated components?
30. Explain the term lift slab construction.
31. What are the dynamic stresses induced in the precast panel?
32. What are the criteria in selection of the lifting points if the surface should be free of discernible cracks?
33. What are the factors which affect the loading conditions in demoulding and transport of components?
34. Distinguish between site prefabrication and plant prefabrication.

PART – B

1. What are the types and needs of Prefabricates?
2. What are the Production techniques
3. What are the methods for Manufacture of precast concrete elements and explain briefly
4. What is the process involved in manufacture of PFS?
5. What are erection stresses? How are they reduced or eliminated?
6. What are the importance aspects considered during hoisting, erection and transportation of precast element?
7. Explain the need for prefabrication systems.
8. Explain the production process of prefabricated structural elements.
9. Explain necessity of prefabrication in India

10. Discuss in detail the concept of modular coordination .State its significance in prefabricated structures.
11. Discuss the concept of production techniques.
12. List out the principles of prefabricated design.

UNIT II - PREFABRICATED COMPONENTS

PART – A

1. What are types of Cross wall system?
2. What are the prefabricated structural units?(Nov/Dec2012)
3. What is meant by box type construction?
4. Write brie fly about Types of Wall Panels?
5. What is the classification of precast large panel? (May /June2012)
6. What is the classification of precast concrete walls?
7. What are the types of precast floors?
8. Write about Prefabricated Roofing and flooring elements
9. What is Shear wall? (Nov/Dec2012)& NOV/DEC 2013
10. Define Long Wall System?
11. How are roofing members in prefabricates classified?
12. How are the prefabricated component classified?
13. What are the space bordering?
14. What is the meant by surface forming members?
15. Differentiate between synclastic and Anticlastic?
16. Write a short on dome structure?
17. Define shear wall?
18. Different classification of shear walls
19. What is ring system?
20. What is necessity of dimensional tolerances?(MAY/JUNE 2013)
21. Mention the types of prefabricated structural elements.
22. Give the classification of floor slabs.
23. What are the lateral load resisting elements in a building?

24. What are the types of prefabricated components?
25. Give classification of wall panels.

PART – B

1. Classify the structure of building based on the load distribution and briefly explain the different types of such prefabricated building **MAY/JUNE 2012) &MAY/JUNE 2013**
2. Explain the methods of construction of roof and floor slab. Also explain the precautions taken during the manufacturing process. **(MAY/JUNE 2012)& (NOV/DEC2013)**
3. What is the necessity of providing shear walls in the precast structures? Also discuss the different types of shear walls **(MAY/JUNE 2009)**
4. Write briefly about types of wall panels
5. Write briefly about precast concrete columns
6. Write about the structural behavior of precast structure
7. Write briefly large panel construction with neat sketches?
8. Explain the merits and demerits of large panel constructions.
9. Explain the behavior of prefabricated roofs and floor slabs.
10. Differentiate the behavior of frame and large panel construction in precast structures.
11. Discuss about behavior of columns in prefabricated structures.

UNIT - III DESIGN PRINCIPLES

PART-A

1. What is disuniting of structures? (NOV/DEC2012) & (MAY/JUNE 2012)
2. At what point in the members disuniting should be done?
3. What are the advantages of disuniting of structures?

4. What are the disadvantages of disuniting of structures?
5. Explain joint flexibility? (MAY/JUNE 2012)& MAY/JUNE 2013& NOV/DEC2013
6. Explain joint deformation? (MAY/JUNE 2012)
7. How the material used in construction does affect the design of the element? (MAY/JUNE 2012)
8. What is meant by expansion joints? (MAY/JUNE 2013 & MAY/JUNE 2012
9. Explain dimensional tolerances
10. Write the need for disuniting of structures.

PART-B

1. Discuss the necessity of disuniting of structures and explain in detail with sketch(NOV/DEC2012)& (MAY/JUNE 2012)& &MAY/JUNE 2013&(NOV/DEC2013)
2. Explain the problems in design because of joint flexibility. Discuss with regard to various location. (MAY/JUNE 2012) (NOV/DEC2013)
3. Why should we give allowance for joint deformation and explain in detail (MAY/JUNE 2009)
4. What are the precautions taken during the disuniting the structures? (MAY/JUNE 2009)
5. Explain the steps involved in the process of disuniting of prefabricated structures.
6. Explain the steps involved in the design of prefabricated columns based on the efficiency of materials used.
7. What is significance of providing tolerances in precast buildings? Explain the different types of tolerances adopted in precast construction
8. Explain how the material selection impacts the design efficiency of a precast element.
9. Explain the problems in design because of joint flexibility. Discuss with regard to various location.

UNIT – IV JOINTS IN STRUCTURAL MEMBERS

PART-A

1. What are the importances's of joints in precast structures when compared to cast- in-situ structures?
2. What is the need for expansion joint in precast structures?
3. What are the connections? (MAY/JUNE 2012)
4. What are the different types of connections?
5. What are the points to be considered while designing the connections?
6. What are the different connections made in a prefabricated structure
7. What are the different types of joints? (NOV/DEC 2012)&MAY/JUNE 2013
8. What are the materials used for concrete joints?
9. Based on the location within a building, how connections can be classified?
10. What are the functions of joints?
11. Write the use of expansion joints.
12. Give any two types of joints in prefabricated structures.
13. What is significance of connections in precast structures?
14. Write note on expansion joint.

PART-B

1. Explain expansion and contraction joint in retaining wall. MAY/JUNE 2012
2. What are the essential requirements of joints in precast construction? MAY/JUNE 2012
3. What are the recommendations for the design of an expansion joint? (MAY/JUNE 2009)
4. Give the recommendations for the detailing the precast element in respect of the connections and erection(MAY/JUNE 2009)
5. Explain about column to column connection(MAY/JUNE 2009)
6. Explain about beam to beam connection. (MAY/JUNE 2009)
7. Explain the merits and demerits of expansion joints in prefabricated structures.
8. Explain any two types of beam column joints in prefabricated structures with neat sketches.

9. Give the guidelines recommended for expansion joint design and location.
10. Explain in detail the different structural connection adopted in a framed precast building with sketches.
11. What is the importance of joints in precast structures when compared to cast in situ structures?
12. What is the need for an expansion joint in precast structures?

UNIT – V DESIGN FOR ABNORMAL LOADS

PART-A

1. What is progressive collapse? (NOV/DEC 2012)& NOV/DEC 2013
2. Define Degree of Progressivity?
3. What are the approaches to avoid progressive collapse?
4. What are the special requirements for building in High Seismic Zones?
5. What are provisions made in a Prefabricated R C floors in a cyclone prone zone?
6. What is strong column weak beam concept?
7. List the possible abnormal effects for prefabricated buildings.
8. Give the formula for design temperature change.
9. How are cyclones formed?
10. What are the different types of seismic waves?
11. Explain equivalent design loads.
12. Explain the importance factor and response reduction factor used in static analysis for the calculation of design seismic force.

PART-B

1. Mention in detail the codal provision for considering the effect of earthquake and cyclones. (MAY/JUNE 2012)
2. Explain strong column and weak beam(MAY/JUNE 2012) (MAY/JUNE 2013)

3. When a progressive collapse does occur? Why is it very critical to avoid progressive collapse of structures? (MAY/JUNE 2009)
4. Explain the procedure for calculating equivalent design loads when the structure is subjected to earthquake loading MAY/JUNE 2009)& (NOV/DEC2013) (MAY/JUNE 2013
5. What are the methods to avoid the progressive collapse? Explain each briefly? (MAY/JUNE 2009)& (NOV/DEC2013)
6. Discuss the codal provisions for the design of prefabricated elements subjected to abnormal effects.
7. How are explosive loads different from loads typically used in building design?

Reg. No. :

Question Paper Code : 20180

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2012.

Eighth Semester

Civil Engineering

CE 2045/ CE 1007/080100060 — PREFABRICATED STRUCTURES

(Regulation 2008)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List the advantages and disadvantages of prefabricated system.
2. List the system for prefabrication,
3. What are the types of prefabricated components?
4. Explain the term lift-slab construction.
5. Explain joint deformation.
6. Explain joint flexibility.
7. What are connection?
8. Write note on Expansion joint.
9. Explain Equivalent design loads.
10. What is meant by progressive collapse?

PART B — (5 × 16 = 80 marks)

11. (a) Discusses the concept of production techniques.

Or

(b) What are erection stresses? How are they reduced or eliminated?

12. (a) Classify the structure of building based on the load distribution and briefly explain the different types of such prefabricated building.

Or

(b) Explain the methods of construction of roof and floor slab.

13. (a) Discuss the necessity of disuniting of structures and explain in detail with a sketch.

Or

(b) Explain the problem in design because of joint flexibility. Discuss with regard to various location.

14. (a) Explain expansion and contraction joint in retaining wall.

Or

(b) What are the essential requirements of joints in precast construction?

15. (a) Mention in detail the codal provision for considering the effect of earthquake and cyclones

Or

(b) Explain strong column and weak beam.