PREFABRICATED STRUCTURES

UNIT I

INTRODUCTION

classifications of prefabricated systems

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

Medium prefabrication:

Suppose the roofing systems and horizontal members are provided with pre casted elements. These constructions are known as medium prefabricated construction. Here the degree of precast elements is moderate.

Large prefabrication:

In large prefabrication most of the members like wall panels, roofing / flooring systems, beamsand columns are prefabricated. Here the degree of precast elements is high. One of the main

factors whichaffect the factory prefabrication is transport. The width of the road, mode oftransport vehicles are the factors which determines the prefabrication which is to be done on-siteor in factory. Suppose the factory is situated far away from the construction site and the vehicleneeds to cross congested traffic areas withheavy weighing elements the cast in-siteprefabrication is preferred. Even though the same condition as the cast in site prefabrication ispreferred only when umbers of houses are more for small elements the conveyance is easier withnormal type of lorry and tractors. We can adopt factory or off-site prefabrication for this type ofconstruction.

Open system of prefabrication:

In the total prefabrication systems, the space frames are casted as a single unit and erected at thesite. The wall fitting and other fixing are done on site. This type of construction is known as opensystem of prefabrication.

Closed system of prefabrication:

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

Partial prefabrication:

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

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

Total prefabrication:

Very high speeds can be achieved by using this method of construction. The method can be employed for frame type of construction or for panel type; the total prefabrication is done on-site or off-site. The choice of the two methods depend on the situations when the factory produced elements are transported and erected on site, we call it off-site prefabrication. If this method is to be adopted we should have a very good transportation facility for the products to be transported to the site of construction. If the elements are cast near the building site and erected, the transportation of elements can be eliminated, but we have to consider the space availability for establishing such facilities though it istemporary.

modular coordination

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

1. Assembly of single components into largecomponents.
2. Fewest possible different types ofcomponent.
3. Minimum wastage of cuttingneeded.

Modular coordination is the basis for a standardization of a mass production of component. A setof ruleswould be adequate for meeting the requirements of conventional and prefabricatedconstruction. These rules are adaptable for,

a. The planning grid in both directions of the horizontal plan shallbe
   1. 3m for residential and institutionalbuildings,
   2. For industrialbuildings,

- 15m for spans up to12m
- 30m for spans between 12m and18m
- 60m for spans over18m

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 ora line on the wall 5 cm from the internal face of thewall.

c. The planning module in the vertical direction shall be 1m up to and including a height of2.8m.

d. Preferred increments for the still heights, doors, windows and other fenestration shall be 1m. e. In case of internal columns the grid lines shall coincide with the centre lines of columns.

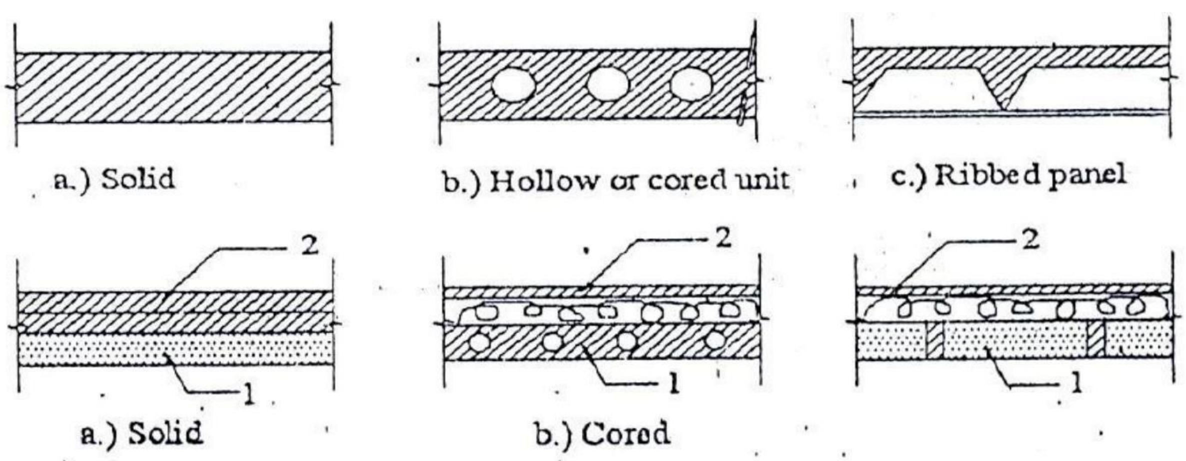
e. In case of external columns, the grid lines shall coincide with the centre lines of the columnsin the storey or a line in the column from the internal face of the column in the topmoststorey.

A basic module can be represented as module and for larger project modules are represented Mp. For eg: For a project module in horizontal coordination, the component can be of 30cm and for vertical component size be of 10cm.

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

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

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



Systems of prefabrication:

System is referred to a particular method of construction of buildings using the prefabricated componentswhich are inter related in functions and are produced to a set of instructions. With certain co strains, several plans are possible; using the same set of components, the degree of flexibility varies from system to system. However in all the systems there is a certain order and discipline. The system of prefabricated construction depends on the extend of the use of prefab components, their characteristics to be considered in devising a system:

a. Intensified usage ofspaces
b. Straight and simple wallingscheme
c. Limited sizes and numbers ofcomponents
d. Limited opening in bearingwalls

e. Regulated locations ofpartitions

f. Standardized service and stairunits

g. Limited sizes of doors and windows with regulatedpositions

h. Structural clarity andefficiency

i. Suitability for adoption in low rise and high riseblocks

j. Ease of manufacturing storing andtransporting

k. Speed and ease oferection

l. Simple jointingsystem

Principles of prefabrication techniques:

- Design for prefabrication, preassembly and modular
- Construction. Simplify and standardize connectiondetails.
- Simplify and separate building systems.
- Consider worker safety during
- Deconstruction Minimizebuilding
- Components andmaterials.
- Select fittings, fasteners, adhesive and sealants that allow for quicker assemblyandfacilitate the removal of reusablematerials.
- Design to accommodatedeconstruction
- Logistics. Reducebuildingcomplexity.

Design for reusablematerials.

- Design for flexibility andadaptability.

Advantages:

o Self supporting readymade components are used, so the need for formwork, shuttering and scaffolding is greatlyreduced.

o On-site construction and condition is minimized.

o Less waste mayoccur.

o Construction time is reduced and buildings are completed sooner, allowing an earlier return of the capitalinvested.

o Quality control can be easier in a factory assembly line setting than a construction sitesetting.

o Prefabrication can be located where skilled labour is more readily available and costs of labour, power materials, space and overheads arelower.

o Time spoil in bad weather or hazardous environments at the construction site is minimized. Saving in cost, material, time & manpower. Shuttering and scaffolding is not necessary. Independent of weathercondition.

o

Disadvantages:

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

Attention has to be paid to the strength and corrosion resistance of the joining of prefabricated sections to avoid failure of the joint.

- Transportation costs may be higher for voluminous prefabricated sections than for the materials of which they are made, which can often be packed more efficiently.

- Large group of buildings from the same type of prefabricated elements tend to look drab and monotonous

- Local jobs are lost.

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 materials are not easilyavailable.

2. PFS facilities can also be created at near a site as is done to make concrete blocks usedin plane of conventionalknick.

3. Structures which are used repeatedly and can be standardized such as mass housing storage sheds, godowns, shelter, bus stand security cabins, site offices, Fool over bridges road bridges. Tubular structures, concrete building blocks etc., are prefabricatedstructures

SYSTEMSPRODUCTION

The term production of systems is describes a series of operation directly concerned In theprocess of making or more apply of moulding precast units on the face

of it there are very many techniques since almost every type prefabricates requires a Specific series of operation in its production.

These techniques however may be grouped into three basic method of production. These are

4. The standsystem
5. The conveyor belt or production linesystem
6. The aggregatesystem
7.

Stand system

In the stand system the prefabricates mature at the point where they were moulded

While the production team moves to successive stands the bed on which prefabricates.

Conveyor belt

The conveyor belt system of production splits the whole production process in to a series of operation carried out at a separate successive and permanent point to the heat may be by means of conveyor belt trolleys & craneetc.

Aggregate system

The word aggregates describes a large, complex permanently installed set of machines and mechanical application which can carry out most of the separate operation involved in casting concrete components.

PRODUCTION

The location of pre casting yards consist of storage facilities suitable for transporting anderection equipments and availability of raw materials are the critical factors which should becarefully planned and provided for effective and economic use of pre-cast concrete componentsinconstruction.

The manufacture of the components can be done in a centrally located factor of
ina site where pre casting yards set-up at or near the site of work.

FACTORY PREFABRICATION;

Factory prefabrication is restored in a centrally located plant for manufacture of standardizedcomponents on a long form basis.

It is a capital intensive production where work is done throughout the year preferably under acovered shed to avoid the effects of seasonal variations high level of mechanization can alwaysbe introduced in this system where the work can be organized in a factory like manner with the help of constant team of workmen.

The basic disadvantage in factory prefabricated, is the extra cost in occurred in transportation of elements from plant to site of work sometimes the shape and size of prefabricable are to be limited due to lack of suitable transportation equipment roads controls etc.

SITE PREFABRICATION:

In this scheme, the components are manufactured at site near the site of work as possible. This system is normally adopted for a specific job order for a short period. The work is normally carried out in open space with locally a valuable labour force. The equipment machinery and moulds are of mobile nature.

Therefore there is a definite economy with respect to cost of transportation. This system suffers from basic drawback of its non-suitability to any high degree of mechanization. It has no elaborate arrangements for quality control.

PROCESS OF MANUFACTURE:

The various processes involved in the manufacture of precast elements are classified as follows:

1) Mainprocess
2) Secondary (auxiliary)process
3) Subsidiaryprocess

MAIN PROCESS:

It involves the following steps.

1) Providing and assembling the moulds, placing reinforcement cage in position forreinforced concrete work, and
2) Fixing of inserts and tubes wherenecessary.
3) Depositing the concrete in to themoulds.
4) Vibrating the deposited concrete into themoulds.
5) Demoulding theforms.
6) Curing (steam curing ifnecessary)
7) Stacking the precastproducts.

SECONDARY (AUXILLARY) PROCESS:

This process is necessary for the successful completion of the process covered by the main process.

1) Mixing or manufacture of fresh concrete (done in a mixing station or by a matchingplant).
2) Prefabrication of reinforcement cage (done in a steel yard ofworkshop)
3) Manufacture of inserts and other finishing items to be incorporated in the main precastproducts.
4) Finishing the precastproducts.
5) Testing the precastproducts.

STAGES OF PREFABRICATED CONCRETE PRODUCT:

FLOW DIAGRAM OF STAGES OF PROCESSING

CONCRETE---------MOULD-----------------STEEL

↓ ↓ ↓

MIXING-------------PREPARATION--------CUTTING

↓ ↓

FILLING-------------------------------------REINFORCING

COMPONENT

COMPACTION

CURING

DEMOULDING

|

STORAGE

TRANSPORT

Transport of prefabrication elements must be carried out and with extreme care to avoid any flock and distress in elements and handled as far as possible to be placed in final portion.

Transport of prefab elements inside the factory depends on the method of production selected for the manufacture. Transport of prefab elements from the factory to the site of action should be planned in conformity with the trafficable rules and regulations as stipulated by the authouriticthe size of the elements is often restricted by the availability of suitable transport equipment, such as tractor-am-tailor, to suits the load and dimension of the member in addition to the load carrying capacity of the bridges on theway.

While transporting the prefab elements in various systems, such as wages, trucks, bullock cards etc. care should be taken to avoid excessive cantilever actions and desired supports are maintained. Special care should be taken in negotiating sharp beds uneven of slushy roads to avoid undesirable stresses in elements and in transport vehicles.

Before loading the elements in the transporting media, care should be taken to ensure thebase packing for supporting the elements are located at specified portion only.

process of erection of prefabrication

ERECTION

It is the process of assembling the Prefabrication element in the find portion as per the drawing.In the erection of prefab elements the following items of work are to be carried out.

1).Slinging of the prefab elements.

2).Tying up of erection slopes connecting to the erection

hooks.3).Cleaning the elements and the site of erection.

4).Cleaning the steel inserts before incorporation in the joints lifting and setting the elements to correct position.

5).Adjustments to get the stipulated level line and plumb.

6).Welding of deats.

7).Changing of the erection tackles.

8).Putting up and removing the necessary scaffolding or supports.

9).Welding the insorts laying the reinforced in joints.

The erection work in various construction jobs by using prefab elements differs with risk condition, hence skilled foremen, and workers to be employed on the job.

Equipments required for erection

Equipments required for the prefab elements in industry can be classified as.

1) Machinery required for quarrying of course and fineaggregates

2) Conveying equipment, such as but conveyor, chain conveyorsetc.

3) Concretemixers

4) Vibrators

5) Erection equipment such as cranes, derricks, chain pulleyetc.

6) Transportmachines

7) Work shop machinery for fabricating and repairingsteel.

8) Bar straitening, bending and weldingmachines

9) Minor tools and takes, such as concrete bucketsetc…

10) Steam generation a plant for acceleratedcuring

Planning co-ordination

It is important to have the pre caster erector/installer and builder working together to achievebest performance.

Site Access and storage

- Check for site accessibility and precast panels deliveryto site especially low bedtrailers
- Check whether adequate space for temporary storage before installation andground conditions. (firm ground &leveled)
- Uneven ground will cause overstress & crackpanels.

Planning crane Arrangement

- Plan the crane capacity and lifting gears basedon
- Heaviest weight of precastpanels
- Liftingheights.
- Workingradius
- Position of crane in relation to final panellocation

Plan other equipments

- Boom lift and scissor lift for unhooking installedpanels.
- Liftinggears

Skilled personnel's

- Competent craneoperators
- Rigger
- Signaledetc

General considerations for crane selection

- Total liftingweight
- Cranemodel
- Crane safe working load (SWL) (i.e) Based on 15% capacity buildin

F.O.S. 1.33 o Lifting capacity must be 1.5 times the total weight i.e) F.O.S
1.5

- Lifting and swingradius
- Crane countereight
- Crane boom length is relation to the vertical and horizontal clearance from thebuilding.

Installation Process

Installation of vertical componentsVerification of Delivered Panels

- Check the panels delivered for correct marking lifting hook and positionetc.
- Surface finishingcondition
- Pc Dimensioncompliance
- ReinforcementProvision/position
- Architectural Detailcompliance

1. **Settingout**

- Check the panels delivered for marking, lifting hook andcondition.
- Set the reference lines &grids
- Check starter bars for vertical components before hoisting forinstallation

2. **Setting out Quality controlpoint**

- Ensure correct offsetline
- Check shim pedal/plate level andfirm
- Rubber gasket propertysecured
- For external wall/column place backerrod.

3. **Hoisting, Rigging andInstallation**

- While tilting provide rubber pad to avoid chipoff.
- Lift and rig the panel to designatedlocation
- Adjust the panel in position andsecure
- Lifting of space adding items with balanced centre of gravity.
- Ensure horizontal alignmentcorrect
- Ensure panel vertically to correctplumb
- Check panel to panel gap consistency
- Check stability of prop before releasing hoistingcable.

4. **Groutingworks**

- Prepare and apply non shrink mortars toseal
- For corrugated pipe sleeve on spliced sleeve pour NSGT or proprietary grouts into pipeslab.

- Keep installed panels undisturbed for 24hrs.
- Check joint widths are consistent beforegrouting
- Grout used should be same grade of components and self compacting to preventcracking.
- Collect test cube sample for testing for critical element or load bearingelements

5. Connecting joints

- Cast in situ joints install rebars asrequired
- Set up forms for castingjoints
- Do Concreting
- Remove forms after sufficientstrength
- For external connections sealant shall beused
- Panel with welded connections welding asrequired

Installation of Horizontal Elements

1. Settingout

- Set reference line/offset line to required alignment and level of slab/beam duringinstallation
- Put temporary prop to support the precast slab/beamelements
- Before Hoisting chem.Dimensions
- Check level and stability ofshim
- Check protruding/ starter bars are within the Specified tolerance to prevent anyobservation during the erectionprocess

2. Hoisting & Installation

- Put temporary props to supportslab/beam
- Lift and rig the elements in designatedlocation
- Align and check the level beforeplacement
- The beams shall prop at least 2location
- Balcony planter box and shall be supported more than 2 location based on designconsiderations
- Check level of precastelements

3. Connections/Jointing

- Precast with cast-in-situ joints place the lap rebars asrequired
- Set formwork for castingjoints

- Remove formwork after concrete strength isachieved
- Supporting beams shall be designed to form part of formworkjoints
- The connecting/lapping rebars tied &secured
- Same grade of concrete 10 to be used that of pael.

4. Installation using Bigcanopy

- Big canopy high rise precast concrete constructionsystem
- This is used for faster andefficient

5. ErectionPurpose

- **In Japan**
  - Used to construct the 26 storey pre-cast concrete30,763m^2
  - The system realized 60% reduction inlabor

requirement for the frameerection.

- **InSingapore**
  - DBS China square used the system to erect is efficient andfaster

SYSTEMS

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

CHARACTERISTICS OF A PREFABRICATION SYSTEM:-

The following characteristics among others are to be consideration devising a system.

1) Intensified usage ofspaces.
2) Straight and simple wallingscheme.
3) Limited sizes and number ofcomponents.
4) Limited opening in bearingwalls.
5) Regulated locations ofpartitions.
6) Standardized service and stairunits.
7) Limited sizes of doors and windows with regulatedpositions.

8) Structural clarity andefficiency.

9) Suitability for adoption in low rise and high riseblocks.

10)Ease of manufacturing, storing and transporting.

11)Speed and ease oferection.

12)Simple jointing system.

PREFABRICATED CONSTRUCTION SYSTEMS:-

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

1) Smallprefabrication
2) Mediumprefabrication
3) Largeprefabrication
4) Open prefabricationsystem
    a. Partial prefabrication opensystem
    b. Full prefabrication opensystem
5) Large panel prefabricationsystem
6) Wallsystem
    a. Cross wallsystem
    b. Longitudinal wallsystem
7) Floorsystem
8) Stair casesystem
9) Box type system

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 precasted and used in buildings. This is called as small prefabrication. That the degree of precast element is verylow.

MEDIUM PREFABRICATION

Suppose the roofing systems and horizontal member are provided with precastelements. These constructions are known as medium prefabricated construction.Here the degree of precast elements are moderate.

LARGE PREFABRICATION

In large prefabrication most of the members like wall panels, roofing/flooringsystems, beams and columns are prefabricated. Here degree of precast elementsare high.

OFF-SITE (FACTORY) PREFABRICATION

One of the main factors which affect the factory prefabricate on is transport.The width of road walls mode of transport vehicles are the factors which factor theprefabrications which is to be done on site or factory. Suppose the factory situated
at along distance from the construction site and the vehicle have to cross a congestedtraffic with heavy weighed elements the cost in-situ prefabrication is preferred eventhough the same condition are the cast in site prefabrication is preferred only whennumber of houses are 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 PREFABRICATION SYSTEM:-

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

1) Reinforced concrete channelunits
2) Hollow coreslabs
3) Hollow blocks andbattens
4) Precast plank andbattens
5) Precast joists andtiles
6) Cellular concreteslabs
7) Pre stressed / reinforced concreteslabs
8) Reinforced / pre stressed concreteslabs
9) Reinforced / pre stressed concretecolumns
10) Precast lintels andsunshades
11) Reinforced concrete waffle slabs / shells
12) Room size reinforced / pre stressed concretepanels
13) Reinforced / pre stressed concrete wallingelements
14) Reinforced / pre stressed concretetrusses

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

Foundation for the columns could be of prefabricated type of the conventional cast in situ type depending upon the soil conditions and loads. Thecolumns may have hinged or fixed base connections depending upon the type ofcomponents used and the method of design adopted.

There are two categories of open prefabricated systems depending on theextent of prefabrication used in the construction as given below.

1) Partial prefabrication opensystem
2) Full prefabrication opensystem

PARTIAL PREFABRICATION OPEN SYSTEM:

The system basically emphasizes the use of precast roofingandflooring components and other minor elements like lintels, sunshades, kitchensills in conventional building construction. The structural system could be in theform of in situ frame work or load bearingwalls.

FULL PREFABRICATION OPEN SYSTEM:

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

LARGE PANEL PREFABRICATION SYSTEM:

This is based on the use of large prefabricated components. The components used are precast concrete large panels for walls, floor roofs, balconies, stair cases etc. The casting of the components could be at the site or off the site.

Depending upon the context of prefabrication, this system can also lend it self to partial prefabrication system and full prefabrication system.

WALL SYSTEM:

Structural scheme with precast large panel walls can be classified as

1) Cross wallsystem
2) Longitudinal wallsystem

CROSS WALL SYSTEM:

In this system the cross walls are load bearing walls. The facade walls are non-load bearing. This system is suitable for high rise buildings.

LONGITUDINAL WALL SYSTEM:

In this system, cross walls are non-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) Homogeneouswalls
2) Non-homogeneouswalls

Homogeneous walls:

The walls could be solid or ribbed.

Non-homogeneous walls:

Based on the structural functions of the walls, the walls could be classified as

a. Load bearingwalls

b. Non-load bearingwalls

c. Shearwalls

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

(i) External walls which can be load or non-load bearing depending upon the layout. They are usually non-homogeneous walls of sandwiched type to impart better thermalcomforts.

(ii) Internal walls which provide resistance against verticalloads, horizontal loads, fire etc. and are normallyhomogeneous.

TYPES OF PRECASTFLOORS:

Depending upon the composition of units, precast flooring units couldbe homogeneous ornon-homogeneous.

1) **Homogeneous floors** could be solid slabs, cored slabs, ribbed or waffleslabs.

2) **Non-homogeneous floors** could be multilayered ones with combinations light weight concrete or reinforced / pre stressed concrete with filledblocks.

Depending upon the way, the loads are transferred the precast floorscould be classified as one way or two waysystems.

ONE WAY SYSTEM:-

One way system transfers loads to the supporting members in one direction only. The precast elements of this category are channel slabs, hollow core slabs, hollow blocks and hollow plank system, channels and tiles system, light weight cellular concrete slab etc.

TWO WAY SYSTEMS:-

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

STAIR CASE SYSTEM:-

Stair case system consists of single flights with inbuilt risers and treads inthe element only. The flights are normally unidirectional transferring the loads tosupporting landing slabs or load be ring walls.

BOX TYPE SYSTEM:-

In this system, room size unit are prefabricated and erected at site. Thissystem derives its stability and stuffiness from the box limits which are formedby fouradjacent walls. Walls are joined to make rigid connections amongthemselves. The box unit rest as plinth foundation which may be of conventionaltype of pre-casttype.

MATERIALS USED:

Prefabricated building materials are used for buildings that are manufactured off site and shipped later to assemble at the final location some of the commonlyused prefabricated building. The materials used in prefabricated components are many.The modern trend is to use concrete steel, treated wood, aluminum cellular concrete,light weight concrete, ceramic products etc. While **choosing** the materials for prefabrication the following special characteristics are to beconsidered.

- Light weight for easy handling and transport and to economic ansections and sizes offoundations
- Thermal insulationproperty
- Easyworkability
- Durability in all weatherconditions
- Non combustibility
- Economy incost
- Soundinsulation

CHARACTERISTICS OF MATERIALS

- Easyavailability
- Light weight for easy handling and transport and to economies onsections

  and seizes offoundations.
- Thermal insulationproperty
- Easyworkability
- Durability to all weatherconditions
- Non combustibility
- Economy incost

UNIT II

PREFABRICATED COMPONENTS

behavior of large panel construction

Large panel structure

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

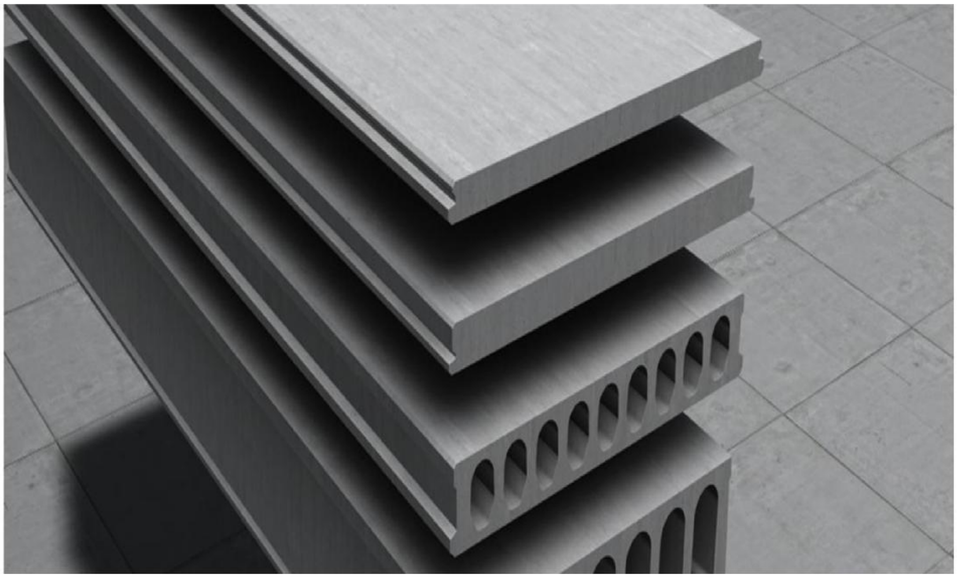
- Large panel structure for Exteriorwall
- Large panel structure for Interiorwall.
- Large panel structure for floorslab
- Large panel structure for Roofelement.

a) Large panel structure for Exteriorwall;

- Large panel structure for exterior walls consist of panel one or two stories in height andone or two rooms in width. The panel may be blind (without openings) or with window or dooropenings.
- In terms of design, the wall panels may be single layer (solid) and multilayer(sandwitch) Solid panels are manufactured from materials that have insulating properties and at the sametime can perform supporting functions for example, light weight concrete, cellular concrete, and hollow ceramic stone.
- Sandwich wall panels are made with two or three layers: their thickness depends on theclimate conditions of the regions and the physic technical properties of the materials used for the insulating layer and for the exteriorlayer.
- The surface of exterior wall panels is covered with decorative mortar or isfaced with ceramic or other finishingtiles.
- After assembly, the joints between panel are filled with mortar orwith lightweight or ordinary concrete and then sealed with packing and specialmastics.

b) Large panel structure for Interiorwalls:

- The large panel structure of interior walls may be non load bearing or loadbearing.
- In the first case, they are made from gypsum slag concrete or fromother materials that act as enclosures. In the case of load bearing structure, the wall panels, which combine enclosing and load bearing function, are made from heavy or lightweight, silicate or cellular concrete, or vibration set brick or ceramicwork.
- The dimensions of the panels are determined by the dimensions of the rooms (in apartment houses), their height is equal to the height of a story, the width is equal to the depth or width of a room, and the thickness of the walls between rooms is usually 10-14 cm(between apartment 14-18cm)



c) Large panel structure for floorslab:

- The large panel structure of floor slabs are usually made from reinforced concrete, the area of the floor slabs in apartment buildings usually equals the area of one room and be as great as 30 sq.m.

- Flagging panels have an area of 5-8 sq m. The large panel floor slabs of housing public,and administrative building are of both the solid and sandwich types in the latter, provision is made for a sound insulation layer to reduce air and impactnotice.

- Composite floor panels, consisting of a load bearing reinforced concrete panel combined with a floor or ceiling panel and soundproofing, insulating, and other lay r, a e often used in housingconstruction.

d) Large panel structure for RoofElement:

- The large panel roof elements are used in housing and public buildingsmainly in the form of combined articles roofs, and in industrial buildings the roof panels have a span of up to 12m.

- The weight of large panel structure depends on the method of dividingthe building into prefabricated element; it is usually 1.5-7.5tons.

- Large panel structure of a high rise apartment building consist of (1) foundation slab,(2) exterior wall panel,(3) interior wall panel, (4) floor slab,(5) deck ,(6) exterior panel in the process ofinstallation

- At the joints, the panels have to which steel connecting pieces are welded, thus linking together all the panels and providing general stability of thebuilding.

- Large panel structures are used in the construction of high risebuilding.

roof and floor slabs construction and precaststructure

Behavior of roof and floor slabs:

- The roofing / flooring system consist of RC planks andjoists.
- The planks are casted to a standard size and they are connected with RCCjoists whichare provided at a regularinterval.
- The loads from planks are transmitted to RCC joists and then to mainbeams.
- The main beams are provided with channel sections 10cm projections on the necessary side with the spacing ofjoist.
- The joists are seated in the channel and boltedtogether.
- The loads from slabs to the main beam will come as pointloads.
- The roofing / flooring slabs system consists of planks which are supported overRCC joist.
- The planks can be made in any one of the following form with orwithout prestressing. According to the span and loads.
- The usual width of these of slabs is 0.5m and spanning to the requirement up to a maximum limit of 5m withoutprestressing.
- The thicknesses of planks are casted in two steps with different mould to access monolithic action with adjacent slab by putting necessary reinforcement andconcreting.

Structural Behavior Of Precast Structure:

1. The design load-carrying structure advantage from the viewpoint ofprefabrication.
2. Principles of structuralanalysis.
3. Variousspecifications.
4. Dimensioning ofjoists.
5. Elimination of handlingstresses.
6. Redistribution of stresses in jointedstructure.
7. Calculation of reinforced concrete structure co-operating with strengthening concrete layercast-in-situ.
8. Influence of the sequence and the method of placing on the stressof the state of thestructure.
9. Stability of precast structuralmembers.
10. Quality of materials used for precast reinforced concretestructure.

Methods Of Construction

In Floor and Roof:

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

Precast RC planks:

- This system consists of precast RC planks supporting over partially precast joist. RC planks are made with thickness party varying between 3 cm and 6cm.
- There are haunches in the planks which aretapered.
- When the plank is put in between the joists, the space above 3 cm thicknessis filled with in-situ concrete to get tee-beam effect of thejoists.
- The planks are made in module width of 30 cm with maximum length of 150cm and the maximum weight of the dry panel is 50kg.
- Precast joists are rectangular in shape, 15 cm wide and the precast portion is 15cmdeep.
- The main reinforcement of the overhang provided at the top in the in-situ concrete attains sufficientstrength.
- The savings achieved in practical implementations compared with conventional RCC slab about25%.

Prefabricated brick panel:

- The prefabricated brick panel roofing system consist of is made of first class brick reinforced with two MS bars of 6mm dia and joists filled with either1:3 cement mortar or M15concrete.
- A panel of 90cm length requires 16 bricks and a panel of 120cm requires 19bricks.
- Partially precast joist it is a rectangular shaped joist 13cm wide and 10cm to12.5cm deep.
- The overall depth of joist with in-situ concrete becomes 21cm to 23.5cm, it is designed as composite tee-beam with 3.5cm thickflange.
- The partially precast RC joist, is designed as simply supporting tee-beam with 3,5cm thick flange.

Precast curved brick arch panel:

- This roofing is same as RB panel roofing except that the panels do not have anyreinforcement.
- A panel while casting is given a rise in the centre and thus an arching action iscreated.

  An overall economy of 30% has been achieved in single storied buildingand 20% in two or three storied building.

Precast RC channel roofing:

- Precast panel channels are trough shaped with the outer side corrugatedand grooved at the ends to provide shear key action and to transfer moments between adjacentunits.
- The lengths of the units are adjusted to suit thespan.
- The flange thickness is 30mm to35mm.
- A savings of 14% has been achieved in actual implementation in variousprojects.

Precast hollow slabs roofing:

- Precast hollow slabs are panels in which voids are created by earthenkulars, without decreasing the stiffness orstrength.
- These hollow slabs are lighter than solid slabs and thus save the cost of concrete, steeland the cost of walling and foundation too due to lessweight.
- The width of the panel is 300mm and depth may vary from 100mm to 150mm asper thespan.
- The outer sides are corrugated to provide transfer of shear between adjacentunits.

L - Panel roofing:

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

Trapezon panel roofing:

- Typical precast RC trapezon panel has trapezium section in orthogonaldirections.
- The components are sound and can be manually handled withease.
- These components are placed in position to from roof and haunch fillingis done with in situ concrete to make a monolithicsurface.

Unreinforced pyramidal brick roof:

- Unreinforced pyramidal brick roof construction system is suitable for lowcost houses in cyclone affected and other coastalareas.
- Corrosion of reinforcement was found to be the major cause of failure ofRCC structure in coastal area and a pyramidal roof with brick and cement concrete without reinforcement was thereforedeveloped.
- The roofing is provided with peripheral RCC ringbeam.

Shear Walls

Necessity of shear wall:

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

Types of shear walls based on materials:

- RC shearwall
- Plywood shearwall
- RC hollow concrete brick masonrywall
- Steel plate shear wall

RC shear wall:

- It consists of reinforced concrete wall and reinforced concreteslabs.
- Wall thickness varies from 140mm to 150mm, depending on the numberof stories, building age, and thermalrequirement.

- In general these walls are continuous throughout the building height however, some walls are discontinuous as the street front or basement level to allow for commercialor parkingspaces.

Plywood shear wall:

1. Plywood is the traditional material used in the construction of shearwalls.
2. The creation of prefabricated shear panels have made it possible to inject strong shear assemblies into small walls the fall at either side of a openingin a shear wall plywood shear wall consistsof

- Plywood to transfer shear force
- Chords to resists tension / compression generated by the over turningmoments.
- Base connections to transfer shear to foundation.

RC hollow concrete block masonry walls:

- This walls are constructed by reinforced the hollow concrete blockmasonry, by taking advantage of hollow spaces and shape of the hollowblocks.
- It requires continuous steel rods both in the vertical and horizontaldirections at structurally critical locations of the wallpanels.
- RHCBM element are designing both as load bearing walls for gravity loads and also shear walls for lateral seismic loads to safety withstandearthquakes.

Steel plate shear wall:

- Steel plate shear wall s stem consists of a steel plate wall, boundary columns and horizontal floorbeams.
- Together the steel plate girder, the column act as a vertical plate girderand steel plate wall act as itsweb.
- The horizontal floor beams act more or less as transverse stiffeners in a plategirder.
- The steel plate shear wall systems have been used in recent year in highly seismic areas to resists lateralloads.

Precast Structures**Roof and floorslabs:**

- The roofing / flooring system consist of RC planks andjoists.
- The planks are casted to a standard size and they are connected withRCC joists which are provided at a regularinterval.
- The loads from planks are transmitted to RCC joists and then to mainbeams.
- The main beams are provided with channel sections 10cm projectionson the necessary side with the spacing ofjoist.
- The joists are seated in the channel and boltedtogether.
- The loads from slabs to the main beam will come as pointloads.
- The roofing / flooring slabs system consists of planks which are supportedover RCCjoist.

- The planks can be made in any one of the following form with orwithout prestressing. According to the span andloads.
- The usual widths of these of slabs are 0.5m and spanning to the requirement up to a maximum limit of 5m withoutprestressing.
- The thicknesses of planks are casted in two steps with different mouldto access monolithic action with adjacent slab by putting necessary reinforcement andconcreting.

Beams:

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

Wall panels:

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

Columns:

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

UNIT III

DESIGN PRINCIPLES

Joint Flexibility

In precast concrete construction the joint between the element are of very important.

- Dry joint
- Wet joint

The wet joints are by using mortar or in-situ concrete where as the dry joint is done by welding or bolting.

The following consideration shall be taken into account

Structural requirements: The connection must with all requirements regarding the transmission of forces, moment and permissible deformation or rotation.

Tolerances: The measure to which deviates must be taken up in the joint. It is called joint flexibility.

Aesthetical requirements : The joints remains completely or in part exposed.

Mode of Erection: With regard to available erection equipment fastest possible erection, andavoidance or minimizing ob bracing, support, etc

Necessity of checking and adjusting : The joint must be checked whether it is properdimensioned or not . Therefore the adjustment may be possible.

Design of joint:

While designing of joints following points are considered:

It must be based on relevant standard specific codes of practice or recommendation must be

- relevantLoading under working condition
- Stability of structures
- Loading condition during construction
- Effect of shrinkage, creep and temperature
- Unequal settlement

Loading under working condition

The entire structure as well as each unit own must be designed to resist all loads, forces and moments acting there on when the structure is in the use.

Stability of structures

The overall stability of the structure must be need during each phase of construction.

Loading condition during construction

Loading condition during construction my causes higher stresses than those through normal usage. Temperature loads are erected due to erection , material and temperature supports.

Effect of shrinkage, creep and temperature

The fixed end beam connection the stresses and moments due to shrinkage , creep and temperature drop of the beam must be considered or the connection proper and for the structure as a whole.

Unequal settlement

In case of fixed end joint the possibility of settlement at the supports should be investigated.

Reinforcement anchorages:

In general the connection will require additional reinforcement bars and anchorage whichmust be so designed that a sound fill and proper compaction of the concrete can be realized.

Threaded and non threaded reinforcement inside :

All insert whether Threaded and non threaded reinforcement including those for thesecuring of piping and of erection aids must be calculated to meet the forces acting there on andmust be indicated on the drawing with the relevant measurement.

Chamfers:

Square edges of all precast elements are liable to sapling or chipping and also causes accident.

Bond:

The bond surface which should transmit vertical shear must either be roughed or ribbed

Bolted Connection:

When using bolted connection , tolerance can be increased by either providing one of the plates **of each pair with a slot or by drilling the bolt hole.**

Design of Column Based Efficiency of MaterialUsed

One of the principle aims of the prefabrication in general but particular of prefabrication on the site is that the dead load of precast member should be lessened to the Greater possible degree .

This also correct because the greater part of the stresses are caused by dead load is by the uses of stresses.

This was due to frequently developing cracks in the tension chords.

One can find no real reason for this aversion partly because the cracking of tension chord has no significance and partly because the possibility of cracking can be reduced by stressing the tensioned bars before there concreting.

Fibster welder used to stress the tensioned bar after the load had been applied vierendeel columns are excellent for the stanchions of frames and the columns of other reinforced concrete structures while trusses are fairly suitable for use in any kind of that structure .

They are particularly applicable for industrial buildings.

Trusses and vierendeel columns in addition to making the smallest demand in material open up new possibilities for the aesthetic forming of the interior of the building.

The structure manufactures in a horizontal position requires less material for shuttering their reinforcement and concreting is also simple.

An additional advantage of these type of columns is that tube pipes and other lines can beeasily be attached to and led through the shaft.

This means that forms the standard point of operation, lost and unutilized area decrease toa minimum inside the building itself.

The problem of vierendeel column connecting to a truss is solved by using a hinge.

In comparison with a structure with moment t-bearing joints the above solution isconnected with greater force effect.

If vierendeel columns and trusses are used the bearing of latter requires only a slightsurplus in material.

Arched structure can be produced in the trussed form.

The spread of reinforcement concrete trusses, trussed arches and vierendeel columns hasbeen impeded by their difficult monolithic execution complicated reinforcement as well as by thedifficult calculation of secondary stresses.

Joint Deformation

Methods of disuniting of structures :

- Systems consisting of linear members disunited at joints.
- System for the prefabrication of entire rigid frames.
- Straight members disunited at points of minimummoments.
- Two hinged and three hingedarches.

System consisting of linear member disunited at joints :

Disunity at joints which gives linear member, this means a great advantages and facility from the point of view both manufacture and assembly ,using this system, auxiliary scaffolding are not necessary and the hoisting process is, as a rule, very simple. In the system is that the joints are corners, so the forming of the joints are very difficult. The quality of subsequent concreting executed in-site only exceptionally and at readily accessible places as be over dimensioned. This necessities additional material for the precast member too. This, on one hand, justifies the newer precast members and , on the other hand , the newer trend of replacing moment resistant joints by hinge like ones .Although this method requires more material for the beams . The complicated construction of rigid corners can beomitted.

Advantages :

- It is very simple.
- Scaffoldings are not necessary .
- Easy of hoisting process .
- Easy of assembling .

Disadvantages :

- Formation of joints is very difficult .
- Joints are at corners , where the moments usually reach their maximum values .

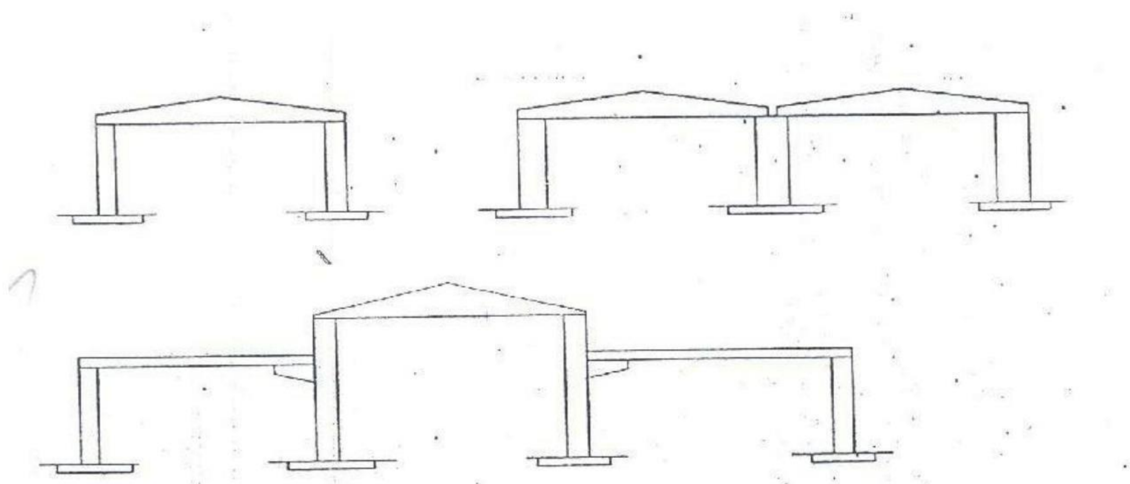


Fig 1.2.Members of frame disunited at the joints

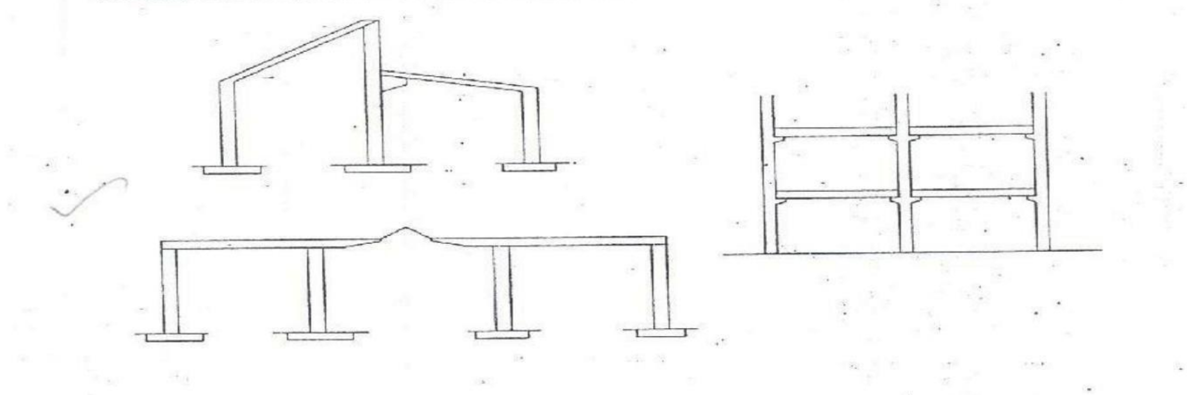
Systems for the prefabrication of disuniting of entire rigid frames:

The trend to lesson the number of joints and to precast larger members in one piece leads to the prefabrication of entire frames . Such frames are as shown in figure , but these solutions are appropriate only for site prefabrication . The production of frames does not cause particular trouble , but their hoisting is more difficult and requires careful preparation . The stress distribution of straight members during their hoisting is, in general, statically determined . Example that of a beam lifted at two points or at more than two points when using a balance, or a cable – rocker or that of column lifted at one point and supported at its lower end.

The stress distribution arising in frames during their hoisting. On the other hand, is frequently statically redundant. The tilting of a frame from the horizontal into the vertical position, lifted at two points by two separately acting hoisting machines, illustrates the above statement. If these two points are not hoisted exactly at the same time and with prefect uniformity , the frame itself will be affected by torsion. Connecting the two suspension points by a balance or a cable rocker enables the frame to be hoisted at one singlepoint.

Now the stress distribution is statically determined but if the rocker is not suspended at the exact point, torsion can also arise in this case. This shows that the hoisting of a frame is far more complicated than hoisting a straight member. The hoisting of asymmetric frame is particularly difficult. In this case the force affecting the rocker does not act at the same place during the tilting up process as it does later, when the frame is already suspended. Therefore, the elimination of torsion during hoisting and placing requires either the transfer of the suspension point on the rocker after the tilting up is finished or the application of a counter weight. Entire frames are precast as a rule, in a horizontal position on the ground close to their final location.They can also be produced in a vertical position standing side byside.

System for prefabricates of entire rigid frame:



Straight members disunited at point of minimum moment:

In this method is there is any deviation into member at points where the moment aresmallest.This method called lambda method in some countries. The recognition of thedifficulties met with when carrying out a moment-bearing junction at a place where the moment is greater led to this method. Therefore the junction must be re-sited in places where the moment is smallest.

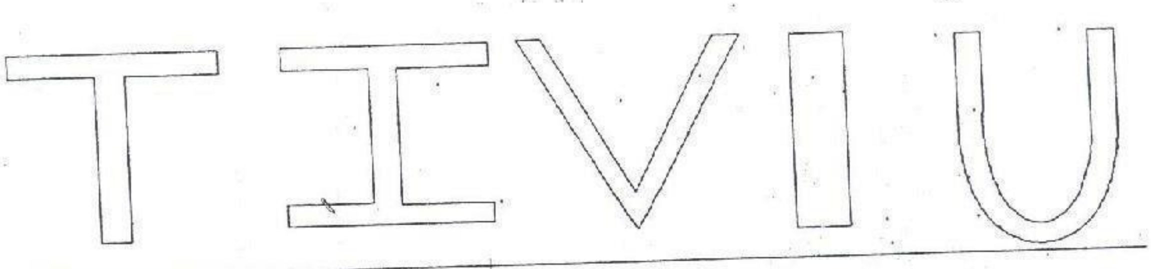


*Fig1.4*System consisting of Structures disunited at points where the moments are smallest Moments

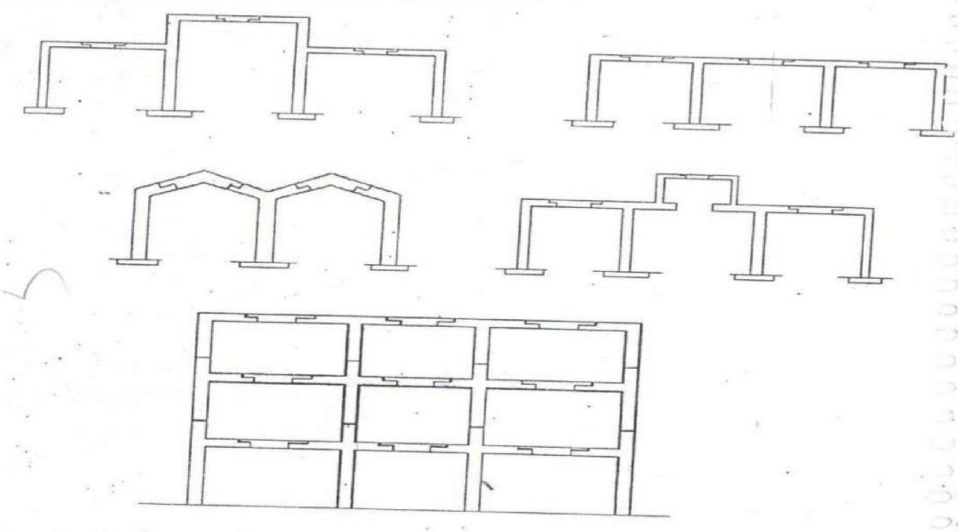
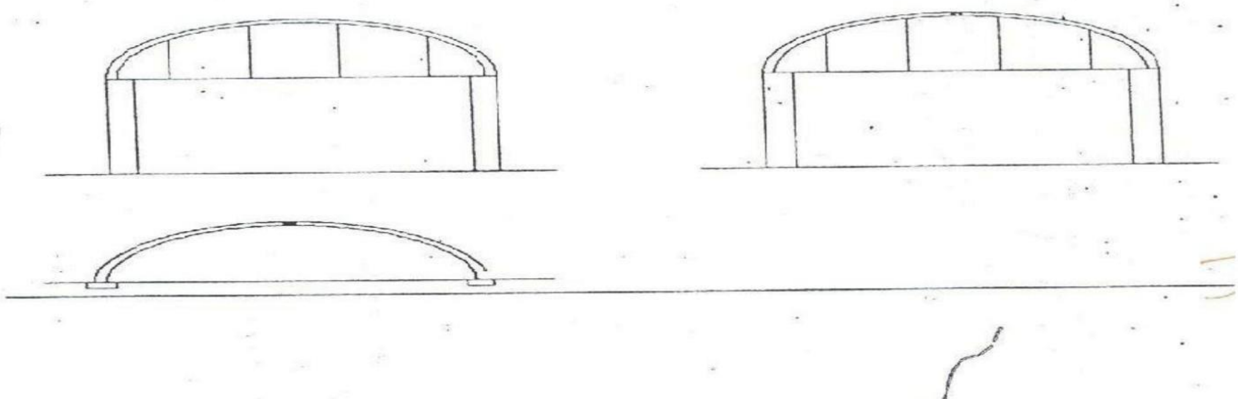


Fig 1.5 Structures disunited at points where the moments are smallest

Two hinged andthreehinged arch:

Arch structures are normally used for bridging span of more than 20-25m. Theirproduction and placing is more difficult than that of straight members but as they demand littlematerial their use for long span structure is economical.



Disuniting Of Prefabricated Structures

Necessity of disuniting of prefabricated structures

- Easy erection process
- Heavy tones capacity cranes are not necessary hence standard cranes are enough to hoisting of prefabricated element.
- Easy transportation because of long span girder is splitted into smaller members.

- Scaffolding work is not necessary.
- Easy handling
- The design process are very simple.
- Easy and very simple molding at the plants.
- In the production process standard system only needed
- Simple hoisting machines only required
- Hoisting process is very simple.
- Rapid hoisting work
- Simple technique are followed
- The member are less weight

Precaution taken during disuniting of prefabricated structures

- All material stored in tires shall be stacked , racked, blocked, interlocked or otherwise secured safely to prevent sliding , falling or collapse and in an orderlymanner to avoid obstruction of any passage way at the place of work.
- Maximum safe load limits of floor within building and structures in kg/cm2 shallbe conspicuously posted in all storage areas except for floor or slab on gradient.Ailes and passage ways shall be kept clear to provide for the free and safe
- movement of material handling equipment or per-sons. such areas shall be kept ingood repair.
- When a difference in road or working levels exist means such a ramp blocking orgrading shall be used to ensure the safe movement of vehicles (cranes) betweentwolevels.
- Materials stored inside the buildings under construction shall not be placed within two m of any hoist way or inside floor openings nor with in 3.2m of exteriorwall which does not extend above the top of materialstored.

[illegible]

- The organization of a prefabrication plant in general which involves many tasks, such as site investigation before construction process starts, material delivery (plant elements) and procurement management, keeping better site records, keeping good site communication and high level of information level flow, monitoring performance regularly, establishing a well co-ordination system among different parts, and performing a good site layoutplanning.
- The problems are in the plant of operational inefficiency, and can increase the small elements, the following problems may occur,
- Material stacks wrongly located
- Plant and equipment wronglylocated
- The mixer is in accessible for the delivery of materials, not enough room for the storage of aggregates
- Fixed cranes and unable to reach all parts of works
- Hoists have insufficient capacity or height to handle the loads or badly located in relation to the floor layout
- Inadequate space allowed

- Site huts wrongly located in relation to their effective use

Organization of prefabricated plants:

- A well planned plant which including all temporary facilities and utilities lead to
- Increasing productivity and safety
- Reducing area needed for temporary construction
- Maximizing utilization

The following points should be considered in good site layout

- **Safety**
- **Fire prevention**: fire is a major cause of damage on construction sites. So that,

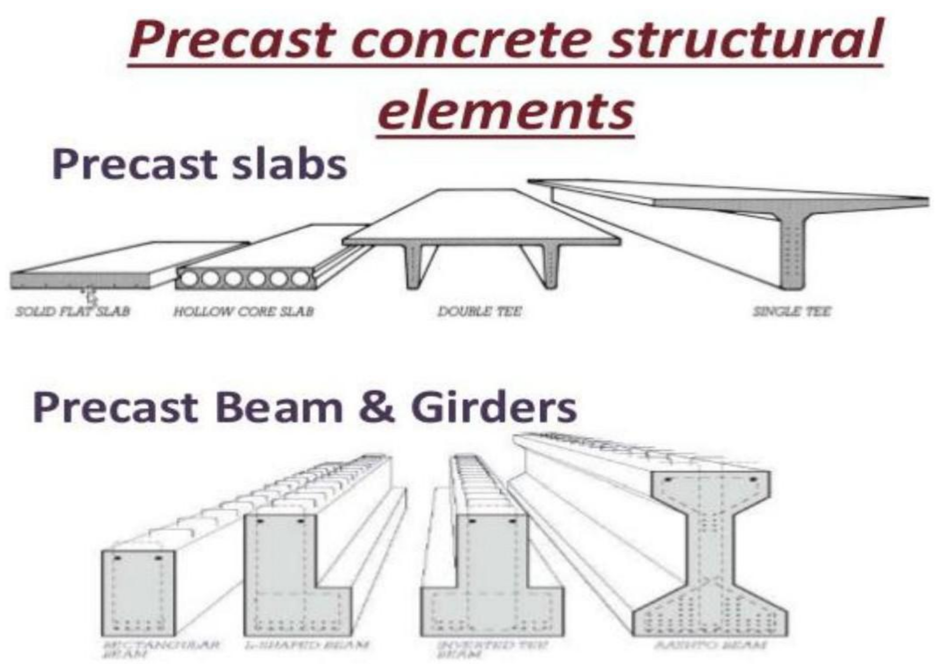
- **Medical services**: on plant, a first aid kit is a must. In remote areas a wellequippedmedical room with a doctor and nurse
- **Safety wear**: safety shoes, hard hats, gloves and goggles must be used
- **Site accessibility:**
  Easy accessibility will keep the morale of the equipment and vehicle drivers high,minimize the chance of accidents and save time to arrive and done the small element
- **Lighting**: It is necessary to have a stand by generator to maintainplantlighting
- **Water supply and sanitation**: It is necessary to have water and toilet facilities inconvenient locations to accommodate the work force.
- **Material handling**:
  All plants operations can be classified as mater al handling. The use of properequipmentfor material handling and advance planning for minimizing multiplehandling will result in direct cost and time savings.
- **Storage and plant cleaning**:
  fire extinguishers are basic requirements on a plant.

Criticism of existing site layout:

- Both hoists have separate scaffold staging, causing increased costs
- Materials are not stockpiled near hoists
- Entrance to the site is too narrow for truck to pass
- Stores are left behind the batching plant so obscuring store man's view and check point is separated from the stores.
- Concrete and mortar mixers are located too far from the hoists
- Stockpiles are dispersed are hinder unloading
- Temporary roads are long and narrow
- Some stores are difficult to reach

Suggested improved layout

- Both hoists are housed in a common scaffold
- Batching plants have direst discharge into dumpers
- The access has been widened near the site entrance
- The stores are located to give a good view of all materials stockpiles, and are sited near the temporary road
- Concrete and mortar mixers are located near the hoists
- The temporary road is shorter and wider
- A compound is provided to police non-bulk materials.



UNIT – IV

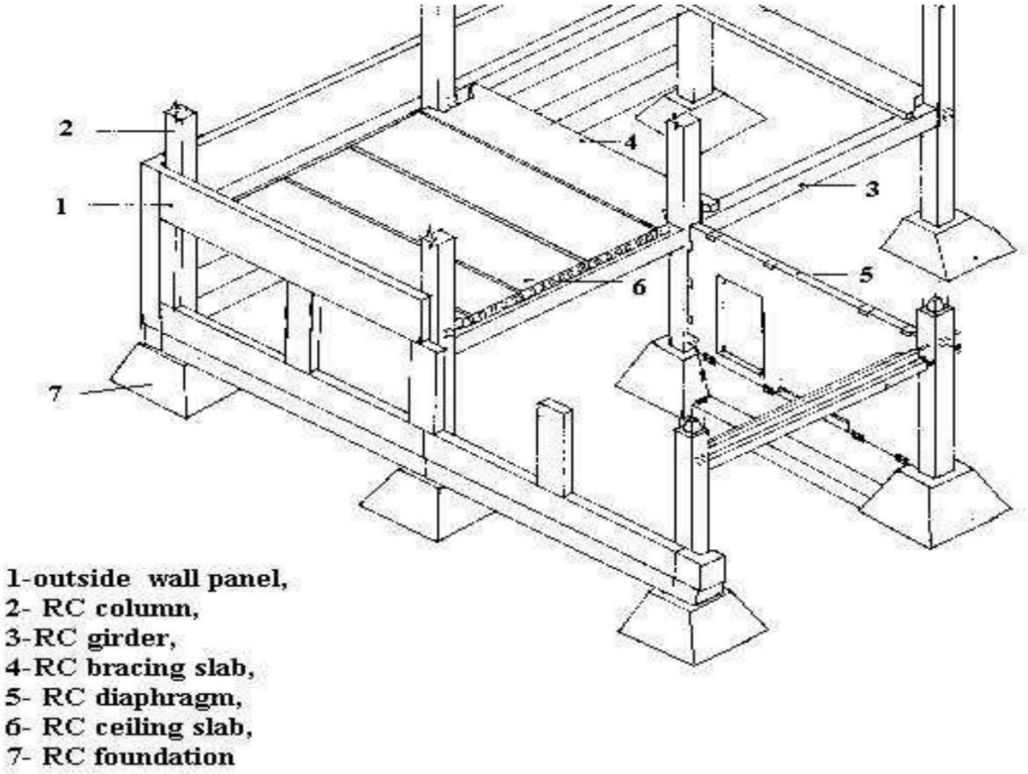
JOINTS IN STRUCTURAL MEMEBERS

Joints For Different Structural Connections:

- Jointing of column to footing
- Jointing of column to beam on top of column.
- Jointing of column to beam at an intermediate functions.
- Lengthening of columns.
- Jointing of beams.
- Forming of joints of arched structure.
- Joining of joints of post tensionedstructures.
- Joining of precast to monolithic reinforced concrete structures.

(a) JOININNG COLUMNS TOFOOTING:

This joint is usually rigid but also can be hinge. A rigid joint can be made byplacing the column into a calyx of the footing or by using a welded joint. The figureshows the three variations of this method. Can be used for smaller, For average, Forlarge footings



The depth of the calyx is dimensioned according to the long or side length of the column.The depth of the calyx should be equal to 12.5% of the length of the column.

The opening of the calyx is 6-10 cm greater in all direction than the class of the column. This is enabling the vibrator to be operated while concreting at the bottom of the calyx of 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 frame 100x100x10 to 150x150x10 mm a chord into the concrete after the column is put in placed properly plumbed two 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 for simpler and requires less time than in the case of a weldedjoint.
2. The method is least sensitive to inaccuracies occurring during the construction. The disadvantages of the calyx joint are more suitablefor small columns. Inthe

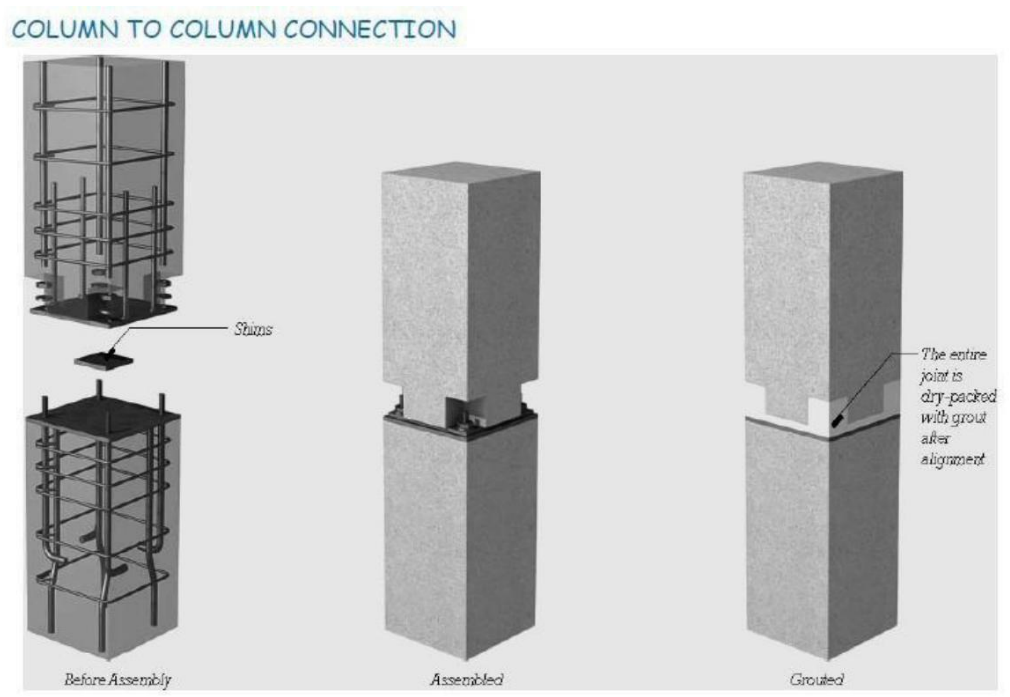
case of largecolumnsrequiring calyx depth of which is greater than 1m.

(b) JOINING OF COLUMN TO BEAM AT AN INTERMEDIATEUNCTION:

One method of forming a hinge like joint consists either or placing tobeam on to a small cantilever protracting frame the column or of putting it on thebottom of an adequately shaped opening left out of the column shaft.

The beam rests temporarily on a tongue like extension on a steel plate placed in this opening on the supporting surface the tongue is also furnished with a steel plate anchored into 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.



Hinge like joining of girder to column:

1. Opening forcasting.
2. Subsequentconcreting.
3. Steelplate.

(c) LENGTHNING OFCOLUMNS:

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 footing, accordingly the upper columns rests on the lower ones by a tongue like extension. The steel bars of the main reinforcement are joined by overlapping looped steel bars a welding. There after the stirrups have to be placed of finally the joint must be concreted.

(d) JOINING OFBEAMS:

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

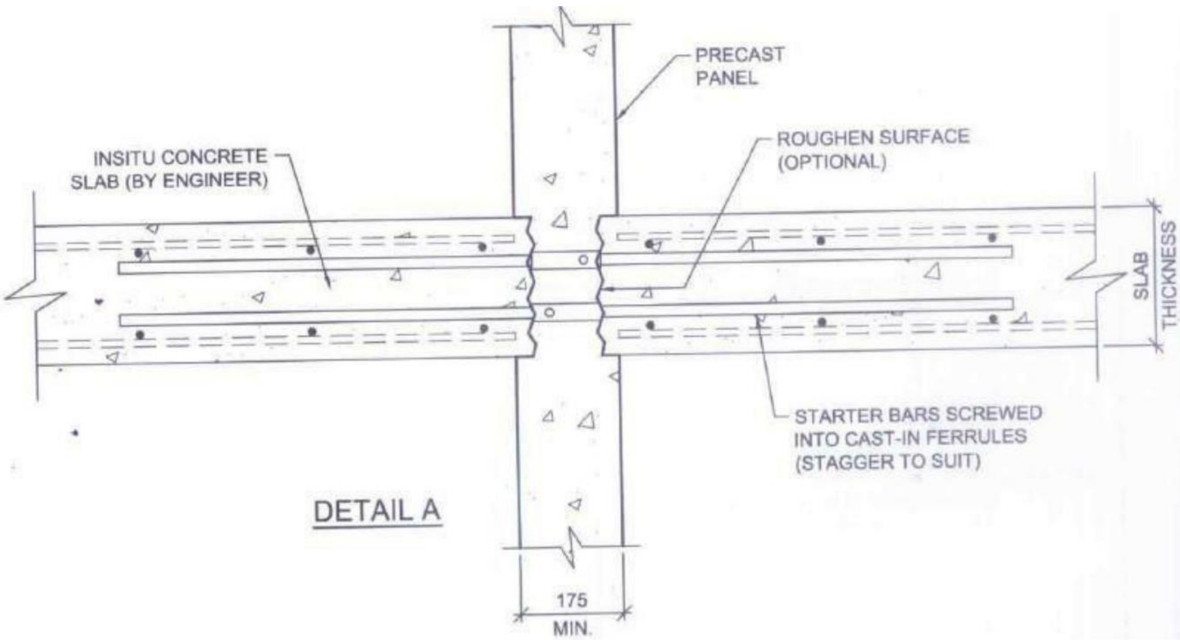


Fig. shows the hinge like joint of purlins. In this method the whole shearmust beborn by both cantilevers (i.e.) by two separate structures therefore it isexpedient to form this joint at least for largegirders.

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

(e) FORMING OF FUNCTIONS OF ARCHEDSTRUCTURES:

Precast arches are usually produced and assembled in the form of threehinged structures. When the constant load has already been applied the centre joint isfrequently eliminated. The omission of the centre joint increases the rigidity of thestructures. Naturally arched structures can also be precast in a piece i.e. in the form of two hingedones.

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 of forming of joints on an arched structure.

The arrangement of the Centre junction and the end hinge of an arched structure. This method was used in the construction of the hall for the middle rolling train in D.O.Sgyor. The structure was precast of assembled in the form of a three-hinged arched transformed latest into a two-hingedone.

(f) DESIGN OF JOINTS FOR POST TENSIONEDSTRUCTURES:

Post tensioned structure 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 by so doing longer beams can also be produced from shorter precast member. Thus is post tensioned structures the forming of joints does not causedifficulties.

Sketches on solution 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 ducts of the stressing cables to avoid this cable ducts are joined by placing a shore piece of tube or rubber ring into the ductitself.

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

(g) JOINING OF PRECAST TO MONOLITHIC REINFORCED CONCRETE STRUCTUR S:

It frequently occurs that a monolithic beam has to be joined to a precast column.

In this case the function can be established in the same way as already beendescribed inthe previous paragraph an joining namely by placing the end of thebeam either on to a cantilever protruding from the column or into an opening formedi to the columnsshaft.

When making the joint, first of all a 2.5 cm deep cavity is chiseled out of thesole of the precast column. The bottom of this cavity should be roughend so as to attain abelter band between the concrete of the monolithic beam and the precastcolumn.

Types Of Structural Joints

Types of joints in concrete constructions are:

1. ConstructionJoints
2. ExpansionJoints
3. Contraction Joints
4. IsolationJoints

Construction Joints in Concrete:

Construction joints are placed in a concrete slab to define the extent of the individual placements, generally in conformity with a predetermined joint layout.

Construction joints must be designed in order to allow displacements between both sides of the slab but, at the same time, they have to transfer flexural stresses produced in the slab by external loads.

Construction joints must allow horizontal displacement right-angled to the joint surface that is normally caused by thermal and shrinkage movement. At the same time they must not allow vertical or rotational displacements. Fig.1 summarizes which displacement must be allowed or not allowed by a constructionjoint.

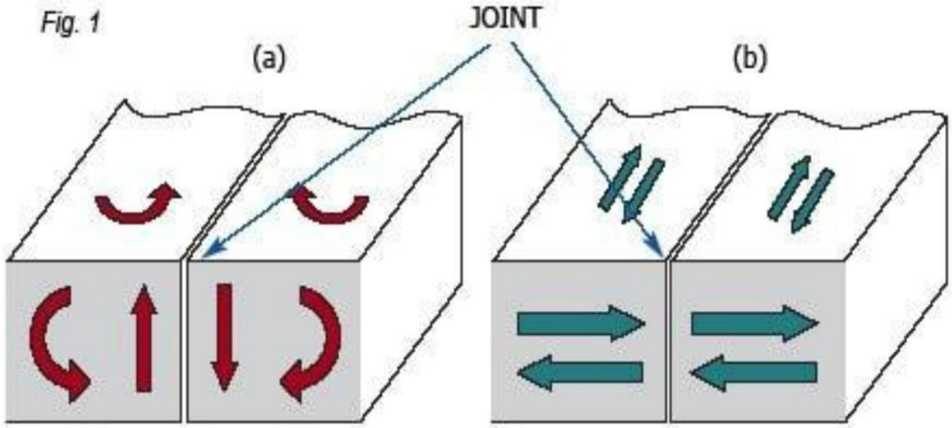
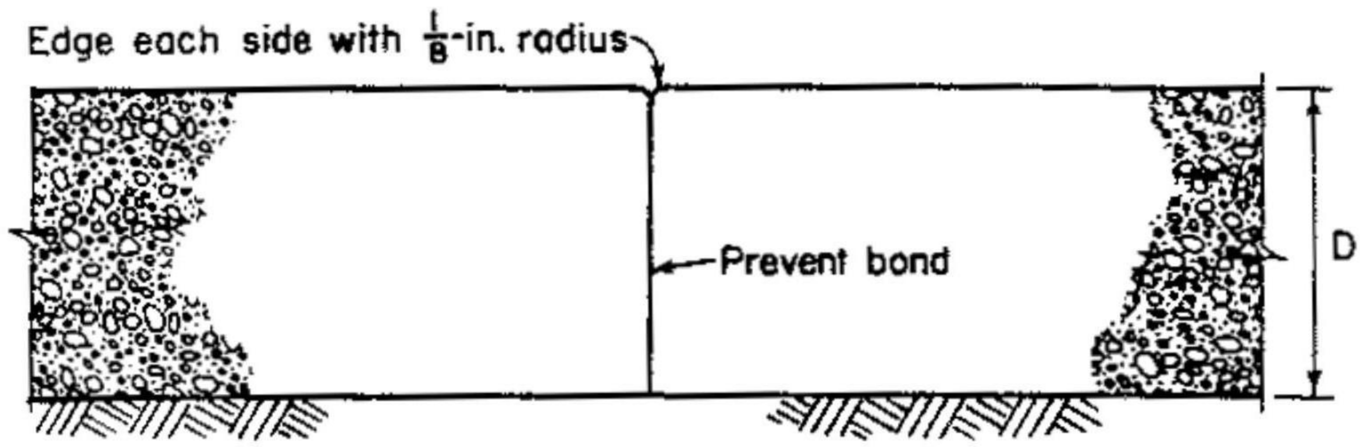
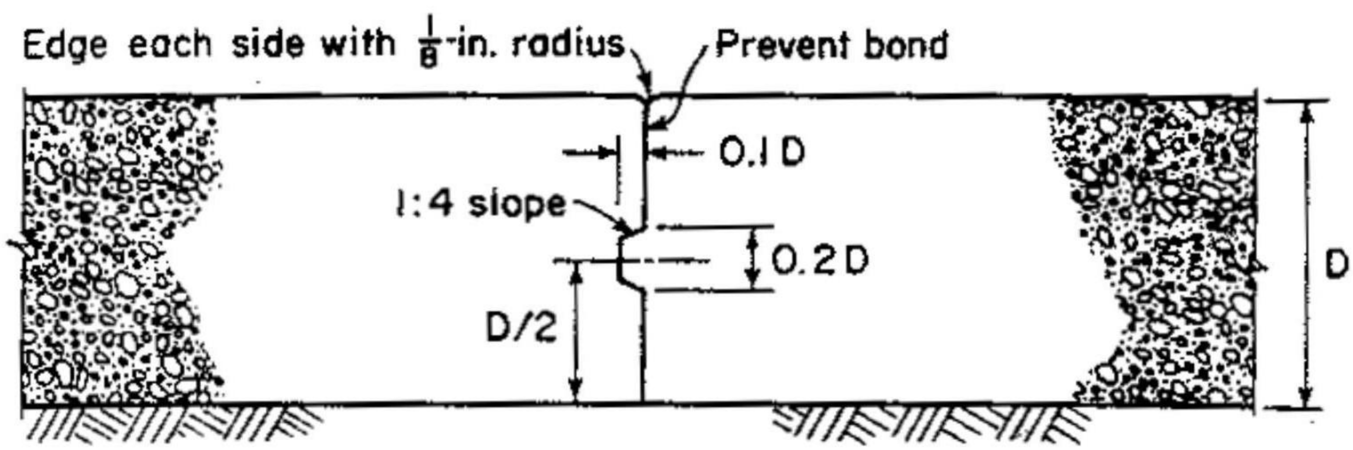


Figure 1 – Relative movements which must be (b) allowed and (a) not allowed by a con-struction joint for concrete slabs



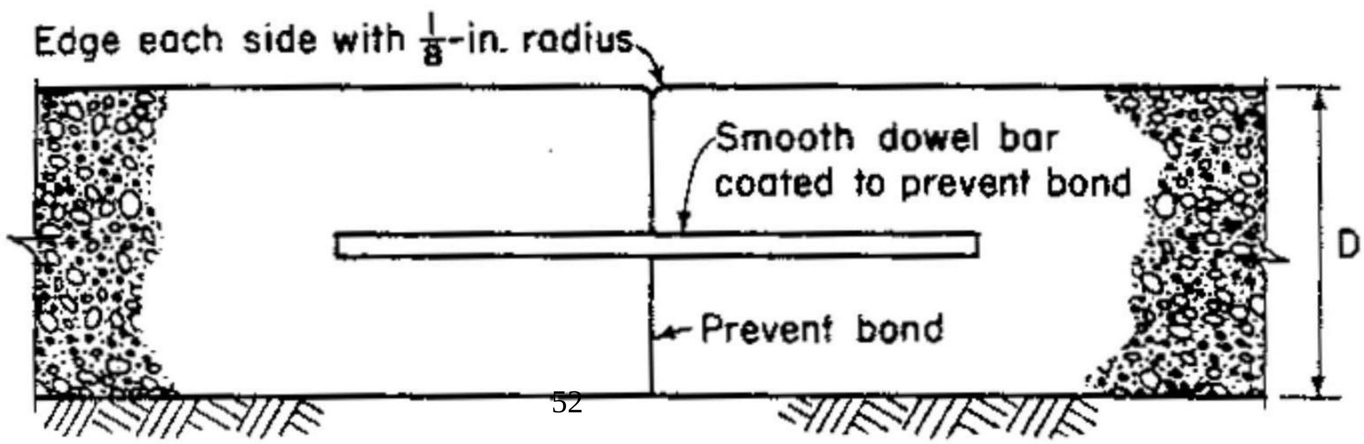
Butt-type construction joint

(a)



Tongue-and-groove construction joint

(b)



Butt-type construction joint with dowels

(c)

Expansion joints in Concrete

The concrete is subjected to volume change due to many reasons. So we have to cater for this by way of joint to relieve the stress. Expansion is a function of length. The building longer than 45m are generally provided with one or more expansion joint. In India recommended c/c spacing is 30m. The joints are formed by providing a gap between the building parts.

Contraction Joints in Concrete

A contraction joint is a sawed, formed, or tooled groove in a concrete slab that creates a weakened vertical plane. It regulates the location of the cracking caused by dimensional changes in the slab.

Unregulated cracks can grow and result in an unacceptably rough surface as well as water infiltration into the base, sub base and sub grade, which can enable other types of pavement distress.

Contraction joints are the most common type of joint in concrete pavements, thus the genericterm jointǁ generally refers to a contraction joint. Contraction joints are chiefly defined by theirspacing and their method of load transfer. They are generally between 1/4 – 1/3 the depth of theslab and typically spaced every 3.1 – 15 m

Isolation Joints in Concrete

Joints that isolate the slab from wall, column or drainpipe

Isolation joints have one very simple purpose they completely isolate the slab from somethingelse. That something else can be a wall or a column or a drain pipe. Here are a few things toconsider with isolation joints:

- Walls and columns, which are on their own footings that are d p than the slab sub grade,are not going to move the same way a slab does as it shrinks or expands from drying ortemperature changes or as the sub grade compresses a little.

Even wooden columns should be isolated from the slab.

- If slabs are connected to walls or columns or pipes, as they contract or settle there will be restraint, which usually cracks the slab—although it could also damage pipes (standpipes or floor drains).
- Expansion joints are virtually never needed with interior slabs, because the concrete doesn’t expand that much—it never gets that hot.
- Expansion joints in concrete pavement are also seldom needed, since the contraction joints open enough (from drying shrinkage) to account for temperature expansion. The exception might be where a pavement or parking lot are next to a bridge or building—then we simply use a slightly wider isolation joint (maybe ¾ inch instead of ½ inch).
- Blowups, from expansion of concrete due to hot weather and sun, are more commonly caused by contraction joints that are not sealed and that then fill up with non-compressible materials (rocks, dirt). They can also be due to very long un jointed sections.
- Very long un jointed sections can expand enough from the hot sun to cause blowups, but this is rare.

- Isolation joints are formed by placing preformed joint material next to the column or wall or standpipe prior to pouring the slab. Isolation joint material is typically asphalt-impregnated fiberboard, although plastic, cork, rubber, and neoprene are also available.
- Isolation joint material should go all the way through the slab, starting at the sub base, but should not extend above the top.
- For a cleaner looking isolation joint, the top part of the preformed filler can be cut off and the space filled with elastomeric sealant. Some proprietary joints come with removable caps to form this sealant reservoir.
- Joint materials range from inexpensive asphalt-impregnated fiberboard to cork to closed cell neoprene. Cork can expand and contract with the joint, does not extrude, and seals out water. Scott White with APS Cork says that the required performance is what determines the choice of joint materials. How much motion is expect, exposure to salts or chemicals, and the value of the structure would all come into play—and of course the cost.

- At columns, contraction joints should approach from all four directions ending at the isolation joint, which should have a circular or a diamond shaped configuration around the column. For an I-beam type steel column, a pinwheel configuration can work. Alwaysplace the slab concrete first and do not install the isolation joint material and fill aroundthe column until the column is carrying its full deadload.

Requirements of joints

a. The joints should beleveled
b. The joints should be perfectlyrigid
c. The joints should posses sufficient strength a dfitness
d. The joints should get sufficient yieldstrength
e. The joints should be provided rich mortar (or) concrete comparedwith joiningmember
f. The joints should be plumbchecking
g. The module of the joint should bechecked
h. The dowel rod must be welded with mainmembers
i. Sufficient stirrups should be provided for beammembers
j. Sufficient lateral ties should be provided for beam members

Beam ToColumnConnection

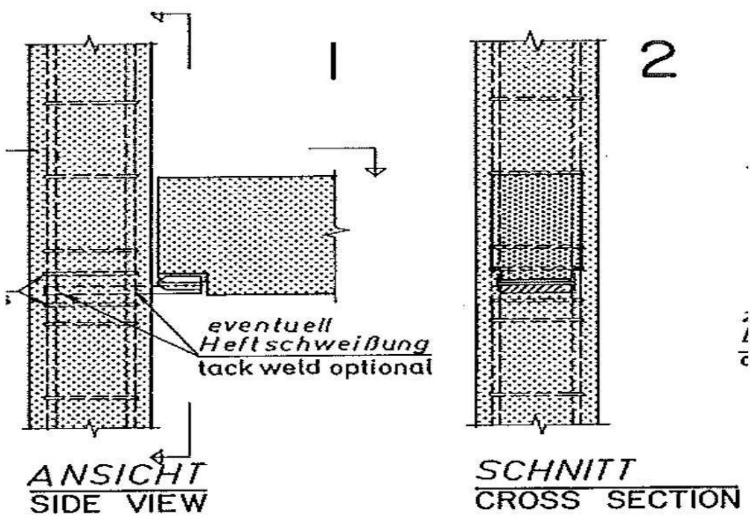
Various Types OfConnections

- Beam To Column Connection With Steel PlateCorbel
- Beam To Column Connection With AngleCorbel
- Beam To Column Connection With Built Up SteelCorbel
- Beam To Column Connection With Steel Joist Corbel, Encased In TheBeam
- Beam To Column Connections With Vertical Steel BearingPlates
- Beam To Column Connection With ConcreteCorbel

- Beam To Column Connection With Steel JoistHanger
- A Beam column joint is said to be desirable if it is able to transmit large amountof vertical shearforces.
- Depending on the type of bearing and the size of the bearing surface, differentbeam column joints will be able to transmit various magnitudes of vertical shearforce.

BEAM TO COLUMN CONNECTION WITH STEEL PLATE CORBEL

- The beam is supported on a horizontal steel bearing plate which is cast into the column and is tack welded to the main reinforcingbars
- This connection for SSB beams may be considered if the vertical shear force is verysmall
- The plate should have sufficient thickness to prevent it from bending. In determining the thickness, the maximum cantilever moment may be assumed to occur at the column reinforcingbars.

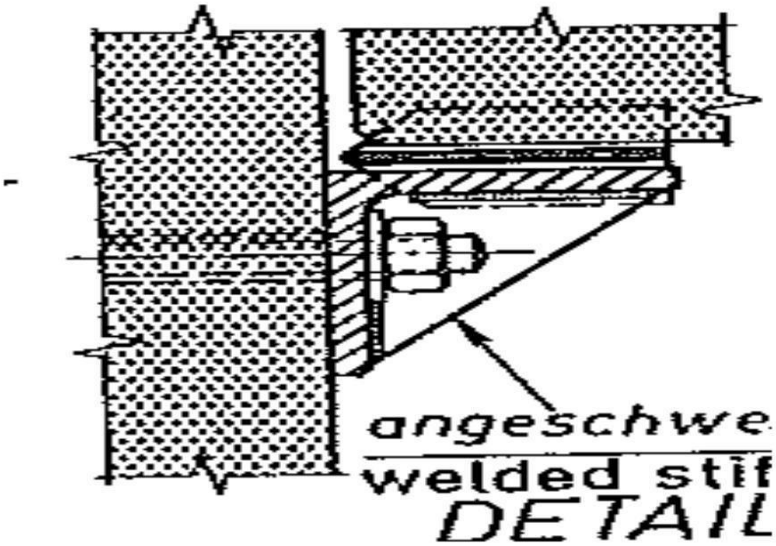


- To avoid point bearing ,special care should be taken to install the beam perpendicular to columnface
- For lateral location of the beams ,saddle plates may beused.
- The bearing plate must be provided with permanent protection against corrosion and againstfire.

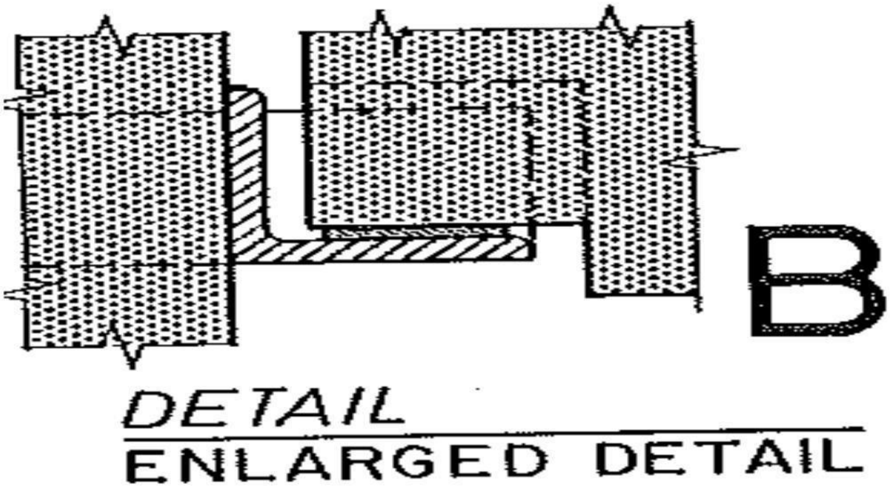
BEAM TO COLUMN CONNECTION WITH ANGLE CORBEL

- This connection for SSB when carried out according to variant ―A‖ is only able to transmit small vertical shear force and could be generally considered only fortemporary structures
- **VARIANT"A"**
- In variant A the angles are connected with the horizontal flange up and by mild steelbolts

- Point bearing on the column face can be avoided by applying an epoxy layer atthe interface with the vertical angles just prior to placing theangles
- The entire corbel construction should be prefabricated and must be cast in whichmakes manufacture of corbel morecomplicated
- This should not be considered for fire proofbuildings.



- **VARIANT"B"**
- In variant B ,the angles with the horizontal flange down are connected by verticalflat bars welded to the ends of theangles.
- In the column ,the bearing surface is increased by horizontal flat bars welded to the undersides of vertical flatbars.
- Ensures a better anchorage and greater stiffness of the corbel and lateral location of thebeams.



BEAM TO COLUMN CONNECTION WITH BUILT UP STEEL CORBEL

- This connection for SSB will be able to transmit a large vertical shearforce.
- The beams are supported on a built up steel corbel which is cast into thecolumn.
- VARIANTA
- In variant A the corbel consists of two vertical flat bars to which the horizontalbearing plates are welded
- In column the bearing surface is increased by horizontal flat bars welded tothe undersides of the vertical flat bars.
- The max B.M in the vertical flat bars is assumed to occur over the centre of thehorizontal connectionplates.

VARIANT B

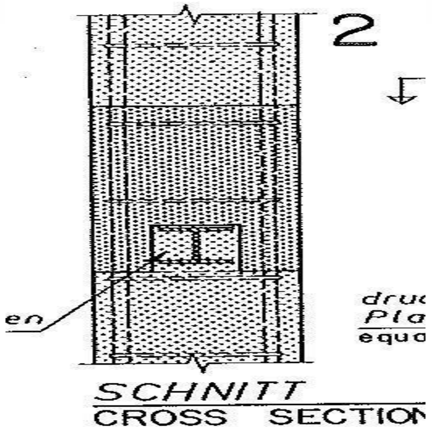
- The corbel consists of two vertically placed channels to which, outside thecolumn horizontal bearing plates arewelded
- An additional tie must be provided immediately under the corbel, in an end columnalso above the corbel to counteract the splittingforces

BEAM TO COLUMN CONNECTION WITH STEEL JOIST CORBEL,ENCASED IN THE BEAM

- This connection for SSB can depend the size of the bearing surface, transmit a fairlylarge vertical shearforce.
- In this case the beams are supported on a steel joist corbel which extends into a recessin the end of thebeam.

VARIANT A

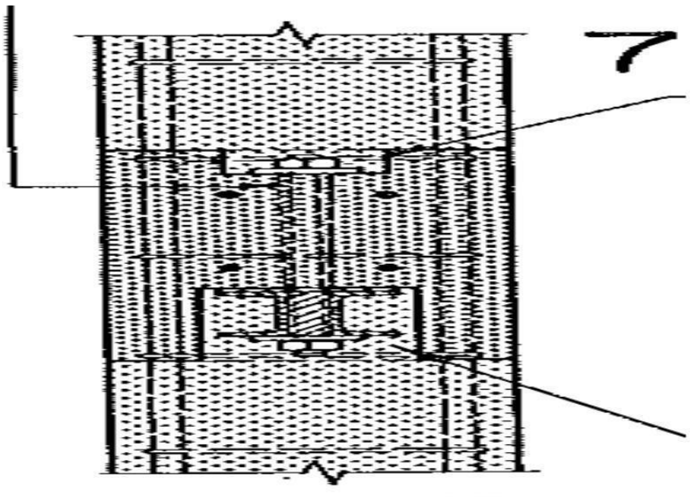
- The corbel is formed by a cast-in broad flange rolled steel Isection.
- Additional tie is provided to counteract the splittingforces.



VARIANT B

- Could be considered if the beams must also be locatedvertically.

- The corbel consists of two rolled steel I sections with splice plates welded in betweenthe webs, so that the bolts can pass through a hole in thebeam.
- Additional tie under the corbel to counteract the splittingforces.
- Corbel must be provided with a permanent protection against corrosion and fire



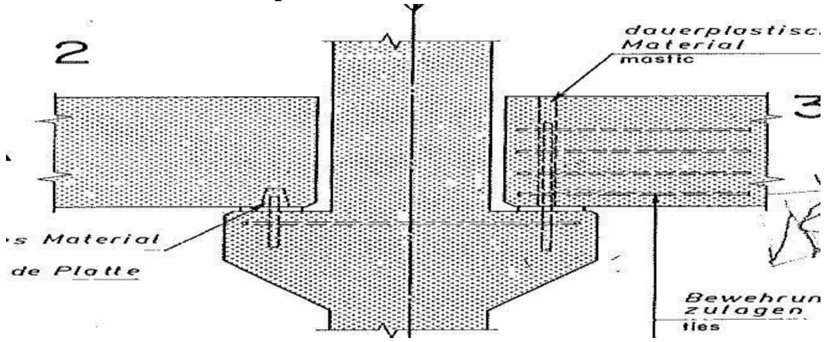
BEAM TO COLUMN CONNECTIONS WITH VERTICAL STEEL BEARING PLATES

- The beams are supported on vertical steel plates against the column faces. The beamends are also provided with a vertical steelplate.
- The entire bearing construction is contained within the beamsection.
- This connection will be able to transmit large vertical shear force. Due to limited bearing surface this connection should be considered only for shortbeams.
- Anchorage of steel plates must not only cater for transmission of vertical shear but also prevent the plates from being pulledout.
- To avoid point bearing ,care must be taken to install the bearing plates perpendicular to the columnface
- Disadvantage is that only very small tolerances can be allowed. Temporary safety measures during erection are necessary and permanent stability after erection isrequired.

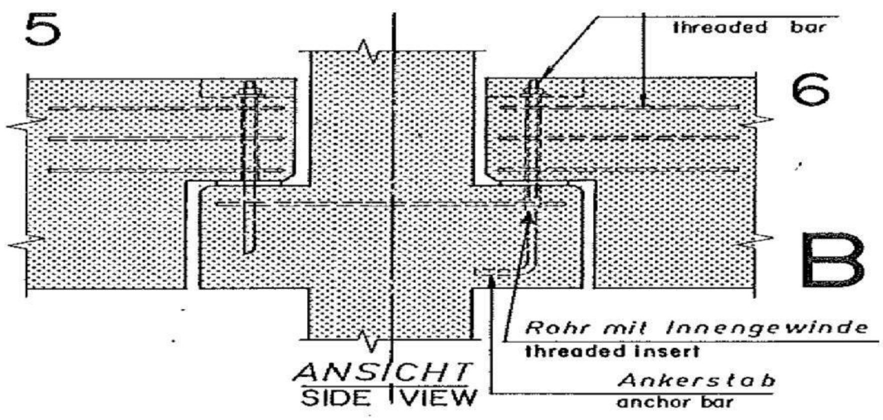
BEAM TO COLUMN CONNECTION WITH CONCRETE CORBEL

- The beams are supported on concretecorbels
- This connection is generally applied to simply supportedbeams

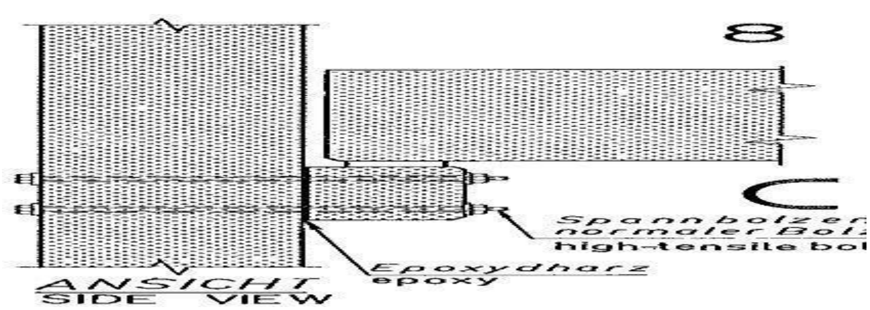
- **VARIANTA**
- The concrete corbels protrude under thebeams.



- **VARIANTB**
- The beams have notched ends and are supported oncorbels.
- The notched ends must be reinforced against the vertical shear force and also against torsion if it is eccentricallyloaded.



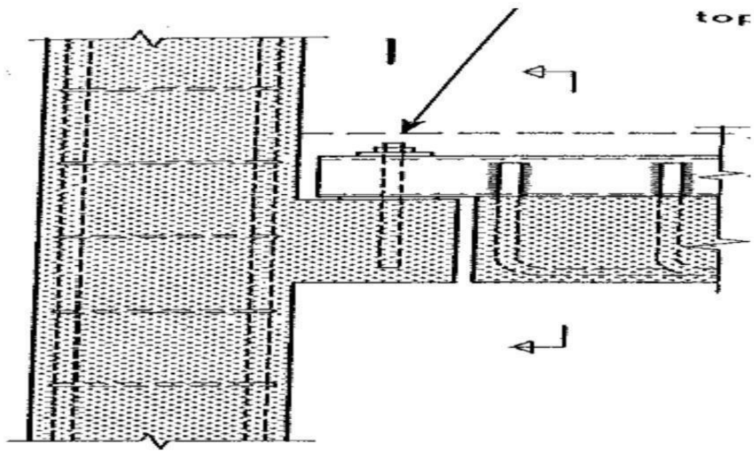
- **VARIANTC**
- Columns are provided with concrete corbels which are bolted to the columnfaces.
- It is advisable to use high tensile bolts and provide an Epoxy layer at the column a d corbel interface. The bolts and nuts must have permanent protection againstcorrosion andfire.



- To prevent the beams from toppling, beam and column interface could be shaped toform a tongue and groovejoint.

BEAM TO COLUMN CONNECTION WITH STEEL JOIST HANGER

- Beams are supported by means of steel joist hangars on concretecorbels.
- This connection is suitable for limited constructiondepths.
- The hangar construction must be designed to transmit the total vertical shear force.Since the connection cannot transmit torsion, it is unsuitable for edgebeams.



- The hanger construction consists of two vertical channels with flanges facing each other which are welded to anchor bars projecting from top ofbeam
- During erection, these channels are placed on an equalizing pad on top of thecorbel.
- The beam is secured vertically and laterally by tightening a nut with washer on abolt which projects from the corbel through the slot in between the channelflanges.

Dimension And Detailing

Joint Techniques:

The joint technique is a vital role for prefabricated structures. The joint mechanism is implemented to prefabricated elements. In case of dry joint the joint is under the category of bolting and welding .The bolted or welded connection should be designed properly with economical consideration. In case of wet joint the joint is in situ concrete. The in situ concrete should be in rich mortar.

Design of expansion joint

1 The expansion joint are provided to accommodate movements of thermalexpansion
2 To avoid the cracks expansion joints should beprovided
3 The thermal are formed due to summer seasons and the precast member will expand behind the original dimension. This cause the cracks will be developed in the prefabricatedstructures
4 Hence to avoid the formation of cracks expansion joint should be provided intheprefabricatedstructures

Spacing's of Expansion joints

SI.NO	TYPE OF WALL	MAX SPACING IN METRE
1	Large Block	35
2	Curtain Wall	80
3	Large panel (homogeneous)	45
4	Large panel (non-homogeneous)	60

5. AS per NBC the structures which are more than 20m the expansion joint must be provided the material are used for expansion joints bitumen with mineral , filler and cork strip. The expansion joint is protected by a sealing compound at the top against intrusion. The building is commonly separated the structure. The welded joints between the panels which permits therotation.

The exposed roof elements are higher expansion produced the materials are alsoexpanded. The common building material, linear co-efficient of thermal expansion are givenbelow

SI.NO	MATERIALS	CO-EFFICIENT $\alpha, 10^{-4}$ PER ^{0} C
1	Gravel	13
2	Brick	5
3	Concrete	8
4	Clinker	6
5	Blast furnace slag	11
6	Expanded clay	10
7	Lime stone	10
8	Expanded shale	10
9	Prelate	11
10	Vermiculite	14

Design Procedure For ExpansionJoint

Expansion joint must be sized to accommodate the movements of several primary phenomena imposed upon the bridge following installation of its expansion joint devices. Concrete shrinkage, thermal variation, and long term creep are the three most common primary sources of movement.

Calculation of movements associated with each of these phenomena must include the effects to super structure type, tributary length , fixity condition between super structure, sub structure and pear flexibilities.

a) Shrinkageeffects

Accurate calculation of shrinkage as a function of time requires that average ambient humidity, volume to surface ratios and curing methods to be taken in consideration as summarized, because expansion joint devices are generally installed in their respective block at least 30 to 60 days following concrete deck placement, they mustaccommodate only the shrinkage that occurs from that time onwards. For most situations,that shrinkage strain can be assumed to be 0.0002.For normal weight concrete is an

unrestrained condition .This value mustbe corrected for restrained conditionimposed by various super structure types

$$\Delta shrink = \beta . \mu . L_t$$

Where

L_t =Tributary length of the structure subjected to shrinkage

β = ultimate shrinkage strain after expansion joint installation estimated as 0.0002 of more refined calculations

μ = restrained factor accounting for the restraining effect imposed bysuperstructure element installed before the concrete slab is cast =0.1 for steel girders ,0.5for precast prestressed concrete girders ,0.8 for concrete box girders and T beam ,1.0 forflat slabs.

b) Thermaleffects:

Bridges are subjected to all modes of heat transfer, radiation, convection and conduction.Each mode affects the thermal gradients generated in a bridge superstructure differentially.Climate influences vary geographically resulting in different seasonal and average properties.

Example:

A massive concrete box girder bridge will be much slower to respond to an imposed thermal situation, particularly diurnal variation than steel plate Girder Bridge composed of many relatively thin steel elements.

Variation in superstructure average temperature produces elongation and shortening .Therefore thermal movement ranges calculated using a maximum and minimum anticipated bridge. Super structure average temperature anticipated during the structures life time. The consideration in the proceeding have led to the following temperature guide lines

Concretebridges	0^0 F to 100^0 F
Steelbridges	30^0 F to 120^0 F

Total thermal movement range is calculatedas

$$\Delta temp = \alpha . L_{t..} \partial_T$$

Where

L_t =Tributary length of the structure subjected to thermal variation

α= Co-efficient of thermal expansion 0.000006 in $/^0$ F for concrete and 0.0000065 in $/^0$ F

∂_T=Bridgesuperstructureaveragetemperaturerangesasafunctiononbridgetypeand location Generally these settings are specified for temperature of 40^0F , 64^0 F and 80^0F

UNIT V

ABNORMAL LOADS

Codal Provisions For Progressive Collapse

Avoidance of progressive collapse.

- Progressive collapse occurs when a key member or member of a structure fail.
- The isolated failure of this key member or section then initiates a sequence of events, coursing failure of the entire structure
- Provides a solid exterior surface to meet blast resilience requirements.
- Minimizes cost to fix a damaged area compared to a steel framed building.
- Eliminates perimeter stell leading to greater interior space planning flexibility.

PROGRESSIVE COLLAPSE

- Progressive collapse can be defined as collapse of all or a large part ofa structure by failure or damage of a relatively small part ofit.
- The general services administration (GSA, 2003b) offers a somewhat more specific description of the phenomenon progressive collapse is a situationwhere local failure of a primary structural component leads to the collapse ofadjoining member which in turn leads to additional collapse.
- It has also been suggested that the degree of progressivity in a collapse bedefined asthe ratio of total collapsed area or volume to the area or volumedamaged or destroyed directly by the triggering event.

CODES AND

STANDARDSASCE 7-02

- The American society of civil engineers minimum design load for buildingsandother structure (ASCE,2002) has a section on general structure integritythat reads thus building and other structures Shall be design d to sustain localDamage with the structural system as a whole remaining stable and not beingdamaged to an extent disproportionate to the original localdamage.

- This shall be achieved through an arrangement of the structuralelementThatprovides stability to the entire structural system by transferring loads fromAnylocallydamaged region to adjacent regions capable of resisting those Loads withoutcollapse.

- This shall be accomplished by providing sufficient continuity, redundancy, or energy-dissipating capacity (ductility) or a combination there of in a members of the structure clearly the focused in the ASCE standard is on redundancy and alternate load paths overall other means of avoiding susceptibility to disproportionate collapse. But the degree of redundancy is not specified and the requirements or entirely threat -independent

ACI 318-02

- The American concrete institution building code requirement for structural concrete (ACI, 2002) include extensive requirement for structural integrity in the chapter on reinforcing steel details. Though the commentary states that it is an intend of This section...to improve 6 redundancies there is no 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 overall structure" and many specific prescriptive requirements for continuity of reinforcing steel and interconnection of components.

- There are additional requirements for the typing together of precast structural components. None of the ACI provisions are threat specific inanyway.

GSA PBS Facilities Standards 2003

- The 2003 edition of the GSA'"s facilities standards for the public buildings service (GSA, 2003 a) retained the "Progressive Collapse" heading from the 2000 edition.

- GSA Progressive Collapse Guidelines 2003 GSA Progressive CollapseAnalysis andDesign Guidelines for new federal of his buildings and majorModernization

  Projects (GSA, 2003b) begin with a process for determining whether a buildingis exempt from progressive collapse considerations.

- Exemptions based on the type and size of the structure (for instance, anybuilding of over 10 stories is non- exempt) and is unrelated to the level ofthreat.

- Typical non-exempt buildings in steel are concrete have to be shown byanalysis to beable to tolerate removal of one column of o e-30 ft length ofbearing wall withoutcollapse. Considerable detail is provided regarding thefeatures of the analysis and the acceptance criteria.

GSA Progressive Collapse Guidelines 200

- The GSA Progressive collapse analysis and design guidelines for new federaloffice buildings and major modernization projects(GSA,2003b) begins with aprocessfor determining whether a building is exempt from ProgressiveCollapseconsiderations. Exemption is based on the type and size of thestructure (forinstance any building of over 10 stories is non-exempt) and isunrelated to the level of threat.

- Typical non-exempt buildings in steel or concrete have to be shown by analysis to be able to tolerate removal of one column or one-30 ft length of bearing wall without collapse.

- Considerable detail is provided regarding the features of the analysis and the acceptance criteria.

Avoiding Disproportionate Collapse

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

- Redundancy or alternate load paths
- Local Resistance
- Interior or continuity

Redundancy or Alternate 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 the general collapse does not occur.

- This approaches the benefit of simplicity and directness in its most common applications, design for redundancy requires that a building structure be able totolerate loss of any one column without collapse this is an objective easilyunderstood performance requirements the problem with the redundancyapproachas typically practiced is that it does not account for difference invulnerability .

- Clearly one column redundancy when each column is a W8x35 does notprovide the same level of safety as when each column is a 2000 I/ft build upsection.

- Indeed and explosion that cloud take out the 2000 I/ft column would likelydestroy several of the W8 columns making one column redundancy inadequateto prevent collapse in that case.

- And ate codes and standards mandate redundancy do not distinguish betweentwo situation they threat every column as equally likely to be destroy d in factsince it is generally much easier to design for redundancy of a small and lightlyloadedcolumn redundancy requirements may have the unfortunate consequence of encouraging design with small(and vulnerable) columns ratherthan fewer larger column.

- For safety against deliberate attacks (as opposed to random accidence) this may be a step in wrong direction.

Local Residence

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

Interconnection or continuity

This is strictly speaking not a third approach separate from redundancy and local residence. But a means of improving either redundancy of or local residence (or both).Studies of many recent building collapses have shown that the figure could have been Avoided or at least reduced in scale, at fairly small additional cost if structural components had been interconnecting more effectively. This is the basis of the structural integrity requirement in the ACI 318 specification (ACI 2002)

Explosiveloads:

- It is also called uncontrolled demolition.
- Explosive loads are used to blow up thestructures.
- As the chord was ignited, the fuse got set off, starting explosion in a controlled progressive way at different intervals
- The rubble from the lowest section got spread out in beams across the floor.

Implosive loads:

1. A very small amount of dynamic load is used at strategic points in thestructure to make it and allow it to fall by its ownweight.
2. It is delicate art of detonating explosives in just the right places to makea building collapse about nearly into itsfootprint.
3. It is also called controlleddemolition.
4. Demolition means there is no need to save a y part of the concretestructures.
5. Demolition is mandatory for all RCC works which have completed its lifeperiod.
6. The permission will be provided from buildingdepartment.
7. If the building withstand after their life period or designperiod.
8. It may be damaged in anytime.
9. The building will be demolished after completion of their designperiod.
10. The demolition are givenbelow:
    i. Explosion Method
    ii. ImplosionMethod
    iii. Special attachment to hydraulicexcavators
    iv. HydraulicSplitters
    v. Non explosive demolitionmethod.

DesignOf Earthquake ResistanceStructures

Earthquake Resistance Building:

- Using dampers for Absorbing shocks
- Stiffness in all directions
- Infill wall
- Retrofitting
- RollerFoundation
- Shear wall construction
- Adopting pile foundation
- Concrete members with light weight concrete
- Reducing self weight by using light weight roof
- Limit the height of 30m for seismic design

Following principles are adopted for general design:

- Generally avoid construction of structures across fault zone.
- The long axis of the building is best oriented parallel to the dominant directionof the wave movement
- The foundation is to be embedded on firm bed rock only; otherwise disastrouslateral displacements may occur.
- The greater weight, hence the inertia of foundation and super structure, itscapacity to damp the jarring effect. (A heavy ship is less rolled by storm wavesthan a light boat).
- The super structures should be of as light materials as allowable.
- Deep trenches cut across the path of the way arrival have a damping effect bybreaking continuity.

Designof Cyclone ResistanceStructures

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.

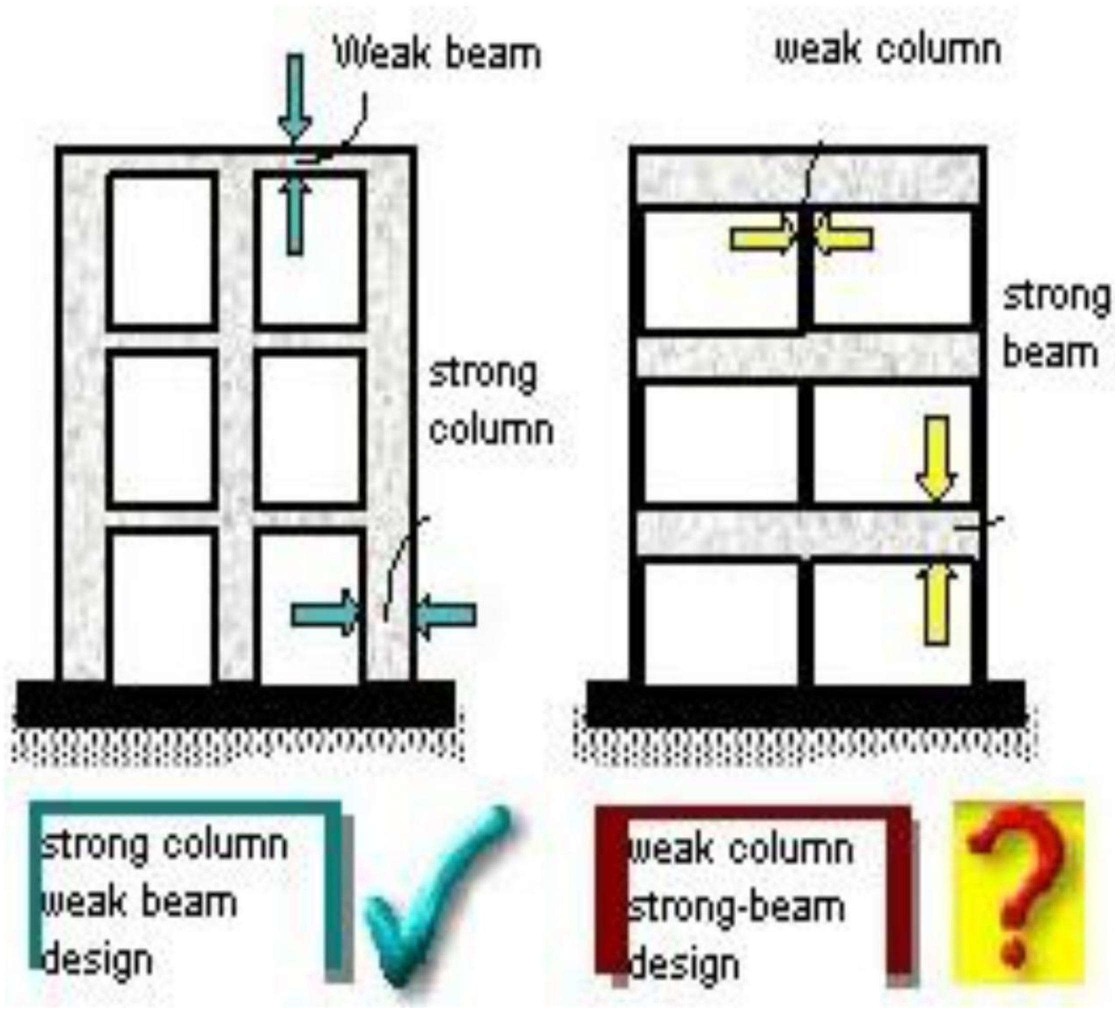
Another solution for elimination of erection stresses in this case the stanchion of a frame to be transported are braced each other. During transportation. So lessening the moments arising at points which are supported by scattolds set up on the conveying trucks. The frames were precast in the upright 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.

Strong Column And Weak BeamTheory

Strong column weak beam theory:

- In case of framed structure it has been mechanism of collapse ensure large energy dissipation capacities in comparison with source collapse mechanism capacity design is the technique of ensuring a predetermined collapse mechanism by suitably adjusting the capacities of member .
- The basic concept of capacity design of structure is to distribute the inelastic deformation throughout the structure in such a way that the formation of plastic hinges at predetermined positions in the members.
- During earthquake, the seismic inertia forces generated at the floor levels are transferred through beams and columns to the foundation.
- In case of ductile frames, this can be achieved by formation of plastic hinges purposely at both ends of all the beams in all floors of the building.
- While the column remains essentially elastic in all stories, excluding bottom storey.
- It is desired to allow the formation of plastic hinges in the beams rather than columns because,

- Plastic hinges in beam have higher rotation capacities than in columns which are used to increase the ductile behavior of the frame.
- Failure of beam which can be repaired simply and strengthened easily, but the entire structure may collapse due to column failure.
- Failure of beam normally results in a localized failure, whereas failure of column can affect the entire structure stability.
- Thus purposely are designing the beam as a weaker member that the column.
- This concept is called strong column weak beam design.
- In capacity design, the strength developed in weaker member is related to the capacity of the stronger member while yielding.



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Question Paper Code : 71237

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Eighth Semester

Civil Engineering

CE 2045/CE 805/CE 1007/080100060/10111 CEE 44 — PREFABRICATED STRUCTURES

(Regulation 2008/2010)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Give the different types of modular grids.
2. List out the limitations of modular coordination in precast elements.
3. What are the loads acting on wall panel members?
4. What is a shear wall?
5. What do you mean by disuniting of structures?
6. Define "'Joint Flexibility'.
7. Draw a joint connecting wall panel with frame.
8. Write any two characteristics of expansion joints.
9. What is meant by progressive collapse?
10. Differentiate between intensity and magnitude of earthquake.

PART B — (5 × 16 = 80 marks)

11. (a) Explain in detail about different materials used the principle and need of prefabrication.

Or

(b) What are the different types of structural systems used in prefabricated structures? Explain.

12. (a) With a flow chart explain the manufacturing process of roof and floor slabs.

Or

(b) Describe the manufacturing process of wall panels.

13. (a) Explain in detail about the suitable design of cross section based on efficiency.

Or

(b) Discuss the salient points considered while designing a joint. Discuss the importance of joint flexibility.

14. (a) Explain in detail :

(i) Beam to column connection. (8)

(ii) Doors and windows to wall convection. (8)

Or

(b) How do you perform the design of expansion joints?

15. (a) Discuss the codal provisions in the design for structures subjected to earthquakes.

Or

(b) Explain a situation for occurrence of progressive collapse. How do you avoid progression collapse?

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Question Paper Code : 51210

B.E./B.Tech. DEGREE EXAMINATION, APRIL 2014.

Eighth Semester

Civil Engineering

CE 2045/CE 805/080100060/10111 CEE 44 — PREFABRICATED STRUCTURES

(Regulation 2008/2010)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is prefabrication?

2. What is standardization?

3. Name a few prefabricated components.

4. Define a shear wall.

5. What is disuniting?

6. What are the different design principles in prefabricated construction?

7. Name few structural connections.

8. What is an expansion joint?

9. What is an abnormal load?

10. What is meant by progressive collapse?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Enumerate the need of prefabrication. (8)

(ii) Explain the principle of prefabrication. (8)

Or

(b) Discuss the process of production, transportation and erection of prefabrication. (16)

12. (a) (i) Enumerate the process of large panel construction. (8)

(ii) Explain the construction of floor slabs. (8)

Or

(b) (i) Enumerate the construction of wall panels. (8)

(ii) Explain the process involved in prefabrication of columns. (8)

13. (a) Explain with an example, the design cross section based on the efficiency of the material used for construction. (16)

Or

(b) (i) Explain joint flexibility. (8)

(ii) Explain joint deformation. (8)

14. (a) Explain with the aid of neat sketches, any two different structural connection. (16)

Or

(b) (i) Enumerate detailing of structural connections. (8)

(ii) How expansion joints are designed? (8)

15. (a) Explain the concept of equivalent design loads for abnormal effects. (16)

Or

(b) (i) Explain the codal provisions for progressive collapse. (8)

(ii) Enumerate the importance of avoidance of progressive collapse. (8)

Reg. No. : | | | | | | | | | | | |

Question Paper Code : 31193

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2013.

Seventh/Eighth Semester

Civil Engineering

CE 2045/CE 805/CE 1007/080100060 — PREFABRICATED STRUCTURES

(Regulation 2008)

Time : Three hours — Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by Modular Coordination?
2. State any two principles of prefabricated structures.
3. Define a shear wall.
4. What are the loads acting on wall panels?
5. What is joint flexibility?
6. Explain disuniting of structures.
7. State post tensioned connection.
8. Give any four types of joints.
9. Define progressive collapse.
10. Explain equivalent design loads.

PART B — (5 × 16 = 80 marks)

11. (a) What are the principles of prefabrication techniques and explain in detail and also mention its advantages and disadvantages.

Or

(b) Explain the erection principles of precast members with suitable sketches.

12. (a) Explain the behaviour of large panel construction with suitable sketches.

Or

(b) Explain the behaviour of roof and floor slabs construction with suitable sketches.

13. (a) Design principles of disuniting of structures and explain in detail.

Or

(b) What is joint flexibility and allowance for joint deformation? Explain problems in design.

14. (a) What are the requirements of ideal structural joints? Explain different joints of structures.

Or

(b) Explain the joint techniques and material used in detail and explain the design of expansion joint.

15. (a) Explain the equivalent design loads for considering abnormal effects.

Or

(b) Explain the codal provisions for progressive collapse and detail the importance of avoidance of progressive collapse.

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Question Paper Code : 21193

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Eighth Semester

Civil Engineering

CE 2045/CE 805/CE 1007/080100060 — PREFABRICATED STRUCTURES

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the advantages of prefabrication?

2. Explain Dimensional tolerance.

3. Explain the types of prefabrication.

4. What are the desirable properties of concrete and steel for prefabrication unit?

5. Explain different types joint.

6. Explain joint flexibility.

7. Describe the Ductility of joint.

8. What is meant by Expansion joint?

9. Explain Equivalent design loads.

10. Explain prefabrication on multi storey frames.

PART B — (5 × 16 = 80 marks)

11. (a) Explain briefly the general principle of prefabrication.

Or

(b) What are the desirable properties of concrete and steel for prefabrication unit?

12. (a) Explain the different types of production techniques adopted for making pre cast units.

Or

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

13. (a) Describe with neat sketches the organization of a prefabrication plant for Manufacture of small element.

Or

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

14. (a) Classify and explain with neat sketches the different types of joining of structures.

Or

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

15. (a) Explain strong column and weak beam theory.

Or

(b) State and explain the equivalent load procedure.
