PART - B

1) Explain the different types of joints (APR/MAY 2003)

i) Rigid Joints:

- Can take tensile, compressive, shear and bending moments too.
- Relative rotation and relative displacement are impossible.
- Generally used for the junction of columns to footings.
- Used for joining of individual members to each other.

Limitations:

- Requires considerable man power and hence minimum applications.

ii) Hinge like Joints:

- Can transmit forces passing through hinges itself, and also allow certain motion and rotations.
- Joints used in precast members are usually hinge like.
- Requires less working time than that of the rigid joints.
- Execution is simpler.

iii) Shod Joints:

- Used in industrial construction and used for long span only.
- Chiefly used in bridge construction for long span bridges.

iv) Dry Joints:

- A joint accomplished by simple placing of two members on each other and then fastening them is called dry joint.
- The structure becomes immediately loose bearing.

v) Wet Joints:

- The joint requiring not only a casting cement mortar, but also a subsequent concreting is called wet joint.
  Eg: when a rigid joint is formed, generally the lengthening of steel bars is by joining the members by overlapping (or) welding them while the discontinuity is avoided by a skilful subsequent concreting is called wet joint.
- Adequate for the bearing of greater force.
- Structure assembled used a wet joint have a monolithic character.
- Wet joints comply with character of material of structure to be joined.

2) Explain in detail the different structural connections in precast buildings? or Junction types/groups of Joints (April/May 2011) (May/June 2013)

i. Joining of column to footing.
ii. Joining of beam to top of column.
iii. Joining of beam at an intermediate joint.
iv. Lengthening of column.
v. Joining of beams.
vi. Forming of joints for arched structures.
vii. Joining of joints of post tension structures.
viii. Joining of precast to monolithic RC structures.

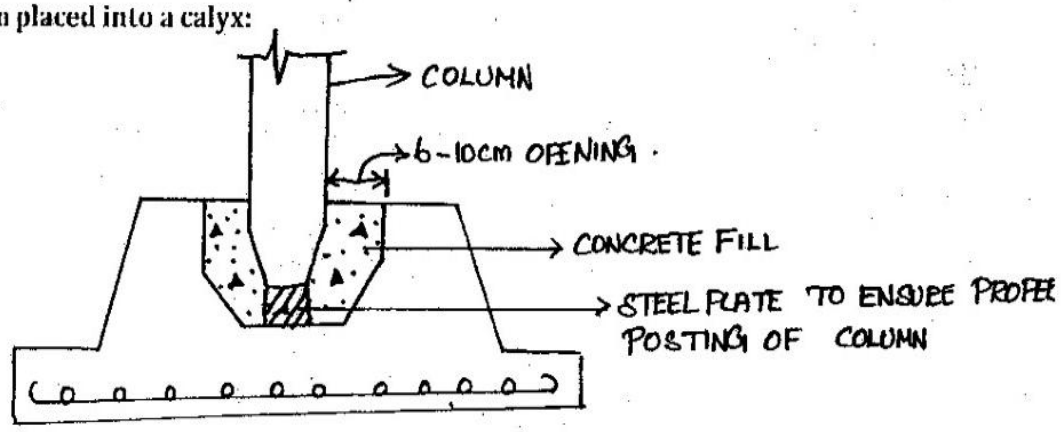
i) Joining of column to footing:

- Usually rigid.
- It may also be hinge-like.

Methods:

A rigid joint can be made by placing the column into calyx at the footing or by using welded joint.

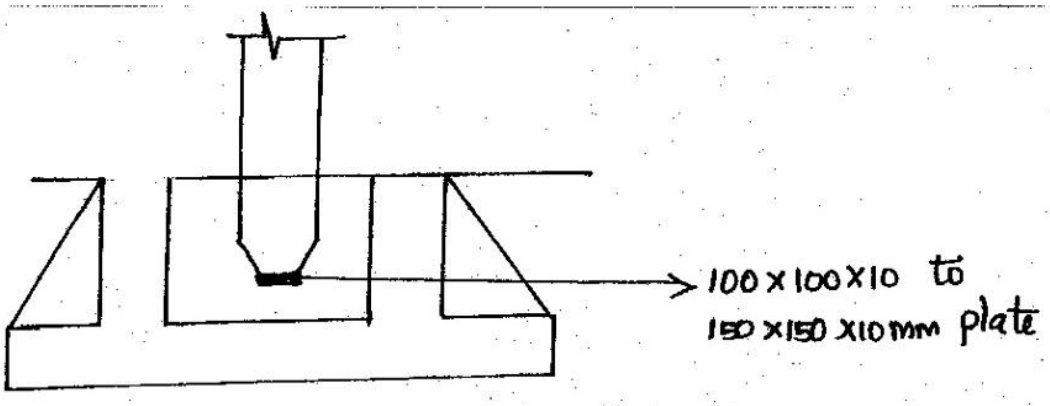
a) Column placed into a calyx:



Advantages:

- It is simpler requires less time suitable for small column. (i.e) placing, pumping, fixing of the column and filling calyx with concrete is easier.
- This method is least resistive to inaccuracies araising due to construction.

b) By welding:



Disadvantages:

- Moment araising from fixity of column demands double bearing.
- The excess material to bear this moment is insignificant for small columns.

NOTE:

Calyx should be designed to result

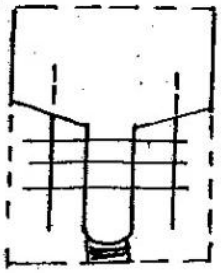
→ Bending

→ Shear

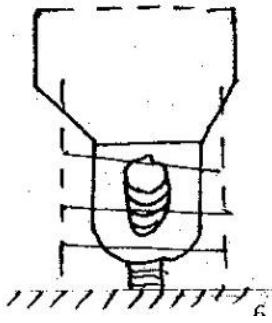
→ The forces acting on the calyx wall.

ii) Joining of column to beam on top of column:

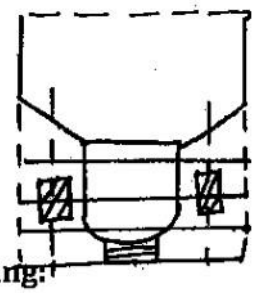
a) By overlapping steel bars:



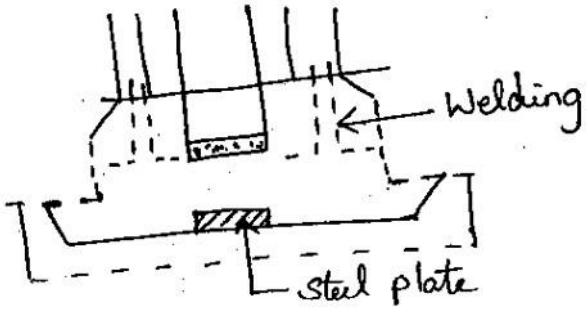
b) By hooked steel bars:



c) By welded joint:



Welding of column to footing:

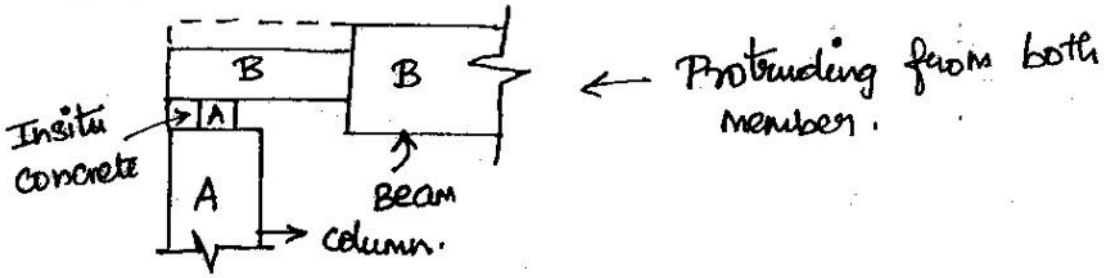


Advantages:

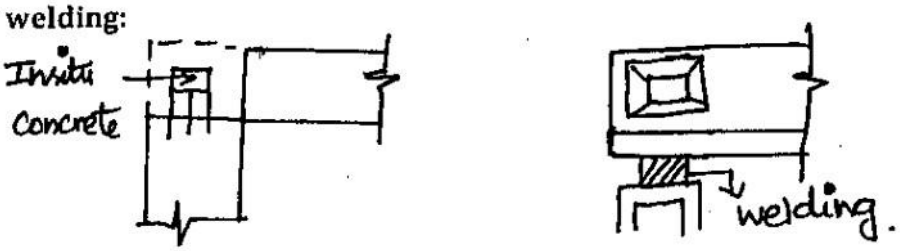
- It is effective and wide spread method.
- It is easily accessible.
- It ensures the well executed work and adequate control.
- It is more economical for larger member than the calyx method.

iii) Joining of beam to column on top of column:

a) By overlapping steel bars:



b) By welding:



- Simple method for rigid junction fitting column with beam at girder.

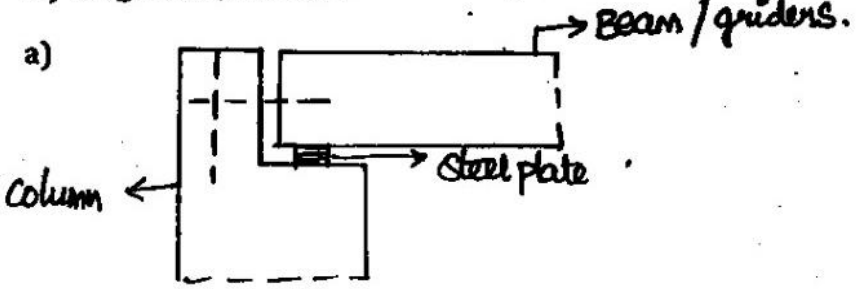
- At the top of the column the use of overlapping steel with beam and subsequating concrete is alone.

Limitations:

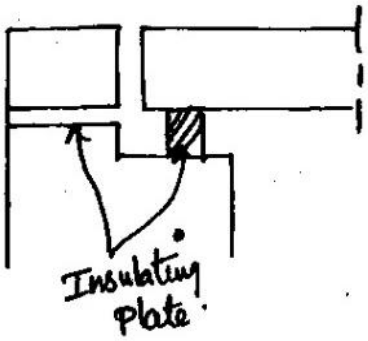
- Demands more care and skill.
- Increased use of steel.
- Execution of work is complicated because the work must be performed at a greatest on a light scaffold suspended on the beam itselt.

Iv) Hinge like joining of column to girders:

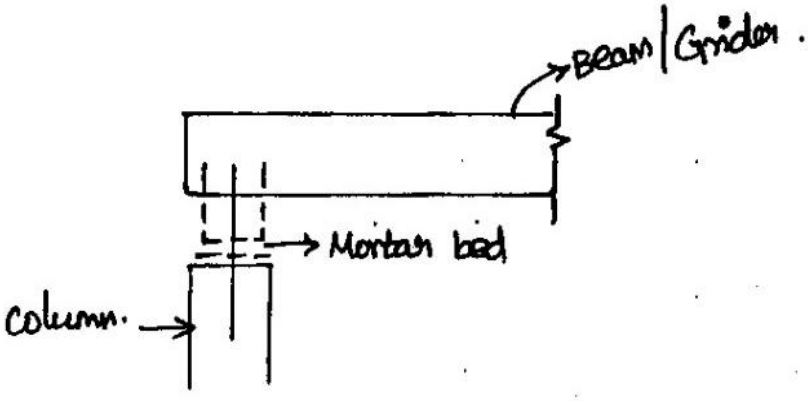
a)



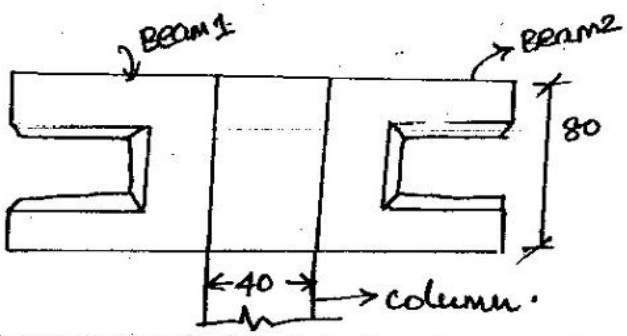
b)



c)

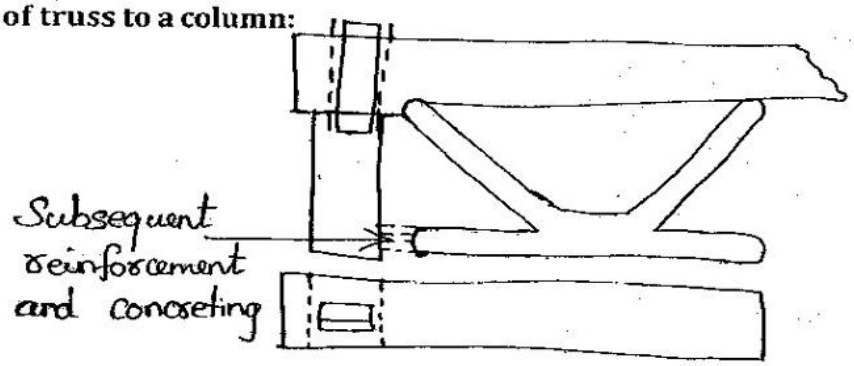


d) Intermediate beam-column joints:



- It is the easiest method (i.e) placing a beam on the top of the column.
- At the resting place, both the top of the column and the underside of the beam must be furnished with a steel plates anchored into the concrete, so that the two steel plates rest on each other.

v) Joining of truss to a column:

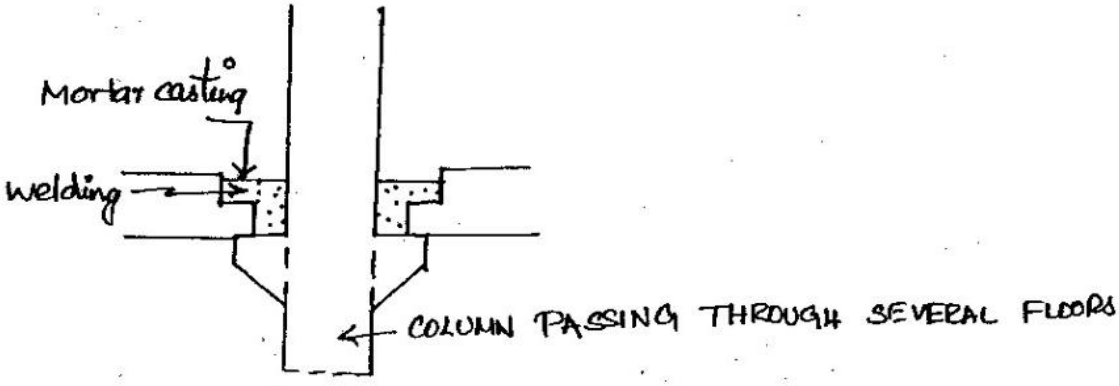


- The truss rests on the column by its cantilever like lengthened upper chord while the lower chord has subsequently be lengthened and joined to a column.

For vertical loads → The joint should be Hinge-like.

For horizontal loads → The joint should be Rigid.

vi) Joining of column to a beam at an intermediate level:



It is applicable for multi-storeyed buildings. There are two methods.

Method I:

The beams rest on cantilever of the column and their top bars are welded to dowels protruding from it.

Method II:

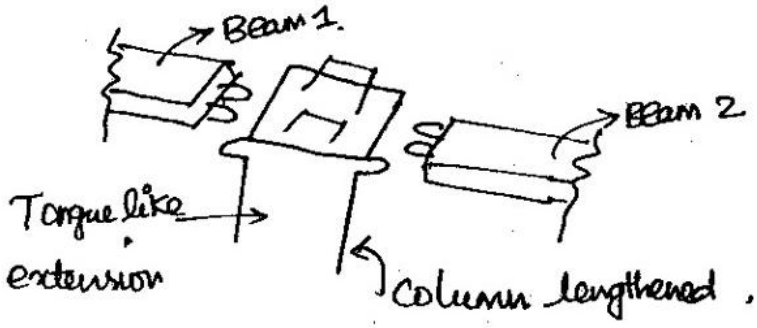
A beam shaped like an inverted 'U' rests on cantilever protruding laterally from the column. The advantage is that the concentric loading can also be accomplished for the outermost columns which is impossible when using method.

NOTE:

If an additional reinforcement is applied, the beam can also be transformed to a continuous beam.

vii) Lengthening of columns:

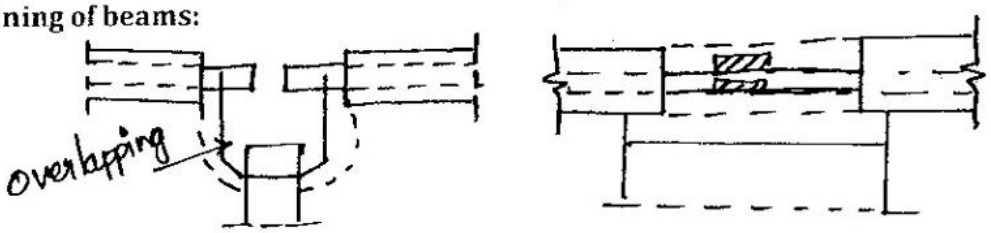
- Columns are usually lengthened at floor levels.
- Intermediate lengthening should be avoided if possible.



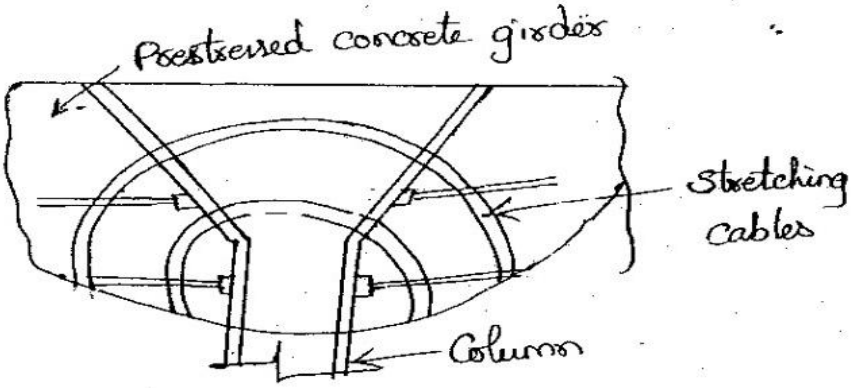
- The upper columns rest on the lower ones by a tongue like extensions.
- The steel bars of the main reinforcements are joined by overlapping are looped steel bars are welding.
- Then the stirrups are to be placed and finally, the joints must be concreted.

viii) Joining of beams:

a)



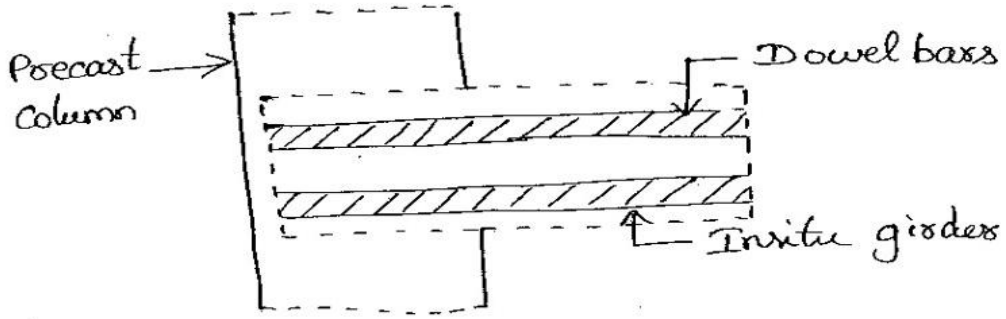
The junction of the beam is done by overlapping the protruding steel bars or by welding them together.



- By post tensioning, it is ensured that the entire structure including the joint only compressive can developed.
- The joints are made by placing plane surfaces side by side and then filling to gaps with cement mortar. By doing so, longer beams can also be produced from shorter pre-cast members.
- No difficulties in making joints.
- After casting of the gaps and hardening of mortar, the short inserted cables are stressed and so rigid joints are established.

xi) Joining of precast to monolithic RC structures:

- Achieved by placing, end of the beam either or two cantilever protruding from the column or an opening from in the shaft of the column.



- When making joints first of all, a 2.5cm deep cavity is chiselled out at the side of the precast column.
- The bottom of this cavity should be roughened so as to attain a better bond b/w the concrete of the monolithic beam and precast column.

3) Explain about suspension of members: (APR/MAY 2003)

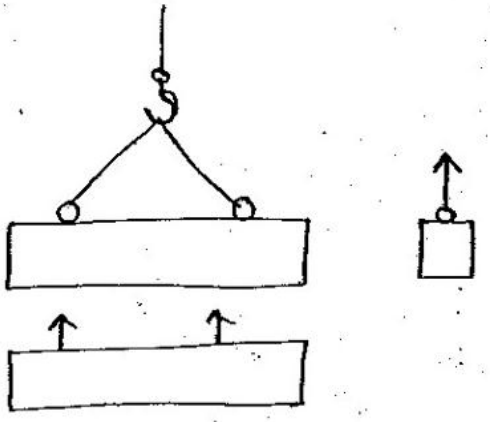
i) Suspension of members by sloping cable.

ii) Suspension of members by using a stock.

iii) Suspension by a triangular cable rocks.

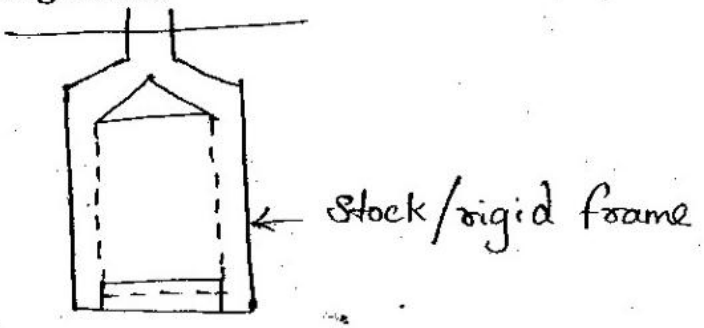
i) Suspension of members by sloping cables:

- The members have to be transported from the manufacturing location to the storing area.
- Sometimes frames (bridge crane, tower crane, gantry crane etc) are usually used for transportation.
- The members are hanging from the hook of the crane. Method of suspension depends on form and dimension of members.



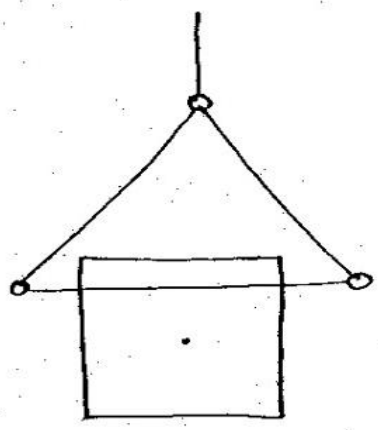
- The suspension must be situated above the beam or else the beam become unstable.

ii) Suspension of members using a stock:



- Stability of the beam may be by enclosing beam by a stock (i.e) by placing the girder into a rigid plane. By doing so, the suspension itself is transferred to a point outside the beam.

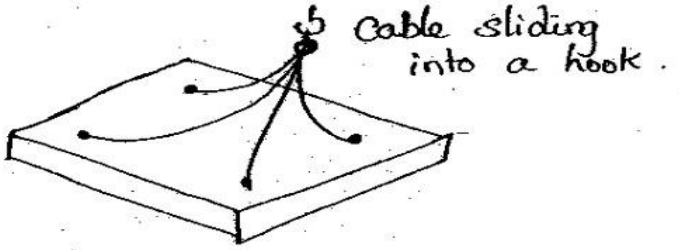
iii) Suspension by a triangular cable rocks:



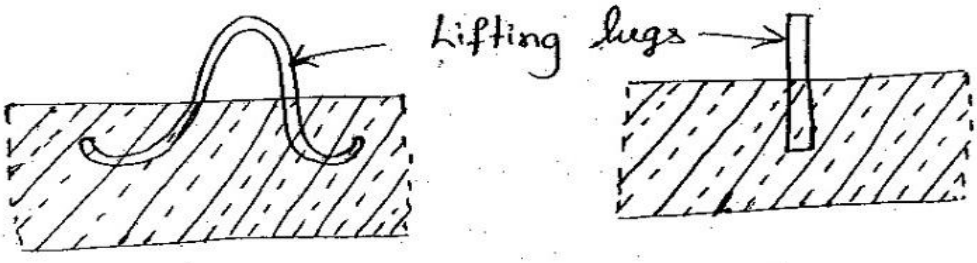
- Increase in the stability can be achieved.
- The branches of the triangular cable rockers are of equal length and join at the suspension joint.

NOTE:

When the members are suspended at any points a lifting should begin simultaneously.



LIFTING LUGS:



4) Large concrete roofing members:

- It rests directly on the main girders of the hall structures.

- Manufactures in length corresponding to the frames (6 to 10m) width is (1.3 to 1.8m).
- They are directly supported by the main girders so that purlins are hot required.
- A large roofing member consists of two longitudinal edge ribs, cross ribs and a slab having a thickness of 2.5 to 3cm and a two way reinforcement.
- These members connected to each other and to the frame girders from by uniformed continuous structure.

5) Kinds of members:

i. Normal members for intermediate placing.

ii. Members with a cornice.

iii. Members having eaves gutter.

iv. Joining members.

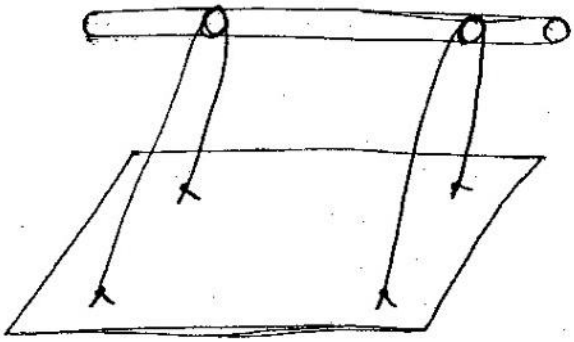
- The members can be solely from RC or combined with porous hollow tiles.
- The heat insulation of the roof surface is achieved by covering at with porous hollow tiles or some other suitable materials after the member have already been placed.
- Level differences amounting to about 1 to 2cm frequently occur due to inaccuracy of placements.
- These must be equalised by a subsequently mortar layer and the heat insulating items have to be embedded into this mortar.

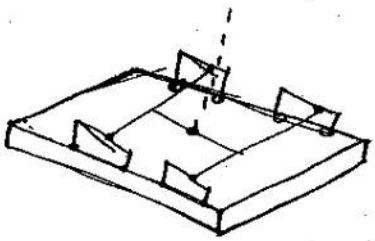
→Edge rib Dimensions are:

- For spans of 6, 9 and 12m, the width is usually 4, 5 and 6m. The depth varying from 25 to 50cm. These widths are necessary for encasing the adequate cover of concrete around the bottom bars of the longitudinal reft.

6) Rockers used for plane members:

- If the member is to be lifted at more than 8 points.
- Distortion in the member takes place.

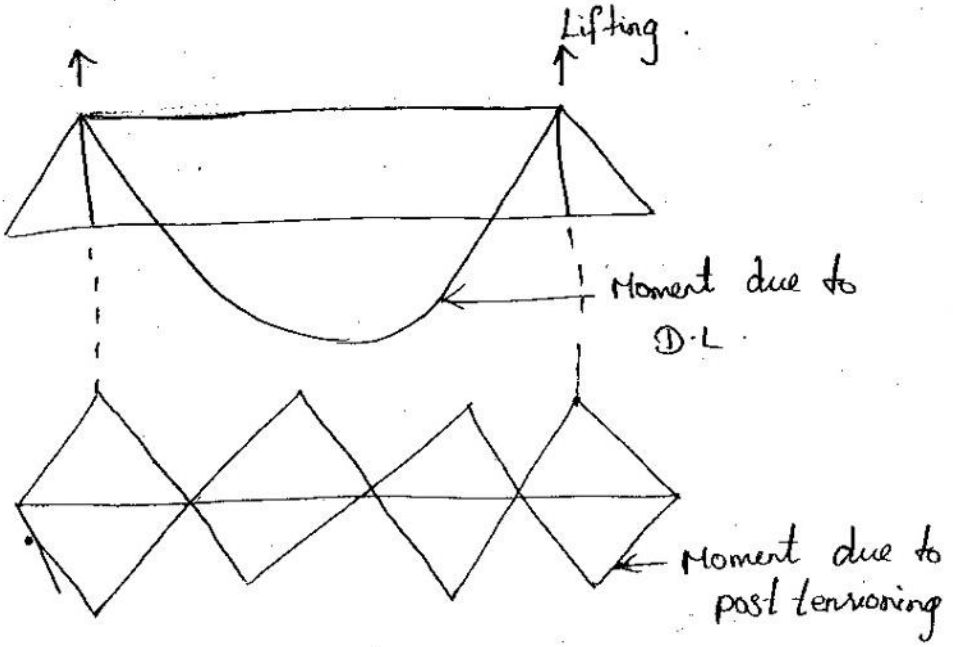




4) How stresses can be eliminated during erection of precast elements. (May/June 2012)

Surplus stresses are forms when members are hoisted and placed. These stresses are called handling or erection stresses.

- In good method of construction is characterised by elimination of those stresses.
- It should be eliminated in such a way that no additional reft is required.
- The stresses due to wind or other external forces are avoided by a temporary racing of the placed members facening.

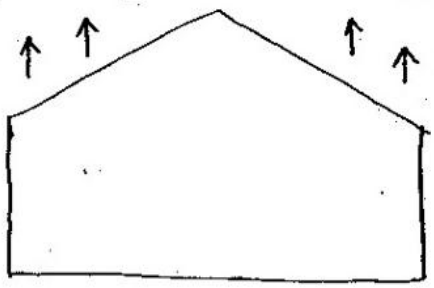


- The hoisting of a straight beam is accomplished by lifting it at 2pts. '

- The location of these 2pts depends on the reft if the beam is the s.s one, the lifting pt should be at the ends or in such a manner that the araising moment should be equalised.
- When hoisting a continuous beam, post tensioning is necessary.

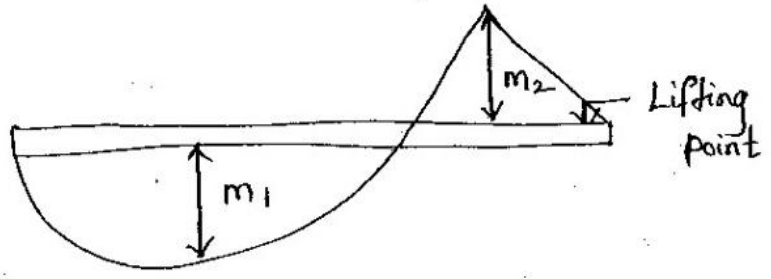
8) Girders:

- A girder having a length of 25cm is clutched at 2pts when it is hoist but the tilting of same girder requires atleast 4 lifting pts.
- These pts should be determined based on equal moments simultaneously taking into consideration. The reft design to resist force affecting the beam, in its final position.



COLUMNS:

- The most advantage pt for lifting should be first determined.
- The column dividing hoisting acts like a s.s beam with the cantilever at the end, loaded by the dead weight, temporary post tensioning must be worked out, so that additional reft is not required.



ELIMINATION METHODS:

- The stresses developing in members during hoisting and placing differs these araise in the final position.
- An additional reft may be sometimes require but becomes unnecessary after placing is finished.

- Hence the additional stresses as well as reft required to resist them should be eliminated.

5) What are the methods used in stress elimination in precast members:

i) a. By an I-profile steel beam to the girder.

b. Using post tensioning.

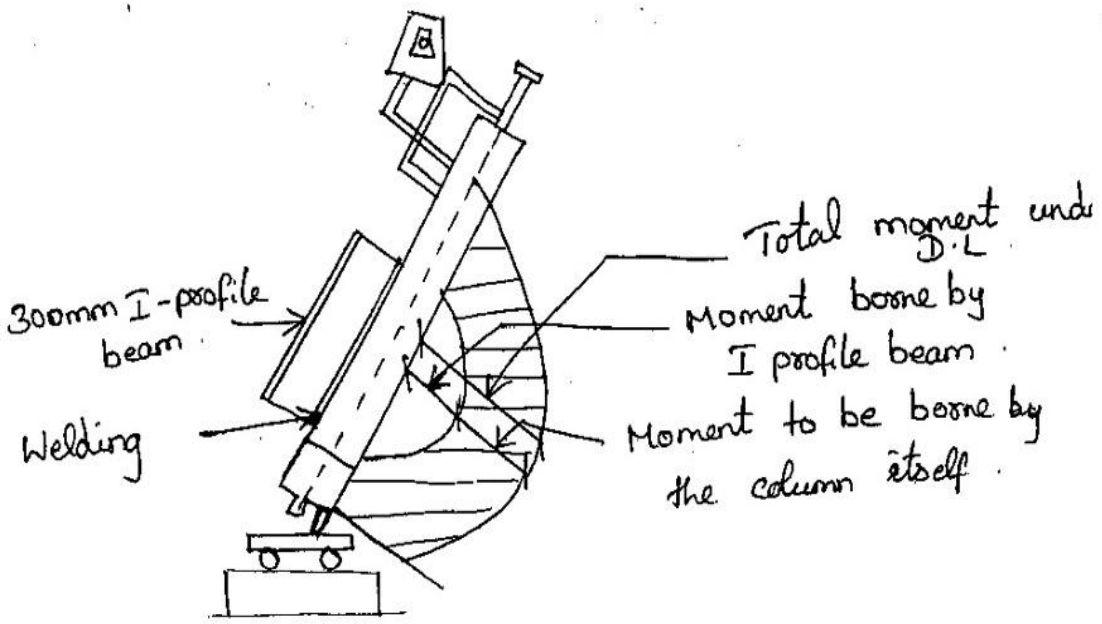
ii) Bracing of two stanchions.

iii) Temporary post tensioning.

iv) Multipoint pickup.

i) By an I-profile steel beam to the girder:

- This is most simple.
- The ends of steel beam are merged to stanchion while its middle is stresses to the stanchion by the bolts of an inserted stirrup which presses it down.
- Hence the developing bending moment due to the dead load is bound by the steel beam and the remaining by the stanchion, without any additional reft.
- After the beam has been hoisted by 45º, the temporary reft steel beam becomes unnecessary and can be removed.
- For large structure, (great length & strong forces) this method is unsatisfactory.
- Hence for those structures post tensioning can be adopted.

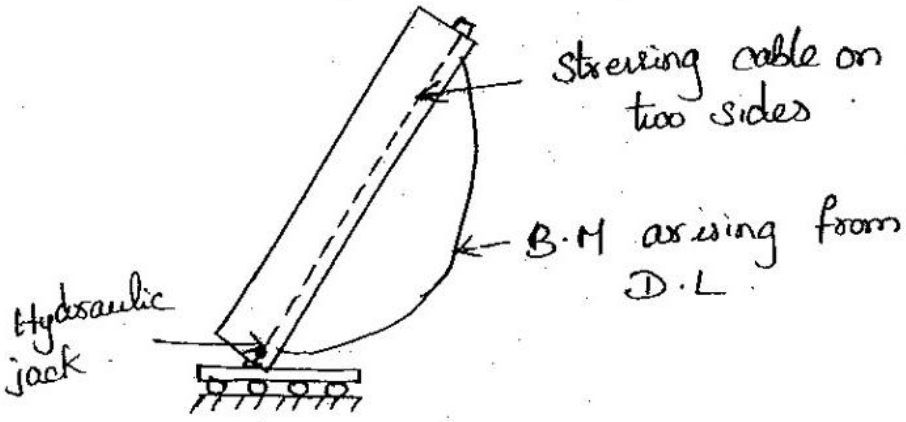


- The tensioning force is controlled by measuring the reaction force developing above the lifting pin using a manometer.
- When the column has been hoisted, the equipment used for post tensioning has to be dismantled before placing begins.

BRACING OF TWO STRUCTURES:

- It is done by placing two stanchion of a plane to be transported, so that the moments arising at the supports are eliminated.
- Developments of negative stresses are overcome by the bracings provided. By using hydraulic jack the hoisting is done. After placing, the bracing bar is removed.

Temporary Post tensioning :

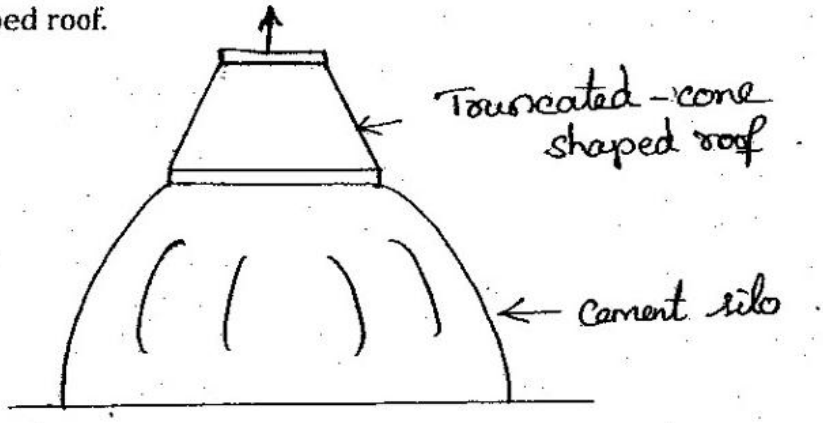


- The elimination of stresses is achieved by temperory post tensioning of a shorter section of the column.
- The required tensioning force is provided by a hydraulic jack.
- The girder is lifted at two pts. The stressing cables are lead in as in a way that the moment developing from post tensioning, diminishes to the necessary degree, the moment arising due to dead load.

Multipoint Pickup:

- It is one of the best solutions for the elimination of erection stresses for eg: hoisting of a truncated cone like roof over a cement silo.
- The roof was lifted at dual pts in a statically determined manner using a three pt suspension.

- This resulted in the elimination of erection stresses in the lower edge ring and truncated cone shaped roof.



NOTE:

Erection stresses during hoisting of column can also be eliminated by using multipoint lift.

6) What are the different Hoisting machines used in precast erection.

i. Tower Cranes.

ii. Crawler Cranes.

iii. Truck Cranes.

iv. Gantry Cranes.

v. Mast Cranes.

vi. Twinned-mast Cranes.

vii. Derrick Cranes.

Transport Trailers:

i. In Horizontal Position.

ii. In Upright Position.

7) Explain about dimensioning of Joints.

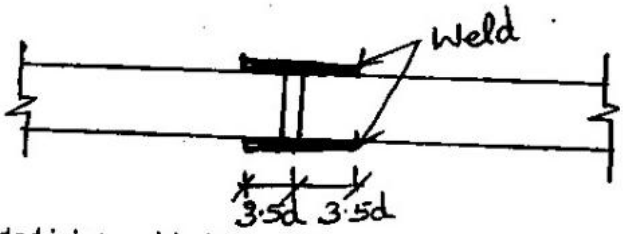
A) According to Hungarian Standards: (MNOSZ 15022:1952)

- Lengthening:

→Either by welding steel bars together (or)

→By Overlapping hooked Steel bars.

- The lengthening of steel bars by overlapping is not permitted when the concrete is subjected to tension everywhere in RC structures.



- The most suitable welded joint welded lengthening is in arc welded joint, consisting of four welds and two laps.

Length of Lap = 2*3.5d = 7d.

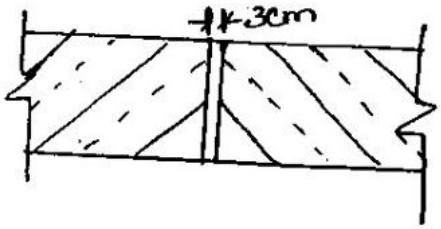
Diameter = 0.7d

d →Diameter of steel bar lengthened.

- Grade of steel used.
- Only steel grades 34.21B, 50, 35 Bmk can be welded, the carbon content is almost 0.27%.

B) According to German Standards (DIN 4225):

- The cube strength of cement mortar should be at least 120 KP/cm².
- The joints found in a floor must be filled with cement mortar for ensuring adequate sound insulation.



- The width of the joint at its top must be at least 3cm, is compressive force is to be transmitted.
- Gaps between slabs like beams are to formed like grooves, which when filled up with C.M is appropriate for the transmission of shear.
- The best concrete quality to be considered in the case of an in-situ concreting.

i) is C 300 if the smallest dimension is not less than 10cm.

ii) is C225 if the smallest dimension is 3cm.

- The permissible compressive stress is 50 KP/cm^2 in the case of joint less than 1cm wide.

C) According to soviet code:

- The quality of concrete used for the concreting of joints shall be:
- Better by 1º than that of the joint members, provided the plan does not comprise any special stipulation.
- If the joints between the precast members are of small size and non-refd, the cross section of these joints cannot subjected to either compressive or shear.
- If the joints are of larger size and refd, their c/s can be taken into account because wider joints make easier and better concreting possible.

D) According to Austrian code:

- Similar to the Hungarian code.
- Specifies the value of the permissible shear stress is the precast and the in-situ concrete at only half of the value of the shear stress can be considered.
- Safety of joints against failure should not less than 3 fold.
- Joining of prefabricates in structural walls.

8) Explain the joint technique and materials used in detail? (Nov/Dec 2013)

Joint techniques normally employed are:

- Welding if cleats or projecting steel
- Overlapping reinforcement, loops and linking steel grouted by concrete.
- Reinforced concrete ties all round a slab
- Prestressing
- Epoxy grouting
- Bolts and nuts connection, and
- A combination of the above.

Materials for concrete joints:

There are numerous different materials used in forming joints in concrete slabs, but the most common are

- Flexible board
- Dowels
- Sealants

Flexible board:

- A fibrous, compressible, flexible board such as flexcell, it is cheap and readily available from builder's merchants in pre-cut strips of the required depth, especially for creating expansion joints.
- It is typically 12mm, 20mm or 25mm thick and right thickness for the joint should be chosen.
- No joint should be wider than 30mm.

Dowels:

- 400 – 600mm long, 20 – 32mm in diameter and manufactured from grade 250 steel.

Sealants:

There are three main types

- Hot poured, usually bituminous in origin. Not as widely used now a days as they once were.
- Cold applied, often a two part poly sulphide mix incorporating resins and curing agent. Usually applied via a mastic gun and smoothed with a putty knife.
- Preformed elastomeric, expensive and need to be squeezed and inserted into a scrupulously clean and well lubricated perfectly formed joint.

9) Explain the design of Expansion joints in Precast Structures (APR/MAY 2013) (Nov/Dec 2013) (May/June 2011)

Expansion joints are necessary in precast structures in order to allow for the expansion and cooling of various members due changing in temperature. In precast structures the shrinkage takes place before the assembling of members, therefore the spacing of expansion joints may be 1.5 to 2 times greater than in monolithic structures.

Expansion joints are usually formed at the joint of roofing members and main girders.