Precast Concrete Structures

Notes by-

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Precast Concrete Structures

* Precast concrete components are casted & cured in a factory & then transported to their "final destination."
* Precast concrete elements are finite size membered joined together to form complete structure.
* Structural difference bet" precast concrete & cast-in-situ concrete :→
  ① Strain & Strain Relationship (Load Induced)
  ② Internal effect [Volumetric change]
  These two factors distinguishes precast & cast-in-situ concrete.

* Advantages of Precast concrete :-
  1) ~~seepdy~~ Speedy construction.
  2) No weather effect
  3) Balancing of Resources :- As supplier invests his money on manufacturing precast units, i.e. factory, labour, equipments which are very costlier & the contractor who purchase that resources pays only for the matl. & manufacturing cost. He will not invest his money on installing factory, labour, equipment. Hence, he can get full advantage by investing very small amount. This is known as Balancing of Resources.

Thus, Supplier or owner invest money in-
① Land
② Establishment charges.
③ Heavy & automatic machinaries
④ Material
⑤ Labour
⑥ storing, handling, hoisting equipment.
Total = X

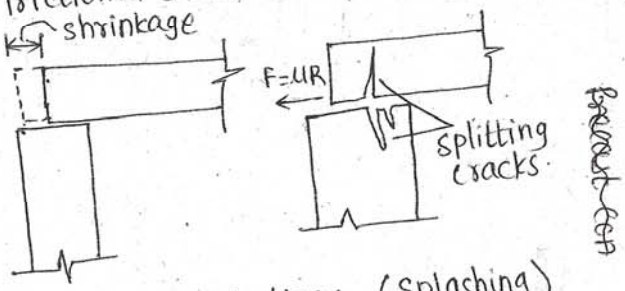
& contractor pays only for :-
The element casted. = x.
where $x \ll\ll X$.

④ Good surface finish. such as self cleaning, moissaic tiles, paint etc.
⑤ Full quality control throughout the process. (i.e. selection of ingredients to the curing & storing).
⑥ No equipments, formwork reqd. at site.
⑦ Simultaneous activities can be carried out. Thus, project duration minimizes.
⑧ slender, economic, light weight sections.

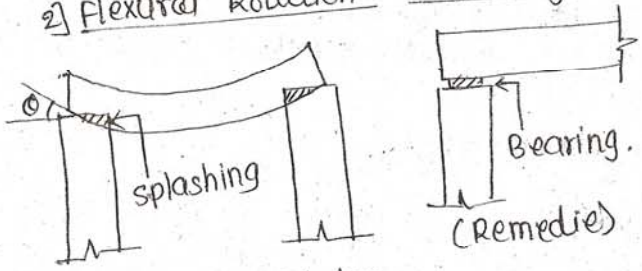
* Strength & Rigidity Consideration

Failure Criteria of Precast concrete :-

1] Change in volume :- (Spliting)
Due to change in vol. of precast units, frictional stress are induced.

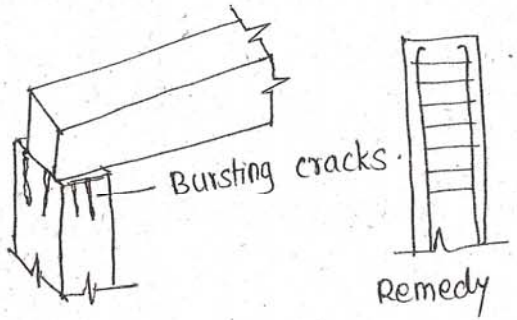


2] Flexural Rotation :- (Splashing)

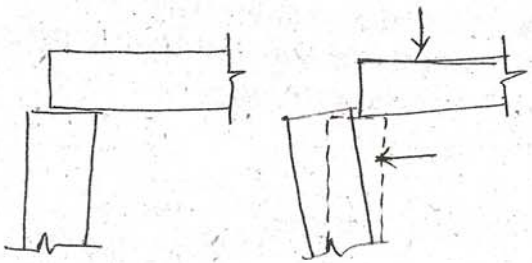


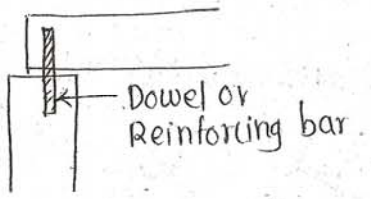
θ = Flexural Rotation.

3] Less Bearing area :- (Bursting).

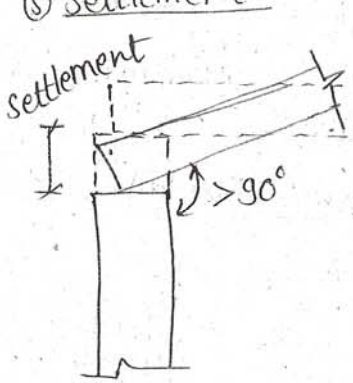


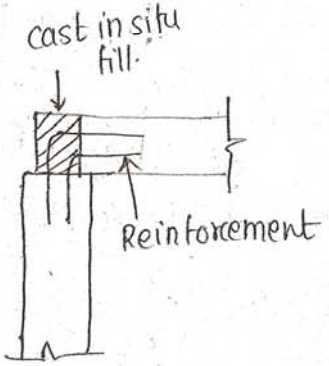
④ Shifting of support:-





⑤ Settlement:-





* Analysis:-

As precast units are manufacted at factory, & transported to site, then connected. The transfer of force from one component to other is not similar to cast-in-situ or monolithic structure.

Thus, we have to find "Most suitable places of connection" in case of precast structure & two components are connected to each other wher force transfer rate is minimum.

* Consider a framed structure:-

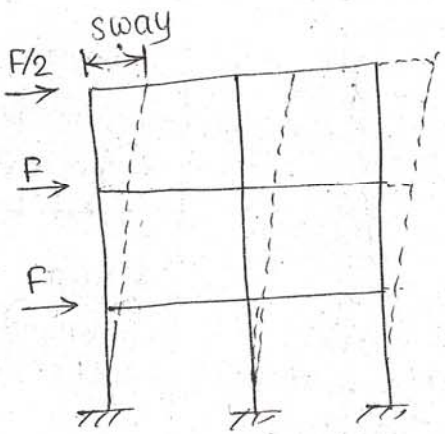
↓

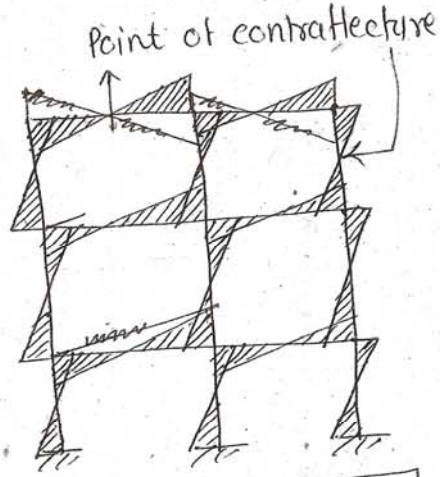
* Failure of precast unit:- ① Splitting → friction → Vol. change
② Bursting → comp. → less bearing area
③ Splashing → Moment → Flexural Rotat^{n}
④ Sway → Thrust → shifting of support
⑤ Settlement → Heavy load → ∠ 90°.

$M = A_{st} \cdot j_d \cdot A_{st}$

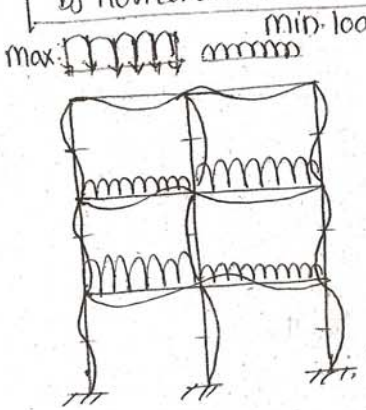
a) Rigid frame (continuous) (Unbraced)

	Point of contraflecture
I] Beams:-	
a) Vertical load (Gravity) Predominanet	0.1d from face of column.
b) Horizontal load (wind) Predominanet	Midspan.
II Column	
a) Vertical load	Midspan
b) Horizontal load	

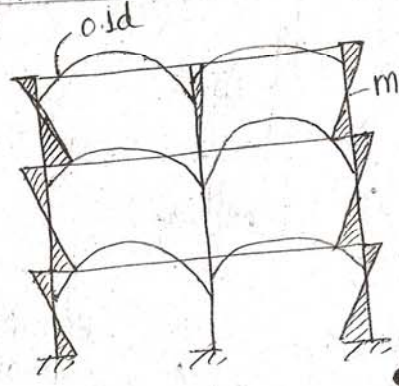




Horizontal load (wind) Predominent



Elastic curve

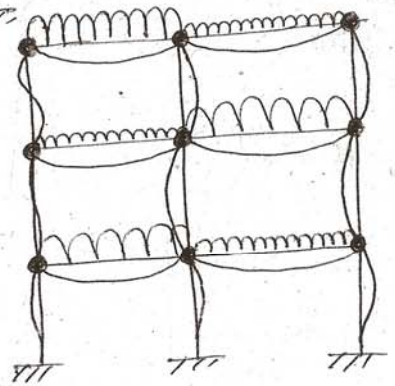


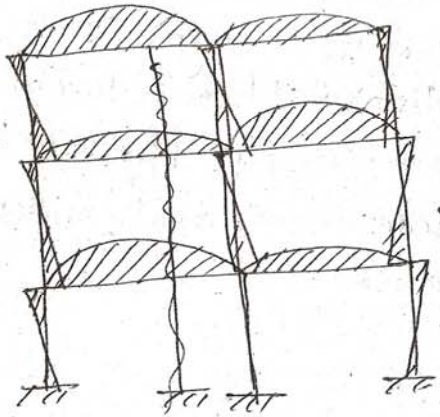
BMD.

Gravity load Predominanet

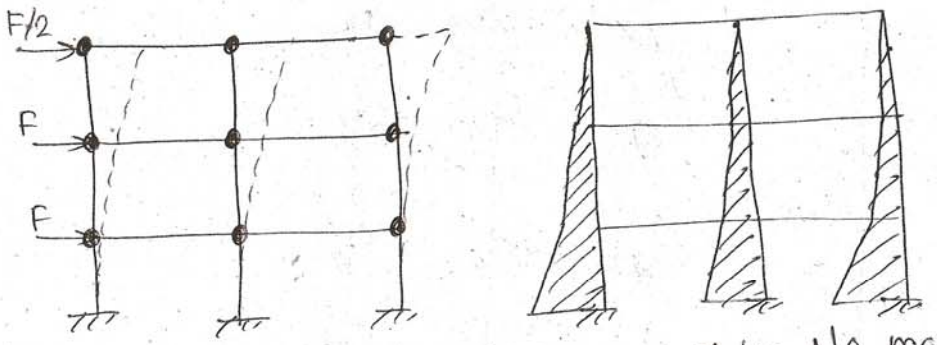
* If stiffness of connection at the end of beam is reduced to zero & only & col^m & found^n are in fixed support [Hinges are provided through out the connection except b col^m & foundation connection) we get,

Note:- Beam-col^m elastic line Remains $\perp^{ar}$ ⇒ Then draw Elastic curve for column & then maintain $\perp^{ar}$ to b/w col^m.





Gravity load Predominant



Horizontal Force Predominent

Note:- No moment Transfer to beam.

Thus in case of pin jointed structure, beams does not transfer moment. This is the principle of Pin jointed unbraced skeleton frame.

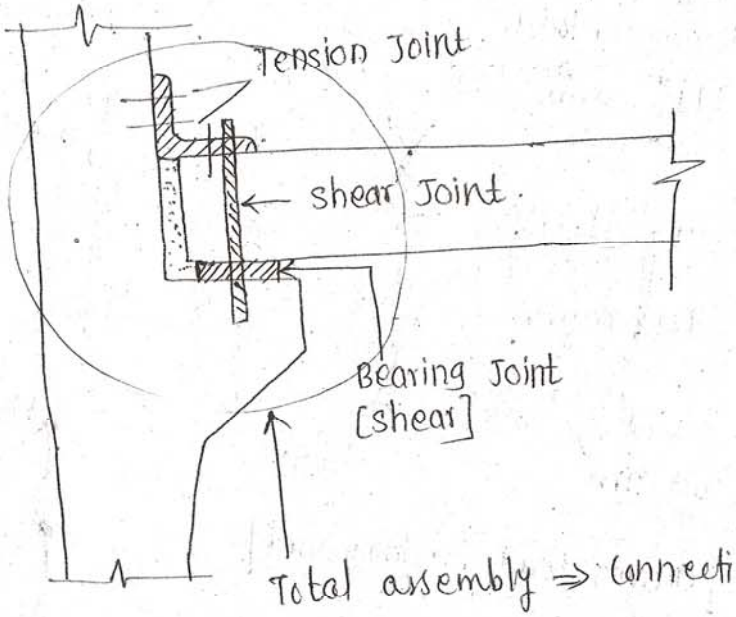
* Thus, from above fig, it is clear that, we should keep joint at midheight of column. & In case of Beam, joint is at distance 0.1d' from face of column [Note:- 0.1d ⇒ Bent-up bars] ~~⇒~~ RCC.

if gravity load is predominant & at midspan if horizontal load is predominent.

Design of connection:- [connection ≠ Joint]

* connection:- Total const° bet° two or more connected component. It includes part of precast component itself & may comprise of several joints.

* Joint:- A part of connection bet° two elements. [elements may be precast, in-situ casted, mortar bedding, mastic sealant etc]



Connection

~~Joint~~ transfers : 1] comp. force
[Monolithic] 2] Tensile force
3] Shear force
4] Bending moment
5] Torsional moment
6] Frictional force.

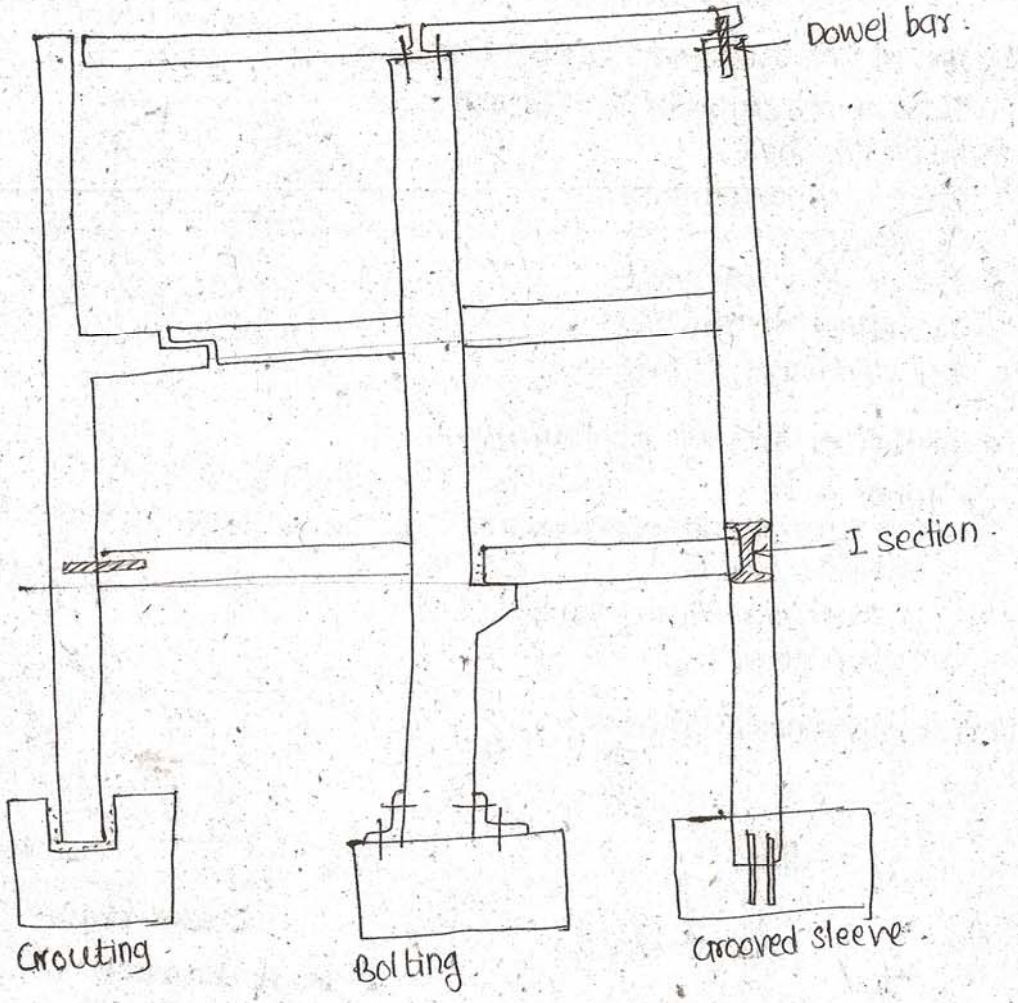
In case of precast unit : a] Pretensioning stress
[In addition to] b] Shrinkage stress
c] Creep stresses.
d] Handling stresses
e] Erection stresses

Design & const^n of Joints (2 elements) & connection (more than 2 element), is very imp. in Precast const^n

Joint :- Action of ① Compression
② Tension
③ Shear

Connection :- ① Comp
② Tension
③ Shear
④ BM
⑤ Torsion (if any)

\+ a] Fire stresses
b] Accident stresses
c] Effect of Temporary const^n.
d] Bad workmanship

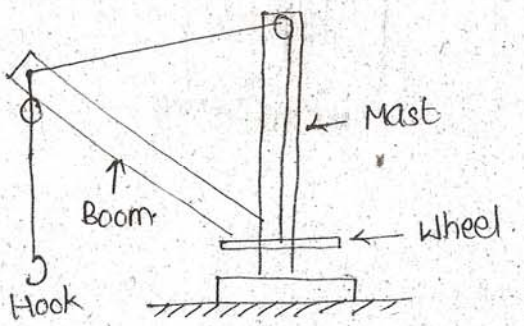


Erection Techniques

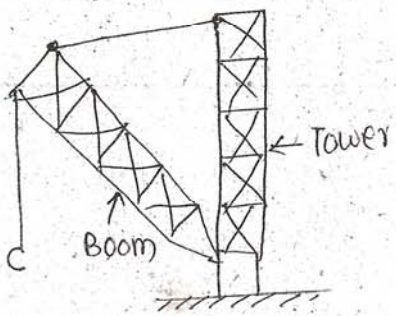
* Factors affecting choice of erect° equipment :-
  1) Type of component - slab, beam
  2) Lifting height
  3) Weight of component
  4) Topography
  5) Length of component
  6) Travelling distance.
  7) Soil condition [space]

* Erection or lifting appliances :-
  1] Cranes :-
    a] Stationary / Derrick Crane
    b] Mobile crane
    c] overhead / Gantry cranes
    d] Travelers

① Derrick / stationary crane :-

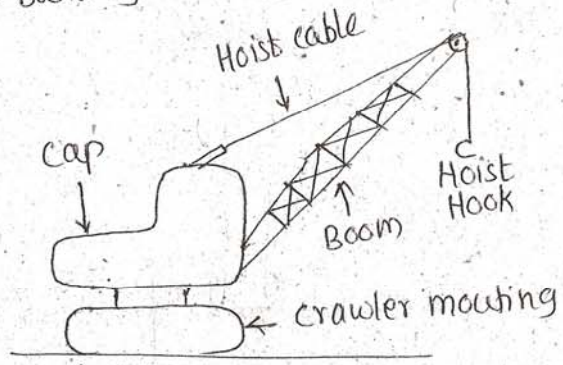


② Guyed Derrick :-



b] Mobile crane :-

* Building covering large area.



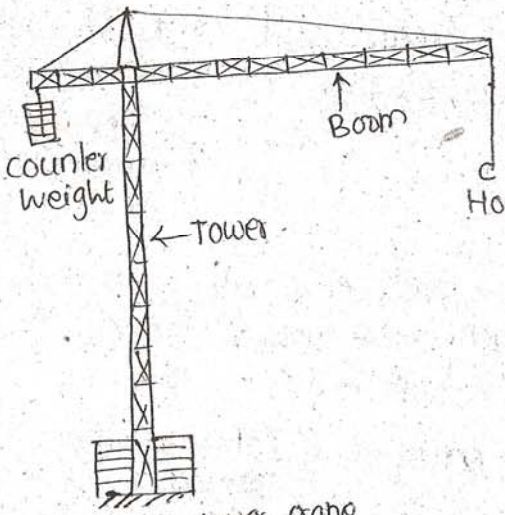
Crawler crane

* Short duration
* More travel.
* ~~Width~~ Height < Length to be travelled
* Derric cranes are suitable for the erection of component at same space

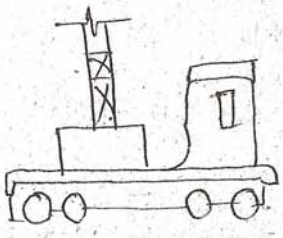
③ Tower cranes :-

1) Static Tower crane
2) Rail mounted tower crane
3) Truck mounted tower crane.

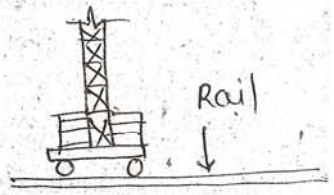
Used for : HRS.



Static tower crane.

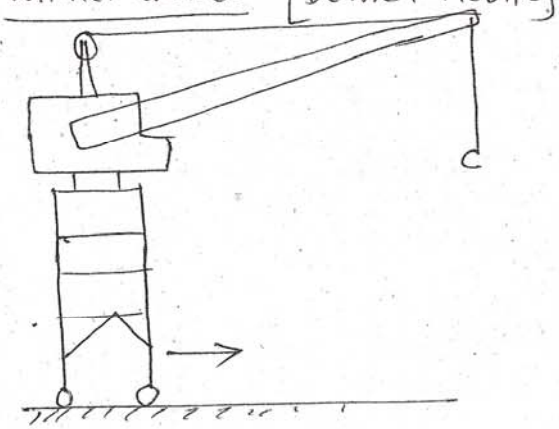


② Truck mounted.

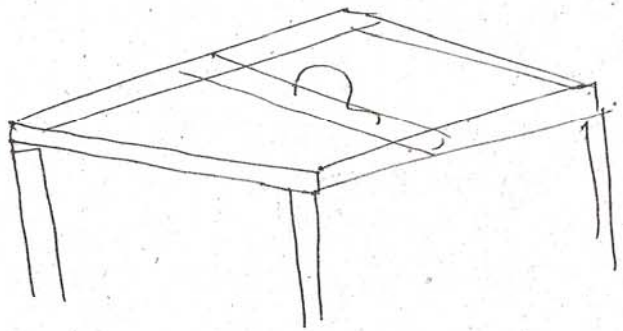


3] Rail mounted.

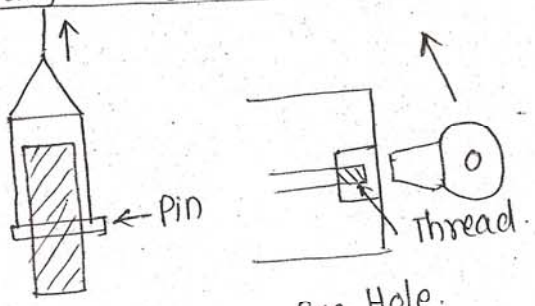
* Whirler Cranes :- [Derric + Mobile]



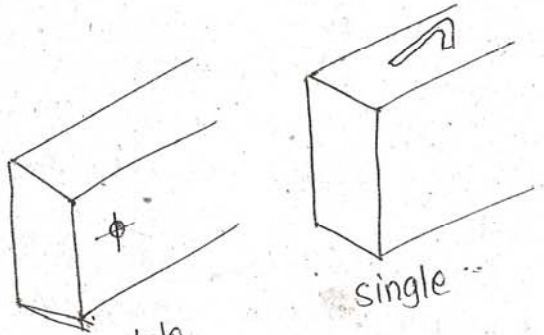
* Golith Crane :- Ganby Crane

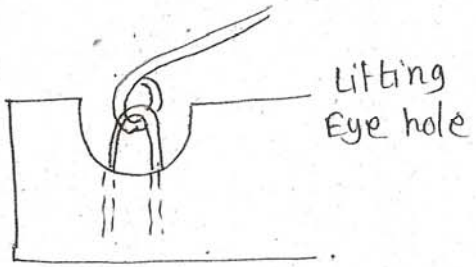


Lifting arrangement

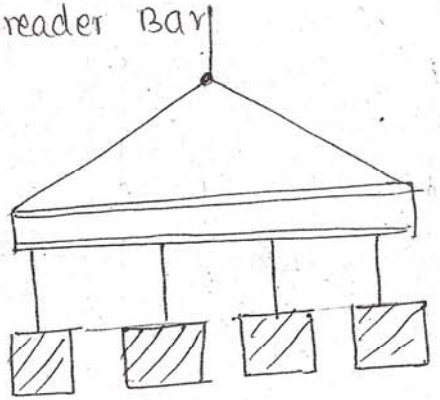


Rope or Nylon sling



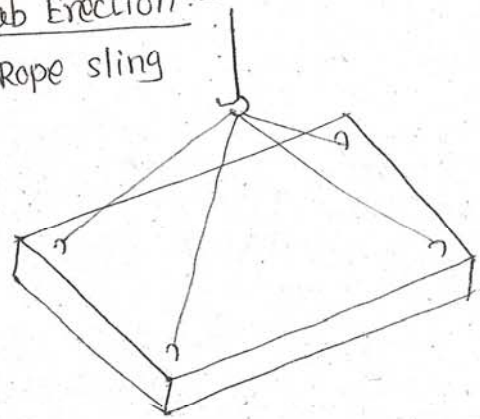


Spreader Bar

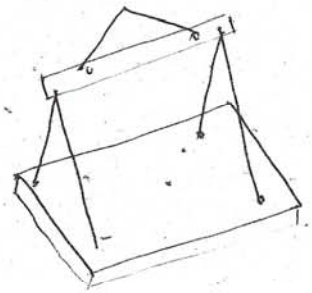


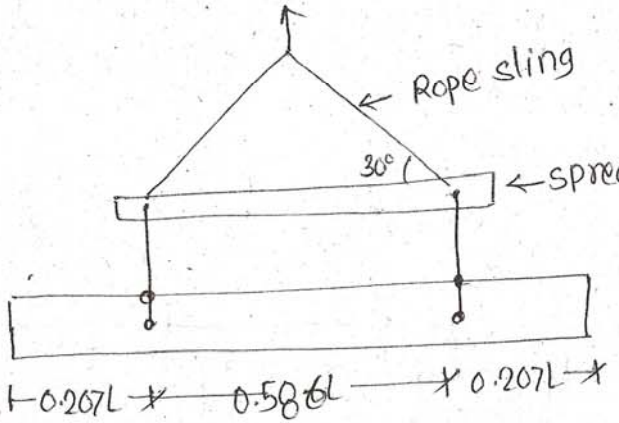
Slab Erection :-

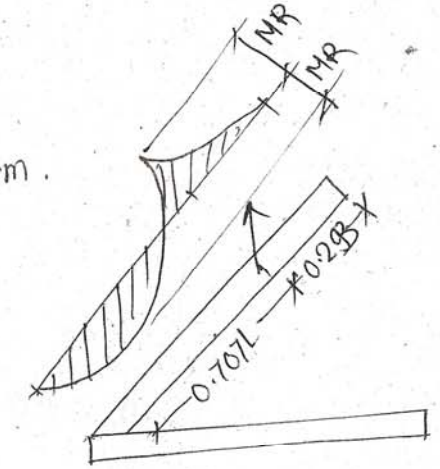
① Rope sling



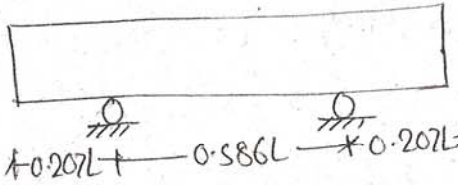
② spreader Beam



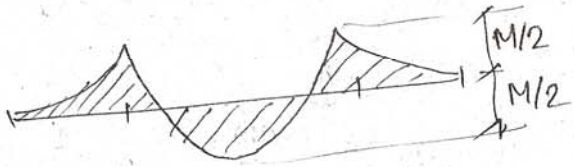




Moment due to handling.



Transportation.



Column Design:-

Columns are demoulded after 12-15 hours & cured in steam curing bath. Lifting is done at 0.207 L from each end.

While designing 25% stresses due to erection & impact should be considered.