REKABENTUK SISTEM KERANGKA KONKRIT PRATUANG.

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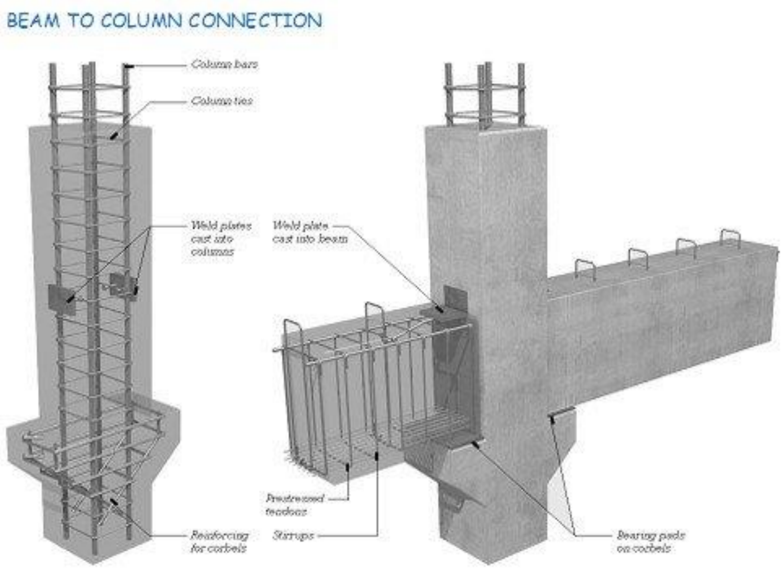
CKAS JKR

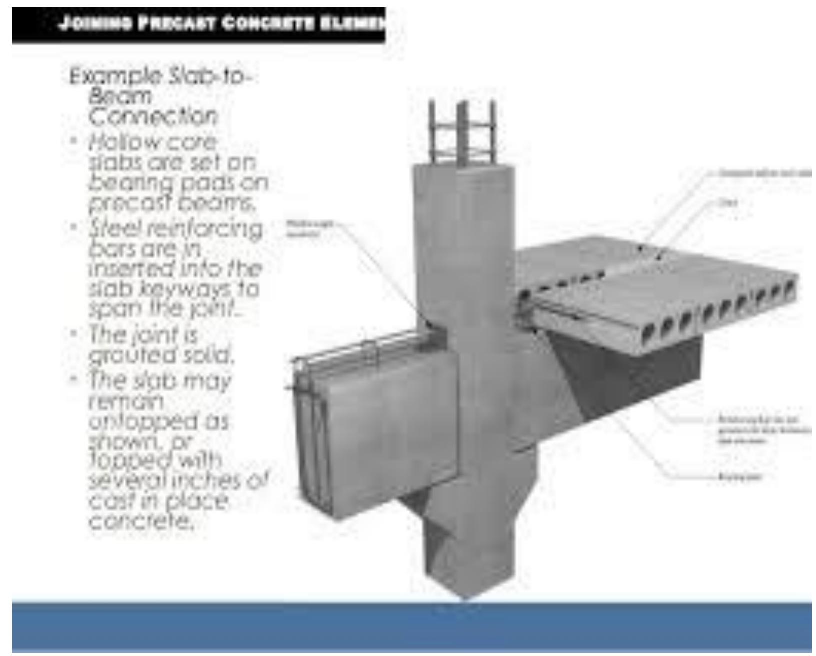
REKABENTUK SISTEM KERANGKA KONKRIT PRATUANG.

1. **Prinsip rekabentuk bangunan konkrit pra tuang.**
2. **Kod amalan rekabentuk.**
3. **Stability kerangka** ***(Frame Stability)***
4. **Sistem kerangka konkrit pratuang**
5. **Rekabentuk braced component** ***(Shear wall).***
6. **Ties and Connections to braced structure.**

Prinsip rekabentuk bangunan konkrit pratuang

- Perbezaan bangunan konkrit insitu dan pratuang adalah pada sambungan (connectivity)
- Sambungan bangunan konkrit insitu berlaku semasa semasa kerja konkrit berjalan.
- Untuk struktur pratuang, sambungan berlaku apabila komponen struktur seperti tiang/rasuk, papak/rasuk disambungkan.
- Kelakuan struktur sepertimana direkabentuk.


BEAM TO COLUMN CONNECTION
Column bars
Column ties
Weld plates cast into columns
Weld plate cast into beam
Prestressed tendons
Stirrups
Reinforcing for corbels
Bearing pads on corbels


JOINING PRECAST CONCRETE ELEMEN
Example Slab-to-Beam Connection
• Hollow core slabs are set on bearing pads on precast beams.
• Steel reinforcing bars are in inserted into the slab keyways to span the joint.
• The joint is grouted solid.
• The slab may remain untopped as shown, or topped with several inches of cast in place concrete.

- The behaviour of the precast structure is dependent on the behaviour of the connections.
- It respond to
  - Resistance to all design forces
  - Ductility to deformations
  - Durability
  - Fire resistance
  - Production and construction consideration

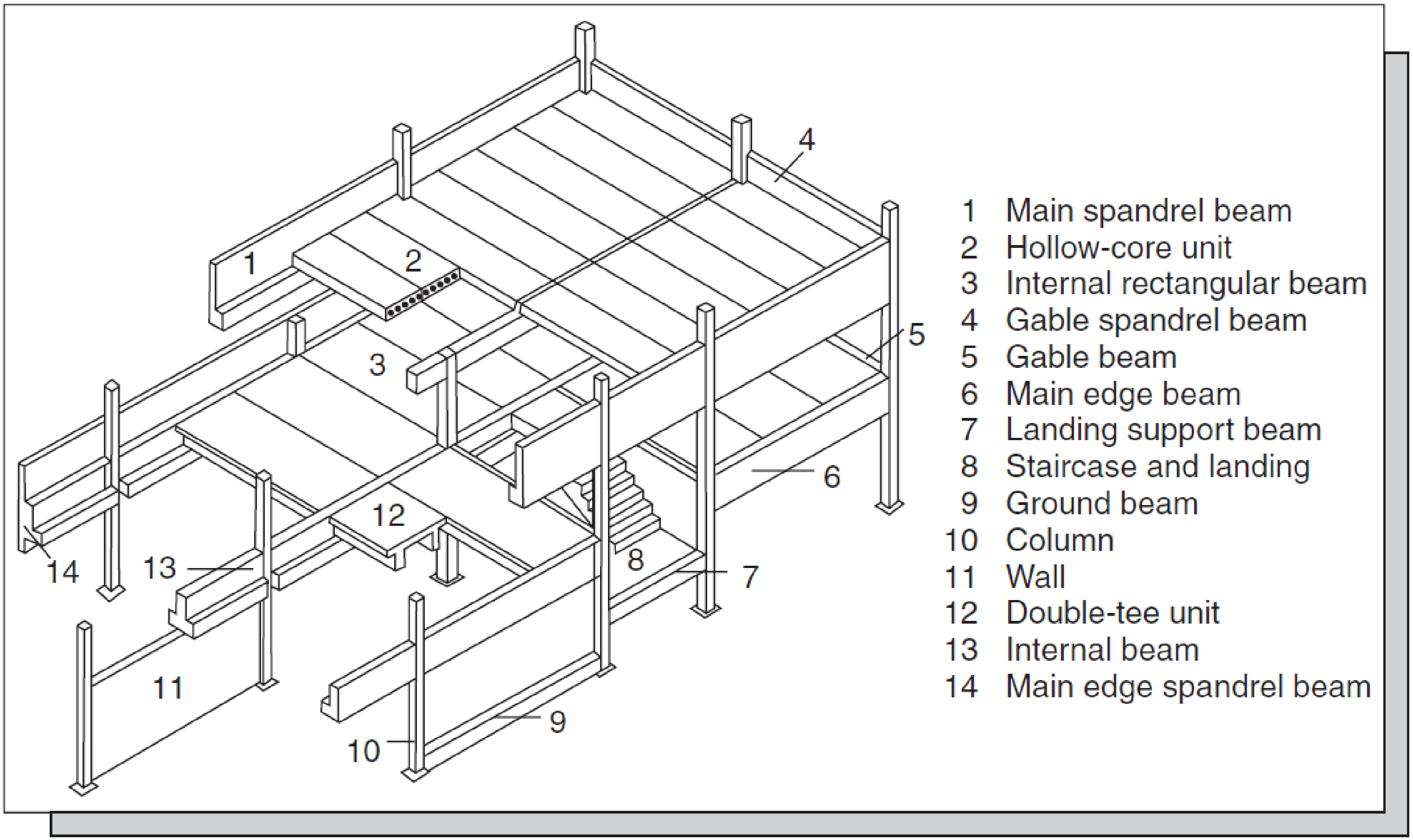


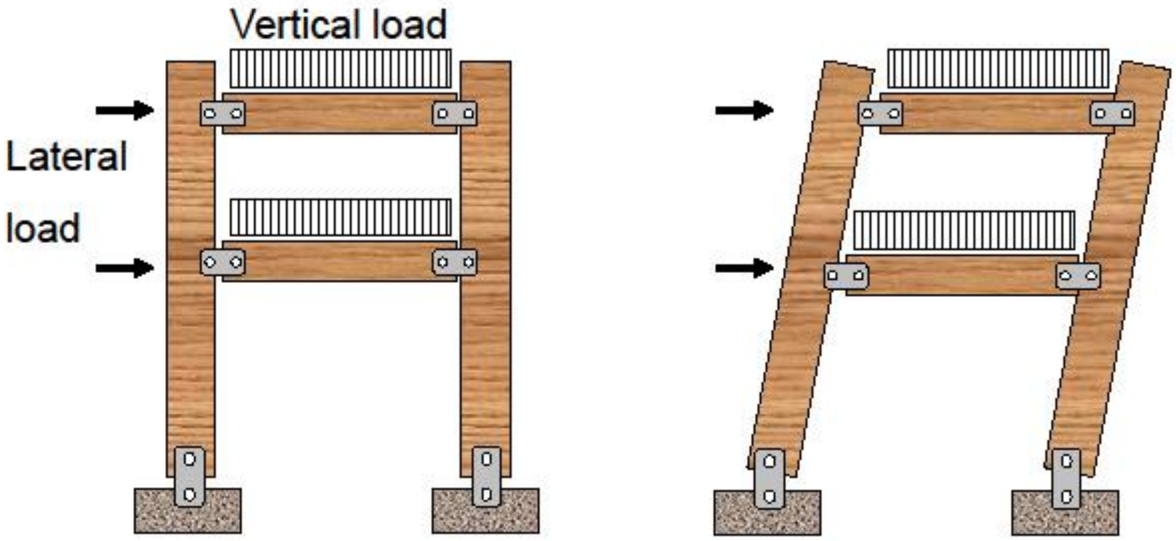
Figure 3.2: Definitions in a precast skeletal structure.

Types of Structural Systems in Precast Concrete Structures

Wall System (Load bearing system)

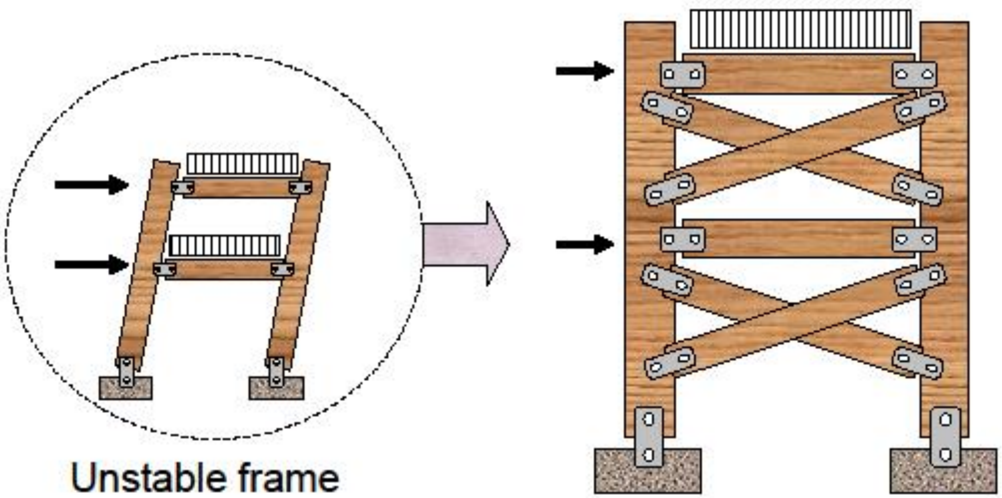
Skeletal frame system

Frame Stability



- **Pinned beam-to-column connections**
- **Frame is not stable when subjected to lateral forces.**

Frame Stability



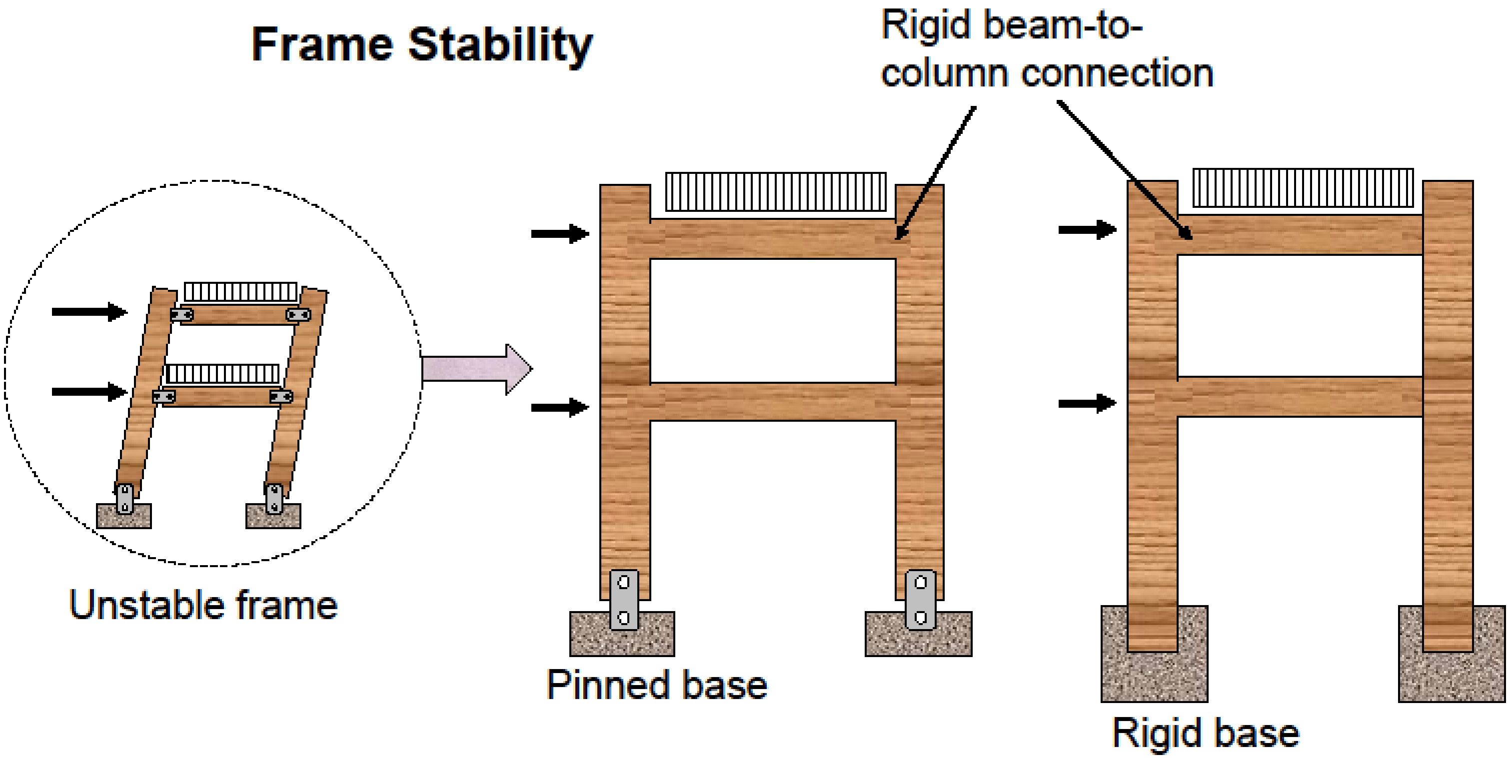
Unstable frame

Stable frame

Methods to stabilize the structure:

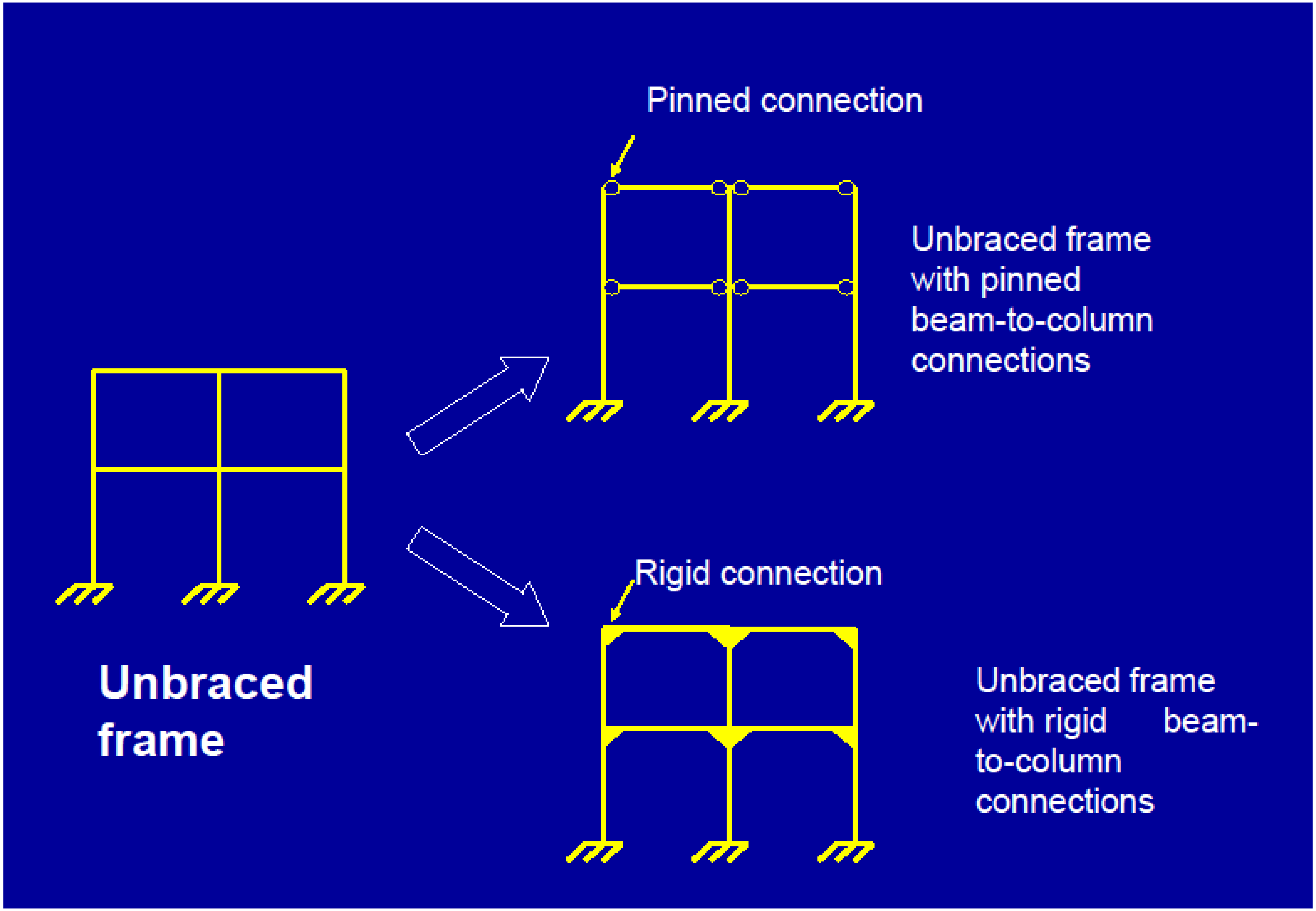
- **Introduce bracing system**
- **The system is known as Simple Construction System**

Frame Stability



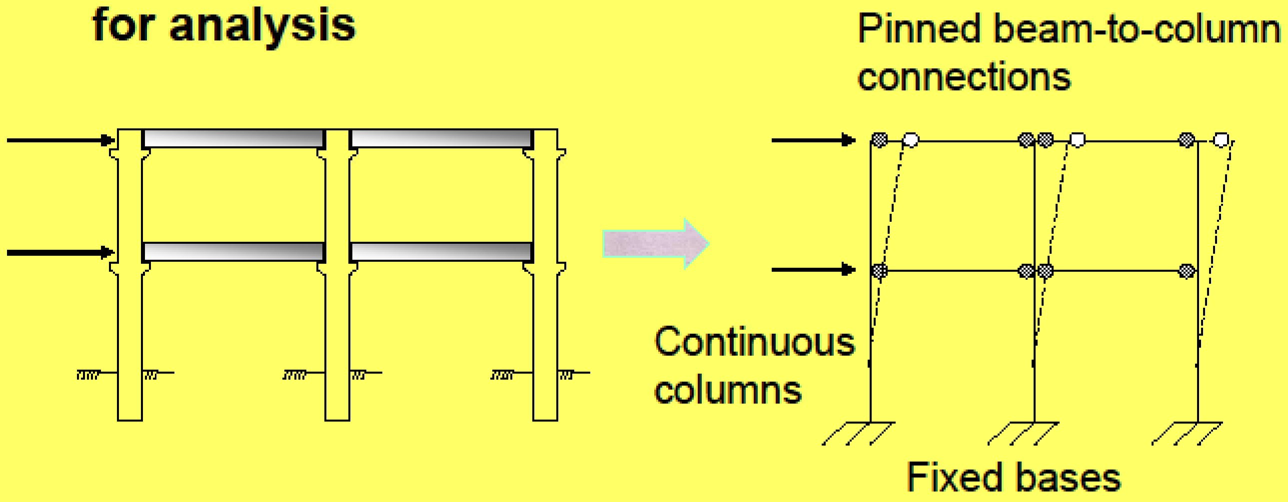
Methods to stabilize the structure:

- **Introduce rigid beam-to-column connections**
- **Column-to-base connection can be pinned or rigid**


Pinned connection
Unbraced frame with pinned beam-to-column connections
Rigid connection
Unbraced frame with rigid beam-to-column connections
Unbraced frame

Frame Action - Cantilever column

Typical frame model for analysis



Frame Action - Cantilever column

Cantilever column:

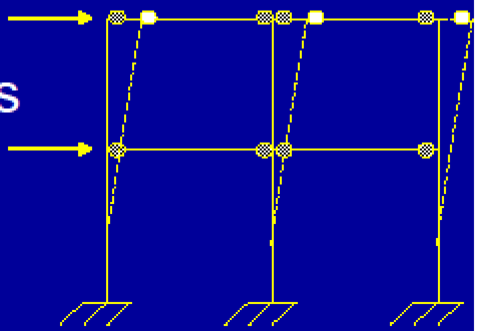
- Low-rise skeleton structures are normally stabilized through the cantilever action of the columns.

Frame Action - Cantilever column

Criteria for unbraced frames with cantilevered columns

- ***Beam-to-column connections are assumed as pinned.***

  Any partial restraints provided by the beam-to-column connections, walls or spandrel panels are ignored.



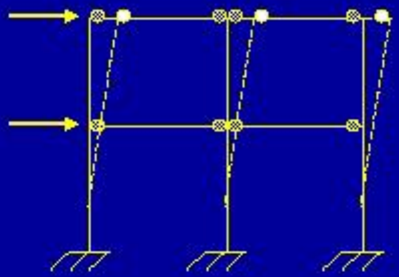
- ***Column-to-base connections are fixed.***

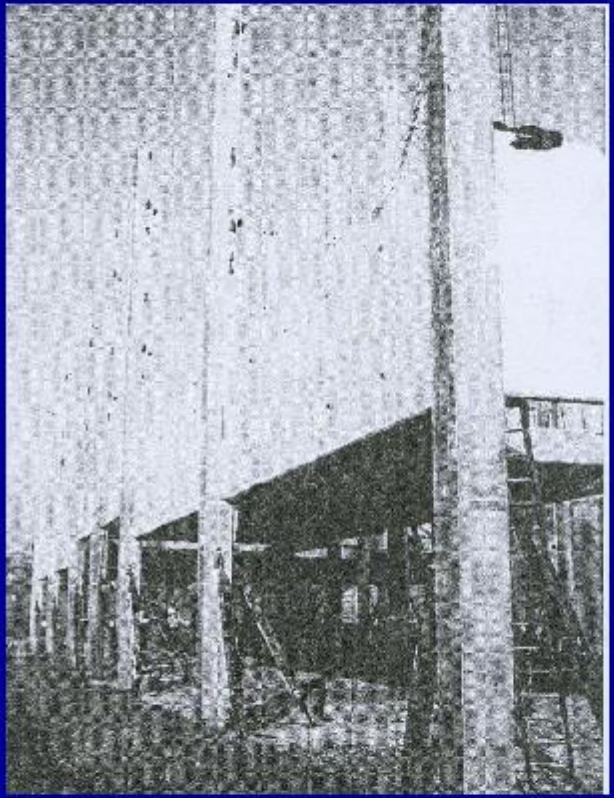
  The precast columns are fixed into the foundations with moment-resisting connections. As a result, columns can be analyzed and designed as cantilevers

- ***No other independent lateral resisting systems such as shear walls or cores.***

Frame Action - Cantilever column

- The stability of unbraced pin jointed frames is provided entirely by columns designed as cantilevers for the full height of the structures.

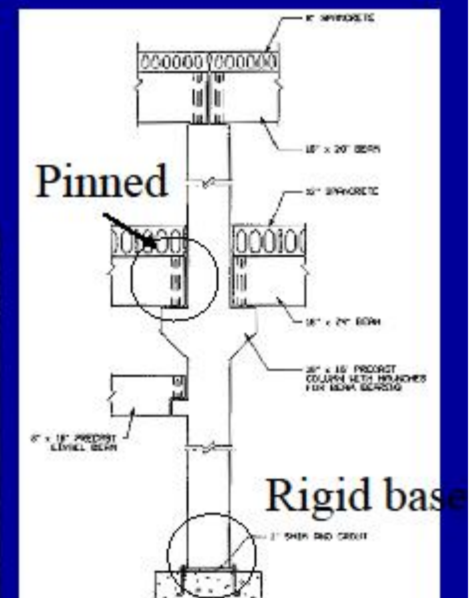




Typical example of unbraced frame with cantilever columns

Frame Action - Cantilever column

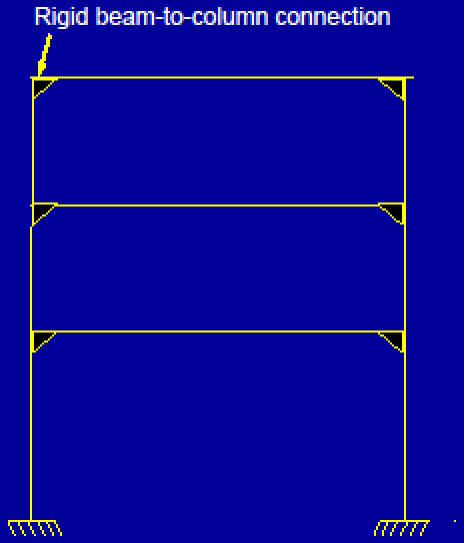
- Other examples where the stability of unbraced frames against lateral forces can be achieved by the designing the columns as cantilevered.



Precast Beams with Haunched Column

Frame Action – Moment Resistance Frame

Criteria for unbraced frames with frame resistance action



- ***Beam-to-column connections are assumed as rigid.***

  Restraints provided by

  the beam-to-column connections are considered in the analysis and design.

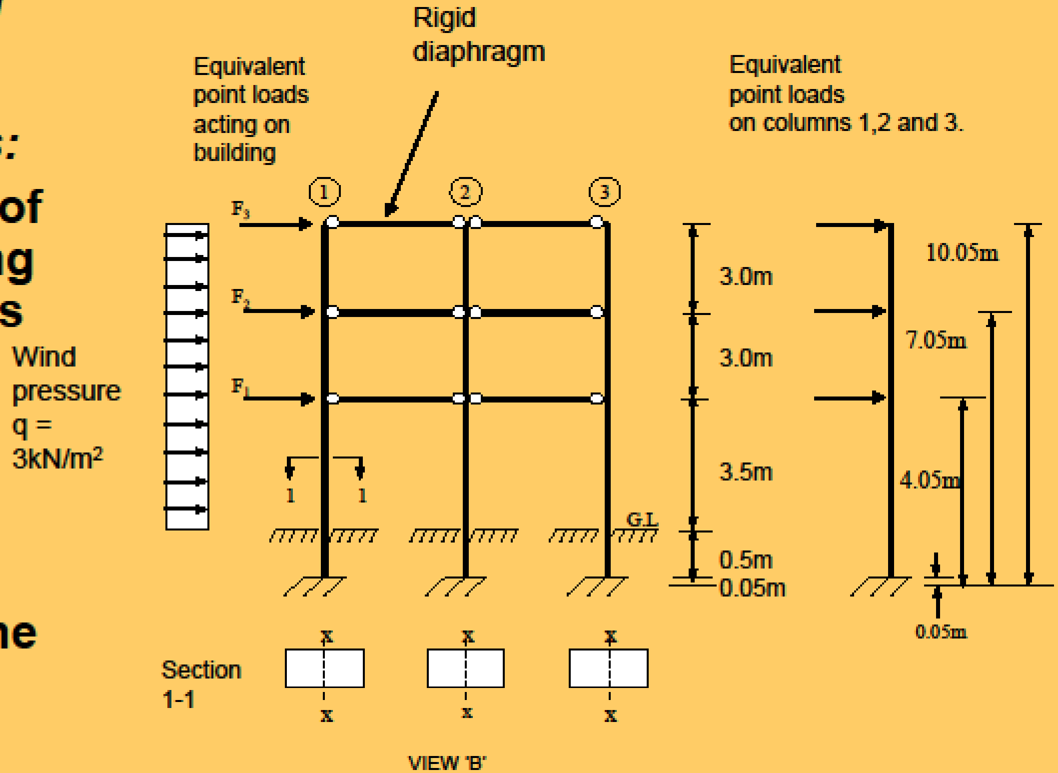
- ***Column-to-base connections are fixed.***

- ***No other independent lateral resisting systems such as shear walls or cores when lateral deflections are not excessive (I.e. in the case of low storey frames).***

Frame Action - Cantilever column

Analysis of lateral loads for unbraced frames with cantilever columns:

- **The distribution of horizontal loading between columns is directly proportional to the second moment area of the columns, I.**
- **In most cases, the columns will be equally loaded horizontally.**



Frame Action - Cantilever column

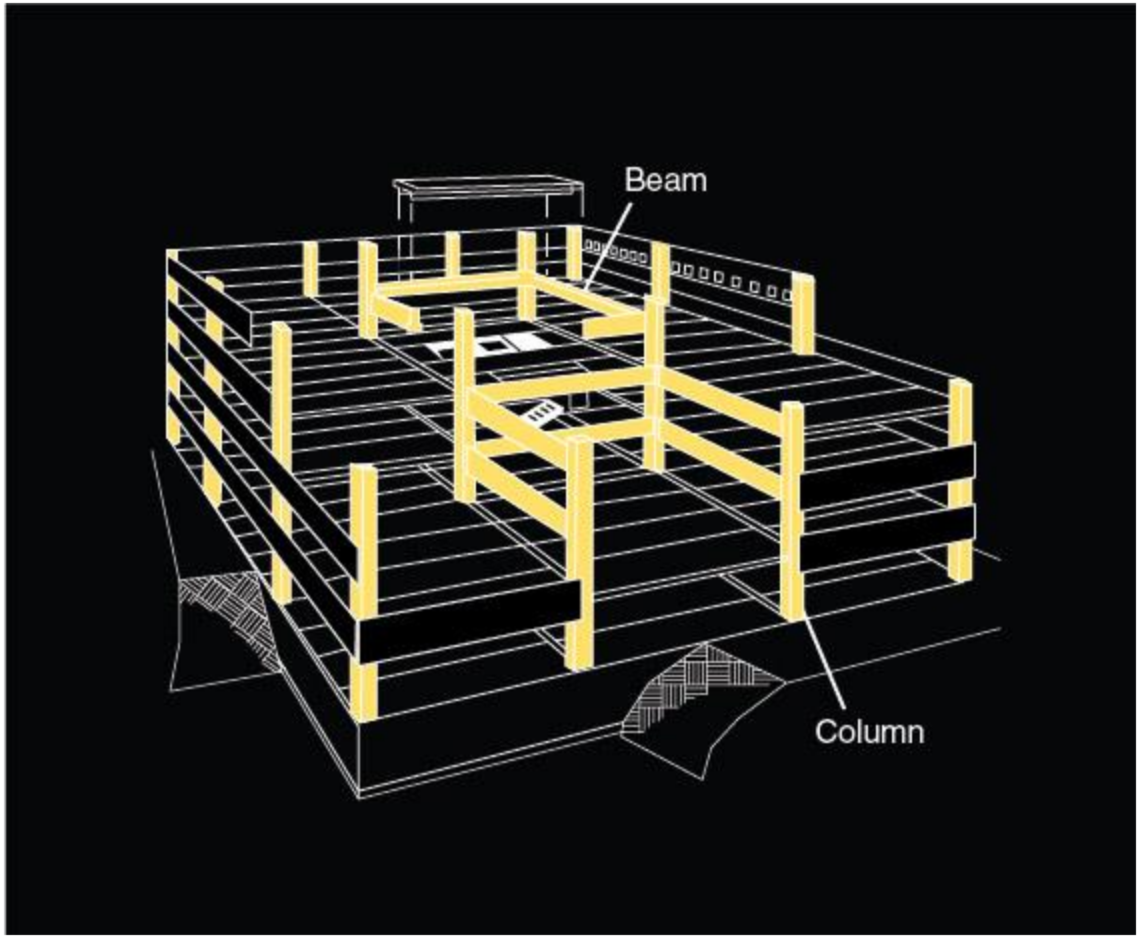
Limitation:

- The maximum height of an unbraced frame with cantilever action is 10m (i.e. up to about 3 storeys).
- Cantilever columns are designed using effective length factor of 2.3, hence larger columns.

Advantages:

- No bracing
- Pinned beam-to-column connections – simple to construct.
- Columns are manufactured in a single length, column splices are not required.


Unbraced Frame
2005 5 11



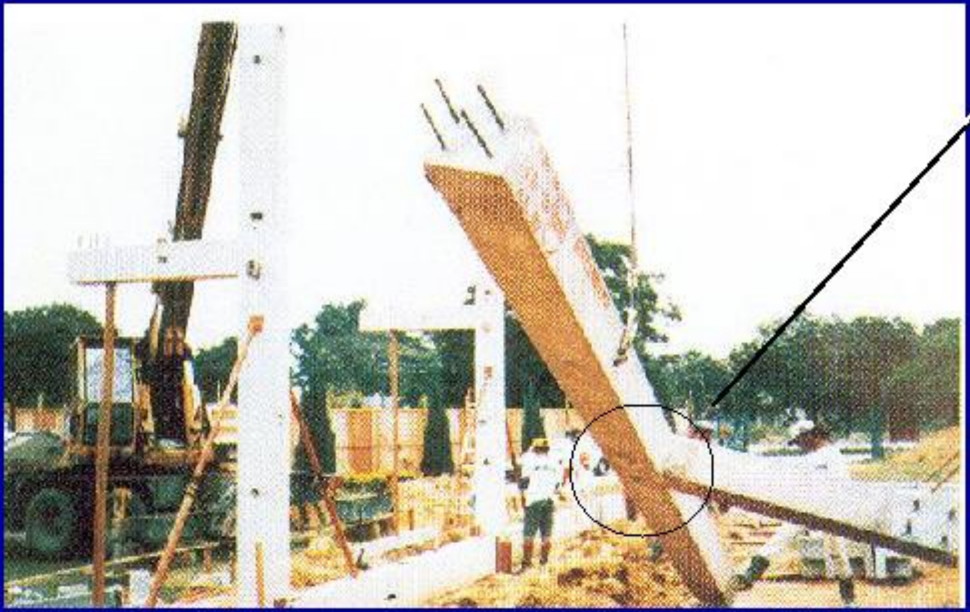
Moment-Resisting Frames

Moment-resisting frames are those in which a degree of rotational restraint is provided between vertical components (usually columns) and horizontal components (usually beams and/or spandrels). This system then resists lateral loads imposed on the structure.

Frame Action – Moment Resistance Frame

- The stability of unbraced rigid frames is provided by the bending resistance and the rigid connections.

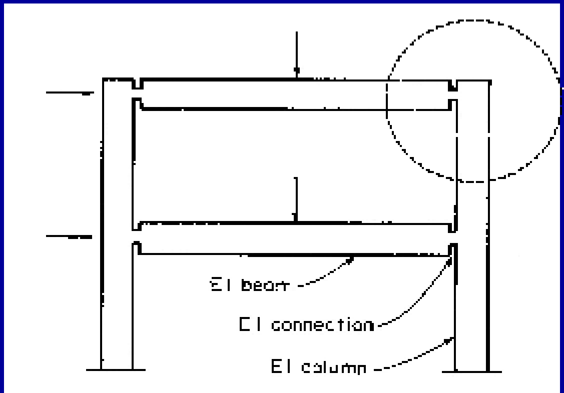
Rigid beam-to-column connections



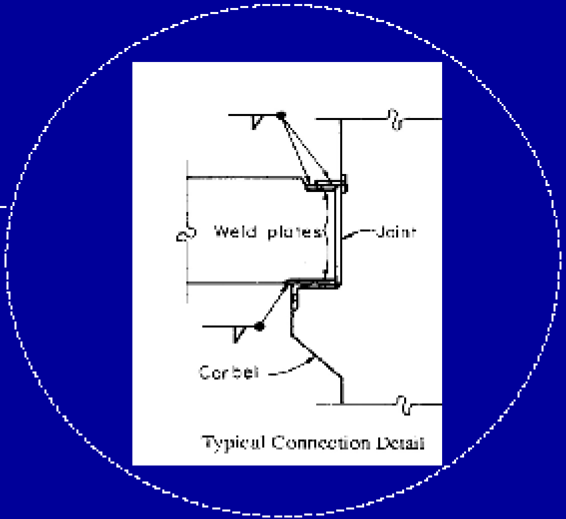
Typical example of unbraced precast frame with rigid beam-to-column connections

Frame Action - Moment Resistance Frame

- Example of moment resisting frame system



Equivalent Stiffness (EI) Diagram

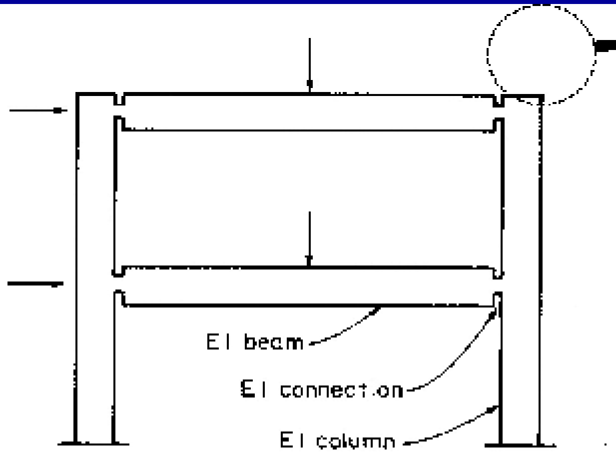


Typical Connection Detail

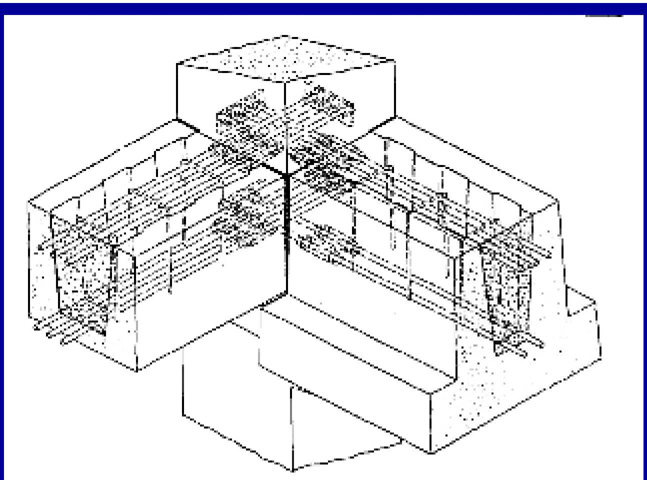
Example of rigid beam-to-column connection

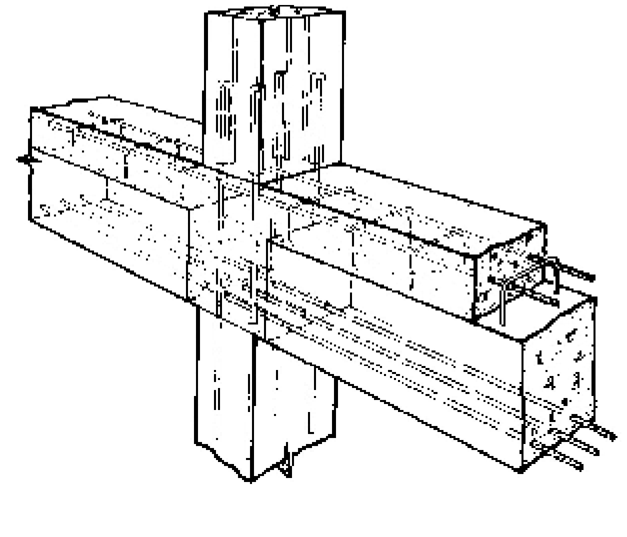
Frame Action –
Moment Resistance Frame

- Other examples of rigid frames



Equivalent Stiffness (EI) Diagram

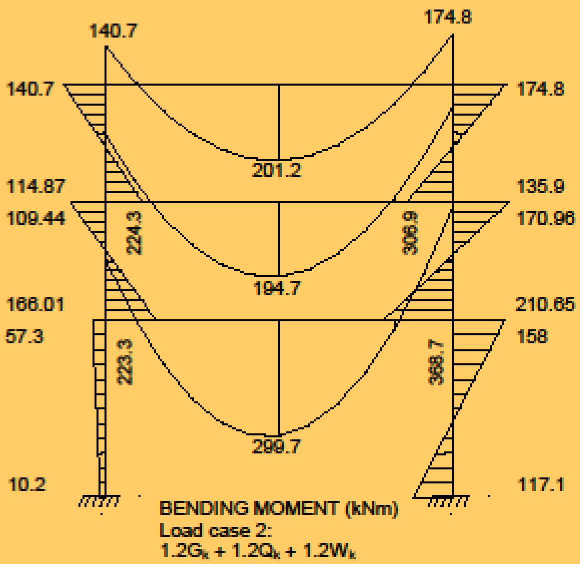


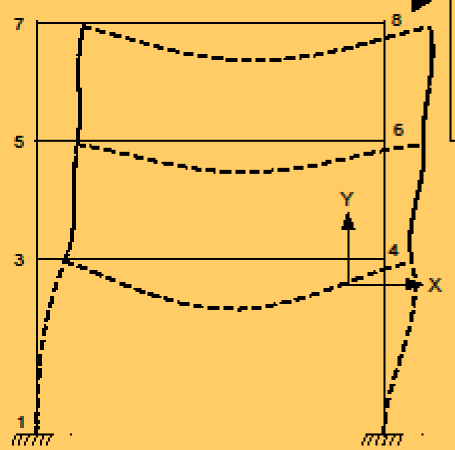


Beam Column Joint

Frame Action - Moment Resistance Frame

Results of analysis of bending moment of resisting frames





The resistance to horizontal loadings is provided by the bending resistance of frame members and their connections

Frame Action – Moment Resistance Frame

Limitation:

- Rigid beam-to-column connections, difficult to construct.
- Rigid base – foundation should be designed considering the moment.

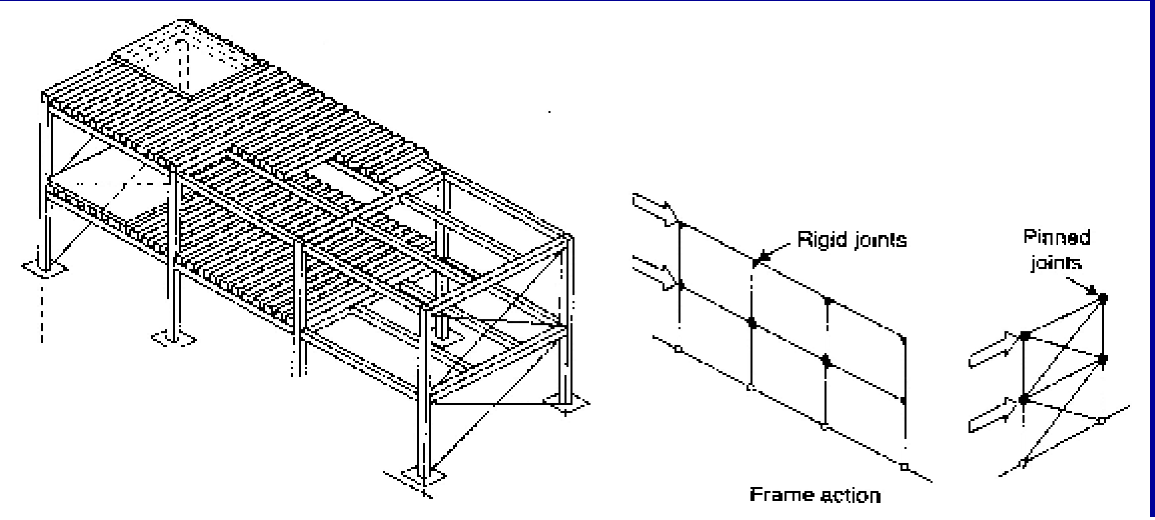
Advantages:

- No bracing such as shear walls or cores.
- Suitable for low rise frames.
- Suitable for buildings in seismic regions.

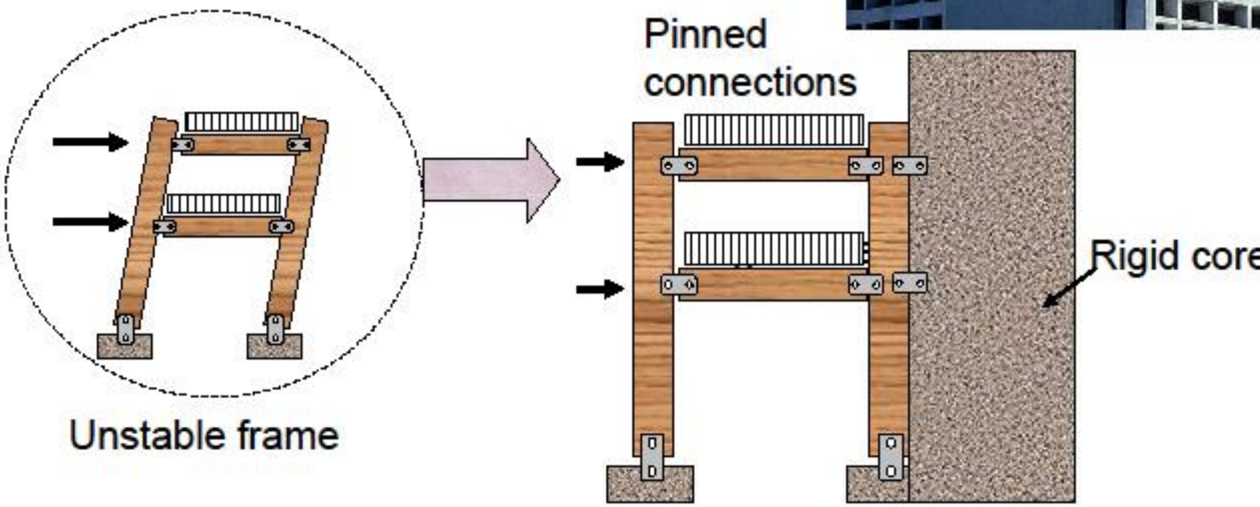
Independent lateral stability system

Skeletal braced frames (the skeletal frames are combined with other lateral stabilising components):

- In precast concrete structures, bracing elements are provided in the forms of shear walls).
- Other methods of bracings are infill brick walls or steel cross-bracing.



Frame Stability

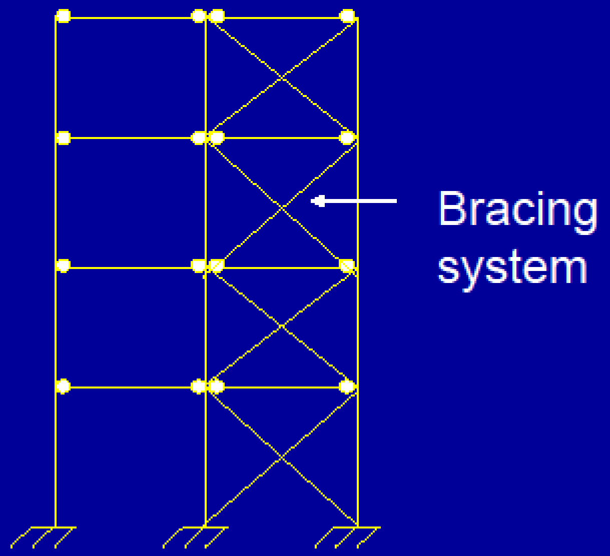


Frame is stabilized by rigid shear wall or RC core

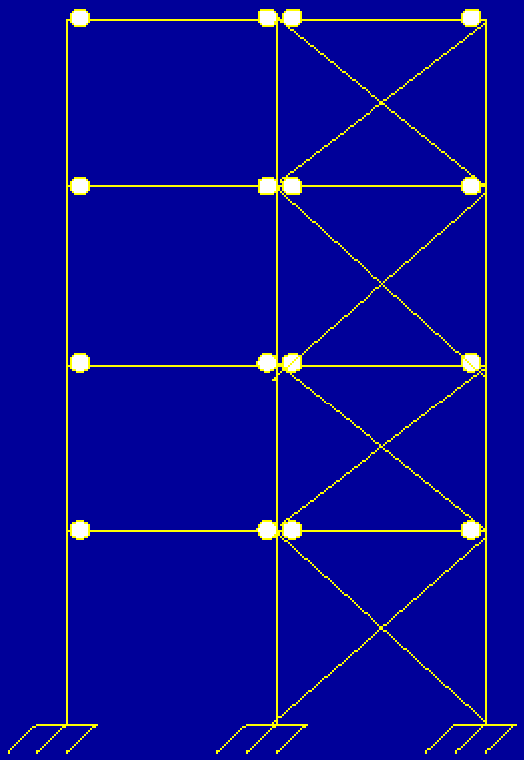
Shear wall

- Shear walls act as vertical cantilever beams
- Shear walls transfer lateral forces from the superstructure to the foundation.
- In most precast, it is desirable to resist lateral loads with shear walls of precast or cast-in-place concrete.
- Shear walls can consist of the following:
  - Exterior wall system
  - interior walls
  - walls of elevator
  - cores

- Precast skeletal structures of more than 3 storeys are normally braced.
- Precast concrete walls may be classified as infill or cantilever.



- In braced structures, pinned beam-to-column connections may be employed, hence connection details, design and construction are greatly simplified.

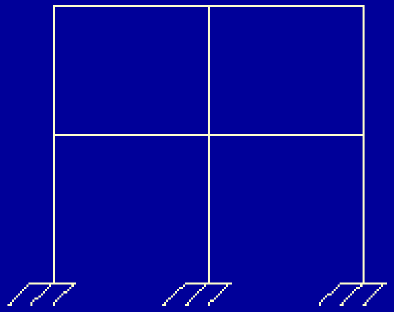


BRACED FRAME

BRACING – precast cross bracing designed as fixed ended "struts"

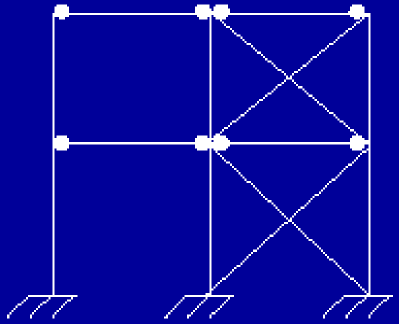
SKELETAL FRAME SYSTEM

Unbraced Frames



In unbraced frame, the lateral forces are resisted by its own lateral stability such as cantilever columns or rigid frames.

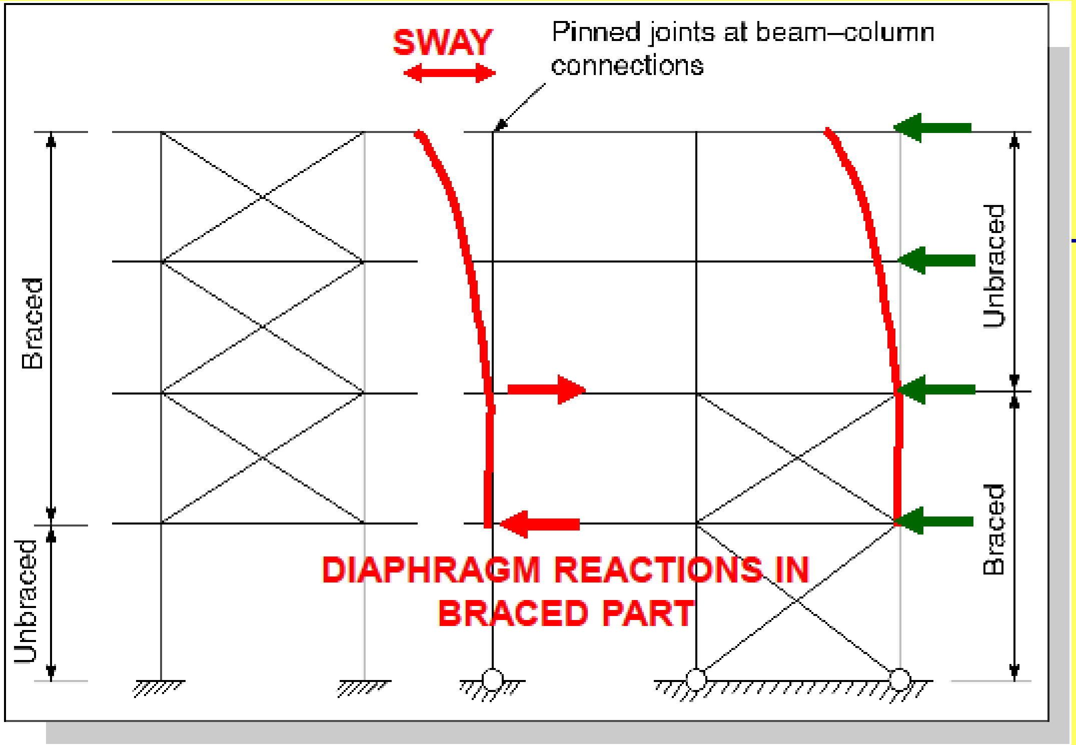
Braced Frames

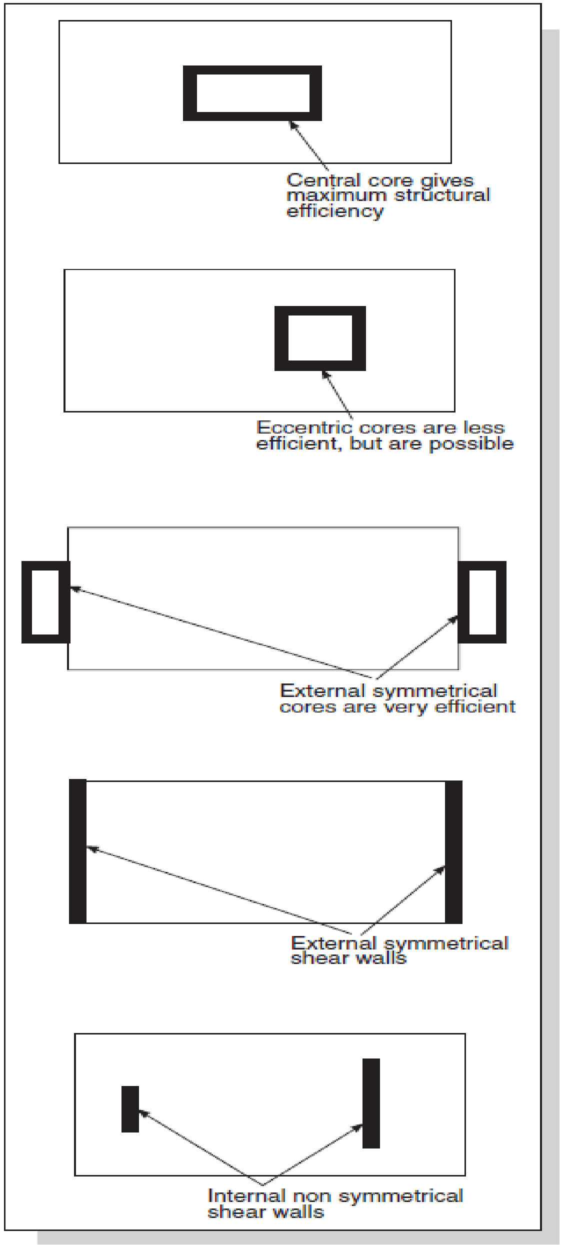


In braced frame, the lateral forces are resisted by lateral supports such as bracing, core or shear wall.

STABILISING METHODS

Partially braced – top up, or bottom down

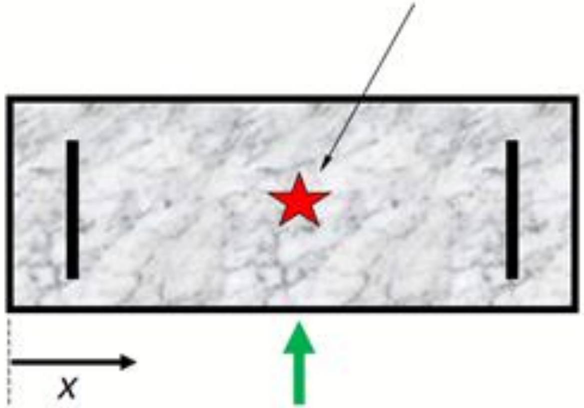



Central core gives
maximum structural
efficiency
Eccentric cores are less
efficient, but are possible
External symmetrical
cores are very efficient
External symmetrical
shear walls
Internal non symmetrical
shear walls

Determine the Centre of Frame Stiffness

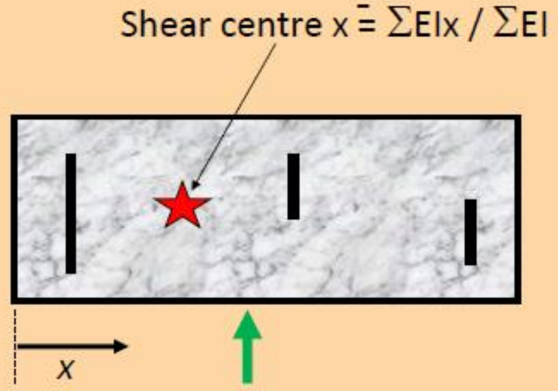
For symmetrical bracing $\bar{x}$ = Mid-length ($L/2$)

Shear centre $\bar{x} = \Sigma EIx / \Sigma EI$



Where does net reaction occur

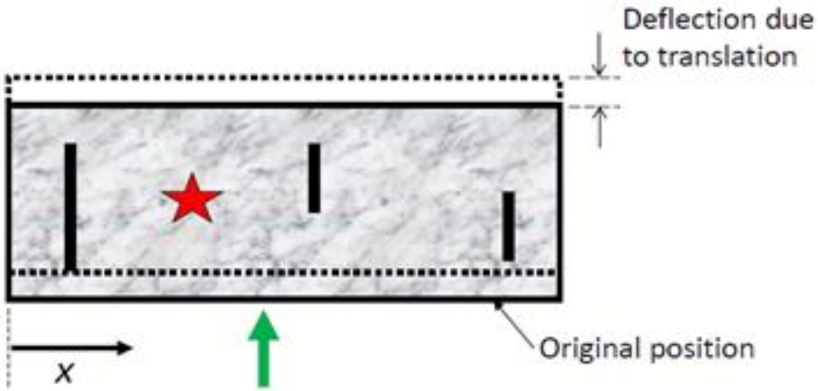
Determine the Centre of Frame Stiffness



Determine the Reactions in the Bracing/Shear Wall

Reaction in each wall due to 2 effects:

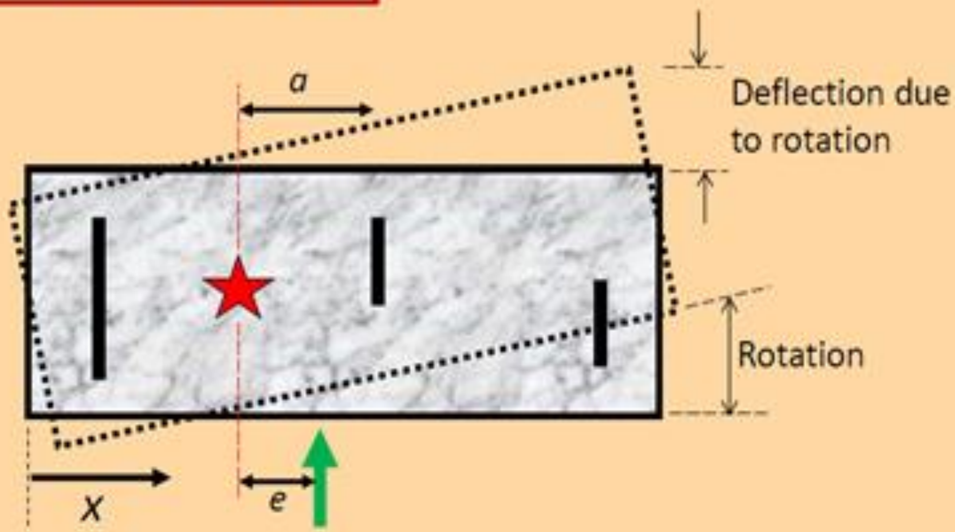
$$\frac{H_n}{H} = \frac{E_n I_n}{\sum E_i I_i}$$



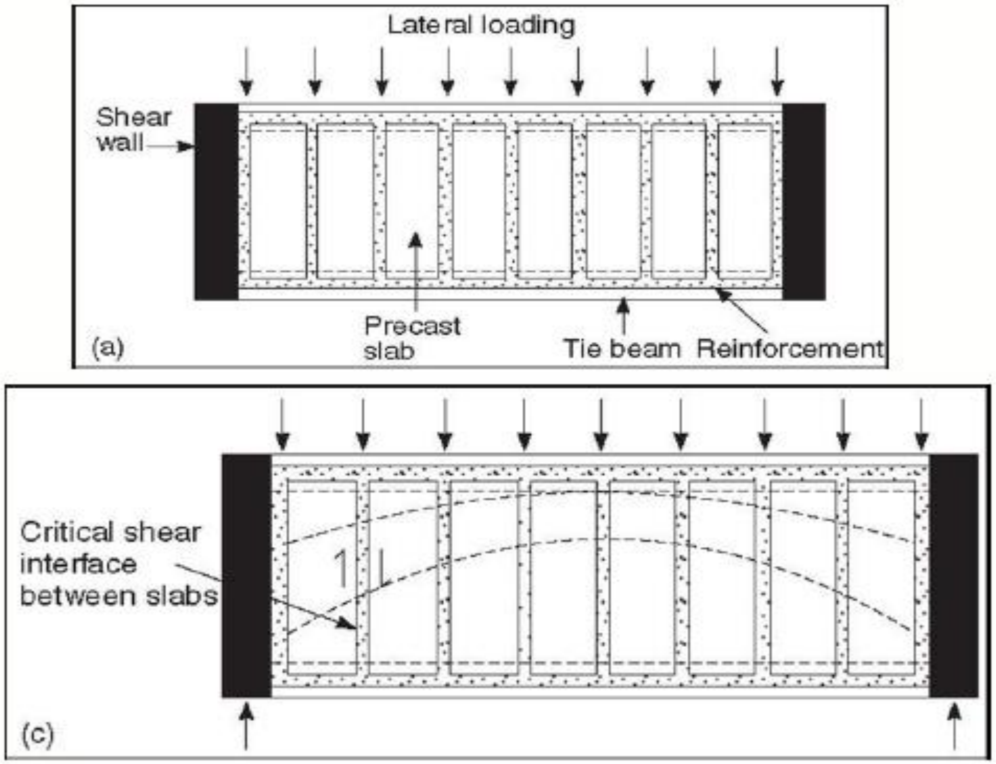
Determine the Reactions in the Bracing/Shear Wall

Reaction in each wall due to 2 effects:

$$\frac{H_n}{H} = \frac{E_n I_n}{\sum E_i I_i} \pm \frac{e E_n I_n a_n}{\sum E_i I_i a_i^2}$$



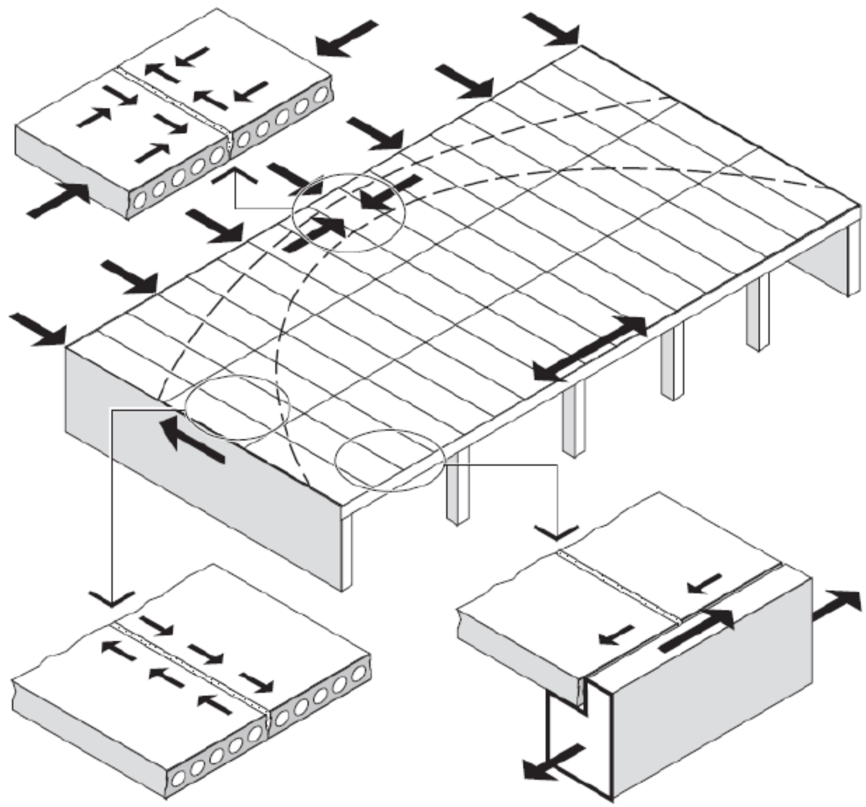
Structural Models



Structural Models

Horizontal Load Transfer by Diaphragm Action

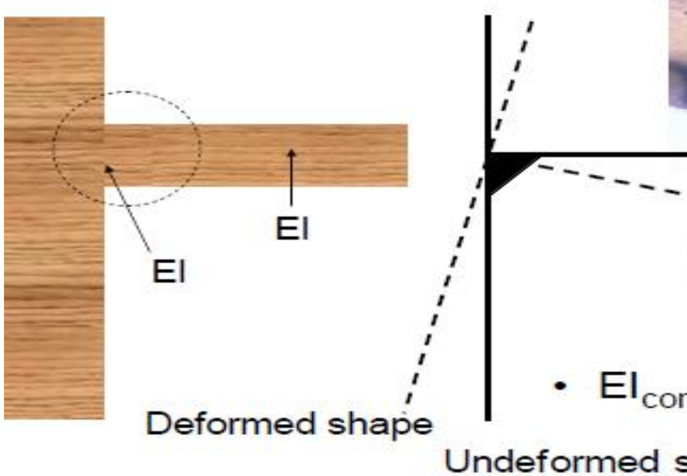
(Hollowcore Flooring Technical Manual: National Precast Concrete Association Australia)



Rigid Connection

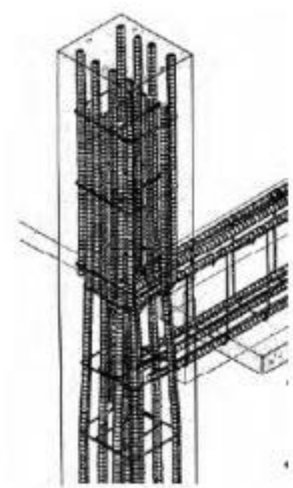
- Rigid connection are also called moment resisting connections
- Rigid connections are able to transfer moment and shear forces
- Best example of a rigid connection are
  ctu

Rigid connection



Typical example of rigid connections in RC structure

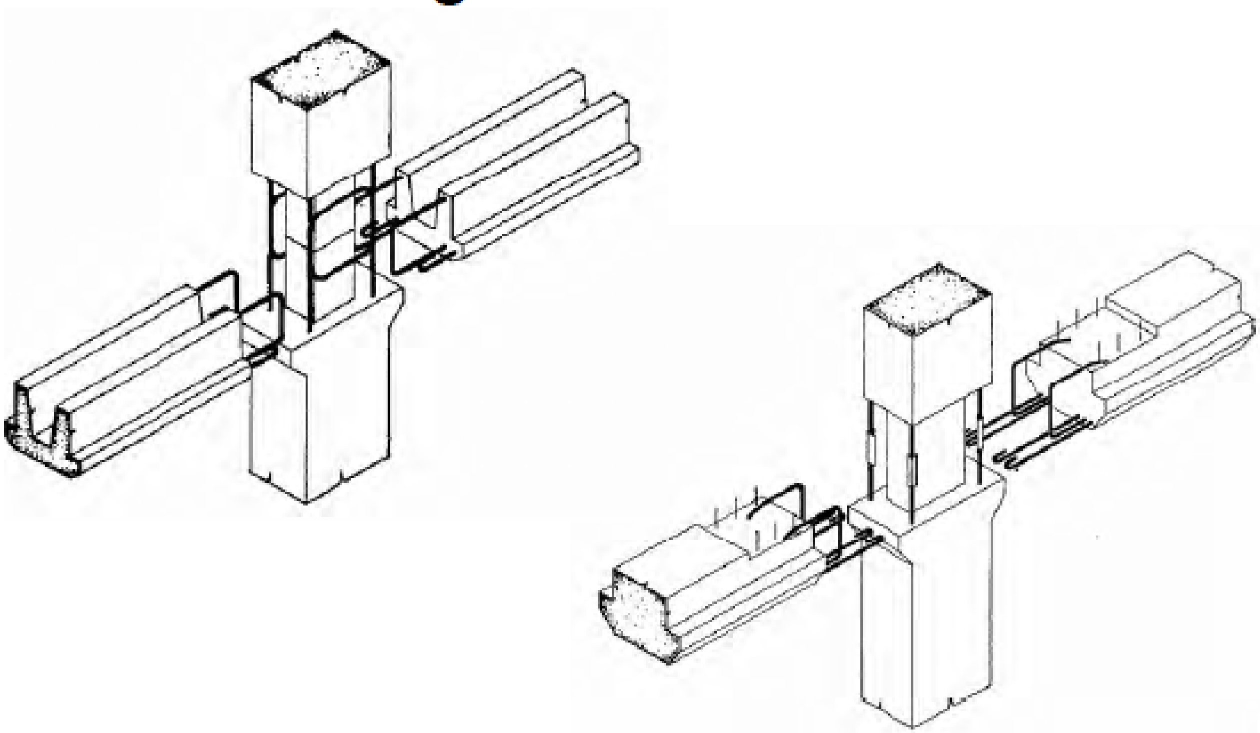
• $EI_{connection} = EI_{beam}$



Monolithic rigid connection in reinforced concrete frames

Rigid Connection

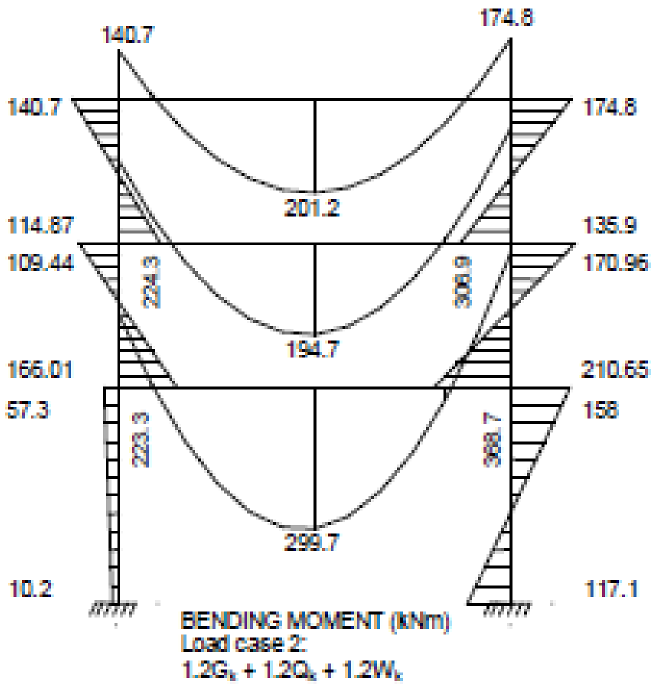
Rigid connection



- Rigid beam-to-column connection is formed by overlapping steel bars and insitu concrete

Rigid Connection

- Resultant applying rigid connections
  - Beam to column connections are able to re



CORBEL

- A corbel is a short cantilever projection from the face of a column (or wall) that supports a loadbearing component on its upper horizontal ledge.
- Mostly use on columns
- Care is needed t … g and anchorage c … nt to contact surfac… fixing tolerances…

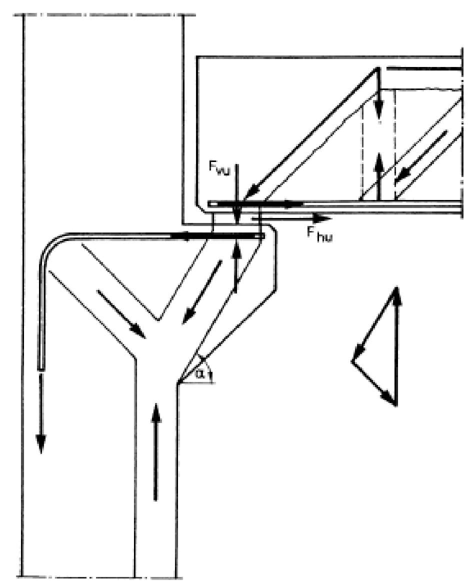


Figure 7.92 Shear force transfer between beam end and column corbel [7.18].

CORBEL

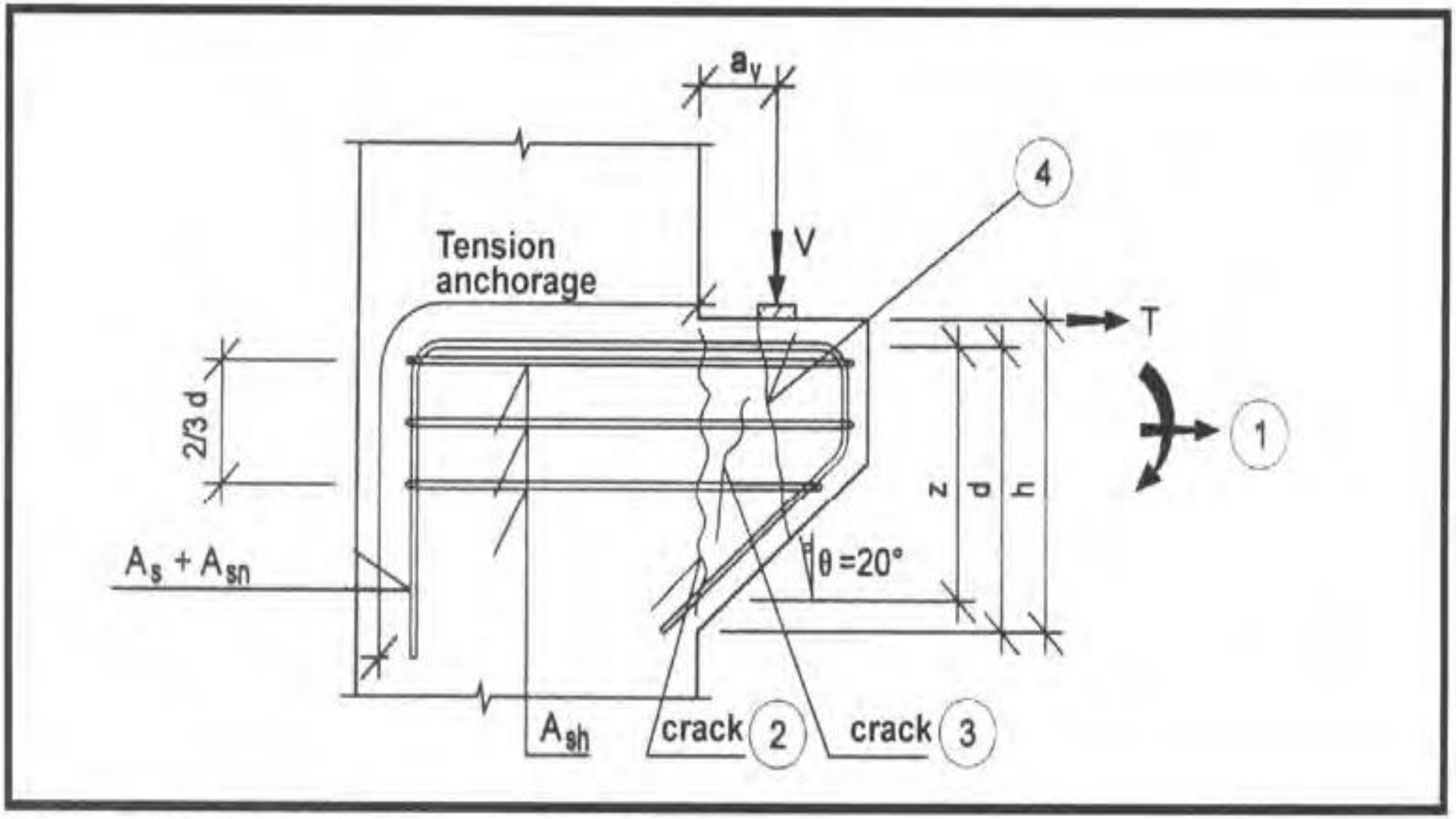
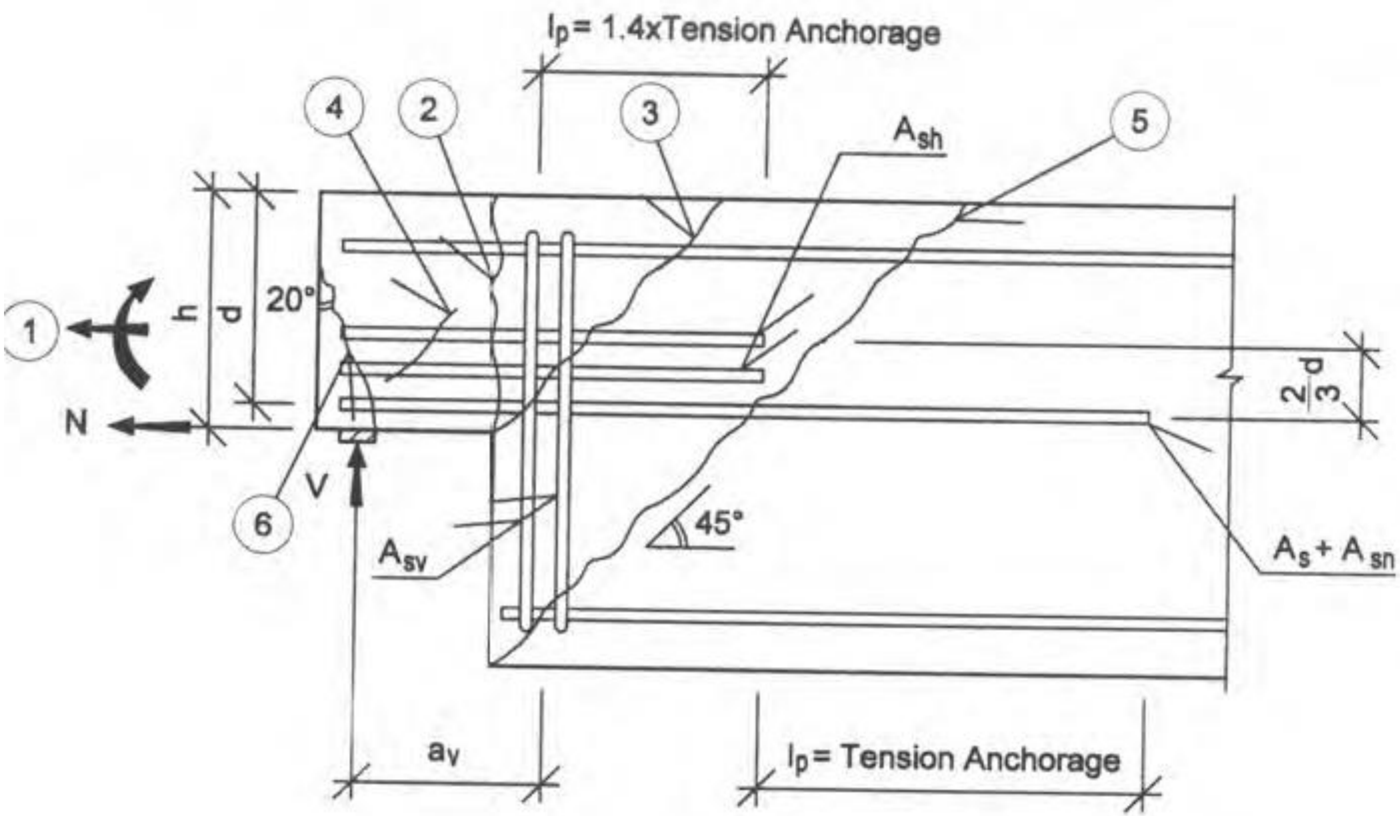


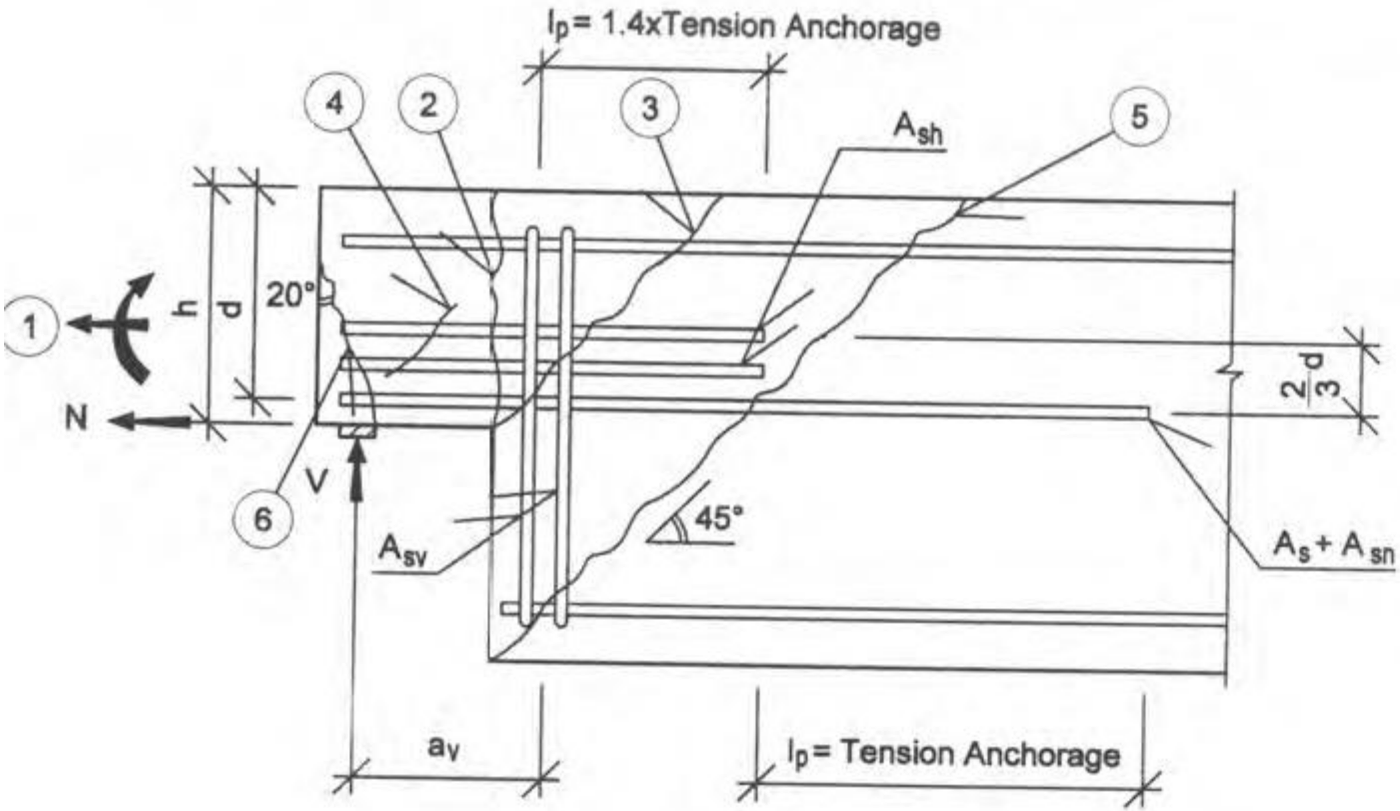
Figure 3.12 Potential Cracks In Corbel

Half Joint Beam



(a) Schematic reinforcement

Half Joint Beam



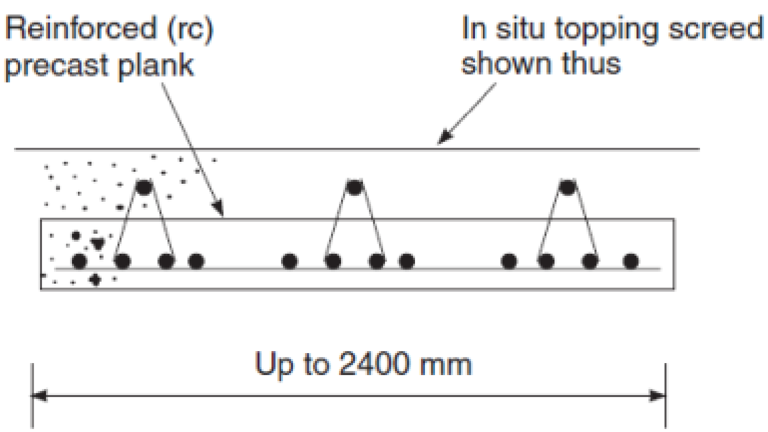
(a) Schematic reinforcement

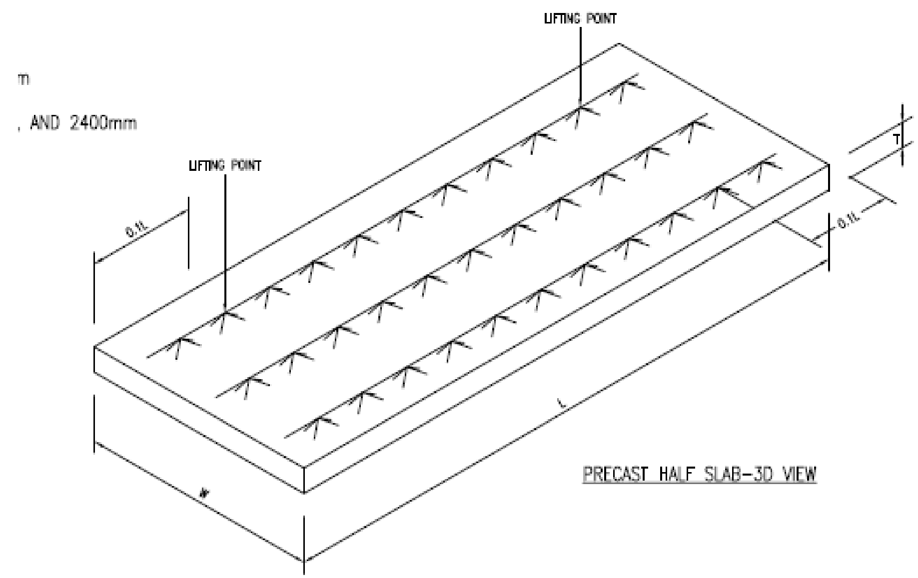
- Full Corbel design

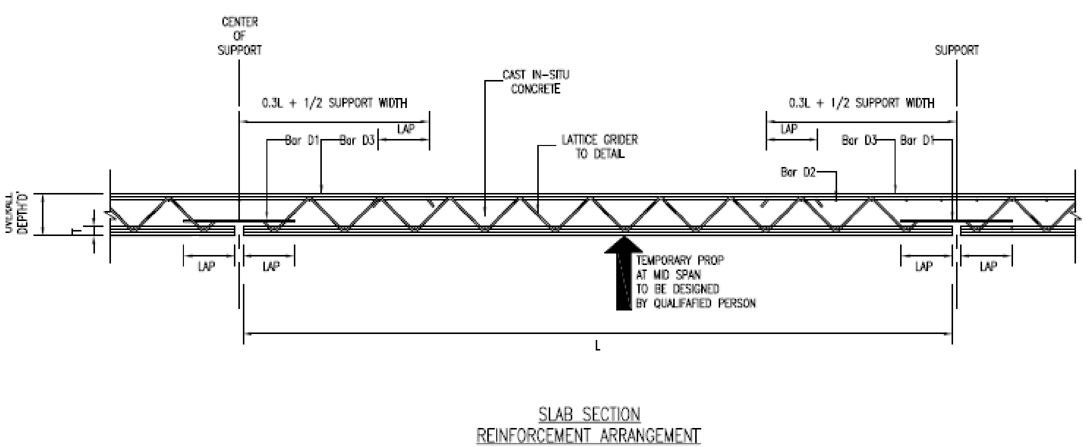
- Hidden Corbel and Half Joint beam design

- Hidden Corbel and Half Joint beam design

Precast Half Slab







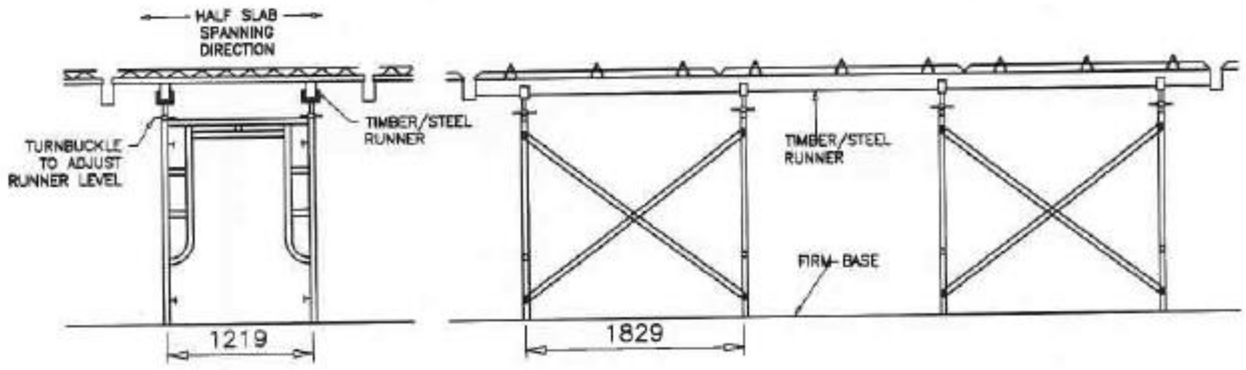


Figure 15 Temporary props for half slab erection

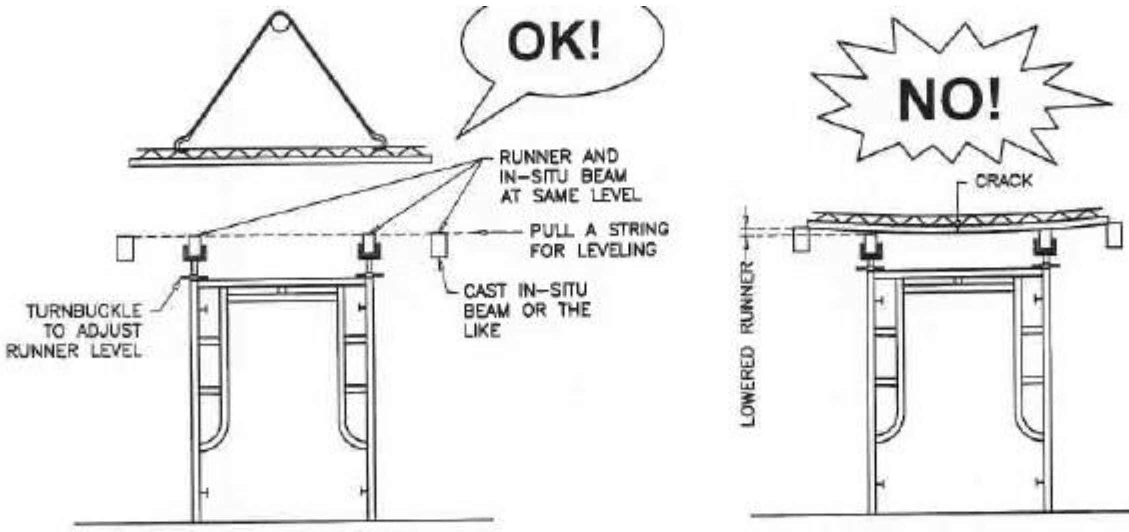


Figure 16 Proper and improper placement of prop

- Extract From Hume Industry Method Statement

3 The sequence of fixing floor slabs should be continuous in one direction commencing from the frame stabilizing elements, e.g. shear wall.

4 Place the half slabs across the beams and the well set scaffold in accordance to the approved construction drawing. Care should be taken at the end bearing length on beams. Any significant discrepancy, e.g. unable to reach the support or clash with the reinforcement beyond adjustment shall be reported to the Designer immediately for further instruction.

5 Bend down the starter bars from the beams into slab as shown in the following figure when the placing of slab fulfill bearing and elevation tolerance requirement.

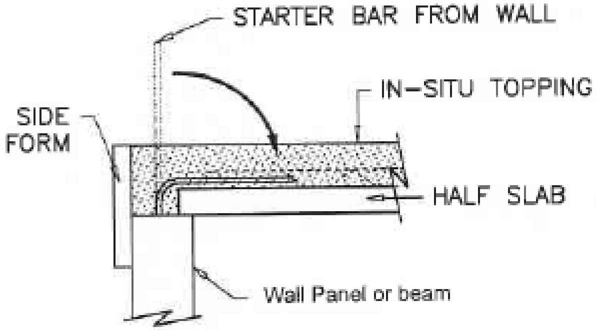


Figure 17 Starter bars from wall

- Extract From Hume Industry Method Statement

● Precast Half Slab Production di MTD ACPI

- Precast Half Slab Production di MTD ACPI

- Precast Half Slab Production di MTD ACPI

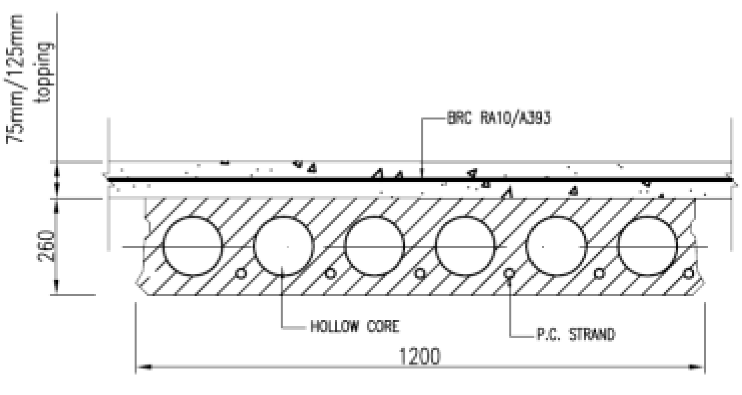
- Gambar Menunjukkan Precast Half Slab Production di Corporate Builders

- Precast Half Slab Yang Telah Dipasang di Balai Polis Sungai Dua (MTD ACPI)

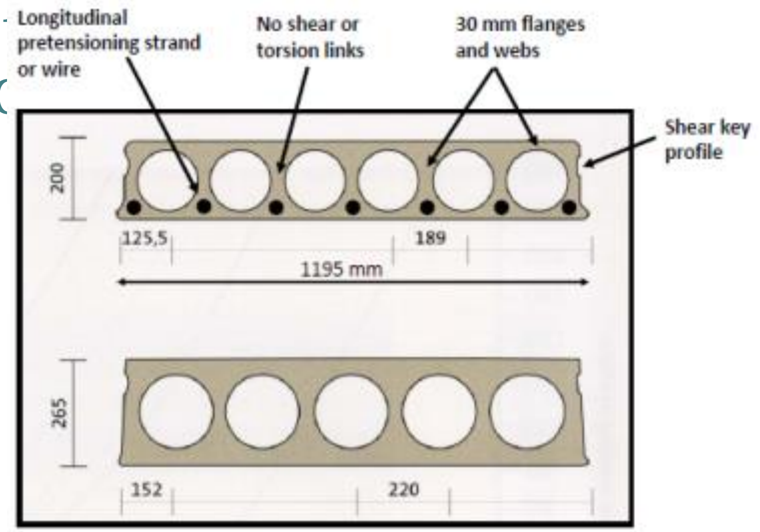
- Precast Half Slab Yang Telah Dipasang di Balai Polis Sungai Dua (MTD ACPI)

Precast Hollow Core Slab

- characteristics
  - 400-3600mm wide, typically 1200mm
  - 90-730mm deep; typically 150,200,250,300mm
  - Selfweight 1.5 to 5.0 kN/m2



PRECAST PRESTRESSED HOLLOW CORE SLAB

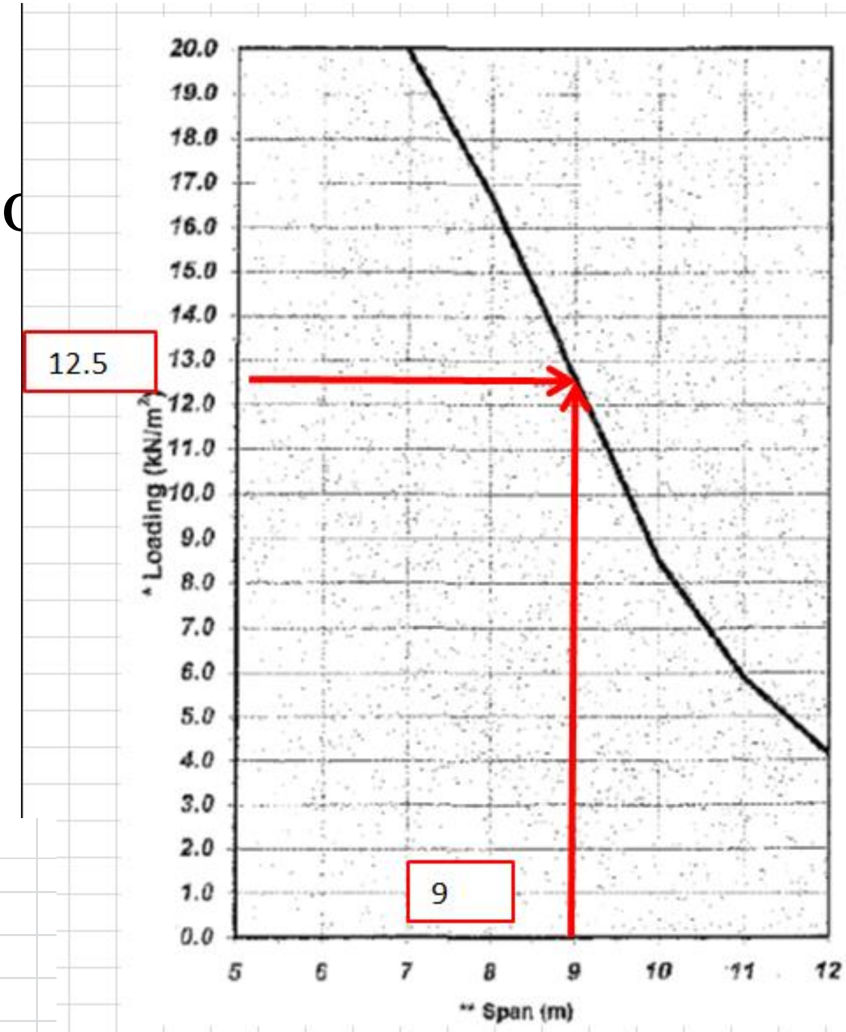


Precast Hollow Core Slab

DL/Action				
Brickwall on HC Slab	=	2.60	kN/m^2	
75mm conc topping	=	-	kN/m^2	
100 mm conc topping for levelling	=	1.25	kN/m^2	
Finishes+Ceilings+M&E	=	1.80	kN/m^2	
HC Slab Selfweight	=	-	kN/m^2	
TOTAL DL	=	5.65	kN/m^2	
LL/Variable	=	5.00	kN/m^2	
Total DL+LL	=	**10.65**	kN/m^2	

elc

Actual Length of of HC Slab			
Longest Grid to Grid =	=	9.30	m
Assume Inverted T /Edge Beam Width	=	300	mm
Actual Length of HC Slab	=	9.00	m



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