Reinforced Concrete Structures

MIM 232E

RC and PREFABRICATED ROOFS
PURLINS FRAMES CANTILEVERS ARCHES

LBSD-7

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RC Roofs

- Roof:

  -The task is to cover up a certain volume
  -Comparing the slabs, roofs can be arranged in several forms and larger spans can be exceeded.

- Design; Architect and Engineer,
  since,
  function, form and structure of a roof LBS have to be considered together.

Function of a Roof:

a) Protection againist rain/snow and wind

b) Lighting

c) Heat/temp isolation

d) Air conditioning

e) Acoustics

RC roof LBS:

3 main requirements in design;

1. Compatibility with function and form
2. Structurally safe (againist loads)
3. Economy (material, workmanship)

RC Roofs;

a) Conventional type: Main beams+purlins
b) Superficial/Shell LBS

RC Roofs

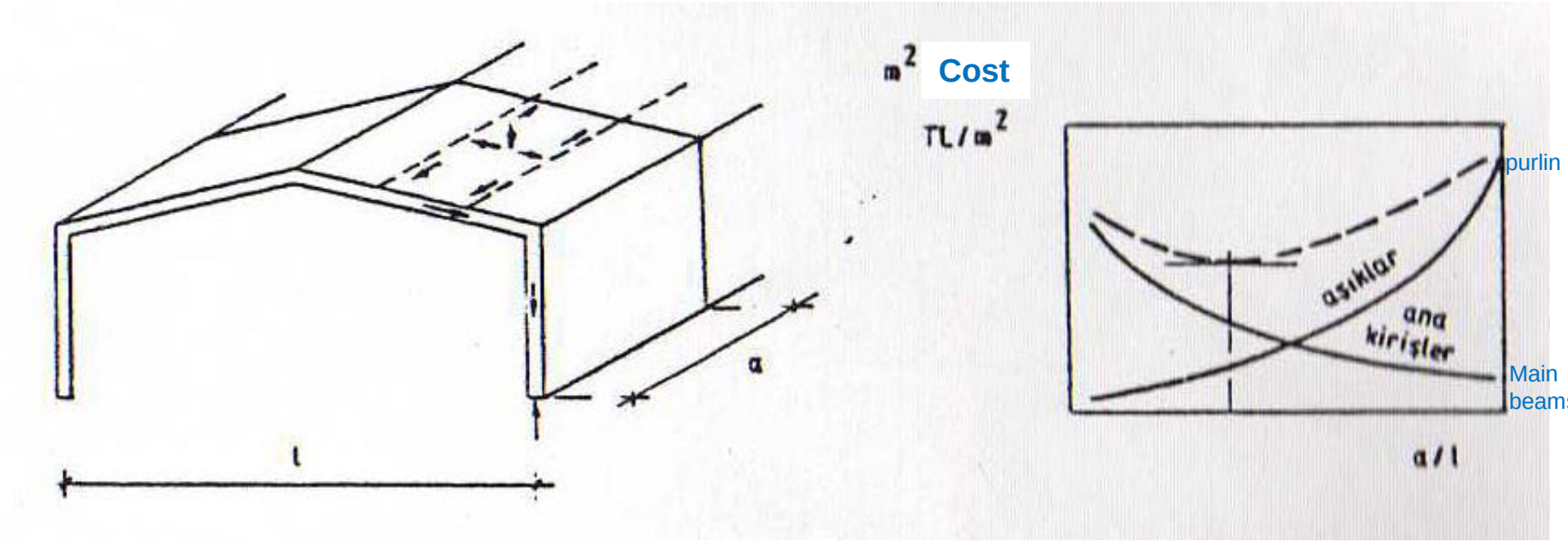
Conventional type:

- Loads are transferred from roof surface to purlins

  than from purlins to main LB beams
- Easy to construct
- Precast members can be used

- Economy of system depends on main beam type, form and purlin spans

RC Roofs



$$a/l \cong 1/3 - 1/4$$

RC Roofs

Main LB members:

- can be prefabricate

Benefits:

- Less formwork/mold
- No Scaffolding
- Less RC work on site

Disadvantage:

- Assemblage/montage cost

RC Roofs

Main LB members:

- Precast member;

  production time- independent from climate cond.

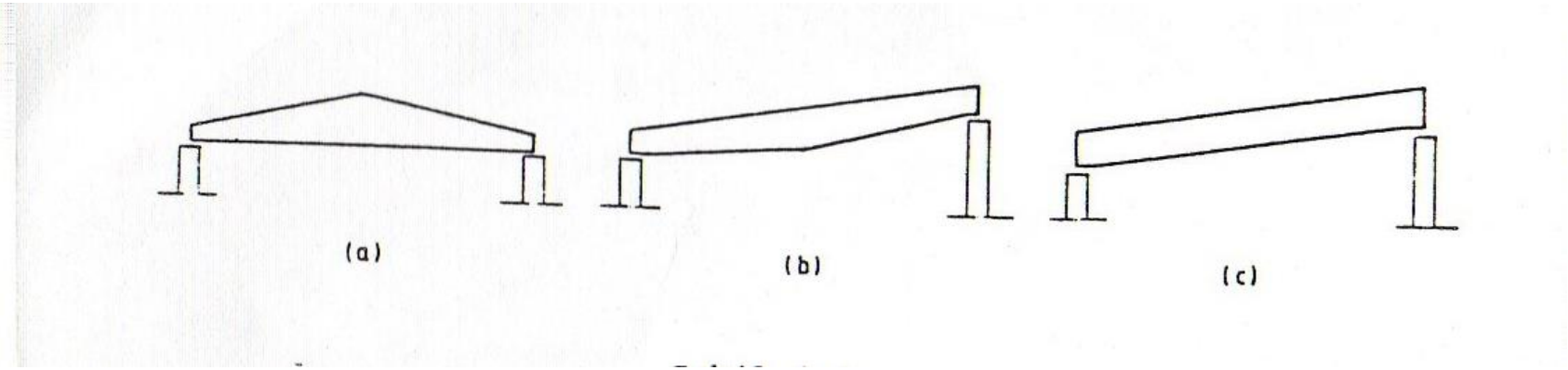
- Transportation cost depends on distance and transport fee

- Prestressing; increase quality and reduce the member CS

RC Roofs

Main roof beams:

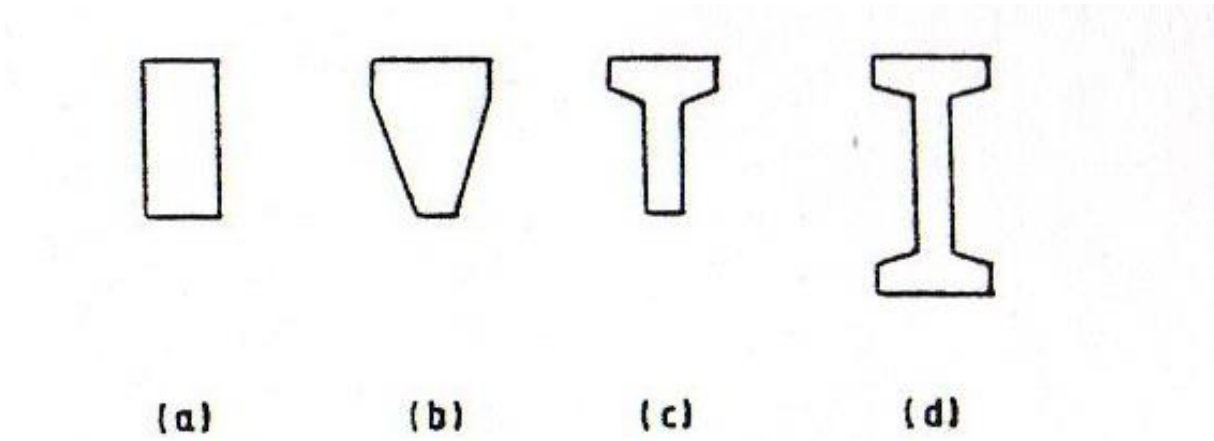
- can be producted as prefabricate in a factory with ~20-30m span, transported ~100m
- can be also producted on site



RC Roofs

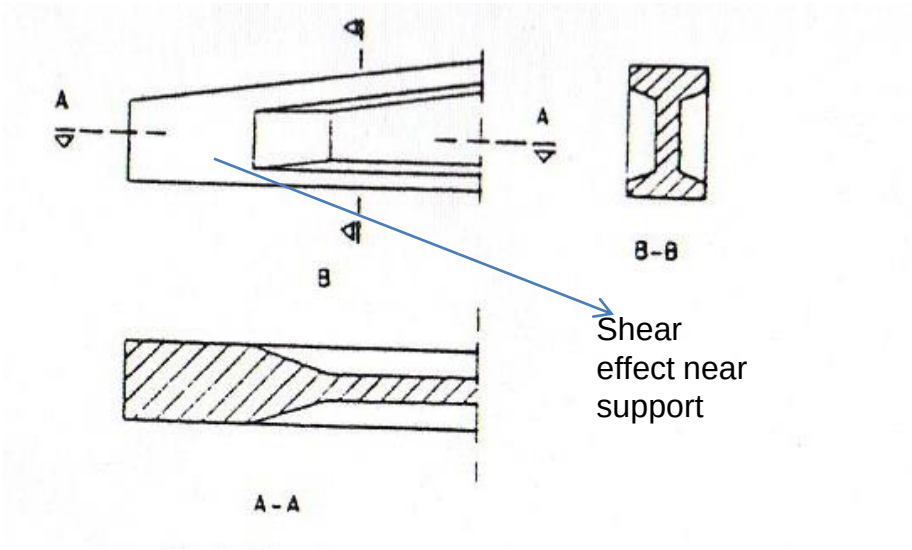
Consdideration to be taken while detemining main roof beam CS:

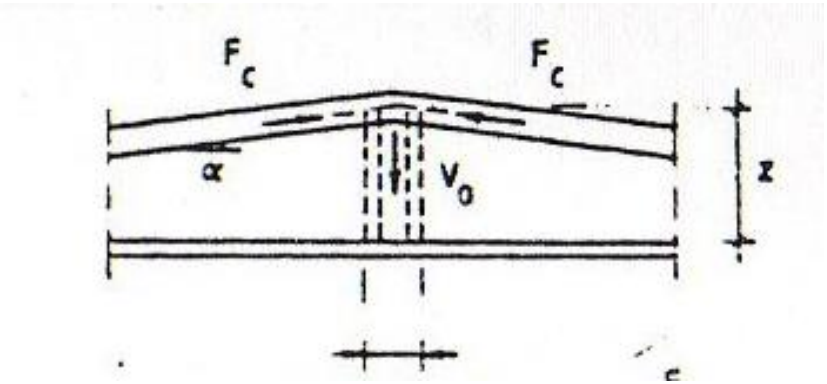
1. M and T
2. Smaller CS as possible
3. Simple formwork
4. Simple reinforcement arrangement
5. Simple concreting



RC Roofs

Inconstant-heigth roof beams:





http://www.archiexpo.com/prod/planas/column-base-plates-precast-reinforced-concrete-105237-1026595.html#product-item_1026451

RC Frames

- Frames are constituted by moment resistant connection of columns and beams.

http://www.ndconcrete.com/award_article.php

- Negative moment near connection;
  reduction of span moment

- In good soil; fixed frame
  in poor soil; 3-pinned frame (no additional internal forces due to displacement)

RC Frames

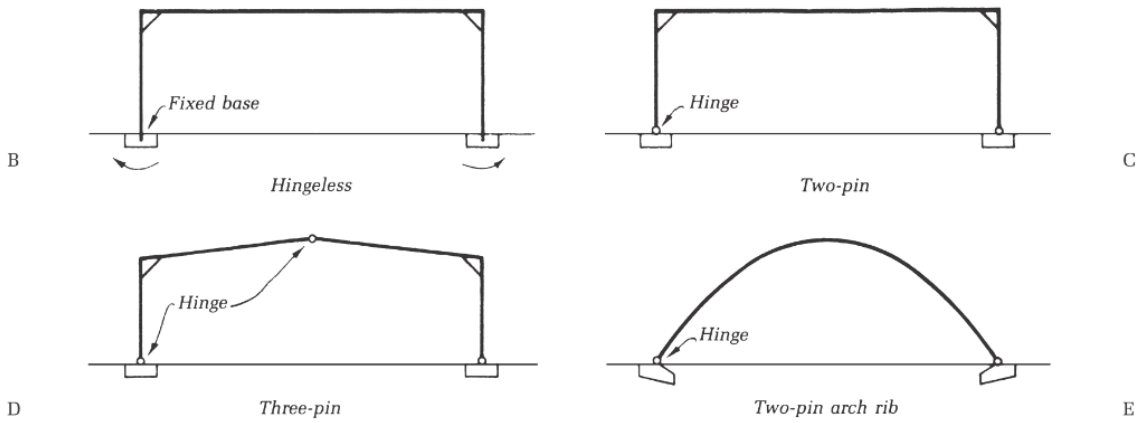


Figure 8.5 Rigid frames

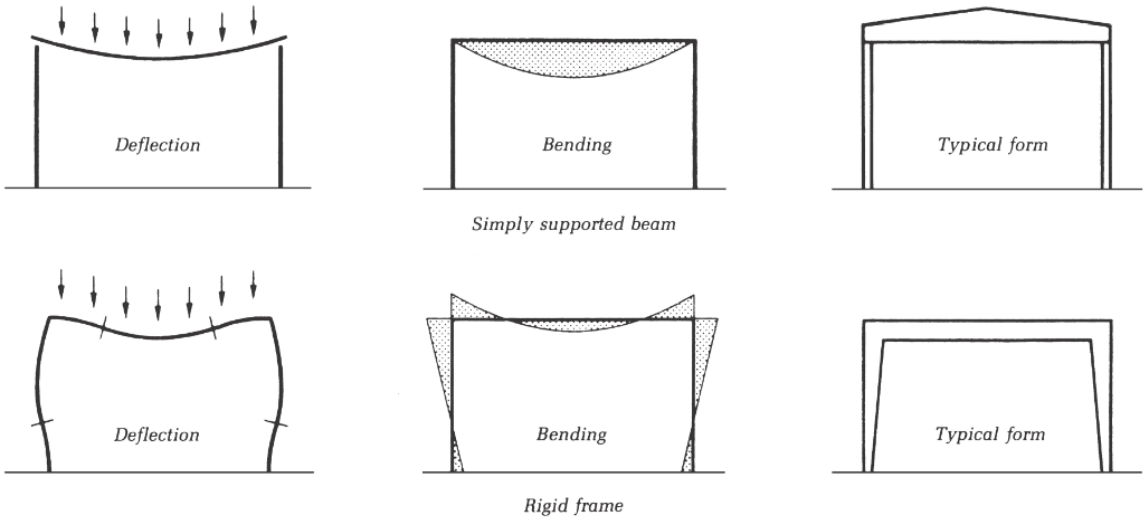


Figure 8.6 Comparison of rigid frame and beam construction

RC Frames

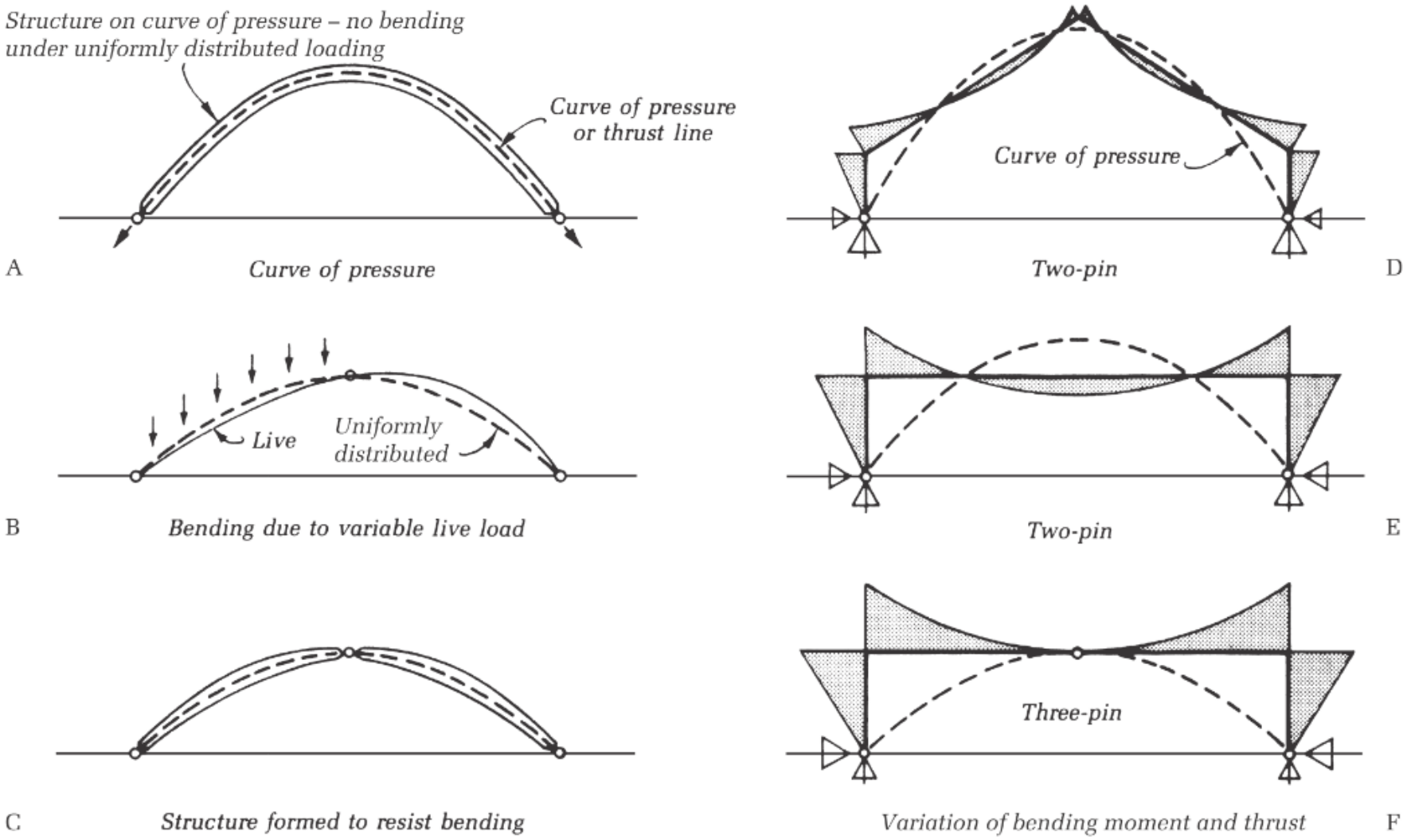
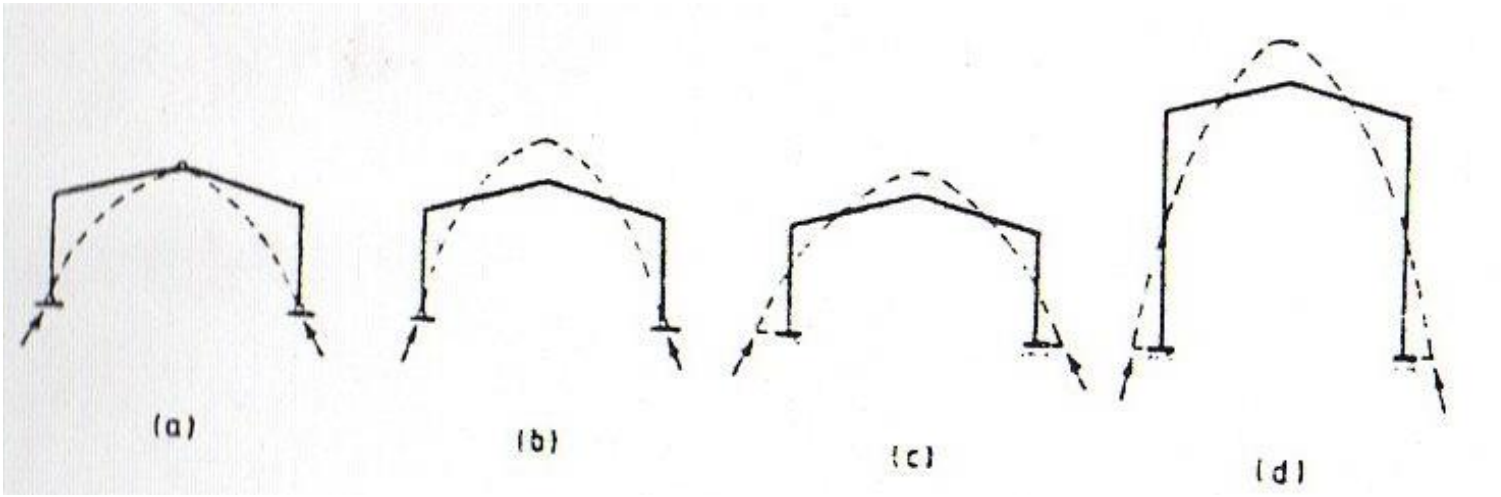


Figure 8.8 Rigid frames

RC Frames



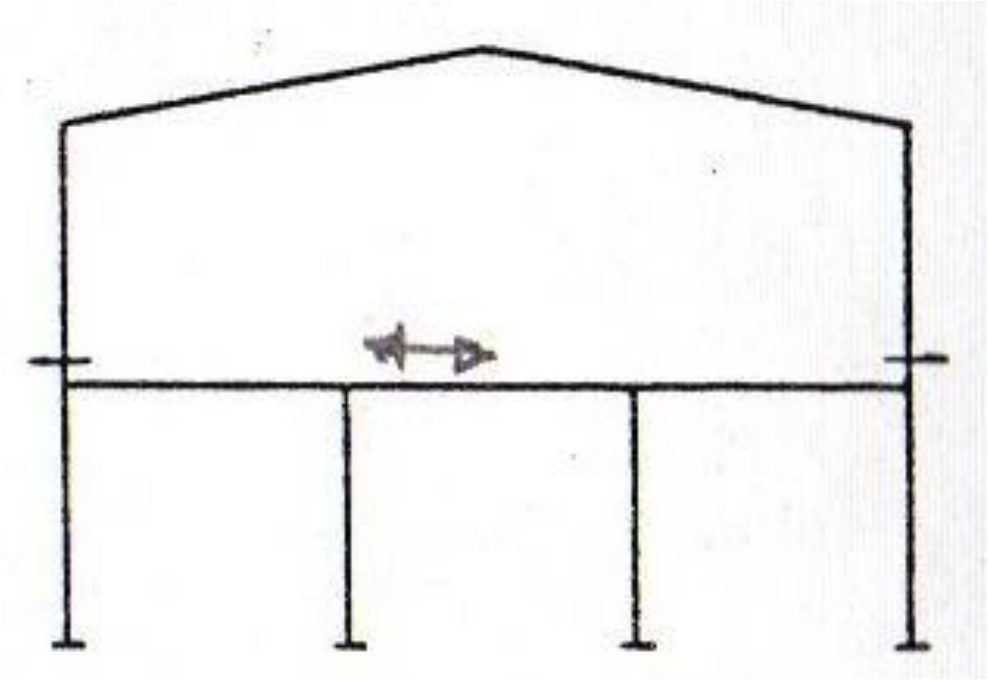
- Tension rod/tie is used to resist the thrust in poor soils.

  maintinance is difficult

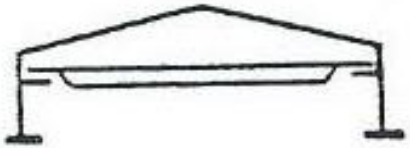
- Frame axis should be close to compression line (to get smaller moment)

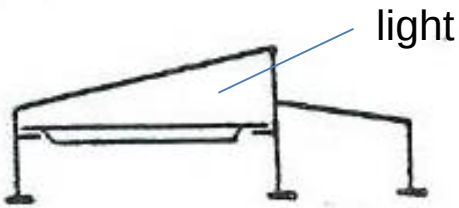
RC Frames

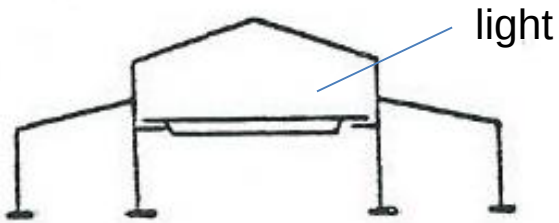
- Working of sub-frame beam as tie.

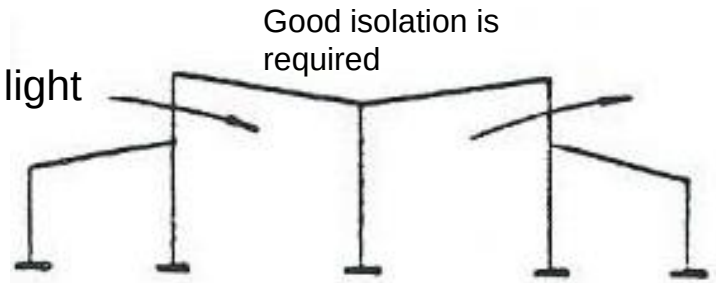


RC Frames









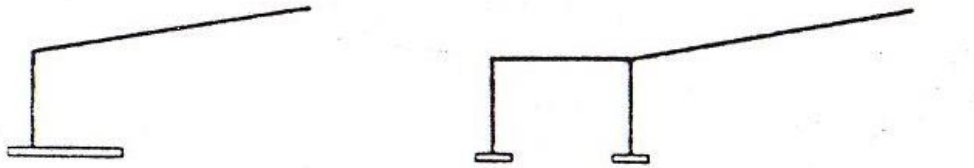
Cantilever

- Cantilevers are used for building eaves, tribune roofs, bus-train platform roofs where an open space side is desired (without columns)

- When the span increase;

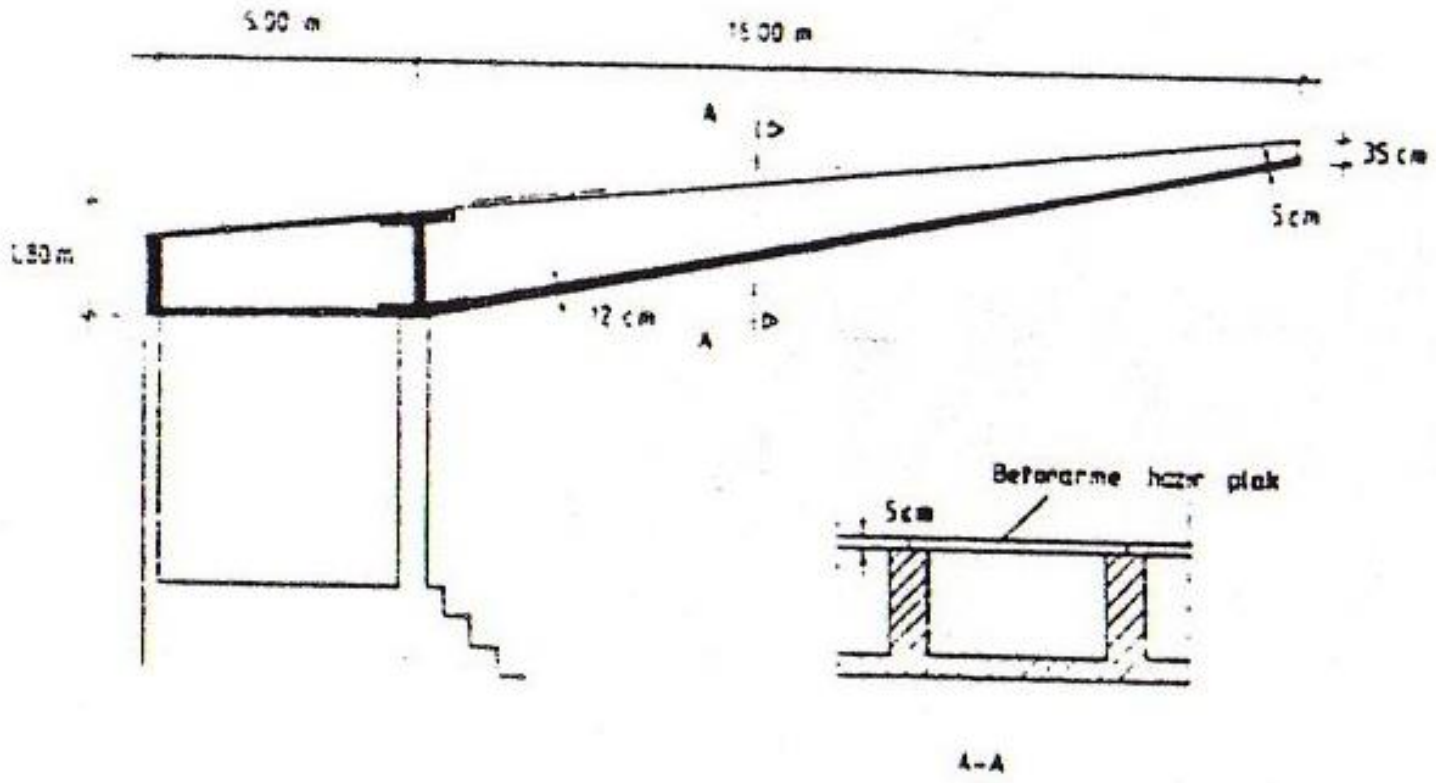
  dimension, material cost and footing dim. increase

- Isostatic (structurally determinate), large deflection



Cantilever

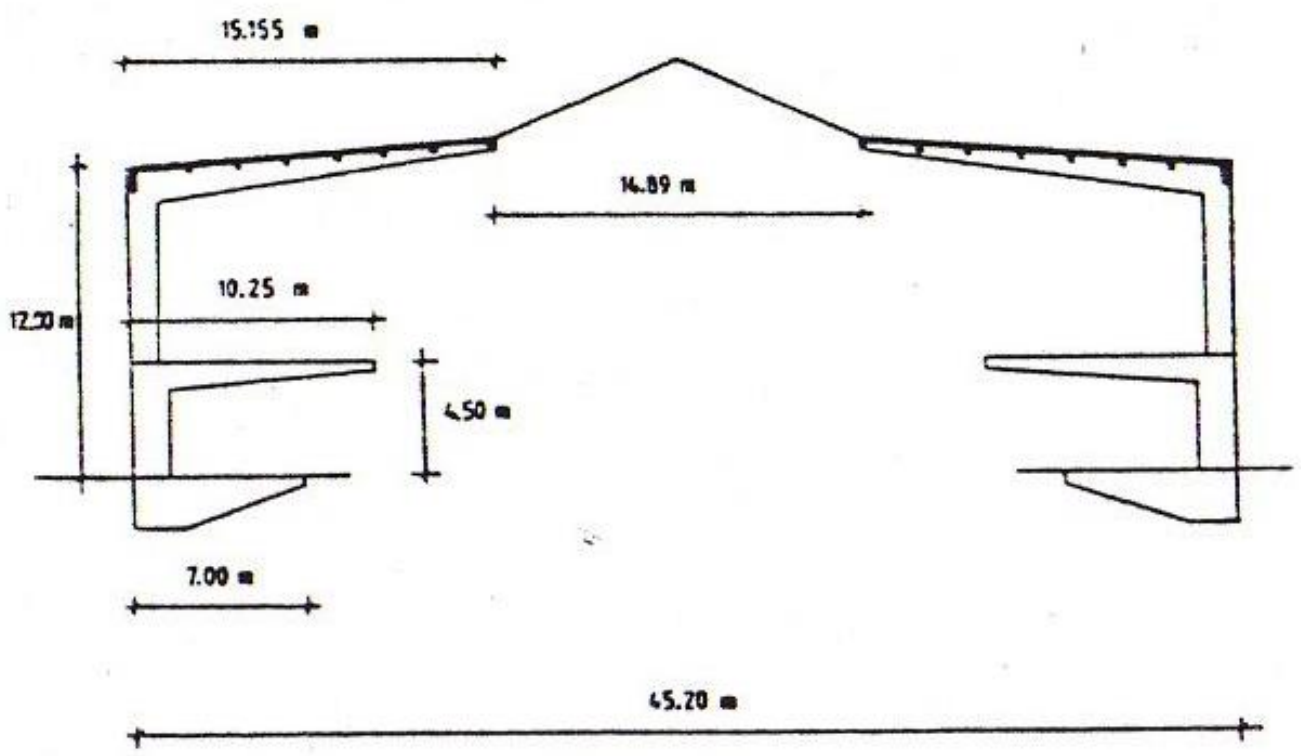
- Old Dolmabahçe stadium tribune roof



Cantilever

- Munich exhibition hall

Continous light line/band in the middle



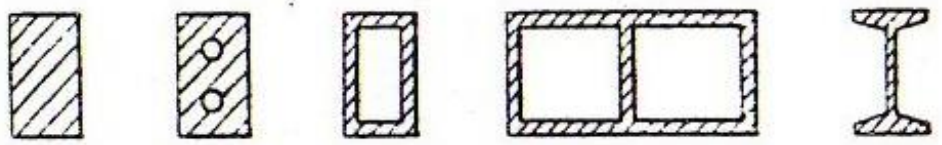
Arches

- When the compression line of loads is considered as LBS axis; an Arch is obtained. Compression only in CS
- Half-snow, EQ, wind may generate moment.
- Convenient especially for long-spans

http://www.armtec.com/en-ca/infostructure/2011-06/bebo-concrete-arches.aspx

http://radiobutlers.blogspot.com.tr/2011/09/hoover-dam.html

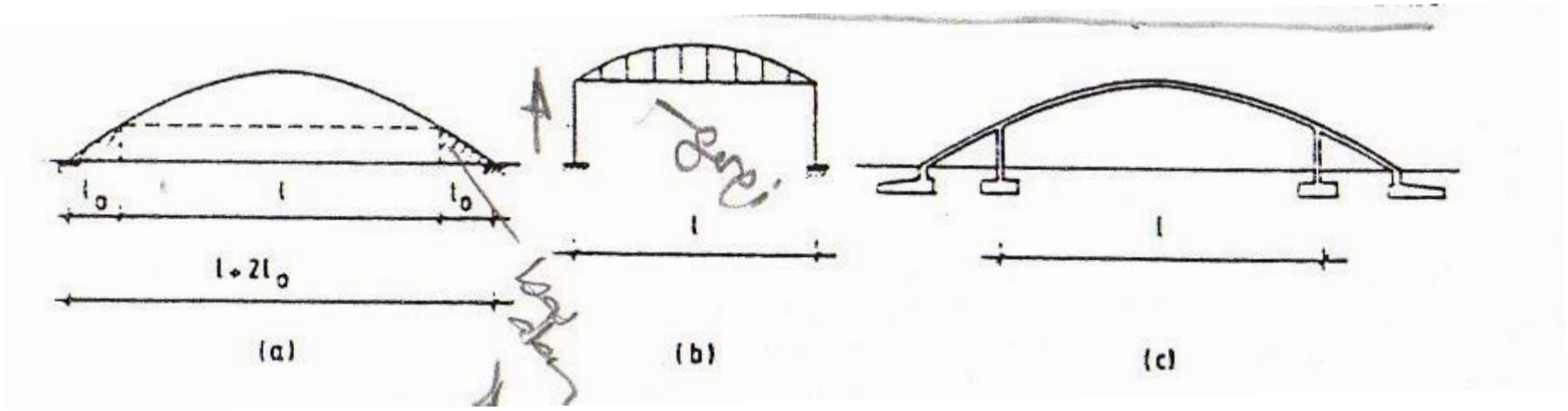
- CS with min. area and high moment inertia is choosen



Arches

- Not convenient for volumes with rectangular vertical section
- Arch thrusts are resisted by ties or transferred to soil
- Non-useful volume at the edges

http://highestbridges.com/wiki/index.php?title=China_2012_Bridge_Trip



Arches

- Ties are used at upper level; to transfer thrusts to columns and soil.

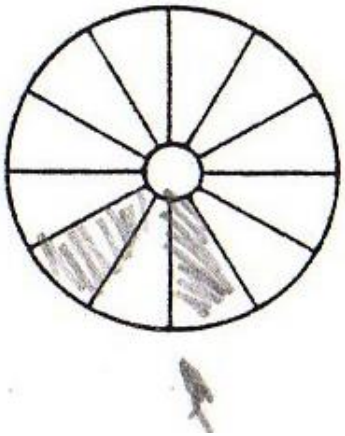
- Upper non-useful volume cause redundant costs such as heating etc.

- Less CS and cost; comparing the frames

  therefore less distance may be used between the arches

  ~(1/5~1/10) of span

Arches



- For circular areas;

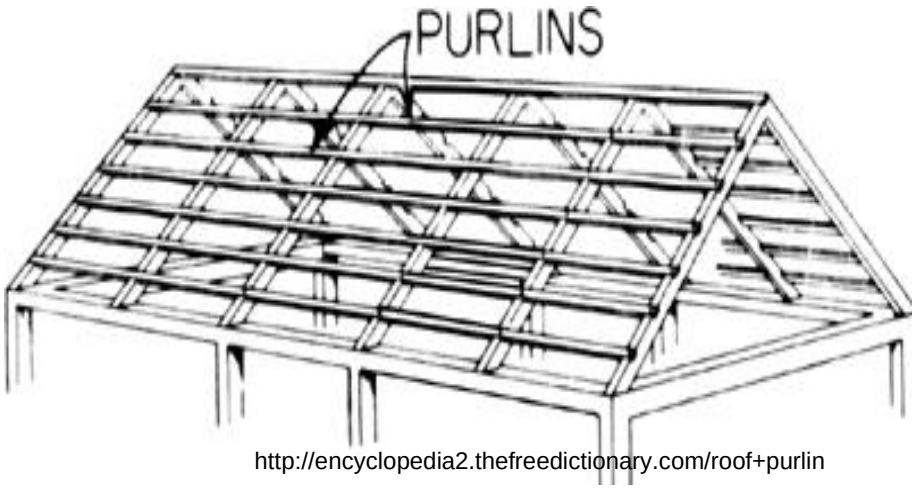
  arrangement of radial arches (compression at top, tension at bottom)

Purlins

- Purlin: A horizontal structural member in a roof, supperted by rafters

- Because of cost; ready/precast purlin and plaque members are preferred

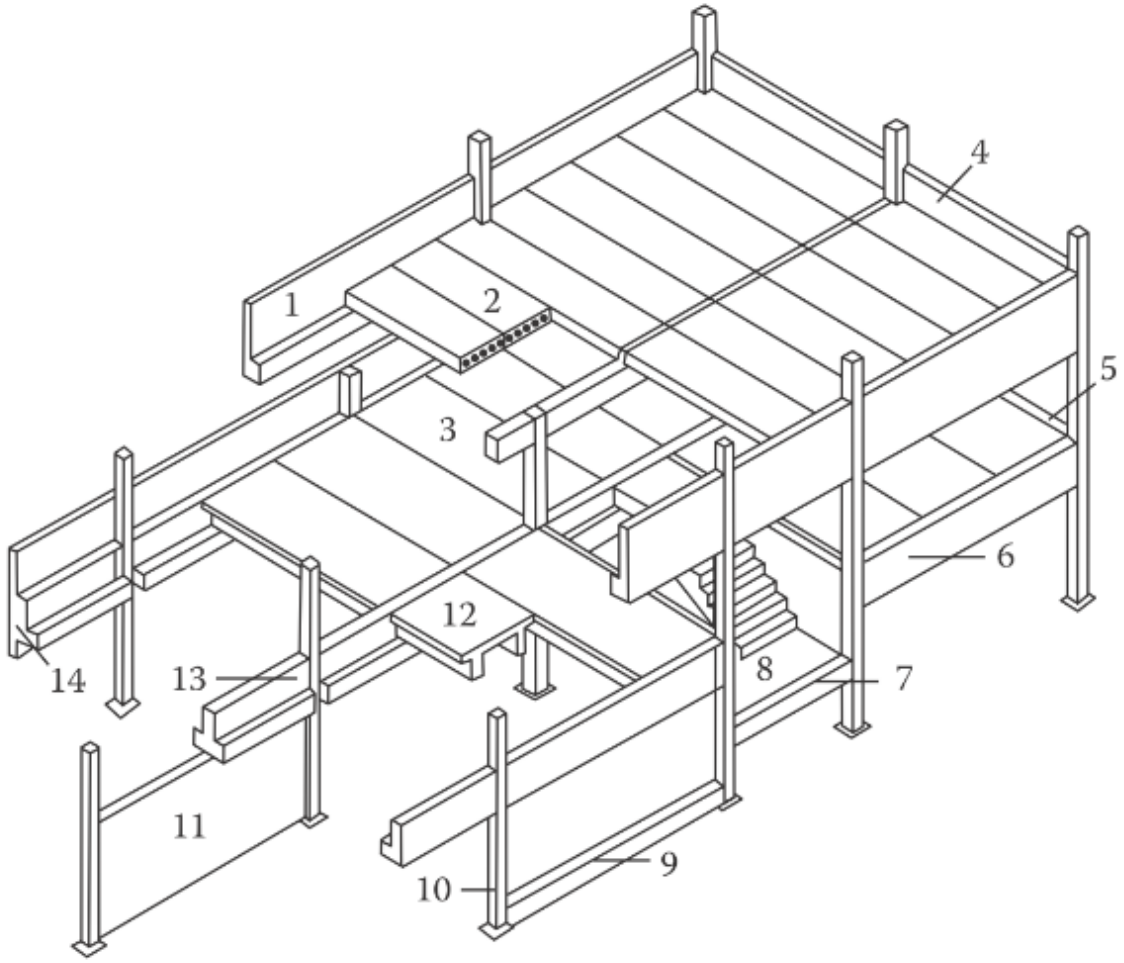
- Smaller purlin CS provides less weigth and less load transfer to rafters. However, deflection increases in that case.



http://encyclopedia2.thefreedictionary.com/roof+purlin

http://www.archiexpo.com/prod/pujol/prestressed-concrete-purlins-89366-915608.html

Precast systems



1 Main spandrel beam
2 Hollow-core unit
3 Internal rectangular beam
4 Gable spandrel beam
5 Gable beam
6 Main edge beam
7 Landing support beam
8 Staircase and landing
9 Ground beam
10 Column
11 Wall
12 Double-tee unit
13 Internal beam
14 Main edge spandrel beam

Figure 3.2 Definitions in a precast skeletal structure.

Precast systems

Figure 1.7 Precast concrete 'skeletal' sway frame, Europark, Rome.

Precast systems

Figure 1.8 Precast concrete 'skeletal' known as 'semi-rigid' frame, Recife University, Brazil.

Precast systems

Figure 1.9 Precast 'skeletal' structure with integrated architectural columns and spandrel beams, Reading Business Park. (Courtesy of Trent Concrete Ltd., UK.)

Precast systems

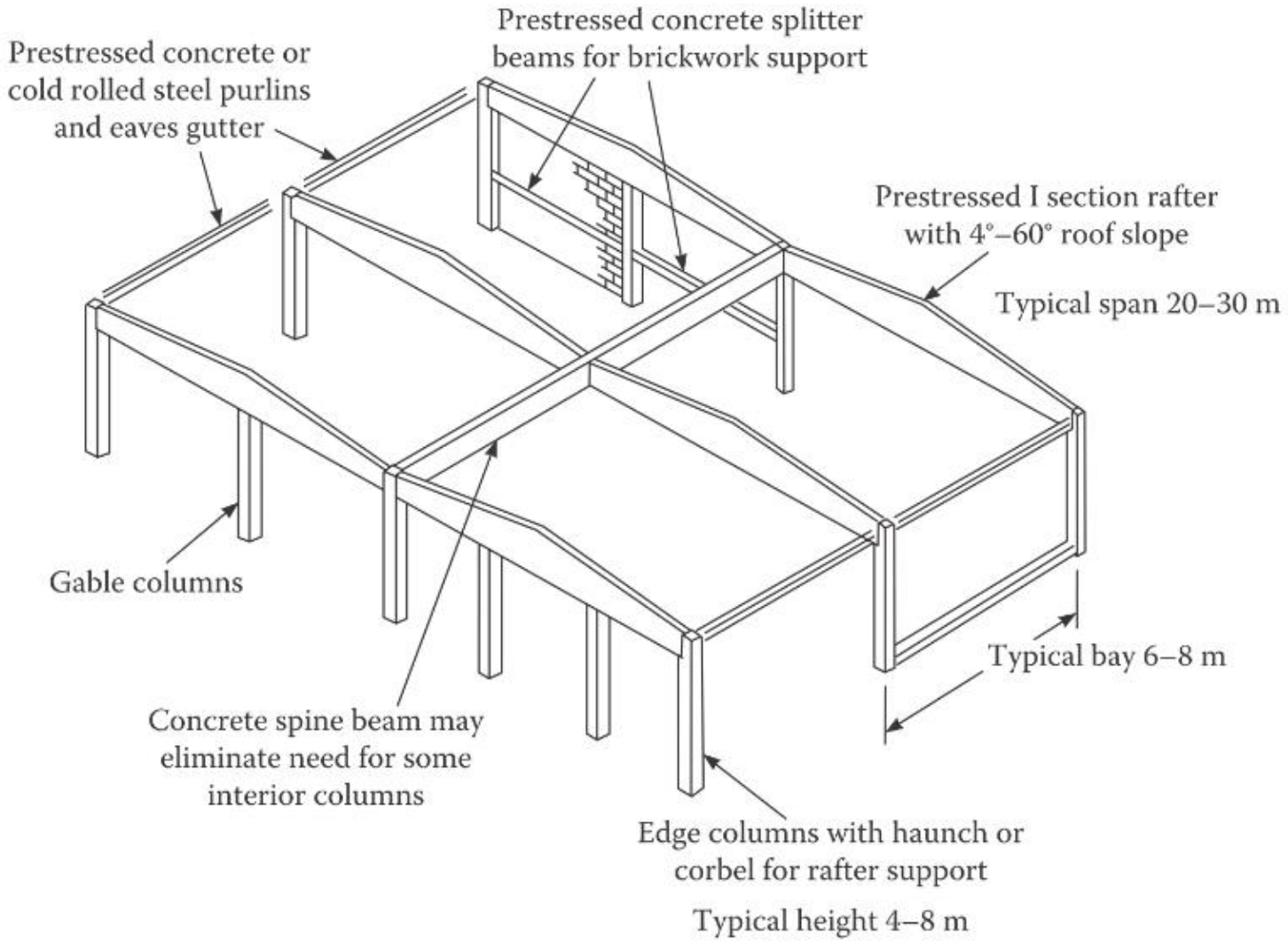


Figure 3.8 Definition of a precast portal frame.

Precast systems

Figure 3.9 Precast portal frame. (Courtesy David Fernandez-Ordoñez, Escuela Técnica Superior de Ingeniería Civil, Madrid, Spain.)

Precast systems

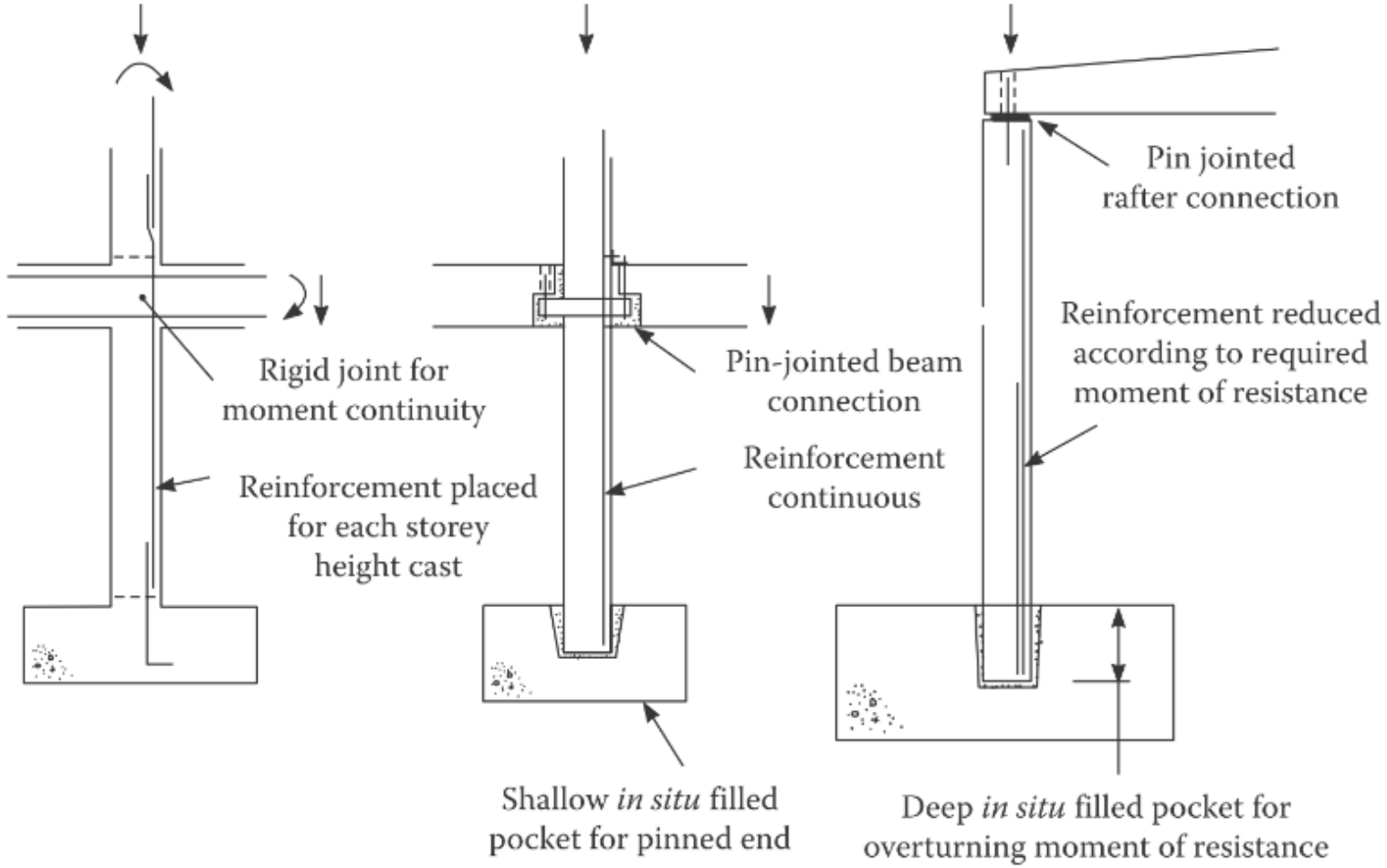


Figure 6.10 Column design philosophy for cast *in situ*, precast skeletal and precast portal frames.

Precast systems

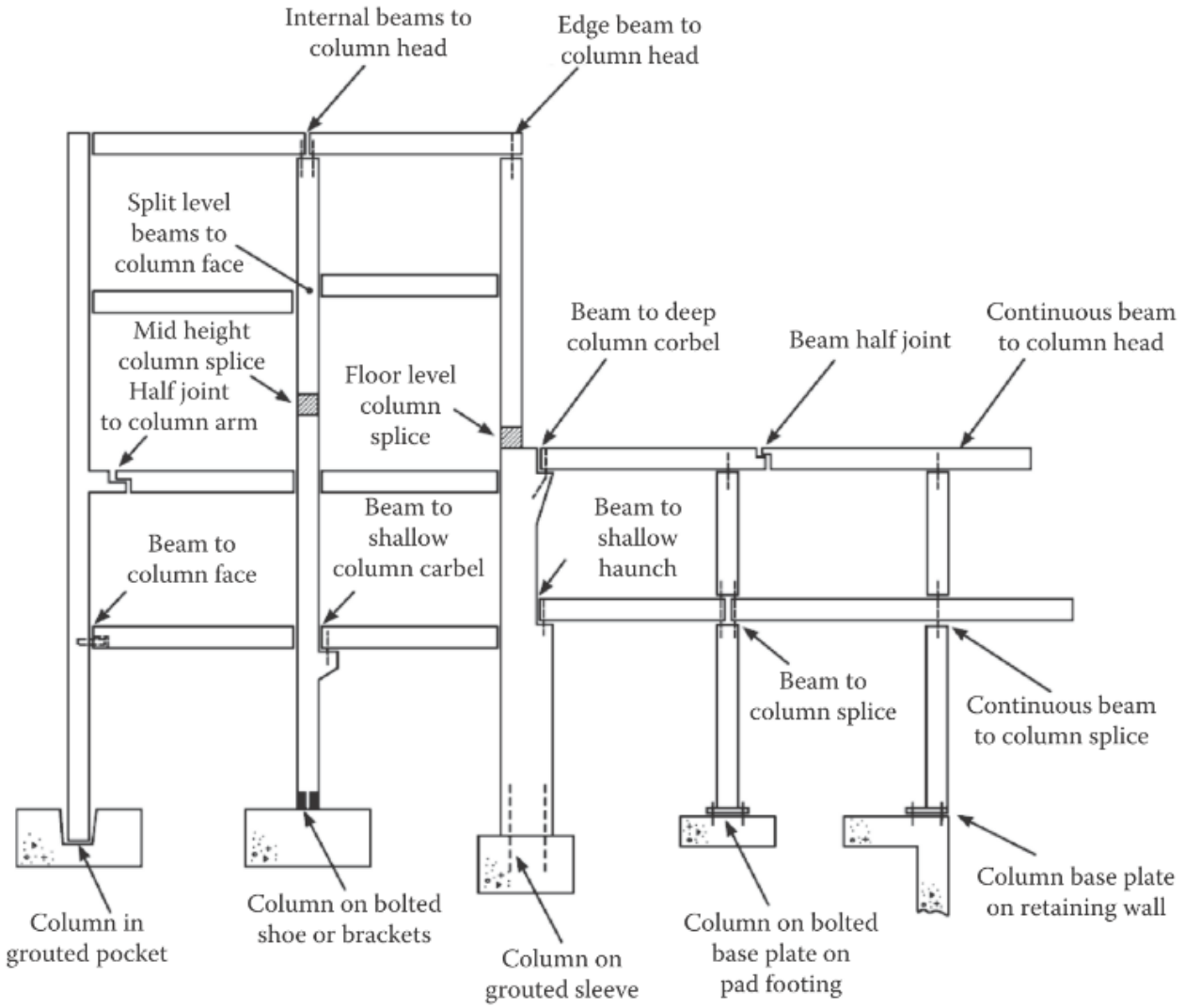


Figure 3.32 Types of connections in a precast structure.

Precast systems

Figure 3.10 Portal frame with folded plate roof units, the University of Sao Carlos, Brazil.

Precast systems

Figure 3.13 Beam half-joints at 0.1× span close to points of contraflexure in a continuous beam.

Precast systems

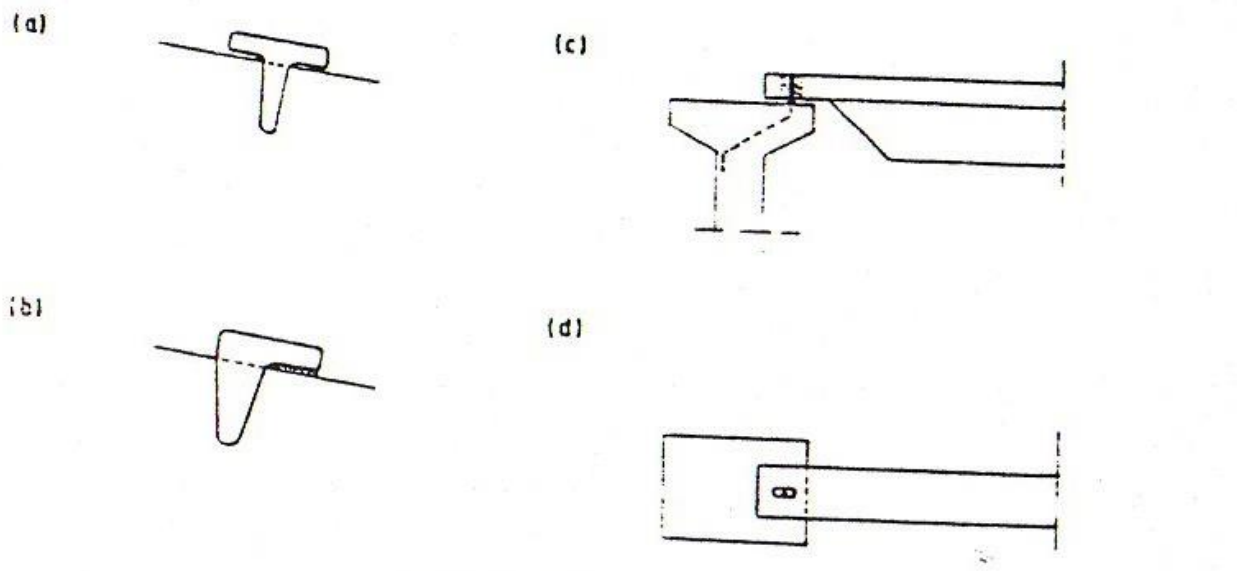
Table 3.1 Application and types of precast concrete frames

Use of building	*Number of storeys*[a]	*Interior spans (m)*	*Skeletal frame*	*Wall frame*	*Portal frame*
Office	2–0	6–15	✓		
	2–50	6–15		✓	
Retail, shopping complex	2–10	6–10	✓	✓	
Cultural	2–10	6–10	✓		
Education	2–5	6–10	✓	✓	
Car parking	2–10	15–20	✓		
Stadia	2–4	6–8	✓		
Hotel	2–30	6–8		✓	
Hospital	2–10	6–10		✓	
Residential	1–40	4–6		✓	
Industrial	1	25–40			✓
Warehouse with office	2–3	6–8 25–40	✓		✓

[a] Typical values, depending on the location, terrain, requirements, etc.

Purlins

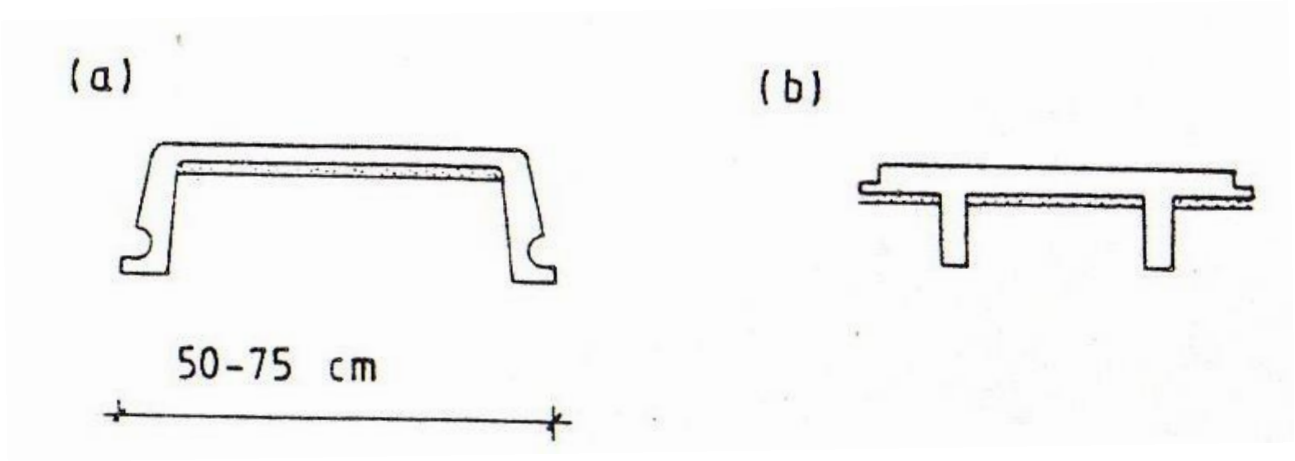
- Purlins provide lateral stability of rafters and longitudunal stability of a roof/building.
- Purlins are connected to main members and fixed.



Purlins and slabs

- A light roof cladding on purlins can be used

- Purlins and slabs can be prepared together as prefabricated



Purlins and slabs

- Aerated concrete usage for slabs (light)
- To obtain diaphragm effect; RC is put in the gap in between slab panels, and also shear studs may be used