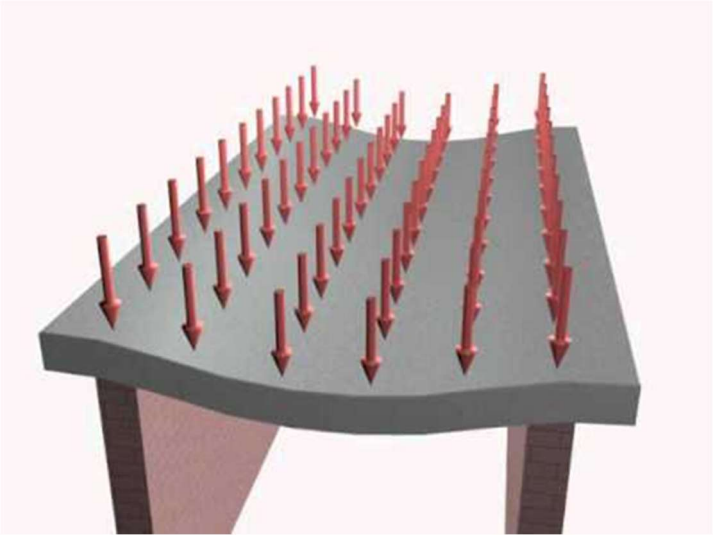
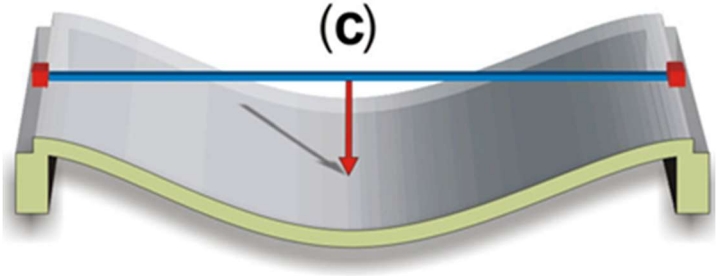
Detailing of Flooring Systems (Slabs)

Chapter 3
Section
3.5

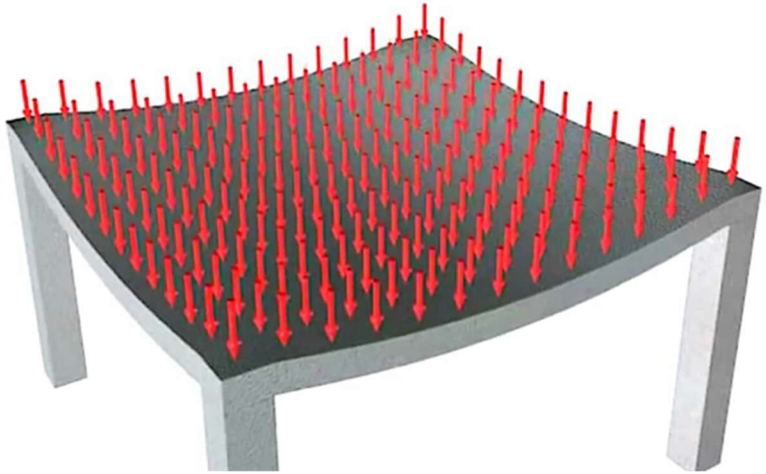
Classification

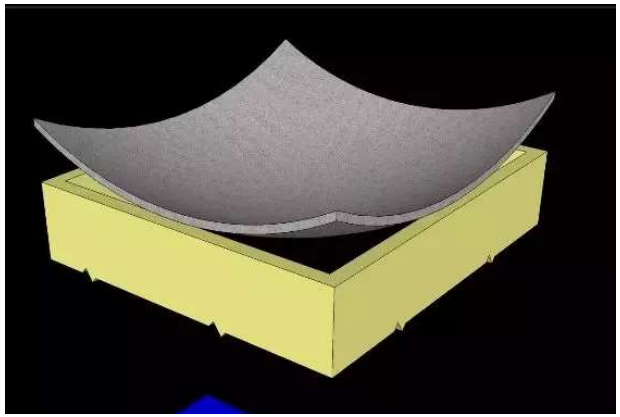
1. Based on Load transformation concept
   - One-way slab : curves and carry load in one direction only.
   - Two-way slab: curves and carry load in two directions.





One-way system – single curvature
Load distributed to the longer edges

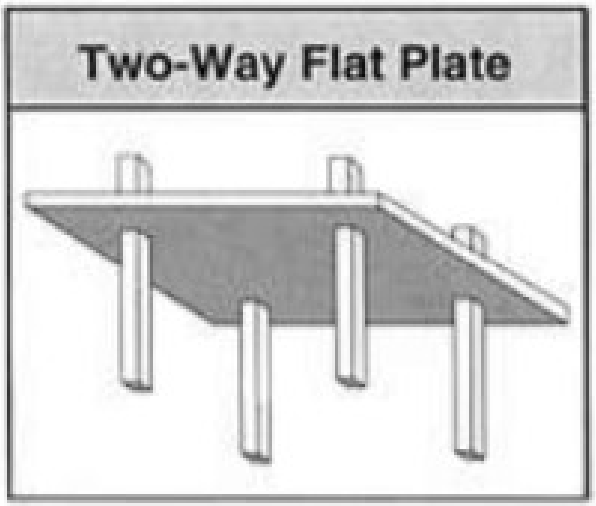


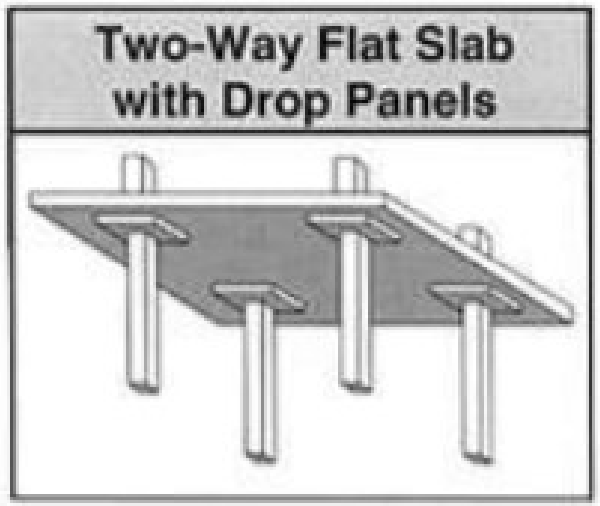


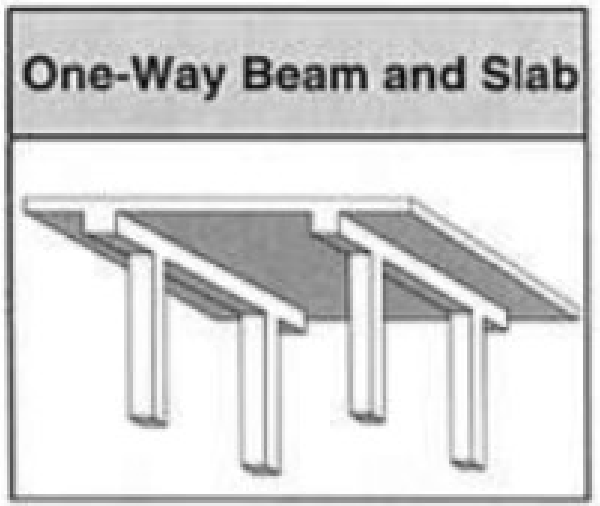
Two-way system – Load distributed to all edges

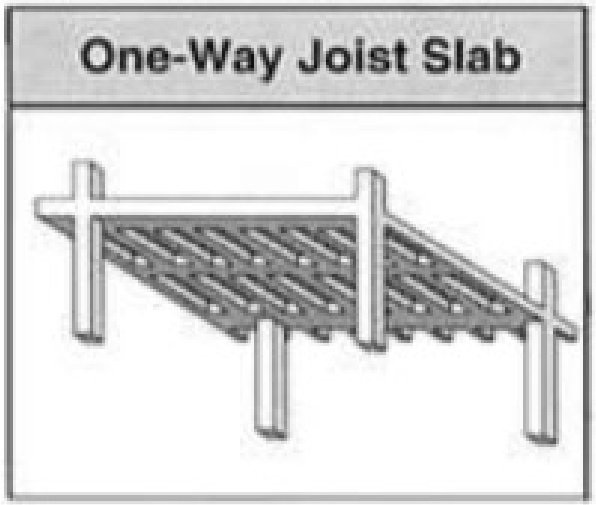
Classification

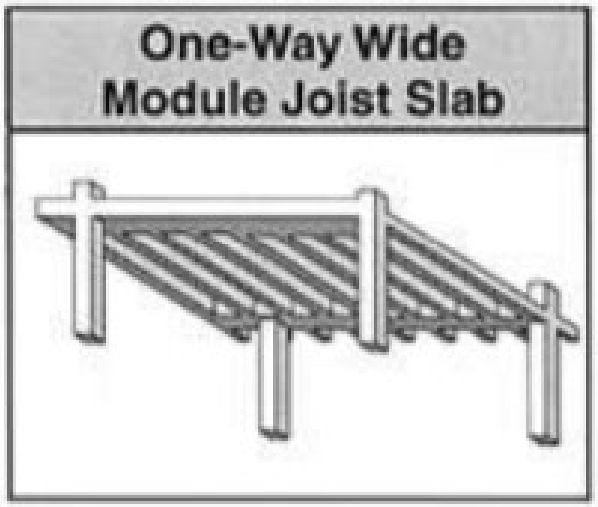
2. Based on slab type

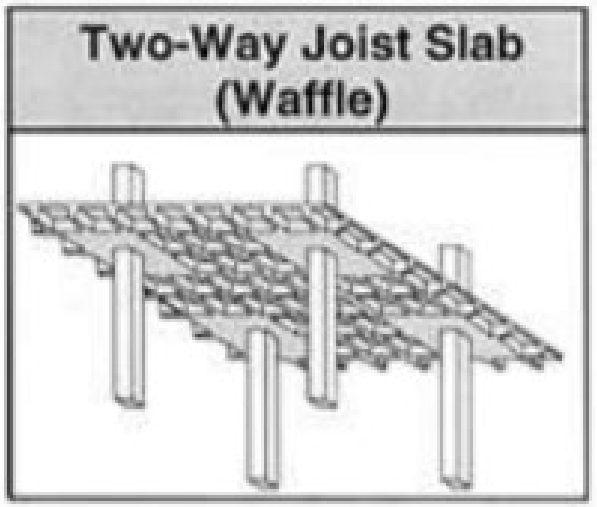








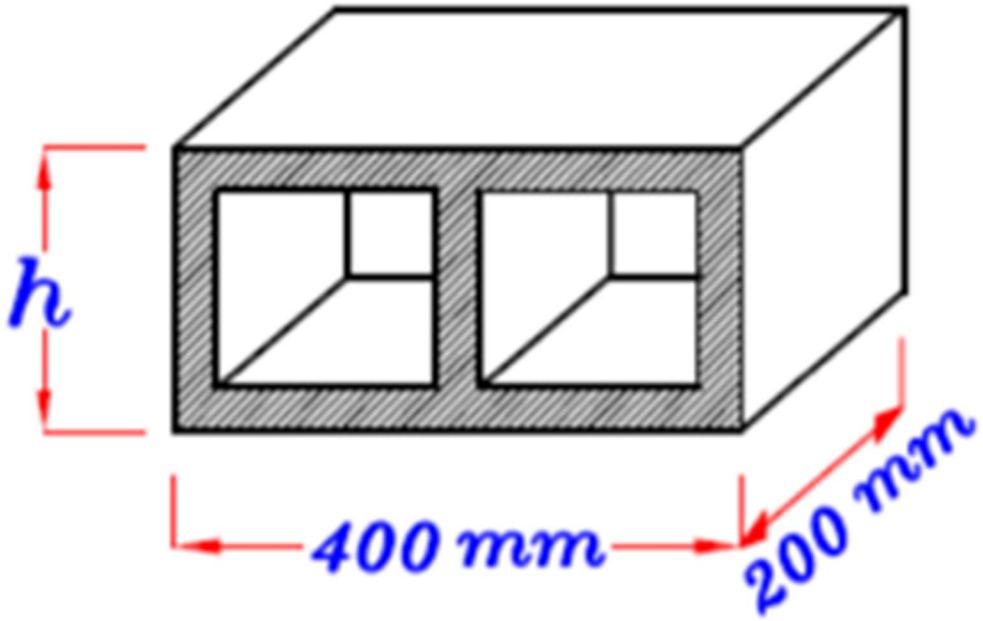




One-Way Joist System (rib slab)

One-Way Joist System (rib slab) - Block

- Joist (rib) can be constructed with normal weight concrete blocks; light weight blocks (Ytong); removable metal or plastic forms.
- Available block size
  - normal weight concrete blocks: h= 170, 200, 240, 300, 320
  - Ytong blocks: can be fabricated as required

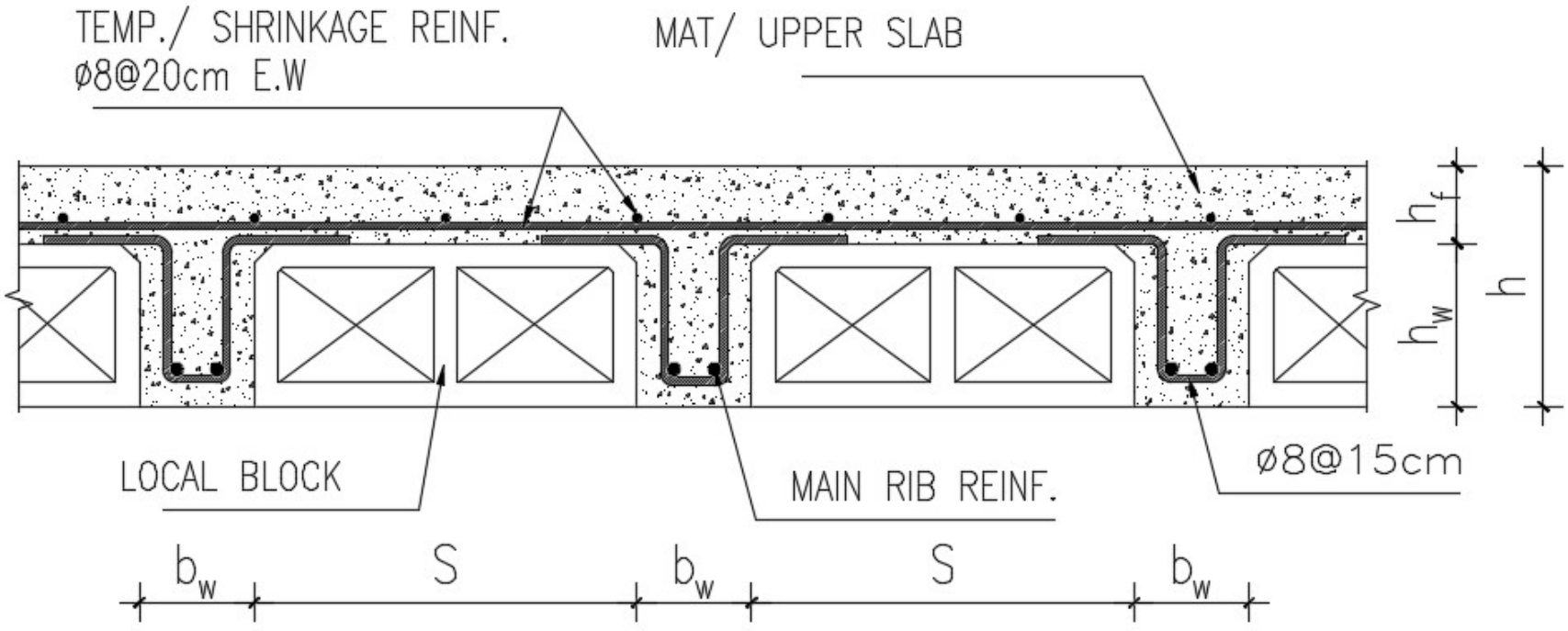


One-Way Joist System (rib slab)

Joist dimensions:

$b_w \geq 100mm$; $h \leq 3.5\, b_w$; $S \leq 750$ mm; $h_f \geq 50$ mm and $\geq S/12$

Typical section

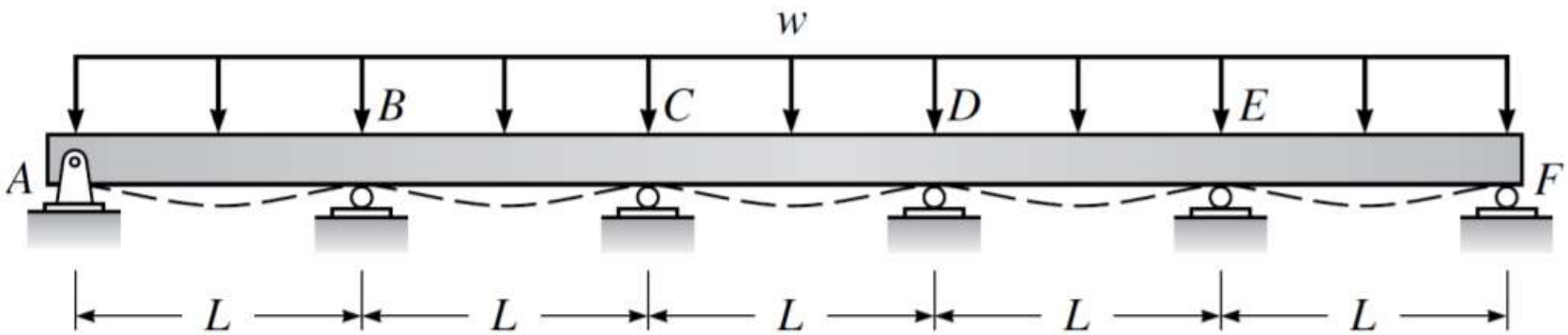


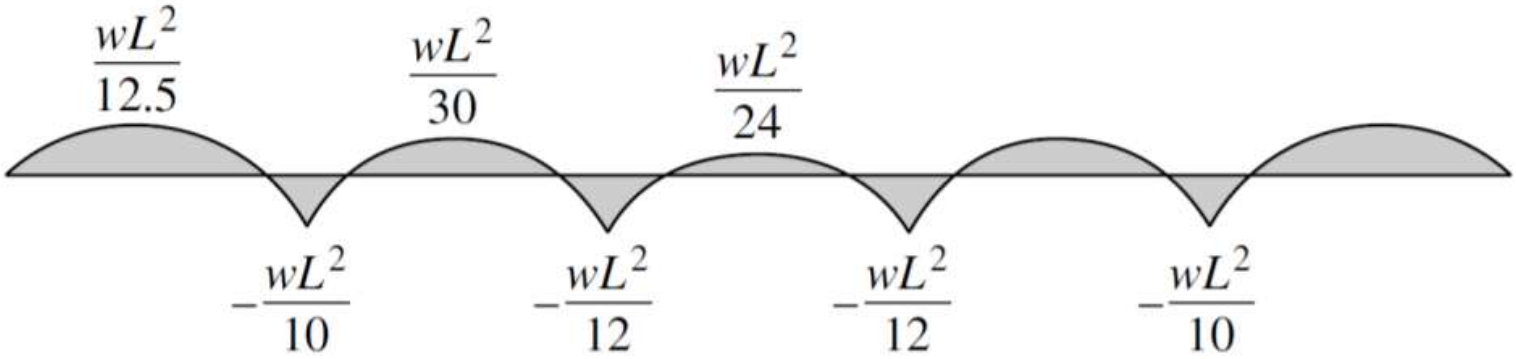
CROSS SECTION IN ONE WAY RIBED SLAB

One-Way Joist System (rib slab)

Modeling & Typical Reinforcement

Ribs are modeled as continuous beams in knife supports.

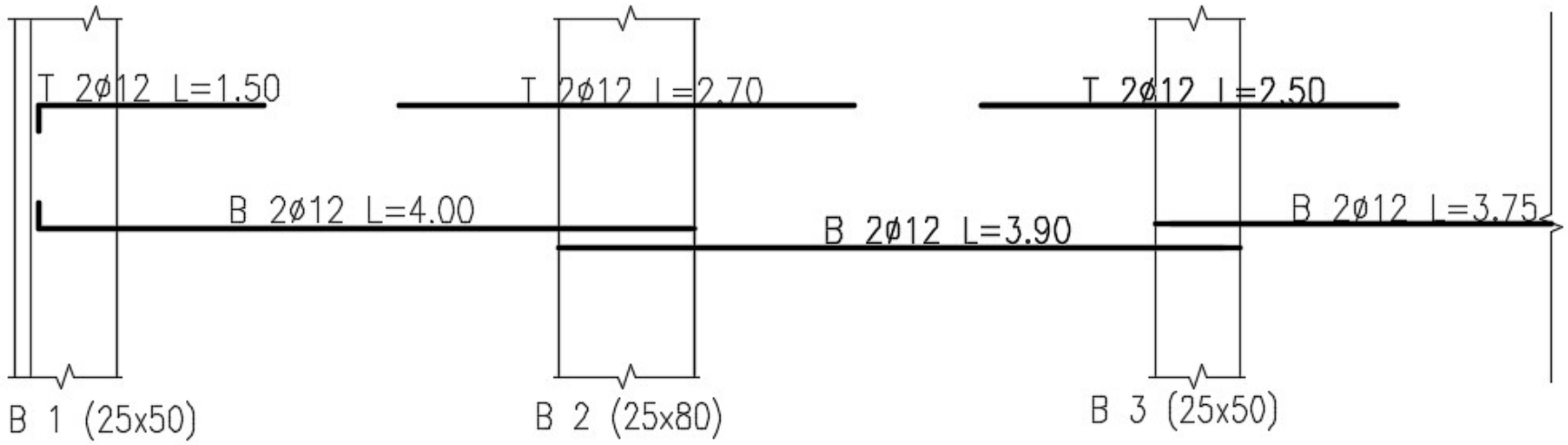




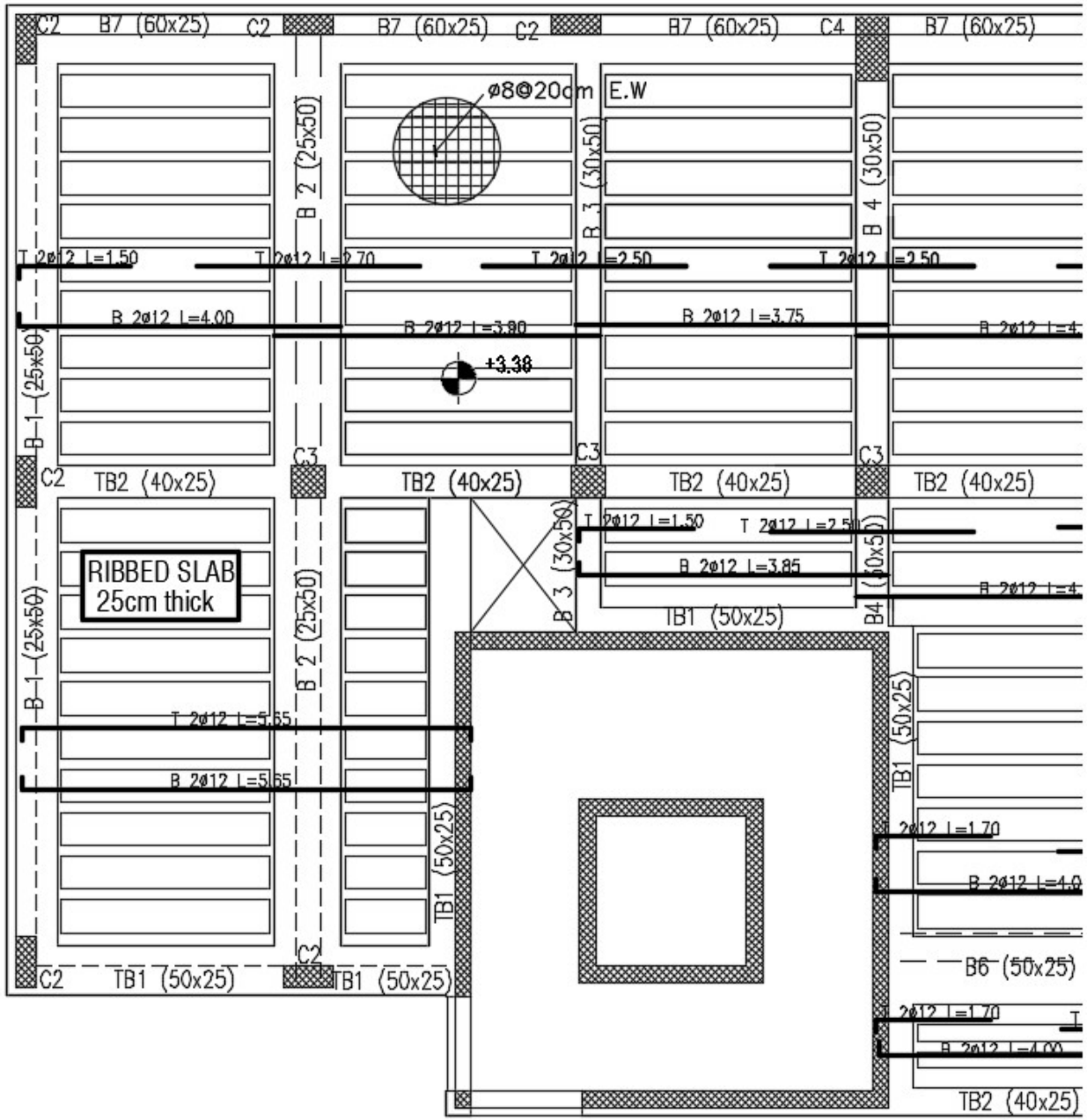
One-Way Joist System (rib slab)

Typical Reinforcement

- As the Ribs are modeled as continuous beams in knife supports. its reinforced by positive bottom reinforcement at middle and negative (top) reinforcement at supports (main beams) as shown.
- Usually rib slab is reinforced for flexural only (shear reinforcement not required.
- Mat is reinforced by temp/shrinkage reinforcement.



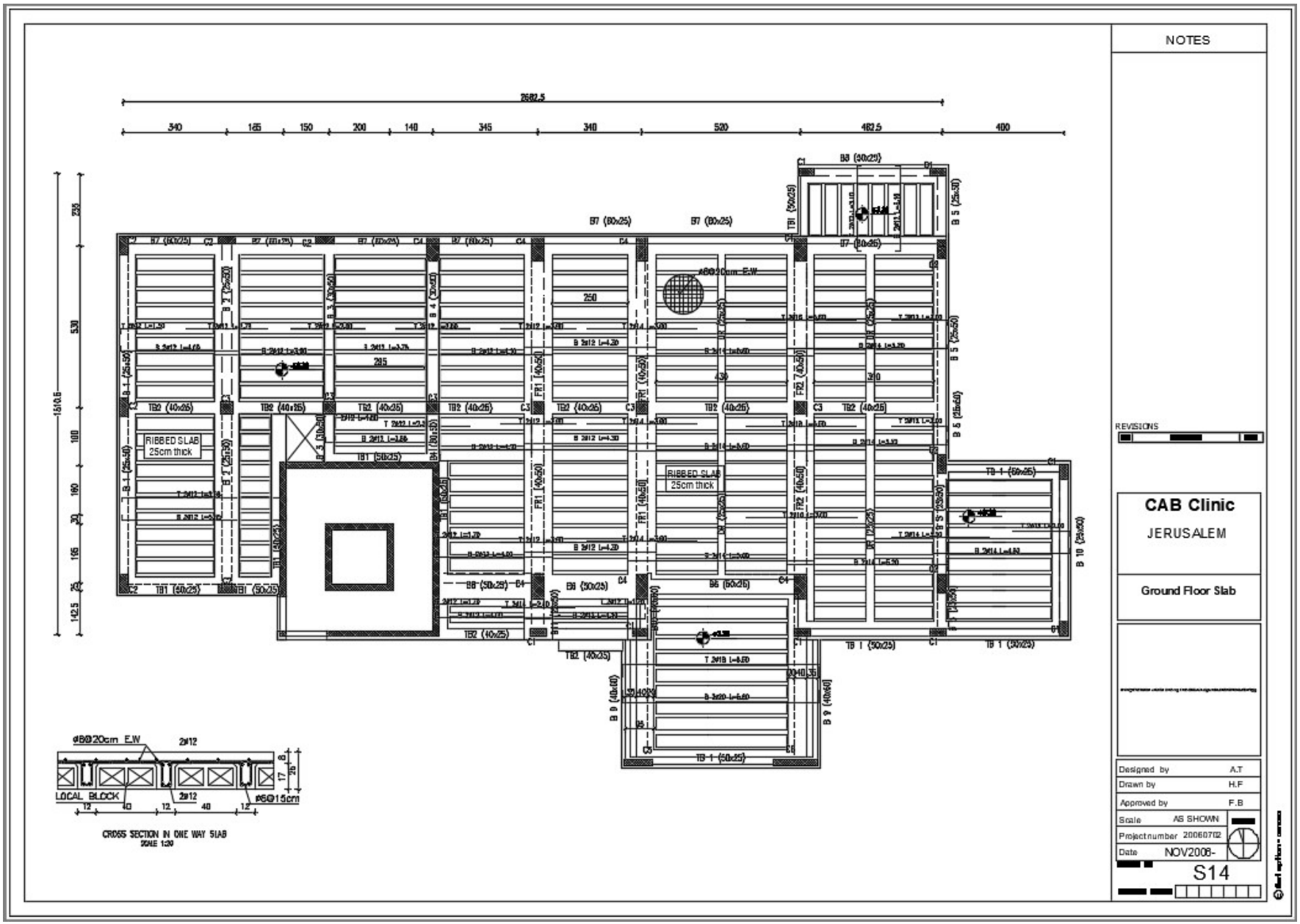
One-Way Joist System (rib slab)



How to draw rib slab?

- Draw beams in each direction. And determine the orientation of the ribs
- Fil the panels in between by appropriate # of ribs
- Maintain rib continuity
- Add reinforcement of each ribs model

One-Way Joist System (rib slab)

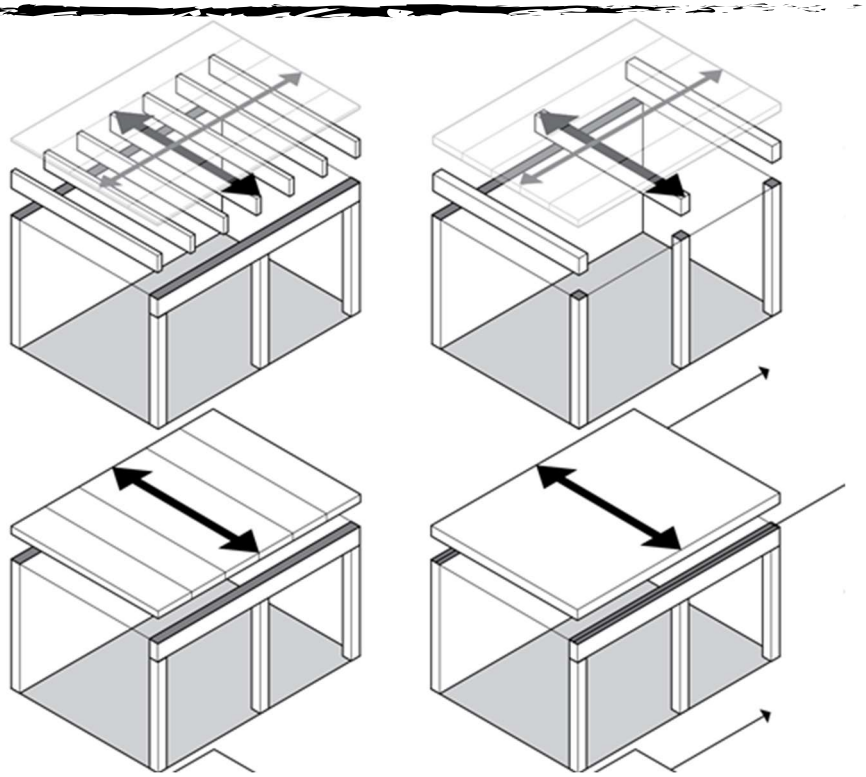


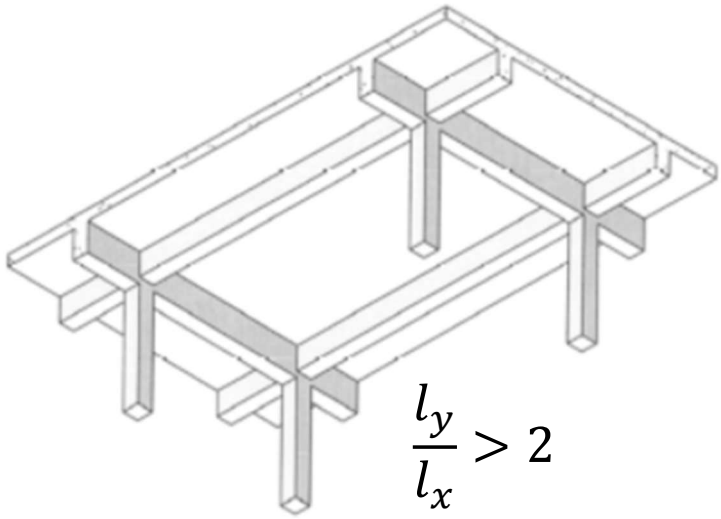
Example of Rib slab floor

One-Way solid slab

As shown in the figure, one way solid slap distribute loads to one direction only based on

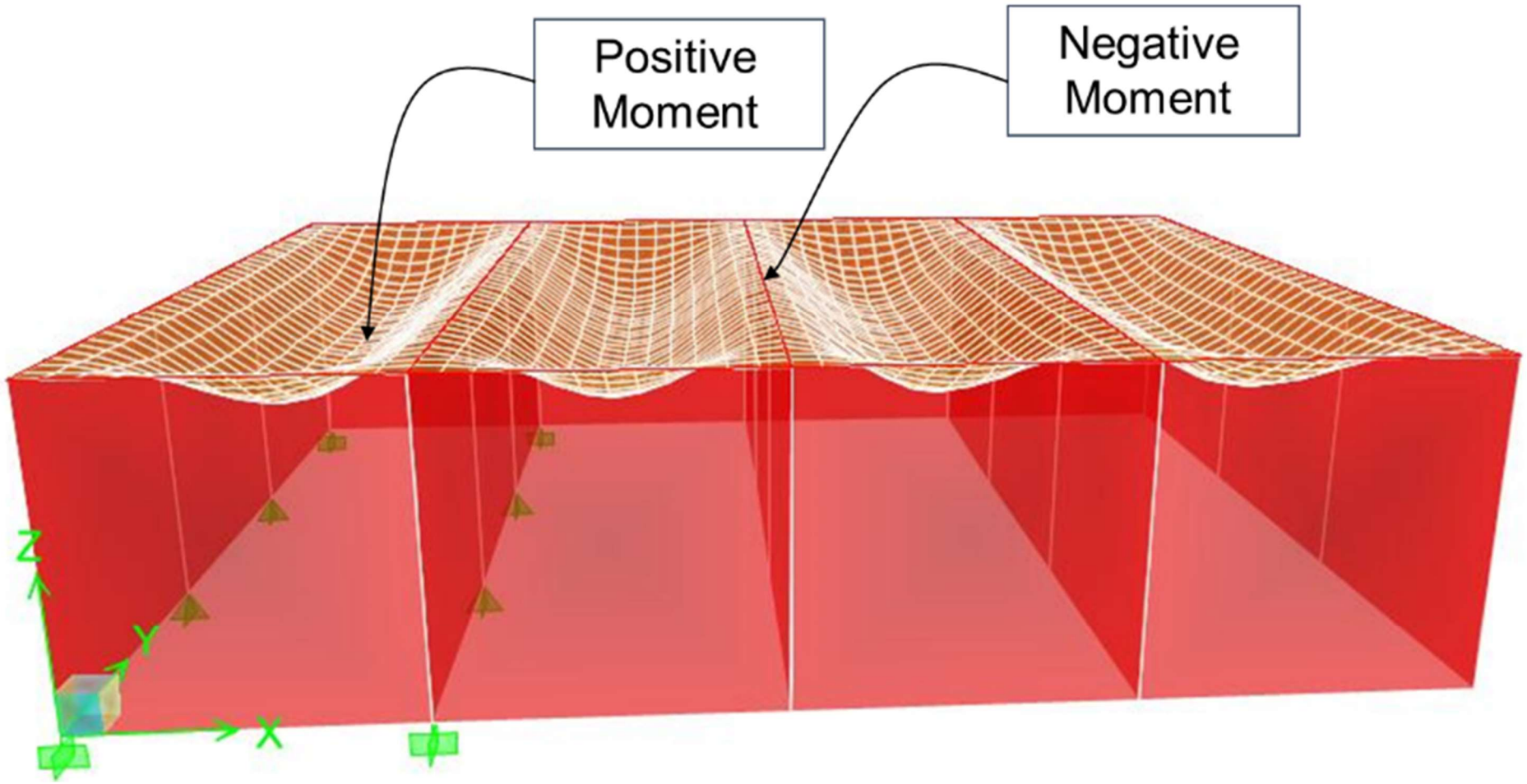
- Structural Geometry: Where the ratio of the long side to the short side of a panel is two or more, load is transferred primarily by bending in the short direction and the panel acts as a one-way slab.
- Method of construction
- The Construction Materials



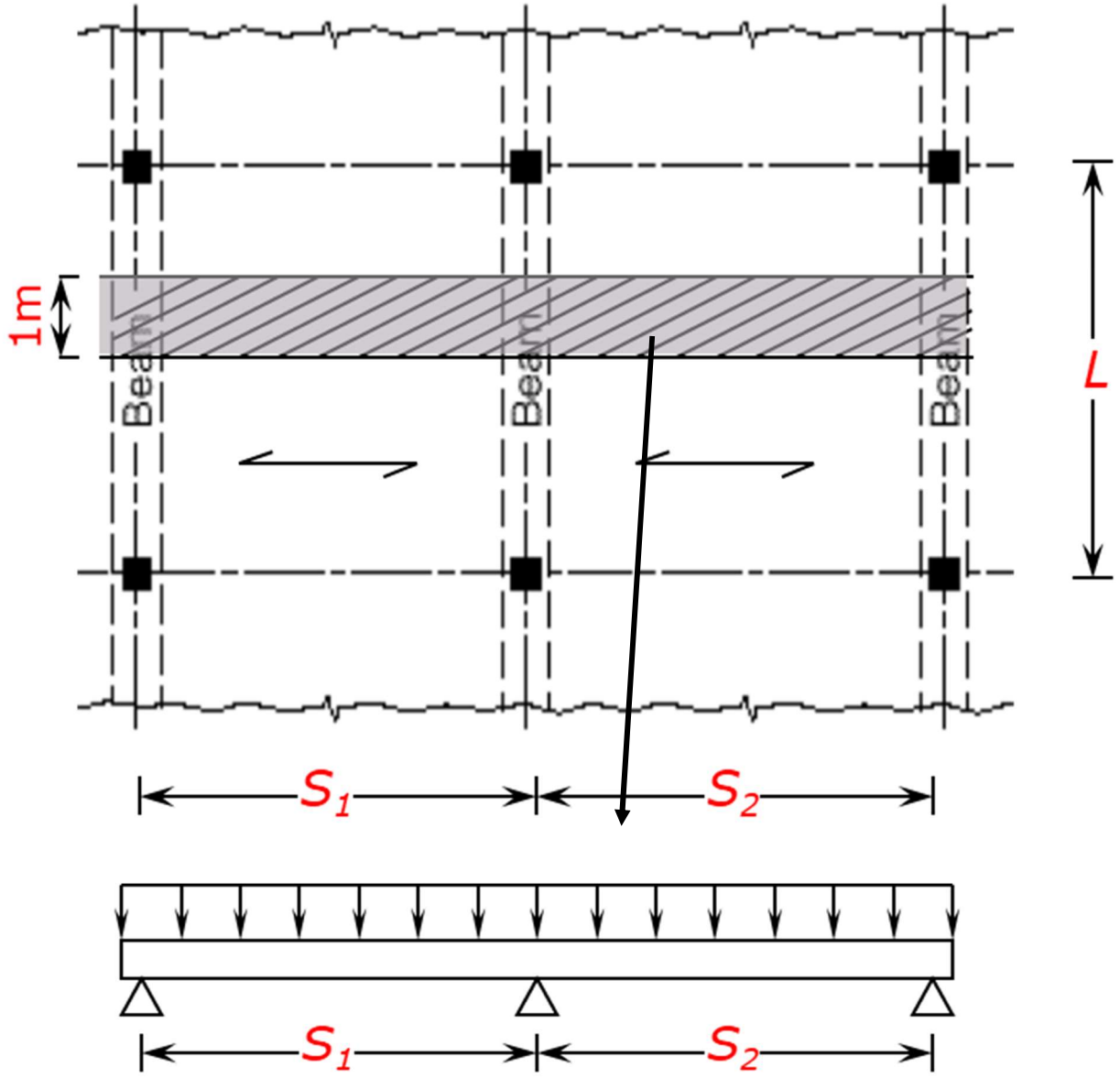


$$\frac{l_y}{l_x} > 2$$

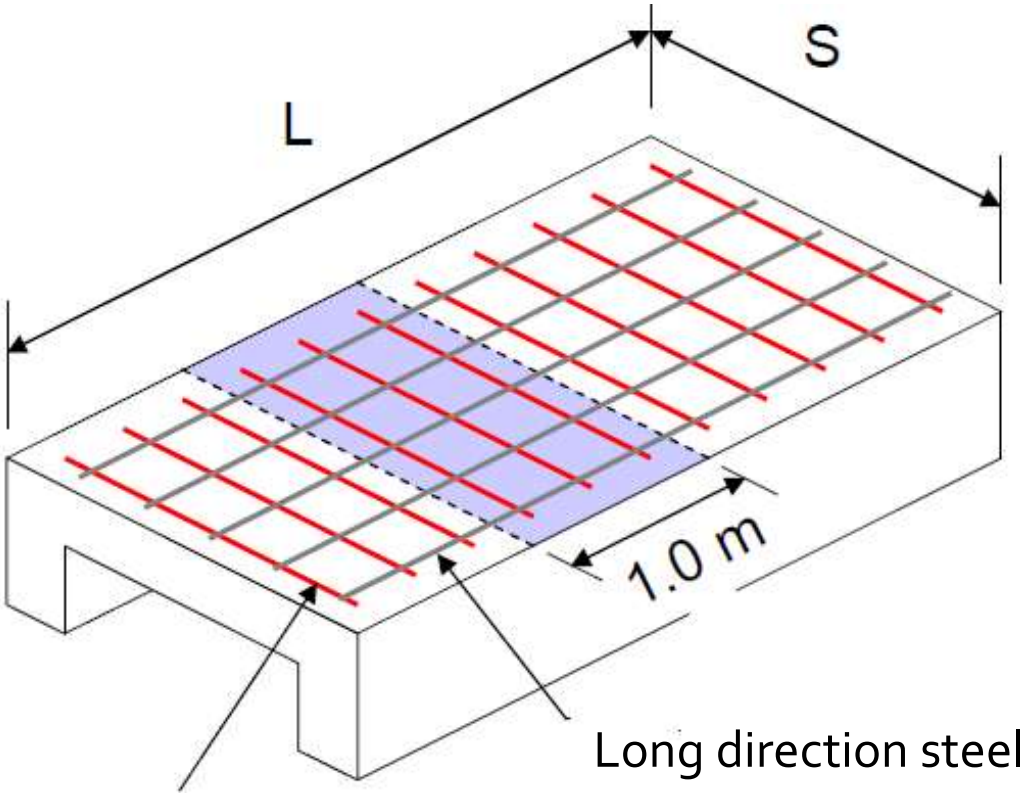
Behavior of One way solid slab

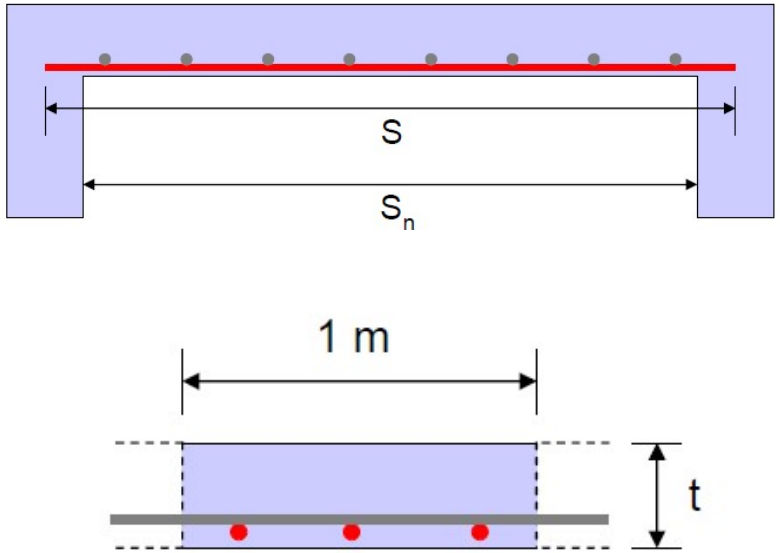


Modeling of One way solid slab



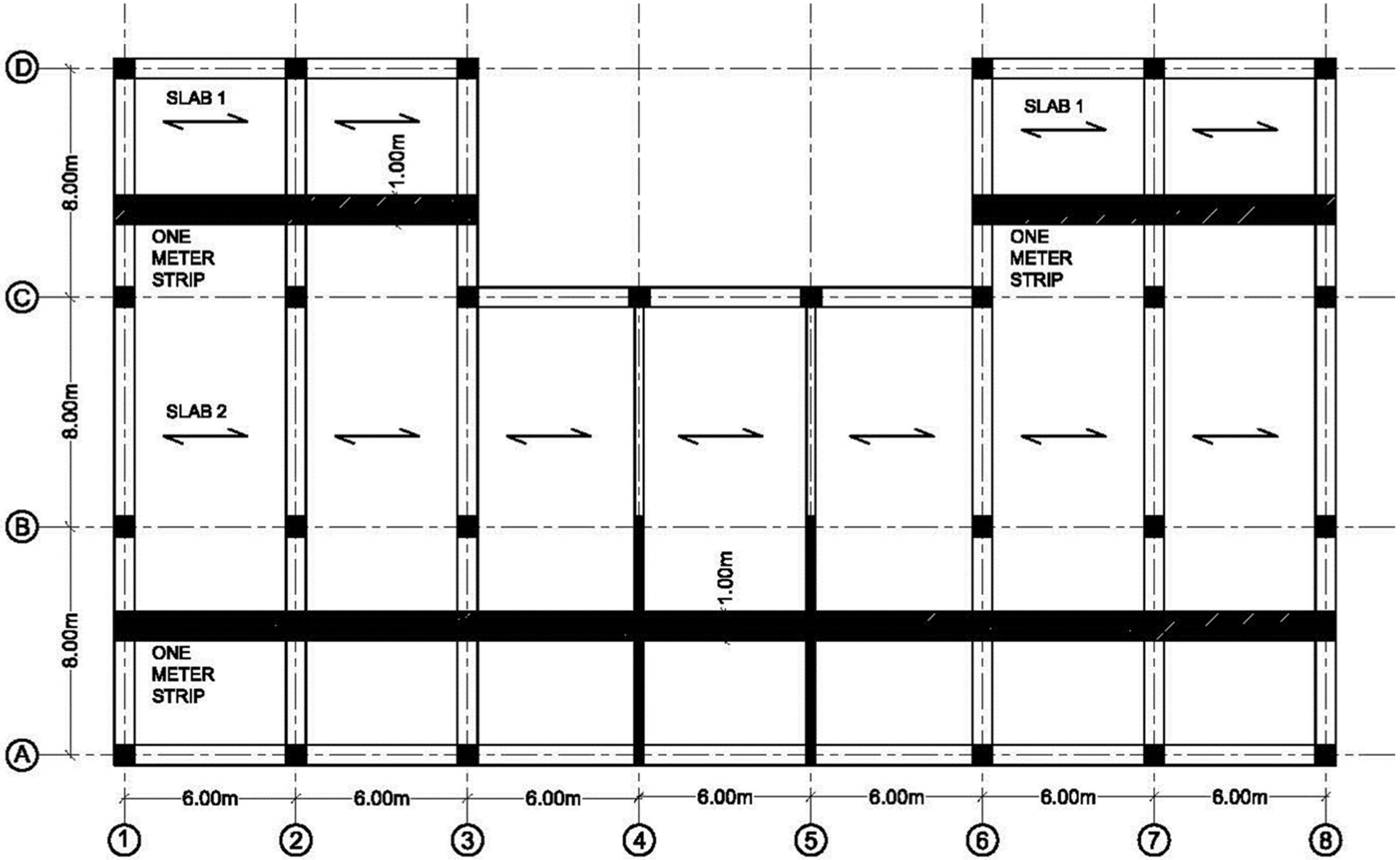
Typical Reinforcement of one-way slab



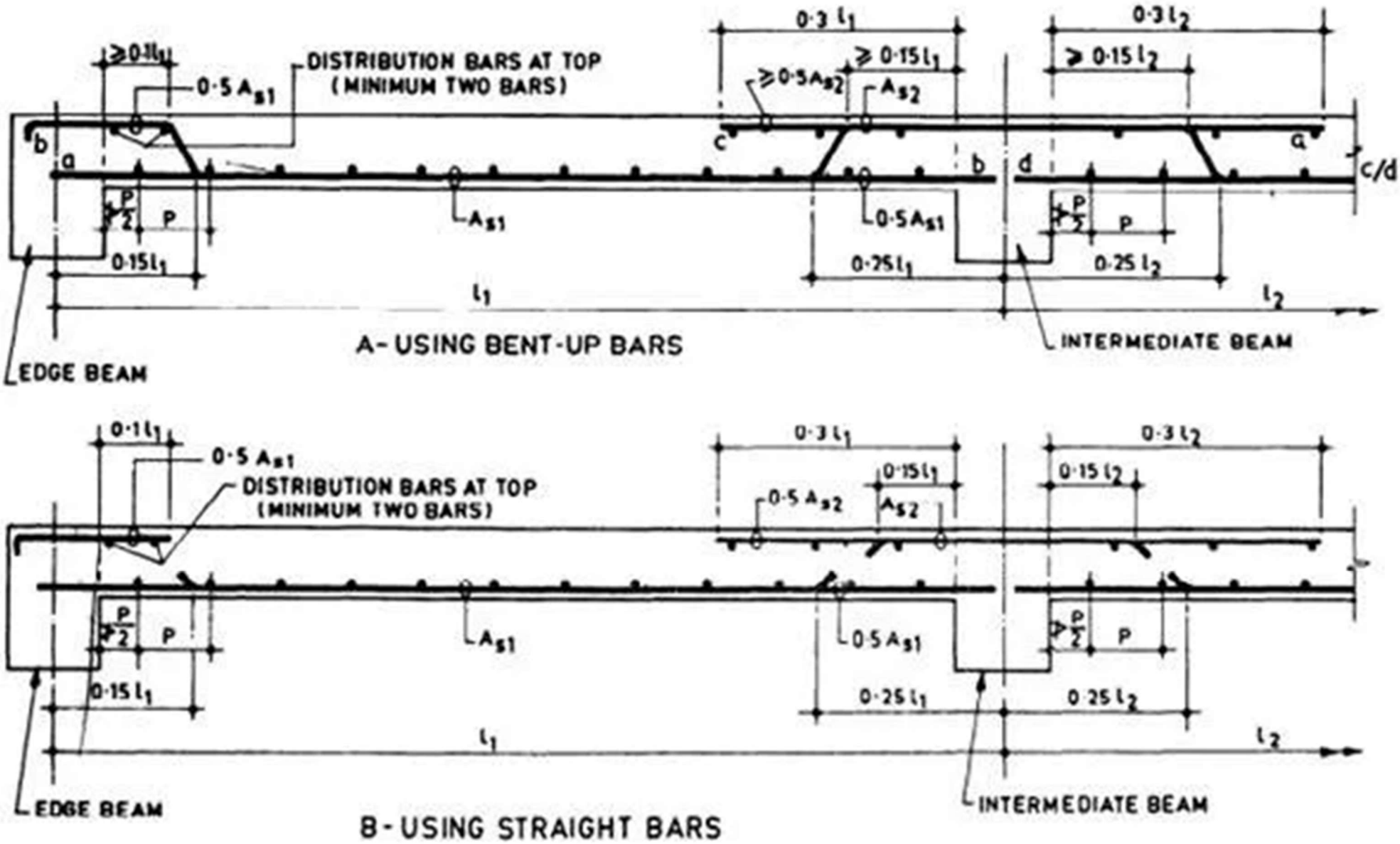


- Flexural reinforcement spacing
  - Less than three times the slab thickness (h_s),
  - Less than 450 mm, center-to-center.

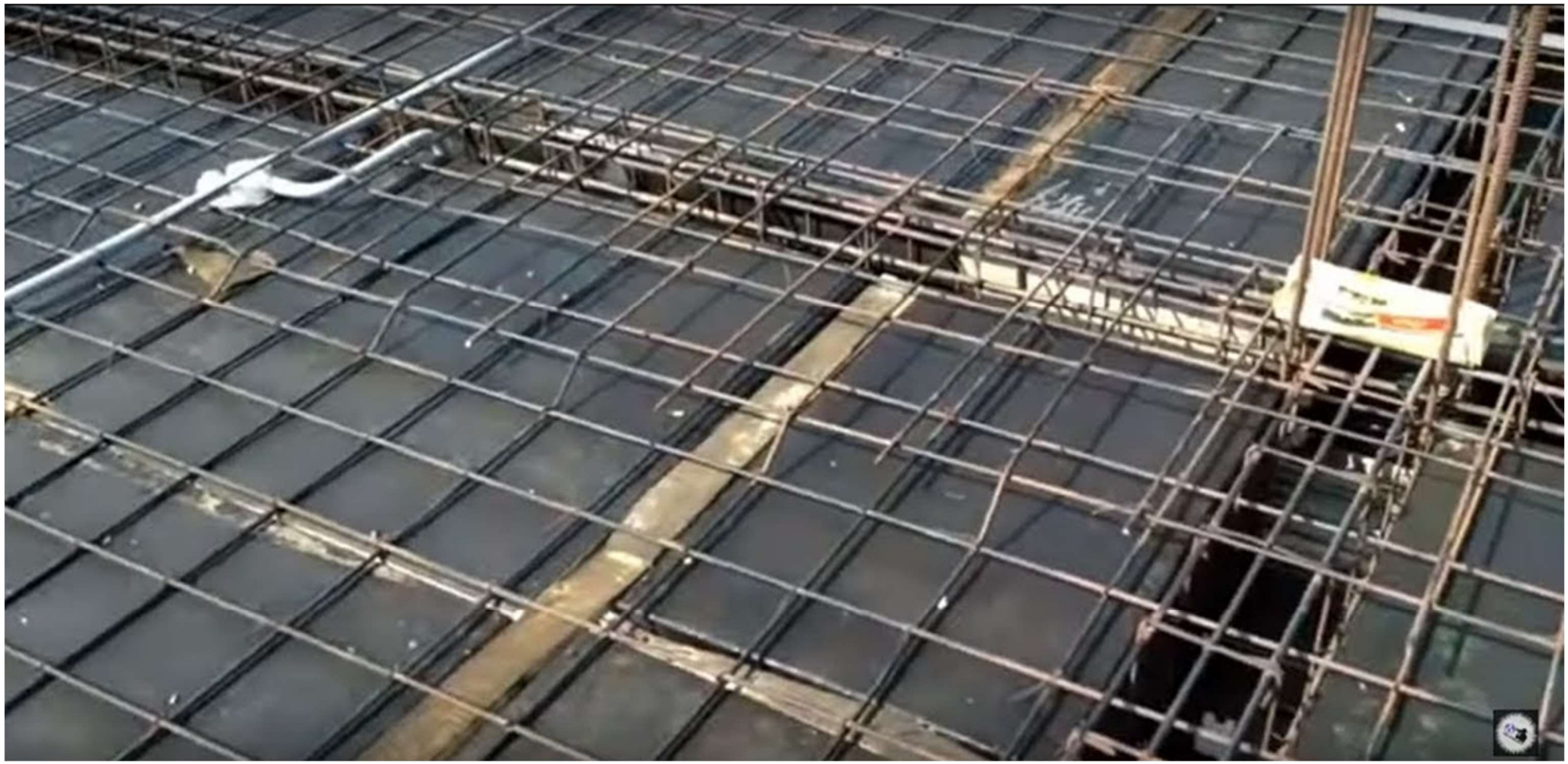
Typical Reinforcement of one-way slab



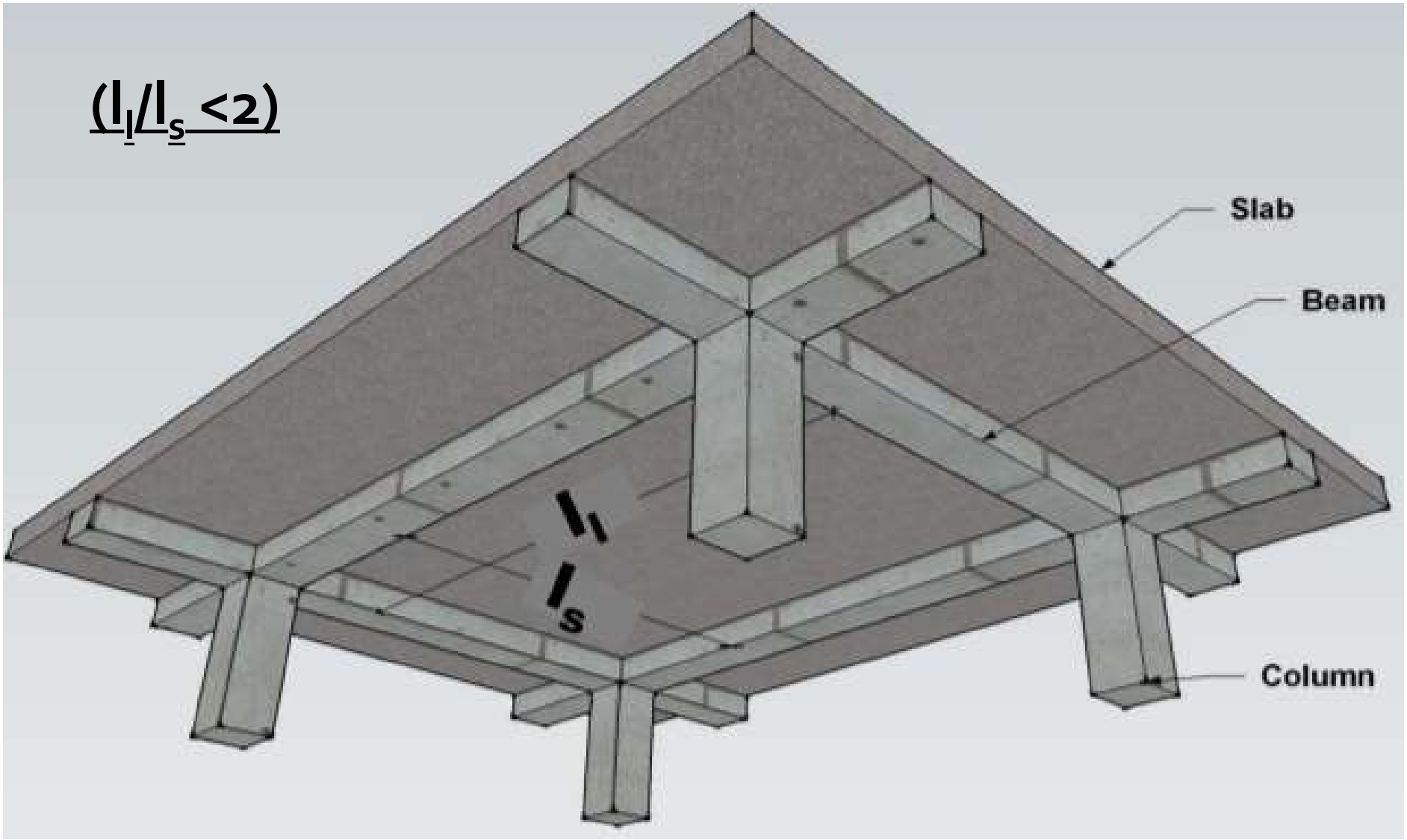
Typical Reinforcement of one-way slab



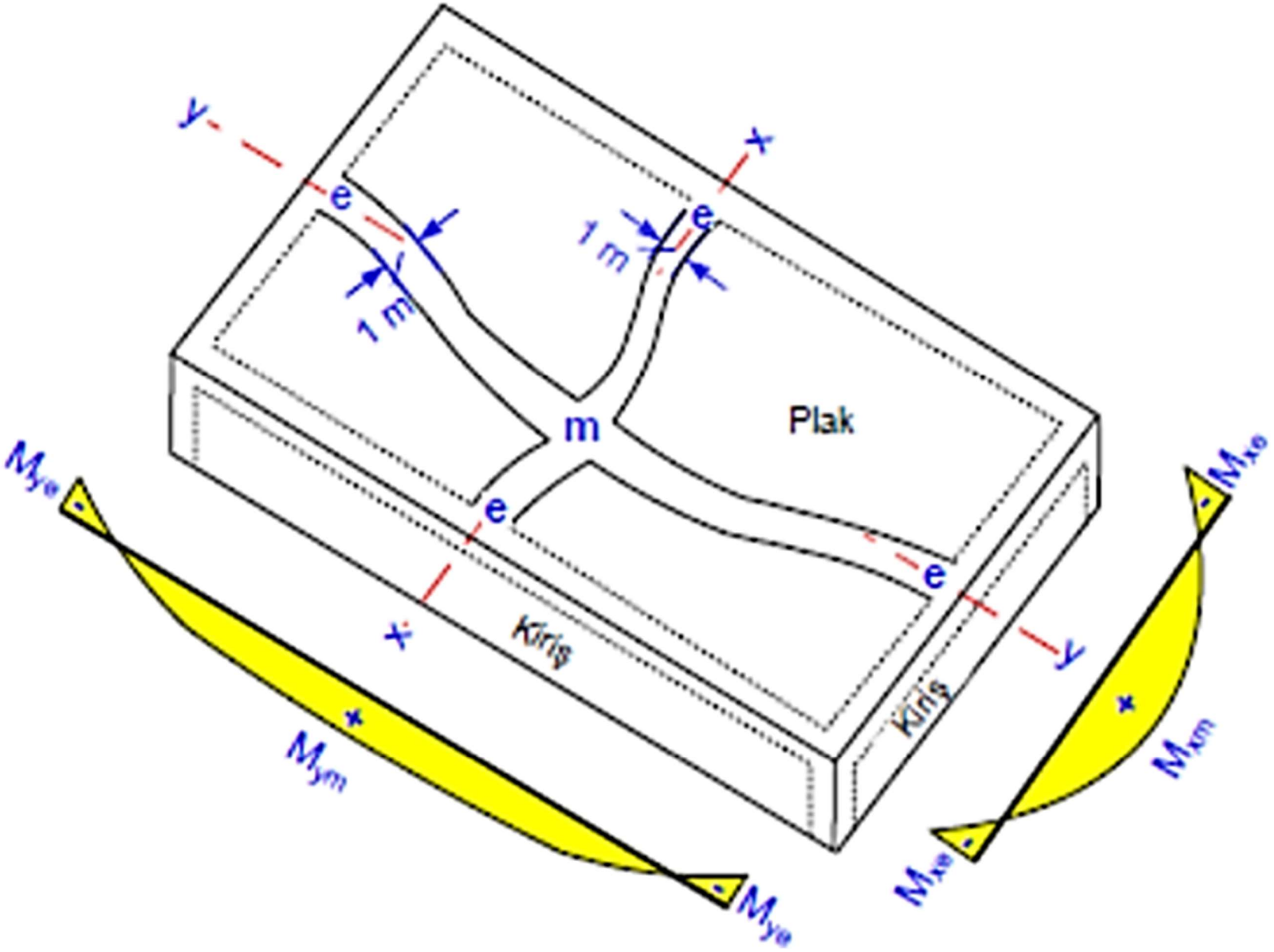
Typical Reinforcement of one-way slab



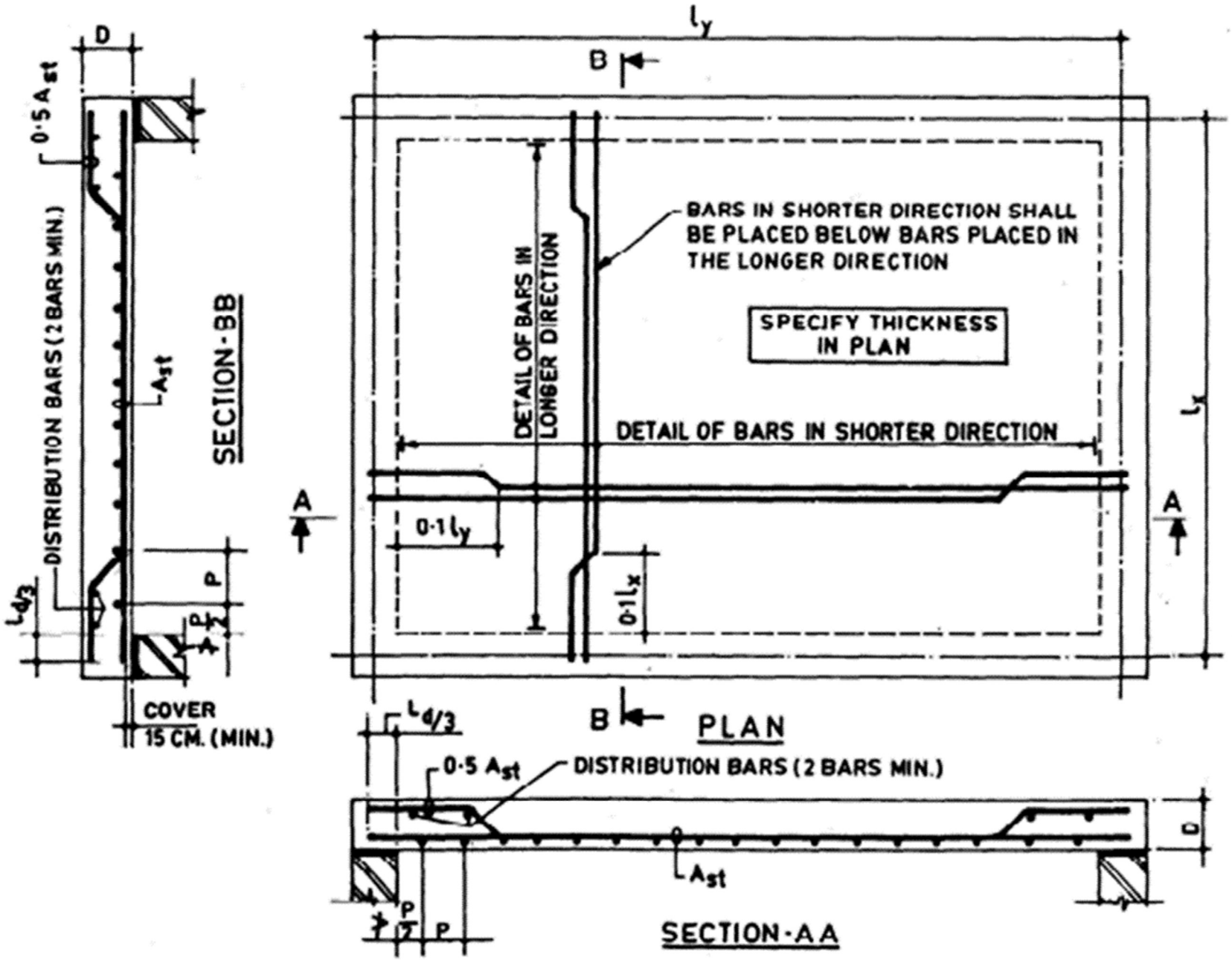
Two-way slabs with beams



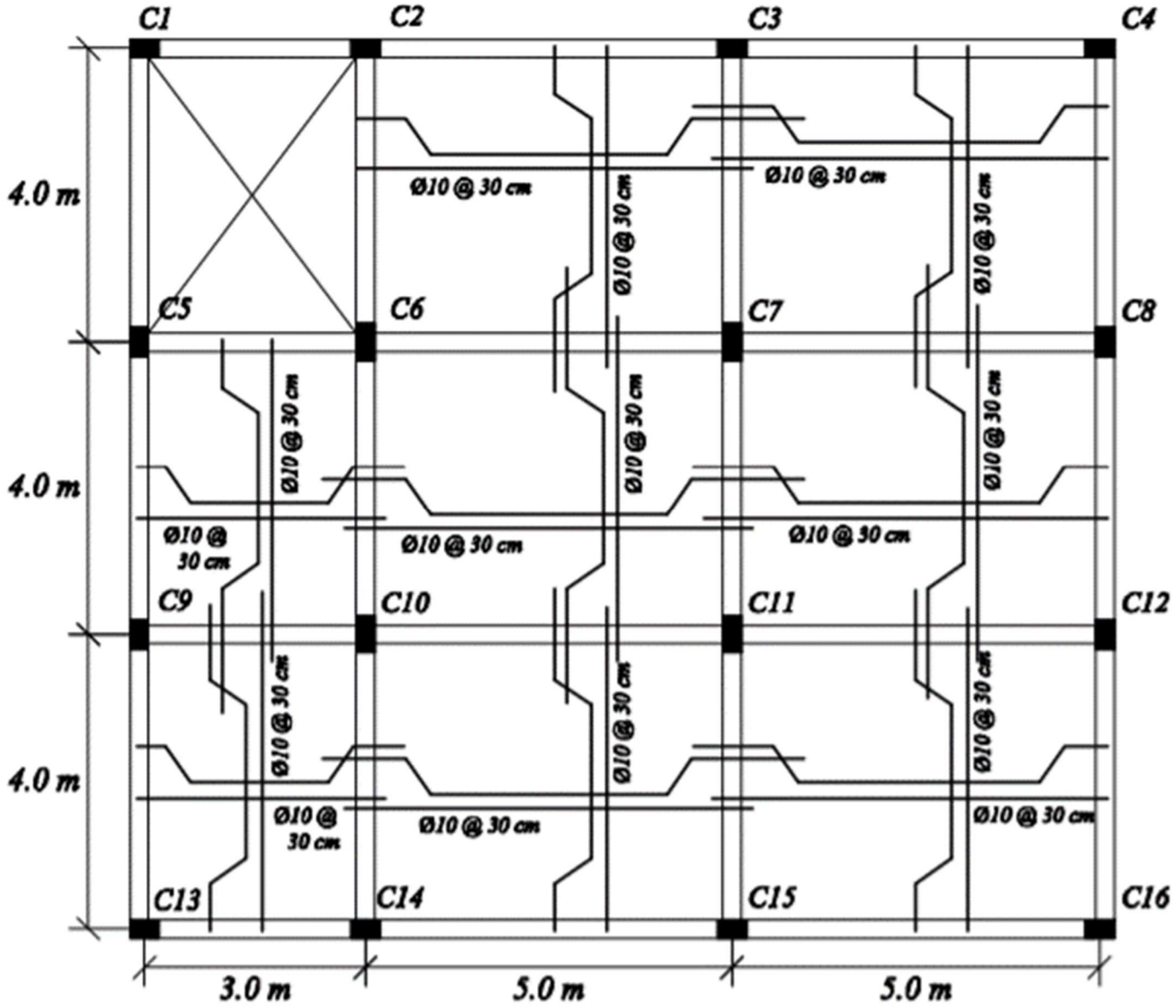
Behavior of Two-way slabs with beams



Typical Reinforcement of two-way slap with beams



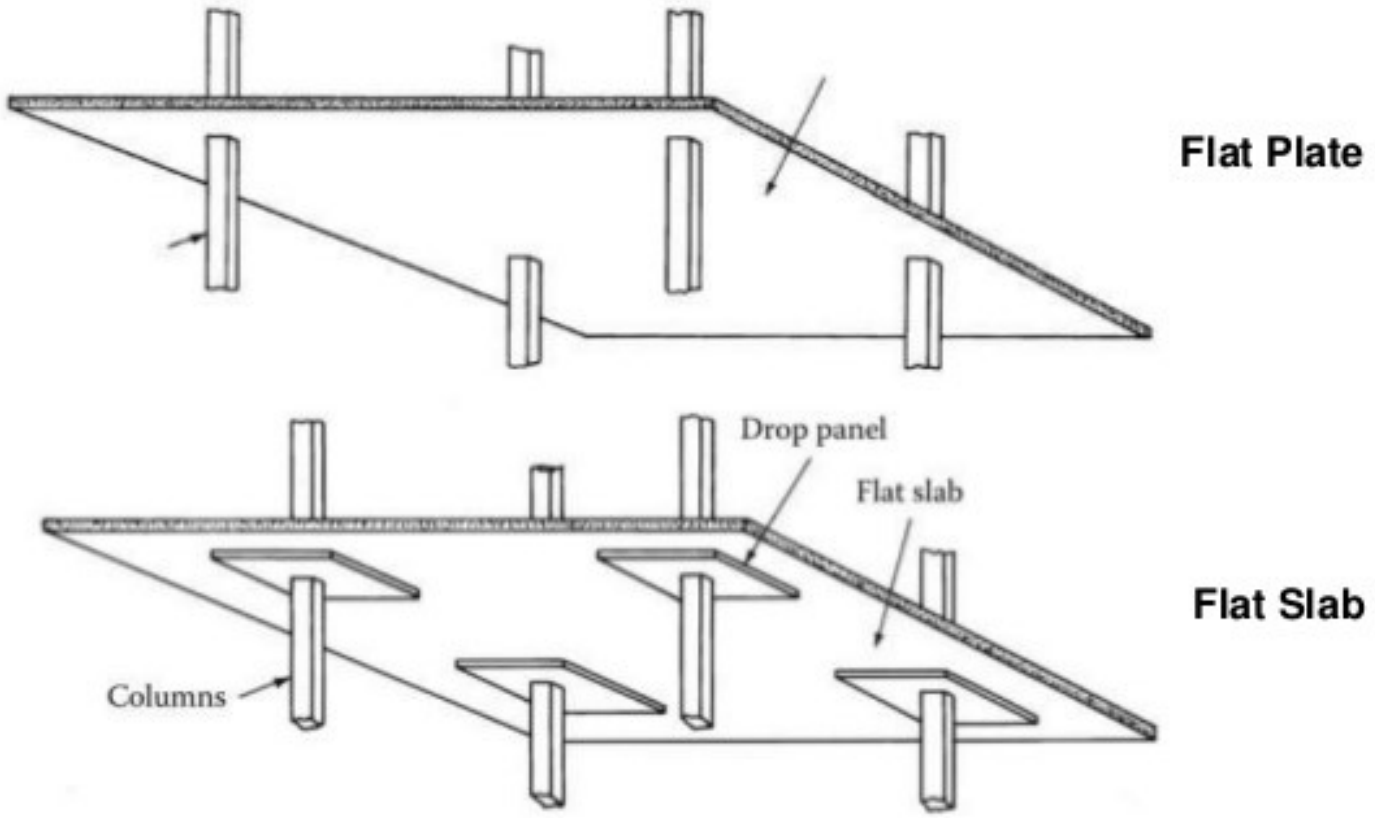
Typical Reinforcement of two-way slap with beams



Reinforcement layout of a two-way slap with beams

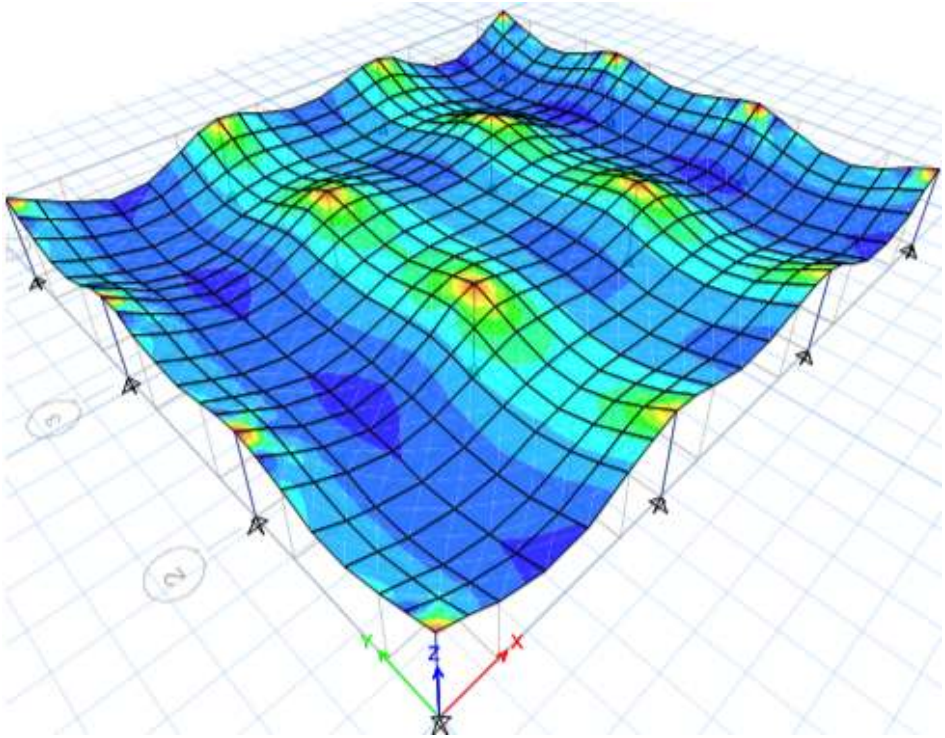
Flat Plate/ Slap System

- A flat plate floor system is a two-way concrete slab. The system has the advantages of simple construction and formwork,
- Typically economical for span lengths between 4.5m and 8m when subjected to moderate live loads.



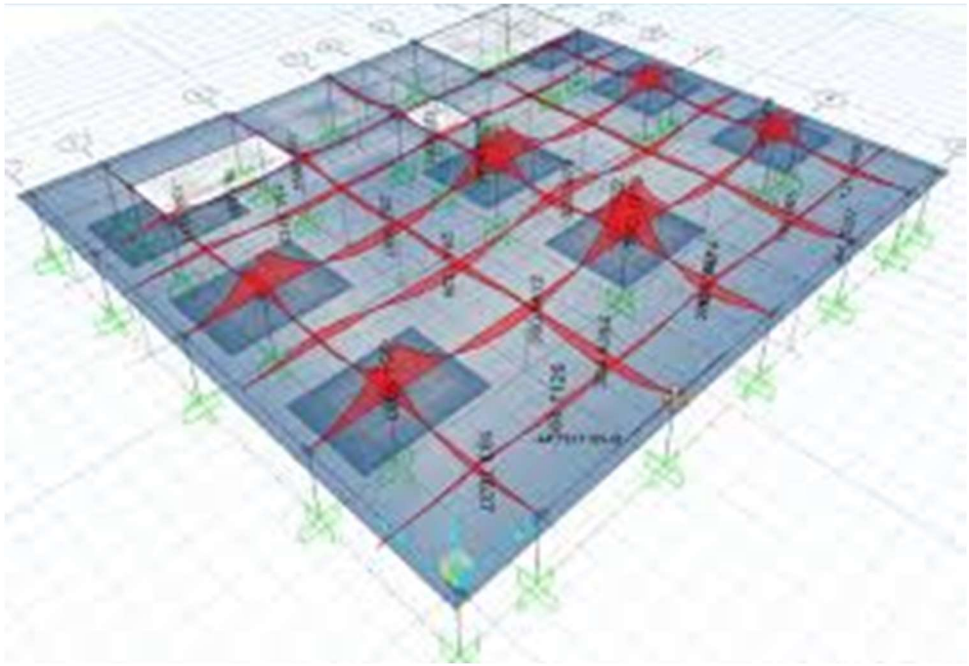
Flat Plate System

Behavior of Two-way slabs with beams



Deflected shape

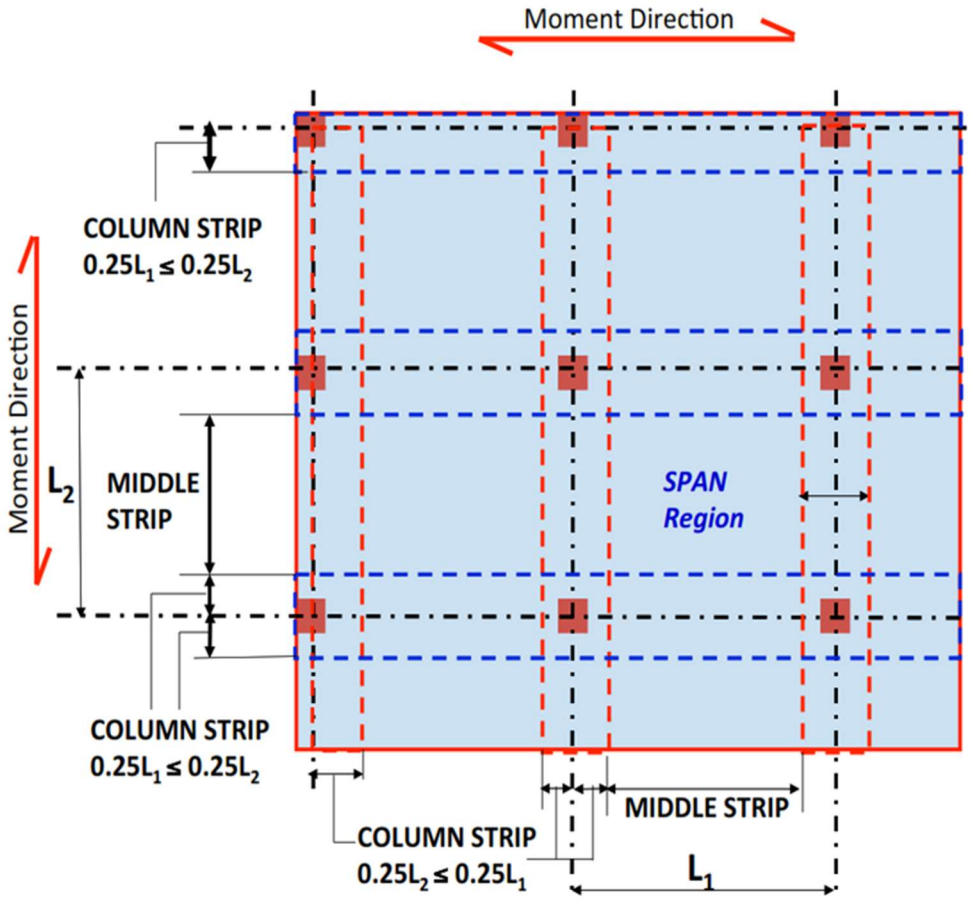
Slab Moment diagram



- For relatively short spans and live loads about 2.5 KN/m² the thickness of a flat plate is usually controlled by deflection requirements.

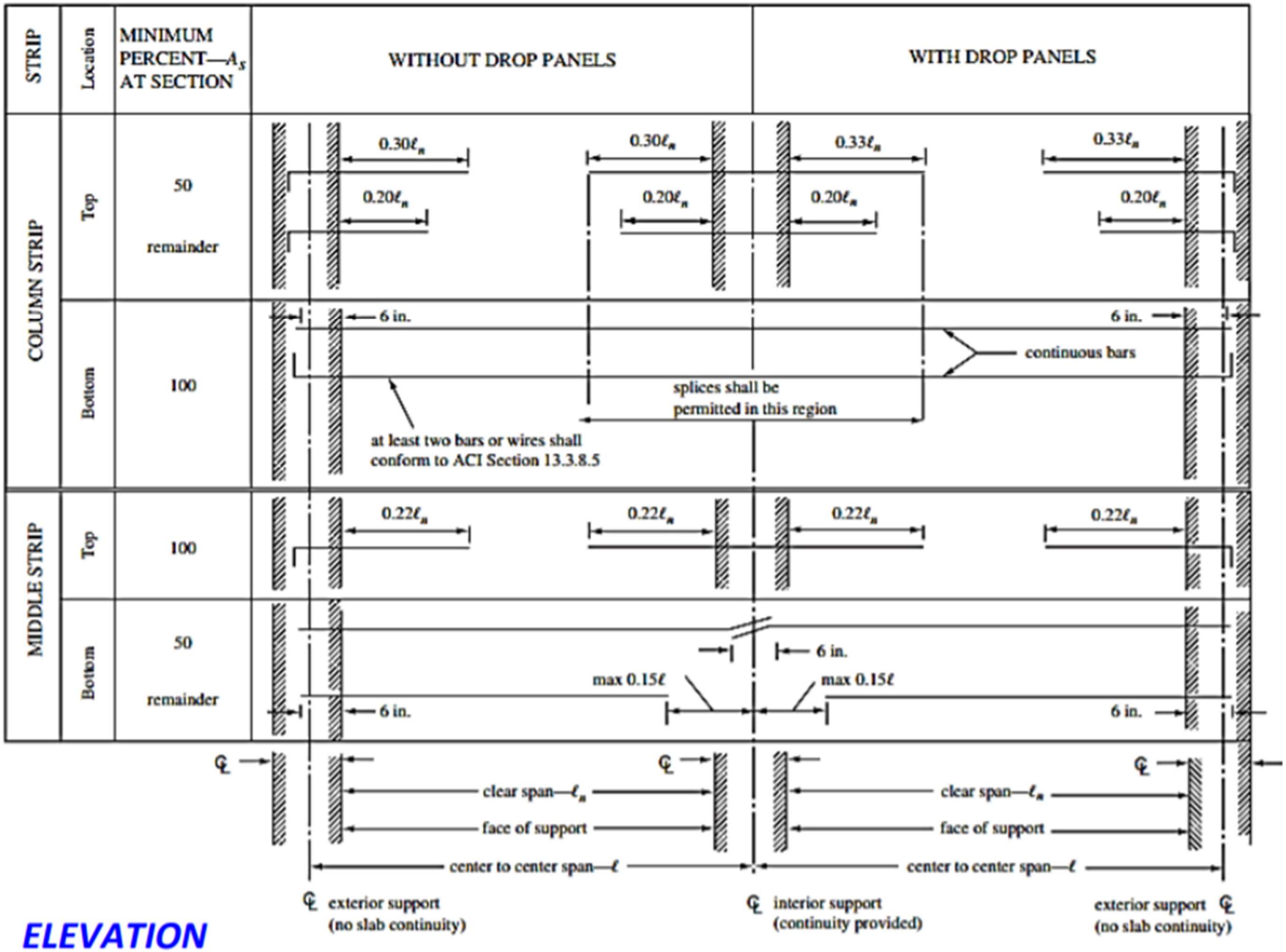
Flat Plate flexural reinforcement

Flexural (or main) reinforcement. The panels are divided into 'column strips' and middle strips 'in both directions as shown in the figure and the required reinforcement is laid off for each strip typically as shown in the next slide. (Usually, two-ways mats two layers are used in small projects)



Note: usually the flexural reinforcement at the critical sections in the column and middle strips will be about the minimum amount specified in codes where the slab deflection is determined by deflection control.

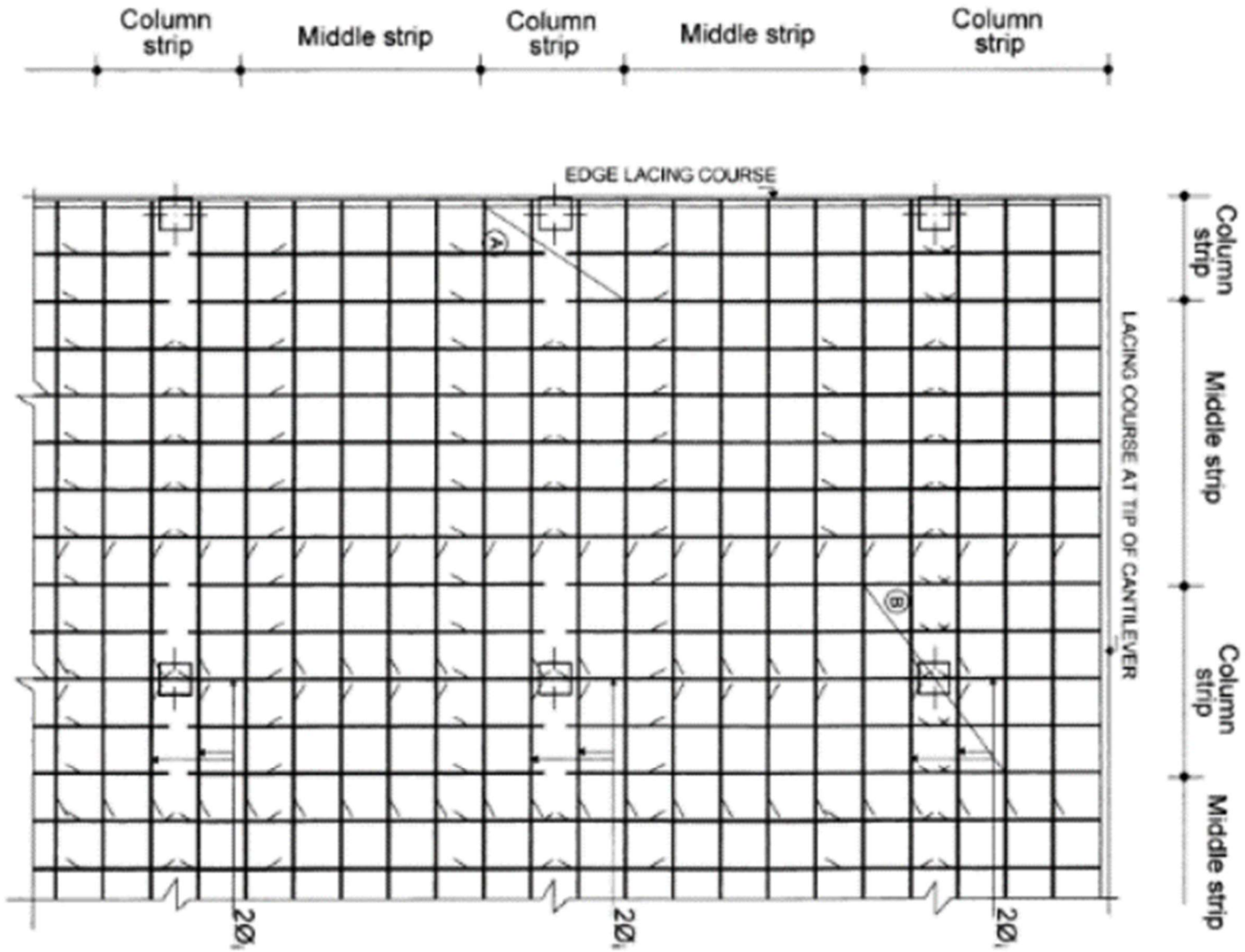
Typical flexural reinforcement



ELEVATION

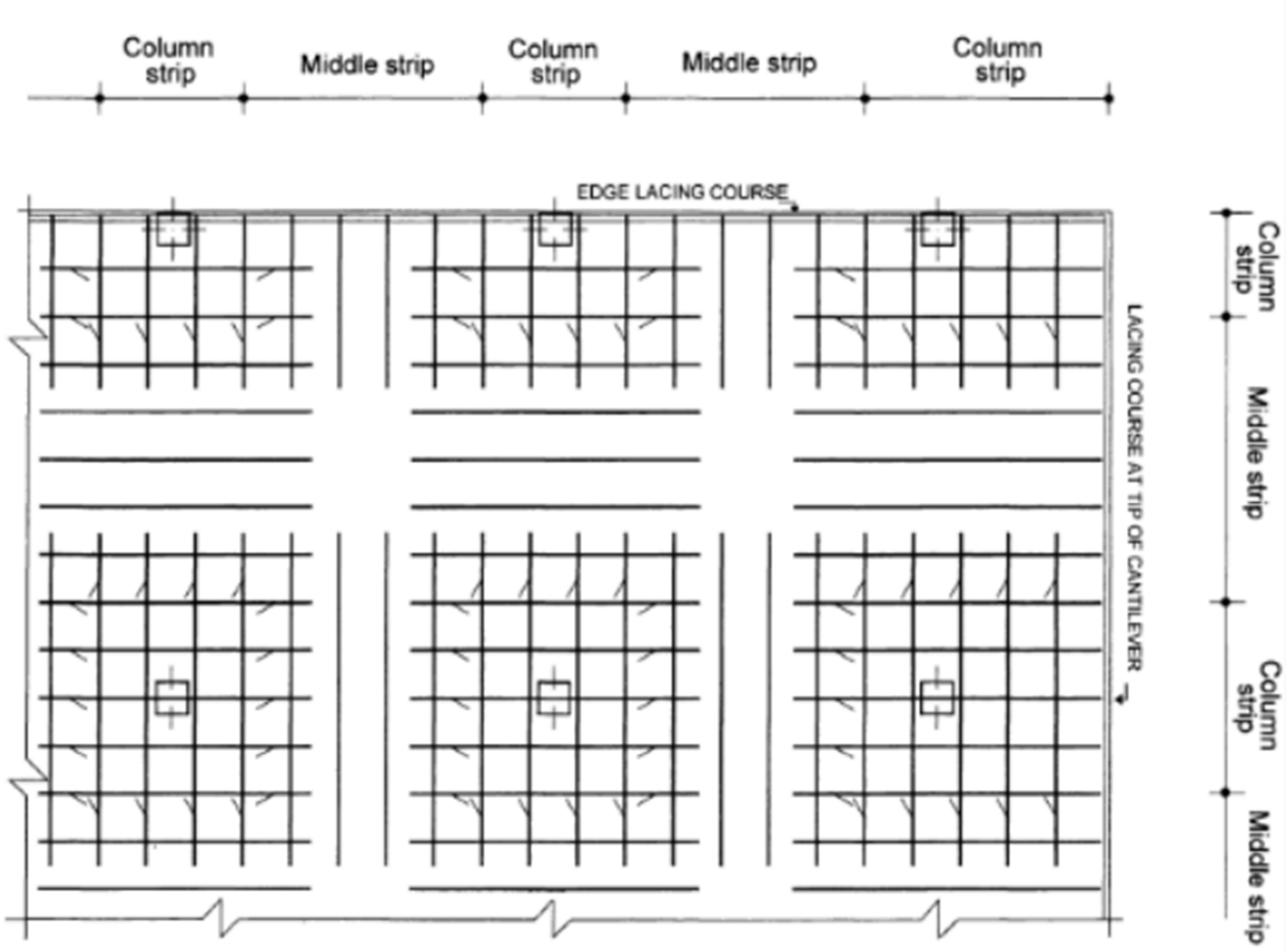
Flexural reinforcement drawings

Typical BOTTOM flexural reinforcement - Plan



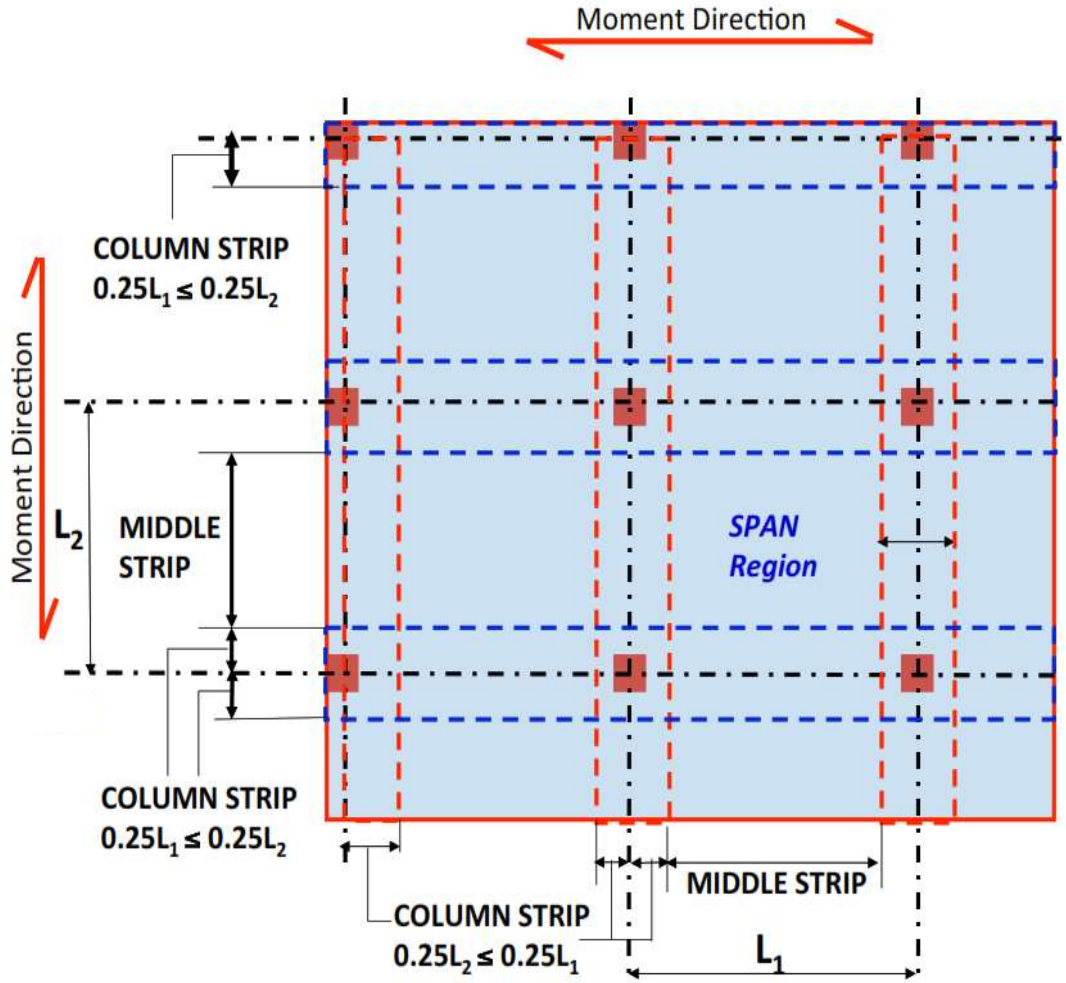
Flexural reinforcement drawings

Typical TOP flexural reinforcement - Plan



Flat Plate System detailing

The panels are divided into 'column strips' and middle strips 'in both direction.

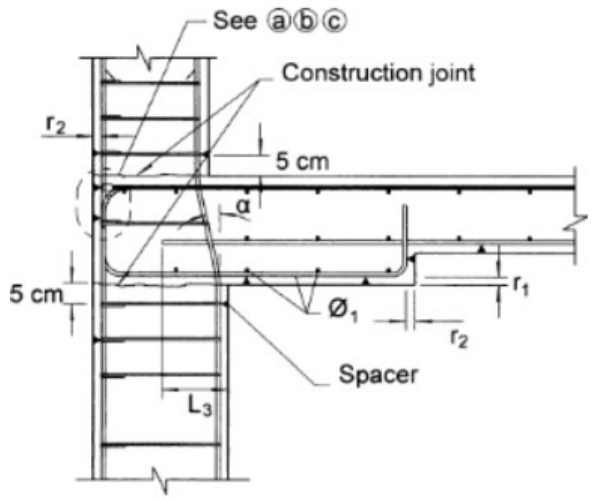


- Punching shear reinforcement
- Crack control reinforcement

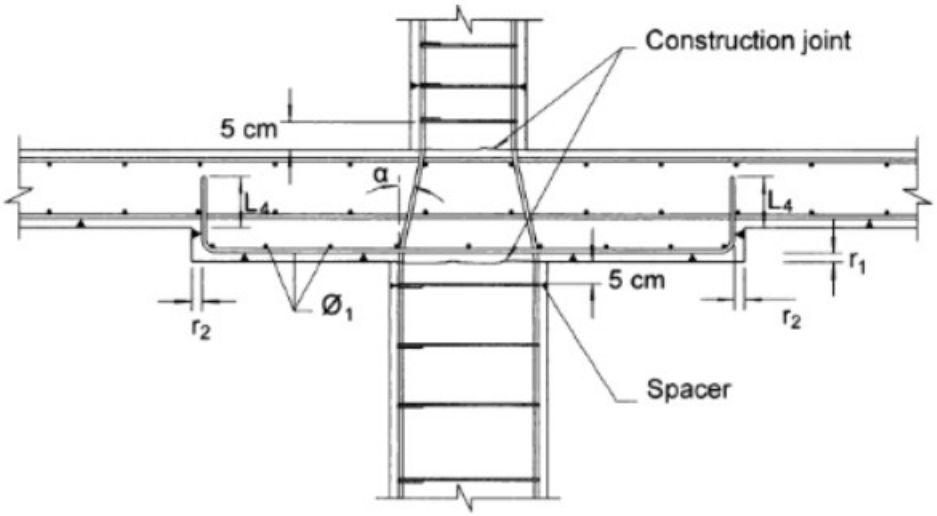
Punching shear requirement

- Where the spans are relatively long and/or the live load is 5 KN/m² or greater. Two-way or punching shear may determine the slab thickness.
- In this case
  - Increase slab thickness
  - Increase column sizes.
  - Use drop panels/ column capital
  - Provide shear reinforcement

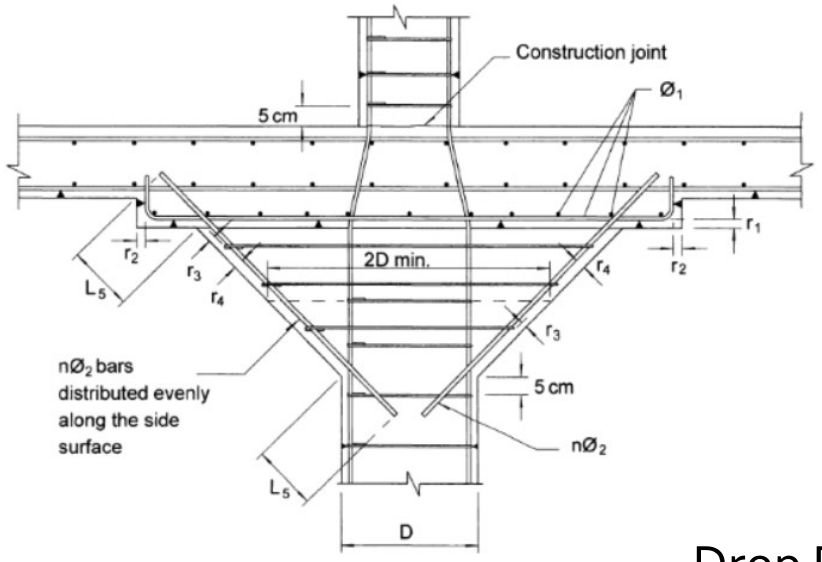
Drop Panels details



EDGE OR CORNER COLUMN



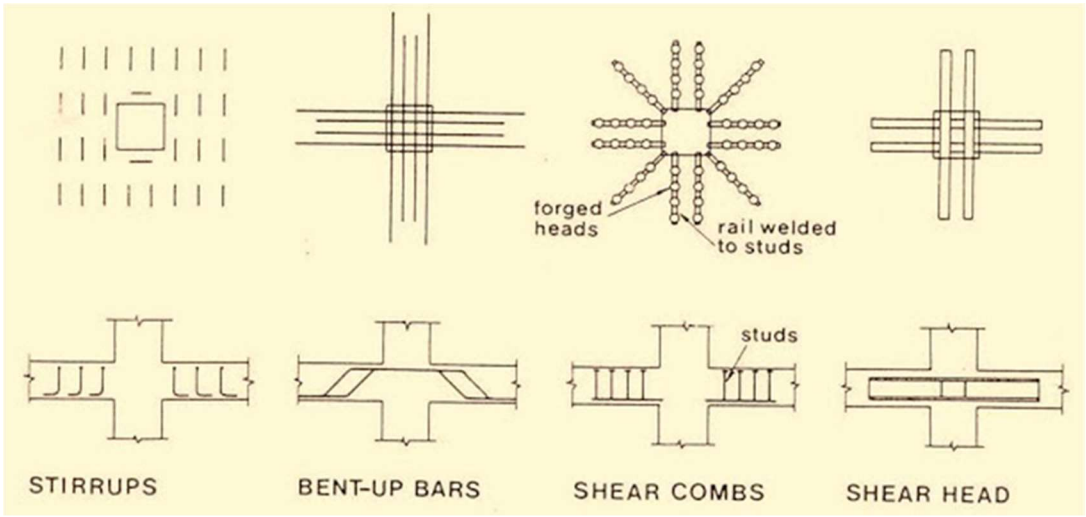
INTERNAL COLUMN

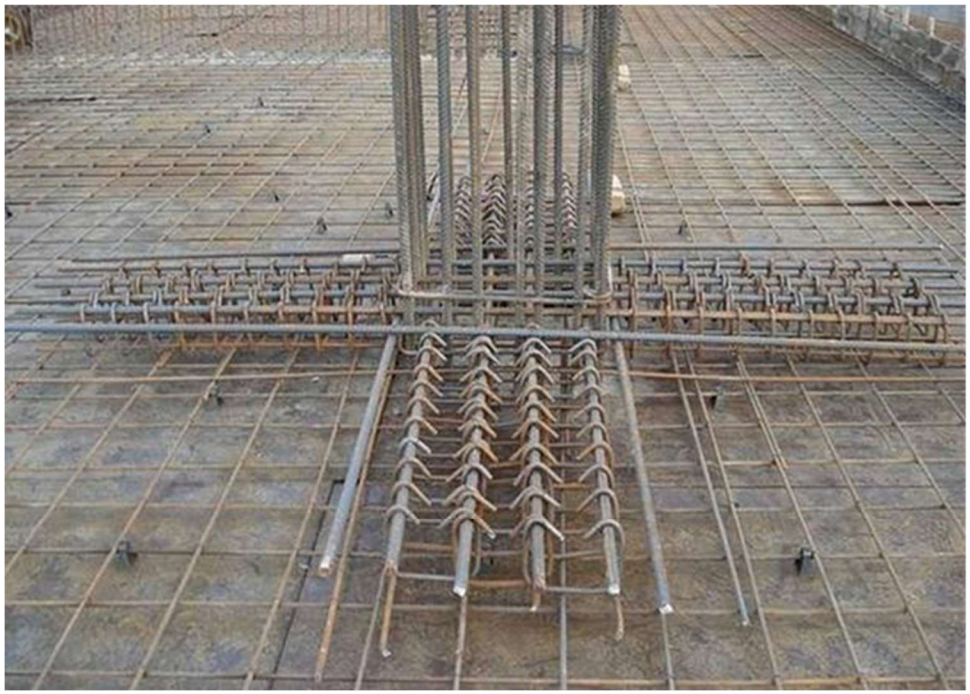


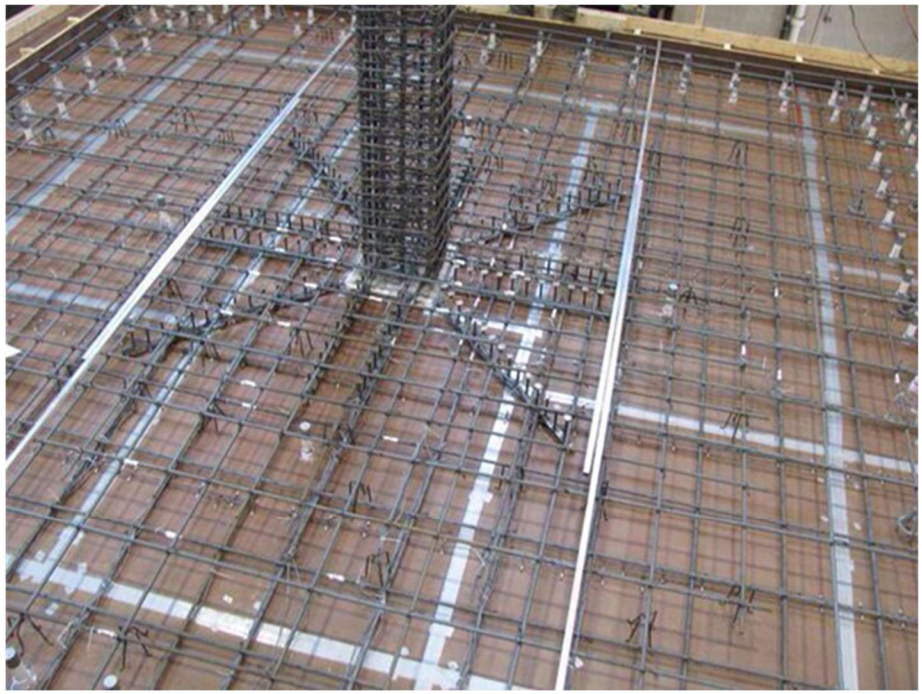
Drop Panels *with column capital*

Punching Shear reinforcement

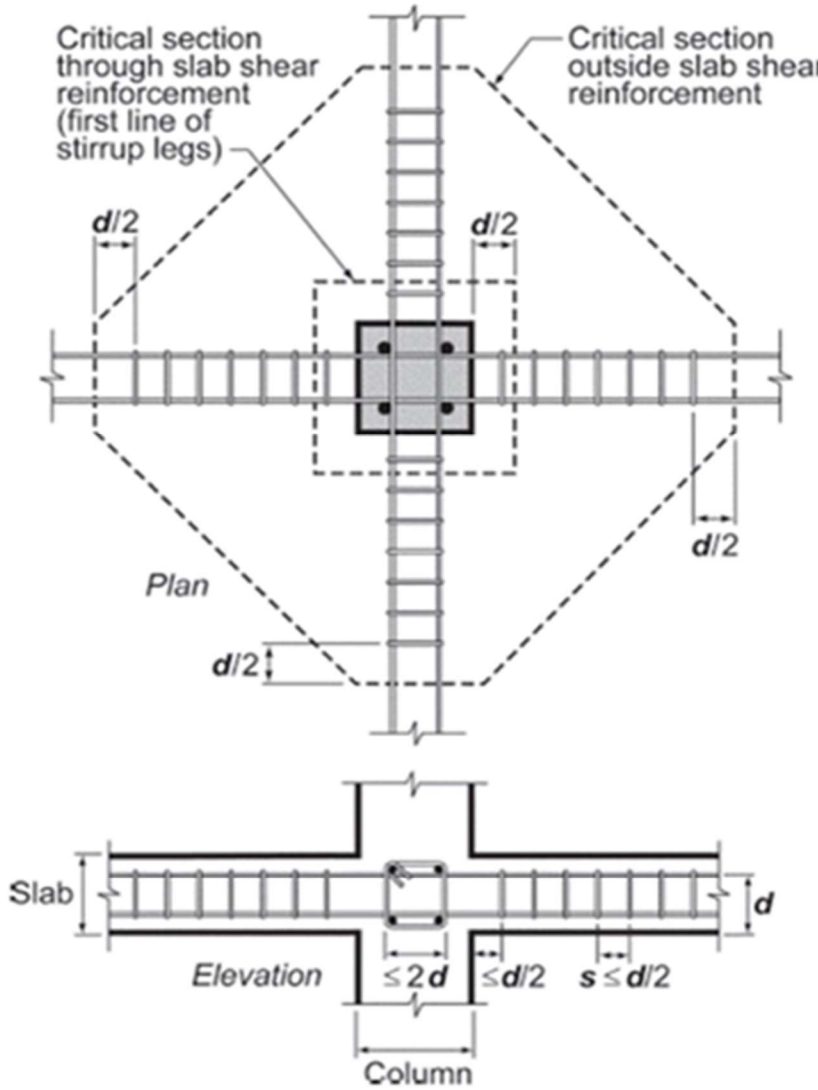
Examples of shear reinforcement for flat plate



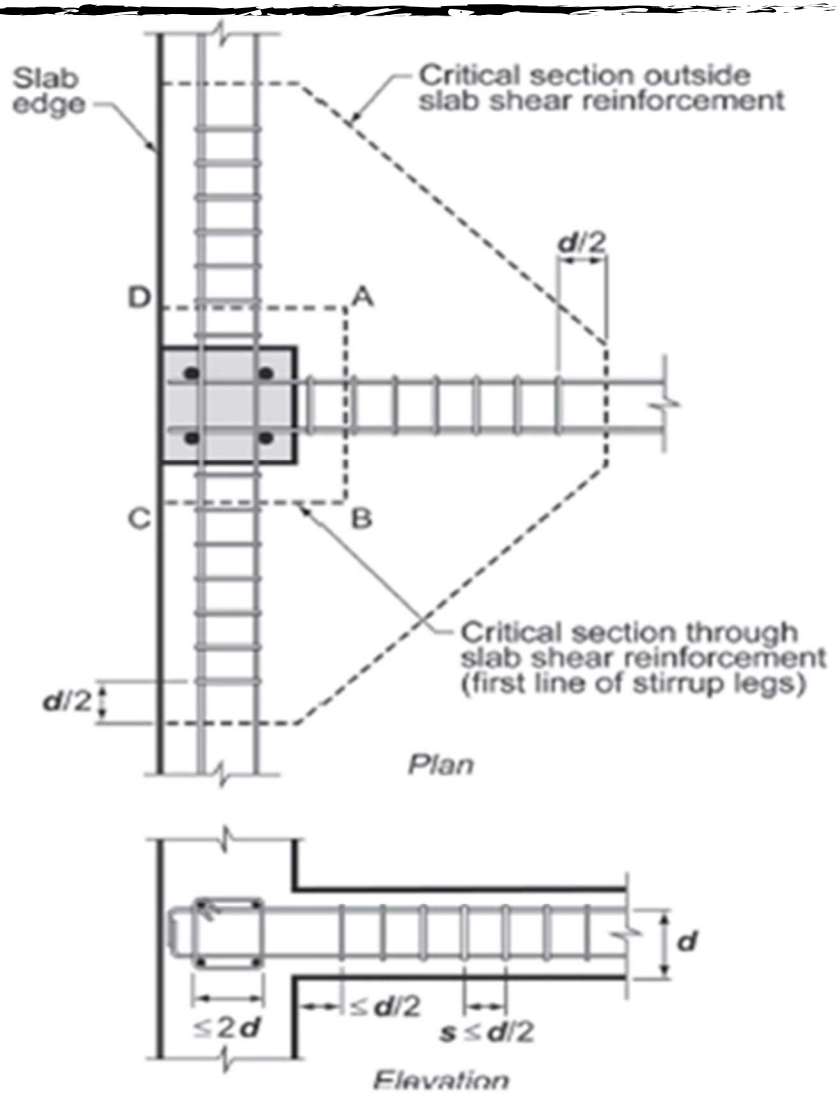




ACI punching shear reinforcement details



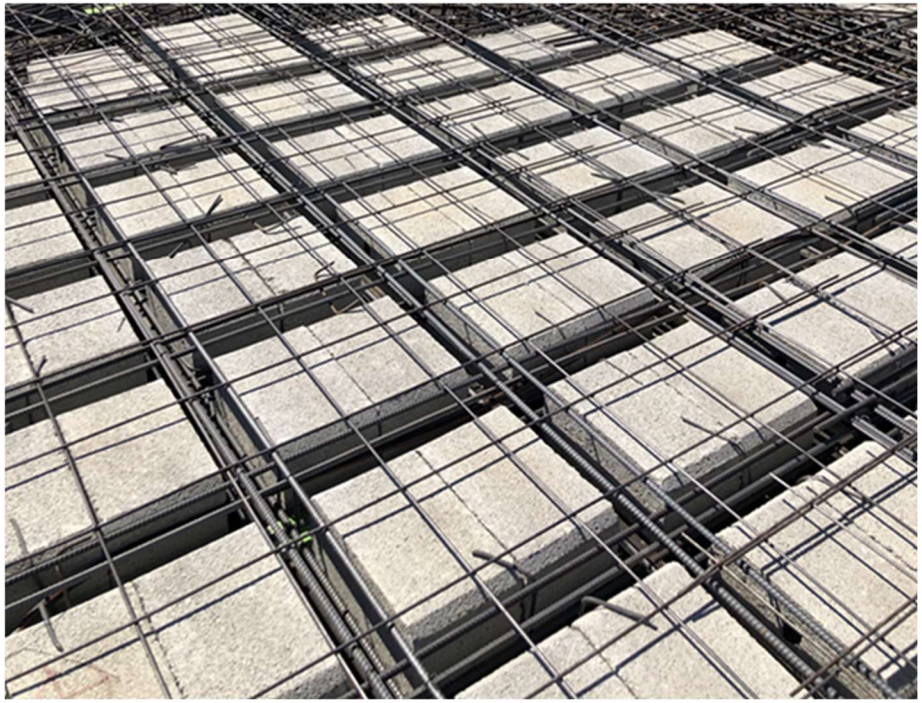
Interior Column



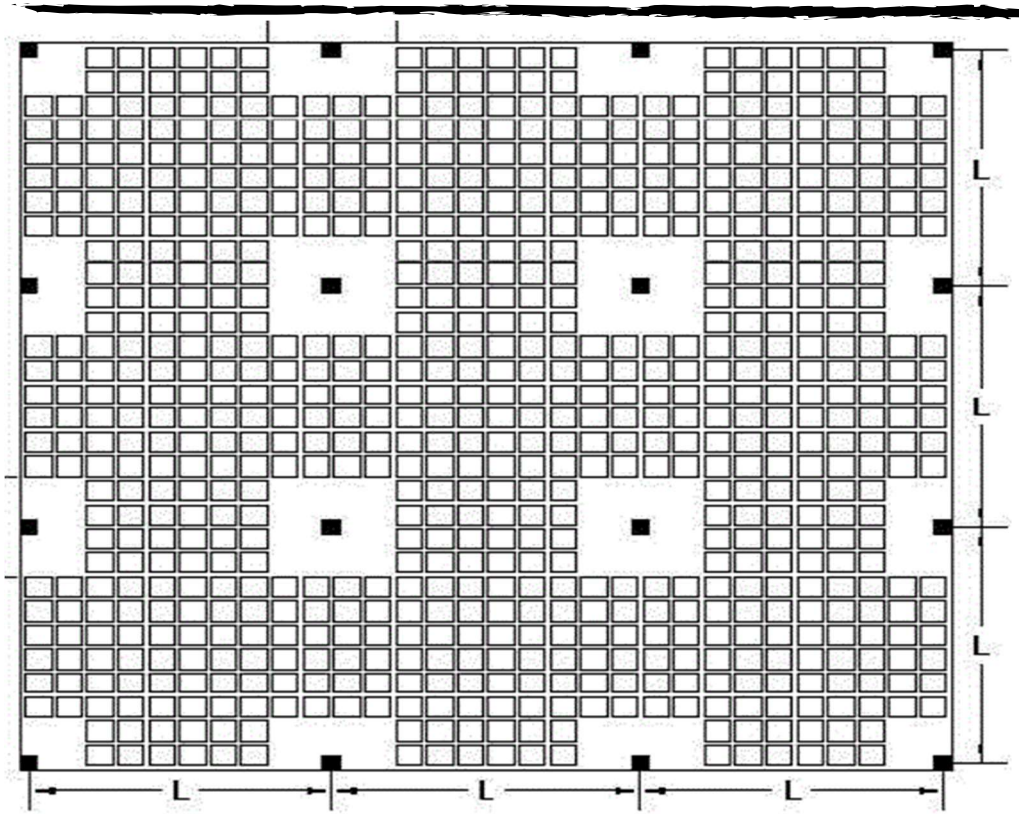
Edge Column

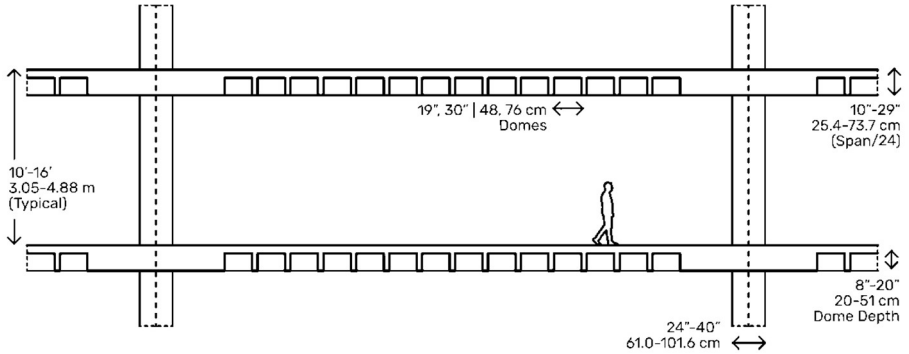
Waffle slab

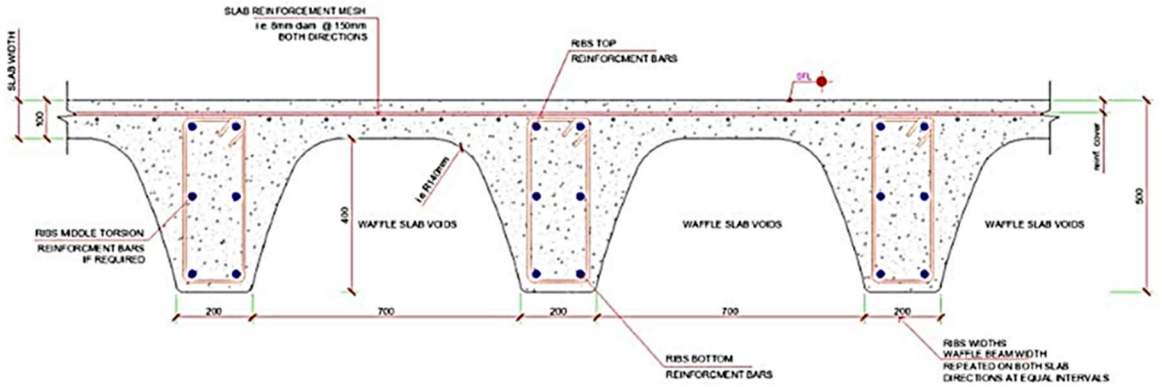
The system (also called two-wary rib slab) is designed to decrease the weight of traditional full-concrete slabs.



Drawings of Waffle System

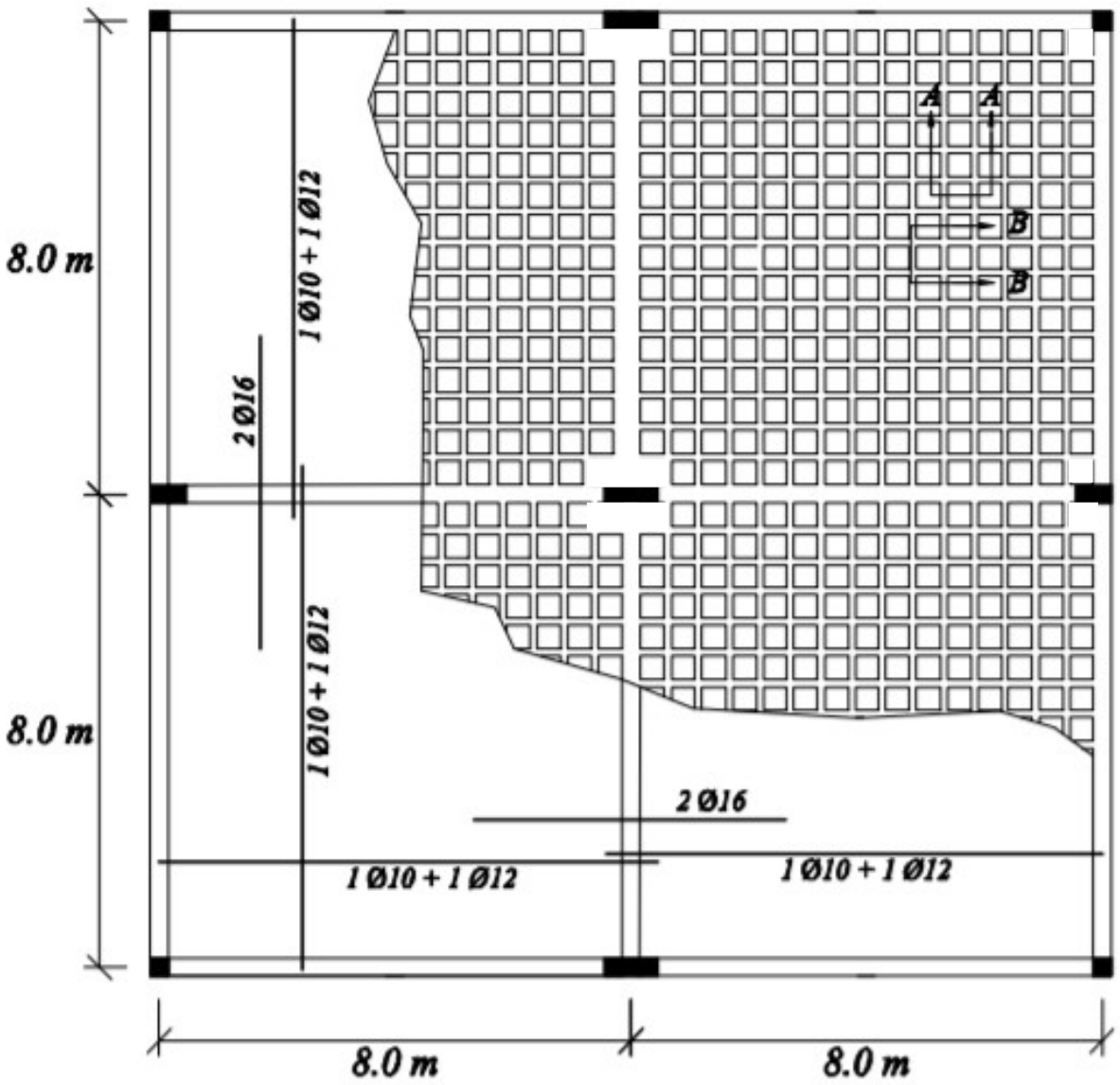


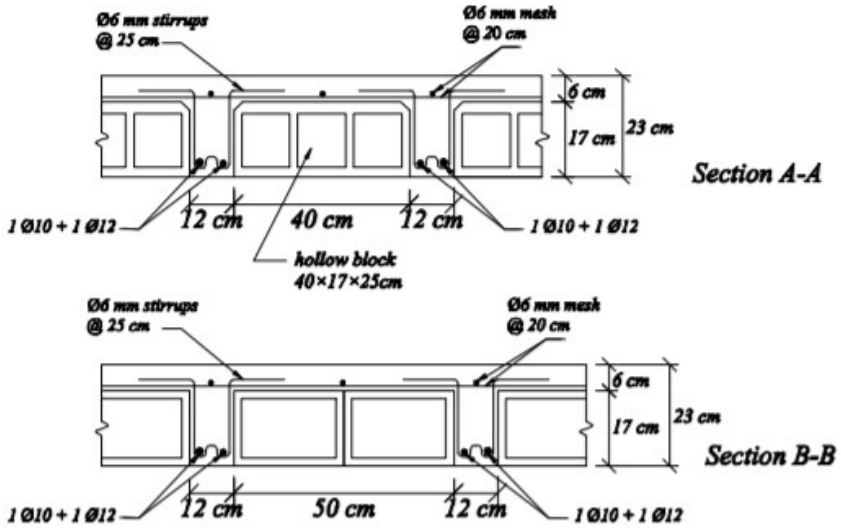




WAFFLE SLAB CROSS SECTION REINFORCEMENT DETAILS

Drawings of Waffle System





Two-way Ribbed Slab - Example