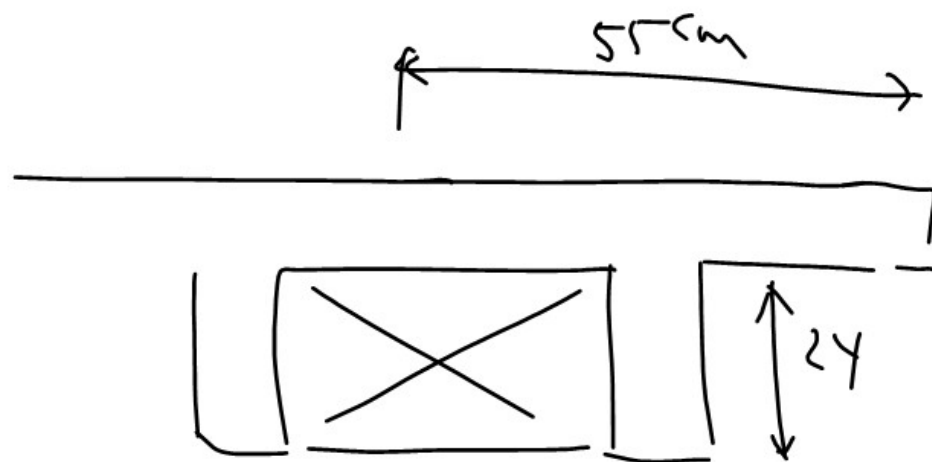




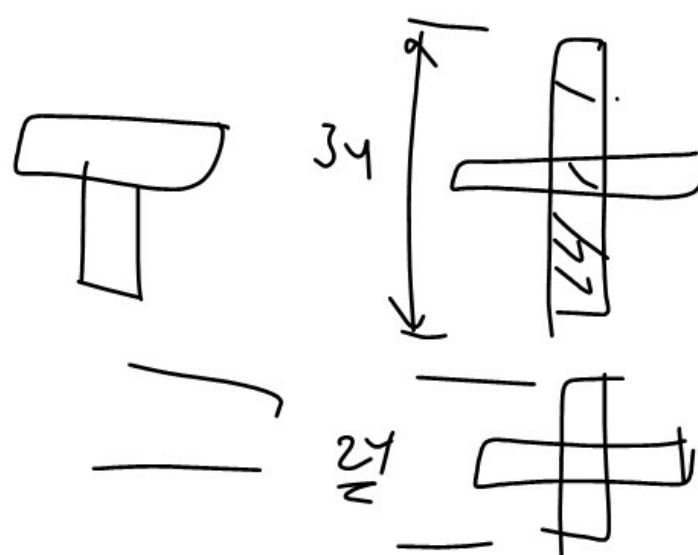
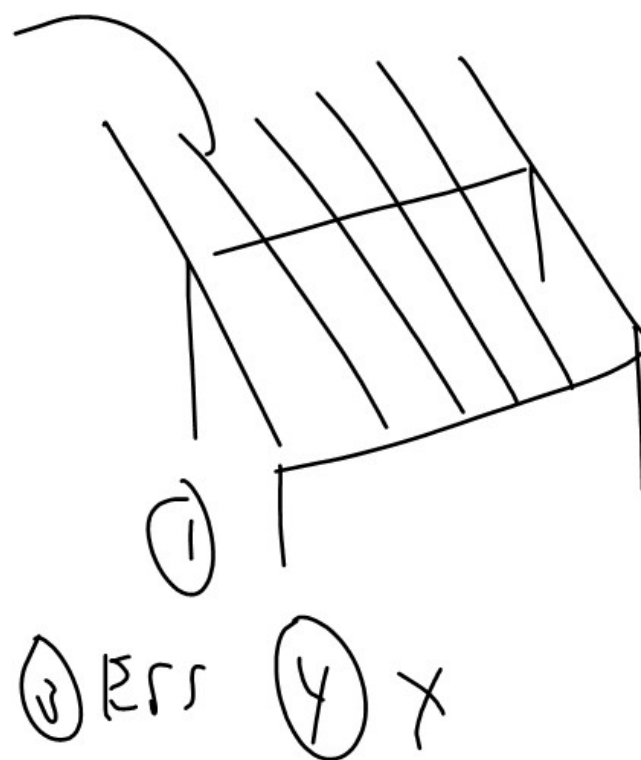
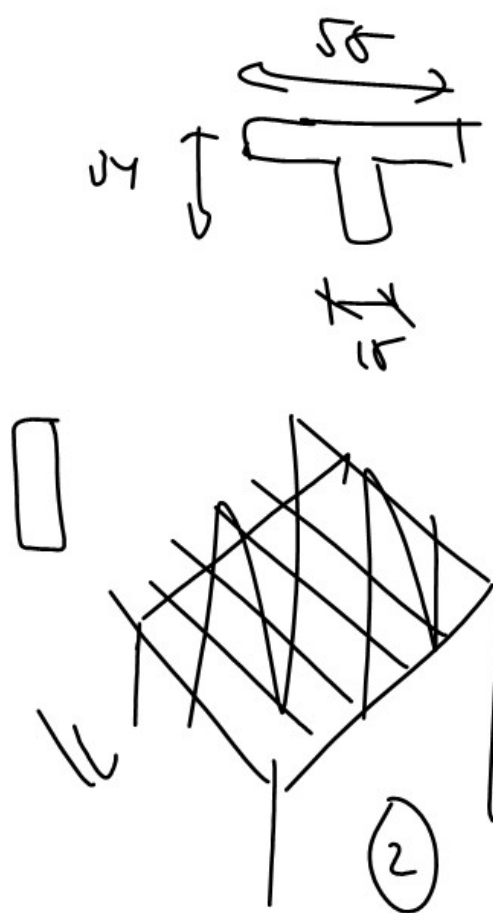
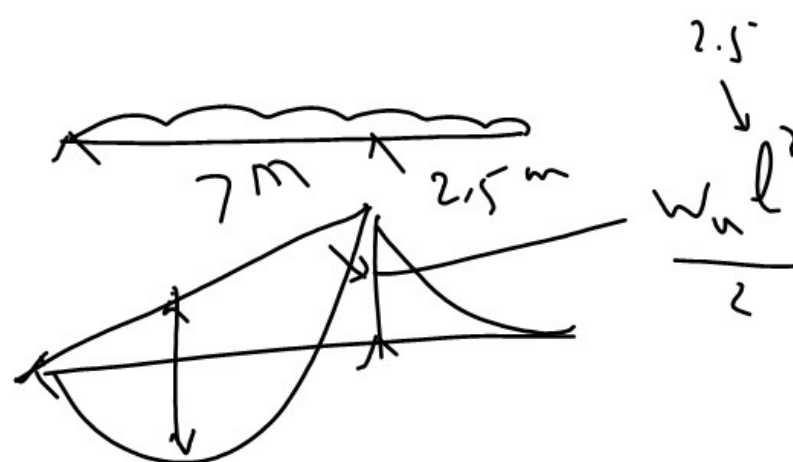
$$w_d = \left[\frac{(0.15 \times 0.24 + 0.1 \times 0.55) \times 24.5 + 0.4 \times 0.24 \times 15}{0.55} \right]$$

$$+ 0.7 =$$

$$w_d = 2 \text{ kN/m}^2$$

$$w_u = 1.2 w_d + 1.6 w_l$$

$$M^+ = \frac{w_u l^2}{8} - \frac{M_{u1}}{2}$$





View of Pan Joist Slab from Below

- Definition: The type of slab is also called a ribbed slab. It consists of a floor slab, usually 5-10cm thick, supported by reinforced concrete ribs. The ribs are usually uniformly spaced at distances that do not exceed 75cm. The space between ribs is usually filled with permanent fillers to provide a horizontal slab soffit.

- ACI Requirements for Joist Construction
(Sec. 8.13, ACI 318-08)
 - Slabs and ribs must be cast monolithically.
 - Ribs may not be less than 10cm in width
 - Depth of ribs may not be more than 3.5 times the minimum rib width
 - Clear spacing between ribs shall not exceed 750mm
- ** Ribbed slabs not meeting these requirements are designed as slabs and beams. ****

Slab Thickness

– (ACI Sec. 8.13.6.1)

$$t \geq 5\text{cm}$$

$$t \geq \text{one twelfth the clear distance between ribs}$$

Building codes give minimum fire resistance rating:

1-hour fire rating: 2cm cover, 7.5-9cm slab thick.

2-hour fire rating: 2.5cm cover, 12cm slab thick.

Shear strength

8.13.8 — For joist construction, V_c shall be permitted to be 10 percent more than that specified in **Chapter 11**.

- Laying Out Pan Joist Floors (*cont.*)
 - Typically no stirrups are used in joists
 - Reducing Forming Costs:
 - Use constant joist depth for entire floor
 - Use same depth for joists and beams (not always possible)

Distribution Ribs

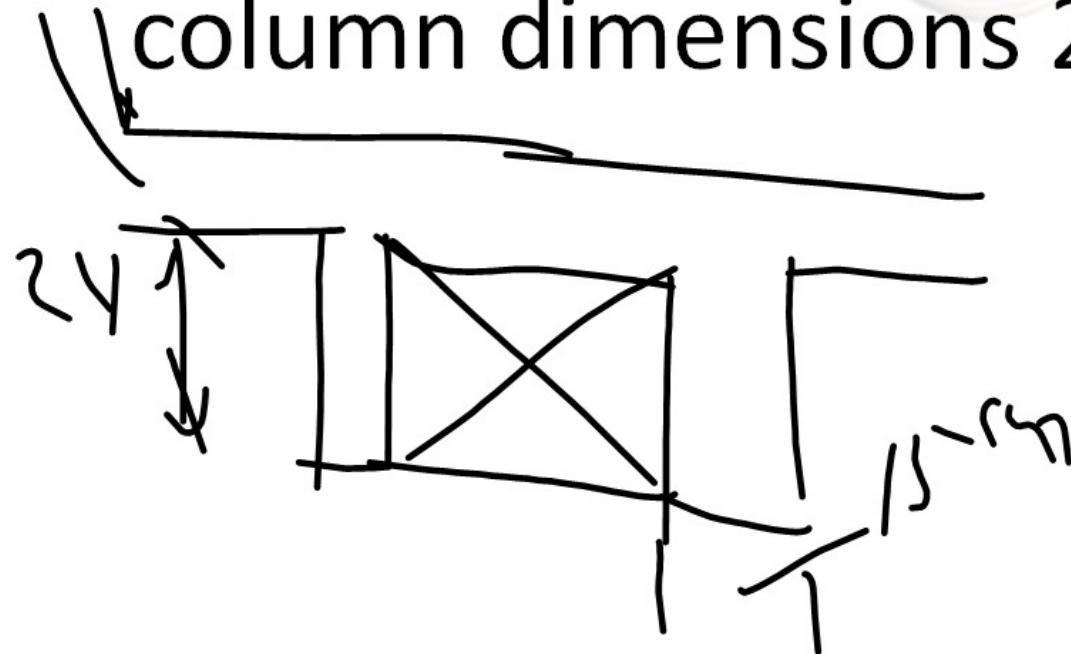
- Placed perpendicular to joists*
- Spans $< 6\text{m.}$: None
- Spans 6-9m: Provided at midspan
- Spans $> 9\text{m.}$: Provided at third-points
- At least one continuous #12mm bar is provided at top and bottom of distribution rib.

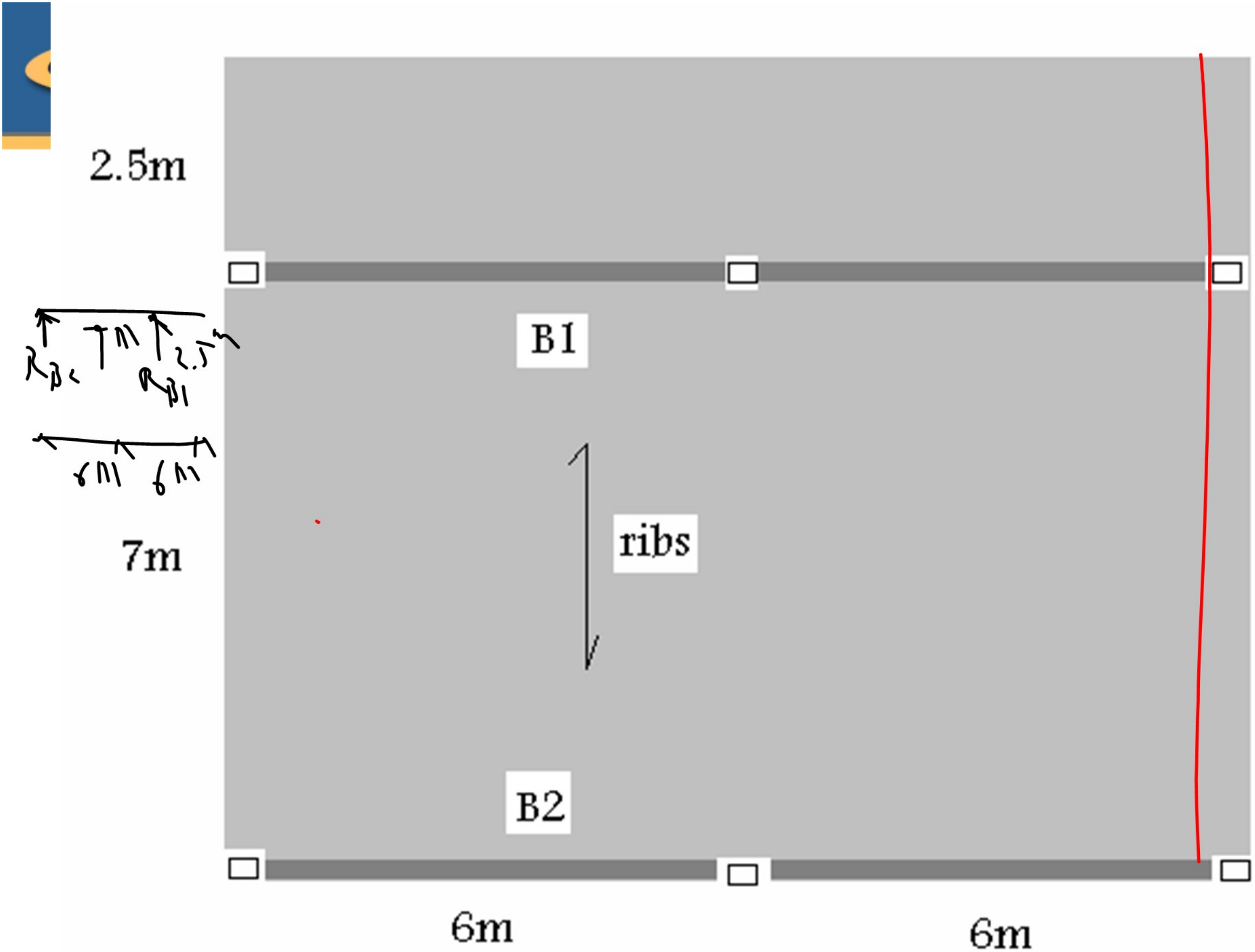


*Note: not required directly by ACI Code, but typically used in construction and required indirectly in ACI 10.4.1:

10.4.1 — Spacing of lateral supports for a beam shall not exceed 50 times b , the least width of compression flange or face.

- Analyze and design (as a one-way ribbed slab in the 7m direction) the following one story structure (3m height) using 3D model (figure next page):
- A. Specifications: B250, $f_y = 420 \text{ MPa}$, superimposed = 0.7 kN/m^2 , live loads = 2 kN/m^2 , ribs 34cm height/ 15cm width, blocks 40X25X24cm height (weight density = 10 kN/m^3), beam 25cm width by 50cm depth, column dimensions 25cmX25cm



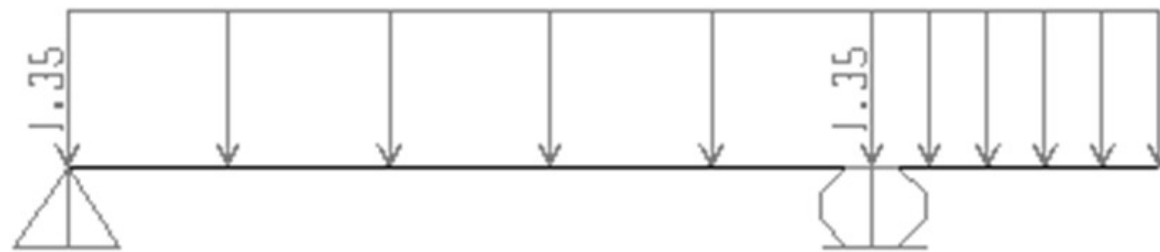


Slab: assume $c=5\text{cm}$

- $w_d = [(0.15 * .24 + 0.55 * 0.1) * 24.5 + 0.4 * 0.24 * 10] / 0.55 + 0.7 = 6.5 \text{ kN/m}^2$
- $w_u = [1.2 * 6.5 + 1.6 * 2] * 0.55 = 6.05 \text{ kN/m/rib}$
- $M_u^- = 6.05 (2.5)^2 / 2 = 18.9 \text{ kN.m}$, $A_s \approx 1.96 \text{ cm}^2$.
- $M_u^+ \approx 6.05 (7)^2 / 8 - 18.9 / 2 = 27.6 \text{ kN.m}$, $A_s \approx 2.85 \text{ cm}^2$

$$A_s = \frac{M_u}{f_y d}$$

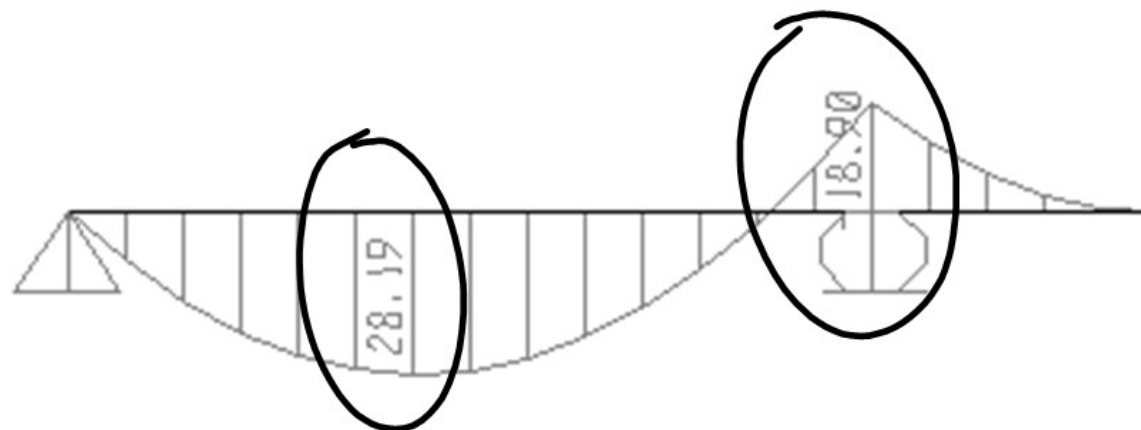
Frame Span Loads (DEAD) (As Defined)



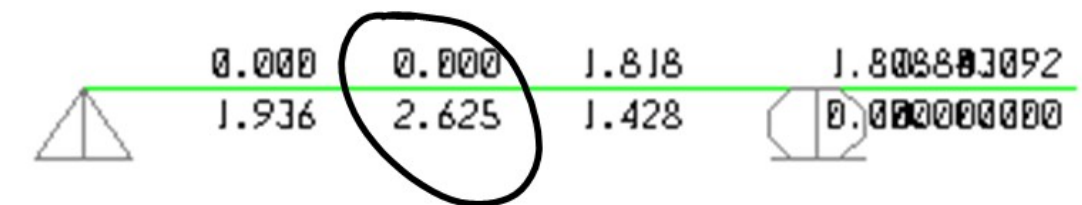
Joint Reactions (DCON2)



Moment 3-3 Diagram (DCON2)

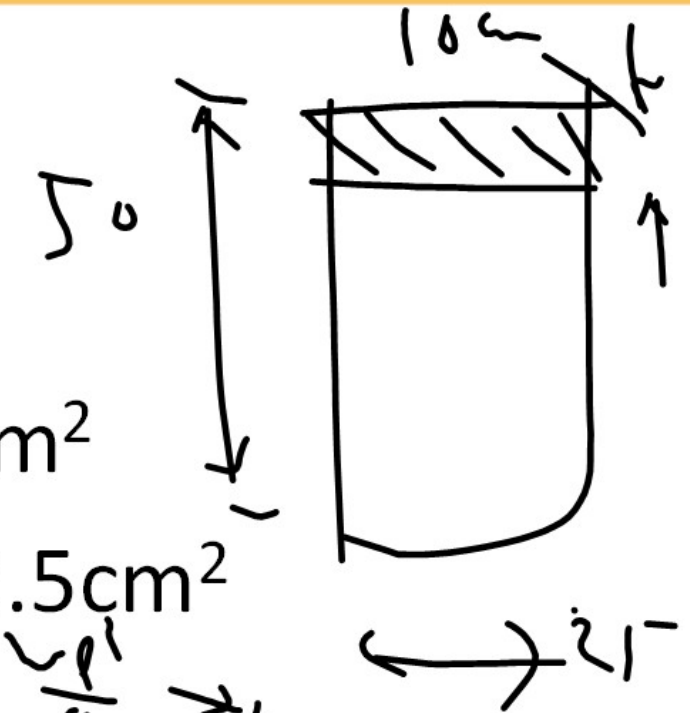


Longitudinal Reinforcing Area (ACI 318-08/IBC2009)



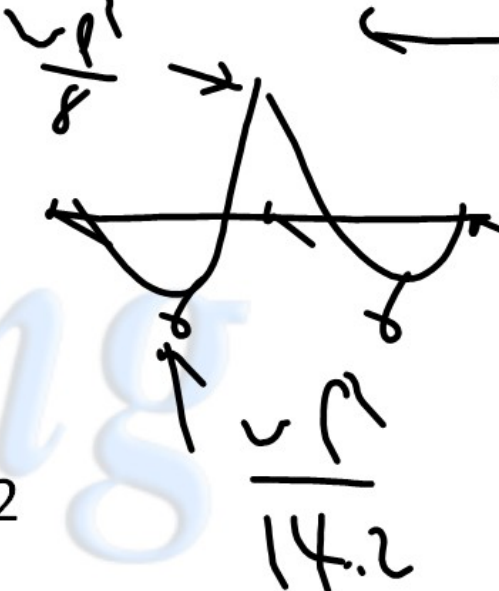
Beam B1: (interior frame)

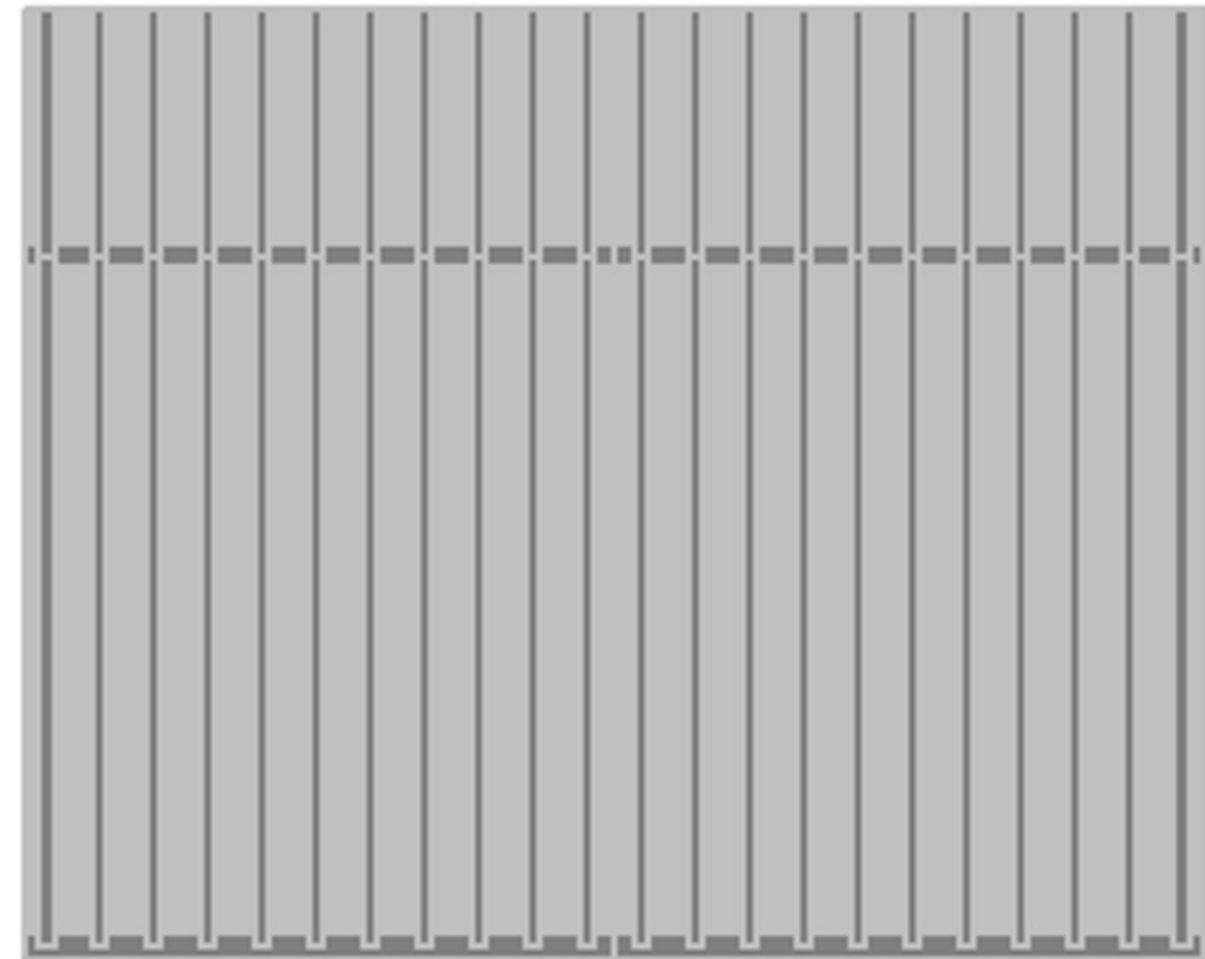
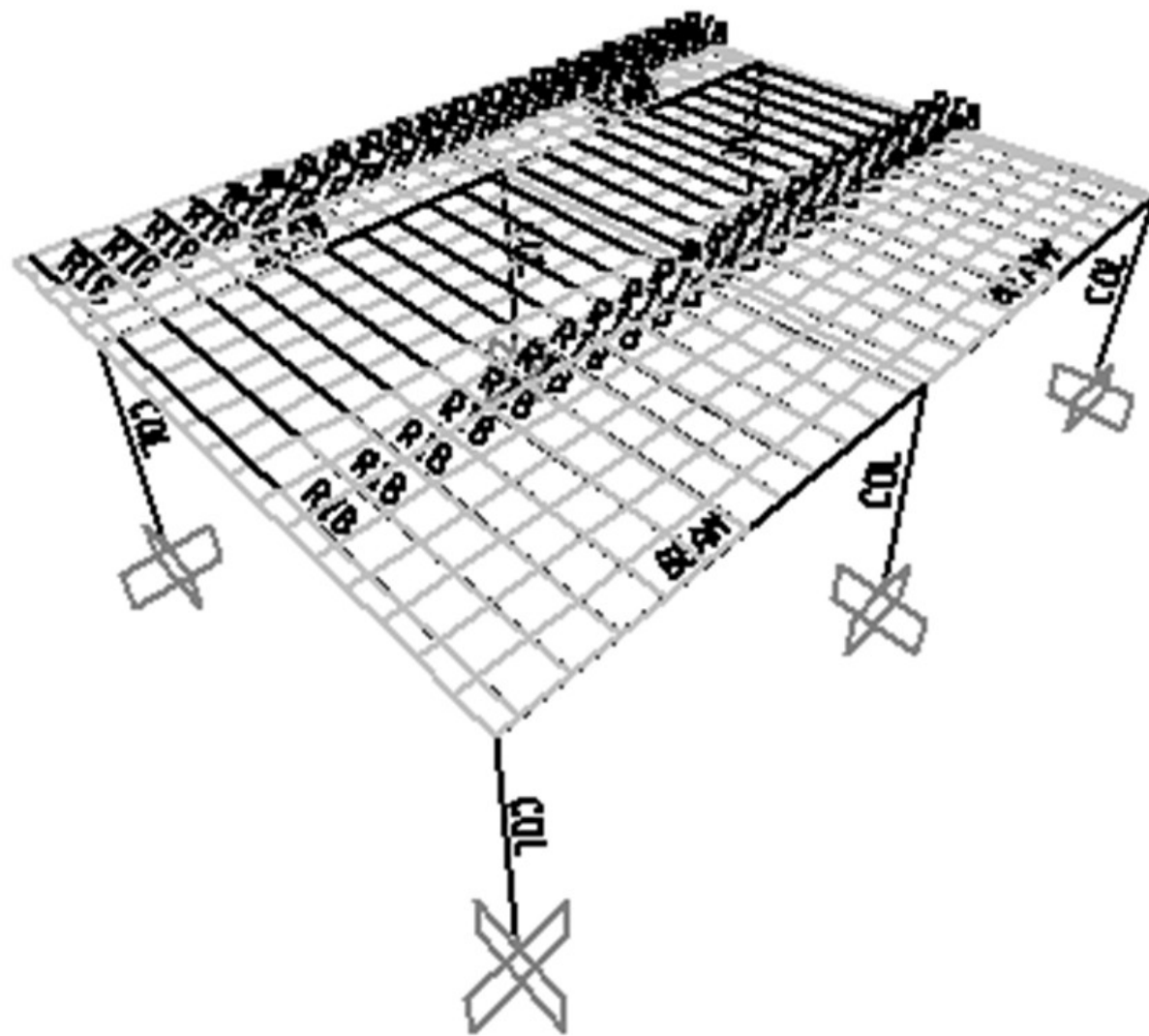
- $w_u = (39/0.55) + 0.25 * 0.4 * 24.5 * 1.2 = 73.8 \text{ kN/m}$
- $M_u^- = 73.8(6)^2 / 8 = 332 \text{ kN.m}$, $A_s = 332 \times 3 / 45 = 22.1 \text{ cm}^2$
- $M_u^+ = 73.8(6)^2 / 14.2 = 187 \text{ kN.m}$, $A_s = 187 \times 3 / 45 = 12.5 \text{ cm}^2$
-



Beam B2: (exterior frame)

- $w_u = (18.5/0.55) + 0.25 * 0.4 * 24.5 * 1.2 = 36.6 \text{ kN/m}$
- $M_u^- = 36.6(6)^2 / 8 = 165 \text{ kN.m}$, $A_s = 165 \times 3 / 45 = 11 \text{ cm}^2$
- $M_u^+ = 36.6(6)^2 / 14.2 = 92.8 \text{ kN.m.}$, $A_s = 92.8 \times 3 / 45 = 6.2 \text{ cm}^2$





3D SAP: if same assumptions are used in 3D model, results should be the same

- A. Set modifiers for slab $M_{22} = M_{12} = 0.01$
- B. Set modifiers for rib torsion=0.01, weight=0.24/0.34
- C. Set modifiers for beam torsion=0.01, flexure 3=10 (do not put 100), weight=0.4/0.5=0.8
- D. Set modifiers for column: axial=100, flexure=torsion=0

D:

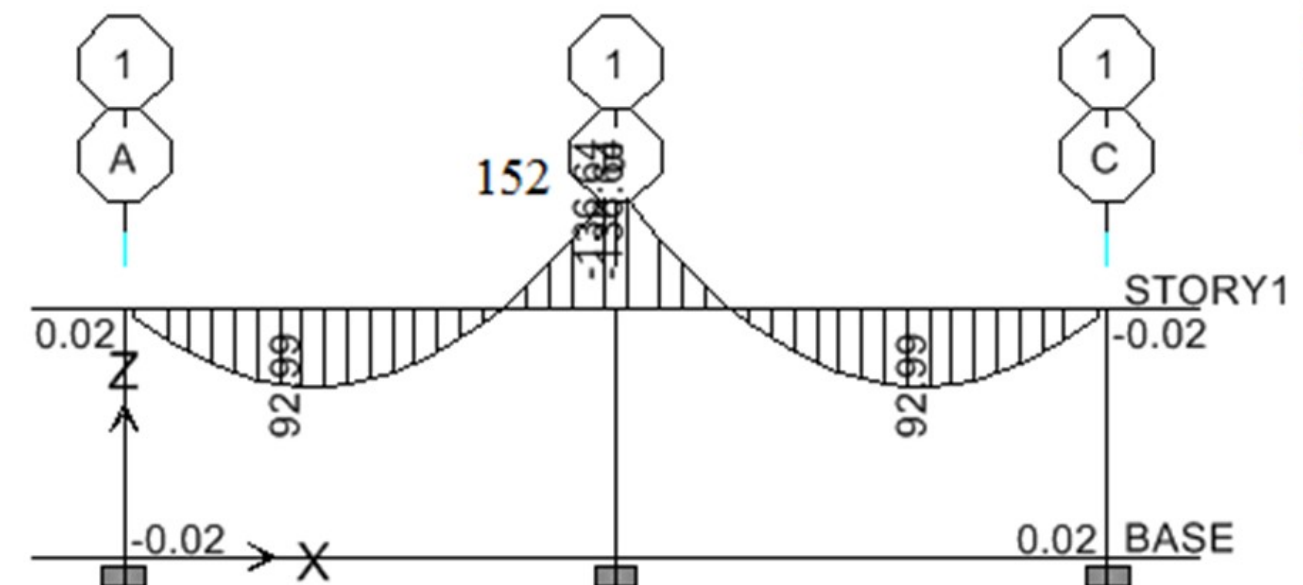
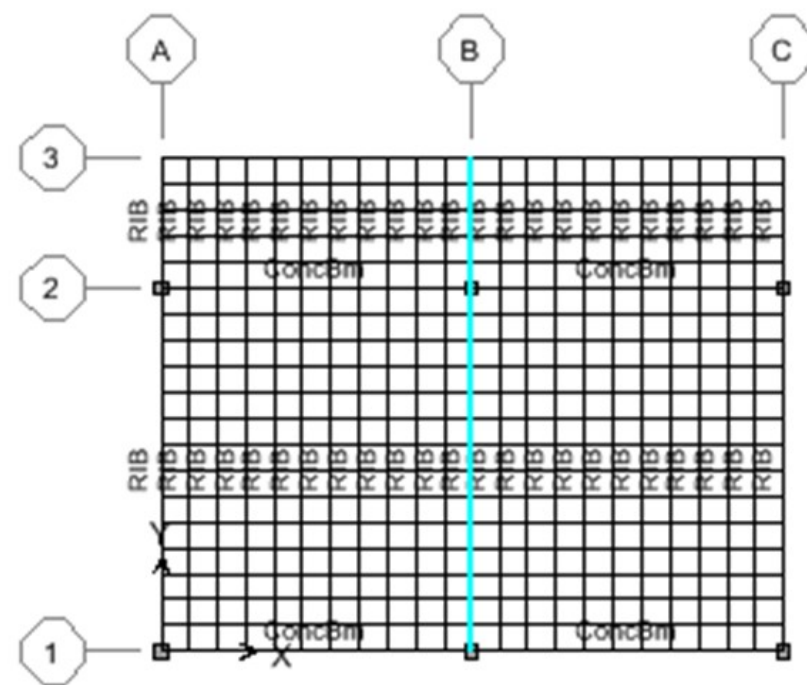
- Slab = $12 \times 9.5 \times 0.1 \times 24.5 = 279 \text{ kN}$
- Superimposed + blocks = $12 \times 9.5 \times ((0.24 \times 0.4 \times 10 / 0.55) + 0.7) = 12 \times 9.5 \times 2.45 = 279 \text{ kN}$
- Ribs = $9.5 \times 23 \times 0.15 \times 0.24 \times 24.5 = 193 \text{ kN}$
- Beams = $(2 \times 12) \times 0.25 \times 0.4 \times 24.5 = 58.8 \text{ kN}$
- Columns = $6 \times 0.25 \times 0.25 \times 3 \times 24.5 = 27.6 \text{ kN}$
- Sum = 837.4 kN

• L:

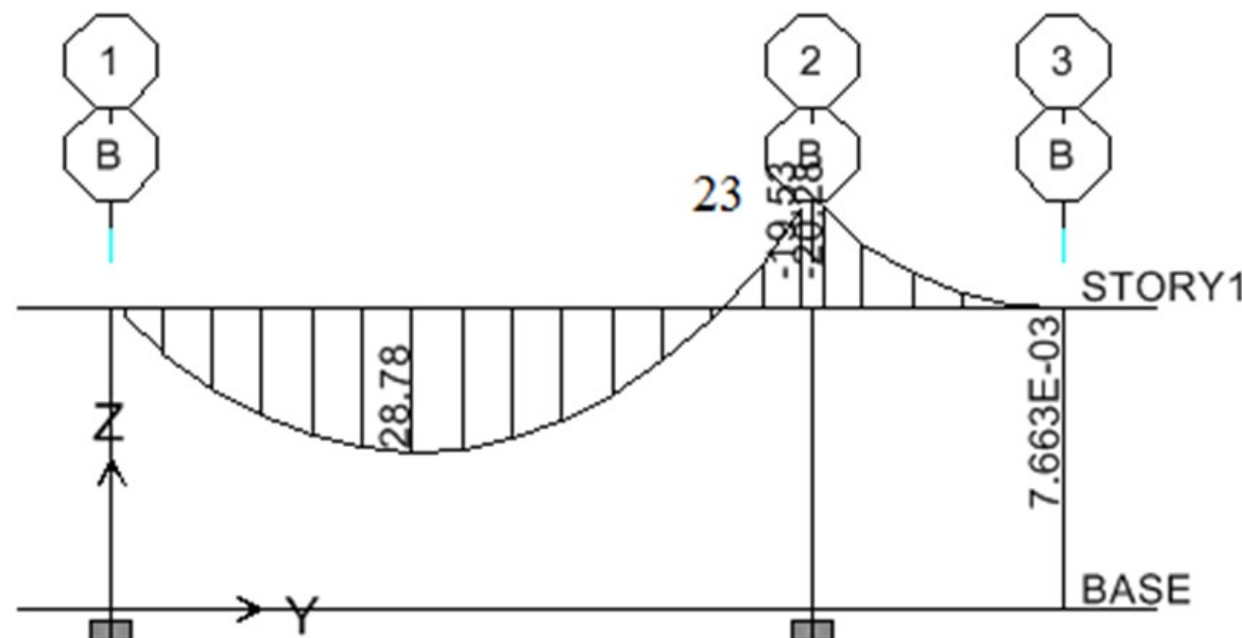
- R = $12 \times 9.5 \times 2 = 228 \text{ kN}$

Support Reactions									
	Story	Point	Load	FX	FY	FZ	MX	MY	MZ
	Summation	0, 0, Base	DEAD	0.00	0.00	837.68	3871.025	-5026.077	0.000
	Summation	0, 0, Base	LIVE	0.00	0.00	228.00	1083.000	-1368.000	0.000

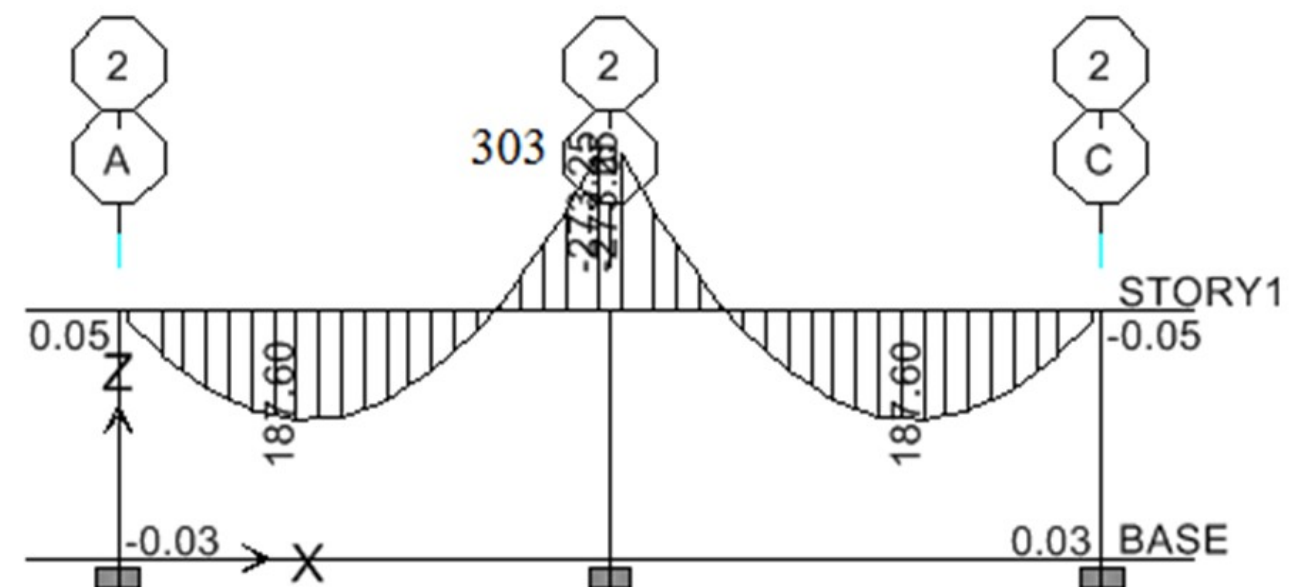




Elevation View - B Moment 3-3 Diagram (COMB1)



Elevation View - 2 Moment 3-3 Diagram (COMB1)

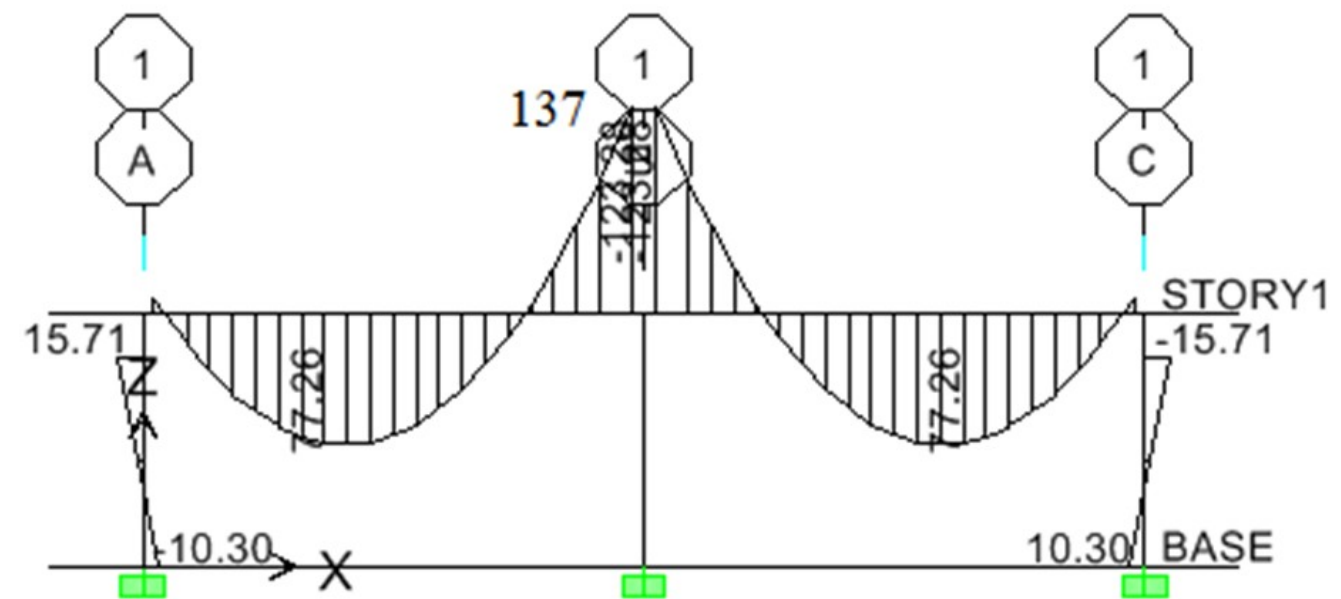
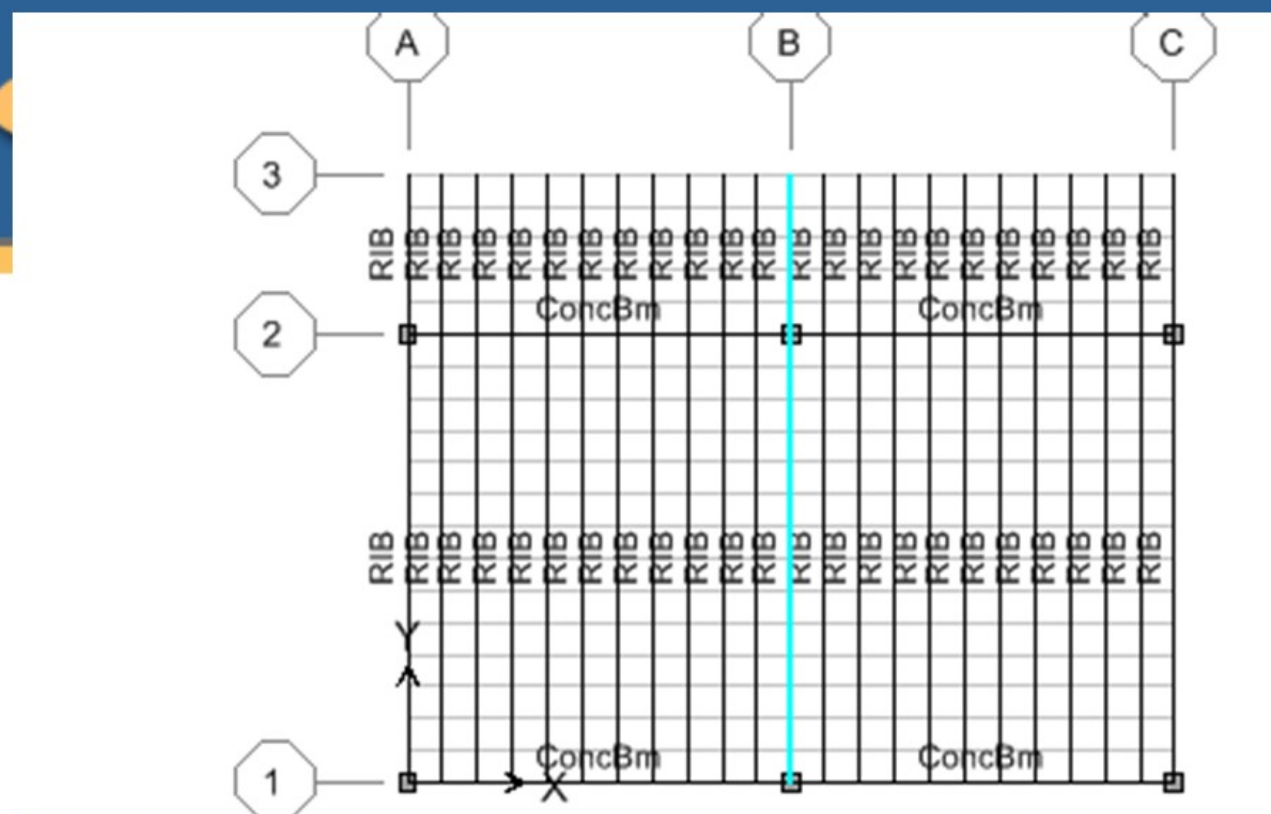


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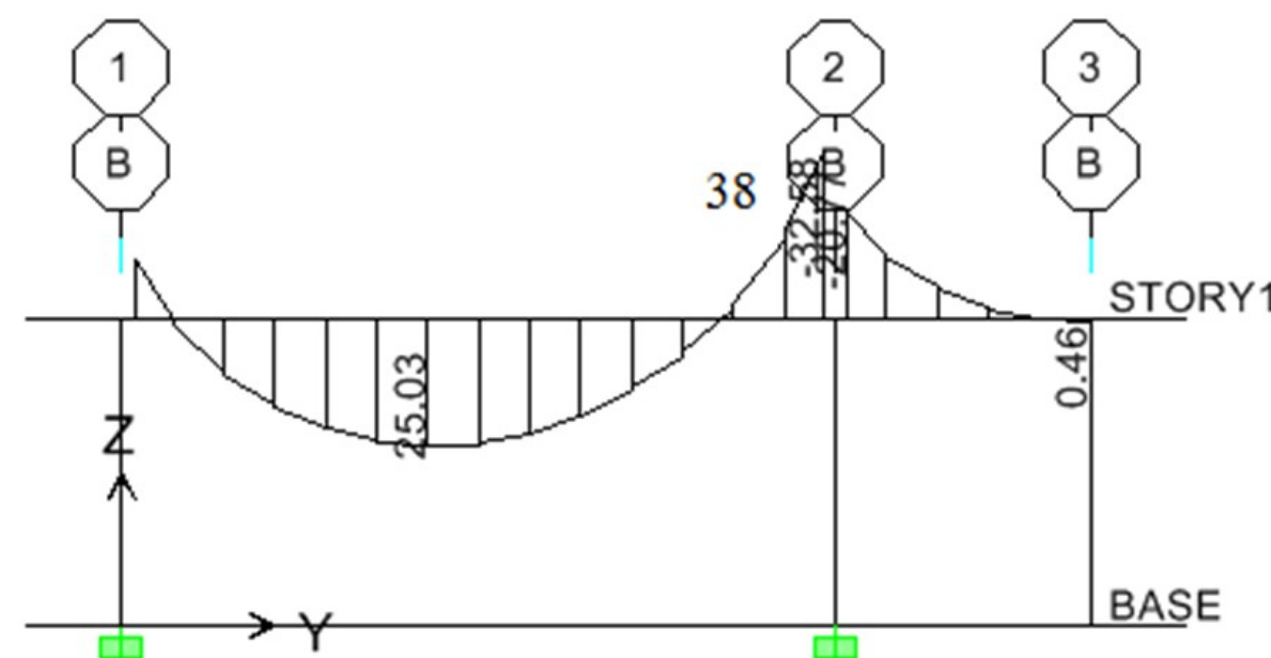
- Left bottom: bending moment in rib at grid B

Right: top bending moment in beam B1, bottom bending moment in beam B2.

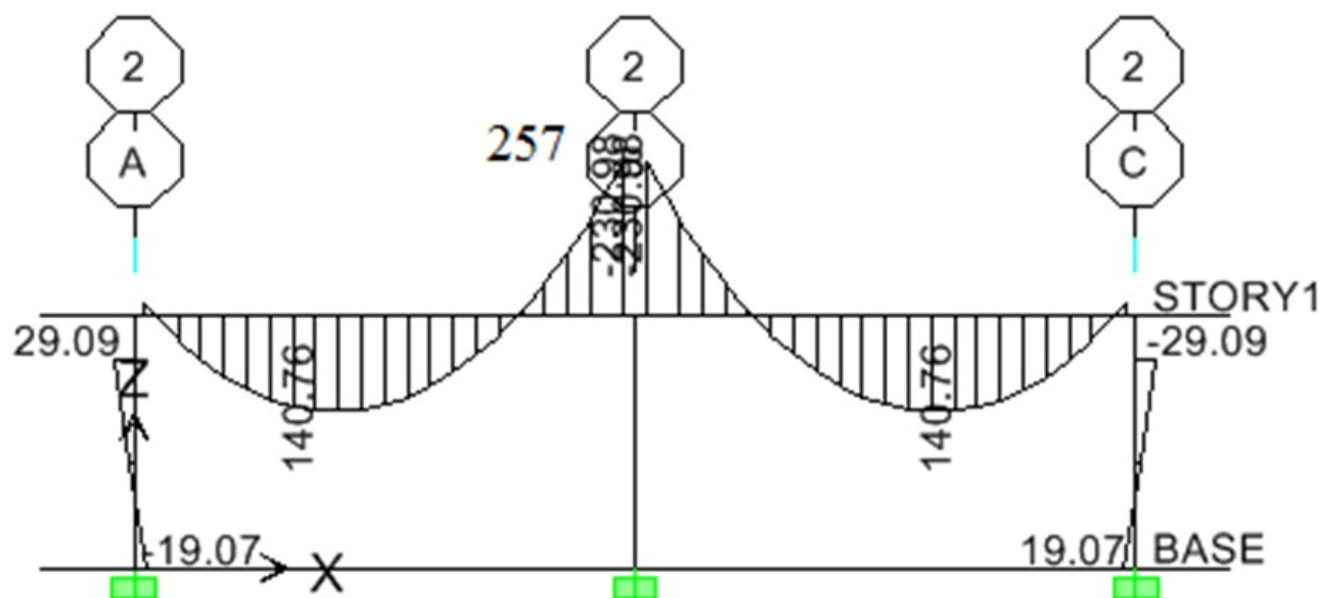
Figure with modifiers



tion View - B Moment 3-3 Diagram (COMB1)



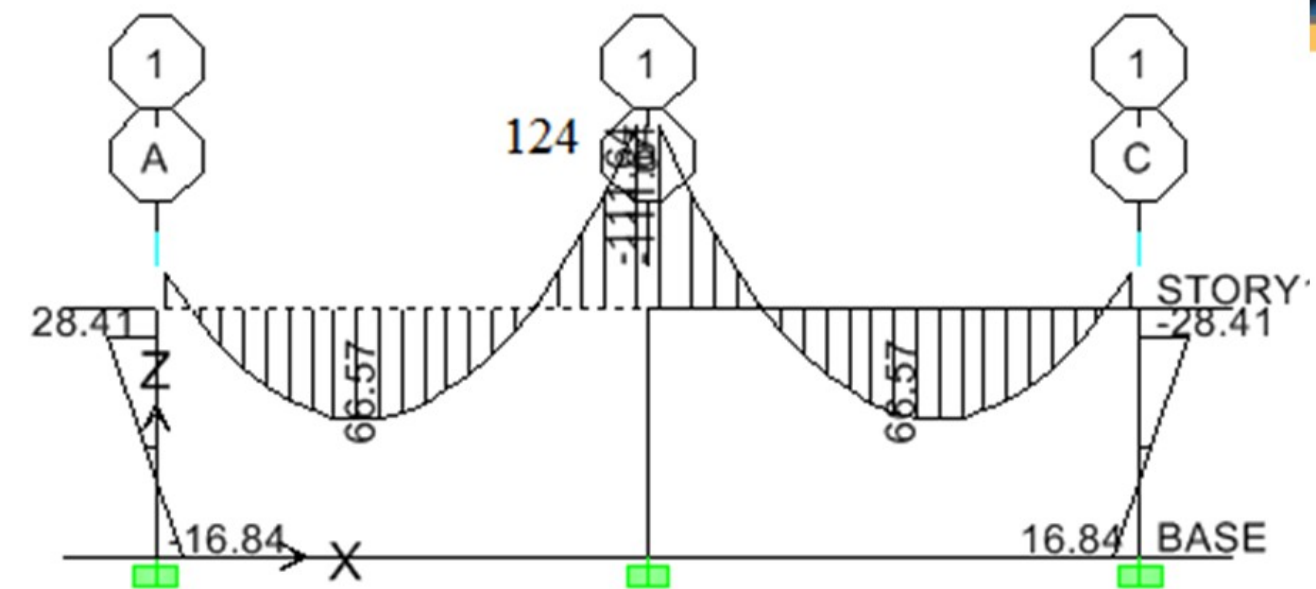
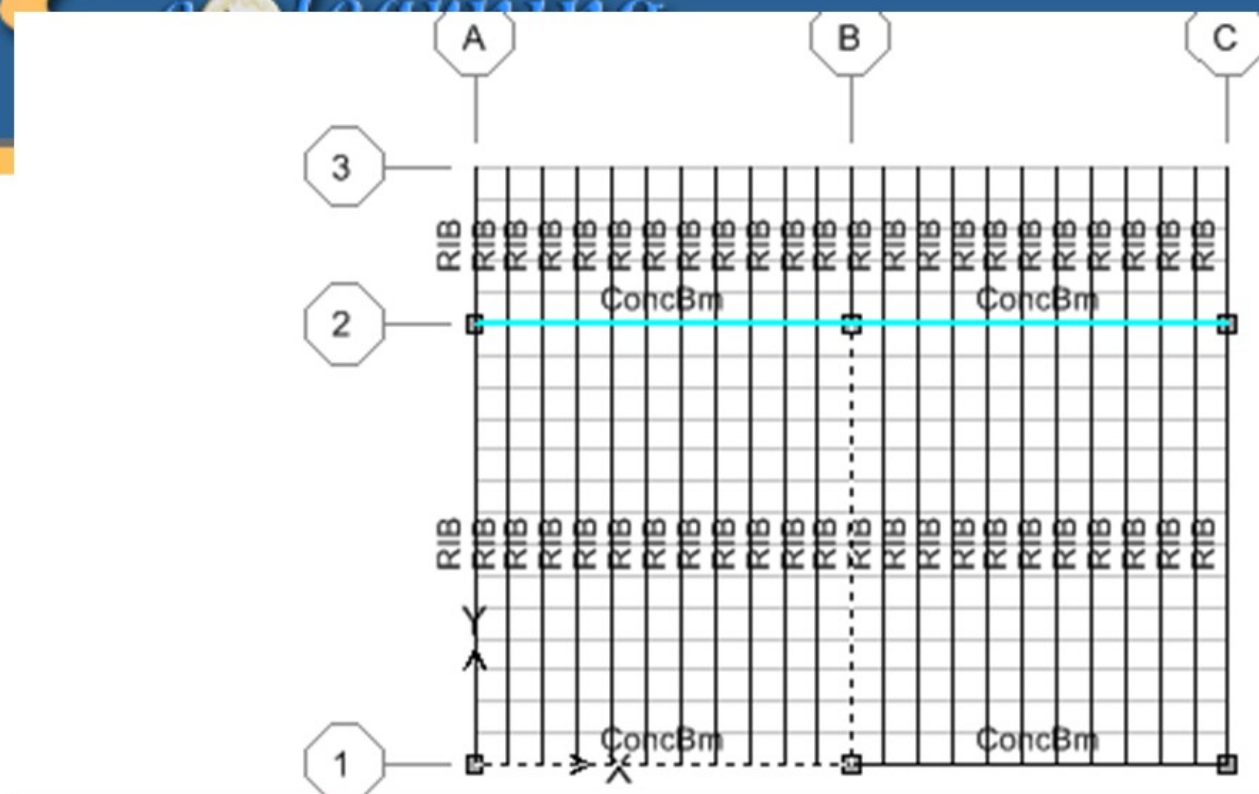
Elevation View - 2 Moment 3-3 Diagram (COMB1)



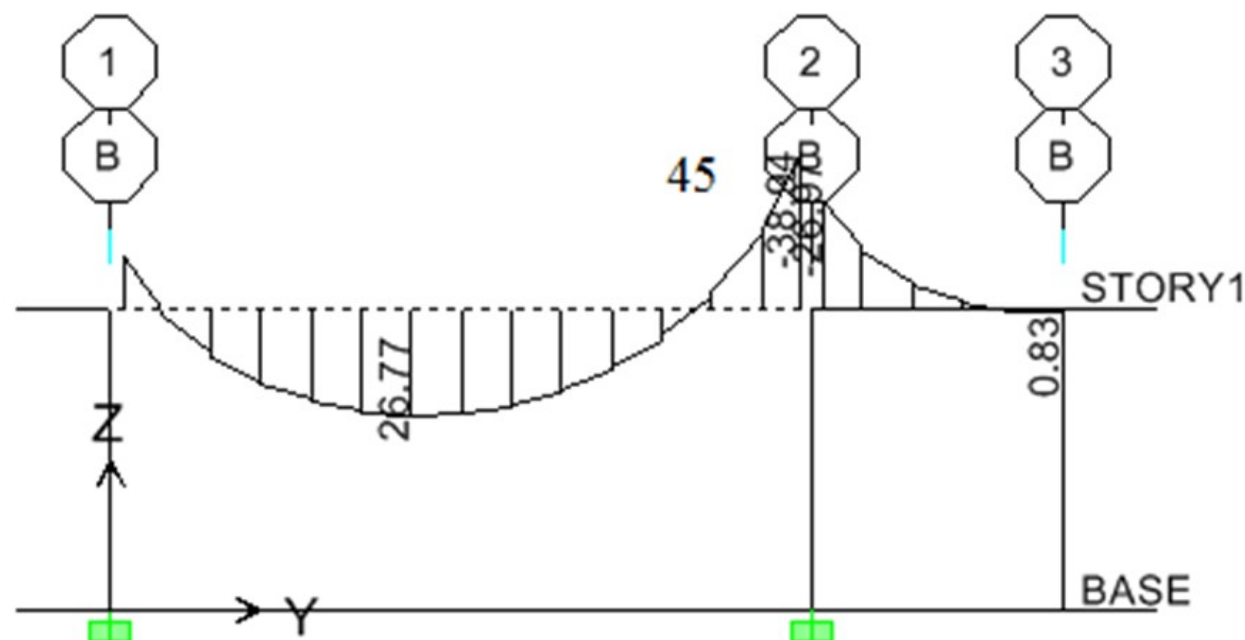
Left bottom: bending moment in rib at grid B
 Right: top bending moment in beam B1, bottom bending moment in beam B2.
 Figure without modifiers

- Repeat previous example but if the beams are 34cm depth by 37cm width .(to preserve beam weight). Draw conclusions

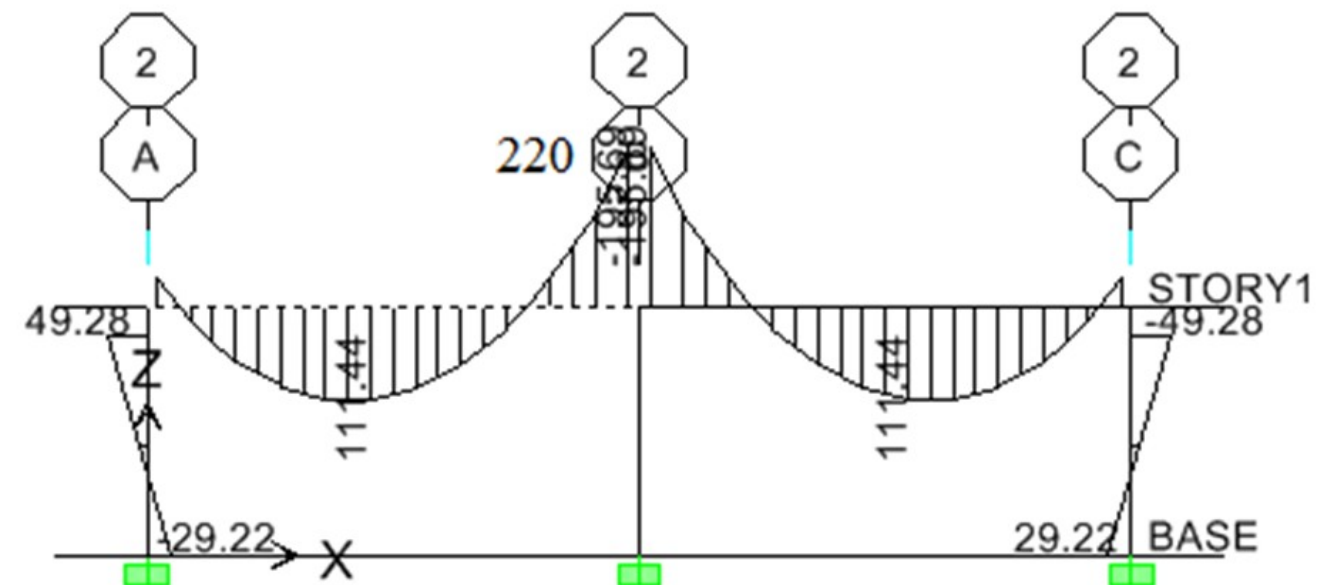




Elevation View - B Moment 3-3 Diagram (COMB1)



Elevation View - 2 Moment 3-3 Diagram (COMB1)



22/3/2015

- Left bottom: bending moment in rib at grid B

Right: top bending moment in beam B1, bottom bending moment in beam B2.

Figure for hidden beam without modifiers

Conclusions:

Ribs

- Moments increased on interior column strip and reduced on interior middle strip, which increases the difference existed previously. Why?
- Do you expect problems in local practice, why?

beams

- All moments are reduced (except at exterior, almost the same), why?
- Exterior moment increases for hidden, why?
- Do you expect problems in local practice?.
- Is it now necessary to change local practice?

•

End of section 5.2

Let Learning Continue