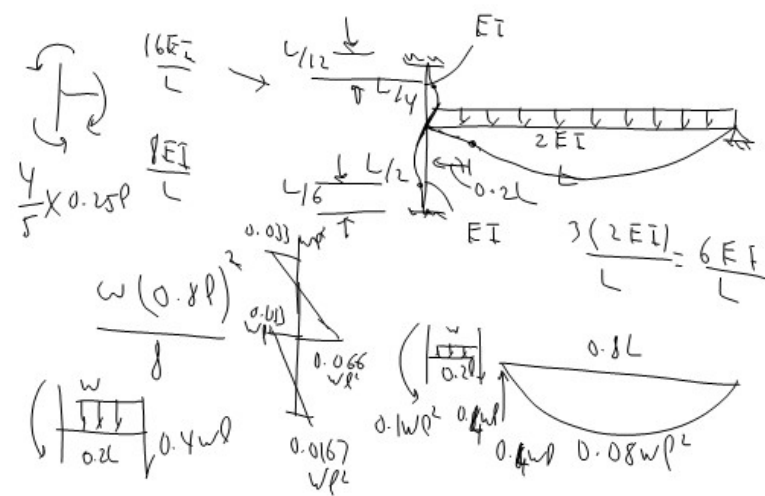
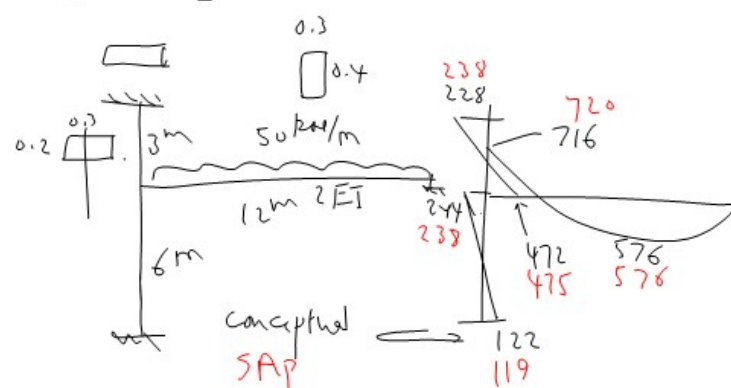
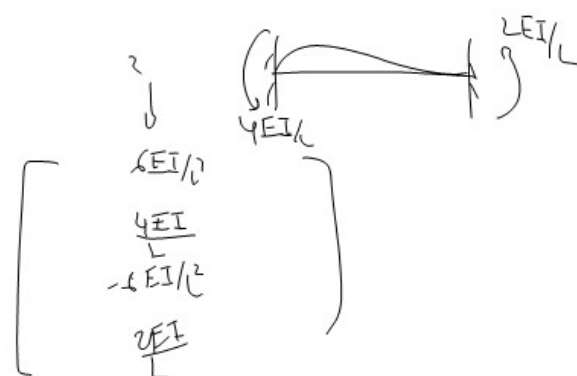
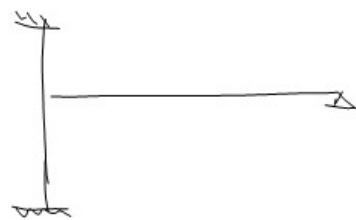
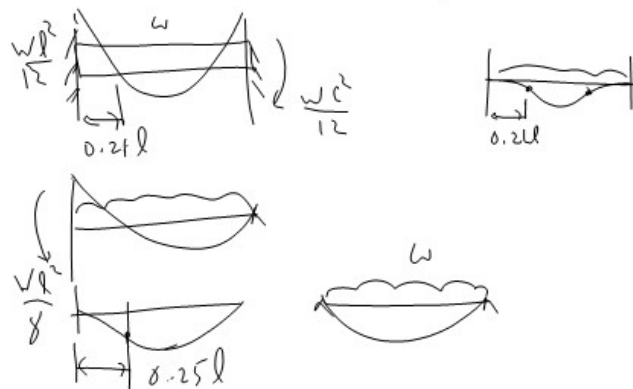
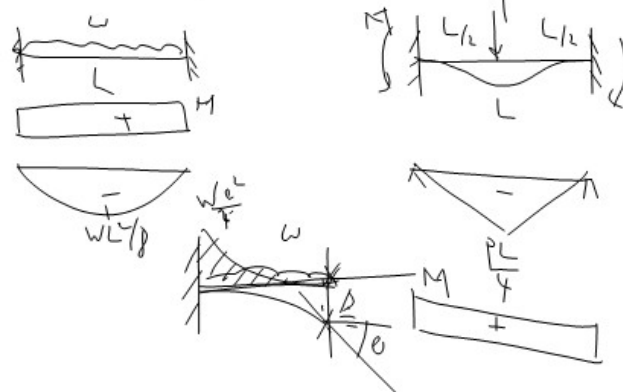




$$\frac{wL^2}{12} = \frac{2}{5} \frac{wL^2}{8} \frac{KL}{EI} = \frac{MK}{EI}$$

$$\frac{1}{2} \frac{PL}{4} \frac{KL}{EI} = \frac{MK}{EI}$$



T Tensor

$$1D \rightarrow 2D$$



5.1. Regular systems

5.2. Ribbed slab systems

5.3. Two way slab systems

If time permits

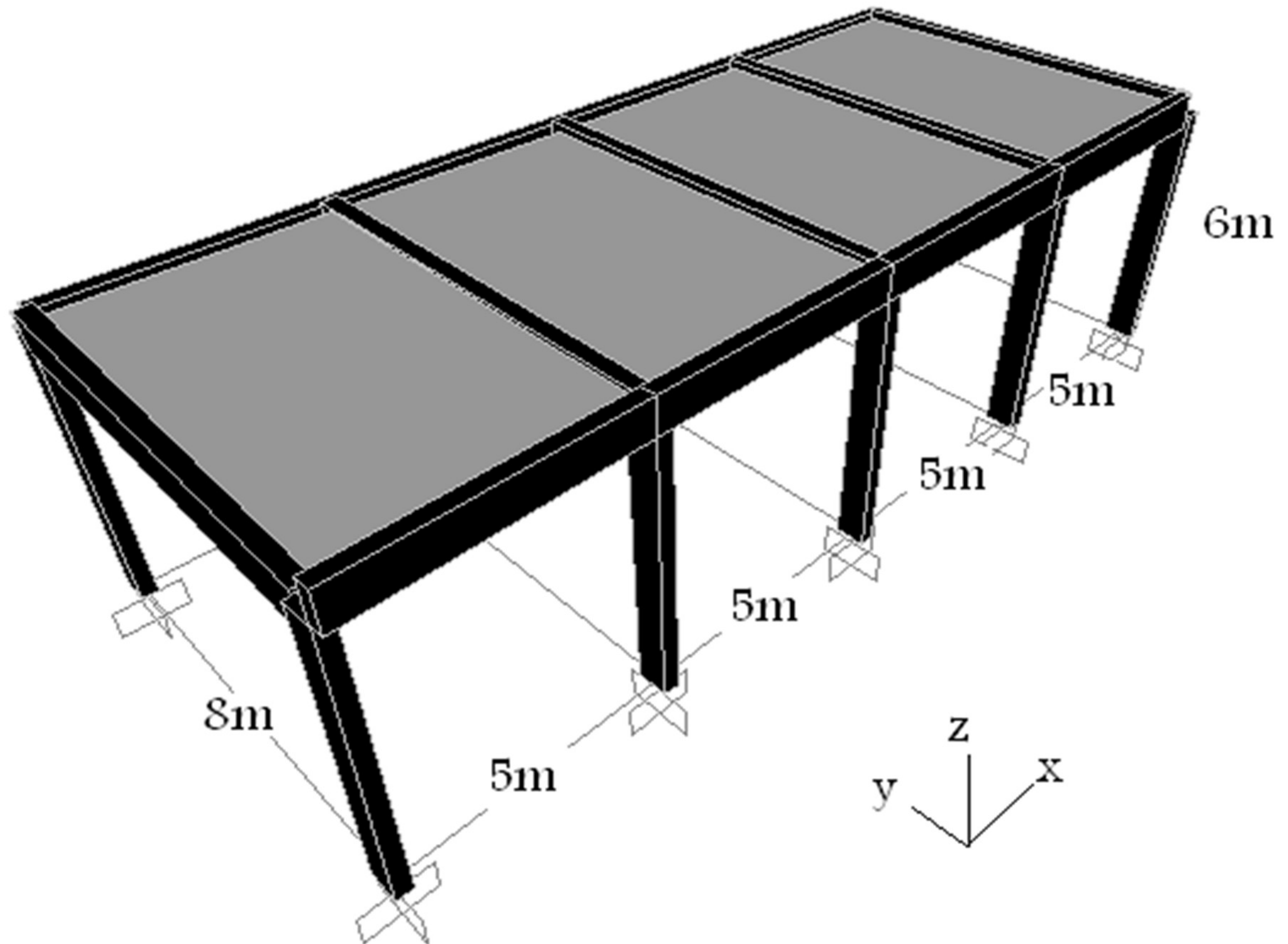
5.4. Systems without vertical continuity

5.5. General shape building systems

Regular systems are those which have one way solid slab and vertical continuity; i.e. load of slab is transferred to beams, from beams to columns and then to footings.

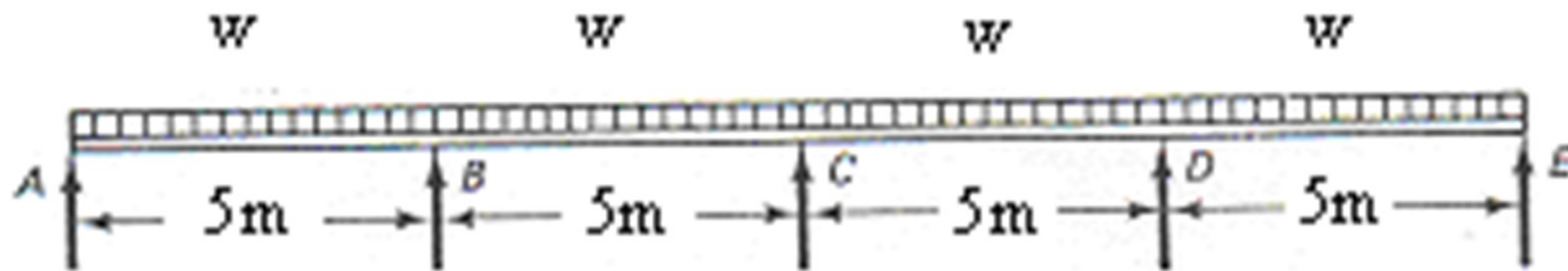
Analysis of all systems are done using either 1D, 2D or 3D modeling.

- 1-storey RC slab-beam factory structure shown next slide
- Fixed foundations, 4 spans 5m bays in x and a single 8m span in y, 6m elevation
- $E=24\text{GPa}$, $\mu=0.2$, $\rho=2.5\text{t/m}^3$
- Cylinder concrete strength=25MPa, steel yield=420MPa
- superimposed loads=5kN/m², live load=9kN/m²

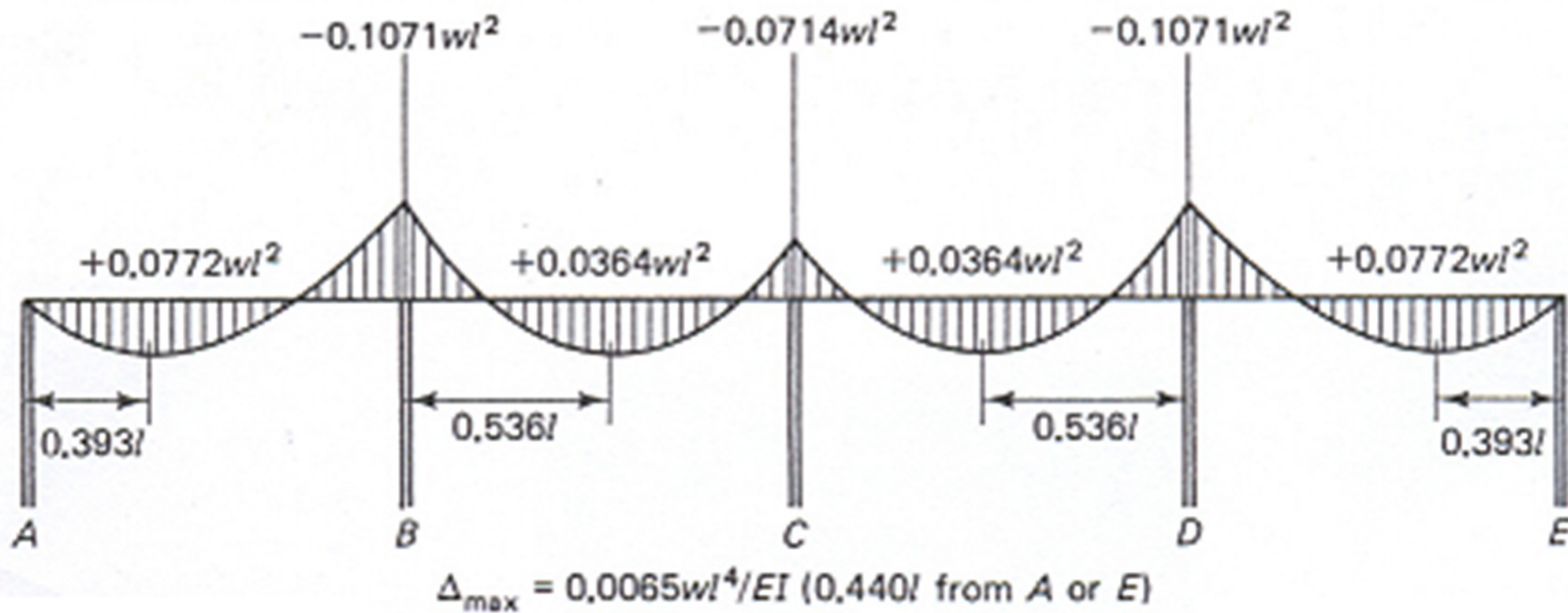


- Due to cracking of elements, use the following modifiers for gross inertia for 3D analysis (ACI R10.11.1):
 - Beam 0.35
 - Column 0.7
 - One way slab (0.35, 0.035)

- Slab: According to ACI 9.5.2 thickness of slab= $500/24=20.83\text{cm}$, but considering that concentrated loads might be placed at middle of slab, use 25cm thickness
- Beam: $800/16=50\text{cm}$, however beams fail by strength and not deflection, and because it is a factory use: drop beams 30cmX80cm (6cm cover)
- Columns: use 30X60cm reinforced on two faces (cover 4cm).



1D analysis and design: slab analysis

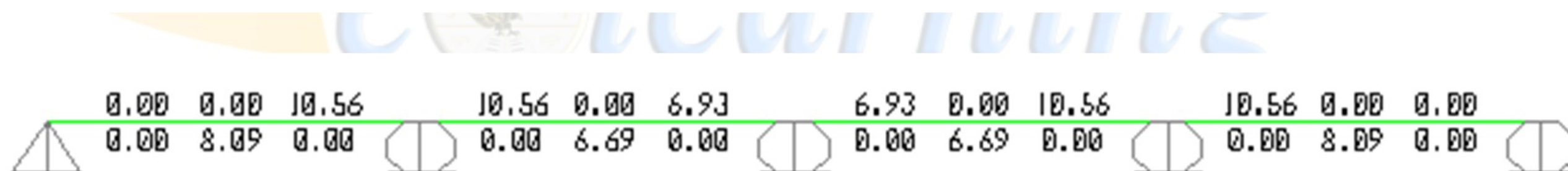
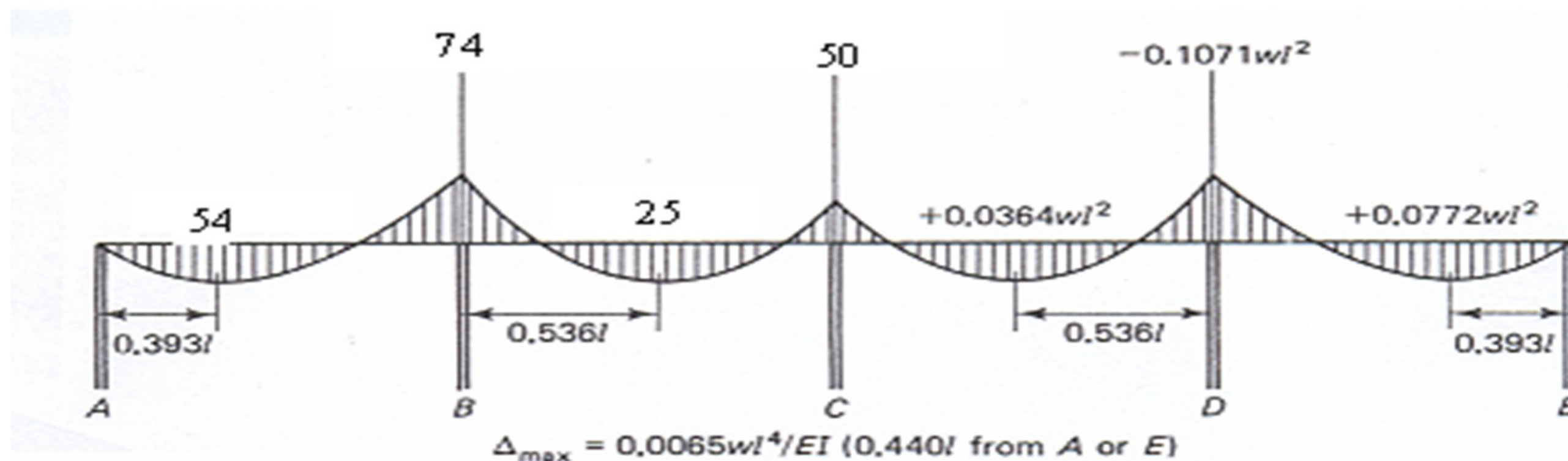


1D analysis and design: slab analysis

- $w_d = (.25 * 24.5 + 5) = 11.125 \text{ KN/m}$
- $w_l = 9 \text{ KN/m}$
- $w_u = 1.2 * 11.125 + 1.6 * 9 = 27.75 \text{ KN/m}$

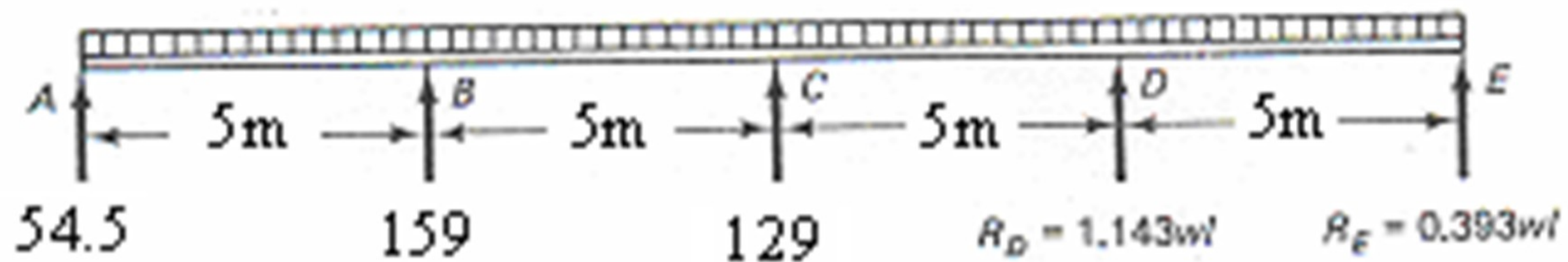
1D analysis and design: slab analysis, BM in KN.m

As in square cm



$$A_s \approx \frac{3M_u}{20} = 0.15M_u \geq \frac{1.4}{420} (100 * 20) = 6.67$$

- Note: for slabs and footings of uniform thickness the minimum steel is that for temperature and shrinkage but with maximum spacing three times the thickness or 450mm. (ACI10.5.4)



1D analysis and design: beam analysis,

- Assume simply supported beam:
- Beam C, $M_u = (129 + 1.2 * 0.3 * .8 * 24.5) * 8^2 / 8 = 1088$
- Beam B, $M_u = (159 + 1.2 * 0.3 * .8 * 24.5) * 8^2 / 8 = 1328$
- Beam A, $M_u = (54.5 + 1.2 * 0.3 * .8 * 24.5) * 8^2 / 8 = 492$

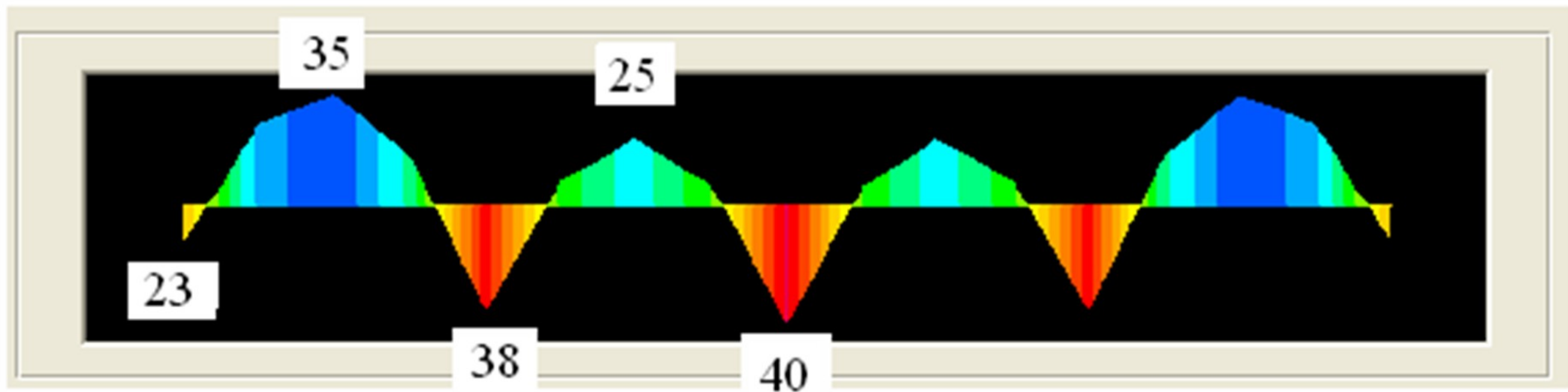
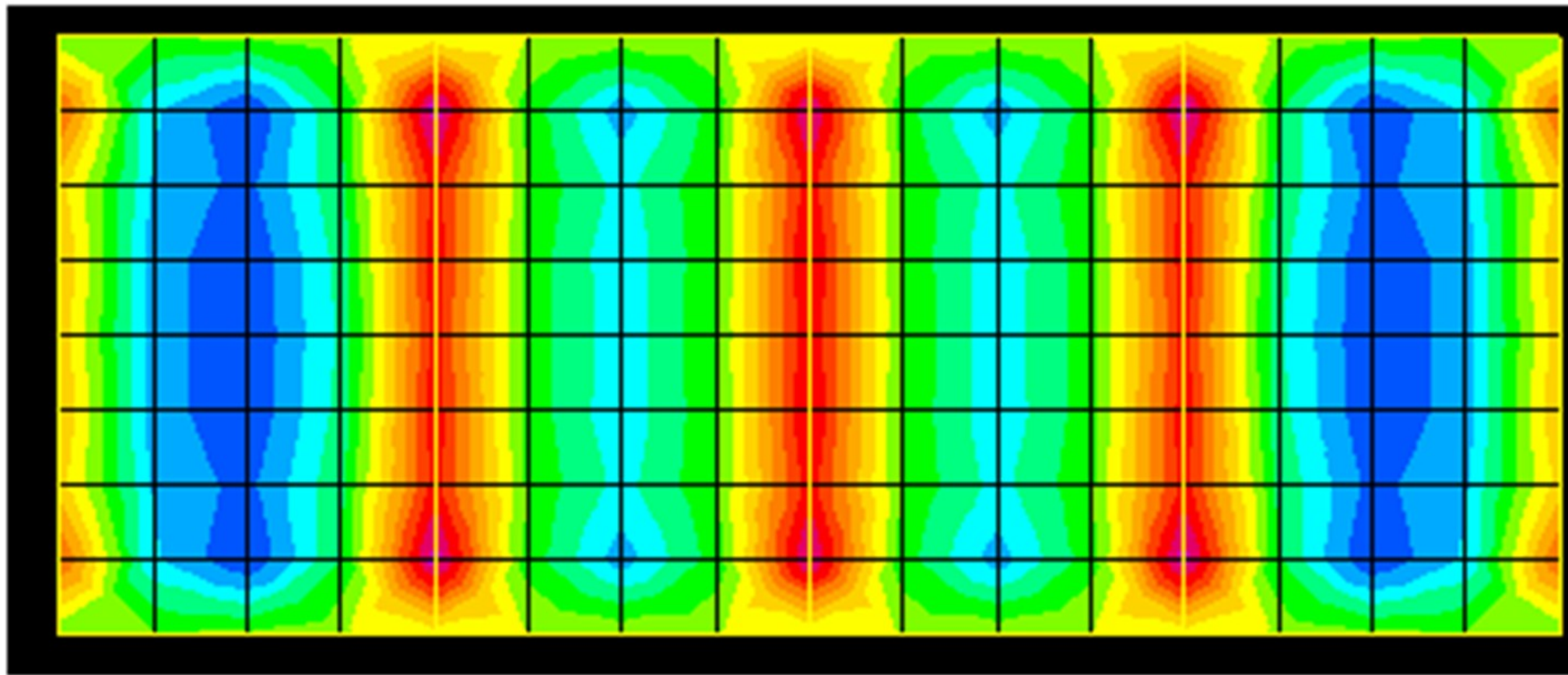


3D SAP: Gravity equilibrium checks

- D:
 - Slab= $20 \times 8 \times (0.25 \times 24.5 + 5) = 1780 \text{ KN}$
 - Beams= $(5 \times 8 + 2 \times 20) \times 8 \times 3 \times 24.5 = 470 \text{ KN}$
 - Columns= $10 \times 6 \times 3 \times 6 \times 24.5 = 264.6 \text{ KN}$
 - Sum= 2514.6 KN
- L:
 - R = $20 \times 8 \times 9 = 1440 \text{ KN}$

- SAP results:

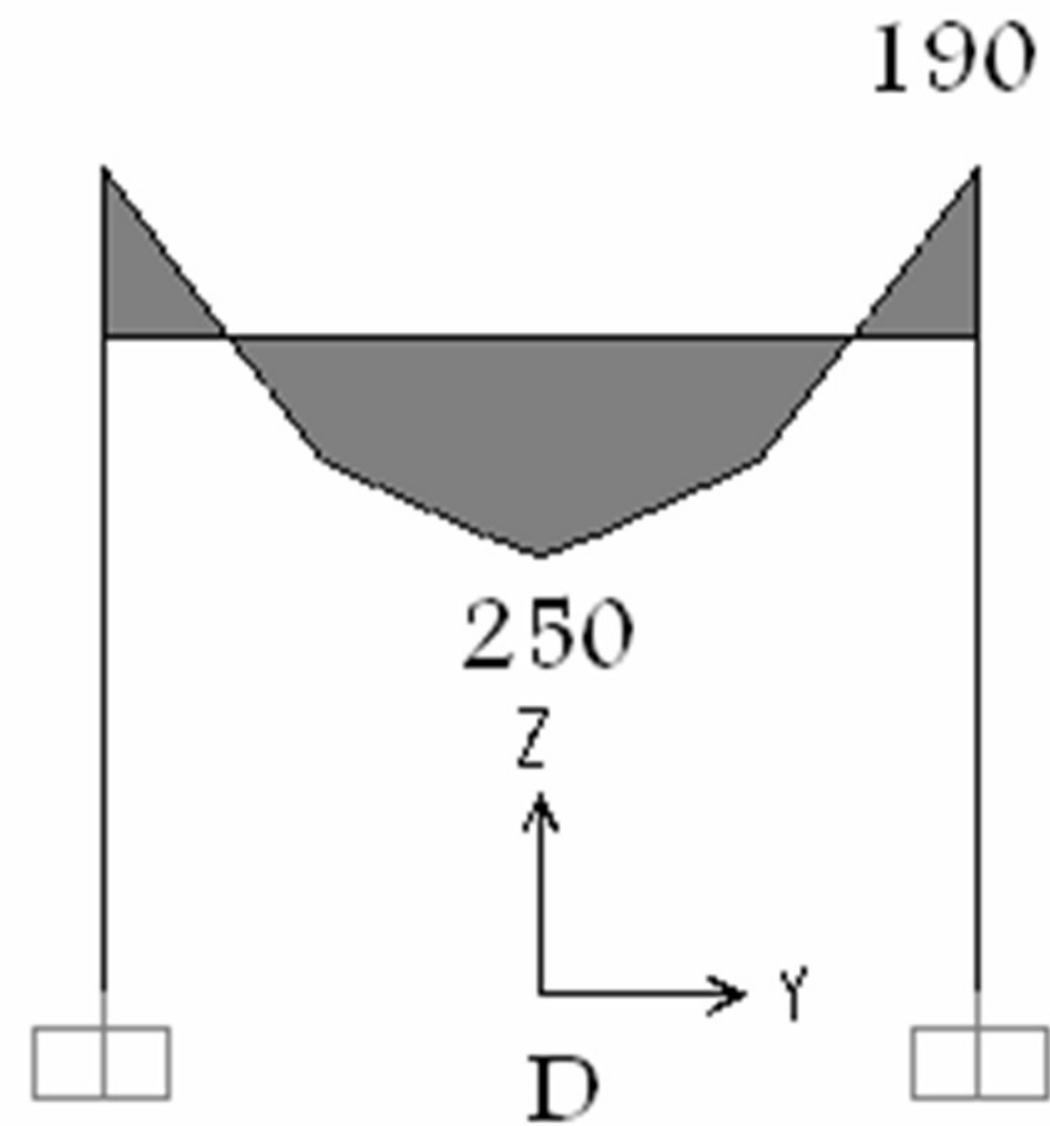
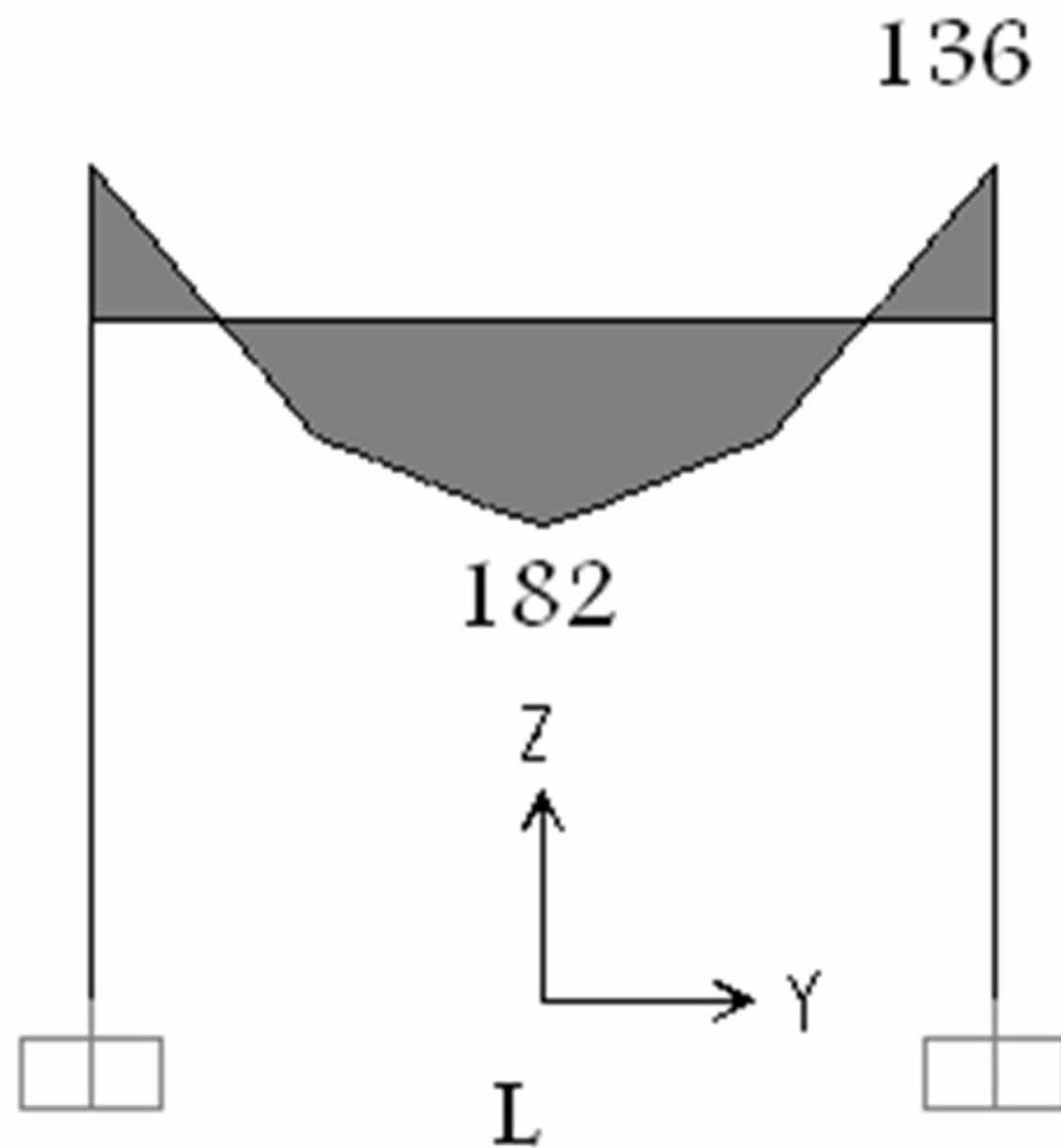
	OutputCase Text	CaseType Text	GlobalFX KN	GlobalFY KN	GlobalFZ KN	GlobalMX KN-m	GlobalMY KN-m	GlobalMZ KN-m
►	DEAD	LinStatic	1.776E-15	0	2515	000000002615	000000004093	000000000151
	live	LinStatic	1.155E-14	-5.329E-14	1440	5.684E-14	000000008527	-5.658E-13



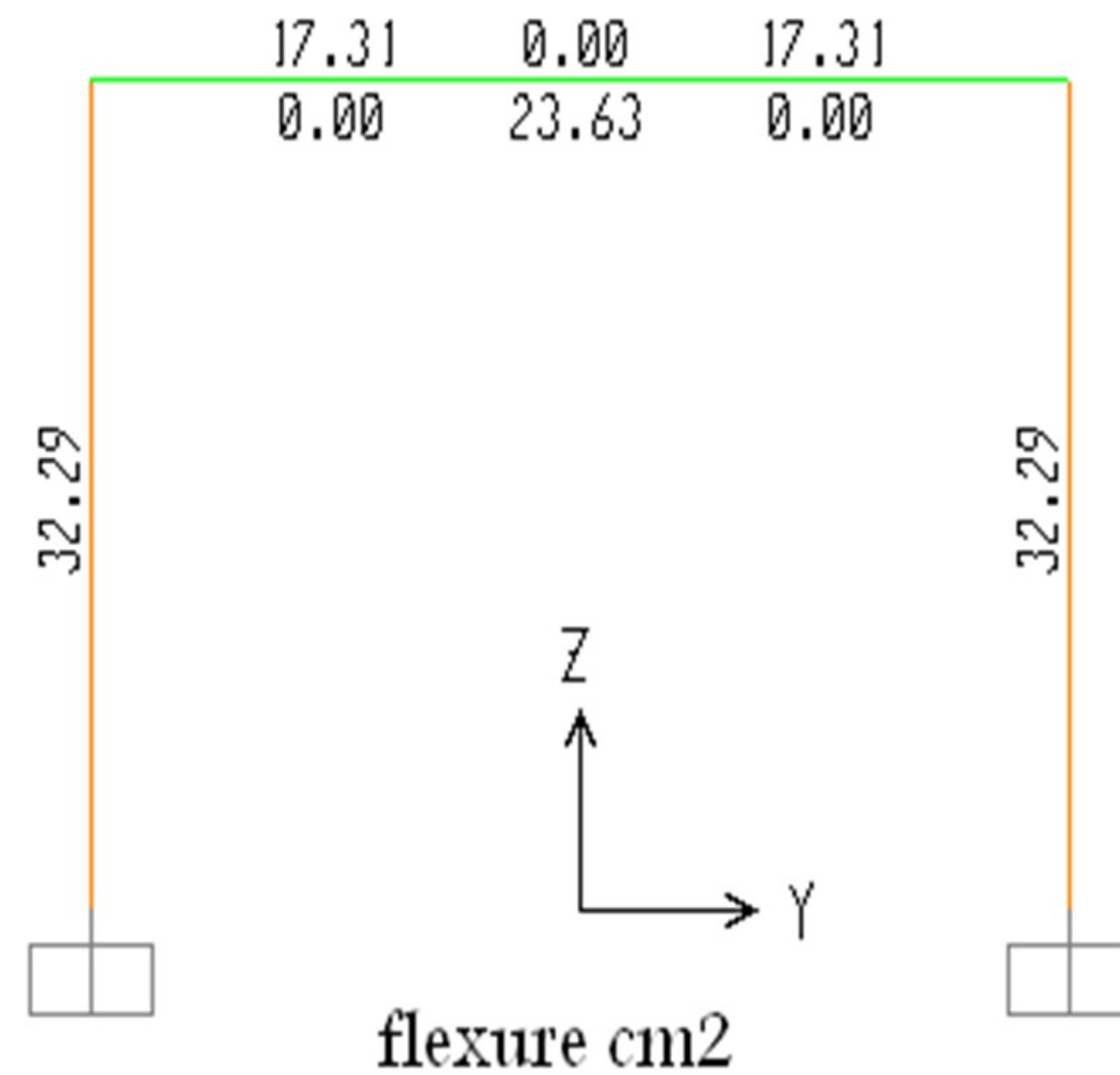
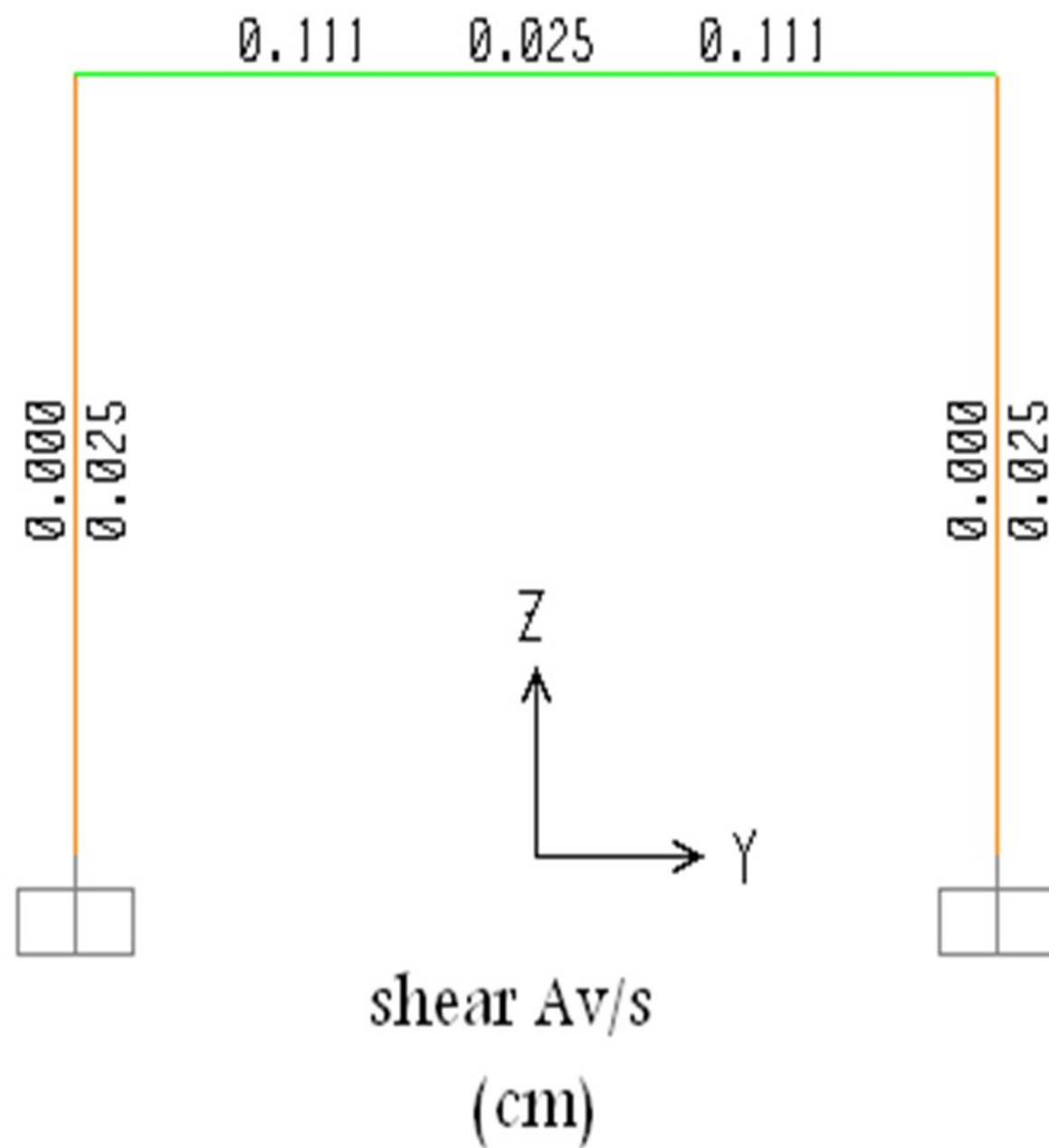
bending moment in slab KN.m



BM in beams in interior frame (KN.m)

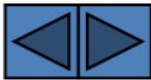
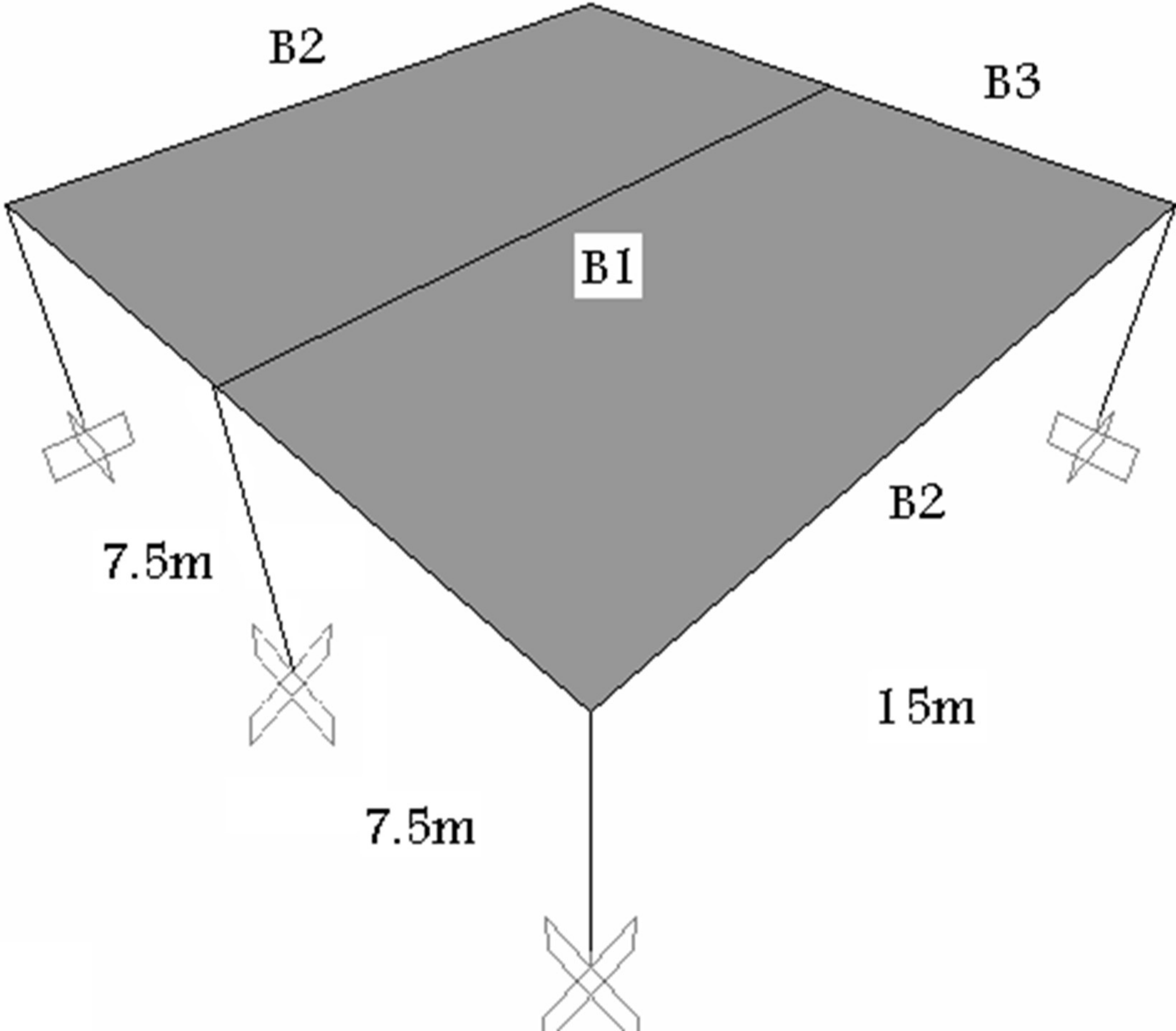


- Conceptual check for dead
 - $W_d = (.25 \times 24.5 + 5) \times 5 = 55.6 \text{ kN/m}$
 - $M_d = 55.6 \times 8^2 / 8 = 445 \text{ kN.m}$ (compare with $250 + 190 = 440 \text{ kN.m}$ ok)
- Conceptual check for live
 - $W_L = 9 \times 5 = 45 \text{ kN/m}$
 - $M_L = 45 \times 8^2 / 8 = 360 \text{ kN.m}$ (compare with $182 + 136 = 318 \text{ kN.m}$ ok)
- Conceptual design for positive moment
 - $M_u = 1.2 \times 250 + 1.6 \times 182 = 591 \text{ kN.m}$
 - $A_s = 3 \times 591 / 74 = 24 \text{ cm}^2$.



- If 3D analysis results are used conceptual understanding of edge beam is wrong, thus expect failure in torsion

- Analyze and design a one story reinforced concrete structure (entertainment hall) made of one way solid slab sitting on drop beams supported on six square columns 50cm dimensions. The superimposed and live loads are 3KN/m^2 and 4KN/m^2 respectively.



End of section 5.1

Let Learning Continue