College of Technological Studies

Department of Civil Engineering Technology

CE 278 Structural Analysis

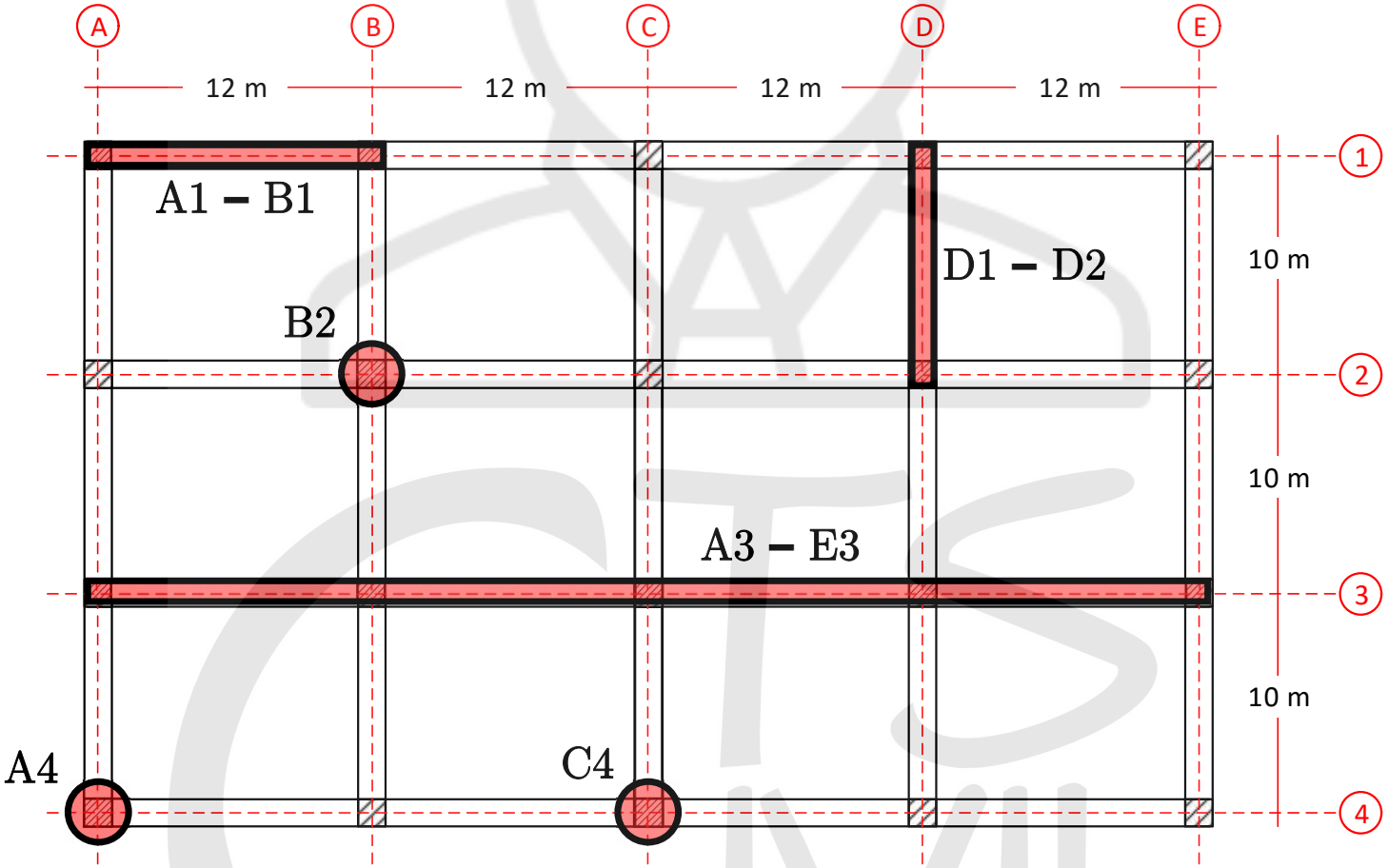
Tutorial (8)

Loads on Structures

(Part I)

Example (1): For the floor plan shown, if $D = 3.4$ kN/m^2 and L $= 2.4$ kN/m^2, find the ultimate loads on

- Columns A4, C4, and B2
- Beams A1 – B1, D1 – D2, and A3 – E3



Columns A4

$$D = 3.4\ \frac{\text{kN}}{\text{m}^2}, \quad L = 2.4\ \frac{\text{kN}}{\text{m}^2}$$

$$w_u = 1.2D + 1.6L$$

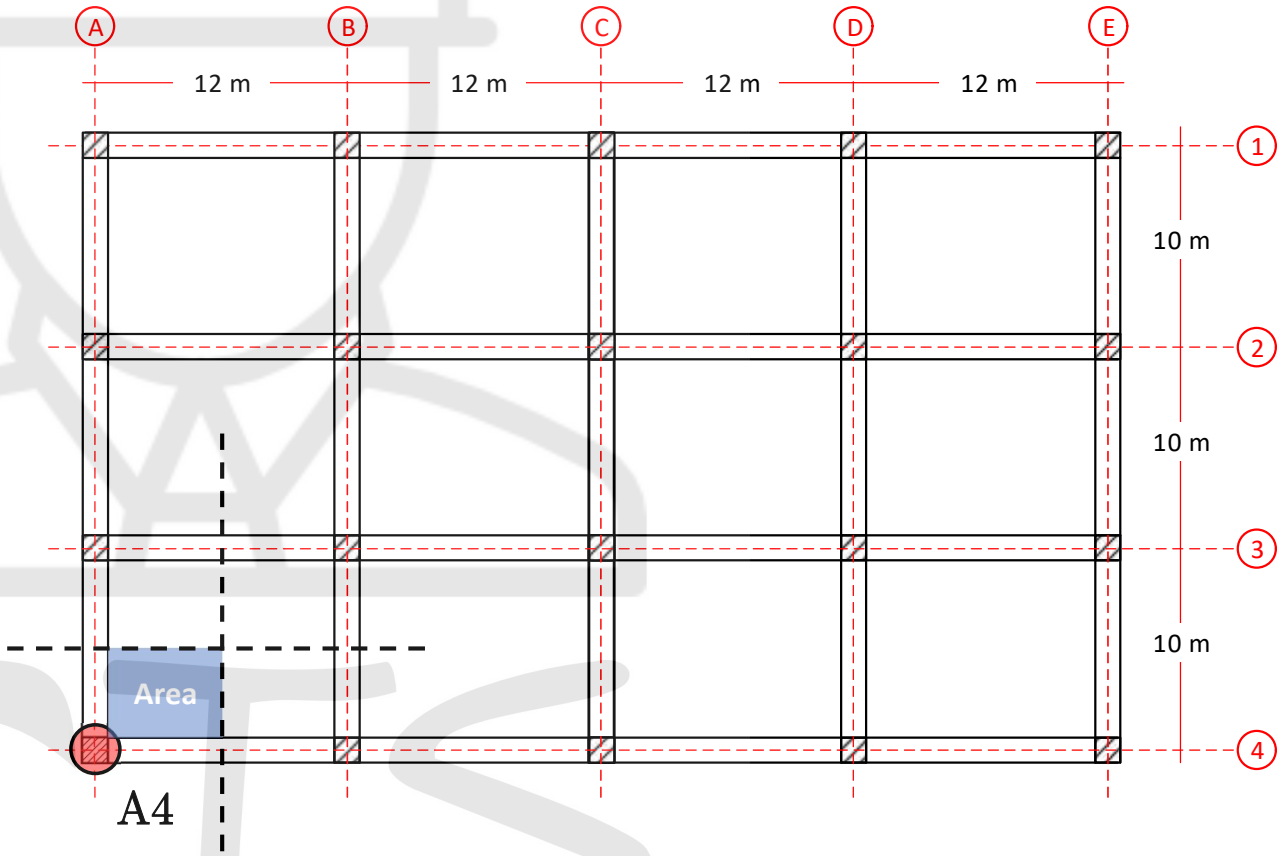
$$= 1.2(3.4) + 1.6(2.4)$$

$$\boxed{w_u = 7.92\ \frac{\text{kN}}{\text{m}^2}}$$

$$\text{Area} = (6 \times 5) = 30\ \text{m}^2$$

$$P_u = (w_u \times \text{Area}) = \left(7.92\ \frac{\text{kN}}{\text{m}^2} \times 30\ \text{m}^2\right)$$

$$\boxed{P_u = 237.6\ \text{kN}}$$



Column C4

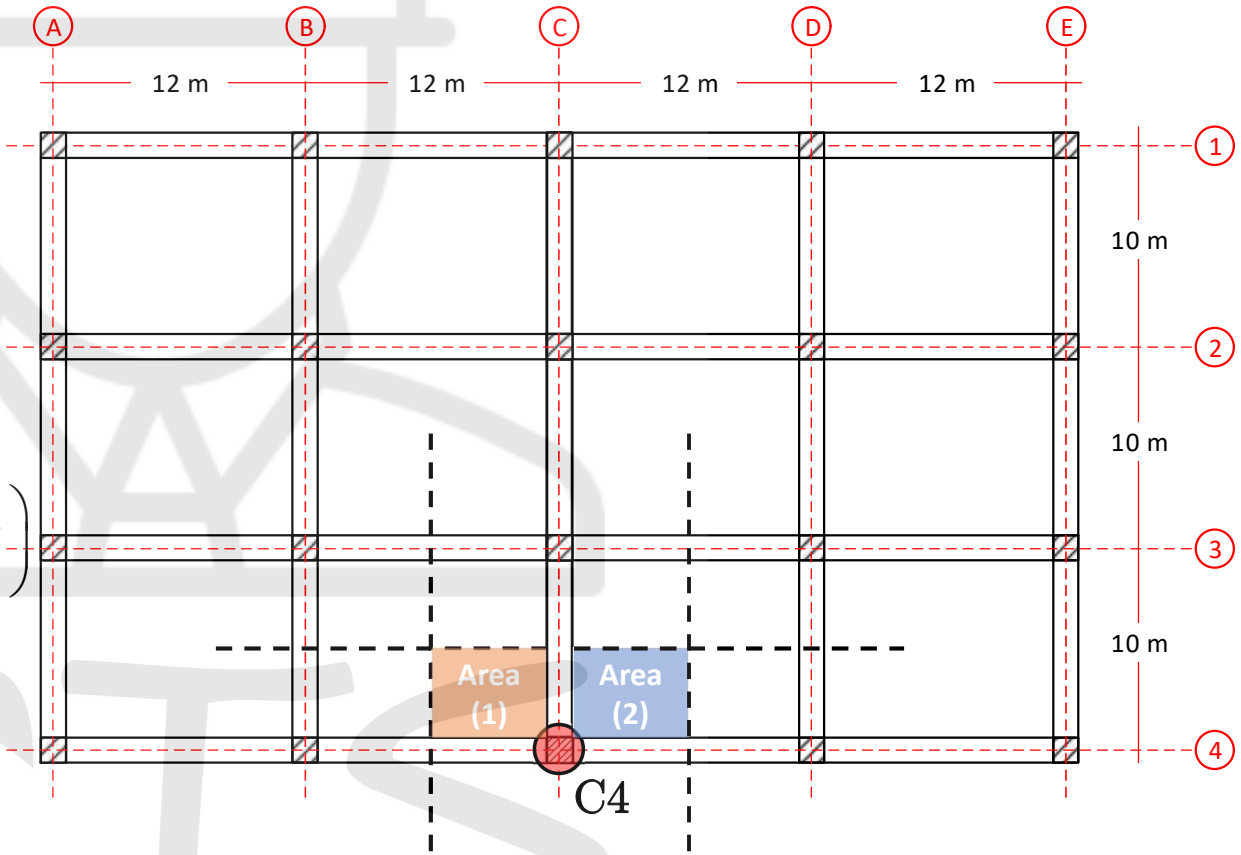
$$\boxed{w_u = 7.92\ \frac{\text{kN}}{\text{m}^2}}$$

$$\text{Area (1)} = \text{Area (2)} = (6 \times 5) = 30\ \text{m}^2$$

$$P_u = (w_u \times \text{Area (1)}) + (w_u \times \text{Area (2)})$$

$$= \left(7.92\ \frac{\text{kN}}{\text{m}^2} \times 30\ \text{m}^2\right) + \left(7.92\ \frac{\text{kN}}{\text{m}^2} \times 30\ \text{m}^2\right)$$

$$\boxed{P_u = 475.2\ \text{kN}}$$



Column B2

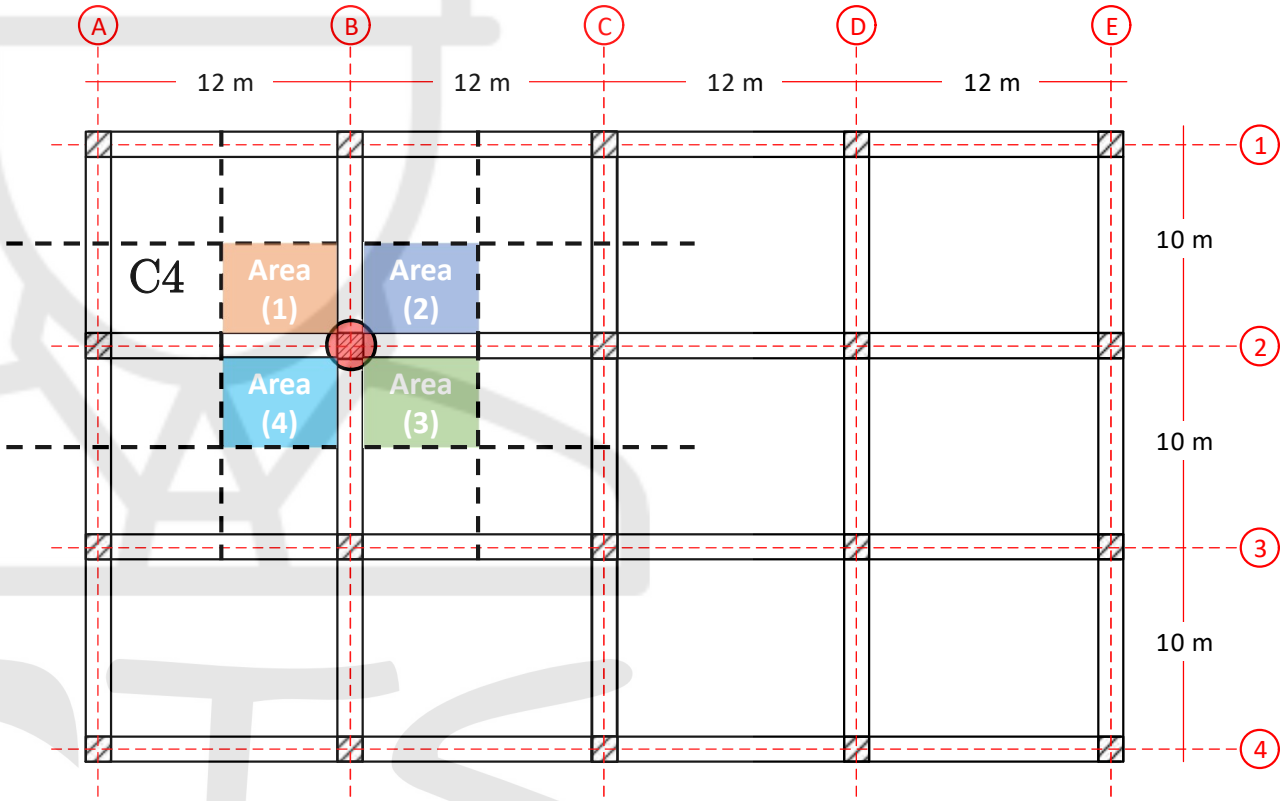
$$\boxed{w_u = 7.92\ \frac{\text{kN}}{\text{m}^2}}$$

$$\text{Area (1)} = \text{Area (2)} = \text{Area (3)}$$
$$= \text{Area (4)} = (6 \times 5) = 30\,\text{m}^2$$

$$P_u = (w_u \times \text{Area (1)}) + (w_u \times \text{Area (2)})$$
$$+ (w_u \times \text{Area (3)}) + (w_u \times \text{Area (4)})$$

$$= \left(7.92\ \frac{\text{kN}}{\text{m}^2} \times 30\,\text{m}^2\right) + \left(7.92\ \frac{\text{kN}}{\text{m}^2} \times 30\,\text{m}^2\right)$$
$$+ \left(7.92\ \frac{\text{kN}}{\text{m}^2} \times 30\,\text{m}^2\right) + \left(7.92\ \frac{\text{kN}}{\text{m}^2} \times 30\,\text{m}^2\right)$$

$$\boxed{P_u = 950.4\ \text{kN}}$$



Beam A1 – B1

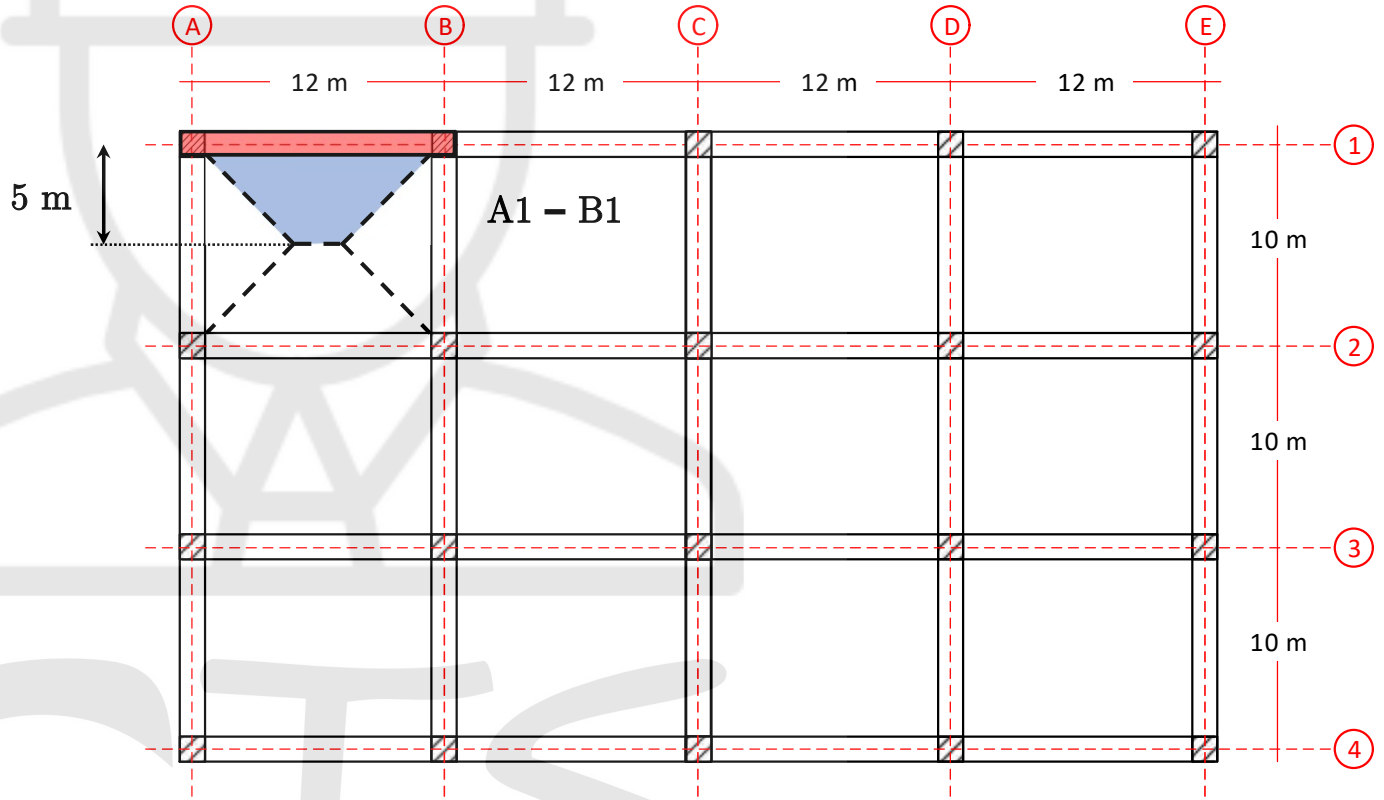
$$w_u = 7.92 \frac{\text{kN}}{\text{m}^2}$$

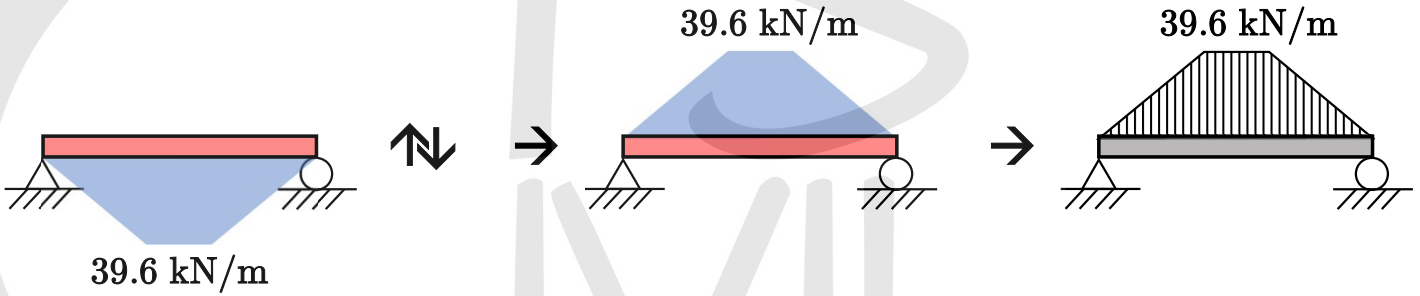
$$L = 5\ \text{m}$$

$$w_{u(\text{BEAM})} = \left(w_u \times L\right)$$

$$= \left(7.92 \frac{\text{kN}}{\text{m}^2} \times 5\ \text{m}\right)$$

$$w_{u(\text{BEAM})} = 39.6 \frac{\text{kN}}{\text{m}}$$





Beam D1 – D2

$$L_1 = L_2 = 5\ \text{m}$$

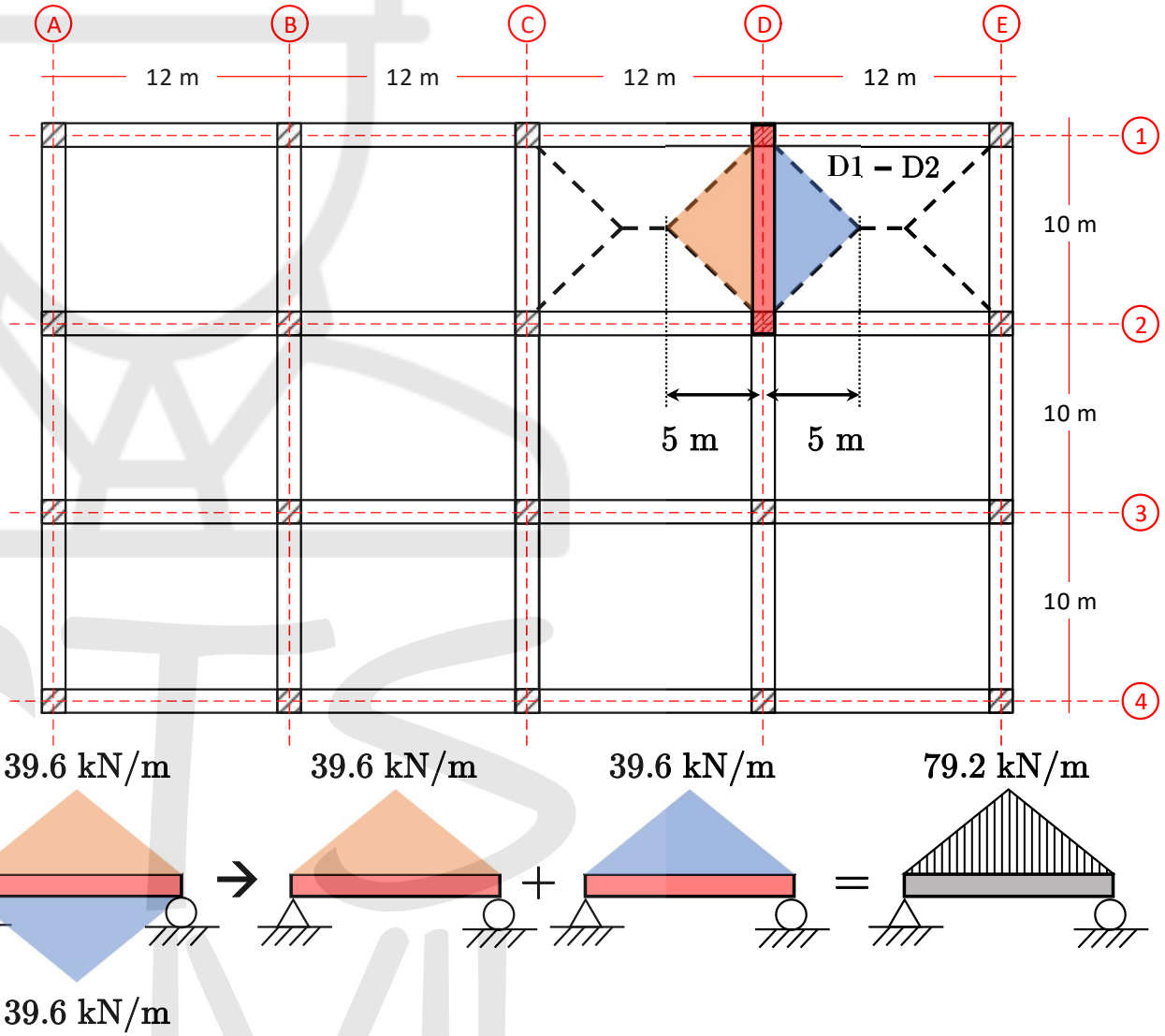
$$w_{u(1)} = w_{u(2)} = 7.92\ \frac{\text{kN}}{\text{m}^2}$$

$$w_{u(\text{BEAM})} = \left(w_{u(1)} \times L_1\right) + \left(w_{u(2)} \times L_2\right)$$

$$= \left(7.92\ \frac{\text{kN}}{\text{m}^2} \times 5\,\text{m}\right) + \left(7.92\ \frac{\text{kN}}{\text{m}^2} \times 5\,\text{m}\right)$$

$$= 39.6\frac{\text{kN}}{\text{m}} + 39.6\frac{\text{kN}}{\text{m}}$$

$$\boxed{w_{u(\text{BEAM})} = 79.2\ \frac{\text{kN}}{\text{m}}}$$



Beam A3 – E3

$$L_1 = L_2 = \ldots = L_8 = 5\ \text{m}$$

$$w_{u(1)} = w_{u(2)} = \ldots = w_{u(8)} = 7.92\ \frac{\text{kN}}{\text{m}^2}$$

$$w_{u(\text{A3 - B3})} = \left(w_{u(1)} \times L_1\right) + \left(w_{u(2)} \times L_2\right)$$

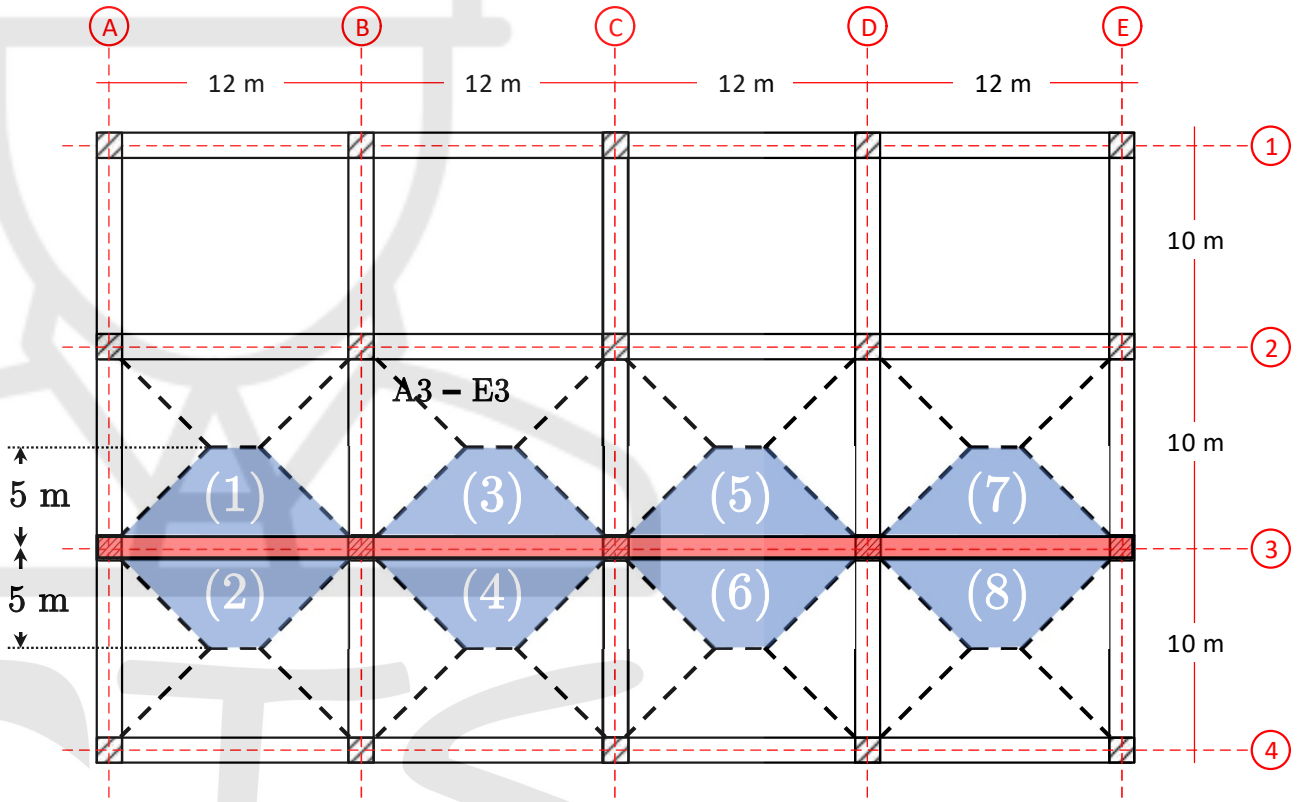
$$\left(7.92\ \frac{\text{kN}}{\text{m}^2} \times 5\ \text{m}\right) + \left(7.92\ \frac{\text{kN}}{\text{m}^2} \times 5\ \text{m}\right)$$

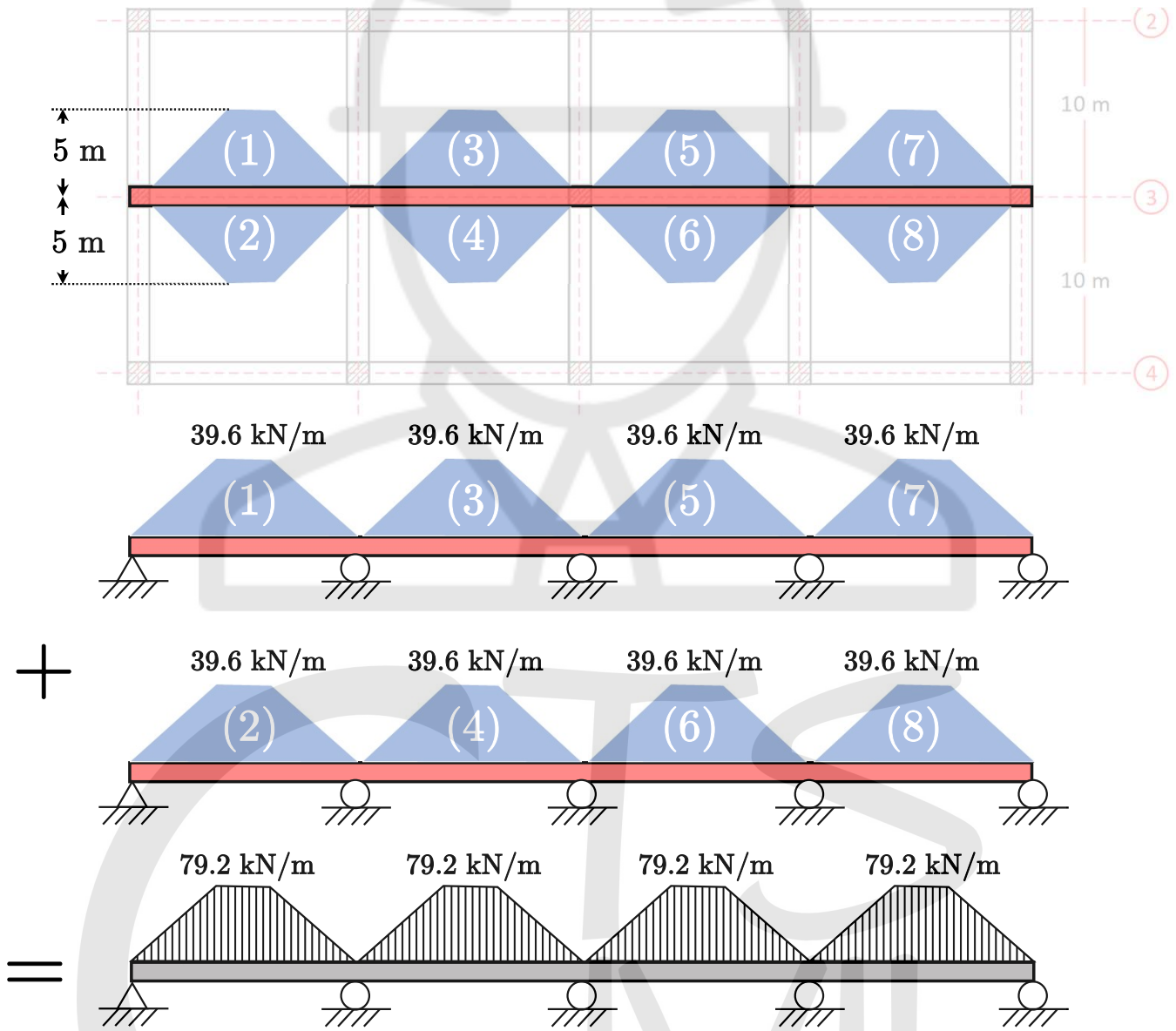
$$= \boxed{79.2\ \frac{\text{kN}}{\text{m}}}$$

$$w_{u(\text{B3 - C3})} = \left(w_{u(3)} \times L_3\right) + \left(w_{u(4)} \times L_4\right) = \boxed{79.2\ \frac{\text{kN}}{\text{m}}}$$

$$w_{u(\text{C3 - D3})} = \left(w_{u(5)} \times L_5\right) + \left(w_{u(6)} \times L_6\right) = \boxed{79.2\ \frac{\text{kN}}{\text{m}}}$$

$$w_{u(\text{D3 - E3})} = \left(w_{u(7)} \times L_7\right) + \left(w_{u(8)} \times L_8\right) = \boxed{79.2\ \frac{\text{kN}}{\text{m}}}$$



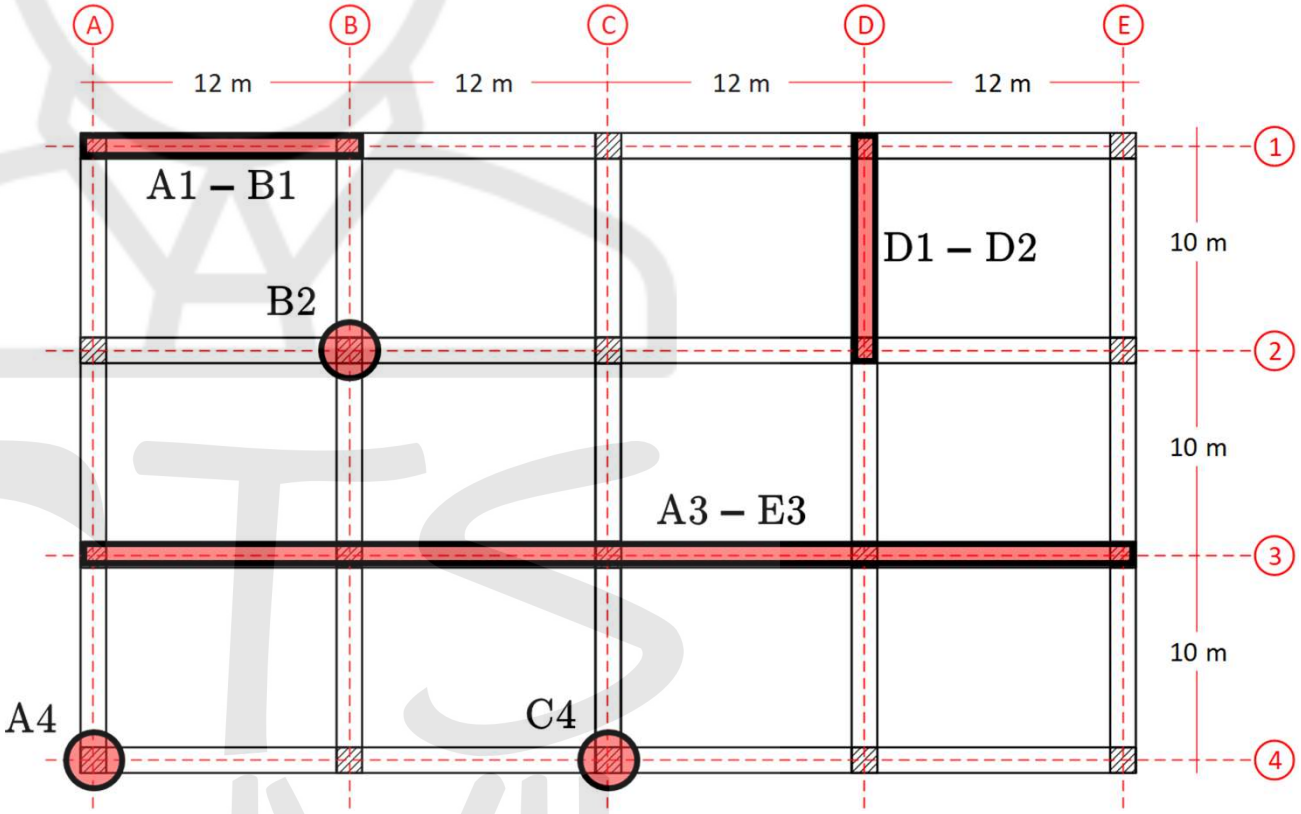

5 m
5 m
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
10 m
10 m
2
3
4
39.6 kN/m
39.6 kN/m
39.6 kN/m
39.6 kN/m
39.6 kN/m
39.6 kN/m
39.6 kN/m
39.6 kN/m
79.2 kN/m
79.2 kN/m
79.2 kN/m
79.2 kN/m

Example (2): For the floor plan shown, assuming $L = 2.4\ \text{kN/m}^2$, all slabs are 12 cm thick and:

- Concrete density (ρ_c) = 24 kN/m³
- Mechanical, Electrical, and Piping = 0.60 kN/m²
- Ceiling system = 0.35 kN/m²
- Roofing = 0.30 kN/m²
- Flooring = 0.50 kN/m²

Find loads on:

- Columns A4, C4, and B2
- Beams A1 – B1, D1 – D2, and A3 – E3



$$L = 2.4\ \frac{\text{kN}}{\text{m}^2}$$

$$D = \left(24\ \frac{\text{kN}}{\text{m}^3} \times 12\,\text{cm} \times \frac{1\,\text{m}}{100\,\text{cm}}\right) + 0.60\frac{\text{kN}}{\text{m}^2} + 0.35\frac{\text{kN}}{\text{m}^2} + 0.50\frac{\text{kN}}{\text{m}^2}$$

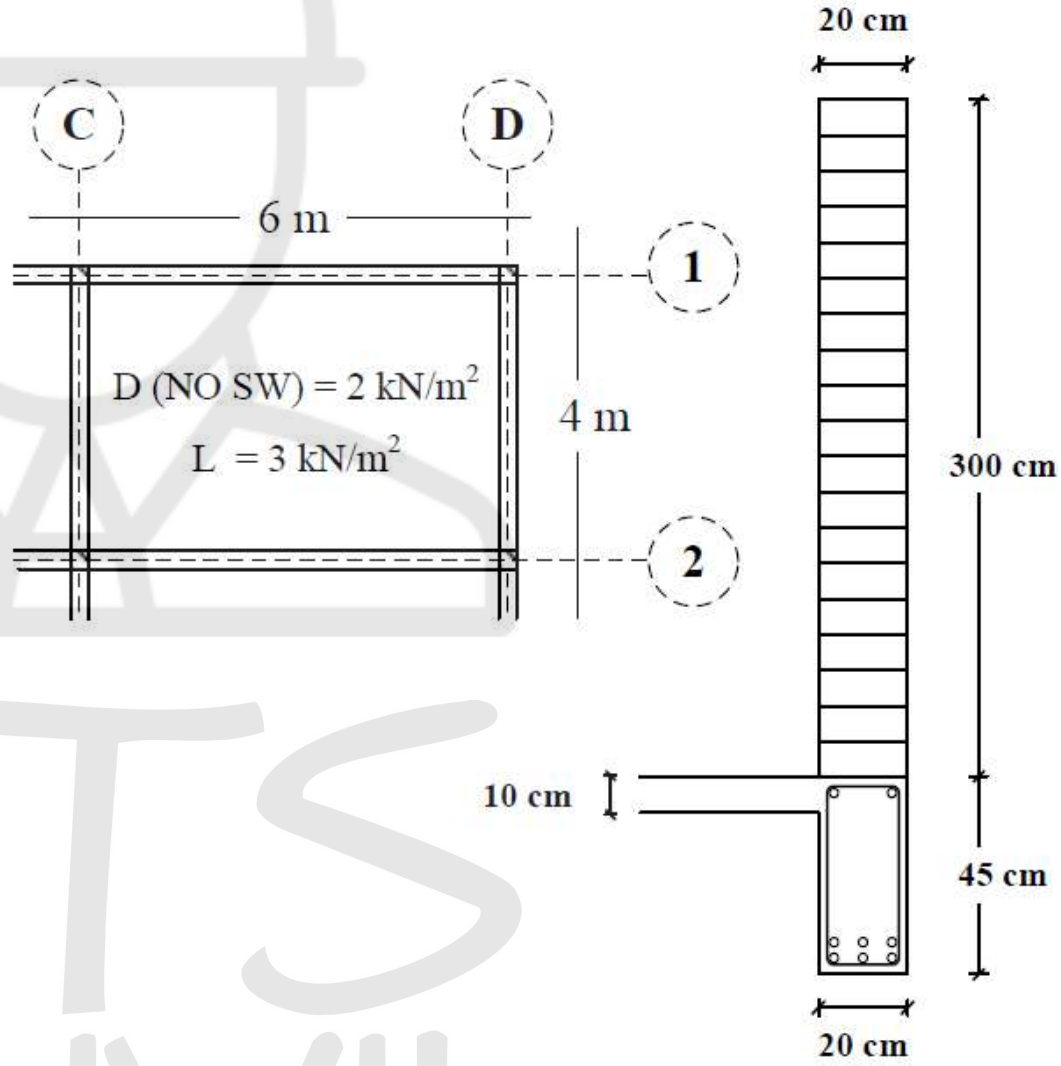
$$D = 4.33\frac{\text{kN}}{\text{m}^2}$$

$$w_u = 1.2D + 1.6L = 1.2\left(4.33\frac{\text{kN}}{\text{m}^2}\right) + 1.6\left(2.4\frac{\text{kN}}{\text{m}^2}\right)$$

$$\boxed{w_u = 9.04\ \frac{\text{kN}}{\text{m}^2}}$$

Example (3): Calculate the ultimate load on the beam (C1 – D1) shown in the figure assuming:

- Reinforced concrete (ρ_c) = 25 kN/m³
- Exterior wall (ρ_{ew})= 16.50 kN/m³



Wall Self-weight

$$\rho_c = 25\frac{\text{kN}}{\text{m}^3}$$

$$\text{Wall}_{(SW)} = \left(25\frac{\text{kN}}{\text{m}^3}\times 20\,\text{cm}\times\frac{1\,\text{m}}{100\,\text{cm}}\times 300\,\text{cm}\times\frac{1\,\text{m}}{100\,\text{cm}}\right)$$

$$\boxed{\text{Wall}_{(SW)} = 15\frac{\text{kN}}{\text{m}}}$$

Beam Self-weight

$$\rho_{ew} = 16\frac{\text{kN}}{\text{m}^3}$$

$$\text{Beam}_{(SW)} = \left(16\frac{\text{kN}}{\text{m}^3}\times 20\,\text{cm}\times\frac{1\,\text{m}}{100\,\text{cm}}\times 45\,\text{cm}\times\frac{1\,\text{m}}{100\,\text{cm}}\right)$$

$$\boxed{\text{Wall}_{(SW)} = 1.44\frac{\text{kN}}{\text{m}}}$$

Total factored Self-weight (From Beam and Wall):

$$\text{Wall}_{(SW)} = 15\frac{\text{kN}}{\text{m}}, \qquad \text{Beam}_{(SW)} = 1.44\frac{\text{kN}}{\text{m}}$$

$$w_{u(\text{Wall+Beam})} = 1.4D$$

$$= 1.4\left(\text{Wall}_{(SW)} + \text{Beam}_{(SW)}\right)$$

$$= 1.4\left(15\frac{\text{kN}}{\text{m}} + 1.44\frac{\text{kN}}{\text{m}}\right)$$

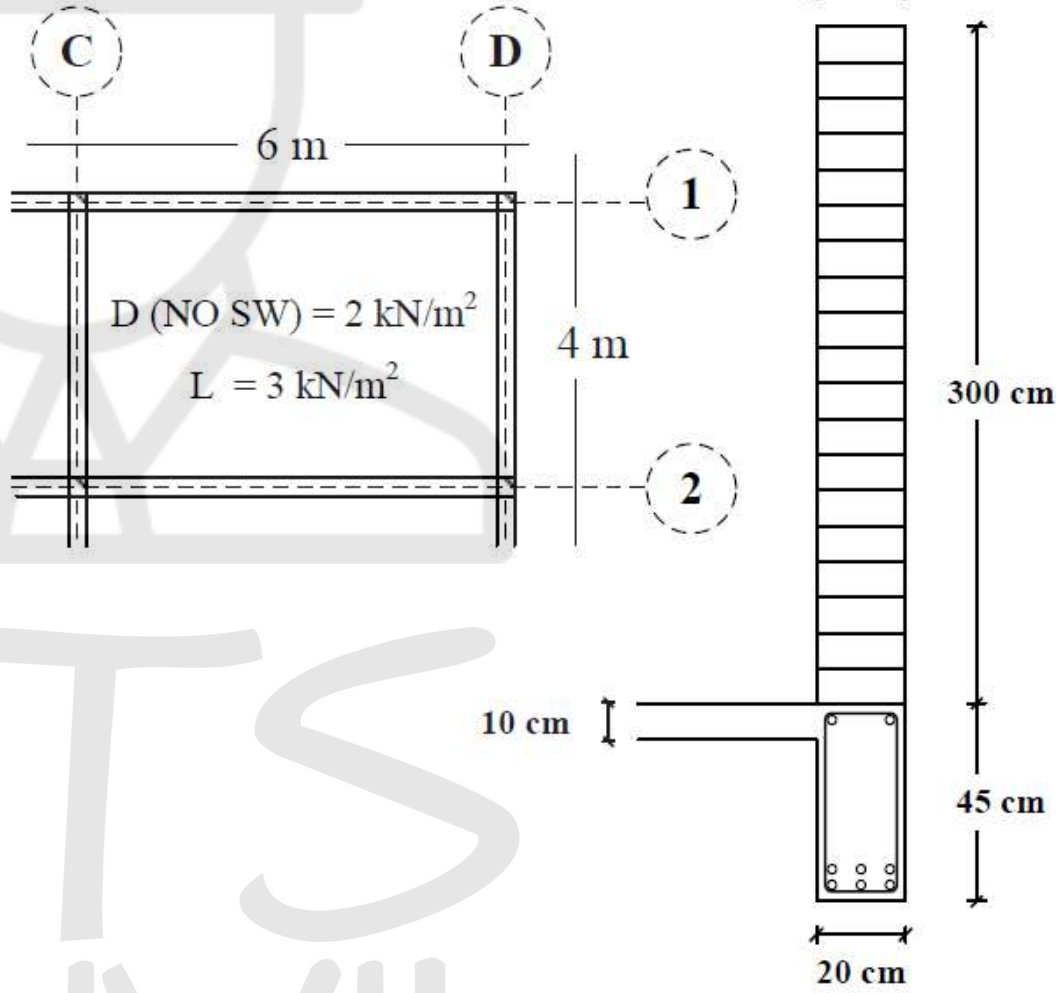
$$\boxed{w_{u(\text{Wall+Beam})} = 23.02\ \frac{\text{kN}}{\text{m}}}$$

Slab Self-weight

$$\rho_c = 25\frac{\text{kN}}{\text{m}^3}$$

$$\text{Slab}_{(SW)} = \left(25\ \frac{\text{kN}}{\text{m}^3} \times 10\,\text{cm} \times \frac{1\,\text{m}}{100\,\text{cm}}\right)$$

$$\boxed{\text{Slab}_{(SW)} = 2.5\frac{\text{kN}}{\text{m}^2}}$$



Total factored load on slab:

$$D = \text{Slab}_{(SW)} + \text{Given}, \quad L = 3\ \frac{\text{kN}}{\text{m}^2}$$

$$= 2.5\frac{\text{kN}}{\text{m}^2} + 2\frac{\text{kN}}{\text{m}^2} = 4.5\frac{\text{kN}}{\text{m}^2}$$

$$w_u = 1.2D + 1.6L$$

$$= 1.2\left(4.5\frac{\text{kN}}{\text{m}^2}\right) + 1.6\left(3\ \frac{\text{kN}}{\text{m}^2}\right)$$

$$\boxed{w_u = 10.2\ \frac{\text{kN}}{\text{m}^2}}$$

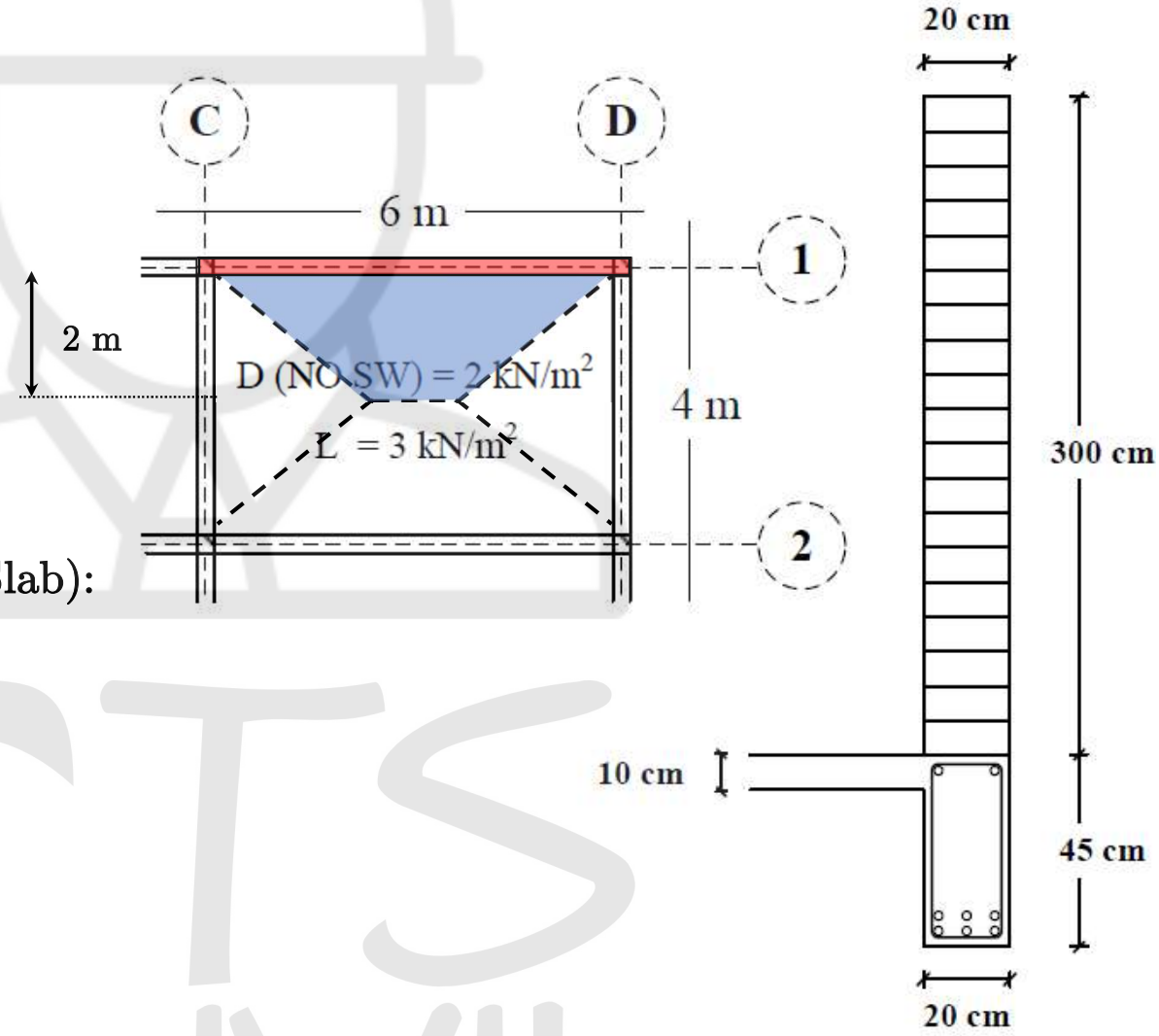
Factored load on beam (C1 – D1) (From Slab):

$$L = 2\ \text{m}$$

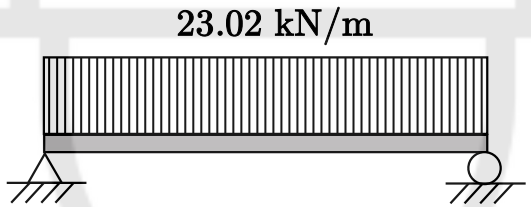
$$w_{u(\text{BEAM})} = \left(w_u \times L\right)$$

$$= \left(10.2\ \frac{\text{kN}}{\text{m}^2} \times 2\,\text{m}\right)$$

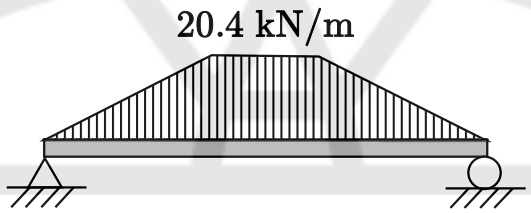
$$\boxed{w_{u(\text{BEAM})} = 20.4\frac{\text{kN}}{\text{m}}}$$



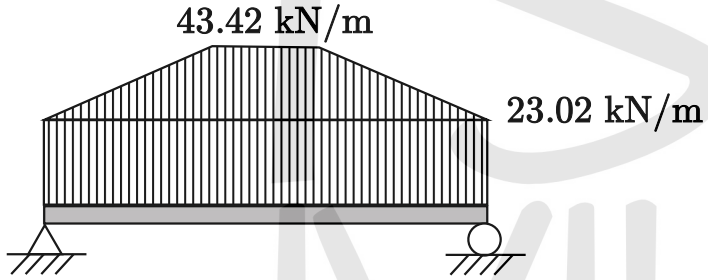
Factored load on beam (C1 – D1) (Wall + Beam)



Factored load on beam (C1 – D1) (Slab)



Factored load on beam (C1 – D1) (Wall + Beam + Slab)



Questions?