Q. 1:

صباحي (٢)

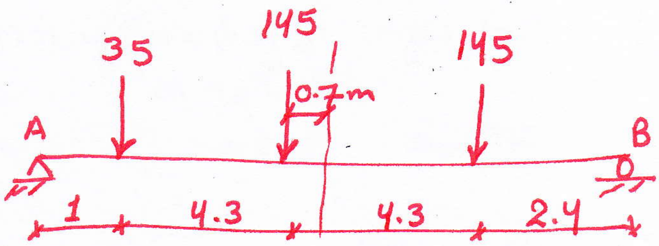
$W_{DC} = 0.6 * 24 = 14.4\ kN/m^2$

$\longrightarrow M_{DC} = 259.2\ kN.m$

$W_{DW} = 2\ kN/m^2$

$\longrightarrow M_{DW} = 36\ kN.m$

$M_{Ln} = 167.4\ kN.m$



$V_A = \dfrac{145[2*2.4+4.3]+35*11}{12} = 142\ kN.$

$M_{Tr} = 142 * 5 - 35 * 4.3 = 602.1\ kN.m$

$W = 10 - 2*1.8 = 6.4\ m \longrightarrow N_L = 2$

$E_{si} = 250 + 0.42 * \sqrt{L_1 * W_1} = 250 + 0.42\sqrt{12*10^7} = 4.85\ m$

$L_1 = 12m < 18m\ \therefore ok$

$W_1 = 10m < 18m\ \therefore ok$

$E_{mi} = 2100 + 0.12\sqrt{12*10^7} = 3.41\ m \leq \frac{10}{2} = 5\ m\ \therefore Ok$

$\therefore E_{int} = 3.41\ m$

$\therefore M_{LL+IM} = [1.33 M_{Tr} + M_{Ln}]/E_{int}.$

$= [1.33 * 602.1 + 167.4]/3.41 \simeq 283.9$

$\therefore M_u = 1.25 * 259.2 + 1.5 * 36 + 1.75 * 283.9$

$= 874.87 \simeq \underline{875\ kN.m}$

مسجابي (ب)

Q.2:

$W_{DC} = 0.6 * 24 = 14.4\ kN/m^2$

$\longrightarrow M_{DC} = 259.2\ kN.m$

$W_{DW} = 2\ kN/m^2$

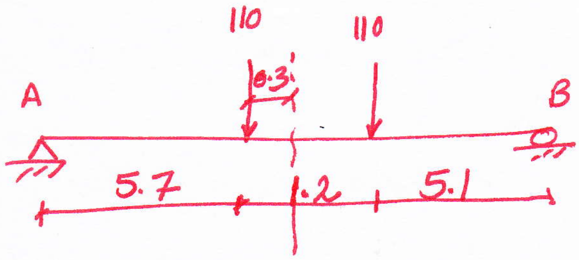
$\longrightarrow M_{DW} = 36\ kN.m$

$W_{Ln} = 9.3\ kN/m^2$

$\longrightarrow M_{Ln} = 167.4\ kN.m$

$V_A = \frac{110[2*5.1+1.2]}{12} = 104.5\ kN$

$M_{Ta} = 104.5 * 5.7 \simeq 595.7\ kN.m$



$W = 10 - 2*1.8 = 6.4\ m$

$\longrightarrow N_L = 2$

$L_1 = 12\ m < 18\ m \quad \therefore OK$

$W_1 = 10\ m < 18\ m \quad \therefore OK$

$E_{si} = 0.25 + 0.42 * \sqrt{12*10} = 4.85\ m$

$E_{mi} = 2.1 + 0.12\sqrt{12*10} = 3.41\ m \leq \frac{10}{2} = 5\ m \quad \therefore Ok$

$\therefore E_{int.} = 3.41\ m$

$\longrightarrow M_{LL+IM} = [1.33 M_{Ta} + M_{Ln}] / E_{int.}$

$= [1.33 * 595.7 + 167.4] / 3.41$

$= 281.4\ kN.m$

$\therefore M_u = 1.25 * 259.2 + 1.5 * 36 + 1.75 * 281.4$

$= 870.45 \simeq 870.5\ kN.m$

Q.3:

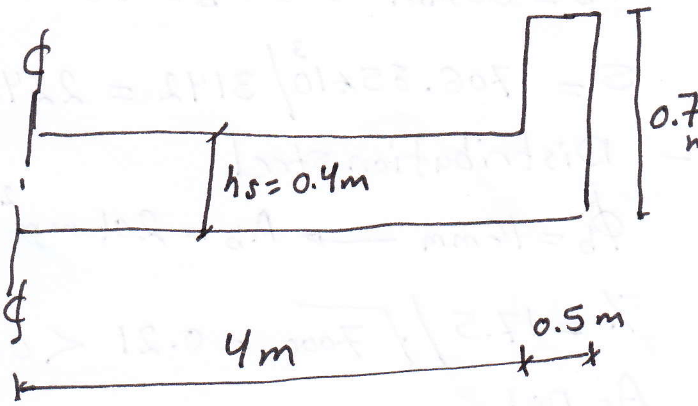
Design the required reinforcement for the interior strip of the slab-bridge section shown below if:

$M_u = 380$ KN.m

$f'_c / f_y = 42/420$ MPa

$S = 7$ m

Then sketch the reinforcement



Solution:

Take $C_b = 25$ mm , $\phi_b = 30$ mm

$d_s = 400 - 25 - 30/2 = 360$ mm

$A_s = 1.25 * 380 \times 10^6 / (420 * 360) = 3142 \ mm^2/m$

$B_1 = 0.85 - 0.05(42 - 28)/7 = 0.75$

$C = 3142 * 420 / (0.85 * 42 * 0.75 * 1000) = 49.29$ mm

$\epsilon_s = [(360 - 49.29)/49.29] * 0.003 = 0.0189 > 0.005$ ∴ ok

$a = 0.75 * 49.29 \ mm = 37$ mm

$M_r = 0.9 * 3142 * 420 (360 - \frac{37}{2}) = 405.6$ KN.m > 380 KN.m ∴ ok

$f_r = 0.63\sqrt{42} = 4.08$ MPa

$\bar{y} = 200$ mm , $I_g = 1000 * 400^3/12 = 5.33 * 10^9 \ mm^4$

$S_{nc} = 5.33 * 10^9 / 200 = 26.67 * 10^6 \ mm^3$

$M_{cr} = 4.08 * 26.67 = 108.88$ KN.m

$1.2 M_{cr} = 130.7$ KN.m

$< 1.33 * 380 = 505.4$ KN.m ok

< 405.6 KN.m ok

$S_{min} = 45\,mm$

$S_{max.} = 450\,mm$

- Main steel

$\phi_b = 30\,mm \longrightarrow A_b = 706.85\,mm^2$

$S = 706.85 * 10^3 / 3142 = 224.96\,mm$ Say 200mm

- Distribution steel

$\phi_b = 16\,mm \longrightarrow A_b = 201\,mm^2$

$\% = 17.5 / \sqrt{7000} = 0.21 < 0.5$ ok

$A_{s,\,Dist.} = 0.21 * 3142 = 658\,mm^2/m$

$S = 201 * 10^3 / 658 = 305.47\,mm$ Say 300mm

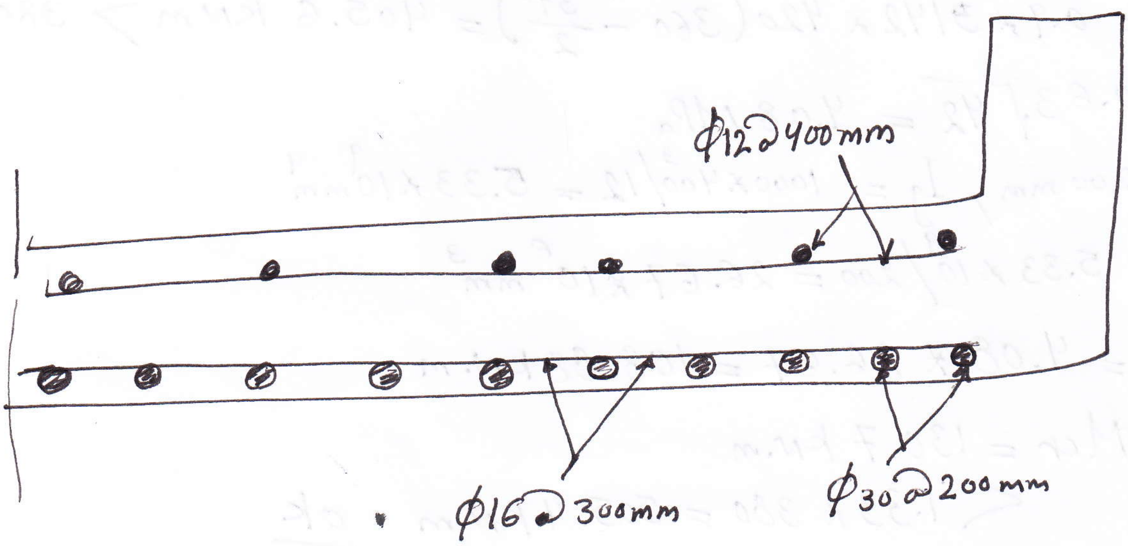
- Shrinkage & Temp. steel

$\phi_b = 12\,mm \longrightarrow A_b = 113\,mm^2$

$A_{s,\,S+T} = 750 * 400 * 10^3 / [2(7000 + 400) * 420] = 255.1\,mm^2/m$

$233 < A_{s,\,S+T} < 1270\,mm^2/m$ ok

$S = 113 * 10^3 / 255.1 = 442.96\,mm$ Say 400 mm.



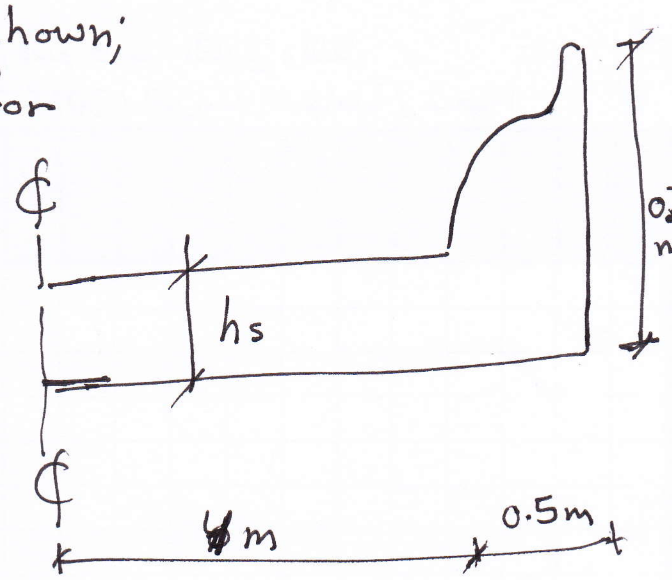
Q. 4.

For the section of Slab_bridge shown; Sketch the required reinforcement for the interior strips. if:

$S = 8m$

$f_c'/f_y = 37/420$ MPa

$M_u = 420$ KN.m



Solution:

$h_{min} = 0.04[8000 + 3000] = 440mm$

Use $h_s = 450 mm$

Take $C_b = 25mm$ and $\phi_b = 30 mm$

$d_s = 450 - 25 - 30/2 = 410 mm$

$A_s = 1.25 \times 10^6 \times 420/(420 \times 410) = 3048.7 \ mm^2/m$

$\beta_1 = 0.85 - 0.05(37 - 28)/7 = 0.786$

$C = 3048.7 \times 420/(0.85 \times 37 \times 0.786 \times 1000) = 51.82 mm$

$\epsilon_s = [(410 - 51.82)/51.82] \times 0.003 = 0.0207 > 0.005$ ok

$\longrightarrow \phi = 0.9$

$a = 0.786 \times 51.82 = 40.8 \ mm$

$M_r = 0.9 \times 3048.7 \times 420(410 - \frac{40.8}{2}) = 449 \ kN.m > 420 \ kN.m$ ok

$f_r = 0.63\sqrt{37} = 3.83 \ MPa$

$\bar{y} = 225 mm \rightarrow I_g = 10^3 \times 450^3/12 = 7.59 \times 10^9 \ mm^4$

$S_{nc} = 33.75 \times 10^6 \ mm^3$

$M_{cr} = 3.83 \times 33.75 \times 10^6 = 129.3 \ kN.m$

$1.2 M_{cr} = 155.2 \ kN.m$

$< 1.33 \times 420 = 558.6 \ kN.m$ ok

$< 449 \ kN.m$ ok

$S_{min} = 45\ mm$

$S_{max.} = 450\ mm$

- Main Steel

$A_b = 706.85\ mm^2$

$S = 706.85 \times 10^3 / 3048.7 = 231.8\ mm$

Say 200 mm.

- Distribution Steel

$\phi_b = 16 mm \longrightarrow A_b = 201\ mm^2$

$\% = 17.5/\sqrt{8000} = 0.195 < 0.5$ ok

$A_{s,Dist} = 0.195 \times 3048.7 = 596.5\ mm^2/m$

$S = 201 \times 10^3 / 596.5 = 337\ mm$

Say 300mm

- Shrinkag & Temp. steel

$\phi_b = 12\ mm \longrightarrow A_s = 113\ mm$

$A_{s,S+T} = 750 \times 450 \times 10^3 / (2 \times 1450 \times 420) = 277.1\ mm^2/m$

$233 < 277.1 < 1270\ mm^2/m$ ok

$S = 113 \times 10^3 / 277.1 = 407.8\ mm$

Say 400mm