

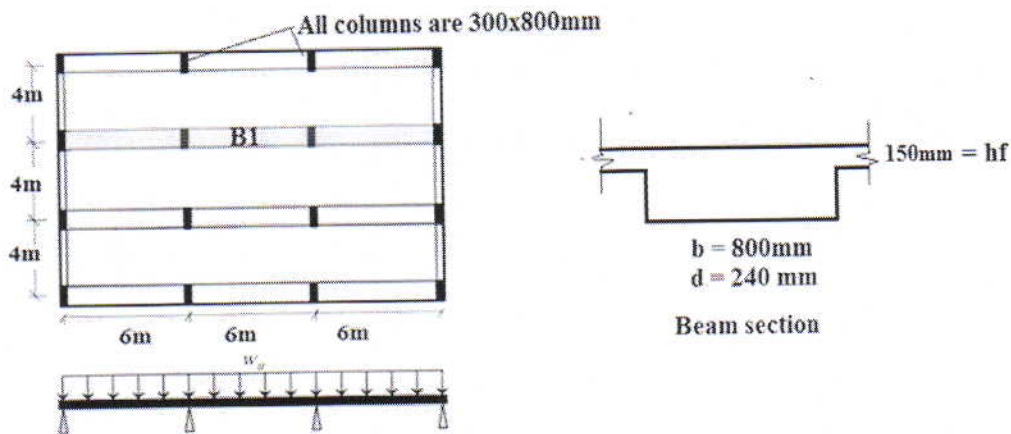


Subject : *Concrete Structures*
Division: *Building and Project Management Dept.*
Examiner : *Asst. Prof. Dr. Iqbal N. Gorgis*

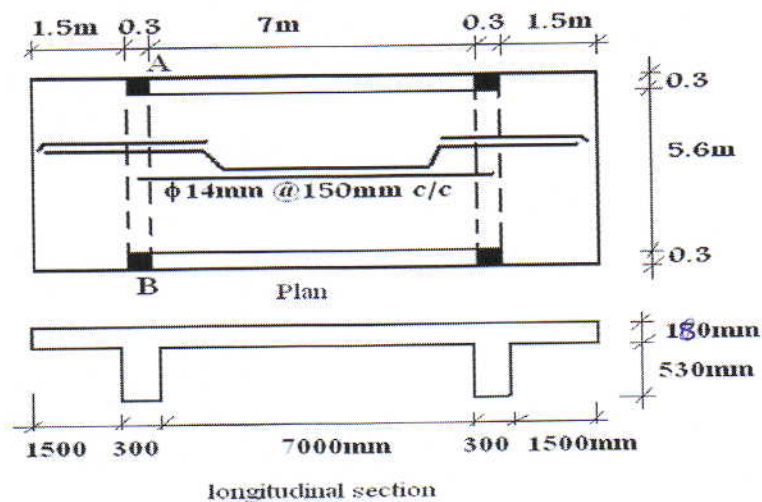
Stage : 4th
Time : 3 hours
Date : 5 / 6 / 2016

Solve only **three** questions & Use $f'c = 25 \text{ MPa}$, $fy = 420 \text{ MPa}$.

Q-1: The rectangular beam B1 shown in the figure has $b = 800\text{mm}$ and $h = 300\text{mm}$ supports a 150mm slab. The factored distributed load (including slab weight) over the slab is $W_u = 14 \text{ kN/m}^2$. Find area of steel required for the critical section of beam B1 using bars with 20mm diameter, then find spacing required for 10mm diameter stirrups at critical section only.



Q.2- A) A reinforced concrete slab with 180mm thickness supports service dead load of 3kN/m^2 and service live load of 5 kN/m^2 . The reinforcement **at supports** and **at mid span** are $\phi 14\text{mm}$ at $150\text{mm } c/c$ as shown in the figure below. Check the adequacy of steel area?

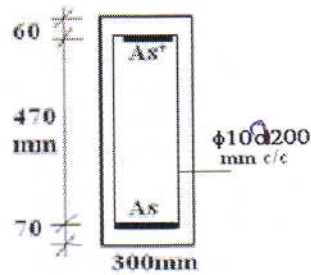


Make use of these:

$$\rho_b = 0.85 * \beta_1 * \frac{f'c}{fy} * \frac{0.003}{0.003 + \epsilon_t} \quad \text{Try } \epsilon_t = 0.005 \text{ for } \phi = 0.9 \quad c = \frac{a}{\beta_1} \quad \text{and} \quad \epsilon_t = \frac{0.003(d-c)}{c} \geq 0.005$$

$$\phi = 0.48 + 83 * \epsilon_t \text{ for } \epsilon_t < 0.005$$

B) Determine allowable and maximum **pure torque** that the beam shown below could withstand using bars with 10mm diameter, (no need for torsion design).



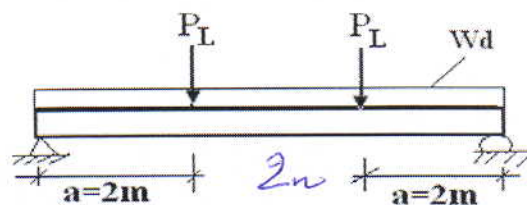
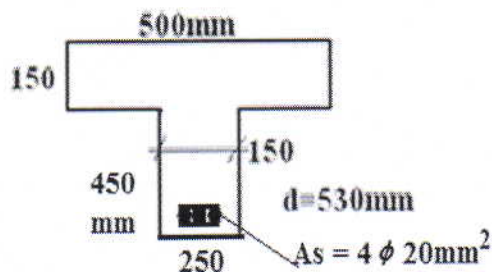
circula

Q.3: A) Design a short, spirally reinforced column to support a service dead load of 800 kN and a service live load of 400 kN. (Try $\rho_g = 1\%$). Use longitudinal bars of 16mm diameter.

- B) A brick wall with 240 mm thickness supports a dead load of 28 kN/m and live load of 40 kN/m. Design a concrete wall footing to withstand the loads so that:
1. The allowable soil capacity at depth of 0.75 m was 100 kN/m².
 2. Density of soil is 16 kN/m³ and concrete is 24 kN/m³.
 3. Try using total thickness of footing 0.20m.
 4. Use bar with diameter of 10mm.

Q.4: A simply supported beam with 6m length, support 20kN/m service dead load including its own weight and two concentrated service live load each one 40kN. Check ($A_s = 4\phi 20\text{mm}$ and $n = 9$):

- 1- The deflection if the beam is part of floor attached to nonstructural element not likely to be damaged by large deflection, and if the 30% of live load is to sustained for 24 months. ($\sum \Delta_{sus} + \Delta_{im_{L.L.}} \leq \frac{L}{240}$)
- 2- The crack width if the beam is interior one.



$$\Delta_{CL,d} = \frac{5w_d L^4}{384EI} \quad \Delta_{CL,L} = \frac{P a}{24EI} (3L^2 - 4a^2)$$

Building and Project management Dept.

Concrete Structures : 4th Stage

5/6/2016

Use $f'_c = 25 \text{ MPa}$ $f_y = 420 \text{ MPa}$.

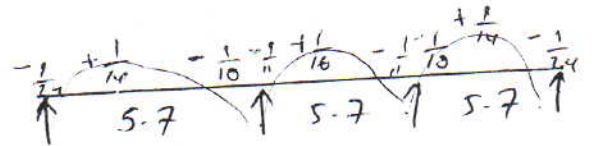
Q.1

$W_u = 1.2 (24 \times 0.8 \times 0.15) = 3.456 \text{ kN/m}$ beam weight

Load from slabs = $(14 \times 11.5 \times \frac{4}{2} + 12 \times \frac{4}{2}) = 60.2 \text{ kN/m}$

$$\Sigma = 63.656 \text{ kN/m}$$

at critical section:



$$M = \frac{63.656 (5.7)^2}{10}$$

= 206.818 kN.m (-ve moment) rectangular section

$$R_u = \frac{206.818 \times 10^6}{0.9 \times 800 (240)^2} = 4.987$$

$$T_y \phi = 0.9 //$$

$$M = \frac{420}{0.85 + 25} = 19.764$$

$$\beta = \frac{1}{19.764} \left[1 - \sqrt{1 - \frac{2 \times 4.987 \times 19.764}{420}} \right] = 0.01373$$

$$P_{max} = 0.85 \beta \frac{f'_c}{f_y} \frac{0.003}{0.003 + \epsilon_t} = 0.85 \frac{25}{420} \left(\frac{0.003}{0.008} \right) = 0.0161$$

$$P_{min} = \frac{1.4}{420} \geq \frac{\sqrt{25}}{4 \times 420} \Rightarrow \boxed{0.0033} \geq 0.00297$$

$\therefore P_{max} > P_{req} > P_{min}$ o.k. under reinforced beam.

Let $\phi = 20 \text{ mm}$ $A_s \text{ bar} = 314 \text{ mm}^2$

$$\text{no. of bars} = \frac{0.01373 \times 800 \times 240}{314} = \frac{2630.4}{314} = 8.3$$

$$9 \phi 20 \text{ mm} \Rightarrow A_s = 2826 \text{ mm}^2$$

$$a = \frac{2826 \times 420}{0.85 \times 25 \times 800} = 69.818 \text{ mm} \Rightarrow c = \frac{a}{\beta} = 82.14 \text{ mm}$$

$$C_t = \frac{d-c}{c} \times 0.003 = \frac{240 - 82.14}{82.14} \times 0.003 = 0.00576 > 0.005$$

$\therefore \phi = 0.9$ ok tension case

For shear spacing:

$$R_u = V_u = 1.15 \times 63.656 \times 5.7/2 = 208.63 \text{ kN}$$

$$V_{ud} = 208.63 - 63.656(0.24) = 193.355 \text{ kN}$$

$$\phi V_c = 0.75 \frac{\sqrt{25}}{6} \times 800 \times 240/1000 = 120 \text{ kN}$$

$$\phi V_s = 193.355 - 120 = 73.355 \text{ kN} < 4\phi V_c \text{ (المعتمد في التصميم)}$$

$$S_{max} \leq \frac{d}{2} = \frac{240}{2} = 120 \text{ mm (govern)}$$

$$\leq 600 \text{ mm}$$

$$\leq \frac{3A_z f_y}{b_u} = \frac{3(157)420}{800} = 247.175 \text{ mm}$$

$$\leq \frac{16(157)420}{\sqrt{25}} = 211.008 \text{ mm}$$

use $\phi 10 @ 120 \text{ mm c/c}$

Q.2(A)

$$W_u = 7.2(3 + 24 \times 0.18) + 1.6 \times 5 = 8.784 + 8 = 16.784 \frac{\text{kN}\cdot\text{m}}{\text{m}}$$

Slab is Case 3 $m = \frac{5.6}{7} = 0.8$

$$d_{av} = 180 - 20 - 14 = 146 \text{ mm}$$

At support $M =$
 from cantilever $= \frac{wL^2}{2} = \frac{16.784(1.5)^2}{2} = 18.882 \frac{\text{kN}\cdot\text{m}}{\text{m}}$

$M^-_{\text{slab}} = 0.061 \times 16.784 \times (7)^2 = \underline{50.167} \frac{\text{kN}\cdot\text{m}}{\text{m}}$
 table (1)

At mid span: $M^+ = (0.02 \times 8.784 + 0.022 \times 8)(7)^2$
 $= 17.232 \frac{\text{kN}\cdot\text{m}}{\text{m}}$

M_u	R_u	F	A_s	Spacing	Notes
50.167	2.615	0.00667	973.82	$\phi 14 @ 168 \times 8$	$A_{smin} = 0.0018 \times 1000 \times 180$ $= 324 \text{ mm}^2/\text{m}$ $Spac = \frac{324 \times 1000}{151.94}$ $\phi 14 \rightarrow 324 \leq 5h$
7.232	0.898	0.00218	318.78	$\phi 14 @ 475$	

$$R_u = \frac{M_u \times 10^6}{0.4 \times 1000 (146)^2} =$$

$$F = \frac{420}{0.85(25)} = 19.765$$

$$F = \frac{1}{m} \left[1 - \sqrt{1 - \frac{2R_u m}{F}} \right]$$

$$A_s = F \times 1000 \times 146$$

is $\phi 14 @ 150$
 adequate

4.2 (B)

$$T_{cr, \text{ allowable}} = 0.75 \frac{\sqrt{25}}{12} \frac{(300 \times 600)^2}{2(300+600)} \times 10^6 = 5.625 \text{ kN}\cdot\text{m}$$

$$x = 300 - 80 - 10 = 210 \text{ mm}$$

$$y = 600 - 80 - 10 = 510 \text{ mm}$$

$$A_{cp} = 107100 \text{ mm}^2$$

$$P_{cp} = 1440 \text{ mm}$$

$$T_{uel, \text{ max}} = 0.75 \frac{5}{6} \sqrt{F_c} \frac{1.7 (A_{cp})^2}{P_{cp}}$$

$$= 0.75 \times \frac{5}{6} \sqrt{25} \frac{1.7 [107100]^2}{1440 \times 10^6}$$

$$= 42.317 \text{ kN}\cdot\text{m}$$

$$Q.3(A) \quad \rho = \frac{A_s}{A_g} \Rightarrow A_s = 0.01 A_g$$

$$P_u = 1.2(800) + 1.6(400) = 1600 \text{ kN}$$

$$P_u = 0.75 * 0.75 [0.85 f'_c (A_g - A_{st}) + A_{st} f_y]$$

$$1600 * 10^3 = 0.6375 [0.85 * 25 [A_g - 0.01 A_g] + 0.01 A_g * 420]$$

$$A_g = 99447.406 \text{ mm}^2 \Rightarrow \frac{\pi D^2}{4}$$

$$D = 355.8 \text{ mm} \quad \text{use } 360 \text{ mm.} //$$

For A_s :

$$1600 * 10^3 = 0.6375 \left[21.25 \left[\frac{\pi (360)^2}{4} - A_{st} \right] + A_{st} (420) \right]$$

$$2509803.922 = 2162986.54 - 21.25 A_{st} + 420 A_{st}$$

$$346817.38 = 398.75 A_{st}$$

$$\therefore A_{st} = 869.76 \text{ mm}^2$$

$$\phi 16 \text{ } A_s = 201 \text{ mm}^2 \quad \text{no. of bars} = 43$$

\therefore use min of 6 ϕ 16 mm as per ACI - Code 318-14 //

$$\rho_{sp} = 0.45 \left(1 - \frac{D_g}{D_{cor}} \right)^2 \frac{f'_c}{f_y}$$

$$D_{cor} = 360 - 80 = 280 \text{ mm}$$

$$= 0.45 \left(1 - \frac{360}{280} \right)^2 \frac{25}{420} = 0.0175 //$$

$$\text{Spacing } \phi 10 \text{ mm spiral} = \frac{4(78.5)(280 - 10)}{0.0175 * (280)^2} = 61.79$$

use 60 mm $> 25 \text{ mm}$
 $< 75 \text{ mm}$

\therefore spiral $\phi 10$ @ 60 mm c/c (pitch) //