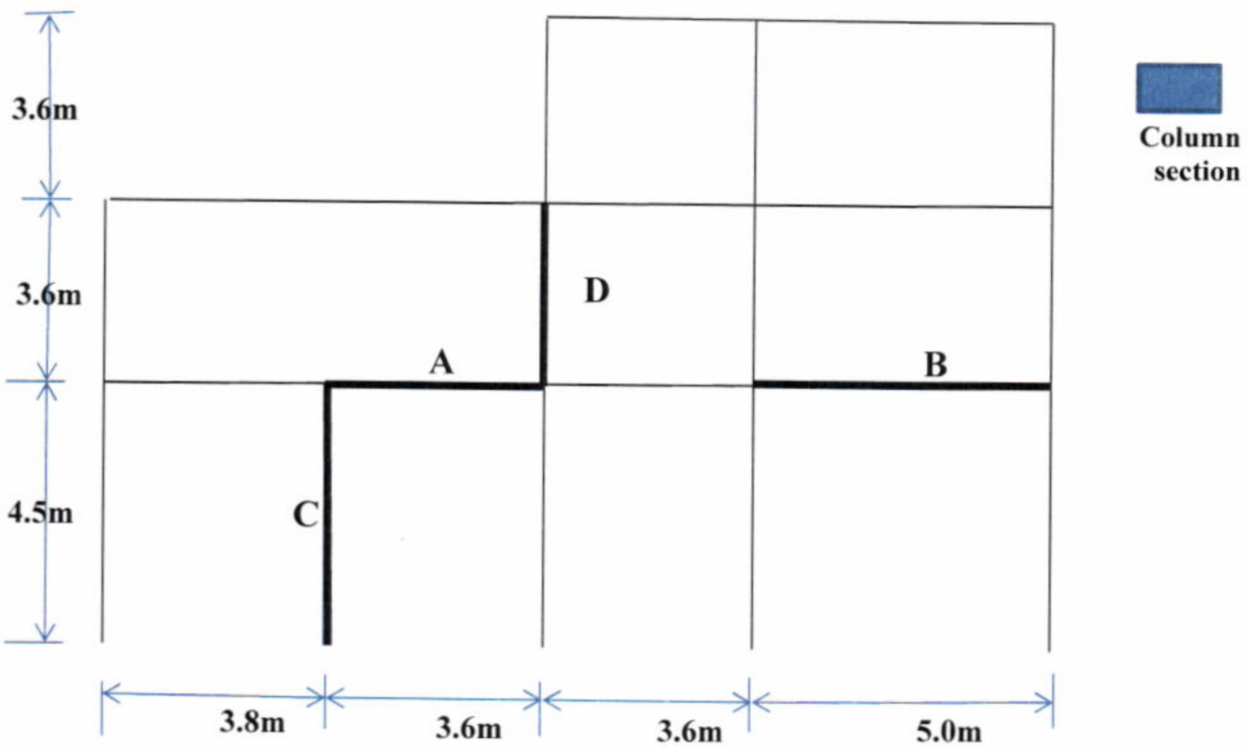
University Of Technology
Building and Construction Eng. Dept.
Final Exam –2013/2014

Subject : Structural Design | Class: Fourth
Branch : Structural | Time : 3 Hours
Examiners :Dr.Faidhi AlKhazraji | Date:9th Jun.2014

Open Book Exam -------- Answer Four Question Including Q2 & Q4

Use: $fc' = 32Mpa$, $f_y = 420Mpa$

Q1) By using sub frame analysis method and alternate pattern loading find the maximum moment end reaction for beams A & B in the precast concrete frame shown in figure. Moreover find the maximum end moments for the columns C & D. Assume column C having pinned support and the beam column connections are pinned. Beams sections are 300x500mm and columns are rectangular 200x400mm. The distance from the edge of the column to the center of beam end reaction is 110mm. Applied: D.L.=44kN/m and L.L.=37kN/m. **20%**

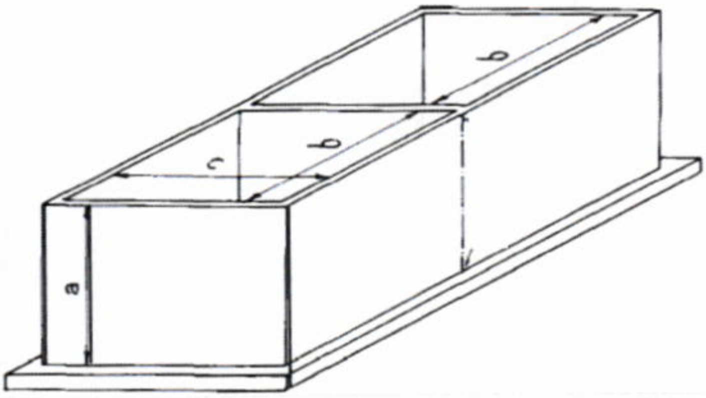


Q2) By using the LRFD method find if it is adequate to use rebar (Ø16@175mm c/c) for the longitudinal main reinforcement parallel to the traffic direction for the 250mm thick deck slab. If not redesign it. The deck slab having span length 5.5m and width 7.5m and supported on two 300x600mm concrete beams. Assume the wearing surface is made of 7cm thick asphalt of $23kn/m^3$ density and the live load according to AASHTO is HS15. Use γconcrete=$24kN/m^3$.

25%

Q3) A column Corbel of overall depth h=600mm, width b=400mm, effective depth d=530mm and shear span a_V=120mm. Considered to carry factored shear force Vu=540kN and factored horizontal tensile force Nu=200kN. Assuming the concrete surface of the Corbel is intentionally roughened according to ACI-11.6.9. Required to check the code limitations of the Corbel and design the steel area according to ACI-318M.08 with detailed drawing. Use Rebar: Ø20mm for reinforcement and Ø10mm for stirrups. **20%**

Q4)



A rectangular concrete water Tank of two cells having the dimensions a=5m, b=10m and c=5m with wall thickness t=320mm. The Tank has no cover at the top and hinged support at the base. Required:

1- Flexural reinforcement for the absolute maximum horizontal and vertical moments (for both faces) for the long outer wall. Draw section in the wall showing the reinforcement details. (Hint: write the coefficient moment table)

2- Design reinforcement following the BS8007, assuming the maximum allowable crack width is 0.2mm. Use, T_1=35°C, T_2=60°C, α=12x10^{-6}m/m/°C, Rebar Ø20mm (A_b=314mm^2) and Cover=50mm. **35%**

Q5) Circular water Tank of dimensions D=20m, H=6m and wall thickness t=0.36m. The Tank has no cover and hinged support at the base. Required:

1- Design the horizontal tension reinforcement using rebar Ø16mm (A_b=201mm^2).
2- Check for crack stress.
3- Check for shear force.
Use: E_s=200000Mpa, E_c=26587Mpa and c=0.0003

20%

Q1

$W_{u\,max.} = 1.2\,DL + 1.6\,LL$
$= 1.2 \times 44 + 1.6 \times 37 = 112\ kN/m$

$W_{u\,min.} = 1.2\,DL = 1.2 \times 44 = 52.8\ kN/m$

$e = \frac{h}{2} + 110mm = 200 + 110 = 310mm$

Beam A: $M_{max} = 112 \times \frac{[3.6 - (2 \times 0.31)]^2}{8} = 124.3\ kN.m$

Beam end reactions $= 112 \times \frac{3.6}{2} = 201.6\ kN$

Beam B: $M_{max} = 112 \times \frac{[5 - (2 \times 0.31)]^2}{8} = 268.6\ kN.m$

Beam end reactions $= 112 \times \frac{5}{2} = 280\ kN$

Column C: $R_1 = \frac{112 \times 3.8}{2} = 212.8\ kN$

$R_2 = \frac{52.8 \times 3.6}{2} = 95\ kN$

$M_{col.\,upper} = (212.8 - 95) \times 0.31 \times \frac{0.75 \times (\frac{EI}{h})_c}{0.75 \times (\frac{EI}{h})_c}$

$= 36.51\ kN.m$

$M_{col.\,lower} =$ Zero (Pin)

Column D: $R_1 = \frac{112 \times (3.6 + 3.8)}{2} = 414.4\ kN$

$R_2 = \frac{52.8 \times 3.6}{2} = 95\ kN$

$M_{col.\,upper} = (414.4 - 95) \times 0.31 \times \frac{(\frac{EI}{h})_D}{(\frac{EI}{h})_D + (\frac{EI}{h})_i}$

$M_{col.\,upper} = (414.4 - 95) \times 0.31 \times \left(\frac{3.6}{3.6+3.6}\right)$ $\times \frac{1}{2}$

$= 49.5\ kN.m$

$M_{col\,lower}$: $R_1 = \frac{112 \times 3.6}{2} = 201.6\ kN$

$R_2 = \frac{52.8 \times 3.6}{2} = 95\ kN$

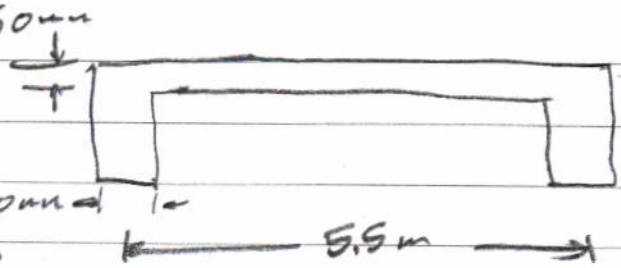
$$M_{col\,lower} = (201.6 - 95) \times 0.31 \times \frac{\left(\frac{EI}{h}\right)_D}{\left(\frac{EI}{h}\right)_D + \left(\frac{EI}{h}\right)_i}$$

$$= 33.034 \times \frac{\frac{1}{3.6}}{\frac{1}{3.6} + \frac{1}{4.5}}$$

$$= 33.034 \times \frac{0.278}{0.278 + 0.222}$$

$$= 18.4\ kN.m$$

Q2 $l_{eff} = 5.5m$



$l_{clear} = 5.5 - 0.3 = 5.2m$

or $l_{eff} = 5.2 + 0.25 = 5.45m$

∴ use $l_{eff} = 5.45m$

D.L: self wt. $= 0.25 \times 24 = 6\ kN/m^2$

$$M_{DC} = \frac{6 \times (5.45)^2}{8} = 22.3\ kN.m/m$$

Wearing asphalt $= 0.07 \times 23 = 1.61\ kN/m^2$

$$M_{DW} = \frac{1.61 \times (5.45)^2}{8} = 6\ kN.m/m$$

L.L: load is HS15

The load on each rear wheel is $\frac{24000}{2}$ lb

∴ L.L (P15) = 12000 lb

$$E = 4 + 0.06S = 4 + 0.06 \times \frac{5.45}{0.3048} = 5.073\ ft < 7\ ft \therefore ok$$

∴ use $E = 5.073\ ft$

The load on a unit width of slab $= \frac{12000}{5.073} = 2365.464\ lb/ft$

$$M_L = \frac{P.S}{4} = \frac{2365.464 \times \frac{5.45}{0.3048}}{4} = 10574\ lb.ft/ft$$

$$M_L = 10574 \times \frac{4.448}{1000} = 47\ kN.m/m$$

or $M_L = 900S \times \frac{3}{4} = 900 \times \frac{5.45}{0.3048} \times \frac{3}{4} = 12069.4\ lb.ft$

∴ use $M_L = 12069.4 \times \frac{4.448}{1000} = 53.7\ kN.m/m$

$$I = \frac{50}{S + 125} = \frac{50}{\frac{5.45}{0.3048} + 125} = 0.35 > 0.3$$

Q2/p.1