University Of Technology
Building and Construction Eng. Dept.
Final Exam – First Attempt – 2010/2011

Branch :structure | Class: 4th
subject : prestreesed concrete | Time : 3 Hours
Examiner : Dr. Eyad | Date : 9 / 6 / 2011

Note: Answer FOUR questions only.

Q1: For the simply supported beam shown in fig.(1) , determine the required area of prestressed steel (A_{ps}) to cause zero tensile stresses in concrete at initial and service stages .Assume total losses (20%), initial prestress stress (f_{si} = 1000 N/mm^2) and γ_c =24 kN/m^3.

Q2: Determine the elastic shortening, creep, and shrinkage losses for the pretensioned , normal weight concrete beam shown in fig.(2). Data required is f'_{ci} = 25 N/mm^2 , f'_c= 35 N/mm^2, initial prestress stress (f_{si} = 1250 N/mm^2), area of prestressed steel (A_{ps} = 790 mm^2) , supper imposed dead load (w_d =2.5 kN/m), kcr =2, relative humidity (RH= 75%) and γ_c =25 kN/m^3.

Q3: For the T- section shown in fig.(3) , determine the ratio of cracking moment to ultimate moment if, area of prestressed steel (A_{ps} = 1000 mm^2) , initial prestress stress (f_{si} = 1000 N/mm^2), ultimate strength of prestress steel (f'_s=1600 N/mm^2) , f'_c= 30 N/mm^2 , modulus of rupture (f_r =4 N/mm^2) and total losses = 20%.

Q4: A simply supported prestressed beam of a rectangular section (b*h), has the following data.
b=300mm, (h=?), Ms=520 kN.m , Mg= 180 kN.m ,allowable stresses are, f_{ci} = 16 N/mm^2 , f_{ti} =1.5 N/mm^2, f_{cs}=16 N/mm^2 , and f_{ts}= 2 N/mm^2. total losses = 20%.
Variable eccentricity, f'_s =1860 N/mm^2. Find the depth of the section (h) and then make final design using 12.7 mm (seven wire strands) . Area of each strand is 92.9 mm^2.

Q5: The simply supported beam shown in fig. (5) ,has the same section of (Q3) . Design for shear at distance (d) from the face of support using the following data
Supper imposed concentrated live load ,P_{sL}=100 kN.
Supper imposed dead load = 0.
f'_c= 30 N/mm^2, fy =400 N/mm^2.
straight tendon, initial prestress force (Fi =1200 kN) , span (L =8m), and γ_c =25 kN/m^3. Use Φ 8 mm stirrups.

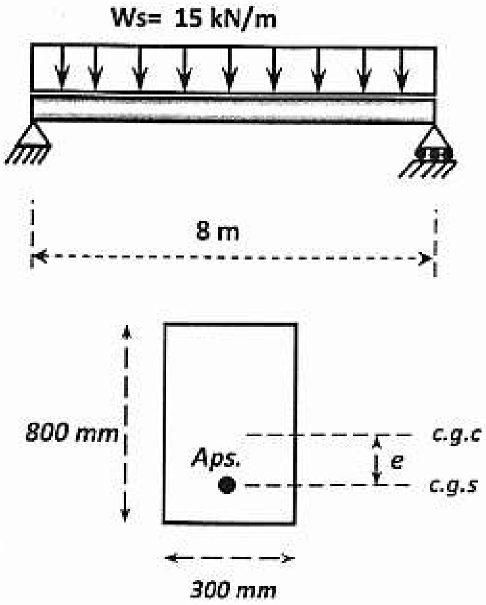

Fig. (1)

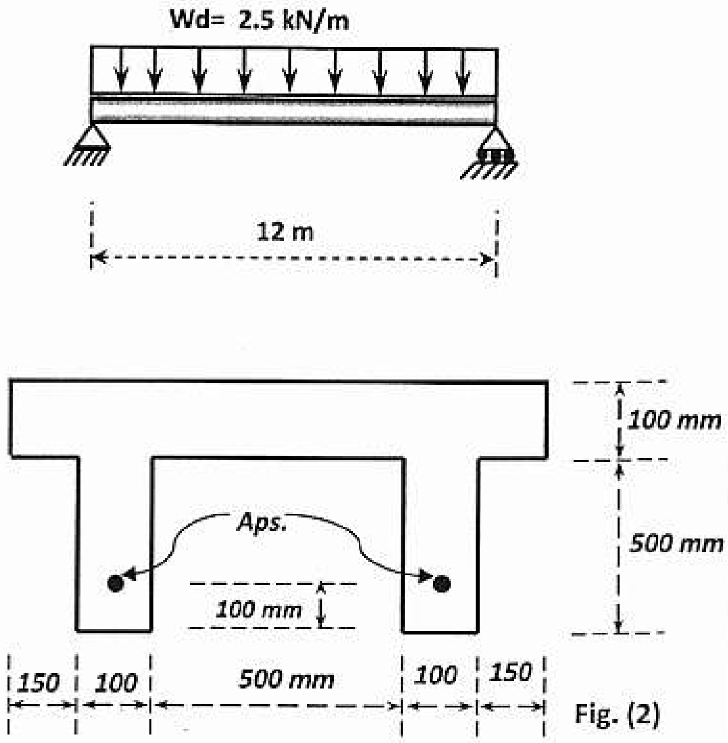

Fig. (2)

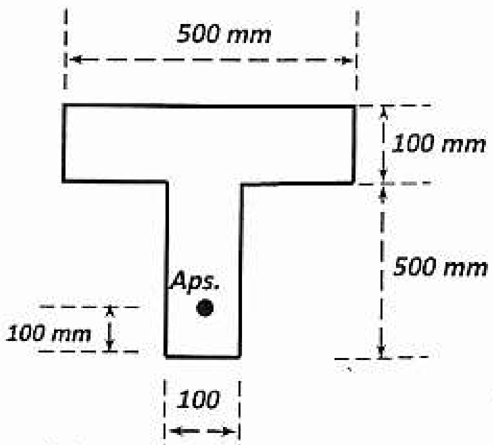

Fig. (3)

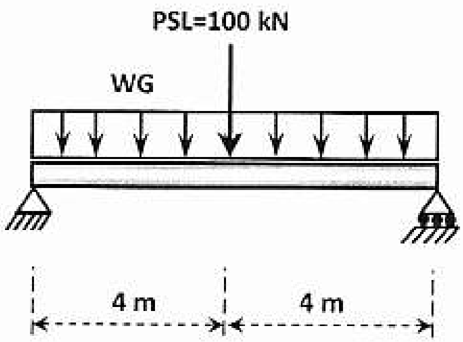

Fig. (5)

Notes

1-General

$$\bar{Y} = \frac{\sum A * Y}{\sum A}, \quad I = \sum (Ic + A * d^2)$$

2-Stresses

Initial stage

$Fi = A_{ps} * f_{si}$

$f_{top} = -\frac{Fi}{A} + \frac{Fi * e * Yt}{I} - \frac{Mg * Yt}{I}$, $\quad f_{bot} = -\frac{Fi}{A} - \frac{Fi * e * Yb}{I} + \frac{Mg * Yb}{I}$

Service stage

$Fse = R * Fi$

$f_{top} = -\frac{Fse}{A} + \frac{Fse * e * Yt}{I} - \frac{Mt * Yt}{I}$, $\quad f_{bot} = -\frac{Fse}{A} - \frac{Fse * e * Yb}{I} + \frac{Mt * Yb}{I}$

3-Losses

$ES = K_{es} * n_i * (\alpha \frac{Fi}{A} + \alpha \frac{Fi * e^2}{I} - \frac{Mg * e}{I})$, $\quad n_i = \frac{Es}{Eci}$, $\quad Es = 200000\ N/mm^2$

$Eci = 4730 * \sqrt{fc'_i}$

$CR = K_{cr} * n * [f_{cir} - f_{cds}]$, $\quad n = \frac{Es}{Ec}$, $\quad Ec = 4730 * \sqrt{fc'}$

$f_{cir} = \alpha \frac{Fi}{A} + \alpha \frac{Fi * e^2}{I} - \frac{Mg * e}{I}$, $\quad f_{cds} = \frac{Md * e}{I}$

$SH = 8.2 * 10^{-6} * K_{sh} * Es * (1 - 0.0024 * V/S) * (100 - RH)$

$ANC = \frac{\Delta * Es}{L}$

$Fx = Fs * e^{-(k * lx + \mu * \alpha)}$ ________________ **exact**

$Fx = Fs/(1 + k * lx + \mu * \alpha)$ _________ **approximate**

$\alpha = 2 * \sin^{-1}(\frac{lx/2}{R})$

4-Cracking and Ultimate moment.

$r = \sqrt{\frac{I}{A}}$, $\quad k_t = \frac{r^2}{Yb}$, $\quad k_b = \frac{r^2}{Yt}$

$M_1 = Fse * (e + k_t)$, $\quad M_2 = \frac{fr * I}{Yb}$, $\quad M_{cr} = Fse * (e + \frac{r^2}{Yb}) + \frac{fr * I}{Yb}$

$kd = \frac{Aps * fs'}{0.85 * fc' * b}$, $\quad A_{comp} = \frac{T}{0.85 * fc'}$, $\quad T = Aps * fs'$, $\quad Mu = T * a$

5- Preliminary and final elastic flexural design.

Fse= $\frac{Mt}{0.65*h}$, Fse= $\frac{Ms}{0.5*h}$, $Aps=\frac{Fse}{fse}$, Ac= $\frac{Fse}{0.5*fc}$

$S_t=\frac{I}{Yt}$, $S_b=\frac{I}{Yb}$, $S_t=\frac{(1-R)*Mg+Ms}{R*fti-fcs}$, $S_b=\frac{(1-R)*Mg+Ms}{fts-R*fci}$

.$f_{cent}=fti-\frac{Yt}{h}*(fti-fci)$, Fi=A * $|f_{cent}|$, fsi=0.7* fs'

.e= $e_m=(fti-fcent)*\frac{St}{Fi}+\frac{Mg}{Fi}$; for rectangular section, $S_b=S_t=\frac{bh^2}{6}$

6-Shear

$V_{ci}=[\frac{\sqrt{fc'}}{20}*bw*d+V_d+\frac{Vi*Mcr}{M\max}]\geq\frac{\sqrt{fc'}}{7}*bw*d$

$V_{ci}=[\frac{\sqrt{fc'}}{20}*bw*d+\frac{Vu*Mct}{Mu}]\geq\frac{\sqrt{fc'}}{7}*bw*d$

$V_{cw}=0.3*(\sqrt{fc'}+fpc)*bw*d+Vp$

.d $\geq$ 0.8* h

$Mcr=\frac{I}{Yten}*(0.5*\sqrt{fc'}+fpe-fd)$

$Mct=\frac{I}{Yten}*(0.5*\sqrt{fc'}+fpc)$

$fpe=\frac{Fi}{A}+\frac{Fi*e*Yten}{I}$; $f_d=\frac{Mg.Yten}{I}$

$fpc=\frac{Fi}{A}$

$\frac{Vu}{\phi}=Vc+Vs$

S= $\frac{Av*fy*d}{Vs}$, S= $\frac{3*Av*fy}{bw}$

If $Vs\leq\frac{1}{3}\sqrt{fc'}*bw*d$ THEN S_{max}= min. { 0.75*h , 600 mm}

If $Vs>\frac{1}{3}\sqrt{fc'}*bw*d$ THEN S_{max}=min {0.375*h , 300 mm }