

## CE 435/535 – Spring 2008

Find a new partner and solve Problems 5-8 together. All of these four problems refer to the beam data provided below.

AASHTO Type III Girder

$$f'_{ci} = 5000 \text{ psi}$$

$$f'_c = 6000 \text{ psi}$$

Span = 75 feet (simply supported)

$$f_{si} = 189 \text{ ksi}$$

$$f_{se} = 140 \text{ ksi}$$

Prestressing Tendons:

30 strands 270k ½-in. diameter

c.g.s. from bottom face of beam:

4 in. over middle 1/3

11.2 in. at ends

Mild steel: 2#9 Gr. 60 at 3 in. from bottom

### Homework #5 (Due Tuesday February 19th)

Calculate the nominal bending capacity of this beam,  $M_n$ , using:

- the stress-strain curve handed out in class (see your purchased notes); and
- the ACI recommendations assuming that no stress-strain curve is available.

Perform the necessary checks on the reinforcement ratios for the beam.

*Hint: Assume that the tapered top flange can be replaced with a flange of equivalent area having a constant width equal to the width of the flange at the top of the cross section.*

### Homework #6 (Due Thursday February 21st)

Prepare a spreadsheet to calculate the stresses in an AASHTO Girder. On separate sheet(s) show any diagrams and equations and their locations in the spreadsheet so you can easily follow and trace the calculations. The spreadsheet should work for both linear and parabolic concrete stress-strain behavior.

Assume that the beam is subjected to a service load moment of 25000 kip-in (which would cause cracking of the beam). You are asked to calculate the stresses in the concrete and steel by two methods:

- strain compatibility assuming a parabolic stress-strain behavior for concrete
- strain compatibility assuming a linear stress-strain behavior for concrete
- decompression moment
- compare the results of part b) and c)

Use  $E_s = 28,000 \text{ ksi}$ ; assume  $f_r = 7.5 \sqrt{f'_c}$

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Homework #7 (Due Tuesday February 25th )

Draw the moment-curvature diagram for the beam. Your diagram should include the following points:

- a) Zero applied moment
- b) Cracking Moment
- c)  $\epsilon_c = 0.001$
- d)  $\epsilon_c = 0.0015$
- e)  $\epsilon_c = 0.0020$
- f)  $\epsilon_c = 0.0025$
- g)  $\epsilon_c = 0.003$

Use the stress-strain diagram that was distributed in class for the prestressing strand. Assume a bilinear stress-strain relationship for the mild steel, with no strain hardening. For parts, c) through g), use the spreadsheet that you have prepared with the parabolic stress-strain behavior for concrete. Also note that as the strain in concrete and beam curvature increases, the mild steel may yield and the stress in the prestressing steel may enter the non-linear portion.

- h) Compare the result of part g) above with HW 5a) where the concrete stress-strain behavior was modeled with Whitney's Stress Block.

Homework #8 (Due Thursday February 27th )

Assume that the moment-curvature values given below are valid for a beam cross section. The beam weighs 600 plf and is simple supported on a 75-ft span and is subjected to a uniform load,  $w$ . Draw a graph of the load,  $w$ , vs. the midspan deflection of the beam. Your graph should include the following points:

- a) no external loads (i.e. only the self weight of the beam is present)
- b) when the applied moment is 20,000 k-in
- c) when the applied moment is 28,000 k-in, and
- d) when the applied moment is 38,000 k-in.

*(Note: For points b, c, and d, the given moments include the moment caused by the self weight of the beam too; the cracking moment for the beam is 21,000 k-in. Also, for the first couple points, you may use the exact area and centroid location under the curvature diagram which is parabolic.)*

Applied External Moment (kip-in.)	Curvature (in./in.*10 <sup>-6</sup> )
0	-2
21000	+2
40000	+14