UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION, APRIL 2001

FOURTH YEAR, CIVIL ENGINEERING

CIV 417S - PRESTRESSED CONCRETE

Examiner: F.J. Vecchio

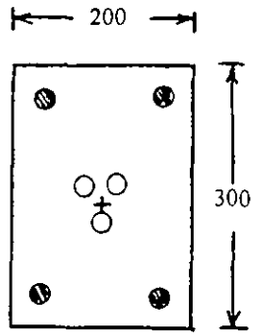
Name: _____

Student No.: _____

Note:
1. Type X examination.
2. Answer all questions.
3. All questions are of equal value.
4. All dimensions shown in mm.

Question	Mark
1	/10
2	/10
3	/10
4	/10
5	/10
Total	/50

1. An axial member, 4.0 m in length, has the cross section shown. The tendons are post-tensioned to 0.75 f_{pu}, and then are anchored and grouted. Assume a 6 mm slip occurs as the tendons are anchored; ignore all other losses due to creep, shrinkage and relaxation. Determine:
   i) the locked-in strain difference, $\Delta\varepsilon_p$;
   ii) the stresses in the concrete, reinforcement and prestressing after anchoring.



f'_c = 30 MPa
4 No. 20, f_y = 400 MPa
3 - 13 mm φ low relax
f_{pu} = 1860 MPa
E_p = 200,000 MPa

2. The cross section shown is subjected to the section forces

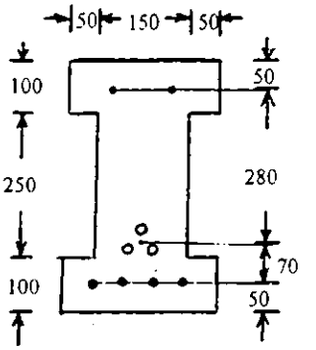
   N = -200 kN, M = 300 kN · m.

   Does the section fail? [Do not apply material resistance factors or load factors.]

   HINT: Use a partial construction of a moment-axial load interaction diagram. One point on the interaction diagram is:

   N = -130 kN, M = 280 kN · m,

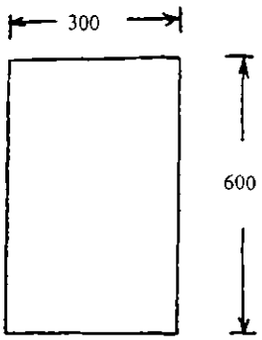
   which corresponds to the strain condition $\varepsilon_{ct} = -3.50 \times 10^{-3}$ and $\varepsilon_{cb} = 3.50 \times 10^{-3}$.



$f'_c = 30$ MPa
2 No. 10 top bars
4 No. 20 bottom bars
$f_y = 400$ MPa
3 - 13 mm φ low relax
$f_{pu} = 1860$ MPa
$\Delta\varepsilon_p = 6.0 \times 10^{-3}$

3. A floor system is to be designed using CPCI standard 2400 x 500 double-tee sections. The beams must span 12.0 m. In addition to their own weight, they are required to carry a superimposed dead load of 0.6 kN/m^2 and a live load of 2.4 kN/m^2. Assume f'_{ci} = 25 MPa and f'_c = 35 MPa.
   i) As a preliminary design, select from the CPCI Handbook the most economical section likely to be suitable.
   ii) For this section, check services stresses at midspan at final condition. Ignore creep and shrinkage effects.

4. A post-tensioned, grouted, simply-supported rectangular beam is required to span a distance of 12.0 m. In addition to its own weight, it must carry a superimposed dead load of 3.0 kN/m and a live load of 15 kN/m. The beam is to be partially prestressed; that is, tensile stresses are permitted.
   i) Assuming that 15 mmφ low relaxation strand will be used, determine the minimum number of tendons required.
   ii) For the design selected above, determine the maximum tendon eccentricity permitted at the ends (e_c).



f'_c = 35 MPa
15 mm φ low relax
f_{pu} = 1860 MPa

5. For the cross section considered in Question 4, and using the Simple Method for shear design, determine the required stirrup spacing at the critical section. Assume No. 10 stirrups will be used, and that the eccentricity of the tendons at the beam ends is zero (ie., $e_e = 0$).