NATIONAL EXAMS – May 2010

98-Civ-B2, Advanced Structural Design

3 Hours Duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is a **"CLOSED BOOK"** examination. Handbooks and textbooks are permitted. **NO notes or sheets are allowed**. Candidates may use one of two calculators, the Casio or Sharp approved models. You must indicate the type of calculator being used, i.e. write the name and model designation of your calculator on the first inside left-hand sheet of the exam workbook.

3. Any five questions constitute a complete paper. Only the first five questions as they appear in your answer will be marked.

4. All questions are of equal value.

5. **All loads shown are unfactored.**

USE THE FOLLOWING DESIGN DATA

Design in	SI
Concrete	$f'_c = 30$ MPa
Structural Steel	$f_y = 350$ MPa
Rebar	$f_y = 400$ MPa
Prestressed Concrete	f_c (at transfer) = 35 MPa $f'_c = 50$ MPa $n = 6$ $f_{ult.} = 1750$ MPa $f_y = 1450$ MPa $f_{initial} = 1200$ MPa Losses in prestress = 240 MPa

1. A simply supported bridge is to be designed in composite steel-concrete construction. The bridge has a span of 15 m, a width of 20 m and a concrete deck slab 230 mm deep. The steel beams are to be spaced at 3.0 m.

   Using unshored construction:

   (a) Design the cross-section of the bridge for a live load of 12 kPa, ignoring the self-weight of the steel beam. Assume 100% interaction between the steel beams and the concrete deck slab.

   (b) Determine the number of shear connectors required.

   [Assume the steel beams have adequate lateral bracings.]

2. Design the prestressed concrete beam, shown in Figure 1, using a rectangular cross-section and prestressing steel strands.

   Determine:

   (a) the appropriate dimensions of the cross-section allowing no tension.

   (b) the area and profile of the steel strands.

3. Use the plastic method of design to choose adequate steel sections for the rigid frame in Figure 2, which shows the members' plastic moment capacities. Also estimate the size and reinforcement required to accommodate the concrete footing at support A. Assume a value for the soil-bearing capacity of 450 kPa.

   [Assume adequate lateral support at all joints and load points. Ignore the effects of shear and axial deformations.]

4. (a) Design a welded corner connection at joint B for the rigid steel frame in Figure 2.

   (b) Carry out the necessary calculations to determine whether the sections chosen for beam-columns AB and DE are adequate.

   [Assume lateral support is provided at joints A, B, D and E.]

5. Figure 3 shows a loaded three-span continuous welded steel plate-girder.

   Determine:

   (a) An adequate cross-section to satisfy the requirements for flexure and shear.

   (a) Check the flexure and shear interaction.

   [Assume adequate size for the load base plates.]

6. The rigid reinforced-concrete frame in Figure 4 is to be designed using the Limit States Design Method.

   Using a suitable rectangular cross-section, determine the amount and layout of reinforcing steel to satisfy flexure and shear for member AC. Assume the same stiffness for members AC and CE.

   [Assume lateral support is provided at all joints and load points.]

7. For the rigid reinforced concrete frame in Figure 4:

   (a) Design the beam column CDE.

   (b) Calculate the long-term deflection at D.

   [Assume adequate lateral support at all joints and load points.]

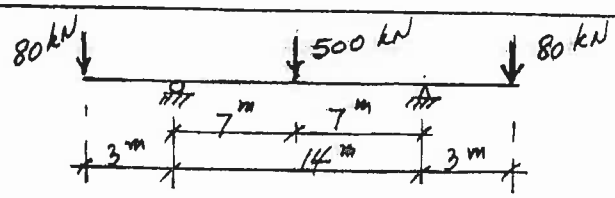

FIGURE 1

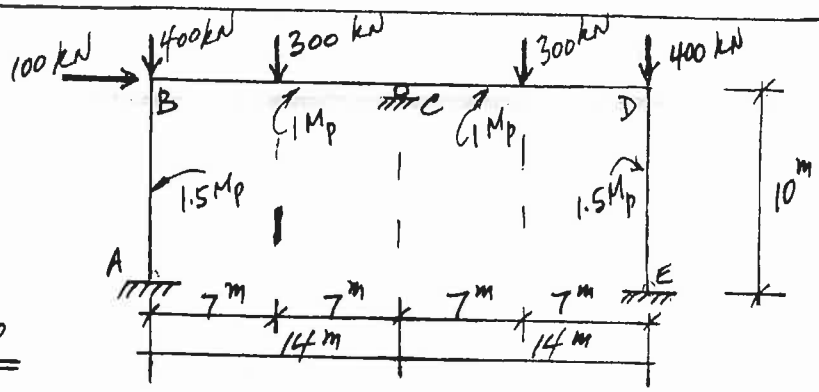

FIGURE 2

NOTE:
Lateral Support Provided @ 2 m Intervals.

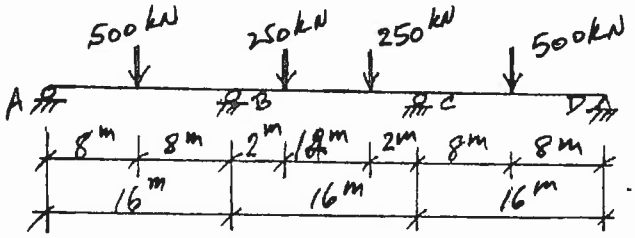

FIGURE 3

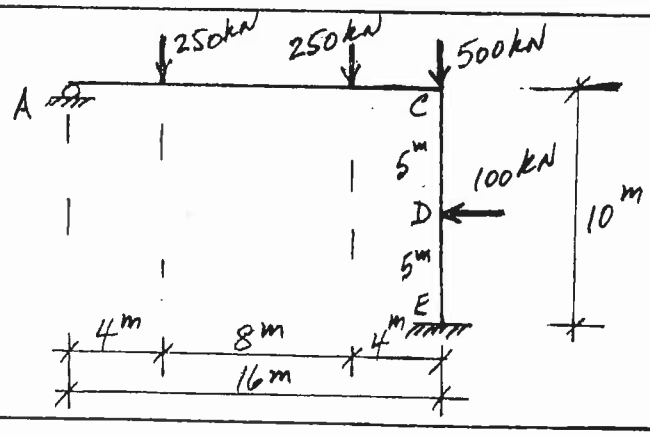

FIGURE 4