NATIONAL EXAMS – December 2009

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. The prestressed concrete girder in Figure 1 is to be post-tensioned.

   (a) Design a rectangular cross-section allowing no tension.
   (b) Calculate the required area of prestressing steel strands and determine their profile.

   [Moment of inertia can be based on the gross cross-section.]

2. An 18-m simply-supported pedestrian bridge, shown in Figure 2, is to be designed in composite construction (unshored). Assuming 100% interaction between the hollow steel section beams and the concrete slab.

   (a) Design the composite cross-section for flexure for a live load of 12 kPa.
   (b) Calculate the required number of shear stud connectors.

   [Assume that the steel members have adequate lateral bracings.]

3. The reinforced-concrete rigid frame in Figure 3 is to be designed for the loads shown, using the Limit States Design Method:

   (a) Design an adequate rectangular cross-section for member CDE to satisfy flexure and shear.

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

4. (a) Determine whether the rectangular cross-section chosen for member CDE in Question 3 is also adequate for member ABC acting as a beam-column.

   (b) Estimate the long-term deflection at the mid-span of member CDE in Fig. 3.

   [Assume the rigid frame in Fig. 3 is braced at joints A, B, C, D, E, F and G.]

5. The two-span continuous welded plate girder, shown in Figure 4, is to be designed using the stiffened-web approach. Design a cross-section suitable for flexure, shear, and their interaction.

   [Assume adequate size for the load base plates.]

6. (a) Use the Plastic Method of Design to select steel sections for the steel rigid frame ABCDE in Figure 5.

   (b) Design a welded connection for the rigid joint at C.

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

7. For the loaded steel rigid frame in Figure 5:

   (a) Check whether the steel section chosen for member CDE is adequate for a beam-column.

   (b) Carryout a preliminary design for a reinforced concrete footing at E. Assume a value for the soil bearing capacity of 400 kPa.

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

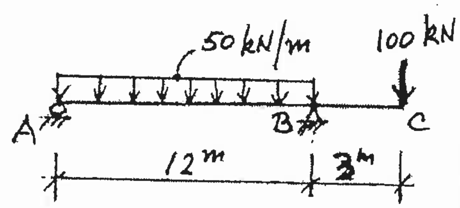

FIGURE 1

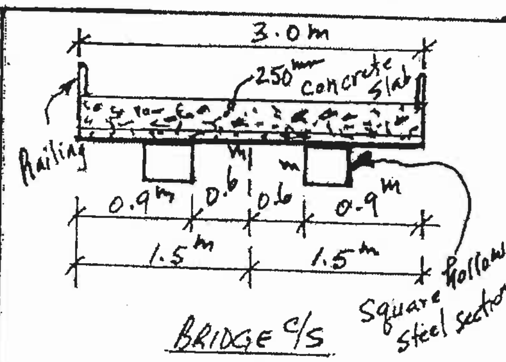

FIGURE 2

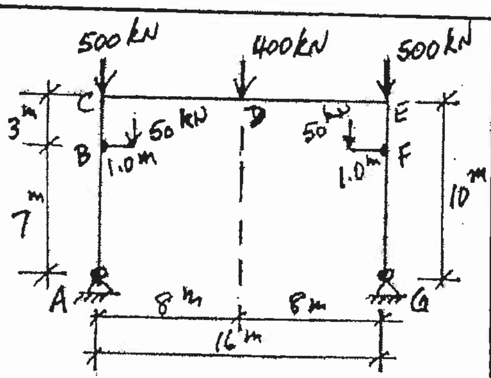

FIGURE 3

NOTE: Lateral Support Provided @3m intervals

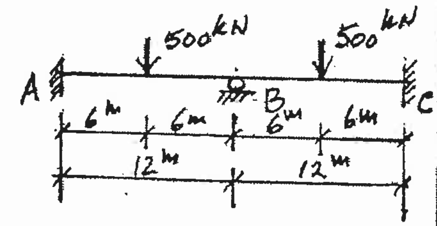

FIGURE 4

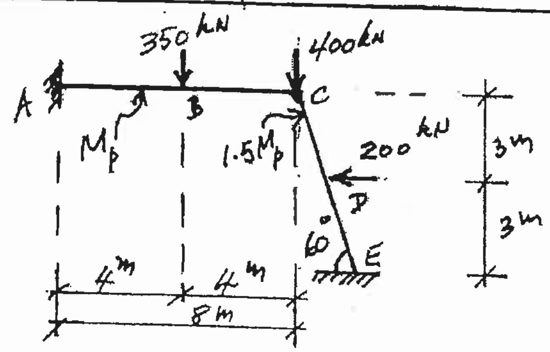

FIGURE 5