NATIONAL EXAMS- December 2011

07-Str-A5 – 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. Use the plastic method of design to choose adequate steel sections for the rigid frame in Figure 1, which shows the members' plastic moment capabilities. Also estimate the size and reinforcement required to accommodate the concrete footing at support A. Assume a value for the soil-bearing capacity of 400 kPa.

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

2. (a) Design a welded corner connection at joint C for the rigid steel frame in Figure 1.

   (b) Carry out the necessary calculations to determine whether the sections chosen for beam-columns AC and FG in Question 1 are adequate.

   [Assume lateral support is provided at joints A, C, F and G.]

3. A simply supported floor system is to be designed in composite steel-concrete construction. The floor has a span of 16 m, a width of 20 m and a concrete deck slab 150 mm deep. The steel beams are to be space at 2.5 m.

   Using unshored construction:

   (a) Design the cross-section of the floor for a live load of 7 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.]

4. (a) Design a rectangular cross-section for the prestressed concrete girder in Figure 2.

   (b) Calculate the required area of prestressing steel strands and determine their profile. The design should not allow any tension in the cross-section.

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

5. The two-span continuous welded plate girder, shown in Figure 3, 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. The continuous girder ACE in Figure 3 is to be designed in reinforced-concrete construction, using the Limit States Design Method:

   Design an adequate rectangular cross-section for member ACE to satisfy flexure and shear. Show the layout of the reinforcing along the girder.

7. Assuming that the rigid frame in Figure 1 is to be constructed in reinforced concrete, design a rectangular cross-section for beam-column ABC. Also, estimate the long-term deflection at mid-span of member ABC.

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

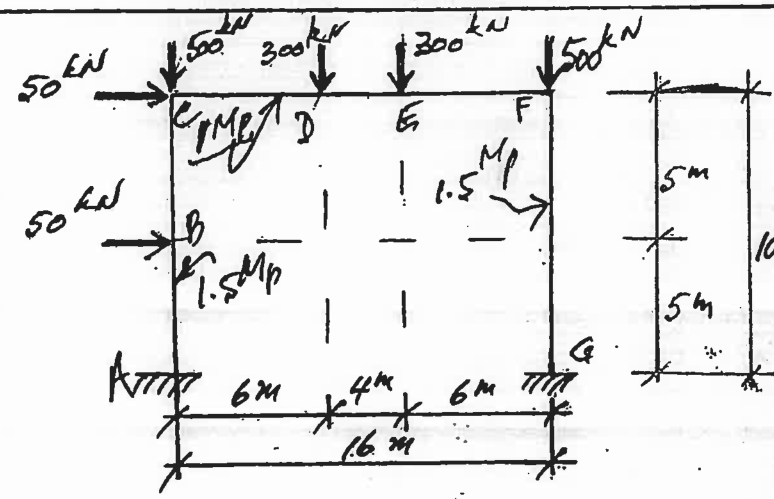

FIGURE 1

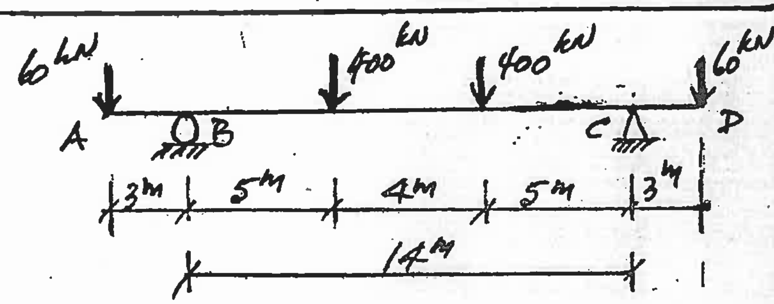

FIGURE 2

NOTE: Lateral Support Provided @ 2.5 m Intervals

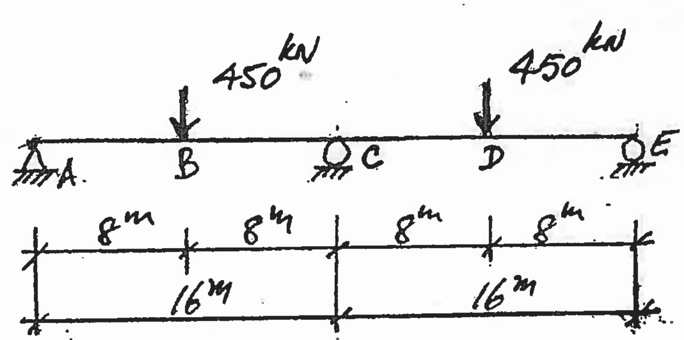

FIGURE 3