NATIONAL EXAMS – May 2013

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

Marks For

Question 1: (12 + 6 + 2)
Question 2: (12 + 8)
Question 3: (14 + 6)
Question 4: (15 + 5)
Question 5: (14 + 6)
Question 6: (14 + 6)
Question 7: (12 + 6 + 2)

1. The ends A and C of the continuous welded steel-plate girder, Figure 1 are rigidly embedded into rock. Using a stiffened web design, choose a suitable cross-section to satisfy:

   (a) Flexure,
   (b) Shear, and their interaction.

   [Assume adequate size for the load base plates.]

2. Figure 2 shows a steel rigid frame, to be designed with a constant plastic moment capacity, M_p. Using the Plastic Method of Design:

   - Select an adequate steel section for member BOC.
   - Carryout a preliminary design for the reinforced concrete footing at joint D, using a value for the soil bearing capacity of 350 kPa.

3. For the loaded steel rigid frame in Figure 2:

   (a) Design a welded corner connection at joint B.
   (b) Check whether the section chosen in Question 2 is adequate for the beam-column AB.

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

4. A heavily-loaded floor of a warehouse is to be designed in a composite steel-reinforced concrete construction. The steel beams are to be spaced 2.5 m, with a design span length of 16 m. The design live load = 18 kPa. Using unshored construction:

   (a) Design the cross-section, assuming 100% interaction between the steel beams and the concrete slab.
   (b) Calculate the number of shear connectors required.

   [Assume the steel beams have adequate bracings.]

5. Figure 2 shows a reinforced concrete frame to be designed using the Limit States Design Method. The members of the frame can be assumed to have the same stiffness. Determine a suitable rectangular cross-section for member BC, showing the amount and layout of the reinforcing steel for both flexure and shear.

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

6. (a) Check whether the rectangular cross-section chosen for member BC in Question 5 is also adequate for the beam-column CD.

   (b) Design the steel reinforcement at the rigid connection B.

   [Assume the frame in Figure 2 is braced at joints A, B, C and D.]

7. The prestressed concrete girder in Figure 3 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.]

NOTE: Lateral Support provided @ 2m intervals

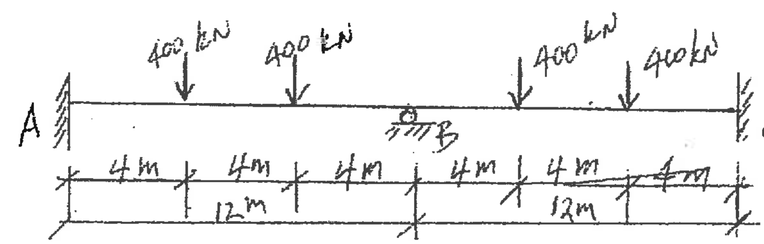

FIGURE 1

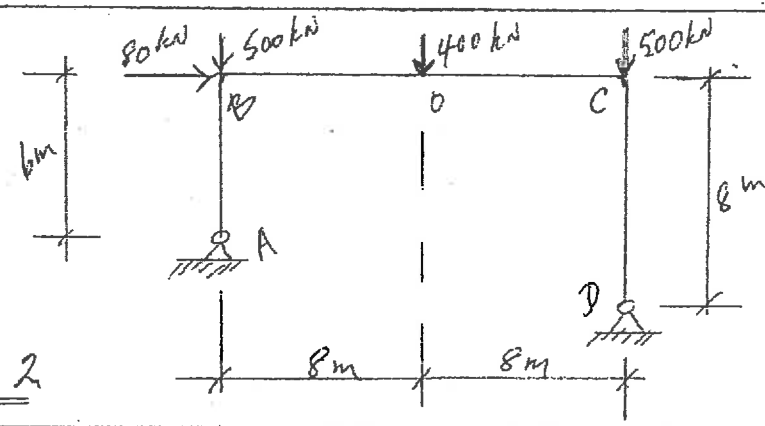

FIGURE 2

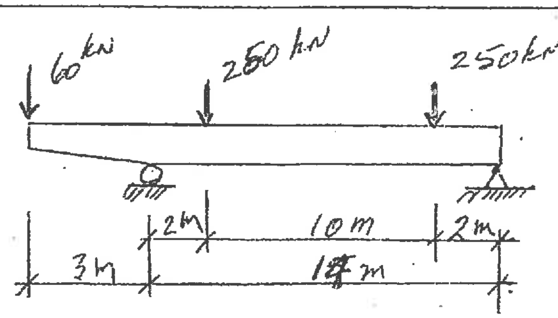

FIGURE 3