NATIONAL EXAMS – May 2015

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. Any Textbooks are permitted as well as Design handbooks. **NO notes or sheets are allowed.** Candidates may use one of two calculators, the Casio or Sharp approved models.

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

5. All questions are of equal value.

6. **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 + 5 + 3)
Question 2: (10 + 5 + 2 + 3)
Question 3: (15 + 5)
Question 4: (14 + 6)
Question 5: (14 + 6)
Question 6: (15 + 5)
Question 7: (12 + 4 + 4)

1. Figure 1 shows a loaded steel rigid frame. The plastic moment capacities of the members are shown. Use the Plastic Method of design to:

   (a) Select the steel sections for all the members; and
   (b) Estimate a size for the concrete footing at base A, given the soil bearing capacity as 400 kPa.

   [Assume lateral support is provided where necessary. Ignore effects of shear and axial deformations.]

2. (a) Design the welded corner at joint B for the steel frame in Fig. 1.

   (b) Carry-out the necessary calculations to check whether the sections chosen in Question 1 for beam columns AB and DF are adequate.

3. (a) Design a section for the three-span continuous welded plate girder, ABCD, Figure 2. The section must satisfy flexure, shear and their interaction.

   [Assume adequate size for the load-base plates.]

   (b) Estimate the long-term vertical displacement at mid-point of member BC.

4. Composite steel-concrete construction is to be used to design a pedestrian bridge, 20 m in span, 5 m wide, supported by a 220 mm r.c. slab and two steel beams, placed 4 m apart. Assuming 100% interaction between concrete and steel:

   (a) Design the bridge to carry a live load of 14 kPa as well as its dead load;
   (b) Calculate the required number of shear connectors.

   [Assume that the steel beams are adequately braced.]

5. Figure 3 shows a loaded prestressed concrete tee-beam:

   (a) Design the cross-section allowing no tension.
   (b) Determine the required area of prestressing steel strands and their profile along the beam.

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

6. The rigid frame in Fig. 4 is to be designed in reinforced concrete construction. Using the Limit States Design method, design member BC, for: (a) Flexure; and (b) Shear. Also, sketch the reinforcing details for member BCD. Assume the same stiffness for all members.

   [Assume lateral support is provided where necessary.]

7. Having analyzed the r.c. frame in Fig. 4, design member AB as a beam-column and sketch the reinforcing details.

07-Str-A5

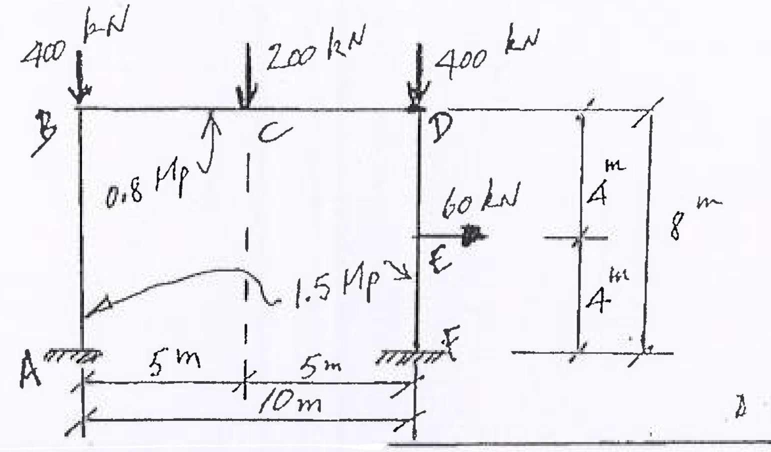

FIGURE 1

NOTE: Lateral Support provided @ 3m interval.

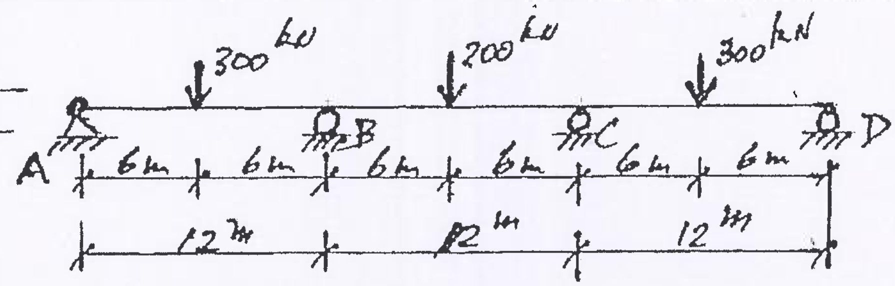

FIGURE 2

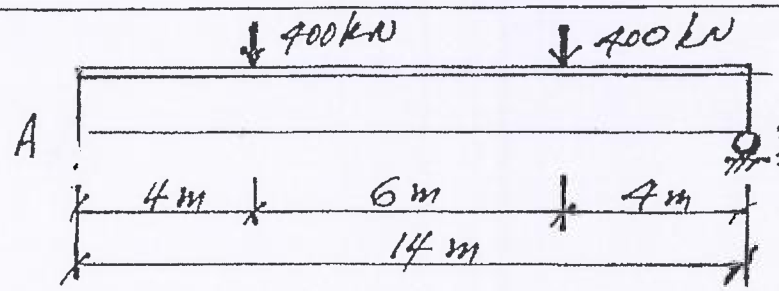

FIGURE 3

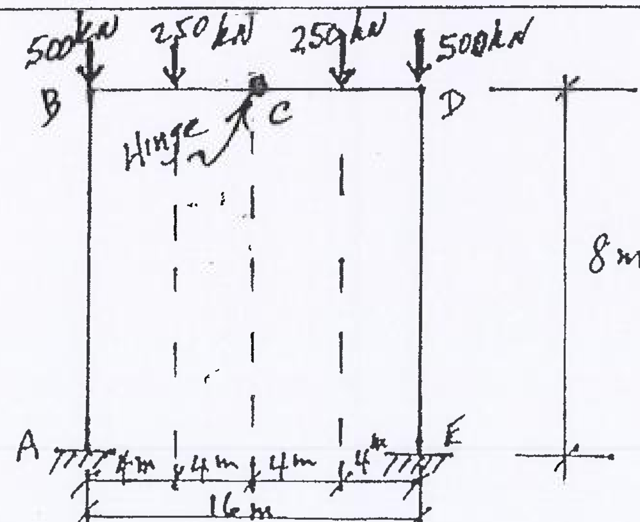

FIGURE 4