NATIONAL EXAMS – December 2017

16-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. Design 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 book 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 + 8)
Question 2: (14 + 6)
Question 3: (12 + 6 + 2)
Question 4: (15 + 5)
Question 5: (12 + 6 + 2)
Question 6: (14 + 6)
Question 7: (14 + 6)

1. (a) Using the Plastic Method of Design, determine the size of the members of the rigid steel frame in Figure 1.

   (b) Design the welded corner at joint E.

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

2. For the loaded steel rigid frame in Figure 1:

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

   (b) Carryout a preliminary design for a reinforced concrete footing at A. Assume a value of the soil bearing capacity of 500 kPA.

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

3. Figure 2 shows a loaded plate girder with fixed supports at A and D. Design a cross-section to satisfy flexure and shear, as well as their interaction.

   [Assume adequate lateral size for the load base plate.]

4. The cross-section of a composite steel-reinforced concrete bridge is shown in Figure 3. The bridge is to be designed as simply-supported, spanning one-way. The design span length and live load are given in Figure 3. Assuming complete interaction between the steel box girders and the concrete:

   (a) Design the composite cross-section, assuming uniform load distribution.

   (b) Calculate the required number of shear stud connectors between the steel box girders and the concrete slab.

   [Assume that the steel beams are adequately braced.]

5. Figure 4 shows a prestressed concrete girder. Design the girder, allowing no tension in the cross-section. Show the profile of the prestressing steel.

6. Figure 5 shows a rigid reinforced concrete frame. Using the Limit States Design Method, design a section for member ABC to satisfy moment and shear. Show the layout of the reinforcing.

7. (a) Check whether the cross-section chosen for member ABC in Question 6 can satisfactorily perform as a beam-column.

   (b) Estimate the long-term vertical displacement at B.

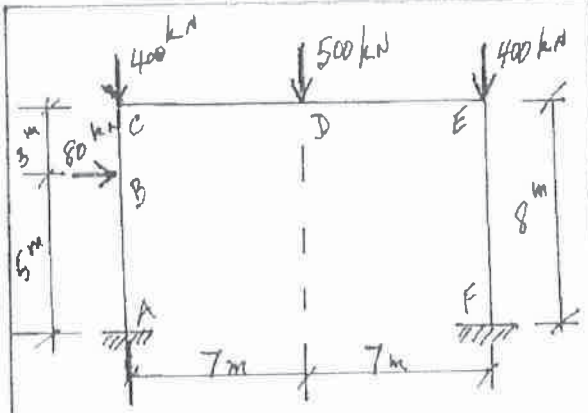

FIGURE 1

NOTE : Lateral Support Provided @ 2m interval.

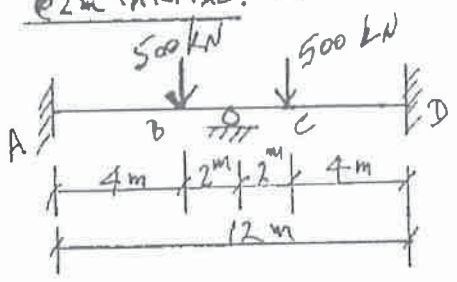

FIGURE 2

NOTE: DESIGN SPAN LENGTH = 18 m
DESIGN LIVE LOAD = 16 kPa

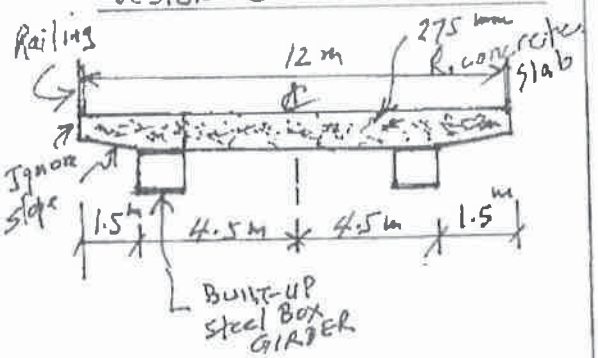

FIGURE 3

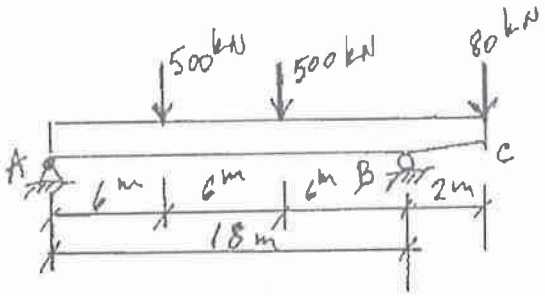

FIGURE 4

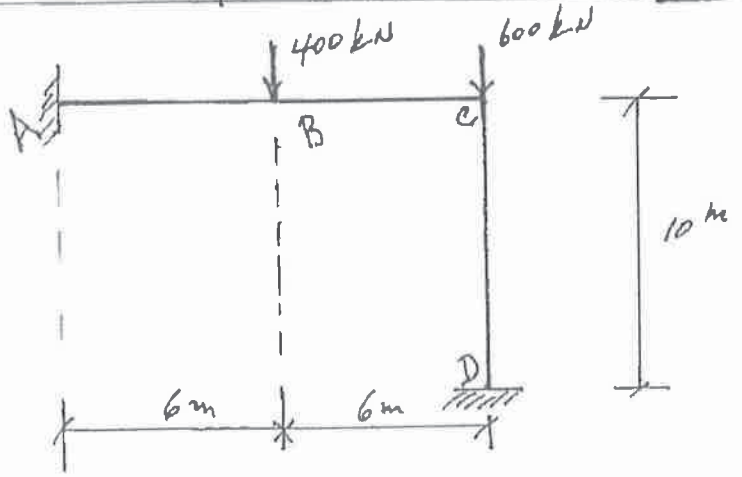

FIGURE 5