NATIONAL EXAMS – December 2014

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

Marks For
Question 1: (12 + 6 + 2)
Question 2: (10 + 5 + 2 +3)
Question 3: (15 + 5)
Question 4: (12 + 8)
Question 5: (12 + 8)
Question 6: (14 + 6)
Question 7: (14 + 6)

1. Figure 1 shows a two-span continuous welded steel plate girder:

   Design a cross-section to satisfy flexure and shear, and their interaction.

   [Assume that the load bearing plates are of adequate size.]

2. The prestressed concrete beam ABC in Figure 2 is hinged at A, rollered at B, with a cantilever BC. Using a T-section and steel strands for post-tensioning:

   (a) Design a uniform T-section, allowing no tension, and determine the area and profile of the steel strands.
   (b) Determine the long-term deflection of point C.

   [Use the gross cross-section to calculate the moment of inertia.]

3. The cross-section of a simply supported composite bridge is shown in Figure 3, designed spanning one-way. The span and design live load are shown. Using unshored composite construction, and assuming 100% interaction between the steel box girders and the reinforced concrete deck:

   (a) Design the cross-section for flexure.
   (b) Determine the number of shear stud connectors required.

   [Assume that the steel box-girders have adequate lateral bracings.]

4. A rigid steel frame with a constant plastic moment capacity M_p, is shown loaded in Figure 4.

   (a) Design a uniform steel section for the frame using plastic method of design.
   (b) Design the welded rigid corner at C.

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

5. (a) Determine the size of the concrete footing at base E of the steel structure, Figure 4, using 300 kPa for the soil bearing capacity.

   (b) Also, investigate whether the section chosen for the beam column CE is adequate to carry the design loads.

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

6. The rigid frame in Figure 4 is to be designed in reinforced concrete. Using the Limit States Design method:

   Determine the amount and layout of reinforcing steel required to satisfy flexure and shear for member AC, using a rectangular cross-section. Show the layout of the reinforcement.

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

7. Using the Limit States Design method, design a rectangular cross-section for the reinforced concrete column CE in Figure 4, carrying out the required strength and stability checks.

NOTE: Lateral Support Provided @ 2m intervals

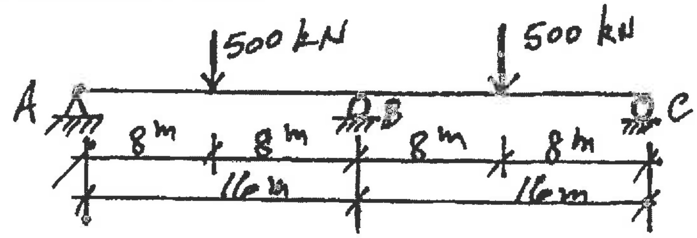

FIGURE 1

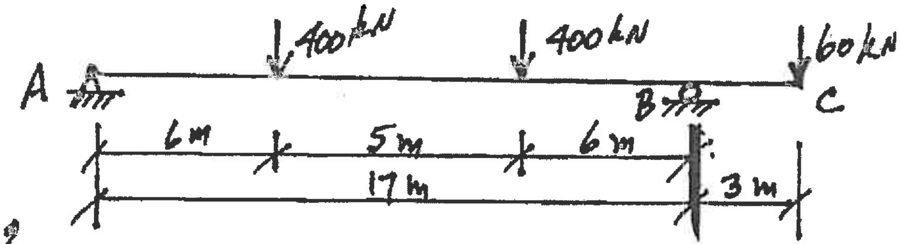

FIGURE 2

NOTE: Design Span Length = 18m; Design Live Load = 20 kPa.

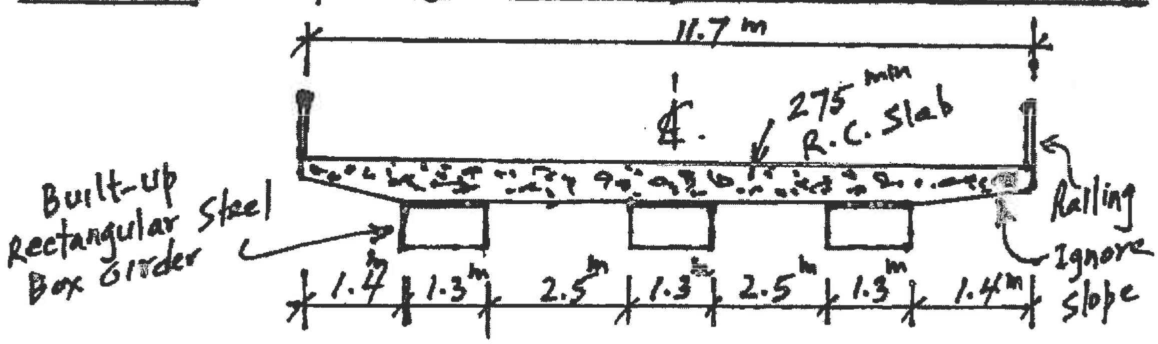

FIGURE 3

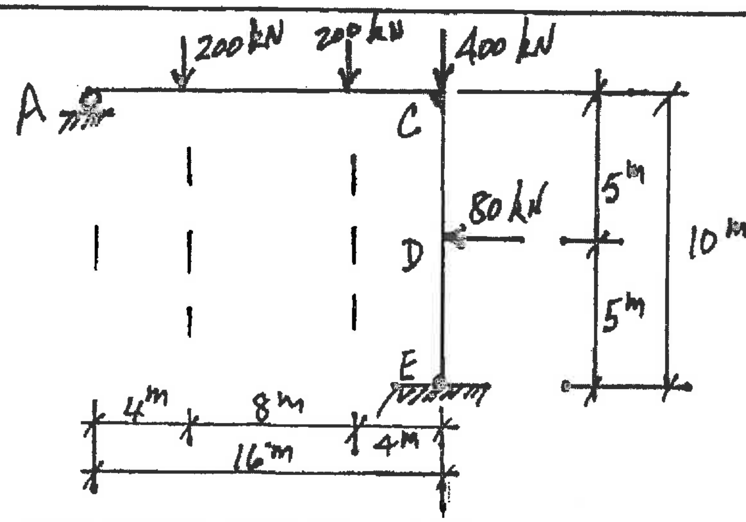

FIGURE 4