NATIONAL EXAMS – December 2016

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. 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 + 6 + 2)
Question 2: (12 + 6 + 2)
Question 3: (16 + 4)
Question 4: (14 + 6)
Question 5: (10 + 5 + 5)
Question 6: (14 + 6)
Question 7: (14 + 6)

1. The prestressed concrete girder in Figure 1 is to be post-tensioned.

   (a) Design a rectangular cross-section allowing maximum permitted tension.
   (b) Calculate the required area of prestressing steel strands and sketch their profile.

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

2. The two-span continuous welded plate girder, shown in Figure 2, is to be designed using the non-stiffened-web approach. Design a cross-section suitable for flexure, shear, and their interaction.

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

3. Use the plastic method of design to choose adequate steel sections for the rigid frame in Figure 3:

   (a) The members' plastic moments capacities are shown.

   (b) Estimate the size of the concrete footing at support A. Assume a value for the soil-bearing capacity of 500 kPa.

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

4. A simply supported heavily-loaded floor system is to be designed in composite steel-concrete construction. The floor has a span of 12 m, a width of 22 m and a concrete deck slab 160 mm deep. The steel beams are to be spaced at 2.5 m.

   Using unshored construction:

   (a) Design the cross-section of the floor to carry a live load of 8 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.]

5. The reinforced-concrete rigid frame in Figure 4 is to be designed for the loads shown, using the ultimate strength method:

   (a) Design an adequate rectangular cross-section for member BC to satisfy flexure and shear.

   (b) Estimate the long-term deflection at mid-span of BC.

   (c) Show the layout of the reinforcing steel along BC.

6. For the steel structure in Figure 3, check whether the chosen section for the steel beam-column, AB, is satisfactory to carry the given loads.

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

7. The continuous beam in Figure 2 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 AB, using a tee cross-section. Show the layout of the reinforcement.

   [Ignore the Note shown in Figure 2, when solving this question.]

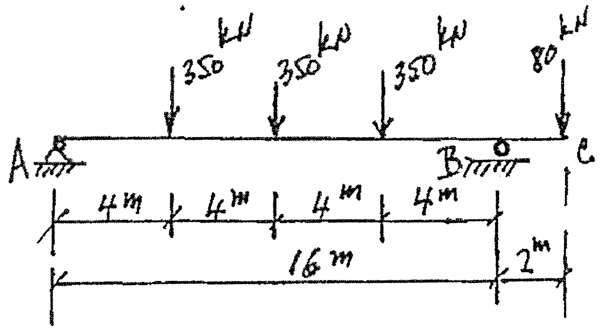

FIGURE 1

NOTE: Lateral Support Provided @ 2m intervals

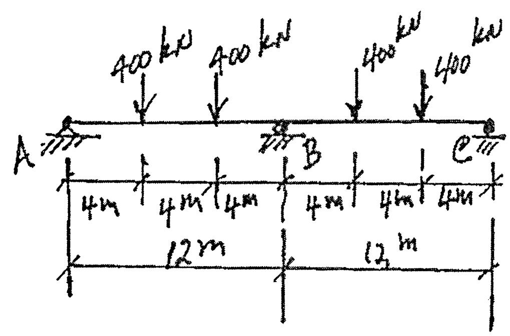

FIGURE 2

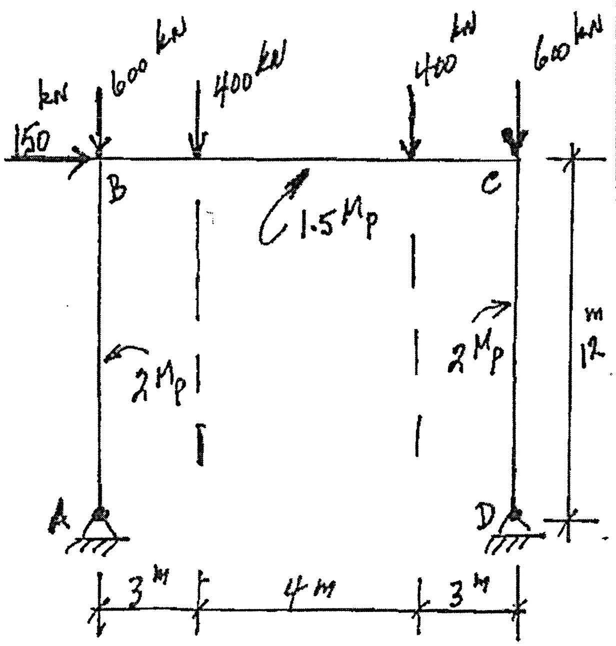

FIGURE 3

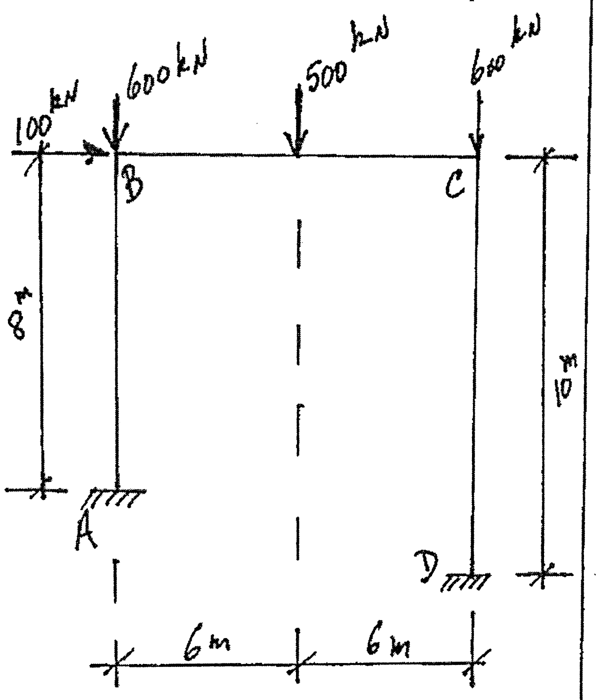

FIGURE 4