NATIONAL EXAMS – May 2018

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 + 6 + 2)
Question 2: (12 + 8)
Question 3: (12 + 4 + 4)
Question 4: (14 + 6)
Question 5: (10 + 5 + 5)
Question 6: (10 + 4 + 6)
Question 7: (12 + 8)

1. The three-span continuous welded plate girders, shown in Figure 1, 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.]

2. Use the plastic method of design to choose adequate steel sections for the members in Figure 1.

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

3. The prestressed concrete girder in Figure 2 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.]

4. A simply supported floor system, for a bridge, is to be designed in composite steel-concrete construction. The floor has a span of 14 m, a width of 12 m and a concrete deck slab 240 mm deep. The steel beams are to be spaced at 3 m apart.

   Using unshored construction:

   (a) Design the cross-section of the floor to carry a live load of 15 kPa, ignoring the self-weight of the steel beam. Assume 100% interaction between the steel beams and the concrete deck slab, and a uniform load distribution.

   (b) Determine the number of shear stud connectors required.

   [Assume the steel beams have adequate lateral bracings.]

5. The reinforced concrete rigid frame in Figure 3 is to be designed for the loads shown, using the ultimate strength method.

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

   (b) Show the layout of the reinforcing steel along joint B in Figure 3.

6. Design the reinforced concrete column BC in Figure 3.

7. Estimate the long-term deflection at mid-span of AB in Figure 3. Also, estimate the size of the support footing at C. Assume a value for the soil bearing capacity of 400 kPa.

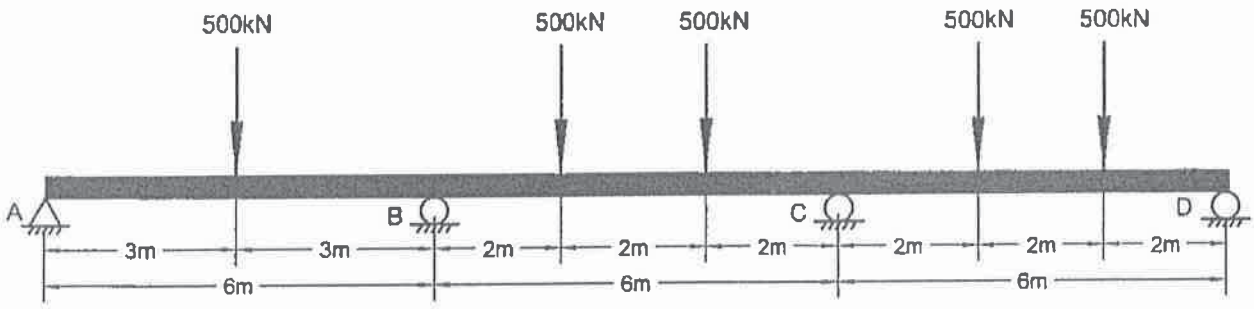

FIGURE 1

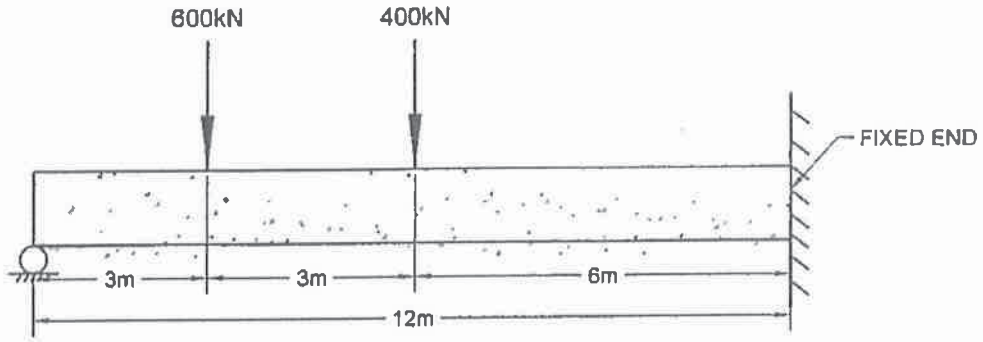

FIGURE 2

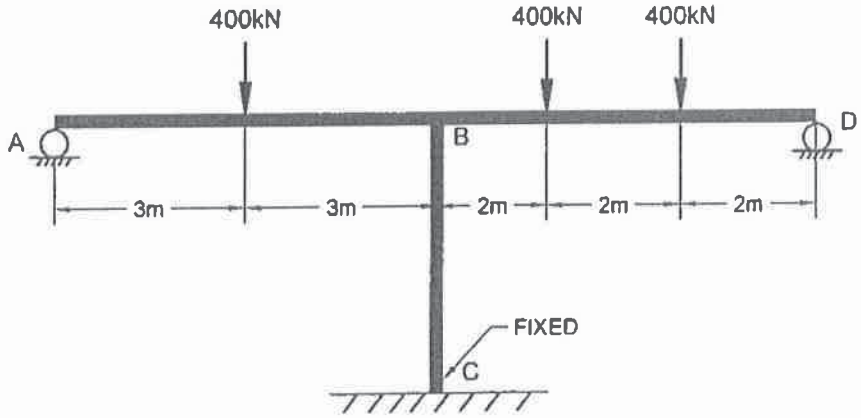

FIGURE 3