NATIONAL EXAMS – December 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. 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 + 5 + 3)
Question 2: (10 + 5 + 5)
Question 3: (15 + 5)
Question 4: (16 + 4)
Question 5: (14 + 6)
Question 6: (10 + 5 + 5)
Question 7: (6 + 5 + 5 + 4)

1. The beam ABC in Figure 1 is a welded steel plate girder, rigidly supported at A and C. Use a stiffened-web design to determine an adequate section to satisfy:

   (a) Flexure
   (b) Shear; and
   (c) Flexure-shear interaction.

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

2. The loaded structure shown in Figure 2 is to be constructed as a post-tensioned prestressed concrete girder. Design a T-section, allowing no tension in the cross-section, and calculate the area and profile of the post-tensioned steel strands.

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

3. The cross-section of a heavily-loaded floor of a warehouse, Figure 3, is to be designed in a composite steel-reinforced concrete construction. Using unshored construction:

   (a) Design the cross-section, assuming 100% interaction between the steel beams and the concrete slab.

   (b) Calculate the number of shear connectors required.

   [Assume the steel beams have adequate bracings.]

4. The steel-rigid frame, Figure 4, is to be designed using the Plastic Method of Design. The plastic moment capacities of the members are shown.

   (a) Select a steel section for members BC and AB.

   (b) Estimate the size of the reinforced concrete footing at support A, given a soil-bearing capacity of 350 kPa.

   [Assume lateral support is provided at all joints and load locations.]

5. For the steel rigid frame in Figure 4:

   (a) Carry-out the necessary calculations to check whether the sections chosen in Question 4 is adequate for the beam-column AB.

   (b) Design the welded corner at B.

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

6. The continuous girder in Figure 1 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 using a rectangular cross-section. Show the layout of the reinforcement.

7. The rigid frame in Figure 4 is to be designed in reinforced concrete using the Limit States Design Method.

   (a) Design the beam-column AB.
   (b) Estimate the horizontal deflection at the middle of AB, allowing for creep.

NOTE: Lateral Support Provided @ 2m INTERVAL

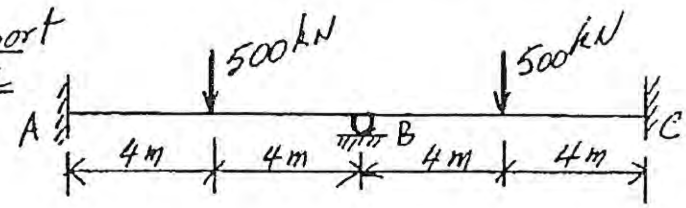

FIGURE 1

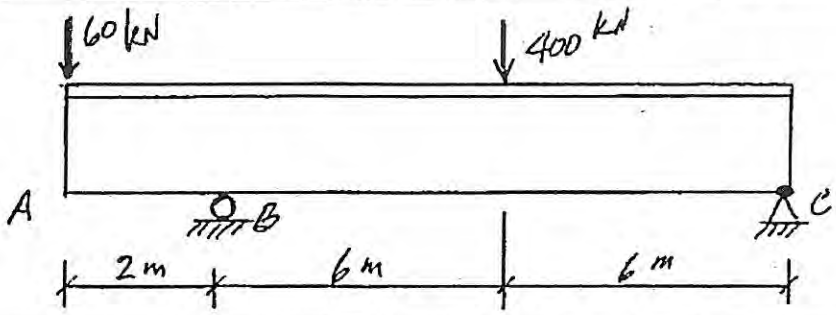

FIGURE 2

NOTE: Design Span Length = 14 m; Design Live load = 16 kPa

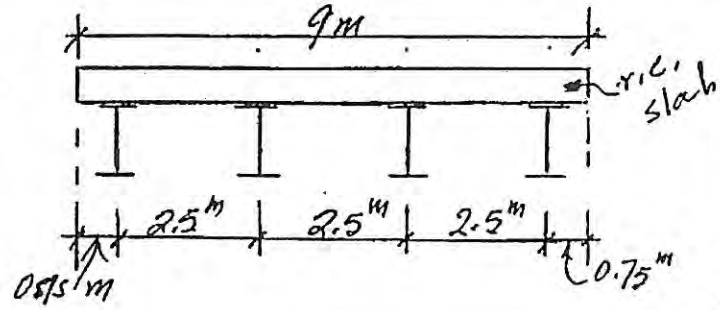

FIGURE 3

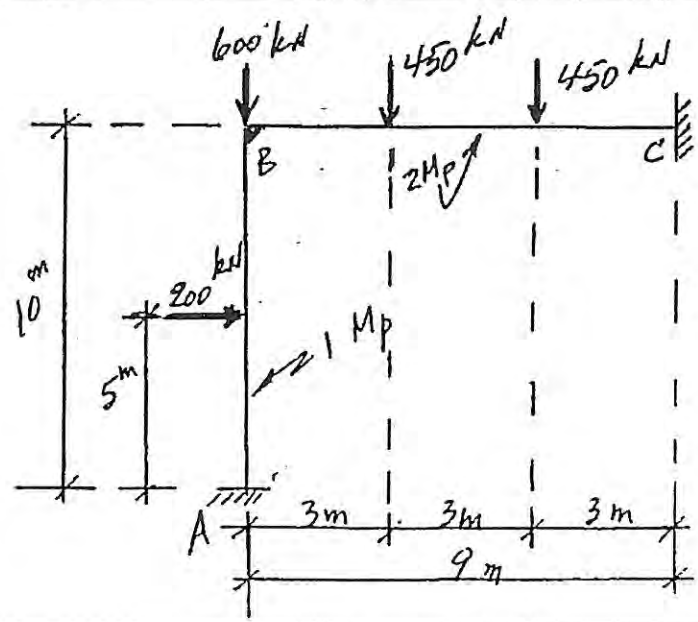

FIGURE 4