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

1. The beam ABCD in Figure 1 is a welded steel plate girder, rigidly supported at A and D. 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. Composite steel-concrete construction is to be used to design a pedestrian bridge, 18 m in span, 5 m wide, supported by a 220 mm r.c. slab and two steel beams, placed 4 m apart. Assume 100% interaction between concrete and steel:

   Given the cross-section shown in Figure 2,
   (a) design the bridge to carry a live load of 14 kPa as well as its dead load;
   (b) calculate the required number of shear connectors.

   [Assume that the steel beams are adequately braced.]

3. Figure 3 shows a loaded steel rigid frame to be designed using the Plastic Method of Design. The members have plastic moment capacities as shown.

   (a) Select adequate steel sections for the members.
   (b) Design a welded corner connection B.

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

4. (a) Check whether the cross-section chosen for member BC in Question 3 is also adequate to act as a beam-column.

   (b) Assuming a value for the soil bearing capacity, estimate the dimensions of a reinforced-concrete footing at C.

   [Assume the frame in Figure 3 is braced at joints A, B and C as well as at the load points.]

5. The rigid frame in Figure 3 is to be built in reinforced concrete and 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) Estimate the long-term deflection at mid-span of AB.

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

6. For the reinforced concrete rigid frame in Figure 3 check whether the section chosen for flexure in Question 5 is satisfactory for the beam-column BC. Carryout all the required checks.

   [Assume the frame is laterally braced at all joints and loads locations.]

7. The loaded structure shown in Figure 1 is to be constructed as a post-tensioned prestressed concrete girder. Design a T-section, allowing no tension in the cross-section, and determine the area and profile of the post-tensioned steel strands.

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

NOTE: Lateral Support Provided @ 2m Interval.

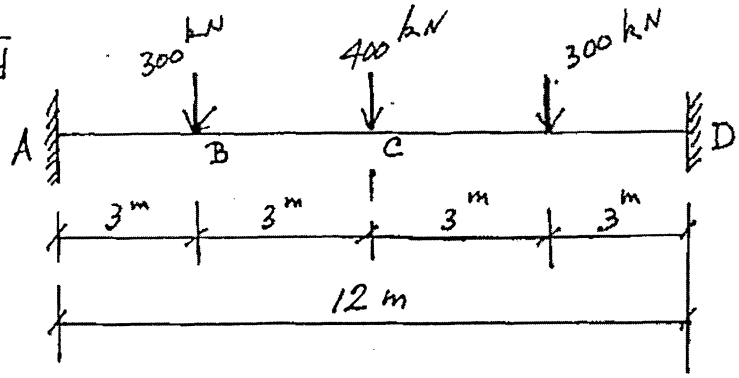
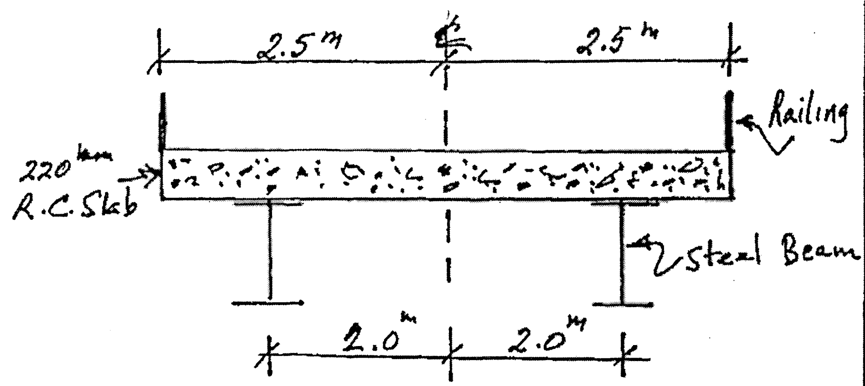


FIGURE 1



BRIDGE CROSS-SECTION

FIGURE 2

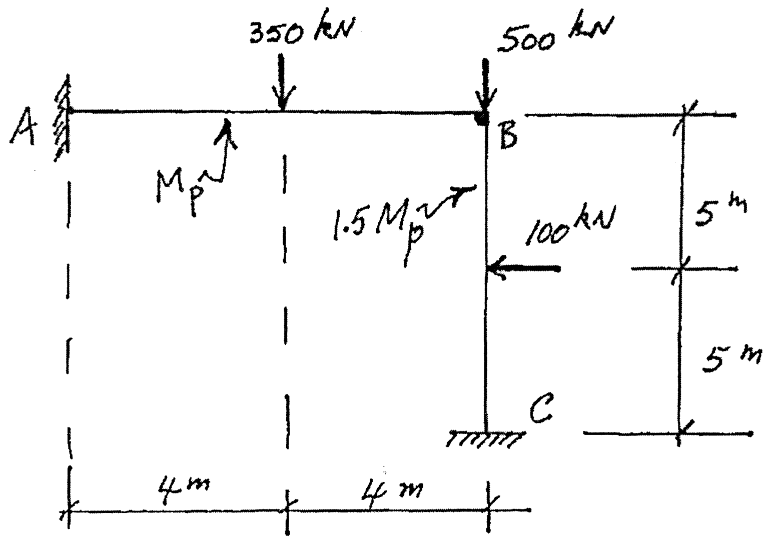


FIGURE 3