NATIONAL EXAMS – May 2014

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. Handbooks and textbooks are permitted. **NO notes on Handbooks, textbooks or loose sheets are allowed.** Candidates may use one of two calculators, the Casio or Sharp approved models.

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

1. The steel rigid frame, shown loaded in Fig. 1 has variable plastic moment capacities, M_p. The frame is fixed at the bases A and D.

   (a) Design sections for members BC and CD to satisfy flexure, using the plastic method of design.
   (b) Design a welded connection at C.

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

2. For the loaded steel rigid frame in Fig. 1:

   (a) Check whether the section chosen for member CD in Question 1 is adequate to perform as a beam-column.
   (b) Assuming a value for the soil bearing capacity of 400 kPa, design a reinforced concrete footing at D.

   [Assume adequate lateral support at joints A, B, C and D.]

3. Design the prestressed concrete beam, shown in Fig. 2, using a rectangular cross-section and prestressing steel strands. Determine:

   (a) The appropriate dimensions of the cross-section.
   (b) The area and profile of the steel strands, and
   (c) The long-term deflection at mid-span.

   [Use the gross-section in calculating the moment of inertia.]

4. A two-span continuous welded steel plate-girder, is shown loaded in Fig. 3. Using a stiffened web design:

   (a) Determine an adequate cross-section for flexure.
   (b) Design the stiffened web.
   (c) Check the moment-shear interaction.

   [Assume adequate size for the load bearing plates.]

5. The rigid frame in Fig. 4 is to be designed in reinforced concrete construction. Using the Limit States Design Method, design member AC for:

   (a) Flexure; and
   (b) Shear.

   Assume the same stiffness for all members.

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

6. For the reinforced concrete rigid frame in Fig. 4:

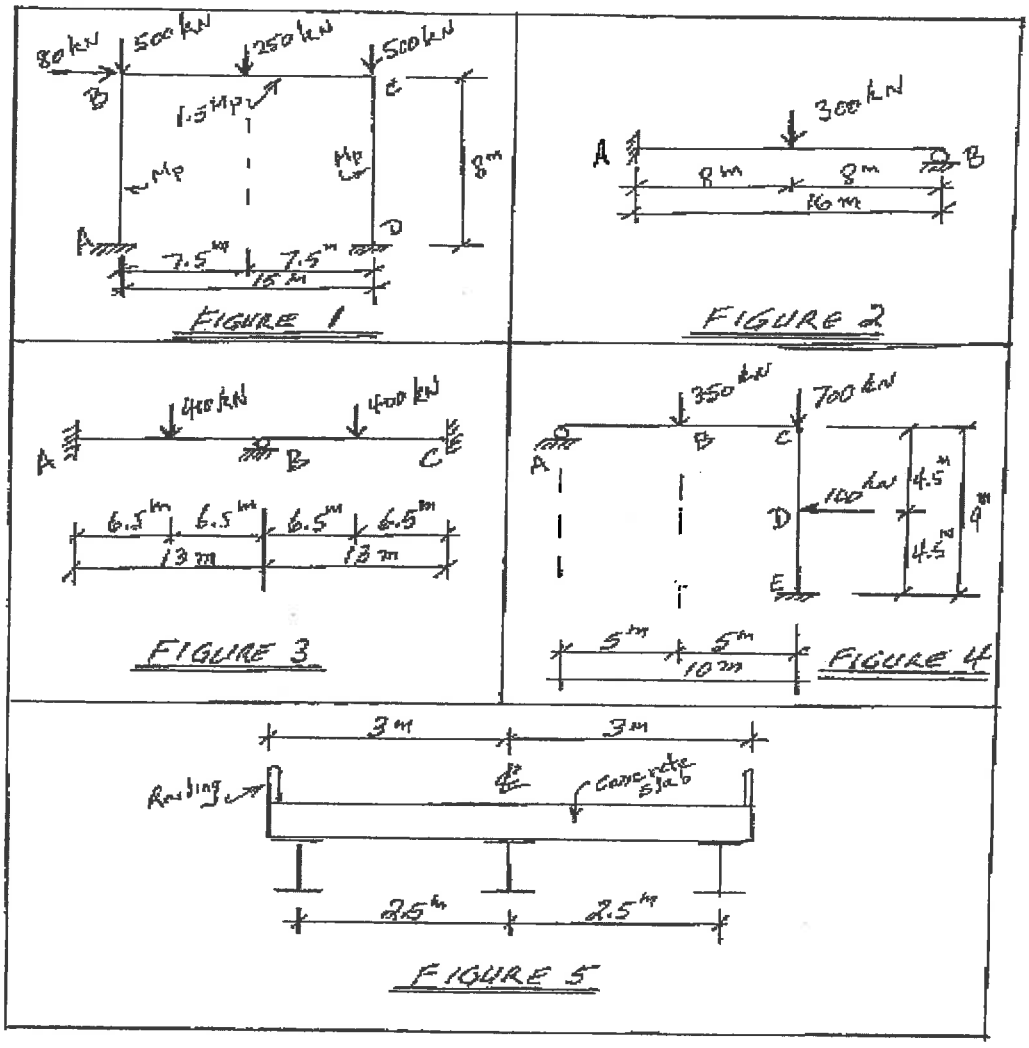
   (a) Design member CDE as a beam-column; and
   (b) Estimate the long-term deflection at mid-span of AC.

   [Assume the frame in braced at joints A, B, C, D and E.]

7. The composite steel-reinforced concrete cross-section of a pedestrian bridge is shown in Fig. 5. The bridge is simply-supported with a span of 18 m. Using unshored construction and a design live load = 15 kPa:

   (a) Design the cross-section for flexure, assuming **100%** interaction between the steel beams and the concrete deck slab.
   (b) Determine the required number of stud shear connectors.

   [Assume the steel beams are adequately braced.]


80 kN
500 kN
250 kN
500 kN
B
C
1.5 Mp
Mp
Mp
8 m
A
D
7.5 m
7.5 m
15 m
FIGURE 1
300 kN
A
B
8 m
8 m
16 m
FIGURE 2
400 kN
400 kN
A
B
C
6.5 m
6.5 m
6.5 m
6.5 m
13 m
13 m
FIGURE 3
350 kN
700 kN
A
B
C
100 kN
D
E
4.5 m
4.5 m
9 m
5 m
5 m
10 m
FIGURE 4
3 m
3 m
Railing
Concrete Slab
2.5 m
2.5 m
FIGURE 5