NATIONAL EXAMS – December 2008

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 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 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

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. The cross-section of a heavily-loaded floor of a warehouse, Figure 2, 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.]

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 at D.

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

4. For the steel rigid frame in Figure 3:

(b) Carry-out the necessary calculations to check whether the section chosen in Question 3 is adequate for the beam-column ABC.
(c) Determine the necessary size for a reinforced-concrete footing at base A, using 350 kPa for the soil bearing capacity.

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

5. 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 calculate the area and profile of the post-tensioned steel strands.

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

6. Figure 4 shows a reinforced concrete frame to be designed using the Limit States Design Method. The members of the frame can be assumed to have the same stiffness. Determine a suitable rectangular cross-section for member BC, showing the amount and layout of the reinforcing steel for both flexure and shear.

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

7. Design a rectangular reinforced-concrete cross-section for beam-column CD in Figure 4. Also, estimate the long-term vertical deflection at mid-span of member BC.

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

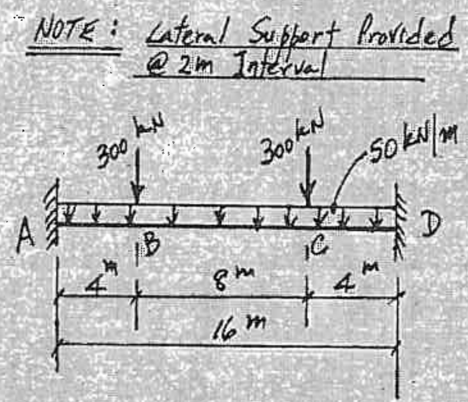

FIGURE 1

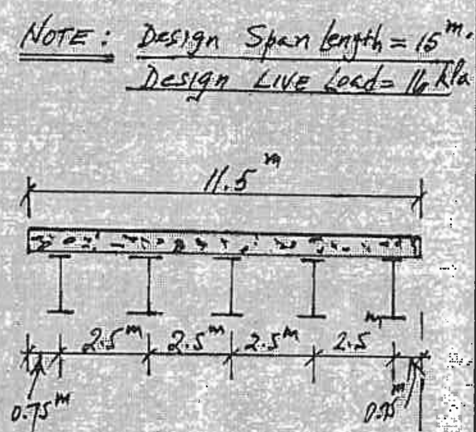

FIGURE 2

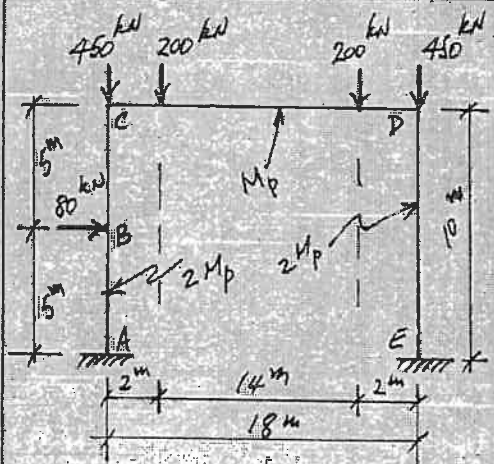

FIGURE 3

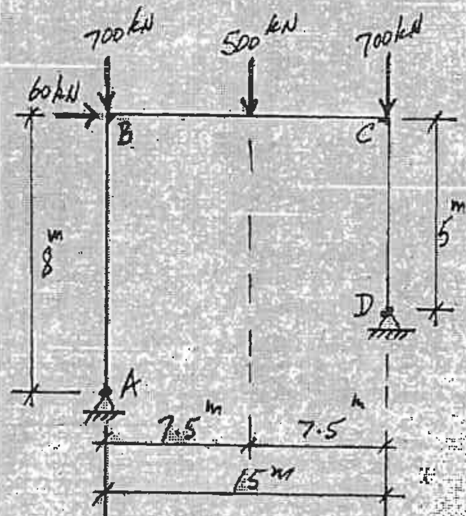

FIGURE 4