NATIONAL EXAMS - December 2003

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. Any non-communicating calculator is permitted. This is an Open Book Exam. Note to candidates: you must indicate the type of calculator being used, i.e. write the name of model designation of the 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.**

6. For figures in Imperial Units and SI, refer to pages 4 and 5, respectively. Solutions in either units are acceptable.

USE THE FOLLOWING DESIGN DATA

Design in	Imperial Units	SI
Concrete or Steel	f'_c = 4 ksi, f_y = 44 ksi, n = 8	f'_c = 30 MPa, f_y = 300 MPa, n = 8
Prestressed Concrete	f_c (at transfer) = 5 ksi, f'_c = 7 ksi, n = 6 $f_{ult.}$ = 250 ksi, f_y = 210 ksi $f_{initial}$ = 170 ksi; losses in prestress = 35 ksi	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. Figure 1 shows a loaded two-span continuous welded steel plate-girder. Determine:

   (a) An adequate cross-section to satisfy the requirements for flexure and shear.
   (b) Estimate the deflection at mid-span of AB.

   [Assume adequate size for the load base plates.]

2. The steel rigid frame, shown loaded in Fig. 2, has a constant plastic moment capacity, M_p. The frame is fixed at the bases A and D.

   (a) Design a section for member BC to satisfy flexure.
   (b) Design a welded connection at B.

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

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

   (a) Check whether the section chosen for flexure is adequate for the beam-column AB.
   (b) Assuming a value for the soil bearing capacity, design a reinforced concrete footing at D.

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

4. Use the ultimate strength method to design a rectangular reinforced-concrete cross-section for member BCD in the reinforced-concrete rigid frame, shown loaded in Fig. 3. The designed cross-section must satisfy the requirements for both flexure and shear.

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

5. (a) Carry out the necessary design calculations to check whether the chosen cross-section for member BCD in Question 4 is adequate also for beam-column AB.

   (b) Estimate the long-term deflection at mid span of member BCD.

   [Assume the frame in Fig. 3 is braced at A, B, D and E.]

6. The simply-supported bridge, shown loaded in Fig. 4(a), is to be designed in composite construction (unshored). Assuming 100% interaction between the steel beams and the reinforced concrete deck slab:

   (a) Design the cross-section, Fig. 4(b), for flexure.
   (b) Determine the required number of shear stud connectors.

   [Assume the steel beams have adequate lateral bracings.]

7. For the simply-supported prestressed concrete T-girder, shown loaded in Fig. 5:

   (a) Design a T-cross-section allowing no tension in the cross-section, using post-tensioned steel strands.
   (b) Determine the area and profile of the post-tensioned steel strands.

   [Use the gross cross-section to calculate the moment of inertia.]

NOTE: Lateral Support Provided @ 10ft intervals

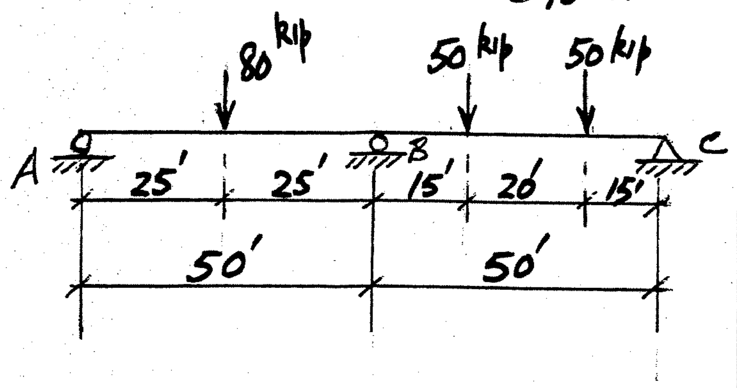

FIG. 1

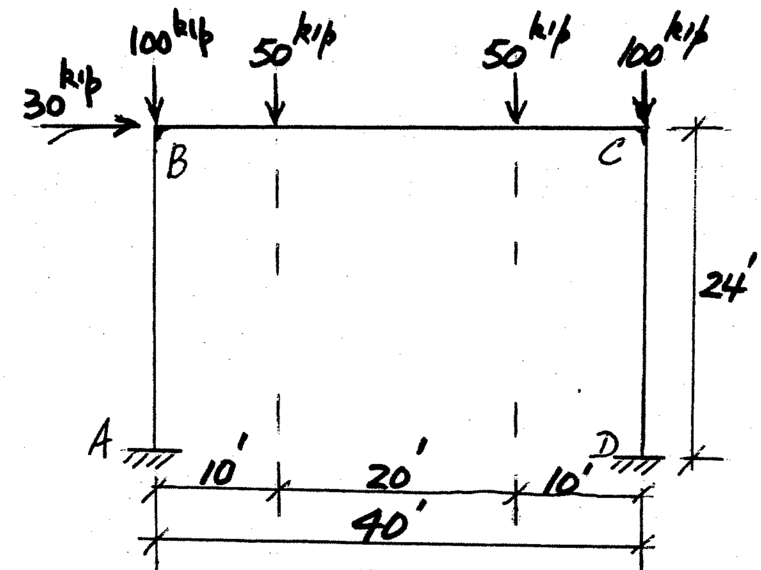

FIG. 2

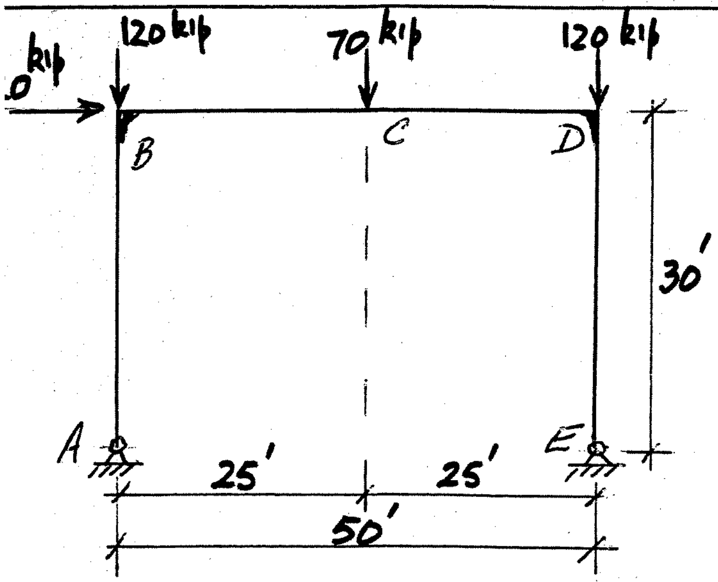

FIG. 3

NOTE: DESIGN FOR LIVE LOAD = 0.36 kip/ft

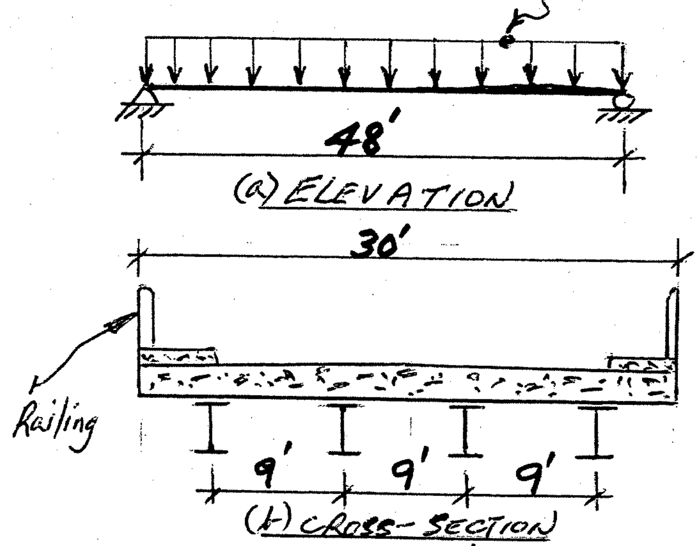

FIG. 4

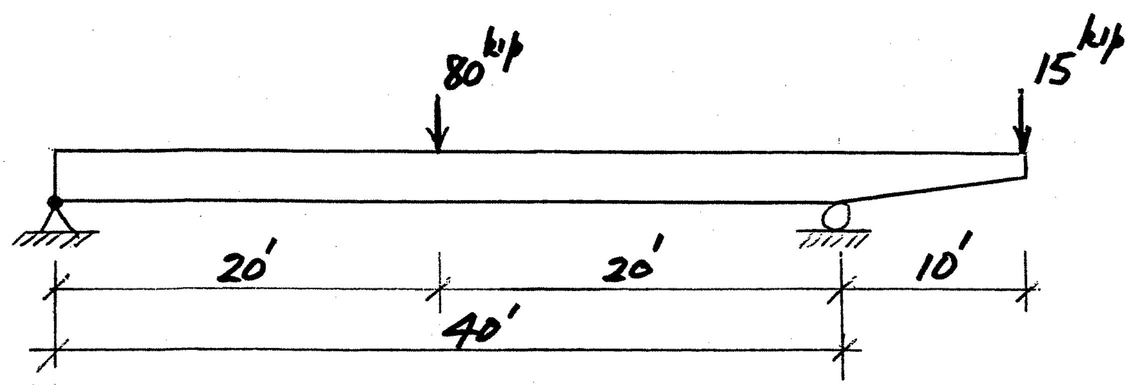

FIG. 5

NOTE: Lateral Support Provided @ 3.5 m intervals

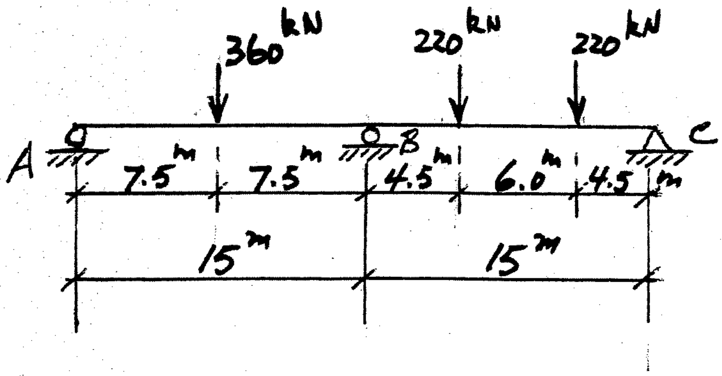

FIG. 1

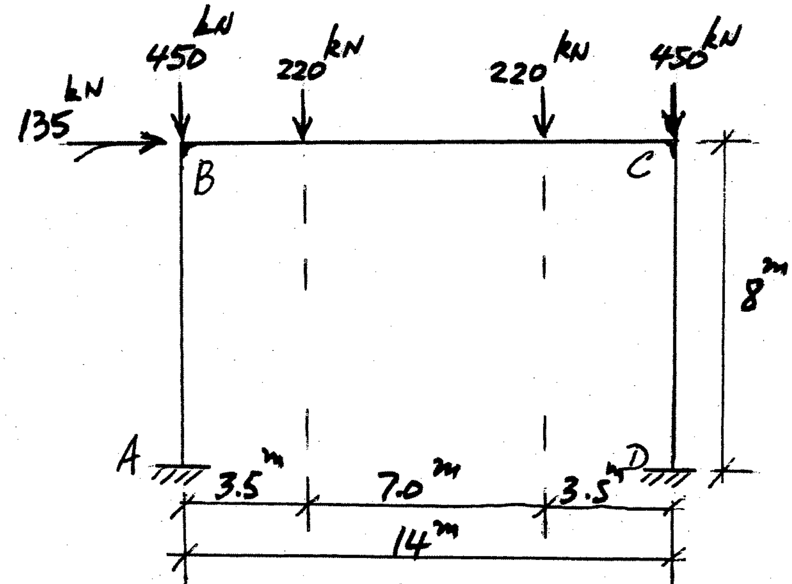

FIG. 2

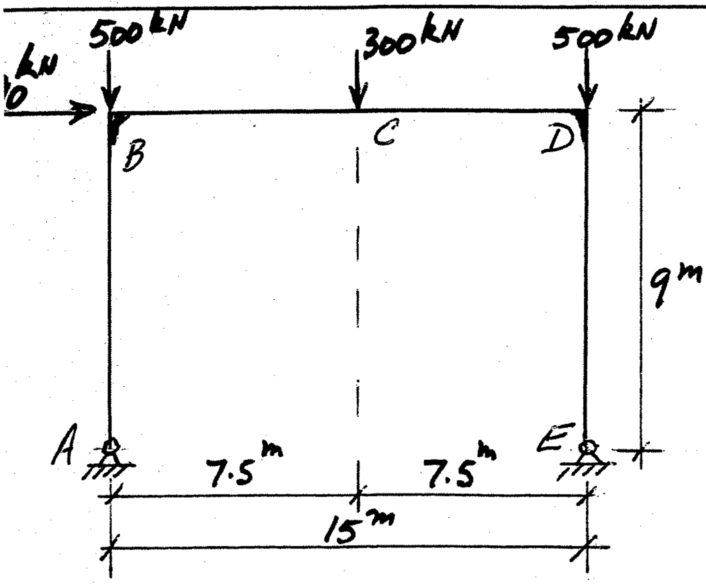

FIG. 3

NOTE: DESIGN FOR LIVE LOAD = 16 kPa

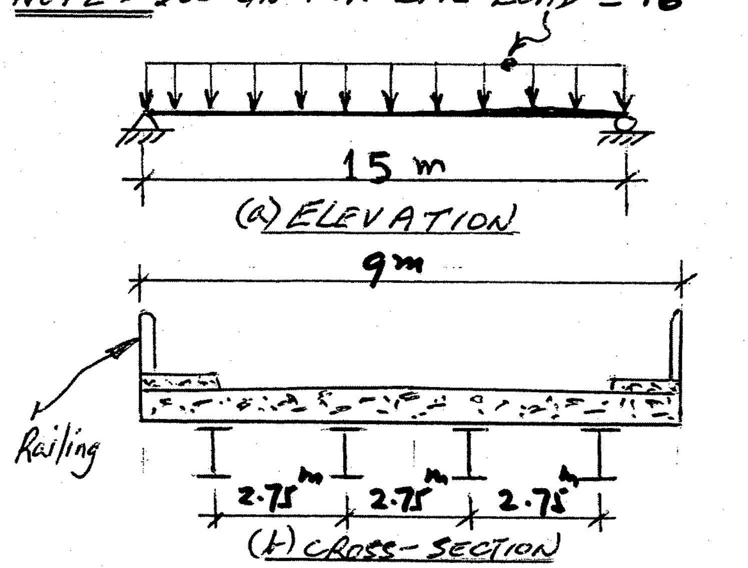

FIG. 4

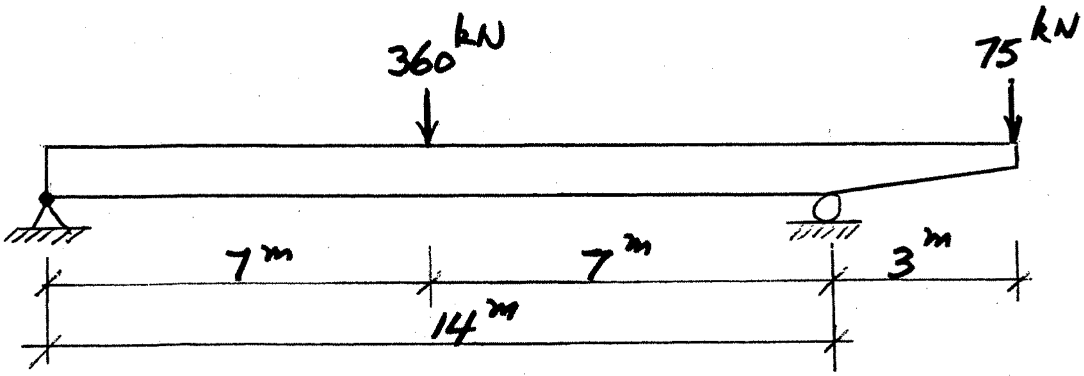

FIG. 5