NATIONAL EXAMS - MAY 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. The steel rigid frame ABCD, shown loaded in Fig. 1, has a constant plastic moment capacity, M_p. It is hinged at A and fixed at D.

   (a) Choose an adequate section for member BC to satisfy flexure.
   (b) Carry out a preliminary design of a reinforced-concrete footing at A, assuming a value for the soil bearing capacity.

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

2. For the uniform section chosen for the steel rigid frame in Fig. 1;

   (a) Check its adequacy for the beam-column member AB.
   (b) Design the welded corner connection at joint B.

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

3. The rigid frame in Fig. 2, is to be designed in reinforced concrete construction. Using the ultimate strength method, design member BC for: (a) Flexure; and (b) Shear.

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

4. For the reinforced concrete rigid frame in Fig. 2:

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

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

5. The continuous welded steel plate girder in Fig. 3 is to be loaded as shown. Using a stiffened web design approach, determine a suitable cross-section adequate for: (a) Flexure; (b) Shear; and (c) Flexure and shear interaction.

   [Assume adequate size for the load base plates.]

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

(a) Design the composite cross-section, Fig. 4(a), for flexure;
(b) Determine the required number of shear stud connectors adequate for the shear transfer between the steel beams and the concrete slab.

[Assume that the steel beams have adequate lateral bracings.]

7. Figure 5 shows a simply-supported girder to be designed in prestressed concrete construction using a T-section. Steel strands are to be used for post-tensioning. For the loads shown in Fig. 5;

(a) Design the T-section allowing no tension in the cross-section.
(b) Determine the area and profile of the prestressing steel required.

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

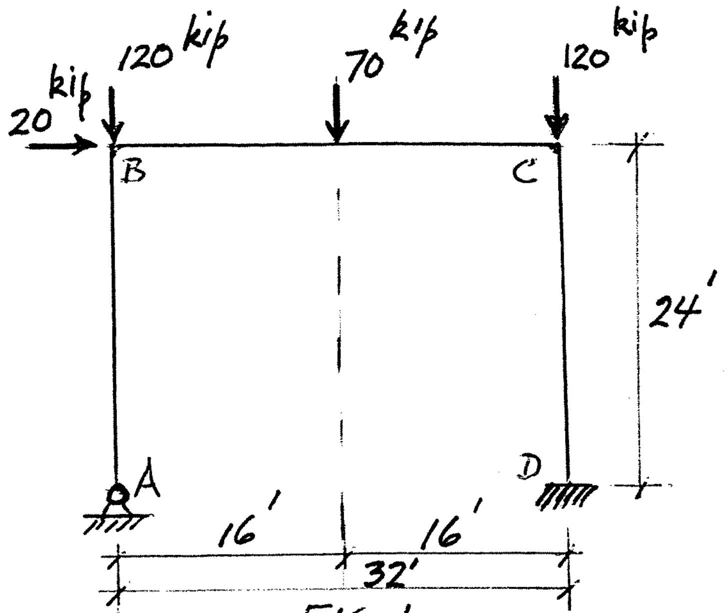


FIG. 1

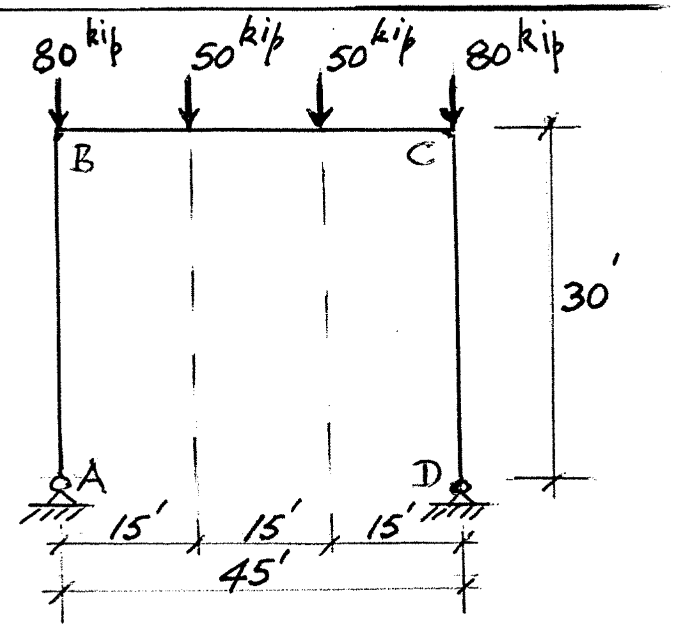


FIG. 2

NOTE: Lateral Support Provided @ 10 ft Intervals

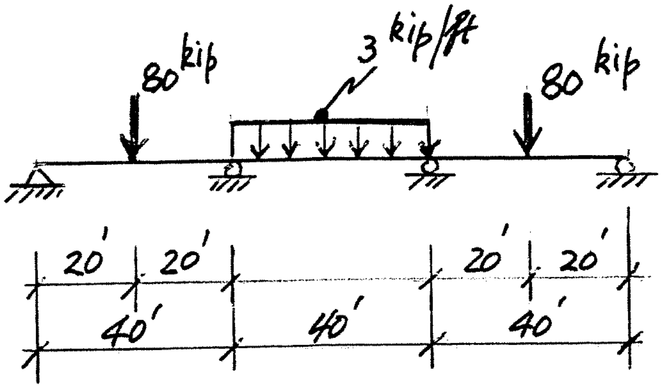


FIG. 3

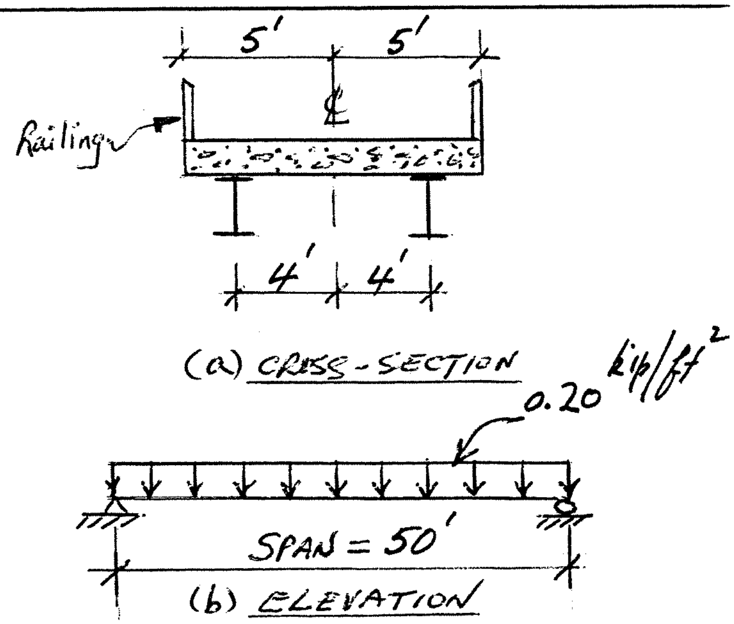


FIG. 4

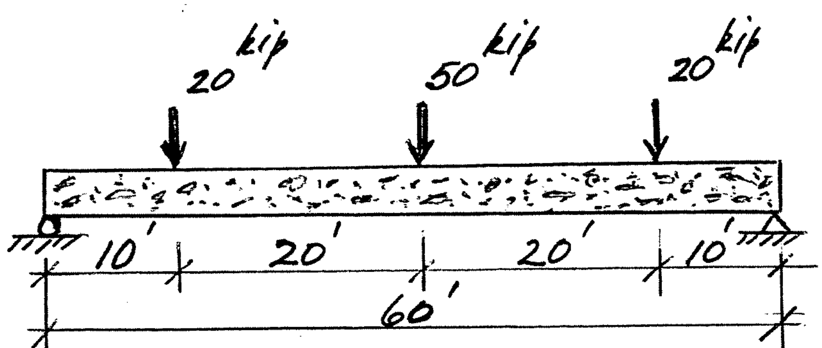


FIG. 5

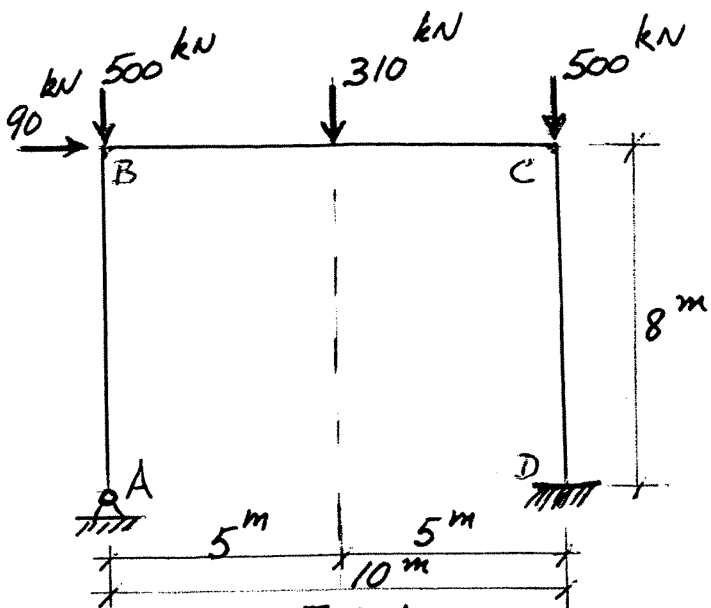


FIG. 1

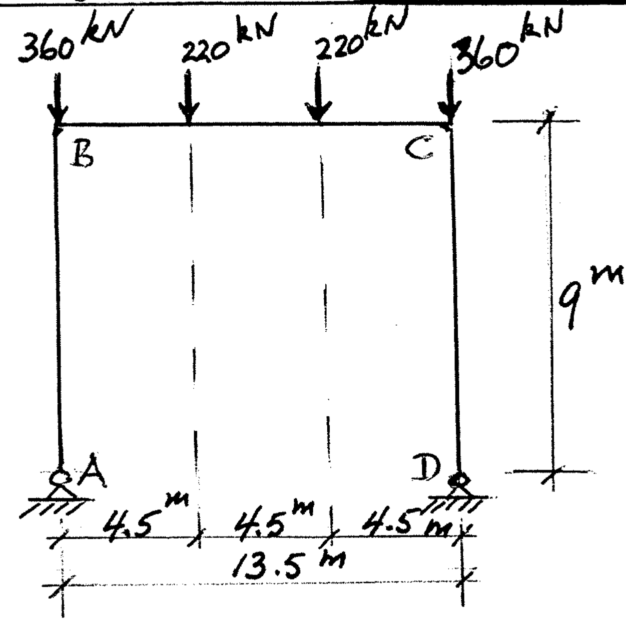


FIG. 2

NOTE: Lateral Support Provided @ 3.5 m Intervals

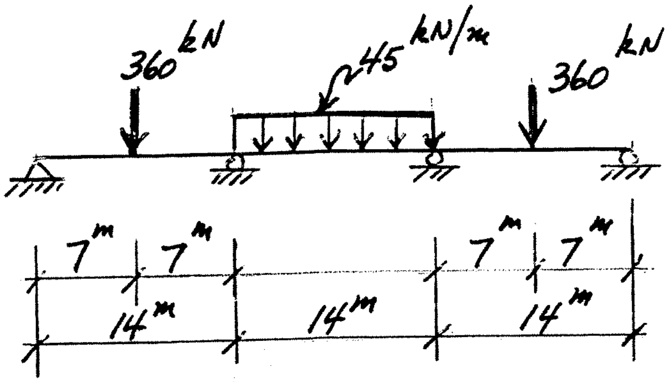
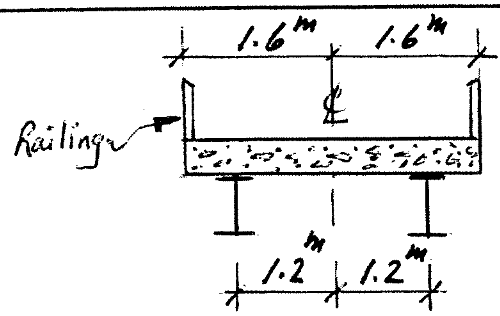
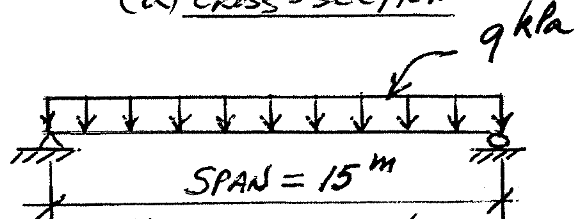


FIG. 3



(a) CROSS-SECTION



(b) ELEVATION

FIG. 4

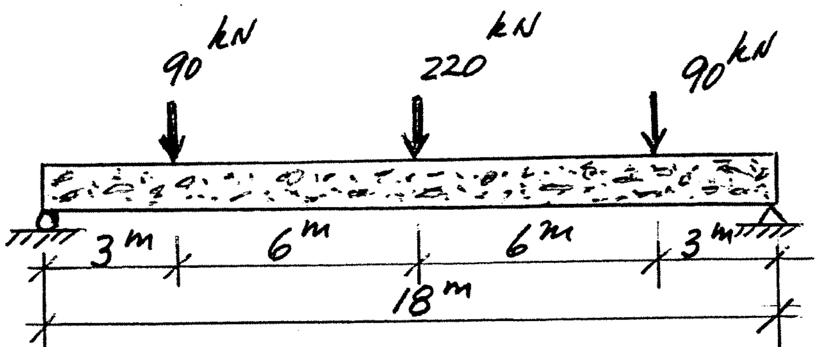


FIG. 5