

NATIONAL EXAMS – December 2010

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	$f'_c = 30 \text{ MPa}$
Structural Steel	$f_y = 350 \text{ MPa}$
Rebar	$f_y = 400 \text{ MPa}$
Prestressed Concrete	$f_c \text{ (at transfer)} = 35 \text{ MPa}$ $f'_c = 50 \text{ MPa}$ $n = 6$ $f_{ult.} = 1750 \text{ MPa}$ $f_y = 1450 \text{ MPa}$ $f_{initial} = 1200 \text{ MPa}$ Losses in prestress = 240 MPa

1. Figure 1 shows a loaded prestressed concrete beam with an overhang. Design a rectangular cross-section, using prestressing steel strands and allowing no tension. Determine the area and profile of the steel strands.
2. Design the rigid steel frame shown in Figure 2 using the Plastic Method of Design. Also, design the welded corner at joint B.

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

3. The simply-supported bridge, shown loaded in Figure 3(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, shown in Figure 3(b), for flexure.
- (b) Determine the required number of shear stud connectors.

Ignore the self-weight of the steel beams.

[Assume the steel beams have adequate lateral bracings.]

4. Design the steel column DGE in Figure 2. Also, estimate the horizontal deflection at G (Figure 2).

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

5. Figure 4 shows a reinforced concrete frame to be designed using the Limit-States Design Method. Design a rectangular cross-section for member BCD to satisfy shear and flexure. Show the layout of the reinforcement.

[Assume all members have the same stiffness and all joints and load points have adequate lateral support.]

6. Design the reinforced concrete beam-column AGB in Figure 4. Also, approximate the size of the footing at A, assuming a value of 500 kPa for the soil-bearing capacity.

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

7. The heavily-loaded plate girder in Figure 5 has fixed supports at A and C. Design a cross-section to satisfy flexure and shear, as well as their interaction.

[Assume adequate lateral size for the load base plate.]

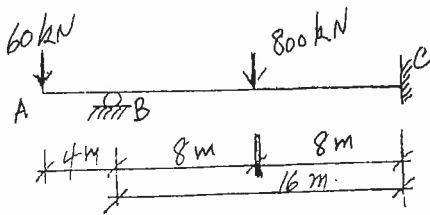
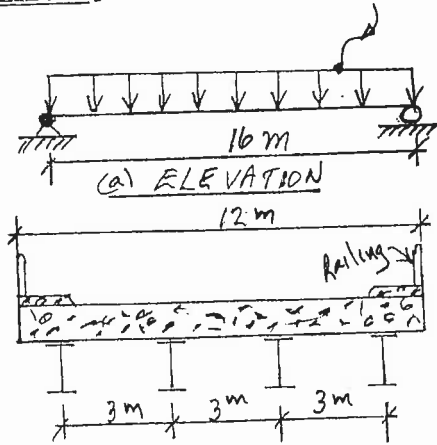


FIGURE 1

NOTE: DESIGN FOR LIVE LOAD = 18 kPa



(b) CROSS-SECTION

FIGURE 3

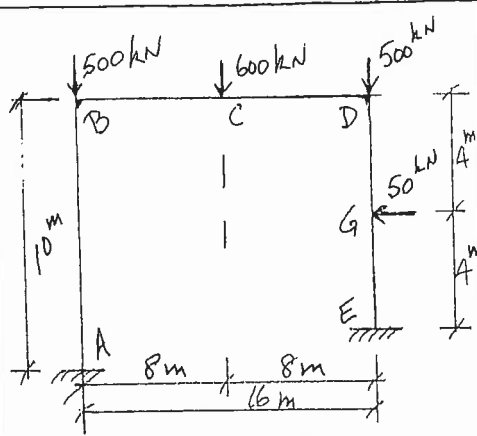


FIGURE 2

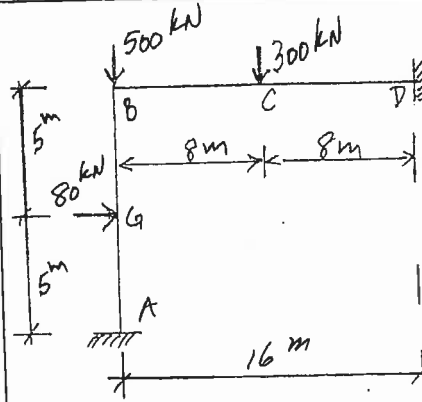


FIGURE 4

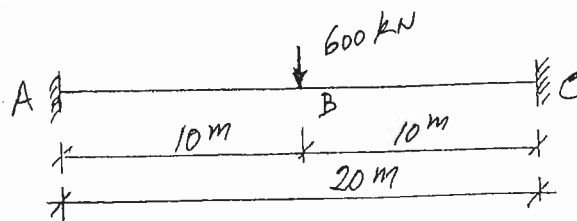


FIGURE 5

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Marking Scheme:

1. (12+6+2)

2. a(15) b(5)

3. a(16) b(4)

4. a(16) b(4)

5. (14+6)

6. (14+6)

7. (12+6+2)