**National Examinations – December 2011**

**98-Civ-A2, Elementary Structural Design**

**3 Hour 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 work book.

3. Solutions must be to the following standards:

| | |
|---|---|
| Steel: | CAN/CSA-S16 (latest edition) |
| Concrete: | CAN/CSA-A23.3 (latest edition) |
| Timber: | CAN/CSA-086 (latest edition) |

4. A total of **five** solutions are required. Only the first five as they appear in your answer book will be marked.

   Do **two** questions from Part A.
   Do **two** questions from Part B.
   Do the **one** question in Part C.

5. All questions are of equal value.

6. **All loads shown are unfactored**.

**Marking Scheme:**

| | |
|---|---|
| A1. | (12 + 8) |
| A2. | (10 + 10) |
| A3. | (4 + 8 + 8) |
| B1. | (12 + 8) |
| B2. | (5 + 10 + 5) |
| B3. | (6 + 7 + 7) |
| C1. | (10 + 6 + 4) |

***Part A (Do <u>two</u> of three questions)***

A1. Figure A1 shows a steel cross-section fabricated from 20 mm G40.21 350W steel plates.

(a) Determine the section moment of resistance about the centroidal axis, x-x.

(b) The section is used for a 7-m span simply supported beam. Calculate the maximum load it can carry at its centre. Assume lateral support to the beam is provided.

A2. A steel cantilever bracket ABC is bolted rigidly to a beam column CD of 10 m height, Figure A2.

(a) Design a steel section for the bracket ABC, for the loads shown.

(b) Design the bolted connection between the bracket and the beam-column.

A3. Design a steel section of G40.21 350W for the 10-m beam-column CD in Figure A2; assuming the column is fixed at the bottom and hinged at the top.

***Part B (Do <u>two</u> of three questions)***

B1. Figure B1 shows the cross-section of a reinforced concrete culvert. Calculate the moment of resistance $M_r$ and the shear resistance $V_r$ of the section. Use $f_c' = 35$ MPa and $f_y = 400$ MPa.

B2. Figure B2 shows the profile of a determinate reinforced concrete frame, ABC. Design a rectangular cross-section and the reinforcement for flexure and shear of beam AB. Use $f_c' = 35$ MPa and $f_y = 400$ MPa. Show the layout of the reinforcement.

B3. For the reinforced concrete frame in Figure B2, design the beam-column BC, assuming that the column is short. Use $f_c' = 35$ MPa and $f_y = 400$ MPa.

***Part C (Do question C1)***

C1. A 89 x 286 mm horizontal beam-column supports a solid wood roof decking over a span of 5 m. The factored vertical load is 2 kN/m and the factored axial load is 90 kN. The member is Douglas-fir No. 1 grade. The spacing of the beam-columns is 1 m centre-to-centre. Assuming the beam-column has adequate lateral support, check whether the member is adequate, assuming dry service conditions.

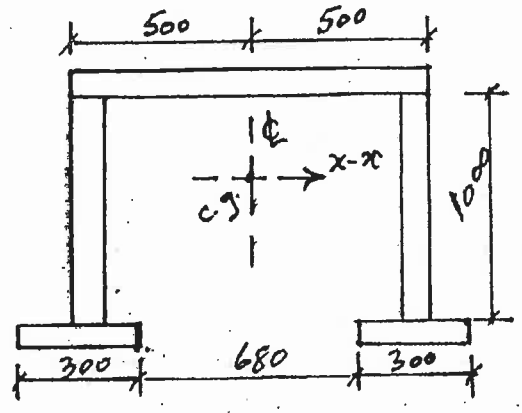


FIGURE A1

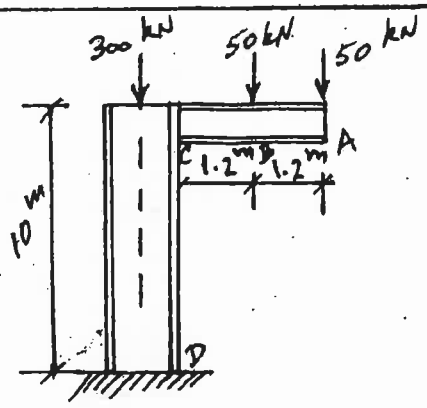


FIGURE A2

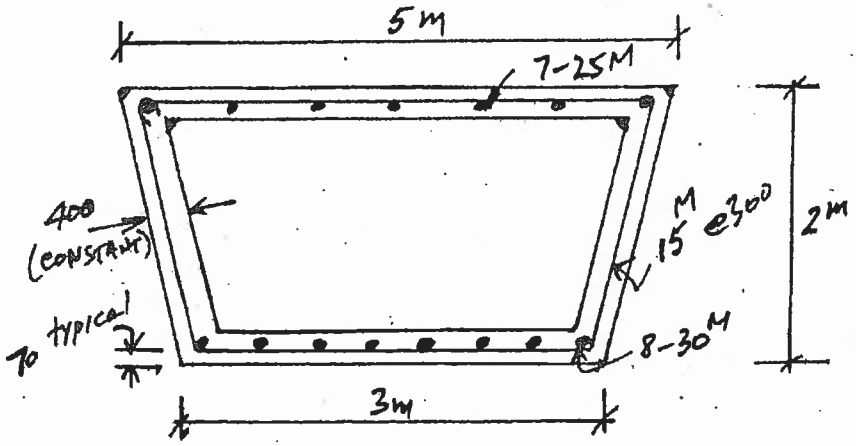


FIGURE B1

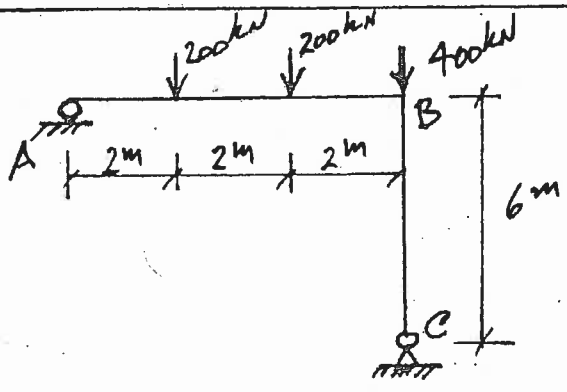


FIGURE B2