

National Examinations – December 2013

07-Str-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. However, 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, unless otherwise noted.

Marking Scheme:

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

**Part A (Do two of three questions)**

- A1. A steel cross-section fabricated from a hollow square section, 304.8 x 304.8, 12.7 mm wall thickness and 16 and 20 mm G40.21 300W steel plates, is shown in Figure A1. Determine the section moments of resistance about the two centroidal axes, a-a and b-b.
- A2. The loaded simply supported steel beam, W530 x 92, G40.21M 350W, in Figure A2 is bolted to the column, W610 x 195 of G40.21M 350W. Design a bolted connection between the steel beam and the column, as well as design the steel tie at B.
- A3. A sign standard post in Figure A3 is made of steel round hollow section of G40.21M 350W Class H, 273.1 mm OD and thickness of 12.7 mm. The post is a free standing column at the top and rigidly fixed to a concrete foundation. The post is subjected to two cantilevered loads, diametrically opposite to each other. Calculate the maximum factored load,  $P_r$ , that can be carried.

**Part B (Do two of three questions)**

- B1. Design a T-section for the simply-supported concrete beam in Figure B1. The amount and layout of the steel reinforcement are required to satisfy moment and shear. Take into account the self-weight of the beam. Use  $f_c' = 35$  MPa and  $f_y = 400$  MPa.
- B2. Figure B2 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.
- B3. Design a square cross-section for a concrete column 6 m long, assumed to be effectively fixed at both ends, and subjected to an axial load of 300 kN at the top as well as a concentrated horizontal wind load of 80 kN at its mid-height.

Use  $f_c' = 35$  MPa and  $f_y = 400$  MPa.

**Part C (Do question C1)**

- C1. The concrete column in Question B3 is to be designed in timber. Design a Douglas-fir glulam rectangular cross-section for the column to satisfy the following conditions:

Permanent load duration; dry service conditions; and, untreated.

[Assume any other data that may be required.]

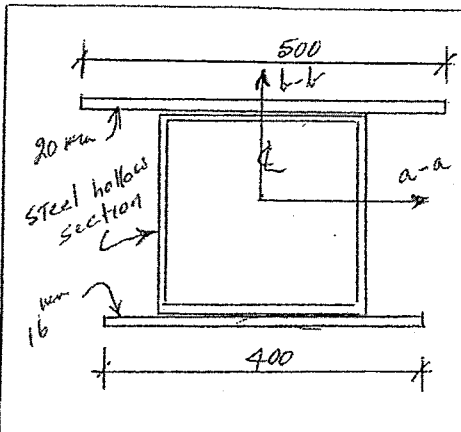


FIGURE A1

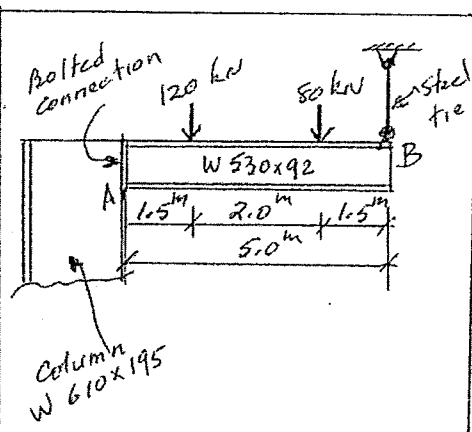


FIGURE A2

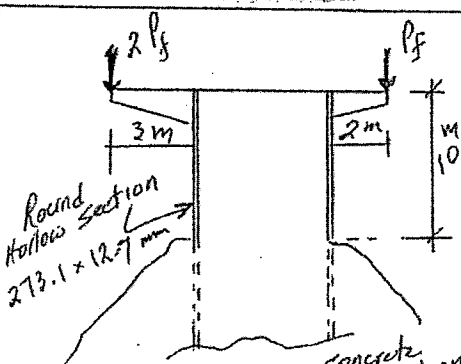


FIGURE A3

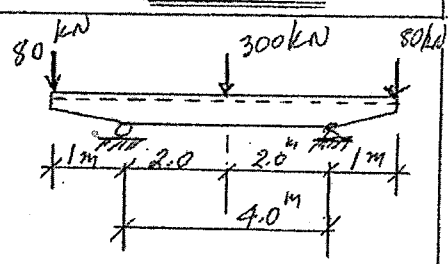


FIGURE B1

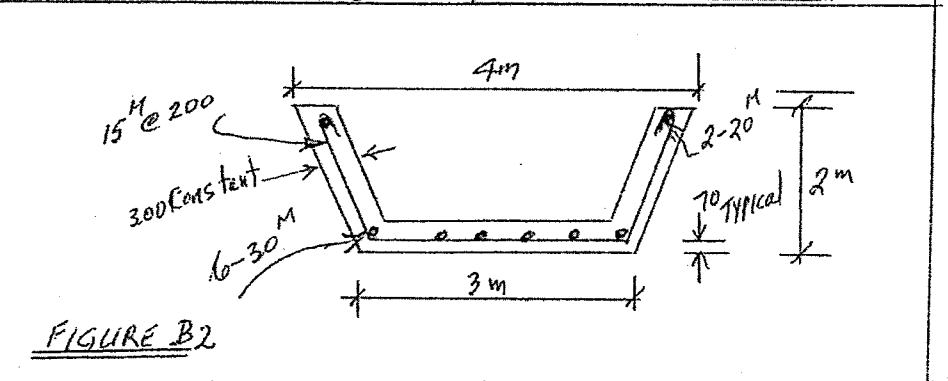


FIGURE B2