

National Examinations – May 2014

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 on the Handbooks, textbooks or loose sheets are allowed.** Candidates may use one of two calculators, the Casio or Sharp approved models.
3. Solutions must be to the following standards:

Steel:	CSA-S16 (latest edition)
Concrete:	CAN/CSA-A23.3 (latest edition)
Timber:	CSA-O86 (latest edition)
4. A total of **five** solutions is required. Only the first five as they appear in your answer book will be marked.

Do <b>two</b> questions from Part A.
Do <b>two</b> questions from Part B.
Do the <b>one</b> question in Part C.
5. All questions are of equal value.
6. **All loads shown are unfactored.**

Marking Scheme:

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

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

- A1. The ends of the steel wide flange beam, W530 x 92, G40.21 350W, in Fig. A1 are fixed to rigid columns, W610 x 125. Design a welded connection at B to transfer both moment and shear at B for the applied load shown. **Note:** Use the Steel Handbook to obtain the values of moment and shear at B.
- A2. A pedestrian bridge cross-section built-up from 20 mm G40.21-350W steel plates is shown in Fig. A2. Determine the moments of resistance of the cross-section about the centroidal axes x-x and y-y.
- A3. The ends of a 18-m long pedestrian bridge, whose steel-section is shown in Fig. A2 are subjected to a horizontal compressive force,  $P_f$ . The force is applied at C, a distance of 80 mm below the c.g. and along the y-y axis. The ends of the bridge can be assumed to be hinged. Calculate the maximum factored load,  $P_f$  that the bridge can sustain horizontally.

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

- B1. Figure B1 shows a loaded reinforced concrete determinate frame. Determine the dimensions of a rectangular cross-section and the required amount and layout of steel reinforcing for member ABC, to satisfy both moment and shear requirements. Use  $f'_c = 35$  MPa and  $f_y = 400$  MPa.
- B2. Design the column CD for the reinforced concrete frame in Fig. B1. The column can be assumed short. Use  $f'_c = 35$  MPa and  $f_y = 400$  MPa.
- B3. Figure B3 shows the cross-section of a reinforced concrete culvert. For the given dimensions and steel reinforcing, calculate its moment ( $M_r$ ) and shear ( $V_r$ ) resistances. Use  $f'_c = 35$  MPa and  $f_y = 400$  MPa.

**Part C (Do question C1)**

- C1. Single span oblique sawn timber purlins are required for a roof. Using treated D. Fir-L select structural grade, in wet service conditions, design the purlins to satisfy the following conditions: Purlin spacing = 2.2 m; Purlin span = 5 m, Roof pitch = 20.0°

Specified dead load (including weight of purlin) = 1.00 kPa;

Specified live load = 2.6 kPa. Assume standard duration of load.

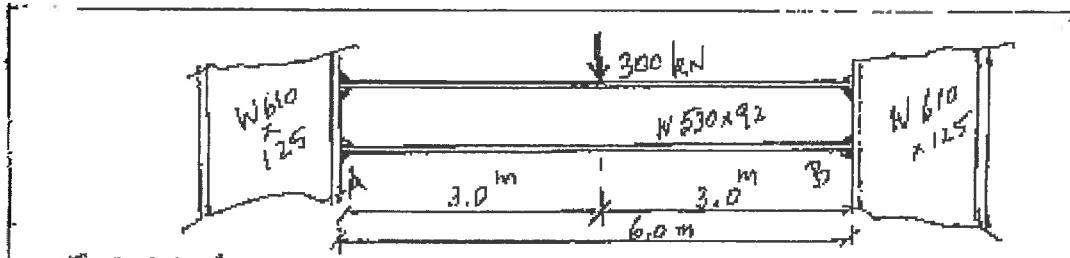


FIGURE A1

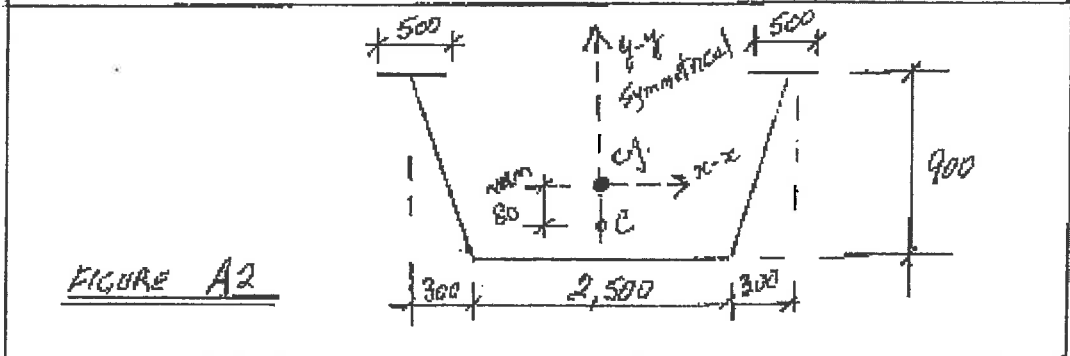


FIGURE A2

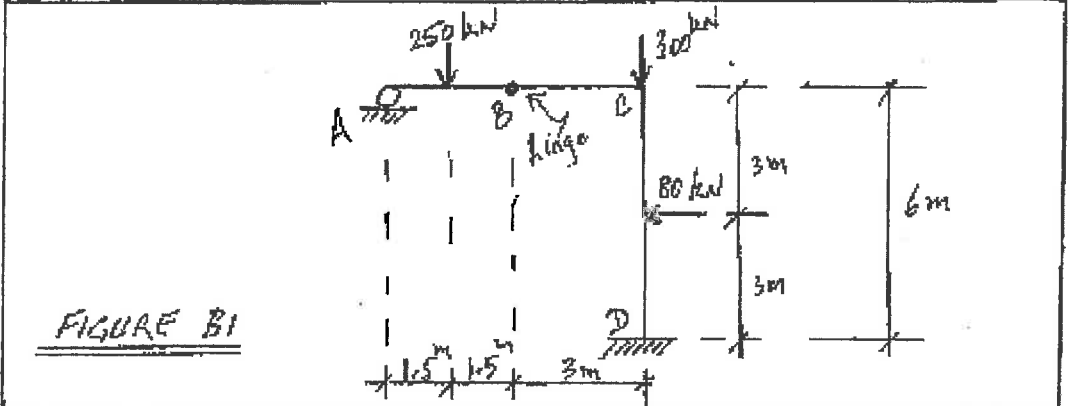


FIGURE B1

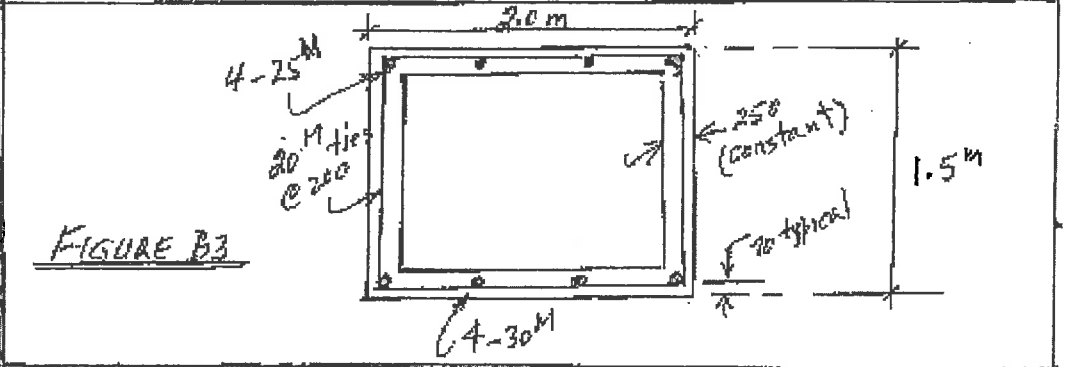


FIGURE B3