National Examinations – December 2018

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. 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:	CSA-S16 (latest edition)
Concrete:	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 **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. (10 + 5 + 5)
A2. (10 + 10)
A3. (12 + 8)
B1. (10 + 10)
B2. (8 + 6 + 6)
B3. (10 + 5 + 5)
C1. (8 + 6 + 6)

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

A1. A steel round hollow section of G40.21 350W Class H, 355.6 mm OD and thickness of 7.95 mm, is used as a column. The 10 m long column is subjected to a vertical bracket load P_f, applied at an eccentricity of 0.6 m. The column is hinged at the top and rigidly fixed at its base. Calculate the maximum factored load, P_f, that can be applied on the column.

A2. A simplified fuselage cross-section is shown in Figure A2. The cross-section is 2 m long and it is simply supported. It is loaded uniformly with 2.0 kPa, and assumed to be designed in one-way bending. Determine the thickness "h" of the section required. Use F_y = 350 Mpa

A3. A steel stub beam W360 x 79 (G40.21 350W) is bolted to a heavy steel column, W610 x 140 (G40.21 350W) on one side, and supported by a steel tie on the other side, as shown in Figure A3. For the loads shown, design the steel beam to column connection and the steel tie.

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

B1. A loaded R.C. determinate frame, Figure B1, is required for design. Using $f_{c'}$ = 35 Mpa and f_y = 400 Mpa determine the size of the member BC, and the required reinforcing steel for moment and shear.

B2. A reinforced concrete beam is shown loaded in Figure B2:

(a) Determine the size of its uniform cross-section; and
(b) Show the profile of the reinforcing steel along the entire beam.

Note: Include the weight of the concrete in your design.

Use $f_{c'}$ = 35 Mpa; and f_y = 400 Mpa

B3. For the loaded determinate frame in Figure B1, design a square cross-section for the column CD, and the corresponding reinforcing steel. Assume the column is short, free at D and monolithic at C.

Part C (Do question C1)

C1. The beam in Figure B2 is to be designed in timber for storage of heavy farm equipment. For the given loading conditions in Figure B2, design a Douglas-fir Glulam rectangular section for the beam ABC, under the following conditions: (a) Dry service conditions; (b) permanent load duration.

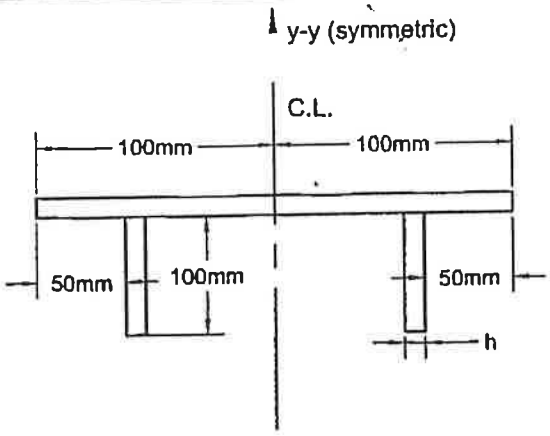

FIGURE A2

NOT TO SCALE

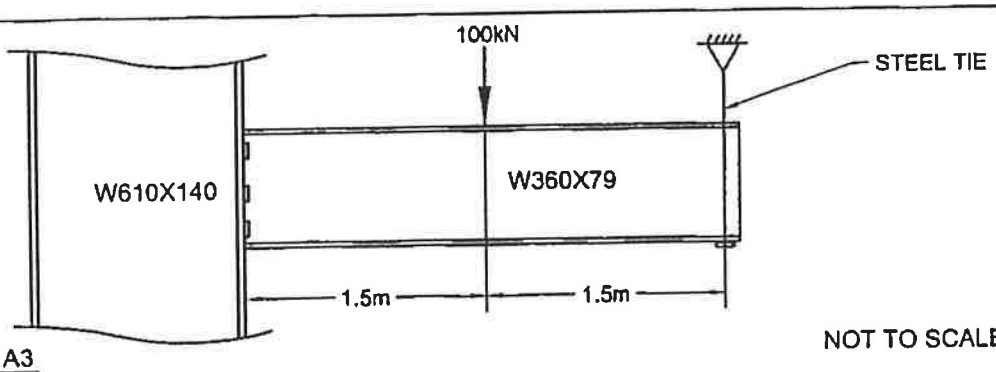

FIGURE A3

NOT TO SCALE

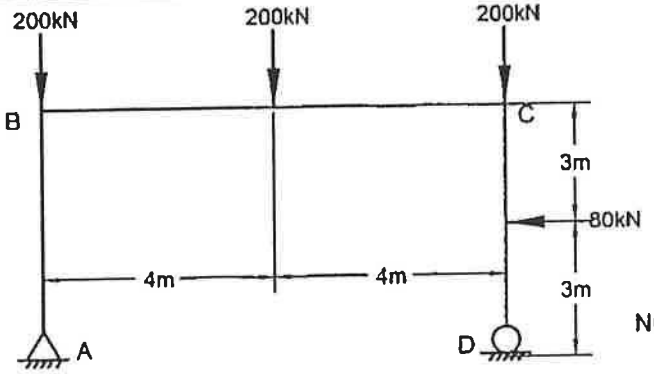

FIGURE B1

NOT TO SCALE

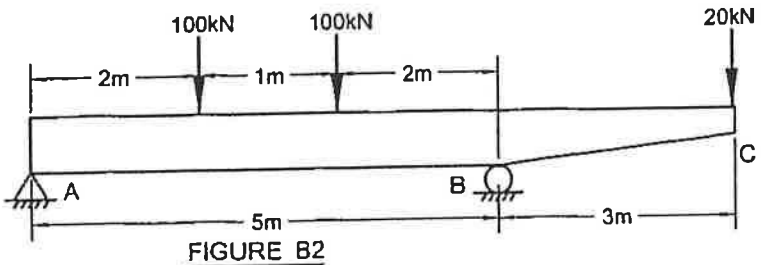

FIGURE B2

NOT TO SCALE