National Examinations – December 2015

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. Any textbooks are permitted as well as Design handbooks. **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 + 10)
A2: (8 + 12)
A3: (10 + 10)
B1: (12 + 8)
B2: (12 + 8)
B3: (10 + 5 + 5)
C1: (8 + 6 + 6)

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

A1. A light standard post in Figure A1 is made of steel round hollow section of G40.21 350W class H, 323.9 mm OD and thickness of 12.7 mm. The 10 m 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 and to a horizontal load as shown. Calculate the maximum factored load, P_F, that can be carried.

A2. The loaded simply supported steel beam, W530 x 109, G40.21M 350W, in Figure A2 is bolted to the column, W610 x 241 of G40.21M 350W and supported by a steel tie rod as shown. Design a bolted connection between the steel beam and column.

A3. A built-up steel cross-section, shown in Figure A3, is needed for an industrial building. The geometry of the cross-section is built up from 25 mm G40.21 350W steel plates. Determine the moments of resistance of the cross-section about the centroidal axis a-a and b-b.

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

B1. The cross-section of a reinforced concrete box girder is shown in Figure B1. Calculate the moment and shear resistances, M_r and V_r respectively, of the cross-section. Use $f_c' = 35$ MPa and $f_y = 400$ MPa.

B2. A 6 m reinforced concrete beam with an overhang of 2 m is subjected to a live load of 50 kN/m. Design the beam for moment and shear and sketch the reinforcing details. Take into account the self-weight of the beam. Use $f_c' = 35$ MPa and $f_y = 400$ MPa.

B3. Design a reinforced concrete square cross-section for a 7 m high column. The column, fixed at both ends, is subjected to a vertical eccentric load of 1000 kN at an eccentricity of 0.2 m from the centroid of the cross-section and along the horizontal axis of symmetry. Use $f_c' = 35$ MPa and $f_y = 400$ MPa.

Part C (Do question C1)

C1. An isolated joist of 5 m span is to be loaded with a specified central concentrated dead load of permanent duration. The joist is unseasoned 130 x 304 mm Douglas-fir No. 2 grade treated with a fire-retardant treatment. Determine the maximum concentrated load the joist can carry for the following conditions:

(i) Wet service conditions;
(ii) Account for the self-weight of the joist;
(iii) Simply supported ends, held in position to prevent lateral displacement and rotation; and
(iv) Deflection not to exceed 8 mm.

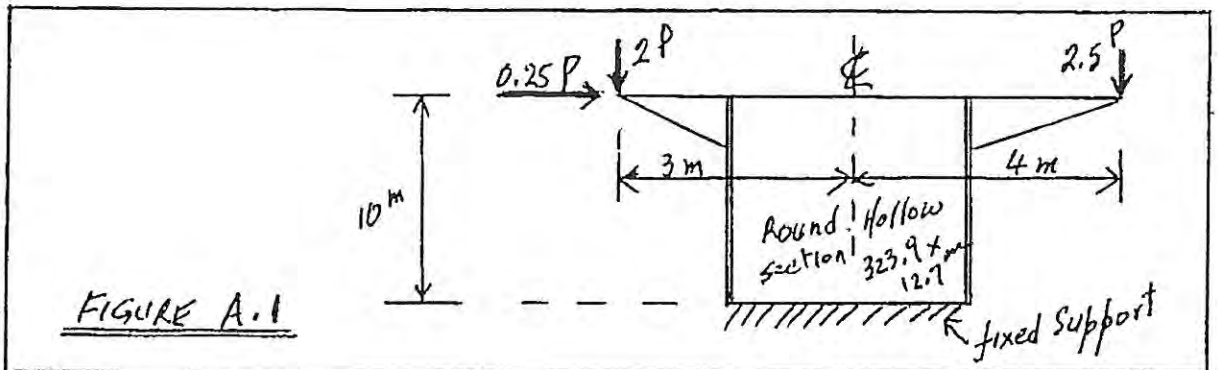

FIGURE A.1

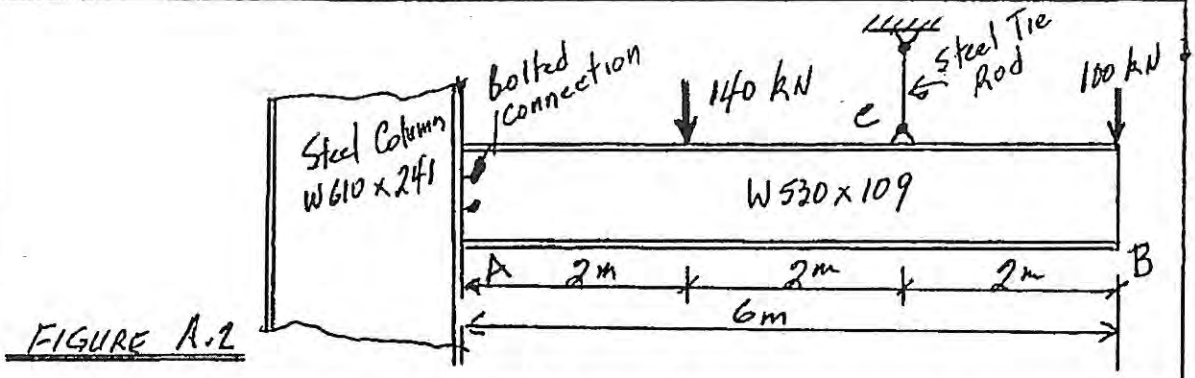

FIGURE A.2

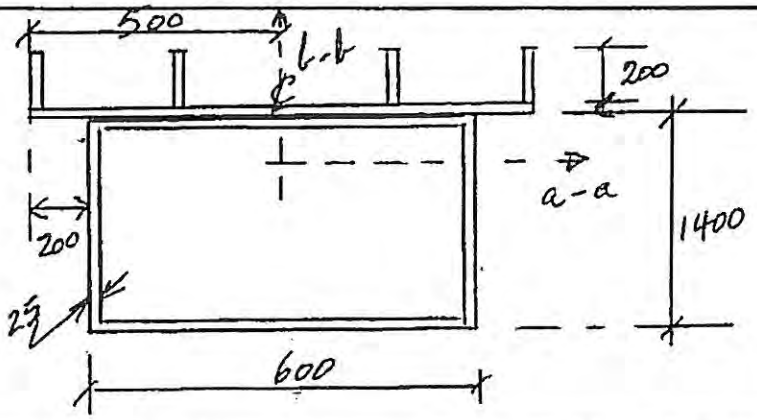

FIGURE A.3

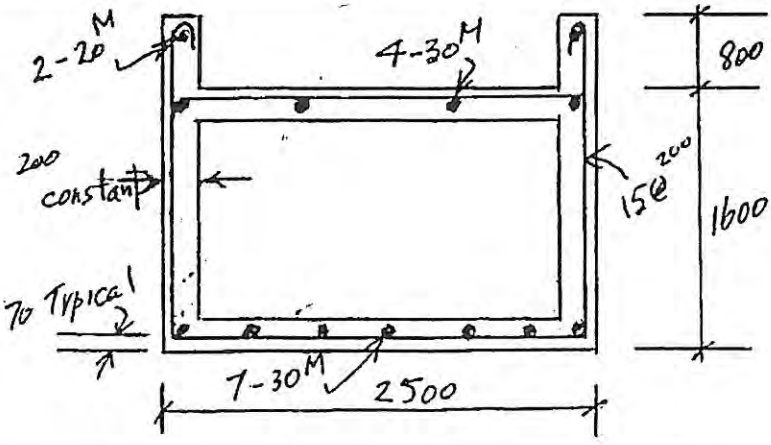

FIGURE B.1