**07-Bld-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:   (12 + 8)
A2:   (10 + 10)
A3:   (8 + 12)
B1:   (8 + 8 + 4)
B2:   (8 + 6 + 6)
B3:   (12 + 8)
C1:   (8 + 6 + 6)

[Assume any other data that may be required].

## Part A (Do two of three questions)

A1.    Figure A1 shows a steel cross-section fabricated from 25 mm G40.21 350W steel plates. Determine the section's moments of resistance about the two centroidal axes, a-a and b-b. Assume fully lateral restraint along the length.

A2.    A 10-m steel pole made of a round hollow section, of G40.21 350W class H, 406.4 mm OD and thickness of 9.53 mm, is used as a column. The column's top is subjected to a vertical bracket load, $P_F$, applied at an eccentricity of 1.2 m. The column is free standing at the top and rigidly fixed at its base. Calculate the maximum factored load, $P_F$, that can be applied.

A3.    The loaded steel beam ABD shown in Figure A3 is supported at A by a bolted shear connection to the column W530 x 138 and at B by a steel tie BC.

   (a) Select a steel section for the beam ABD; and
   (b) Design the steel tie BC.

   [Note: Ignore the self weight of the structure.]

## Part B (Do two of three questions)

B1.    Design a T-section for the simply supported concrete beam, with an overhang as shown in Figure B1. Determine the amount and layout of the steel reinforcement 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.    For the reinforced concrete frame in Figure B2, design the column ABC. (Use $f_c' = 35$ MPa and $f_y = 400$ MPa.)

B3.    A triple T cross-section of reinforced concrete beam is shown in Figure B3. 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.    The determinate frame shown in Figure B2 is to be designed in timber for a farm building. Design a Douglas-fir glulam rectangular cross-section for the column ABC to satisfy the following conditions:

   • Permanent load duration, • wet service conditions, and • untreated.
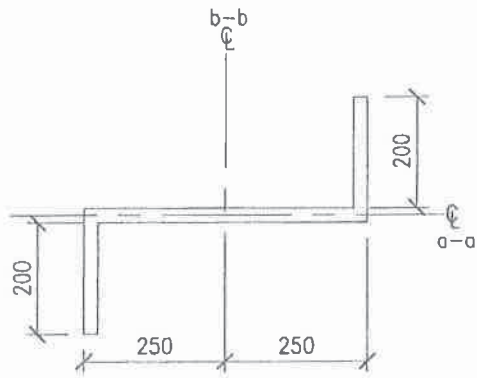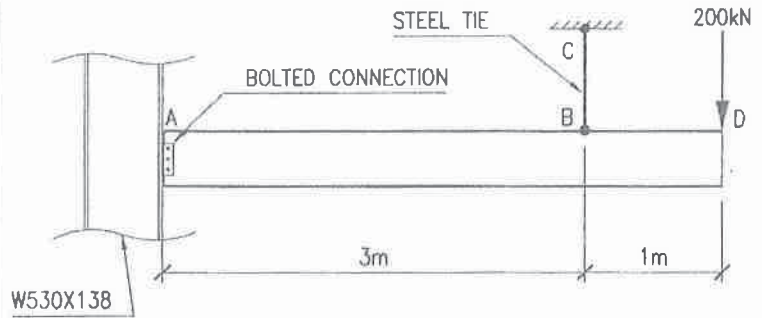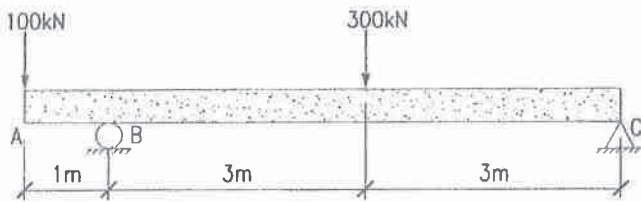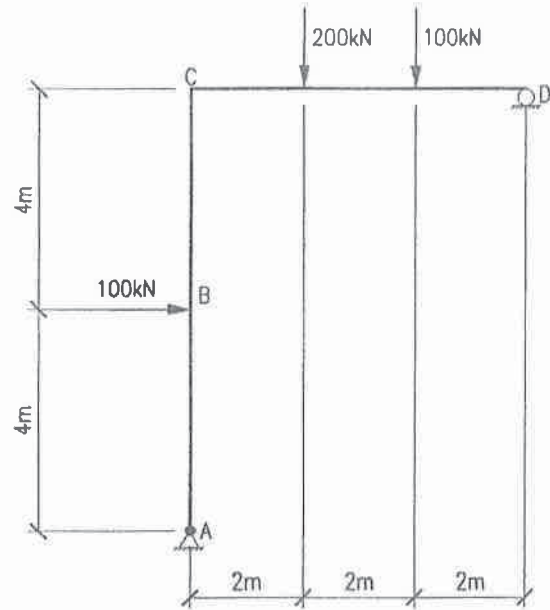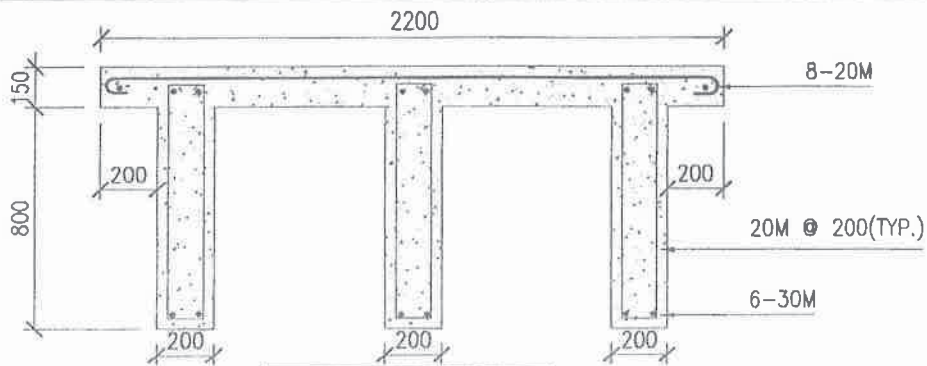
[Assume any other data that may be required].

FIGURE A1



FIGURE A3



FIGURE B1



FIGURE B2



ALL UNITS IN MILLIMETERS

FIGURE B3