National Examinations December 2002

98-CIV-A2 ELEMENTARY STRUCTURAL DESIGN

3 hours duration

NOTES

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. Any non-communicating calculator is permitted. This is an **"OPEN BOOK"** examination. Note to candidates: 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-S16.1 (latest)
Concrete:	CAN/CSA-A23.3 (latest)
Timber:	CAN/CSA-O86.1 (latest)

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.

PART A (do two of three questions)

A1 The beam shown in Figure A1 is simply-supported at A, B, E and F, is pinned at C and D and has a laterally supported top flange along its entire length. AC and BF are W610x195 and CD is W460x97, all beams being G40.21-M350W. There is a uniformly-distributed dead load of 50 kN/m over the entire beam and a uniformly-distributed live load $\mathbf{w_L}$ kN/m that can be placed anywhere along the beam. Calculate the maximum value of $\mathbf{w_L}$ permitted on the beam and show on a sketch where this load would be located.

A2 The beam shown in Figure A1 is supported on HSS 203x203x11 G40.21-350W columns at A, B, E and F. The columns are laterally unsupported over a height of 5000 mm and may be considered pin-ended.

a) Based solely on column resistance, what is the maximum factored total load $\mathbf{w_F}$ kN/m that can be placed on the beam? Identify the critical columns, and show on a sketch where the live load should be placed.

b) **Briefly** discuss any special precautions that should be taken at A, B, E and F during beam design..

A3. A 16 mm steel plate is welded to a steel member with the three 12mm fillet welds shown in Figure A3. If the steel is G40.21-M300W and the electrode E480XX, what is the maximum factored load $\mathbf{P_F}$ kN that can be applied to the connection?

PART B (do two of three questions)

B1. Figure B1 shows the cross section of a 400x400 concrete column reinforced with 8 – 25M longitudinal bars and 10M ties spaced at 300 mm. Assuming a short column, calculate three points a $\mathbf{P_R}$ / $\mathbf{M_R}$ interaction diagram. Sketch the interaction diagram.
Use f_c' = 35 MPa and f_y = 400 MPa.

The tee section shown in Figure B2 spans 12.0 m simply supported at its ends and is reinforced with 4 - 30M longitudinal bars. Calculate the moment of resistance $\mathbf{M_R}$ kN.
Use f_c' = 35 MPa and f_y = 400 MPa.

B3. If the tee section shown in Figure B2 is reinforced for shear with 15M rectangular ties spaced at 300 mm, what is the shear resistance $\mathbf{V_R}$ kN of the section?
Use f_c' = 35 MPa and f_y = 300 MPa.

PART C (do question C1)

Figure C1 shows a plywood box beam with 2 – 38x140 top and bottom flanges and 12 mm plywood webs. List the main features that must be considered in design, commenting **briefly** on each.

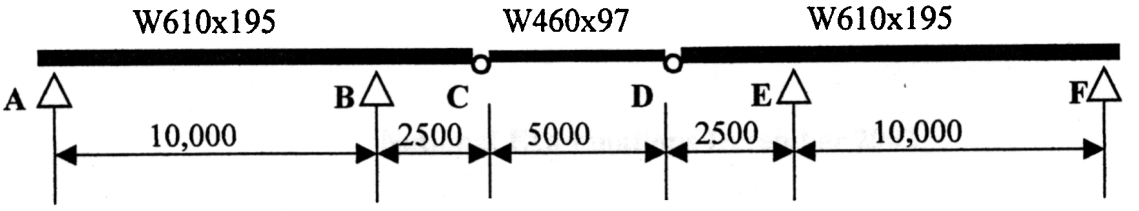


Figure A1

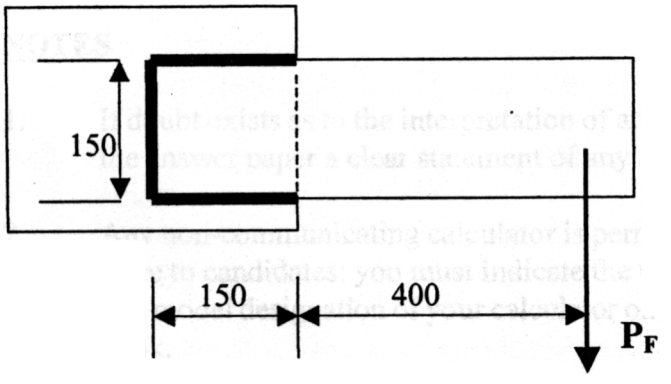
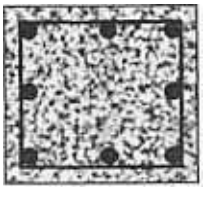


Figure A3



400x400 column
8 – 25M bars vertical
10M ties @ 300
50mm concrete cover

Figure B1

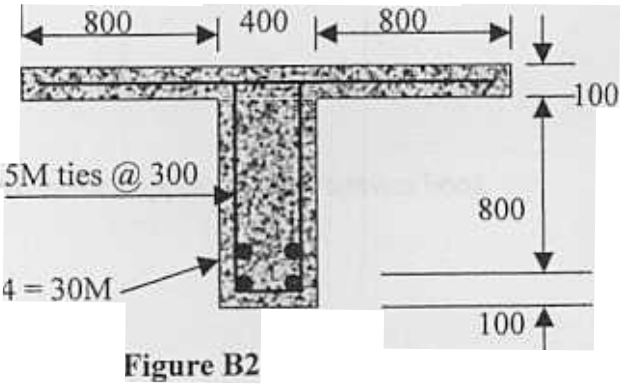
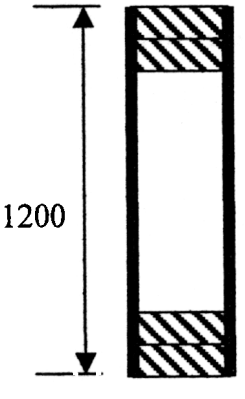


Figure B2



Plywood box beam
2 – 38x140 top and bottom

Figure C1