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Hong Kong Institute

of

Vocational Education

香港專業教育學院

[redacted]

HD in Civil Engineering

(EG114101)

[redacted]

Steelwork Design

(C O N 4 3 3 4)

[redacted]

AY 2017/18

Semester Four Examination

8th January 2018

1:30 pm – 3:30 pm

[redacted]

Notes :

1. The result of this examination will not be counted if you do not meet the minimum attendance requirement governed by the General Academic Regulations of your programme unless approval from the Campus Principal has been granted.
2. This paper consists of **SIX (6)** pages including this cover page.
3. **There are two sections in this paper. Section A contains a compulsory question with a total of 40 marks. Section B is comprised of choice questions and carries a total of 60 marks.**
4. **Answer ALL questions in Section A. Answer ANY TWO (2) questions in Section B.**
5. All symbols have their usual meaning unless otherwise defined.
6. All dimensions are in millimeter unless otherwise stated.
7. All figures are NOT necessary to scale.
8. Examination Data:
   THIRTY-FIVE (35) pages of examination data are provided for reference.

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SECTION A: COMPULSORY QUESTION (40%)

AQ.1 (a) A floor plan of a storage area is as shown in ***Figure AQ1***. Compression flanges of the steel beams (Beam B1 and B2) are fully restrained from lateral torsional buckling by concrete slabs. The concrete slabs are 180 mm thick supporting additional finishes load of 0.4 kN/m^2. The imposed load on the slabs is 4.5 kN/m^2. All steel beams are Grade S355 and simply supported at their ends. Unit weight of concrete is assumed to be 24.5 kN/m^3. All the beams are carrying brittle finishes.

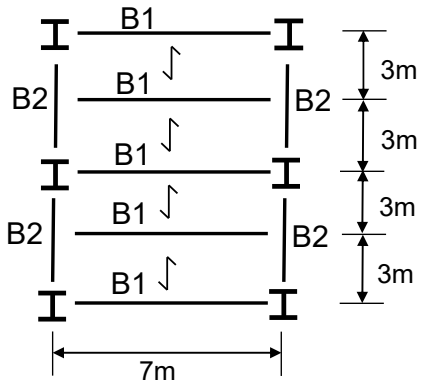
(i) Determine the factored load intensity (in kN/m^2) carried by the slabs. (4 marks)

(ii) With consideration of beam self-weight, calculate the maximum factored shear forces and bending moments of Beam B1 and Beam B2. (8 marks)

(iii) Find the section classes of the steel beam B1 and B2. (4 marks)

(iv) Check the adequacy of steel beam B1 against shear, bending and deflection. (10 marks)

(v) Check the adequacy of steel beam B2 against shear, bending and deflection. (10 marks)



Beam B1: 356 x 171 x 67 kg/m UB
Beam B2: 406 x 178 x 74 kg/m UB

Figure AQ1

(b) With the aid of a diagram, describe the difference of use of channel and circular hollow steel sections in structural steel design. (4 marks)

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Section B – Answer any <u>TWO</u> questions in this Section.

BQ.1 (a) Two 10 mm thick steel plates are bolted to the flanges of a 203x203x60kg/m UC to form a bracket as shown in ***Figure BQ1(a).*** The designed point load P_u of 800kN has a 200 mm eccentricity from centerline of the steel column. All steel plates are of ***Grade S355*** and all bolts are of ***Grade 8.8*** M16 with 18 mm holes.

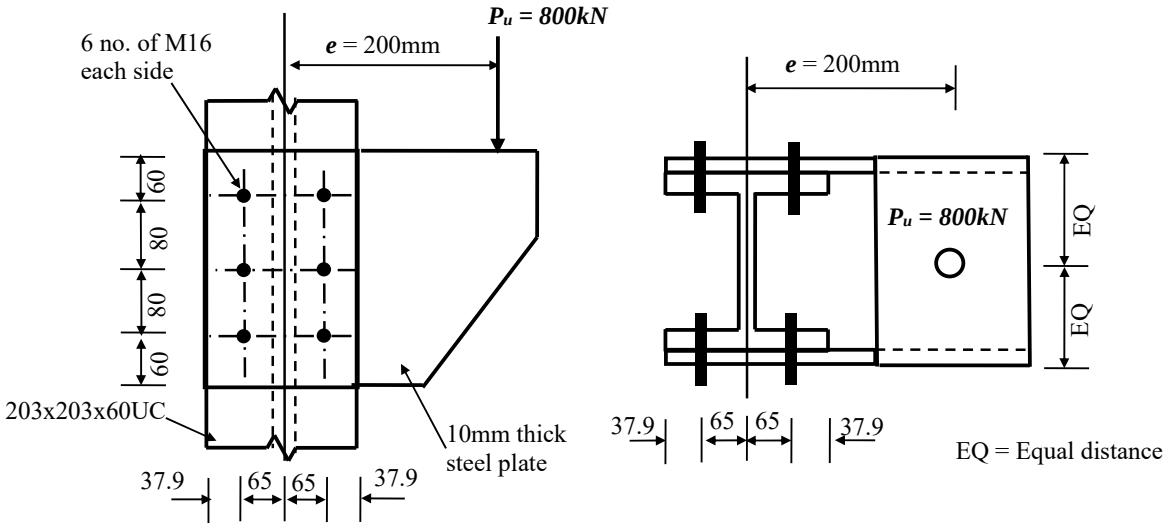
(i) Determine the designed load and designed torsional moment on one plate of the bracket. (2 marks)

(ii) Determine the maximum resultant shear load on a bolt. (5 marks)

(iii) Check the shear capacity of the bolts. (2 marks)

(iv) Check the bearing capacity of the bolts. (2 marks)

(v) Check the bearing capacities of the plates. (6 marks)



<u>Figure BQ1(a) (dimension in mm)</u>

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(b) A tension splice connection as shown in ***Figure BQ1(b)*** is subjected to a designed tensile load of 1000 kN. The main plate is 26 mm thick and the cover plates are 14 mm thick. All steel plates are of grade ***S355*** and the electrode is of ***Class 42***. Assuming the leg length of fillet weld is 12mm.

(i) Check the tensile strength of cover plates and main plate. (5 marks)

(ii) Design the weld length of fillet weld to be provided for the connection. (Provide the answers to the nearest 5mm).
(4 marks)

(iii) Sketch the welding arrangement. (4 marks)

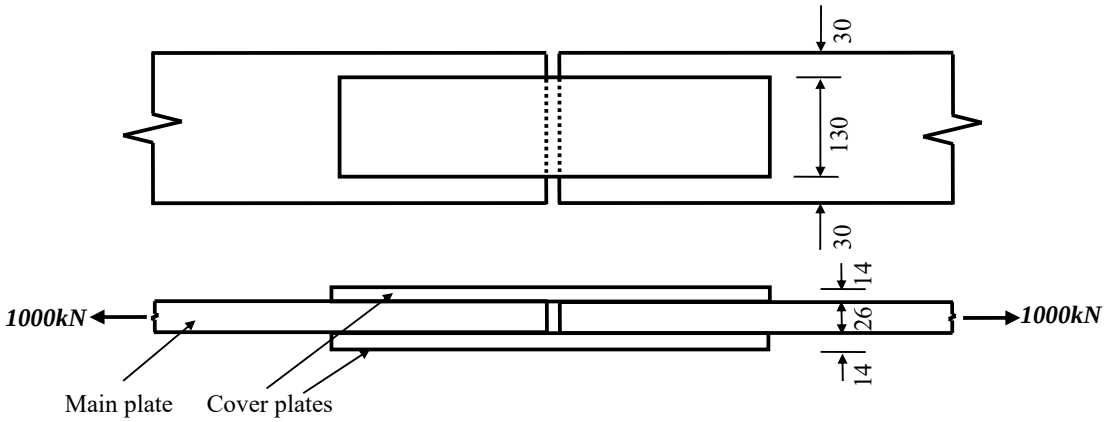


Figure BQ1(b) (dimension in mm)

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BQ.2 A steel column with effective length of 6.0m is subjected to factored end loads as shown below. Check the adequacy of the column section if 254 x 254 x 107 kg/m UC section (Grade S355) is being used.

Loadings:
Factored axial compression = 1200 kN

Factored moment about x-x axis, $M_{x\text{-}x}$, at top of column = +100 kNm
Factored moment about x-x axis, $M_{x\text{-}x}$, at bottom of column = +50 kNm
Amplification factor for P-$\triangle$- δ effect in x-x axis = 1.2

Factored moment about y-y axis, $M_{y\text{-}y}$, at top of column = +50 kNm
Factored moment about y-y axis, $M_{y\text{-}y}$, at bottom of column = -25 kNm
Amplification factor for P-$\triangle$- δ effect in y-y axis = 1.1

Ultimate moment amplified for P-$\triangle$- δ effect governing M_b, M_{LT} = +100 kNm

Note: (+ve for clockwise moment, -ve for anti-clockwise moment)

(30 marks)

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BQ.3 The factored design loads on a 9m long simply supported steel beam are shown in ***Figure BQ3***. Lateral restraints are provided at the supports **A** & **D** and at **B** & **C** respectively. The size of steel beam is 457x191x98 kg/m (Grade S355).

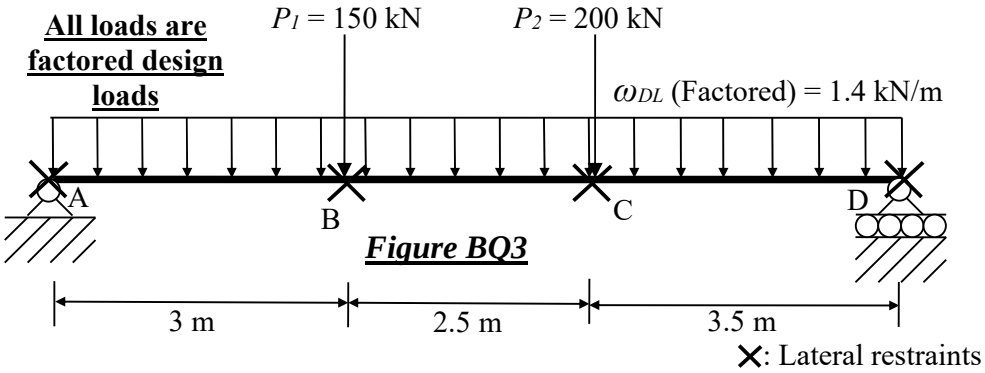


Figure BQ3

(a) Determine the support reactions of the beam. (3 marks)

(b) Draw the annotated shear force and bending moment diagram of the beam. (4 marks)

(c) Check the buckling moment resistance of the steel beam in segment **BC** by using accurate values of parameters ***u*** and ***v*** in the calculation of λ_{LT}. (13 marks)

(d) Check the buckling moment resistance of the steel beam in segment **CD** by using accurate values of parameters ***u*** and ***v*** in the calculation of λ_{LT}. (10 marks)

- END OF PAPER -