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Hong Kong Institute

of

Vocational Education

香港專業教育學院

HD in Civil Engineering

(EG114101)

Steelwork Design

(C O N 4 3 3 4)

AY 2014/15

Semester One Examination

3 January 2015

9:30 am – 11:30 am

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 FIVE (5) pages including this cover page.
3. **There are two sections in this paper. Section A contains compulsory questions 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) Floor plan of a storage area is as shown in ***Figure Q1***. Compression flanges of the steel beams (Beam B1-B3) are fully restrained from lateral torsional buckling by concrete slabs. The concrete slabs are 130 mm thick supporting additional finishes load of 2.0 kN/m^2. The imposed load on the slabs is 5.0 kN/m^2. All steel beams are Grade S355 and simply supported at their ends. Unit weight of concrete is assumed to be 24 kN/m^3. All the beams are carrying brittle finishes.

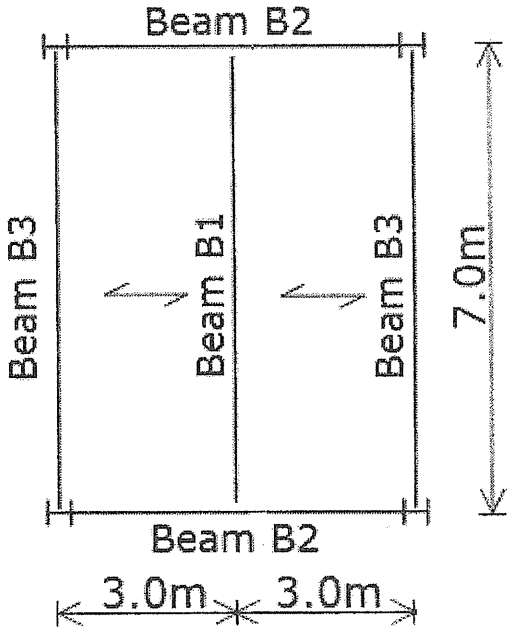
(i) Determine the factored load intensity (in kPa) carried by the slabs. (4 marks)

(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 51 kg/m UB
Beam B2: 457 x 152 x 52 kg/m UB

Figure Q1

(b) With the aid of a sketch, explain the second-order elastic P-Δ and P-δ method of analysis suggested by the *Code of Practice for Structural Use of Steel 2011* in Hong Kong. (4 marks)

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Section B – Answer any TWO questions in this Section.

BQ.2 (a) A tension splice connection is shown in ***Figure Q2(a)***. The main plate is 20 mm thick and the cover plates are 10 mm thick. All steel plates are of ***Grade S355*** and all bolts are of ***Grade 8.8*** M16 with 18 mm holes. Show that the connection has adequate strength to resist a design tensile load of 600 kN. (18 marks)

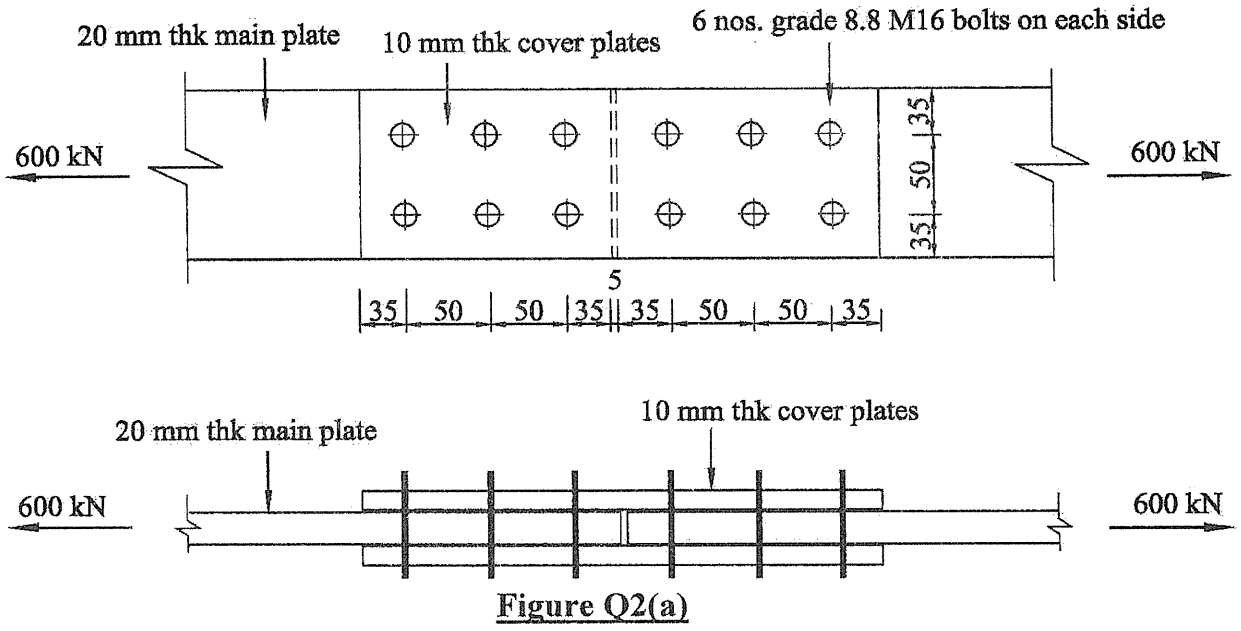


Figure Q2(a)

(b) The steel bracket as shown in ***Figure Q2(b)*** is subjected to a design load of 350 kN. Determine the sizes of fillet welds required in the web and in the flanges of the bracket connection. The steel is of grade ***S355*** and the electrode is of ***Class 42***. You may assume the fillet welds in the web and the flanges resist the design shear force and the design bending moment respectively. (12 marks)

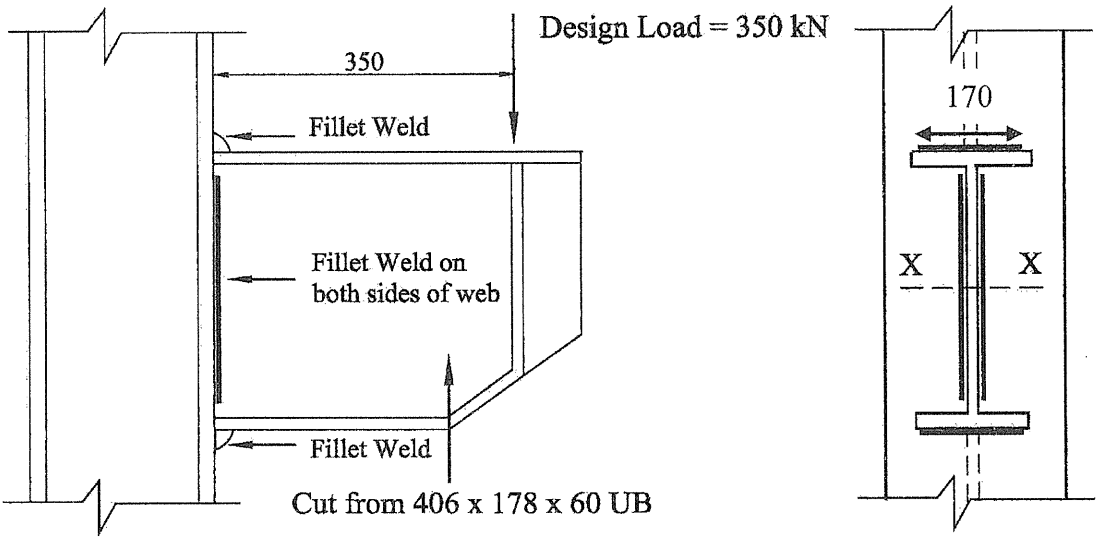


Figure Q2(b) ***(dimension in mm)***

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BQ.3 A steel column between floors of a multi-storey building is subjected to the following eccentric loadings due to beam support reactions as shown in ***Figure Q3***. Stiffnesses of the upper and the lower columns are the same. Check the structural adequacy of a 254 x 254 x 132 kg/m UC (**Grade S355**) if the actual column height is 7.0 m and the effective length of the column is 5.95 m. All the loadings shown below are factored loads. All moment factors are assumed to be 1.0 unless stated otherwise.

Given:

F = 1260 kN including self-weight acting at the centre of the column.

F_{x1} = 300 kN with an eccentricity e_y of 175 mm measured from the y-axis, due to beam reactions.

F_{x2} = 180 kN with an eccentricity e_y of 120 mm measured from the y-axis, due to beam reactions.

F_{y1} = 360 kN with an eccentricity e_x of 250 mm measured from the x-axis, due to beam reactions.

Moment amplification factor P-Δ-δ effect for all moments = 1.15.

(30 marks)

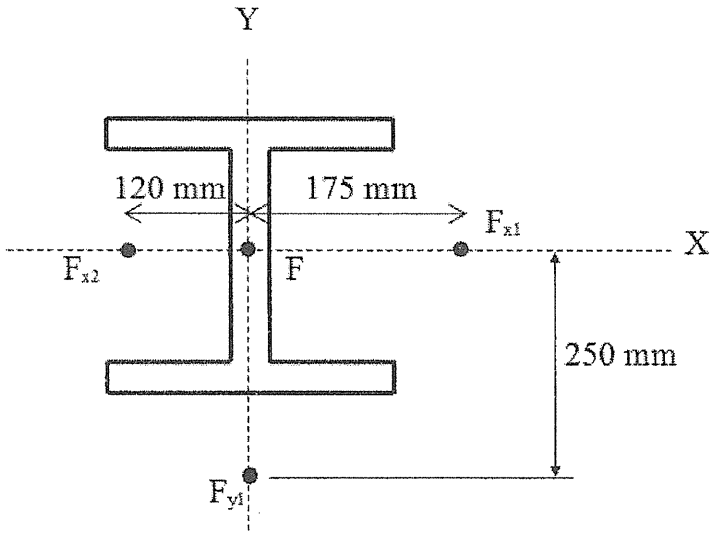


Figure Q3

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BQ.4 A simply supported steel beam with brittle finishes and a span of 9.0 m is subjected to a point load in the middle of the span and the maximum factored loadings are calculated as follows. **Lateral restriants on the compression flange of the steel beam are provided at the end supports only.** Sectional dimension of the beam is 457 x 191 x 98 kg/m UB (Grade S355).

- Design Moment = 450 kNm
- Design Shear Force = 100 kN

(a) Determine the class of the steel beam section. (4 marks)

(b) Calculate the shear capacity of the steel beam and also confirm the adequacy of the steel beam section for shear resistance. (4 marks)

(c) Find the buckling moment resistance of the steel beam by using accurate values of parameters u and v in the calculation of λ_{LT}. (16 marks)

(d) Check the deflection of the beam if the beam is under an unfactored imposed point load of 70kN in the middle of span. (4 marks)

(e) Suggest one factor to increase the lateral buckling resistance of the beam. (2 marks)

- END OF PAPER -