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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 2015/16

Semester One Examination

8 January 2016
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) 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 140 mm thick supporting additional finishes load of 0.5 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.

Given the maximum deflection of Beam B2 is:

$$\Delta_{max} = \frac{PL^3}{24EI}\left[\frac{3a}{L} - 4\left(\frac{a}{L}\right)^3\right]$$

Where
a is the distance measured from the support to the nearest point load.
L is the span of steel beam
P is a point load

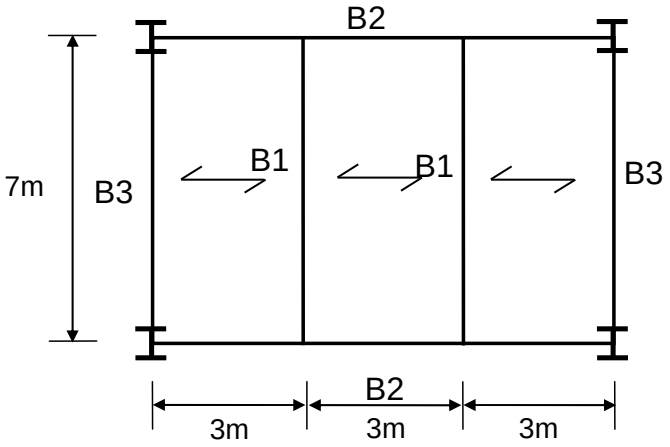
(i) Determine the factored load intensity (in kPa) carried by the slabs. (4 marks)

(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: 406 x 140 x 46 kg/m UB
Beam B2: 610 x 305 x 149 kg/m UB

Figure Q1

(b) Sketch two methods of fire protection for UB sections. (4 marks)

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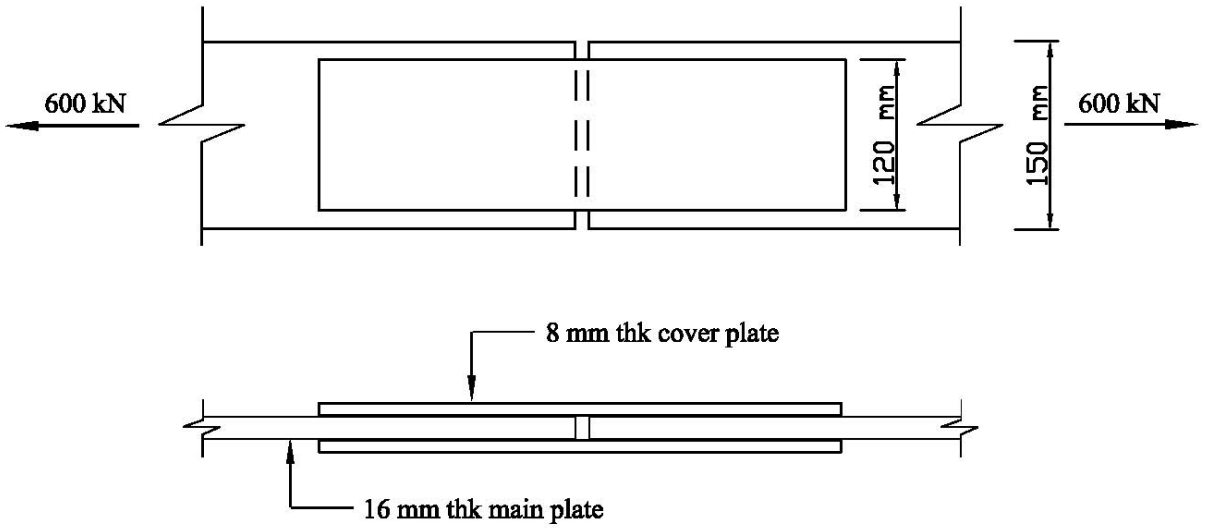
Section B – Answer any <u>TWO</u> questions in this Section.

BQ.1 (a) A tension splice connection as shown in ***Figure Q2(a)*** is subjected to a design tensile load of 600 kN. The main plate is 16 mm thick and the cover plates are 8 mm thick. All steel plates are of ***Grade S355***.

(i) Show that the cover plates and main plate have adequate strength to resist the design tensile load of 600 kN; (5 marks)

(ii) Design the weld size and weld length of fillet weld required for the connection. Given that Class 42 electrodes are to be used; (4 marks)

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



<u>Figure Q2(a)</u>

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(b) The steel bracket as shown in ***Figure Q2(b)*** is subjected to a design load of 350 kN. All the bolts are ***M20 Grade 8.8*** bolts, and steel members are of ***Grade S355***.

(i) Determine the shear and bearing capacity of the bolts; (8 marks)

(ii) Hence check the adequacy of the bolts for the bracket connection. (9 marks)

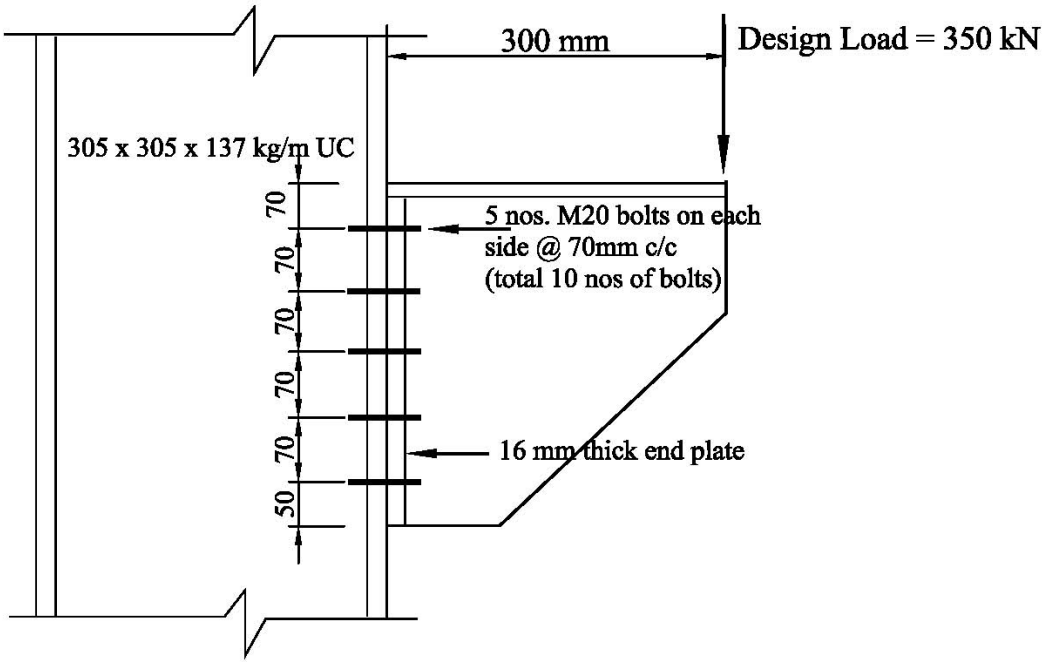


Figure Q2(b) ***(dimension in mm)***

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BQ.2 A 6.0 m long braced steel column in a non-sway frame is subjected to factored end loads as shown below. The column is pinned at one end and fixed at the other end. Assume that the ***K*** value for effective length is 0.85, check the adequacy of the column section of 305 x 305 x 137 kg/m UC (***Grade S355***).

Given:

Factored axial load = 1800 kN
Factored moment about ***x-x*** axis, $\boldsymbol{M_{x\text{-}x}}$ at top of column = +150 kNm
Factored moment about ***x-x*** axis, $\boldsymbol{M_{x\text{-}x}}$ at bottom of column = +70 kNm
Amplification factor ***P-Δ-δ*** effect in ***x-x*** axis = 1.1
Factored moment about ***y-y*** axis, $\boldsymbol{M_{y\text{-}y}}$ at top of column = +90 kNm
Factored moment about ***y-y*** axis, $\boldsymbol{M_{y\text{-}y}}$ at bottom of column = -50 kNm
Amplification factor ***P-Δ-δ*** effect in ***y-y*** axis = 1.2
Factored moment amplified for ***P-Δ-δ*** effect governing $\boldsymbol{M_b}$:
$\boldsymbol{M_{LT}}$ = 1.1 x 150 = 165 kNm
(Note: Positive sign for clockwise moment; negative sign for anti-clockwise moment)

(30 marks)

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BQ.3 A simply supported steel beam with brittle finishes and a span of 7.0 m is subjected to a uniformly distributed load in whole span, The maximum factored loading data are given as follows. **Lateral restraints on compression flange of the steel beam are provided at the end supports only.** The sectional dimension of the beam is 457 x 191 x 74 kg/m UB (Grade S355).

- Design Moment = 175 kNm
- Design Shear Force = 100 kN

(a) Determine the class of the steel beam section. (2 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}. (15 marks)

(d) Check the deflection of the beam if the beam is under an unfactored imposed uniformly distributed load of 9 kN/m in the whole span. (3 marks)

(e) Sketch the deformation of the beam by lateral torsional buckling. (4 marks)

(f) Sketch the diagram for a restraint in the mid-span of steel beam. (2 marks)

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