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Hong Kong Institute

of

Vocational Education

香港專業教育學院

[redacted]

HD in Civil Engineering

(EG524101)

[redacted]

Steelwork Design

(C O N 4 3 3 4)

[redacted]

AY 2015/16

Semester Two Examination

11 May 2016

7:00 pm – 9:00 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 FIVE (5) pages including this cover page.
3. **Answer a total of THREE (3) questions, Question 1 must be answered. Answer any TWO (2) questions from Questions 2, 3 and 4.**
4. **Question 1 carries 40 marks. Question 2, Question 3 and Question 4 carry 30 marks each.**
5. All symbols have their usual meaning unless otherwise defined.

Examination Data:

1. **Unit weight of concrete, γ_w = 24.5 kN/m^3**
2. **All steel members are of Grade S355 unless stated otherwise.**
3. **All dimensions are in mm unless stated otherwise.**
4. **THIRTY-FIVE (35) pages of examination data are provided for reference.**

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SECTION A: COMPULSORY QUESTION (40%)

AQ.1 (a) A typical floor plan of a commercial building is shown in **Fig. AQ.1**. Compression flanges of the steel beams (Beam B1-B2) are fully restrained from lateral torsional buckling by concrete slabs. The concrete slabs are 150 mm thick supporting additional finishes load of 2.0 kN/m^2. The imposed load on the slabs is 3.0 kN/m^2. All steel beams are simply supported at their ends and carrying brittle finishes.

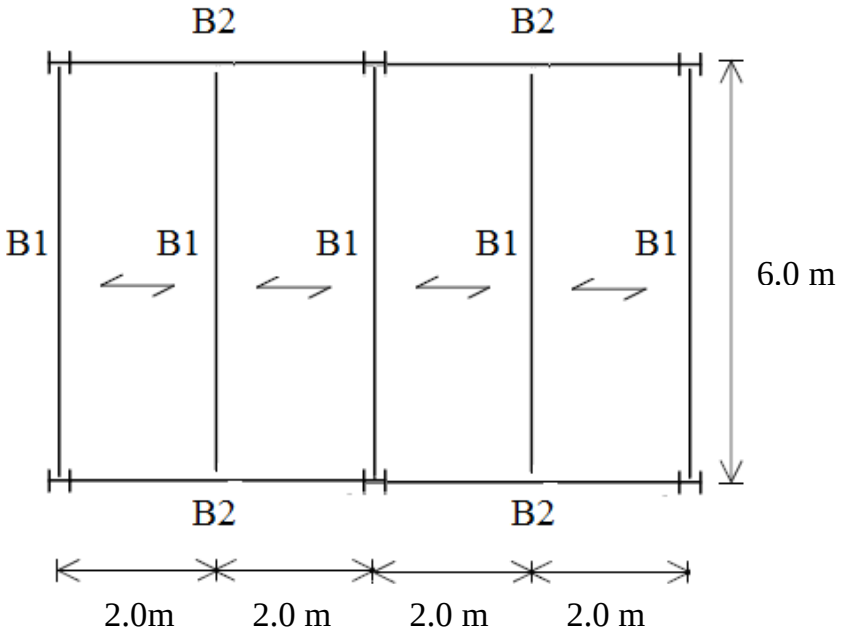
(i) Calculate the factored load intensity (in kPa) carried by the slabs. (4 marks)

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

(iii) Find the section classes of the 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: 305 x 127 x 37 kg/m UB
Beam B2: 356 x 127 x 33 kg/m UB

Fig. AQ.1

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

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Section B – Answer any TWO questions in this Section (30% EACH)

BQ.2 (a) Two pieces of 16 mm thick steel main plates are connected by a tension splice with 2 nos. of 10 mm thick cover steel plates and 8 nos. of M12 Grade 8.8 bolts as shown in **Fig. BQ.2a**. Hole diameter for all bolts is 14 mm. Check the following capacities of the tension splice:

(i) Shear capacity of the bolts; (3 marks)
(ii) Bearing capacity of the bolts; (3 marks)
(iii) Bearing capacity of the cover and main plates; (5 marks)
(iv) Tensile capacity of the main plate; (3 marks)
(v) Tensile capacity of the cover plates; and (3 marks)
(vi) If a designed tension (T) of 300 kN is applied to the splice, determine whether the splice would be failed and the expected failure mode. (1 mark)

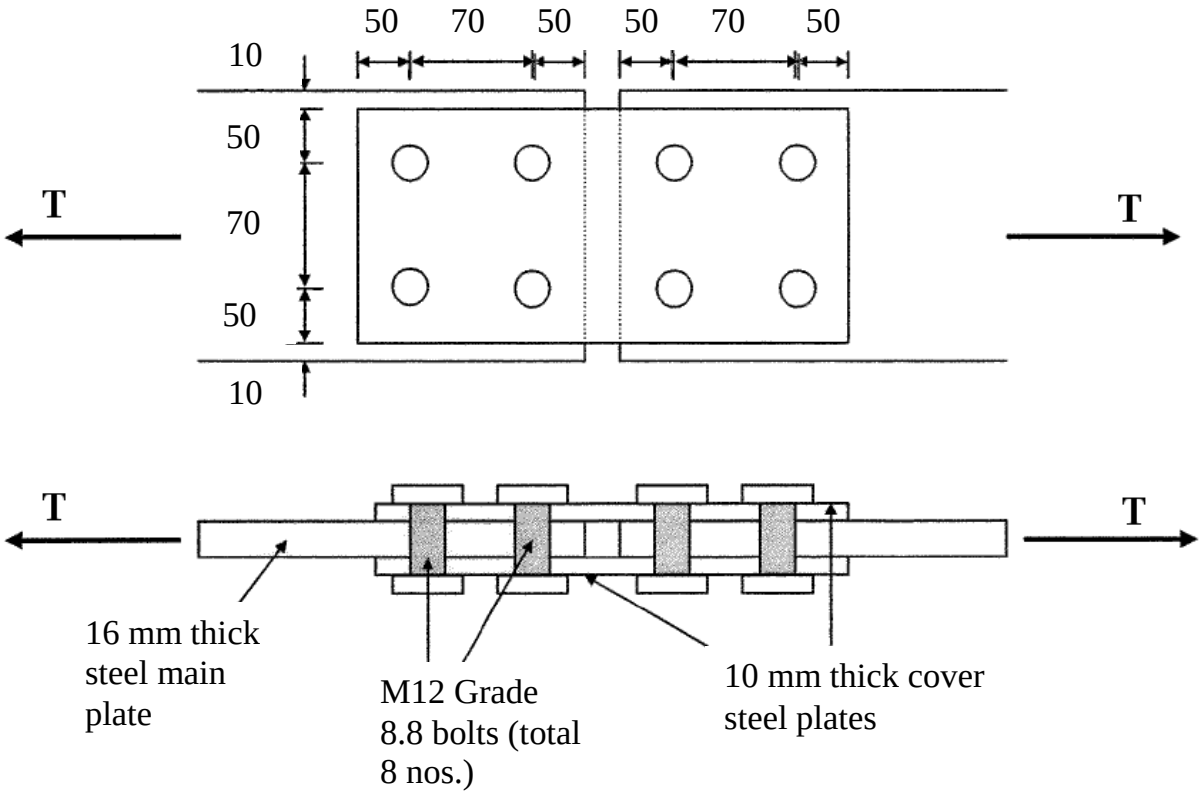


Fig. BQ.2a

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BQ.2 (b) A steel bracket is welded to a steel column as shown in **Fig. BQ.2b**. It is subjected to load as shown. Check the adequacy of the weld connection if the sizes of fillet welds in the web and in the flanges are 6 mm and 10 mm respectively with Class 42 electrode. It is assumed that the fillet welds in the web and the flanges resist the design shear force and the design bending moment respectively. (12 marks)

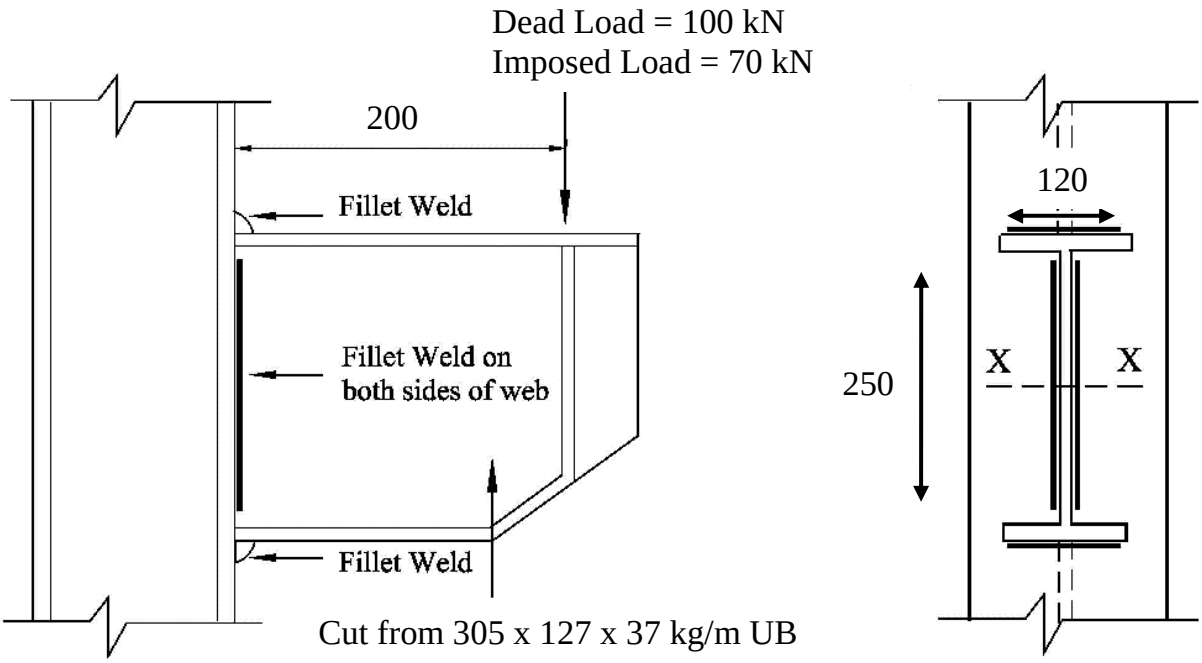


Fig. BQ.2b

BQ.3 A steel column in a residential building with **4.0 m** effective height is subjected to factored end loads as listed below. Check the adequacy of the column section of **254 x 254 x 89 kg/m UC**.

Given:
Factored axial load = 600 kN
Factored moment about x-x axis, $M_{x\text{-}x}$ at top of column = +80 kNm
Factored moment about x-x axis, $M_{x\text{-}x}$ at bottom of column = +40 kNm
Amplification factor P-Δ-δ effect in x-x axis = 1.1
Factored moment about y-y axis, $M_{y\text{-}y}$ at top of column = +60 kNm
Factored moment about y-y axis, $M_{y\text{-}y}$ at bottom of column = -30 kNm
Amplification factor P-Δ-δ effect in y-y axis = 1.15
Factored moment amplified for P-Δ-δ effect governing M_b:
M_{LT} = 1.2 x 80 = 96 kNm
(Note: Positive sign for clockwise moment; negative sign for anti-clockwise moment)

(30 marks)

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BQ.4 A simply supported steel beam 406 x 140 × 46 UB with a span of 6.0 m is as shown in **Fig. BQ.4**. It is subjected to a concentrated design load **of 100 kN** at mid-span. The beam self-weight is negligible.

(a) Calculate the maximum moment and shear force of the beam. (2 marks)

(b) If lateral restraints on the compression flange of the steel beam are NOT provided along the span and **only restraints at end supports are provided**, check the adequacy of the beam against buckling moment resistance of the steel beam by using accurate values of parameters **u** and **v** in calculation of λ_{LT}. (14 marks)

(c) If lateral restraints on the compression flange of the steel beam are NOT provided along the span and **only restraints at end supports and mid-span point load location are provided**, check the adequacy of the beam against buckling moment resistance of the steel beam by using accurate values of parameters **u** and **v** in calculation of λ_{LT}. (14 marks)

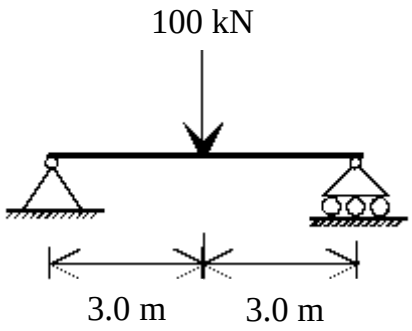


Fig. BQ.4

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