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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 2013/14

Semester Four Examination

9 January 2014
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 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:

THIRTY-FIVE (35) pages of examination data are provided for reference.

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## SECTION A: COMPULSORY QUESTION (40%)

**AQ.1** (a) Steel beam layout of a typical floor with solid concrete slabs is shown in ***Fig. AQ.1***. The compression flanges of the steel beams are fully restrained from lateral torsional buckling by the concrete slabs. The concrete slabs are 150 mm thick supporting additional finishes load of 5.0 kN/m$^2$. The imposed load on the slabs is 3.0 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.

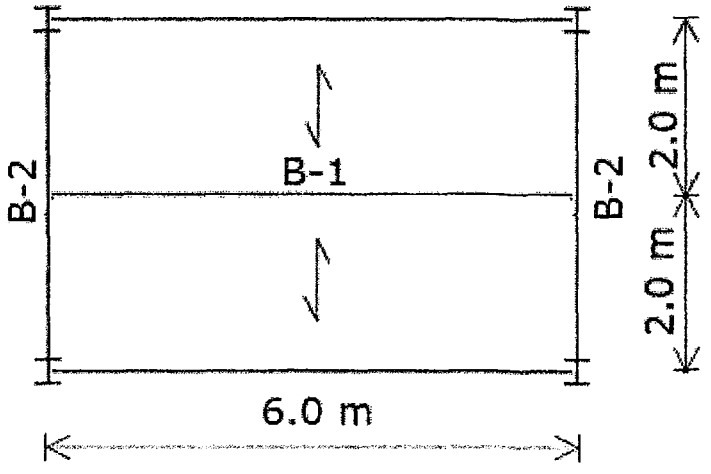
(i) Calculate the design load intensity of the slabs. (4 marks)

(ii) With consideration of beam self-weight, find the maximum factored shear forces and bending moments of both steel beams B-1 and B-2. (8 marks)

(iii) Find the section classes of the beams B-1 and B-2. (4 marks)

(iv) Check the adequacy of steel beam B-1 against shear, bending and deflection. (10 marks)

(v) Check the adequacy of steel beam B-2 against shear, bending and deflection. (10 marks)




B-1 section: 305 x 165 x 40 kg/m UB
B-2 section: 356 x 171 x 45 kg/m UB

**Fig. AQ.1**

(b) Upon completion of structural design, the project manager concerns whether the structural steelwork can be durable under atmospheric corrosion. Propose four (4) viable measures to enhance the atmospheric corrosion resistance of structural steel beams. (4 marks)

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

**BQ.2** (a) Double channels of size 178 x 89 x 26.81 kg/m are bolted to both side of a 20 mm thick gusset plate. The channels are subjected to concentric characteristic tensile forces of 350 kN dead load and 300 kN imposed load as shown in ***Fig. BQ.2(a)***. The channles are connected by 6 numbers grade 8.8 M20 bolts with 22 mm holes. All steel members are of Grade ***S355***. Show by calculations that the connection has adequate capacity to resist the design load. **Checking for gusset plate is NOT required.** (18 marks)

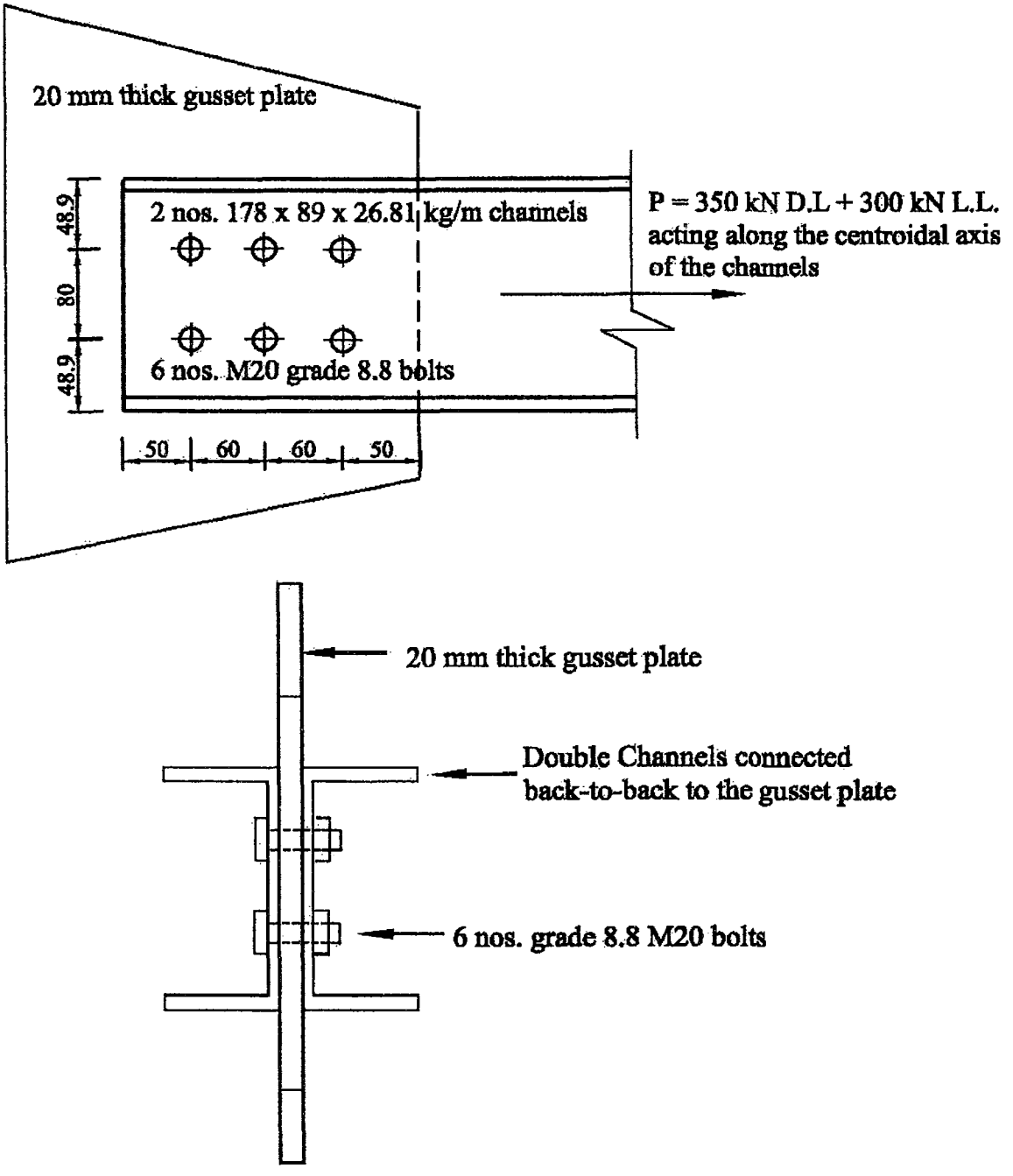



**Fig. BQ.2(a)**

*(con't)*

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*(con't BQ.2)*

(b) The steel bracket as showin in ***Fig. BQ.2(b)*** is subjected to an eccentric design load of 400 kN. Determine the size of fillet weld required for the bracket connection. The steel is of grade ***S355*** and the electrode is of ***Class 42***. (12 marks)

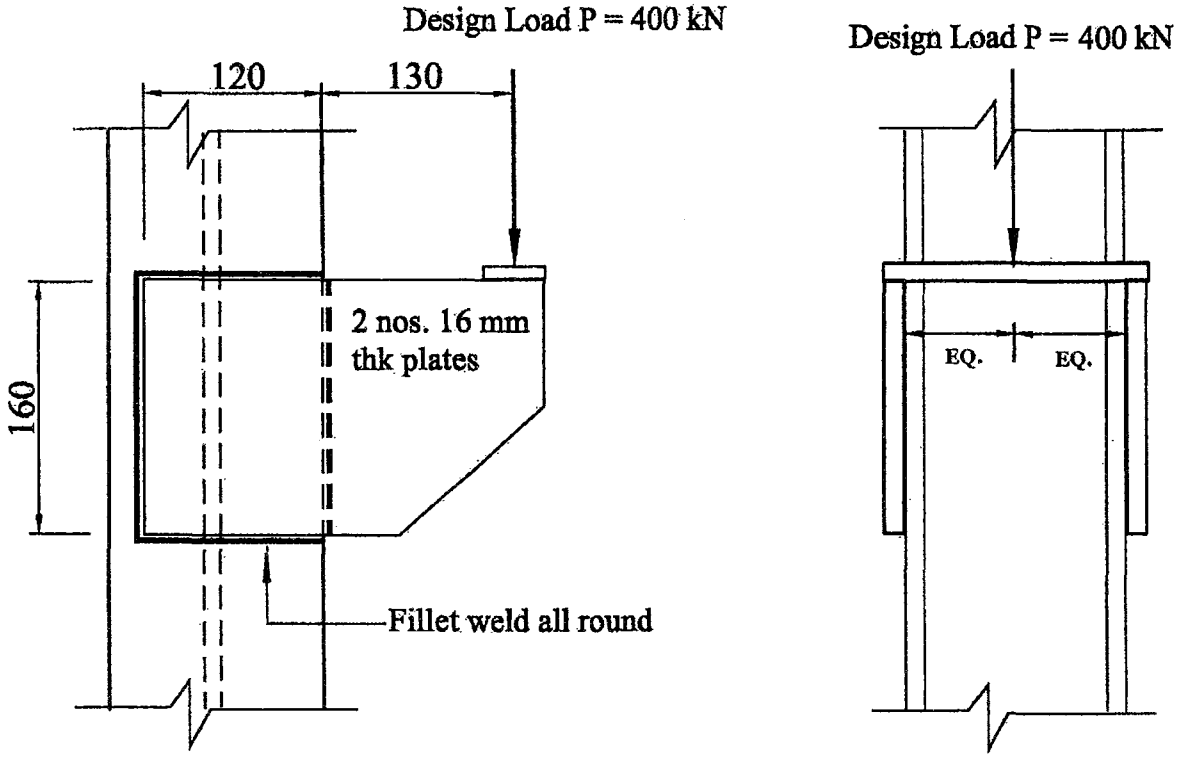



**Fig. BQ.2(b)**

**BQ.3** A steel column with **5.0 m** effective height is subjected to factored end loads as shown below. Check the adequacy of the column section of **305 x 305 x 158 kg/m UC (Grade S355).**

Given:
Factored axial load = 1500 kN
Factored moment about x-x axis, $M_{x\text{-}x}$ at top of column = +120 kNm
Factored moment about x-x axis, $M_{x\text{-}x}$ at bottom of column = +50 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 = -45 kNm
Amplification factor P-Δ-δ effect in y-y axis = 1.2
Factored moment amplified for P-Δ-δ effect governing $M_b$:
$M_{LT}$ = 1.1 x 120 = 132 kNm
*(Note: Positive sign for clockwise moment; negative for anti-clockwise moment)*

(30 marks)

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**BQ.4** A simply supported steel beam with a span of 6.5 m is subjected to a uniformly distributed load and the maximum factored loading data are given as follows. **Lateral restriants on complression flange of the steel beam are provided at the end supports only**. The sectional dimentions of beam is 406 x 178 x 74 kg/m UB (Grade S355).

- Design Moment = 180 kNm
- Design Shear Force = 120 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. (7 marks)

(c) Find the buckling moment resistance of the steel beam by using accurate values of parameters $u$ and $v$ in the calculation of $\lambda_{LT}$. (15 marks)

(d) Check the deflection limit if the beam is under an unfactored imposed load of 5.0 kN/m along the whole span. (4 marks)

**- END OF PAPER -**