© Vocational Training Council

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 2016/17

Semester Four Examination

7th January 2017

9:30 am – 11:30 am

[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. **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.

© Vocational Training Council

SECTION A: COMPULSORY QUESTION (40%)

AQ.1 (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 170 mm thick supporting additional finishes load of 0.6 kN/m^2. The imposed load on the slabs is 4 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.

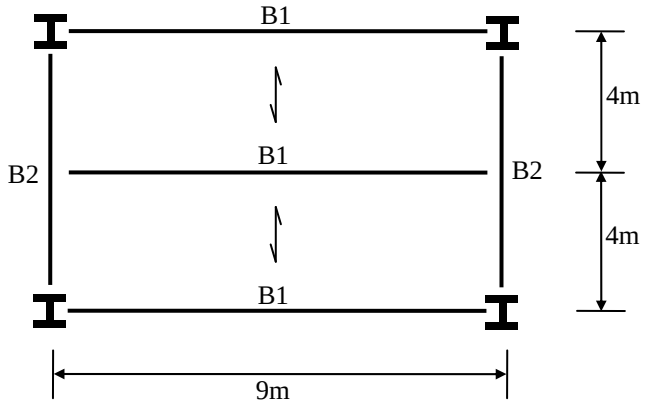
(i) Determine the factored load intensity (in kN/m^2) carried by the slabs. (4 marks)

(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: 533 x 210 x 82 kg/m UB
Beam B2: 610 x 229 x 101 kg/m UB

Figure AQ1

(b) With the aid of a load-displacement diagram, explain the load displacement relationship of different analysis methods in structural steel design. (4 marks)

© Vocational Training Council

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

BQ.1 (a) A tension splice connection is subjected to an ultimate tensile force of ***T*** as shown in ***Figure BQ1(a).*** The main plate is 22 mm thick and the cover plates are 12 mm thick. All steel plates are of ***Grade S355*** and all bolts are of ***Grade 8.8*** M20 with 22 mm holes.

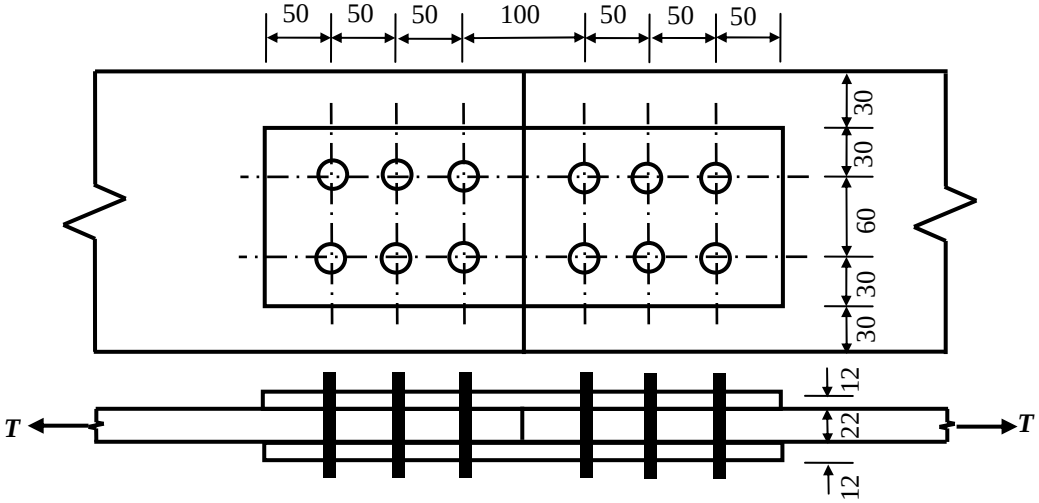
(i) Determine the shear capacity of the bolts; (3 marks)

(ii) Determine the bearing capacity of the bolts; (3 marks)

(iii) Determine the bearing capacities of the cover and main plates; (6 marks)

(iv) Determine the tensile capacities of the cover and main plates; (5 marks)

(v) Determine the maximum tensile force of ***T*** that can be applied to this bolt connection. (1 mark)



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

(b) A steel bracket as shown in ***Figure BQ1(b)*** is subjected to an eccentric design load and welded to one side of a steel column. 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)

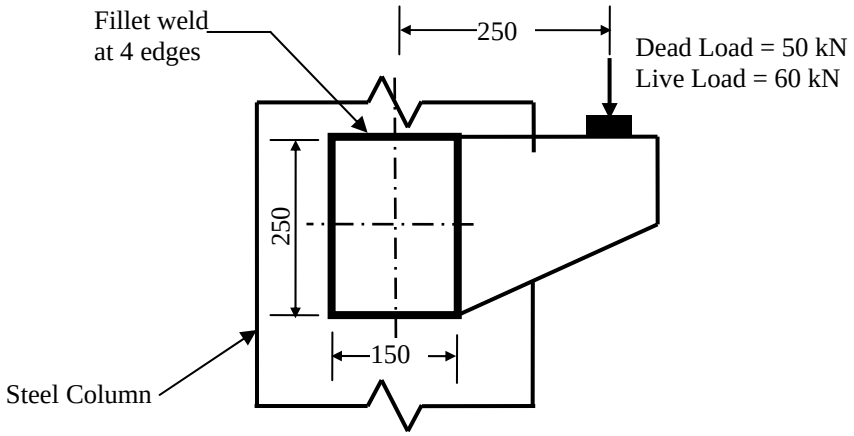


Figure BQ1(b) (dimension in mm)

© Vocational Training Council

BQ.2 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 BQ2***. Assume the **stiffnesses of the upper and the lower columns are the same.** Check the structural adequacy of a 305 x 305 x 118 kg/m UC (**Grade S355**) if the actual column height is 5 m and the effective length of the column is 4.25 m for both axes. All the loadings shown below are factored loads. All moment factors are assumed to be 1.0 unless stated otherwise.

Given:

$\boldsymbol{F}$ = 1500 kN including self-weight acting at the centre of the column.

$\boldsymbol{F_{x1}}$ = 350 kN with an eccentricity $\boldsymbol{e_y}$ of 250 mm measured from the y-axis, due to beam reactions.

$\boldsymbol{F_{x2}}$ = 230 kN with an eccentricity $\boldsymbol{e_y}$ of 150 mm measured from the y-axis, due to beam reactions.

$\boldsymbol{F_{y1}}$ = 420 kN with an eccentricity $\boldsymbol{e_x}$ of 300 mm measured from the x-axis, due to beam reactions.

Moment amplification factor due to $\boldsymbol{P\text{-}\Delta\text{-}\delta}$ effect for all moments = 1.15.

(30 marks)

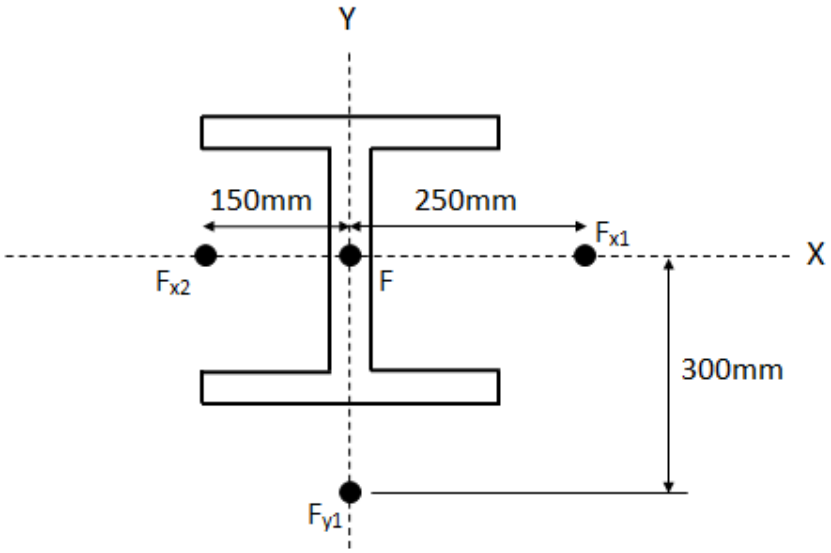


Figure BQ2

© Vocational Training Council

BQ.3 The factored design loads of a 9 m long simply supported steel beam as shown in ***Figure Q3*** . Lateral restraints are provided at the supports **A** & **C** and the point load at **B**. The size of steel beam is 457 x 191 x 82 kg/m (Grade S355).

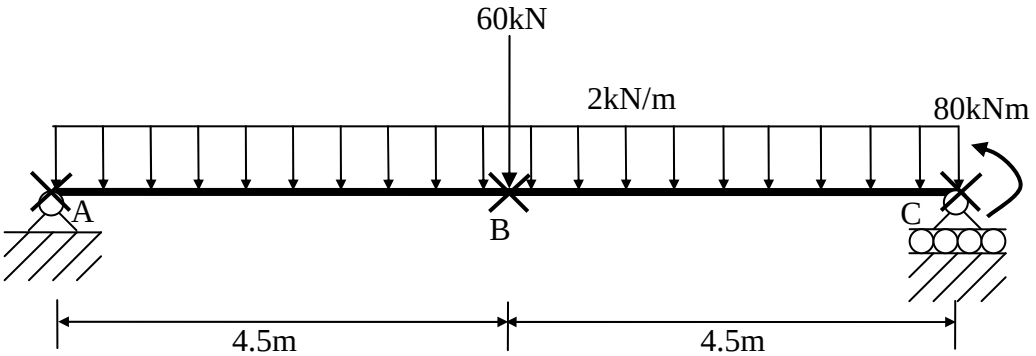


Figure BQ3

(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) Find the buckling moment resistance of the steel beam by using accurate values of parameters ***u*** and ***v*** in the calculation of λ_{LT}. (14 marks)

(d) If the lateral restraint at **B** is removed, find the buckling moment resistance of the steel beam by using accurate values of parameters ***u*** and ***v*** in the calculation of λ_{LT}. (9 marks)

- END OF PAPER -