© Vocational Training Council

Hong Kong Institute

of

Vocational Education

香港專業教育學院

HD in Civil Engineering

(EG114101 and EG314101)

Steelwork Design

(C O N 4 3 3 4)

AY 2021/22

Semester Four Examination

4th Jan 2022

1:30pm – 3:30pm

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 the compulsory question 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:
   EIGHTEEN (18) 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, B2 and B3) are fully restrained from lateral torsional buckling by concrete slabs. The concrete slabs are 150mm thick supporting additional finishes load of 0.5kN/m^2. The imposed load on the slabs is 5kN/m^2. All steel beams are of ***Grade S355*** and simply supported at their ends. Unit weight of concrete is assumed to be 24.5kN/m^3. All the beams are carrying brittle finishes.

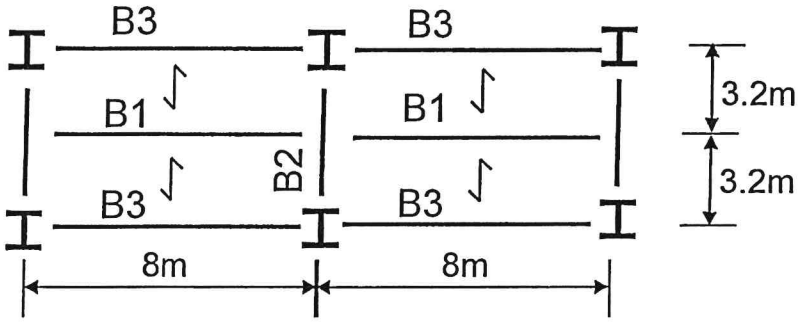
(i) Determine the factored load intensity (in kN/m^2) carried by the slabs. (4 marks)

(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 beams 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 178 x 60 kg/m UB
Beam B2: 457 x 152 x 82 kg/m UB

Figure AQ1

(b) Sketch annotated diagrams to show two fire protection methods for structural steel members. (4 marks)

© Vocational Training Council

Section B – Answer any TWO questions in this Section.

BQ.1 (a) A tension splice connection is subjected to an ultimate tensile force of 960kN as shown in ***Figure BQ1(a).*** The main plate is 24mm thick and the cover plates are 10mm thick. All steel plates are of ***Grade S355*** and all bolts are of ***Grade 8.8*** M27 with 30mm diameter holes.

(i) Check the shear capacity of the bolts. (2 marks)

(ii) Check the bearing capacity of the bolts. (2 marks)

(iii) Check the bearing capacities of the plates. (7 marks)

(iv) Check the tensile capacities of the plates. (5 marks)

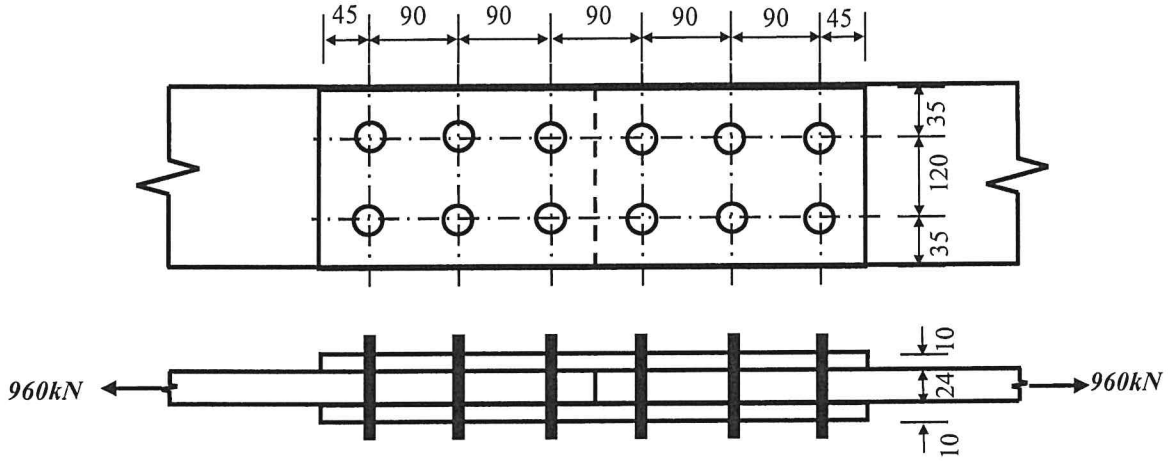


Figure BQ1(a) (dimension in mm)

© Vocational Training Council

(b) A steel bracket as shown in ***Figure BQ1(b)*** is subjected to an eccentric characteristic loads, and the loading is on one side plate. Determine the size of fillet weld required for the bracket connection. The steel is of ***Grade S355*** and the electrode is of ***Class 42***.

Given: Moment of inertia in weld group

$$I_x = \frac{y^3}{6} + \frac{xy^2}{2}, I_y = \frac{x^3}{6} + \frac{x^2y}{2}$$

(14 marks)

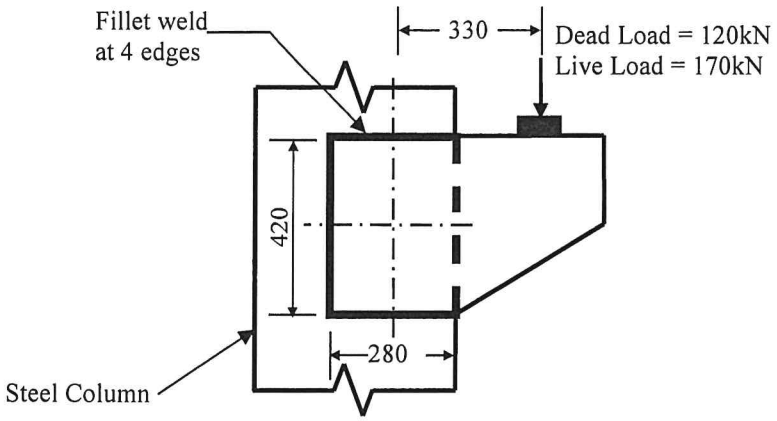


Figure BQ1(b) (dimension in mm)

© Vocational Training Council

BQ.2 A steel column in a residential building with 4.5m effective height is subjected to factored end loads as listed below. Check the adequacy of the column section of **305x305x158 kg/m UC**.

Given:
Factored axial load = 3000 kN
Factored moment about x – x axis, $M_{x\text{-}x}$, at top of column = -90 kNm
Factored moment about x – x axis, $M_{x\text{-}x}$, at bottom of column = 70 kNm
Amplification factor P-Δ-δ effect in x-x axis = 1.1
Factored moment about y – y axis, $M_{y\text{-}y}$, at top of column = -60 kNm
Factored moment about y – y axis, $M_{y\text{-}y}$, at bottom of column = -50 kNm
Amplification factor P-Δ-δ effect in y-y axis = 1.15
Factored moment amplified for P-Δ-δ effect governing M_{LT}:
M_{LT} = 1.1x 90 = 99 kNm
(Note: Positive sign for clockwise moment; negative sign for anti-clockwise moment)

(a) Determine the classification of the steel column. (4 marks)

(b) Check the cross section capacity of the steel column. (7 marks)

(c) Check the member buckling resistances of the steel column. (19 marks)

© Vocational Training Council

BQ.3 The factored design loads on a 8.5m long simply supported steel beam are shown in ***Figure BQ3***. Lateral restraints are provided at the supports **A** & **D** and at **B** & **C** respectively. The size of steel beam is **533x210x109kg/m UB** (Grade S355). Assume the steel section is class 1.

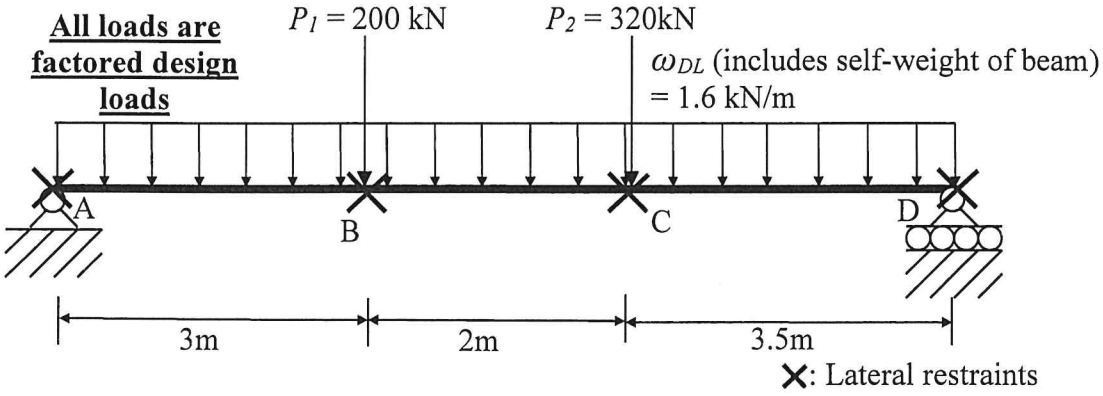


Figure BQ3

(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) Check the buckling moment resistance of the steel beam in segment **BC** by using accurate values of parameters ***u*** and ***v*** in the calculation of λ_{LT}. (13 marks)

(d) Check the buckling moment resistance of the steel beam in segment **CD** by using accurate values of parameters ***u*** and ***v*** in the calculation of λ_{LT}. (10 marks)

- END OF PAPER -