© Vocational Training Council

Hong Kong Institute

of

Vocational Education

香港專業教育學院

[redacted]

HD in Civil Engineering

(EG114101 & EG314101)

[redacted]

Steelwork Design

(C O N 4 3 3 4)

[redacted]

AY 2022/23

Semester Four Examination

5th Jan 2023

1:30pm – 3:30pm

[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 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) The floor plan of an office area is shown in **Figure AQ1**. Compression flanges of the steel beam (Beam **B1** and **B3**) are fully restrained from lateral tostional buckling by concrete slabs. The concrete slabs are 150 mm thick supporting an additional finishes load of 0.5 kN/m^2. The imposed load on the slabs is 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.

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

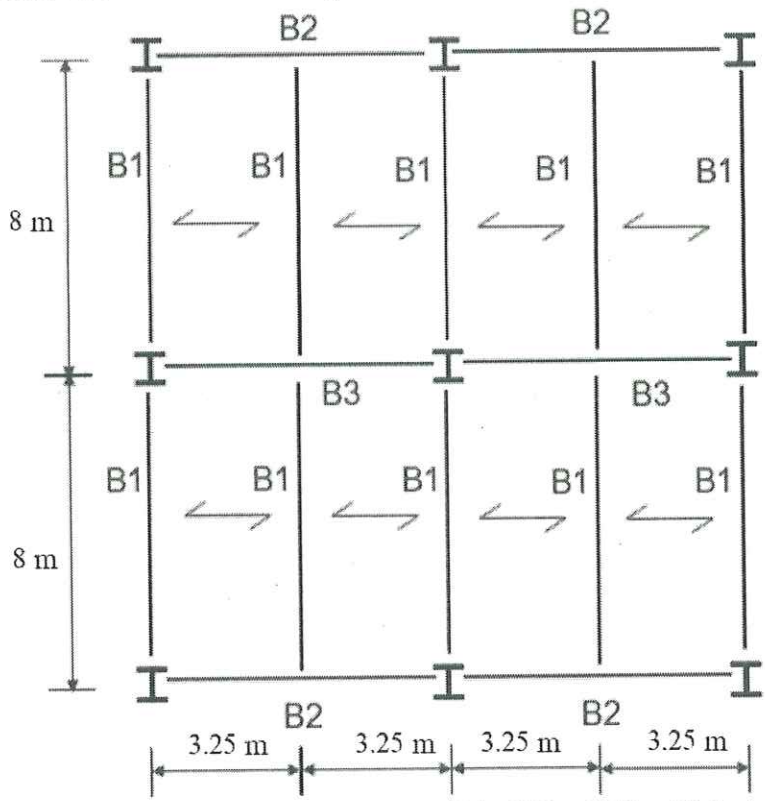
(ii) With consideration of beam self-weight (g = 10 m/s^{-2}), calculate the maximum factored shear forces and bending moments of Beam **B1** and Beam **B3**. (8 marks)

(iii) Find the section classes of the steel beam **B1** and **B3**. (4 marks)

(iv) Check the adequacy of steel beam **B1** against shear, bending and deflection. (10 marks)

(v) Check the adequacy of steel beam **B3** against shear, bending and deflection. (10 marks)

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



Beam **B1**: 406 x 178 x 60 kg/m UB
Beam **B3**: 457 x 152 x 82 kg/m UB

Figure AQ1

© Vocational Training Council

Section B – Answer any TWO questions in this Section.

BQ.2

(a) A double unequal angles of size 200×100×10 are bolted to a 20 mm thick gusset plate. The angles are subjected to a concentric designed force P_u of 1050 kN at centroid of the section as shown in **Figure BQ2(a)**. The angle is connected by 4 numbers of **Grade 8.8 M27** bolts with 30 mm diameter holes. All steel members are of **Grade S355**. **Assume the checking of gusset plate is not required.**

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

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

(iii) Check the bearing capacity of the angles. (6 marks)

(iv) Check the tensile capacity of the angles. (7 marks)

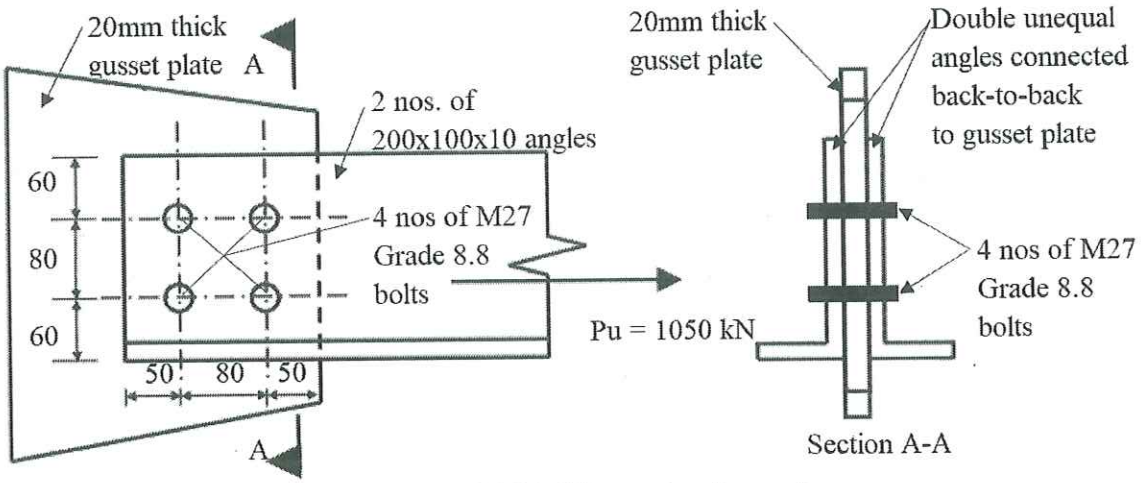


Figure BQ2(a) (dimension in mm)

To be continued…

© Vocational Training Council

BQ.2 (Continue)

(b) The steel bracket as shown in **Figure BQ2(b)** is subjected to a designed load of 600 kN. Check the adequacy of fillet welds in the web and in the flanges of the bracket connection. The steel is of **Grade S355** and the electrode is of **Class 35. Assume the fillet welds in the web and the flanges resist the design shear force and the design bending moment respectively.** (13 marks)

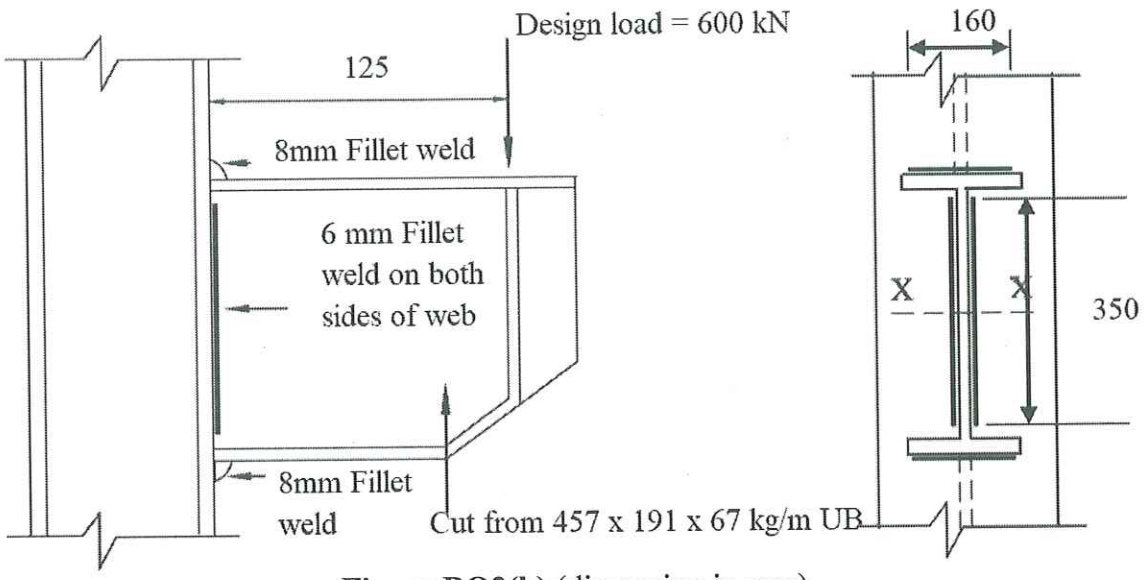


Figure BQ2(b) (dimension in mm)

© Vocational Training Council

BQ.3 A steel column between floors of a multi-storey building is subjected to the following eccentric loadings, as shown in below **Figure BQ3**. Assume the **stiffnesses of the upper and the lower columns are the same.**

Check the structural adequacy of a class 1 steel column section **305 x 305 x 158 kg/m UC** with **Grade S355** if the actual column height is 4.5 m and the effective length of the column is 4.0 m for both axes.

Given:
P = 3150 kN including self-weight acting at the center of the column.
P_{x1} = 200 kN with an eccentricity e_x of 200 mm measured from the x-axis, due to beam reactions.
P_{y1} = 700 kN with an eccentricity e_y of 240 mm measured from the y-axis, due to beam reactions.
P_{y2} = 450 kN with an eccentricity e_y of 220 mm measured from the y-axis, due to beam reactions.
Moment amplification factor due to P-Δ-δ effect for all moments = 1.1.

All the loadings shown below are factored loads. All moment factors are assumed to be 1.0 unless stated otherwise.

(a) Determine the total axial load and moments acting on the steel column. (3 marks)
(b) Check the cross section capacity of the steel column. (8 marks)
(c) Check the member buckling resistance of the steel column. (19 marks)

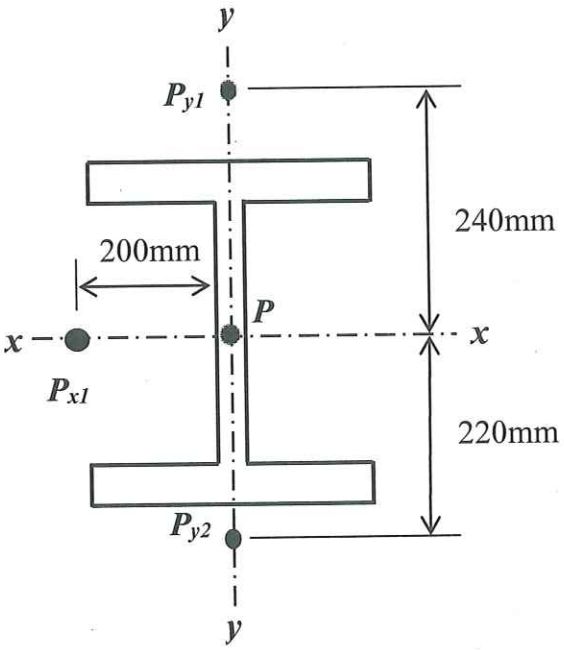


Figure BQ3

© Vocational Training Council

BQ.4 A steel beam **ABCD** with a roller support at **B** and a pinned support at **D** is subjected to the factored design loads as shown in **Figure BQ4**. Lateral restraints are provided at the supports **B** & **D** and at **A** & **C** respectively. The size of steel beam is **457x191x89kg/m UB (Grade S355)**. Assume the **steel section is class 1, and the self-weight of beam is negligible**.

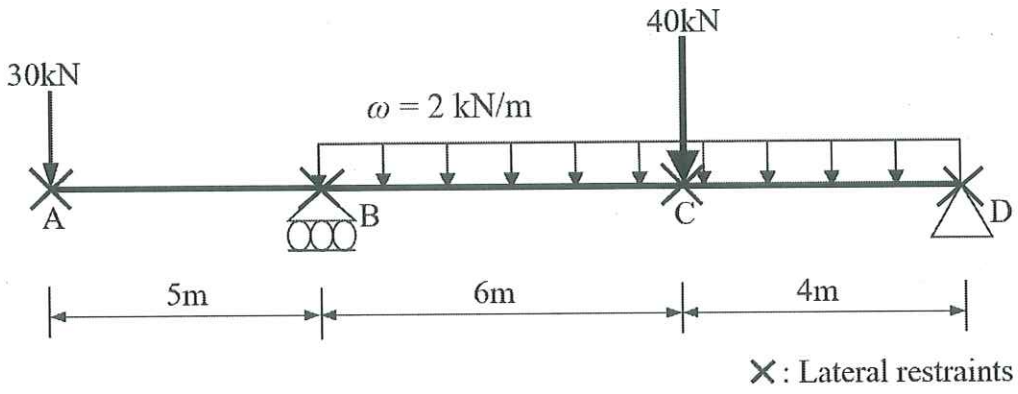


Figure BQ4

(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 **AB** by using accurate values of parameters ***u*** and ***v*** in the calculation of λ_{LT}. (10 marks)

- END OF PAPER -