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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 2023/24

Semester Seven Examination

XXth Jan 2024

7:00pm – 9:00pm

[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.

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SECTION A: COMPULSORY QUESTION (40%)

AQ.1

(a) The floor plan of a storage area is shown in **Figure AQ1**. Compression flanges of the steel beam **(Beam B1 and B2)** are fully restrained from lateral tostional buckling by concrete slabs. The concrete slabs are 180 mm thick supporting an additional finishes load of 0.4 kN/m^2. The imposed load on the slabs is 4.5 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), verify that the maximum factored shear forces and bending moments of Beam **B1** are 123.8 kN and 216.7 kNm respectively. (3 marks)

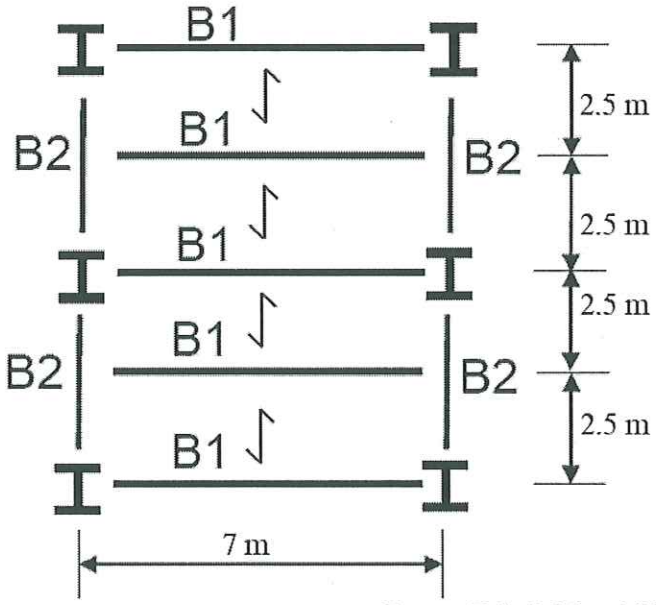
(iii) Verify that the maximum factored shear forces and bending moments of Beam **B2** are 63.5 kN and 156.8 kNm respectively. (5 marks)

(iv) Find the section classes of the steel beams **B1** and **B2**. (4 marks)

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

(vi) Check the adequacy of steel beam **B2** against shear, bending and deflection. (10 marks)

(b) Sketch and name any four common hot rolled sections of structural steel beam. (4 marks)



Beam **B1**: 356 x 127 x 39 kg/m UB
Beam **B2**: 406 x 140 x 46 kg/m UB

Figure AQ1

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Section B – Answer any TWO (2) questions in this Section.

BQ.2

(a) Back to back unequal angles of size 125×75×8 are bolted to web of 305 x 305 x 118 UC. The angles are subjected to a concentric designed force P_u of 350 kN at centroid of the section as shown in **Figure BQ2(a)**. The angle is connected by 3 numbers of **Grade 8.8 M20** bolts with 22 mm diameter holes. All steel members are of **Grade S355**.

Assume the checking of supporting UC 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)

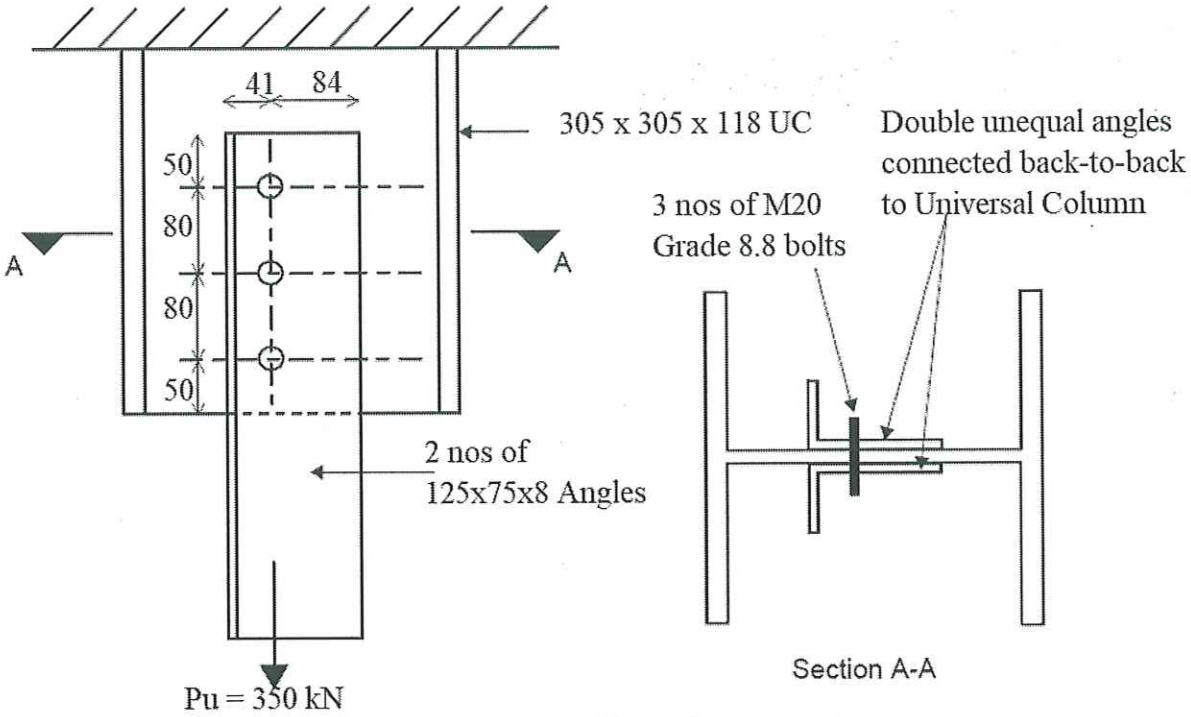

Figure BQ2(a) (dimension in mm)

To be continued…

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BQ.2 (Continue)

(b) An eccentrically loaded steel plate is welded on the web of steel parallel flange channel as shown in **Figure BQ2(b)**. The plate is welded on four sides with fillet weld. Determine the size of fillet weld required for the plate connection. The steel is of **Grade S355** and the electrode is of **Class 42**.

Given: Moment of inertia in weld group (13 marks)

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

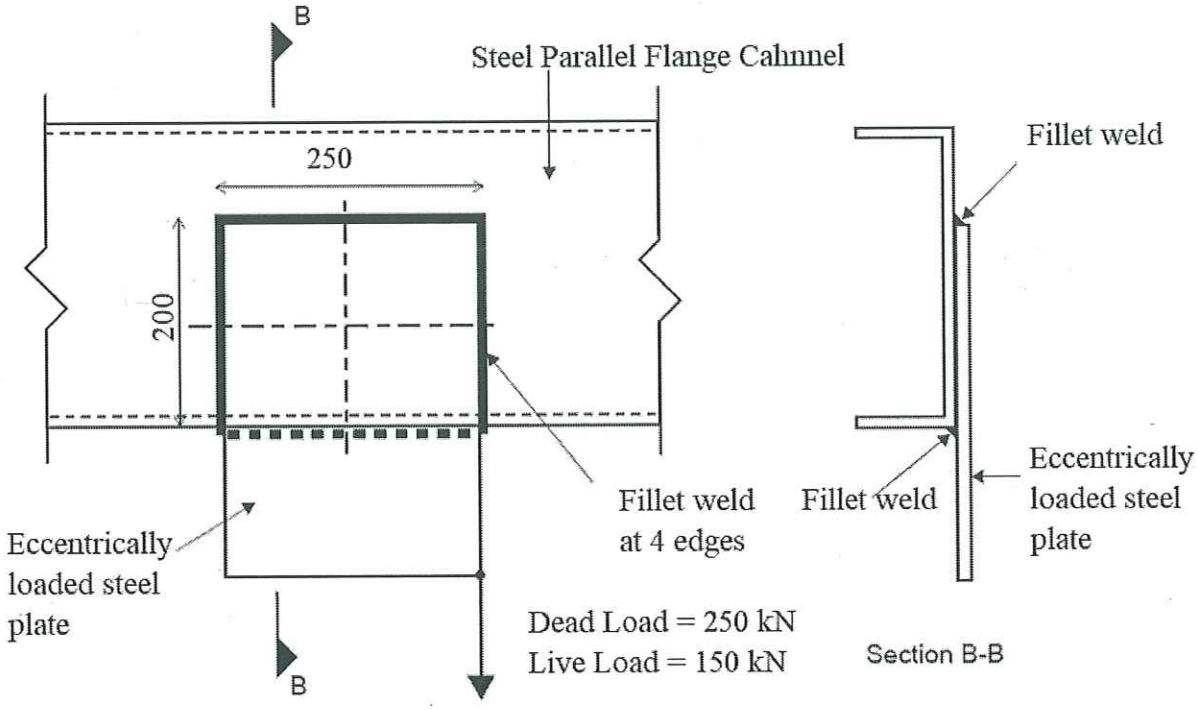

Figure BQ2(b) (dimension in mm)

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BQ.3 A structural steel column of sectional size 254 x 254 x 89 kg/m UC of **Grade S355** in a warehouse building with 4 m effective height is subjected to factored end loads as listed below:

Factored axial load = 650 kN
Factored moment about x-x axis, $M_{x\text{-}x}$ at top of column = +75 kNm
Factored moment about x-x axis, $M_{x\text{-}x}$ at bottom of column = +45 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 = +65 kNm
Factored moment about y-y axis, $M_{y\text{-}y}$ at bottom of column = -39 kNm
Amplification factor P-Δ-δ effect in y-y axis = 1.1
Factored moment amplified for P-Δ-δ effect governing M_{LT}
M_{LT} = +96 kNm

(Note: Positive sign for clockwise moment; negative sign for anti-clockwise moment)

(a) Determine the class of the steel column section. (4 marks)
(b) Check the cross section capacity of the steel column. (7 marks)
(c) Check the buckling resistance of the steel column. (19 marks)

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BQ.4 The factored design loads on a 11m long simply supported steel beam are shown in **Figure BQ4**. Lateral restraints are provided at the supported A & D and at B & C respectively. The size of steel beam is 610 x 229 x 140 kg/m UB **(Grade S355)**. Assume the steel section is **class 1**

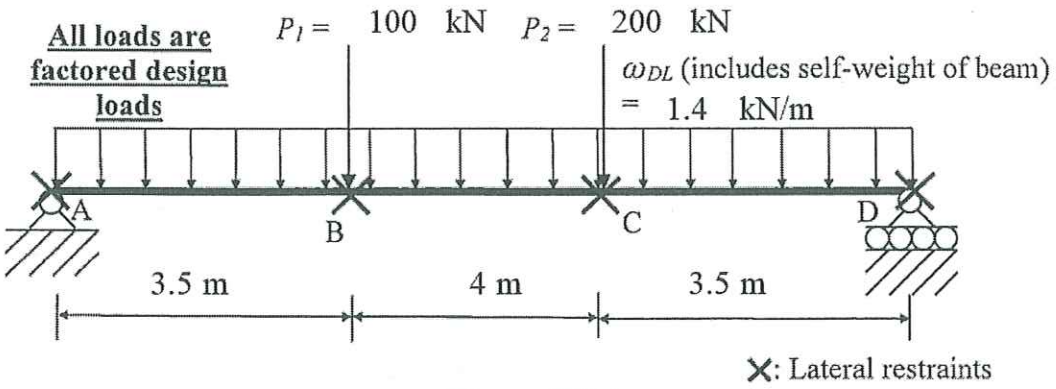

Figure BQ4

(a) Determine the support reactions of the beam. (3 marks)

(b) Draw the annotated shear force and bending moment diagrams of the beam. (4 marks)

(c) Check the buckling moment reisistance 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 reisistance 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 -