70

(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2023/2024 ACADEMIC YEAR

FOURTH YEAR SEMESTER ONE EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL AND STRUCTURAL ENGINEERING

COURSE CODE: CSE 411

COURSE TITLE: STRUCTURAL STEEL DESIGN

DATE: 7TH DECEMBER 2023 TIME: 8 A.M – 10 A.M

INSTRUCTIONS:

1. This paper contains FIVE questions.
2. Question ONE is compulsory.
3. Attempt a total of THREE questions.
4. Assume all steel sections to be Hot Rolled steel sections.
5. BS EN 1993 and BS EN 1992 and steel tables are permitted in this exam.
6. All steel is as EN 10025-2:2004
7. Useful formulas and tables have been provided.

Examination duration is **2 Hour**

MMUST observes ZERO tolerance to examination cheating.

This Paper Consists of 4 Printed Pages. Please Turn Over.

Question ONE {COMPULSORY} (30 marks)

a) Elaborate and differentiate between simple design and continuous design (6mk)

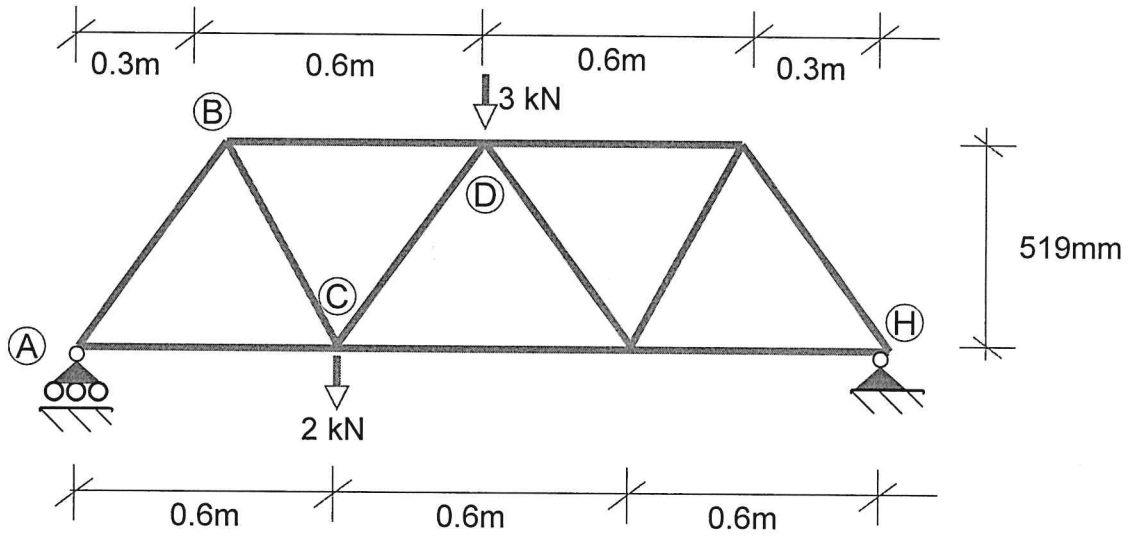


Fig.Q1

b) Consider the truss structure (Fig Q1) with two external loads at joint C (2kN) and D (3kN) and supports at A and H.

i) determine the reactions at the supports A and H (4mks)
ii) determine the forces in members AC and AB and indicate if compressive or tensile (7mks)
iii) Check the adequacy of member AC if a member CHS 75x3mm is used (8mk)
iv) Check the adequacy of member AB if a member RHS 75x50x3mm is used (5mk)

Question TWO (20 marks)

Consider a simply supported 8m long steel floor beam supporting a dead load of 20 kN/m and a live load of 14kN/m. If a universal beam $\text{UB } 533 \times 210 \times 82$ in grade S355 structural steel is used, Determine the following.

(a) Calculate and draw the shear force diagram and bending moment diagram (2 mks)
(b) Classify the section accordingly (3 mks)
(c) Check the adequacy of Moment capacity of the section (5 mks)
(d) Check the adequacy of shear capacity of the section (5 mks)
(e) Check the shear buckling of the section (2 mks)
(f) Check the deflection of the member (3 marks)

Question Three (20 marks)

Consider a 3.5m long column experiencing an axial load of $N_{Ed} = 12kN$ at an eccentricity of 20cm (thus experiences a moment of $M_{Ed} = N \times e = 2.4\ kNm$)

A) Determine the adequacy of the column if a $SHS\ 150 \times 150 \times 5\ mm$ section is used. Take the effective length of the column as $L_E = 0.7L_o$ (14 mks)
B) Explain the failure mechanisms of steel columns (6mks)

Question Four **(20 marks)**

Consider a base for a CHS column $150 \times 6\,mm$ welded onto a $600 \times 600 \times 10mm$ base plate and experiences a vertical load of $N_{Ed} = 800kN$ and a horizontal force $V_{Ed} = 200kN$. Assume all steel is of grade S275, Take the fillet welds as 6mm thick.

Determine/check for the following:

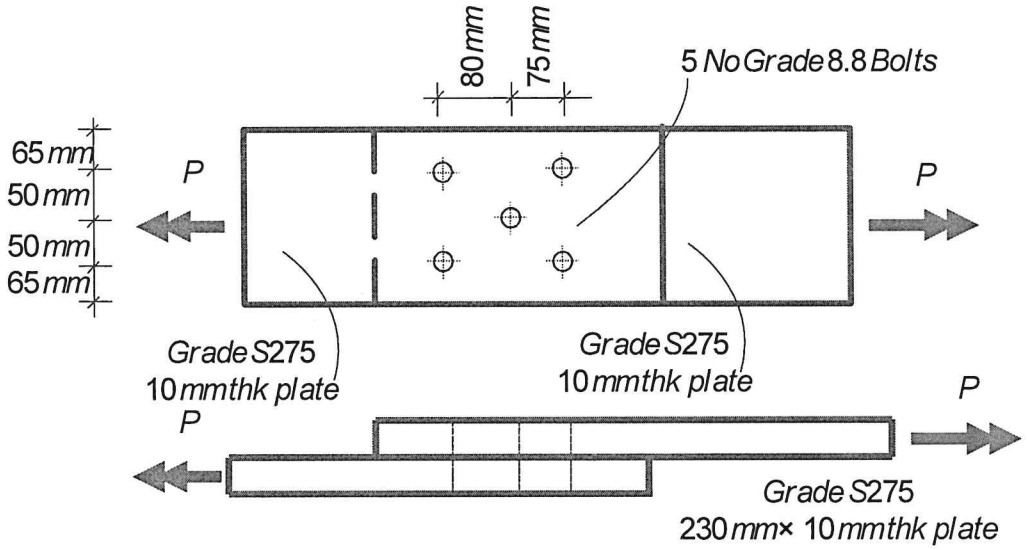
a) the required area for the baseplate (2 mks)

b) the effective area of the base plate (3 mks)

c) The minimum plate thickness (2 mks)

d) The minimum weld length around the base to resist the horizontal load (4 mks)

e) sketch the column base, labeling the key elements (2 mks)



IG.Q4

Consider the connection splice in Fig Q4

Determine the capacity of the connection considering.

(a) Tension capacity of the steel plate (3mks)

(b) The shear capacity of the bolts, if 5No. M20 ordinary bolts are used (2mks)

(c) Bearing capacity of the bolts (2mks)

Question Five **(20 marks)**

A) What do you understand by the term alloy, with regards to structural steel (2mk)

b) outline five major classes of alloys and their properties used for structural steel. (10mks)

c) outline and explain four major methods used to protect structural steel sections (8 mks)

---end—

MEMORY AIDE/ REFERENCE

i) Calculation of deflections for simple supported beams

Deflection due to point load (P kN) at midspan of beam L m long $\delta = \frac{Pl^3}{48EI}$

Deflection due to a uniformly distributed load (ω kN/m) of a simply supported beam L meters long $\delta = \frac{5\omega l^4}{384EI}$

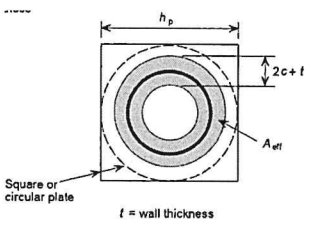
ii) Bolt Areas

Diameter of bolt=d (mm)	12	16	20	24	30
Area=A_s (mm^2)	84.3	157	245	353	561

iii) Loading

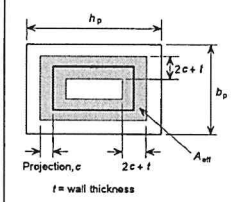
BS EN 1990-A1.3.2(4) $UDL_{Ultimate} = 1.35 \times G_k + 1.5 \times Q_k$

iv) Steel column baseplates



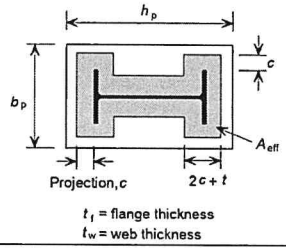
For CHS column: Effective area $A_{eff} = \pi(d-t)(t+2c)$

Overlap $c \geq \frac{d-2t}{2}$



For SHS, RHS column: Effective area $A_{eff} = P_{col}(t+2c)$

Overlap $c \geq \frac{h-2t_f}{2}$:



For UB, UC column: $A_{eff} = 4c^2 + P_{col}\,c + A_{col}$

Overlap $c \geq \frac{h-2t_f}{2}$:

v) Angle connected with one leg

EC3-1-8 3.10.3

With 2 bolts $N_{u,Rd} = \frac{\beta_2 A_{net} f_u}{\gamma_{M2}}$

With 3 or more bolts $N_{u,Rd} = \frac{\beta_3 A_{net} f_u}{\gamma_{M2}}$

Pitch	p_1	$\leq 2.5\, d_o$	$\geq 5.0\, d_o$
2 bolts	β_2	0.4	0.7
3 bolts or more	β_3	0.5	0.7

vi) Concrete compressive strength

Concrete class	C25/30	C30/37	C35/40	C40/50
f_{ck} (N/mm^2)	30	37	40	50
f_{cd} (N/mm^2) Design compressive strength	14.2	16.8	17	22.7

vii) Parameters

$\alpha = \left[c + \frac{N_{Ed}}{t_w \times f_y}\right] / 2c$	$\psi = \frac{\sigma_2}{\sigma_1}$

viii) Deflection limits

	Design situation	**Deflection limit**
1	Cantilever	$\text{Length}/180$
2	Beams carrying plaster or other brittle finish	$\text{Span}/360$
	Other beams (except purlins and sheeting rails)	$\text{Span}/200$