TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING & CIVIL ENGINEERING
UNIVERSITY EXAMINATION FOR:
BACHELOR OF SCIENCE IN CIVIL ENGINEERING
ECE 2407: STRUCTURAL DESIGN I
SPECIAL SUPPLEMENTARY EXAMINATION
SERIES: SEPT. 2017
TIME: 2 HOURS

Instructions to Candidates

You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of four questions.
Answer question ONE (COMPULSORY) and any other TWO questions
Do not write on the question paper.

QUESTION ONE (COMPULSORY)

(a) A 305 x 102 x 33 kg/m UB has a value of Z_{xx} = 414.6 cm^3. Calculate the safe uniformly distributed load for this beam for an effective span of 4.5 m, if the working stress is 165 N/mm^2.

(5.5 marks)

(b) A universal beam of 4.0 m effective span is required to carry central load of 50 kN. Select a suitable section from the steel tables provided. Steel working stress f = 165 N/mm^2

(5.5 marks)

(c) A beam of 5.0 m effective span is loaded as shown in Figure 1.1. Assuming a maximum stress of 165 N/mm^2, calculate the necessary section modulus of the beam.

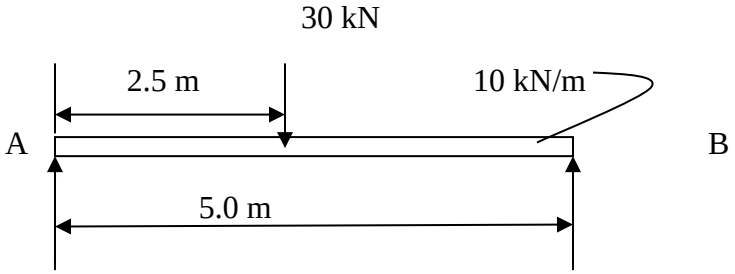

Figure 1.1: Loaded beam

(19 marks)

ATTEMPT ANY TWO QUESTIONS

QUESTION TWO

(a) Concisely, discuss the methods used to determine the strength of struts.

(6 marks)

(b) An intermediate length of a stanchion is 3.5 m long and is loaded as shown in Figure 2.1. The loads indicated are transmitted by floor beams and by the stanchion length above, which is 3.0 m long and consists of a 203 x 203 x 71 kg/m UC. Test the suitability of the section of the intermediate column, with grade 43 steel.

(14 marks)

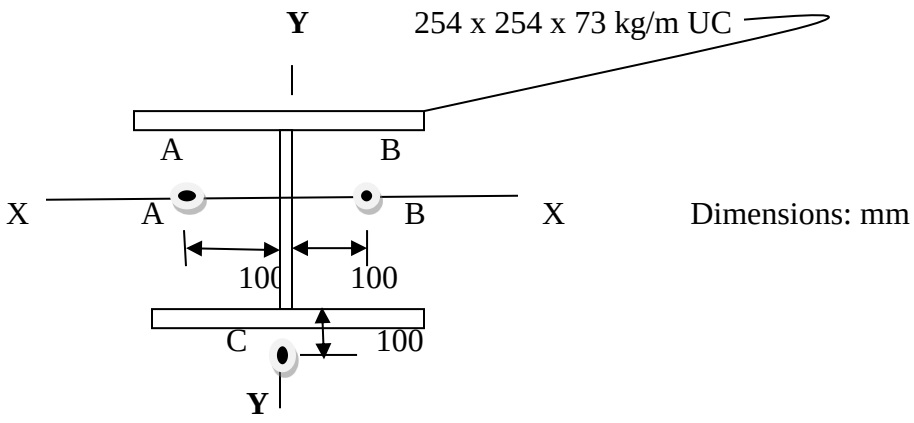

Figure 2.1: Loading of the intermediate column

<u>254 x 254 mm x 73 kg/m UC:</u>

A = web load = 75 kN, B = web load = 100 kN, C = flange load = 75 kN,

Axial load from the column above = 500 kN, web thickness = 8.6 mm,

Effective length = 0.7(actual legth), p_{bc} = 165 N/mm^2.

QUESTION THREE

Design a base plate in grade 43 steel to carry an axial load of 3000 kN. The base rests on 1:2:4 concrete (safe bearing pressure = 4200 kN/m^2) the column serial size: 305 x 305 x 198 kg/m (Actual dimensions: 339.9 x 314.1 mm x 198 kg/m). **(20 Marks)**

QUESTION FOUR

A timber column of redwood GS grade consists of a 125 mm square section which is restrained at both ends in position but not in direction. Assuming that the actual height of the column is 3.5 m, calculate the maximum axial long-term load that the column can support. **(20 Marks)**

Table 4.1: Effective length of compression members

End conditions		$\frac{effective\ length}{actual\ length} = \frac{L_e}{L}$
(a)	Restrained at both ends in position and in direction	0.7
(b)	Restrained at both ends in position and one end in direction	0.85
(c)	Restrained at both ends in position but not in direction	1.0
(d)	Restrained at one end in position and direction and at the other end in direction but not in position	1.5
(e)	Restrained at one end in position and direction and free at the other end	2.0

Table 21, BS 5268

Table 4.2: Softwood species/grade combinations which satisfy the requirements for strength classes graded to BS4978

Standard name	Strength class				
	SC1	SC2	SC3	SC4	SC5
Redwood			GS/M50	SS	M75
Whitewood			GS/M50	SS	M75
Western red cedar	GS	SS			
Scots Pine			GS/M50	SS	M75

Table 3, BS 5268

Table 4.3: Grade stresses and moduli of elasticity for strength classes for the dry exposure condition (based on Table 9, BS5268)

Strength class	Bending parallel to grain (N/mm^2)	Tension parallel to grain (N/mm^2)	Compression parallel to grain (N/mm^2)	Compression perpendicular to grain (N/mm^2)[a]		Shear parallel to grain (N/mm^2)	Modulus of elasticity (N/mm^2)		Approx. density (kg/m^3)[b]
							E_{mean}	E_{min}	
SC1	2.8	2.2	3.5	2.1	1.2	0.46	6800	4500	540
SC2	4.1	2.5	5.3	2.1	1.6	0.66	8000	5000	540
SC3	5.3	3.2	6.8	2.2	1.7	0.67	8800	5800	540
SC4	7.5	4.5	7.9	2.4	1.9	0.71	9900	6600	590
SC5	10.0	6.0	8.7	2.8	2.4	1.00	10700	7100	590/760

[a] When the specification specifically prohibits wane at bearing areas , the higher values may be taken,

[b] Crude estimates of the densities,

Table 4.4: Modification factor K_3 for duration of loading

Duration of loading	*Value of* K_3
Long term (e.g. dead + permanent imposed[a])	1.00
Medium term (e.g. dead + snow, dead + temporary imposed)	1.25
Short term (e.g. dead + imposed + wind[b], dead + imposed + snow + wind[b])	1.50
Very short term (e.g. dead + imposed + wind[c])	1.75

Table 17, BS 5268

[a] For imposed floor loads $K_3 = 1.00$

[b] For wind, short term category applies to class C (15 s gust) as defined in CP 3: Chapter V: Part 2

[c] For wind, very short term category applies to classes A and B (3 or 5 s gust) as defined in CP 3: Chapter V: Part 2

Table 4.5: Modification factor K_{12} for compression members

$\frac{E}{\sigma_c}$	Value K_{12}																
	Value of slenderness ratio λ																
	< 5	5	10	20	30	40	50	60	70	80	90	100	120	140	160	180	200
800	1.000	0.975	0.952	0.903	0.851	0.792	0.724	0.649	0.572	0.497	0.430	0.371	0.280	0.217	0.172	0.139	0.115
900	1.000	0.975	0.952	0.904	0.853	0.797	0.734	0.665	0.593	0.522	0.456	0.397	0.304	0.237	0.188	0.153	0.127

Table 22, BS 5268