2707/302
STRUCTURES III
Oct./Nov. 2017
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN CIVIL ENGINEERING

MODULE III

STRUCTURES III

3 hours

INSTRUCTIONS TO CANDIDATES

You should have a scientific calculator for this examination.
This paper consists of ***EIGHT*** *questions.*
Answer ***FIVE*** *questions in the answer booklet provided.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.
Relevant design tables are attached.
Candidates should answer the questions in English.

This paper consists of 7 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

1. Using the method of moment distribution, analyze the frame shown in **figure 1** and plot the bending moment diagram indicating all the critical values. (20 marks)

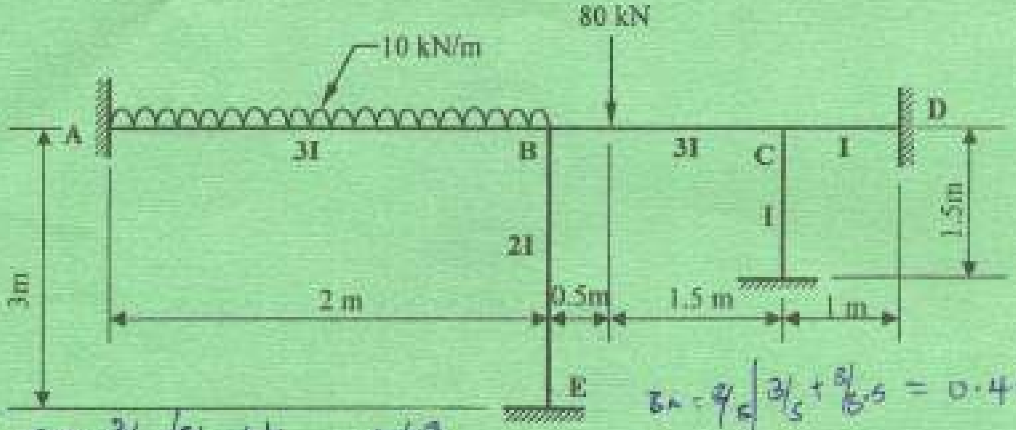

Fig. 1

2. Using the three moment theorem, analyze the beam shown in **figure 2** and plot the bending moment diagram indicating all the critical values. (20 marks)

EI = Constant

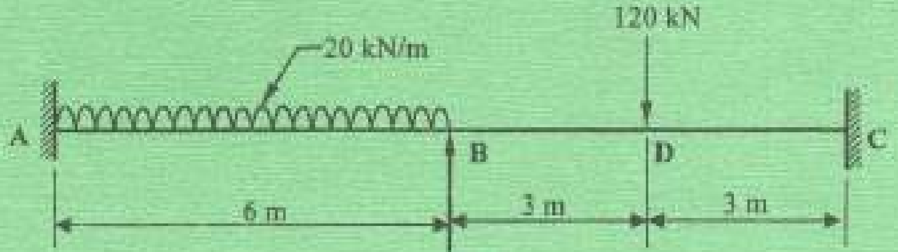

Fig. 2

3. (a) State any **five** factors that influence load carrying capacity for steel columns. (5 marks)

(b) Four equal loads of 150 kN each equally spaced at 2 m part followed by a uniformly distributed load of 60 kN/m at a distance of 1.5 m from the last 150 kN load across a girder of 20 m, 2 pan from right to left as shown in **figure 3**. Using influence lines, calculate the shearforce and bending moment at a section C, 8 m from the left hand support when the load of 150 kN is at 5 m from the left hand support. (15 marks)

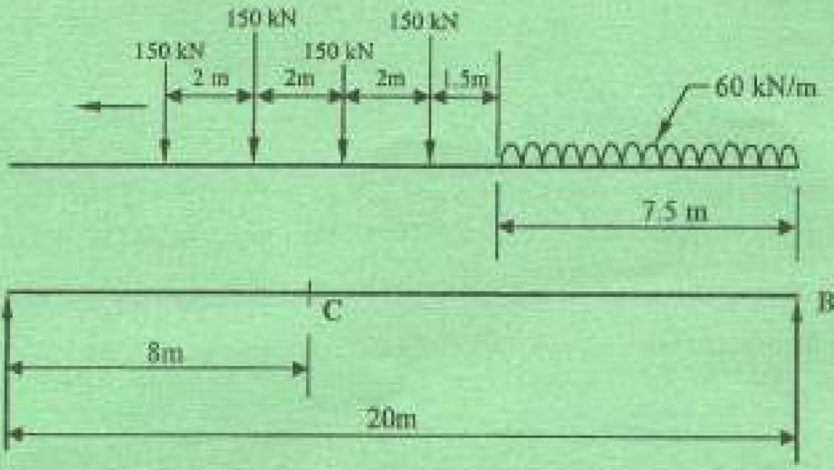

Fig. 3

4. (a). Define the term slenderness ratio. (2 marks)

(b) State **four** conditions that a fillet weld should satisfy as far as the design strength of a welded connection is concerned. (6 marks)

(c) Design a suitable slab base plate for a 203 x 203 x 86 Kg/m UC, supporting an ultimate axial load of 1400 kN, if the foundation is formed from grade 30 concrete. (12 marks)

5. (a) Describe the parameters to be tested during the shear test of timber. (3 marks)

(b) Explain the meaning of the following symbols as used in timber design. -K_2, K_3, K_5, K_7, K_8 and K_{12}. (6 marks)

(c) A 63 mm x 150 mm timber post is to support a medium term total axial load of 12.5 kN restrained in position but not in direction at both ends. The post is 2.75 m in height and the strength class 3 timber is to be used. Determine its adequacy. (11 marks)

6. (a) State **five** assumptions made when rivets are used in steel connections. (5 marks)

(b) With the aid of neat sketches describe the following types of timber connectors:

(i) split ring;

(ii) toothed plate. (5 marks)

(c) A straight steel pin-jointed strut is 5 cm in diameter and 1.25 m long.

Calculate:

(i) the Enter crippling load when loaded along the central axis;

(ii) the eccentricity which will cause failure at 75% of this load if the yield point stress of material is 270 N/mm^2 and Young's modulus is 206 kN/mm^2.

(10 marks)

7. (a) Show that the rankine's formular in calculations for safe loads on columns is determined by:

$$P_R = \frac{f_c \times A}{1 + a(l/r)^2}$$

(10 marks)

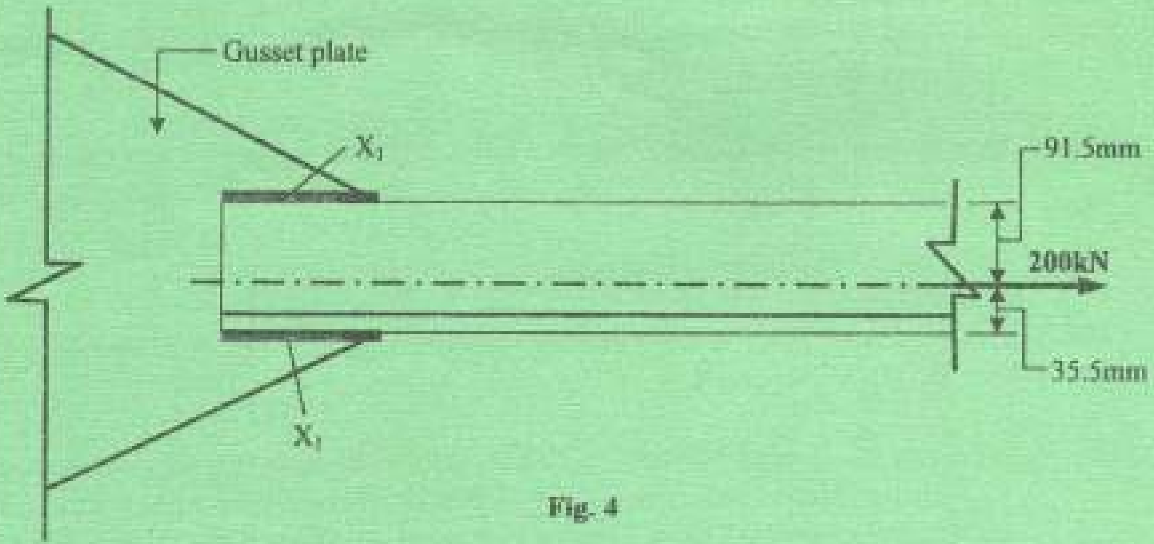

Fig. 4

(b) Using 6 mm fillet welds determine the length of side fillet welds for the connection shown in **figure 4**.

Strength of weld = 483 N/mm (6 marks)

(c) State **four** advantages of cased steel sections. (4 marks) easytvet.com

8. A short column has a rectangular section 160 mm x 200 mm with a circular hole of 80 mm diameter as shown in **figure 5**. It carries an eccentric load of 100 kN, located as shown in figure 5. Determine the values of the stresses at the four corners of the section A, B, C and D.

(20 marks)

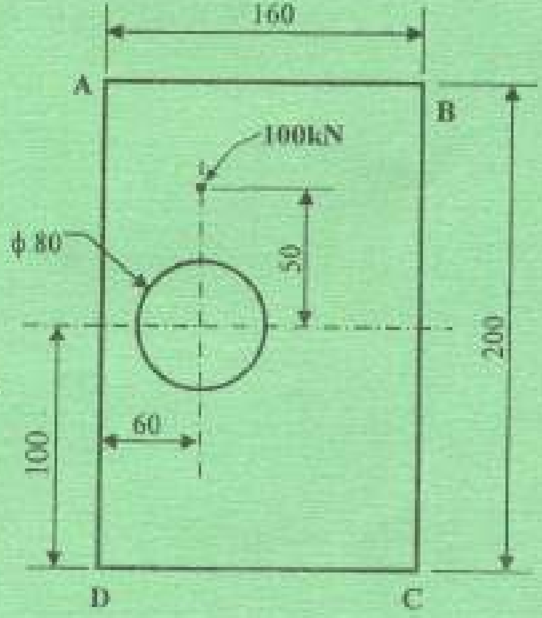

Fig. 5

2514.3

MODIFICATION FACTOR K_3 FOR DURATION OF LOADING	
Duration of Loading	Value of K_3
Long term (e.g. dead + permanent imposed)	1.00
Medium term (e.g. dead + snow, dead + temporary imposed)	1.25
Short term (e.g. dead + imposed + wind dead + imposed + snow + wind)	1.50
Very short term (e.g. dead + imposed + wind)	1.75

Modification factor K_{12} for compression members (Table 22, BS 5268)

$\frac{E}{\sigma_{c,\parallel}}$	*Values of K_{12}*																			
	Values of slenderness ratio λ (= L_e/i)																			
	<5	5	10	20	30	40	50	60	70	80	90	100	120	140	160	180	200	220	240	250
	Equivalent L_e/b (for rectangular sections)																			
	<1.4	1.4	2.9	5.8	8.7	11.6	14.5	17.3	20.2	23.1	26.0	28.9	34.7	40.5	46.2	52.0	57.8	63.6	69.4	72.3
400	1.000	0.975	0.951	0.896	0.827	0.735	0.621	0.506	0.408	0.330	0.271	0.225	0.162	0.121	0.094	0.075	0.061	0.051	0.043	0.040
500	1.000	0.975	0.951	0.899	0.837	0.759	0.664	0.562	0.466	0.385	0.320	0.269	0.195	0.148	0.115	0.092	0.076	0.063	0.053	0.049
600	1.000	0.975	0.951	0.901	0.843	0.774	0.692	0.601	0.511	0.430	0.363	0.307	0.226	0.172	0.135	0.109	0.089	0.074	0.063	0.058
700	1.000	0.975	0.951	0.902	0.848	0.784	0.711	0.629	0.545	0.467	0.399	0.341	0.254	0.195	0.154	0.124	0.102	0.085	0.072	0.067
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	0.096	0.082	0.076
900	1.000	0.976	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	0.106	0.091	0.084
1000	1.000	0.976	0.952	0.904	0.855	0.801	0.742	0.677	0.609	0.542	0.478	0.420	0.325	0.255	0.204	0.167	0.138	0.116	0.099	0.092
1100	1.000	0.976	0.952	0.905	0.856	0.804	0.748	0.687	0.623	0.559	0.497	0.440	0.344	0.272	0.219	0.179	0.149	0.126	0.107	0.100
1200	1.000	0.976	0.952	0.905	0.857	0.807	0.753	0.695	0.634	0.573	0.513	0.457	0.362	0.288	0.233	0.192	0.160	0.135	0.116	0.107
1300	1.000	0.976	0.952	0.905	0.858	0.809	0.757	0.701	0.643	0.584	0.527	0.472	0.378	0.303	0.247	0.203	0.170	0.144	0.123	0.115
1400	1.000	0.976	0.952	0.906	0.859	0.811	0.760	0.707	0.651	0.595	0.539	0.486	0.392	0.317	0.259	0.214	0.180	0.153	0.131	0.122
1500	1.000	0.976	0.952	0.906	0.860	0.813	0.763	0.712	0.658	0.605	0.550	0.498	0.405	0.330	0.271	0.225	0.189	0.161	0.138	0.129
1600	1.000	0.976	0.952	0.906	0.861	0.814	0.766	0.716	0.664	0.611	0.559	0.508	0.417	0.342	0.282	0.235	0.198	0.169	0.145	0.135
1700	1.000	0.976	0.952	0.906	0.861	0.815	0.768	0.719	0.669	0.618	0.567	0.518	0.428	0.353	0.292	0.245	0.207	0.177	0.152	0.142
1800	1.000	0.976	0.952	0.906	0.862	0.816	0.770	0.722	0.673	0.624	0.574	0.526	0.438	0.363	0.302	0.254	0.215	0.184	0.159	0.148
1900	1.000	0.976	0.952	0.907	0.862	0.817	0.772	0.725	0.677	0.629	0.581	0.534	0.447	0.373	0.312	0.262	0.223	0.191	0.165	0.154
2000	1.000	0.976	0.952	0.907	0.863	0.818	0.773	0.728	0.681	0.634	0.587	0.541	0.455	0.382	0.320	0.271	0.230	0.198	0.172	0.160

Grade stresses and moduli of elasticity for various strength classes: for service classes 1 and 2

Strength class	Bending parallel to grain N/mm²	Tension parallel to grain N/mm²	Compression parallel to grain N/mm²	Compression perpendicular to grain [a] N/mm²		Shear parallel to grain N/mm²	Modulus of elasticity Mean N/mm²	Modulus of elasticity Minimum N/mm²	Characteristic density, ρ_k [b] kg/m³	Average density, ρ_{mean} [b] kg/m³
C14	4.1	2.5	5.2	2.1	1.6	0.60	6 800	4 600	290	350
C16	5.3	3.2	6.8	2.2	1.7	0.67	8 800	5 800	310	370
C18	5.8	3.5	7.1	2.2	1.7	0.67	9 100	6 000	320	380
C22	6.8	4.1	7.5	2.3	1.7	0.71	9 700	6 500	340	410
C24	7.5	4.5	7.9	2.4	1.9	0.71	10 800	7 200	350	420
C27	10.0	6.0	8.2	2.5	2.0	1.10	12 300	8 200	370	450
C30	11.0	6.6	8.6	2.7	2.2	1.20	12 300	8 200	380	460
C35	12.0	7.2	8.7	2.9	2.4	1.30	13 400	9 000	400	480
C40	13.0	7.8	8.7	3.0	2.6	1.40	14 500	10 000	420	500
D30	9.0	5.4	8.1	2.8	2.2	1.40	9 500	6 000	530	640
D35	11.0	6.6	8.6	3.4	2.6	1.70	10 000	6 500	560	670
D40	12.5	7.5	12.6	3.9	3.0	2.00	10 800	7 500	590	700
D50	16.0	9.6	15.2	4.5	3.5	2.20	15 000	12 600	650	780
D60	18.0	10.8	18.0	5.2	4.0	2.40	18 500	15 600	700	840
D70	23.0	13.8	23.0	6.0	4.6	2.60	21 000	18 000	900	1 080

NOTE Strength classes C14 to C40 are for softwoods and D30 to D70 are for hardwoods.

[a] When the specification specifically prohibits wane at bearing areas, the higher values of compression perpendicular to grain stress may be used, otherwise the lower values apply.

[b] The values of characteristic density given above are for use when designing joints. For the calculation of dead load, the average density should be used.

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