2707/302
STRUCTURES III
June/July 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN CIVIL ENGINEERING

MODULE III

STRUCTURES III

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Scientific calculator.
*Answer any **FIVE** of the following **EIGHT** questions.*
All questions carry equal marks.
Maximum marks for each part of a question are as shown.
Candidates should answer the questions in English.

This paper consists of 11 printed pages.

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

Turn over

1. Figure 1 shows a continuous beam with three spans. Analyse the beam using the three moments theorem and hence sketch the bending moment diagram indicating all the critical values. (20 marks)

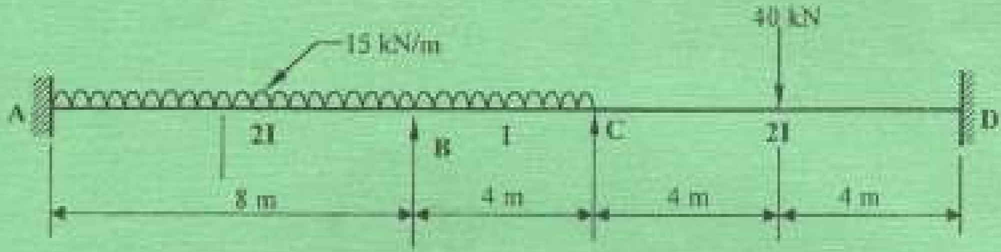


Fig. 1

2. Figure 2 shows a portal frame. Analyse the frame using the moment distribution method and hence plot the bending and shear force diagrams indicating all the critical values. (20 marks)

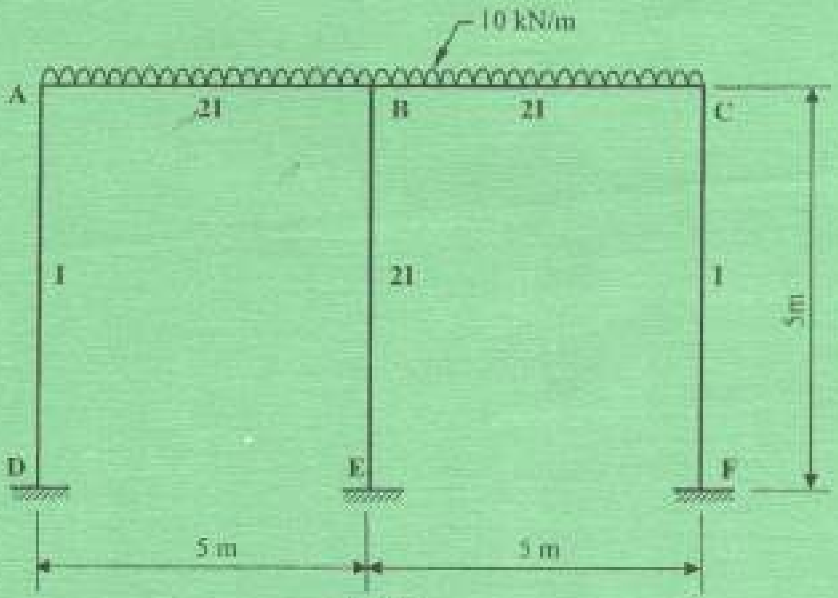


Fig. 2

3. (a) Define the following terms, used in timber design:

(i) basic stress;
(ii) grade stress;
(iii) green stress;
(iv) dry stress. (4 marks)

(b) Design timber floor joists for a domestic dwelling given the following information:

- Timber floor comprises of T and G boards on 4m joist effective span, at 600 mm centres.
- Loads:
  dead bad = 0.4 kN/mm^2
  live load = 1.5 kN/mm^2
- Joists are SC3 class, and limited to a depth of 200 mm.
- Load duration - medium term, K_3 = 1.25
- Load sharing factor, K_8 = 1.1

(16 marks)

4. (a) State **six** assumptions made in the design of a rivetted connection. (3 marks)

(b) A simply supported steel beam spans 8 m and supports an ultimate central point load of 170 kN from secondary beam as shown in figure 3. In addition it carries an ultimate uniformly distributed characteristic dead and imposed loads of 9 kN/m each. If the beam is only restrained at the load position and the ends, select a suitable UB section in grade 43 steel to satisfy bending and shear considerations.
Take E - 210 kN/mm^2 (17 marks)

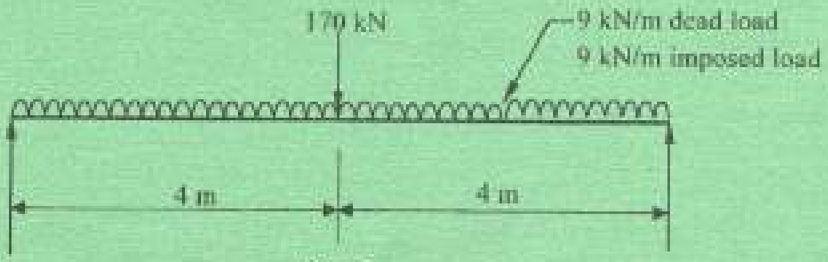


Fig. 3

5. A train of 5 wheels loads crosses a simply supported girder of span 22.5 m as shown in figure 4. Using influence lines, calculate the maximum positive and negative shear forces at midspan respectively. (20 marks)

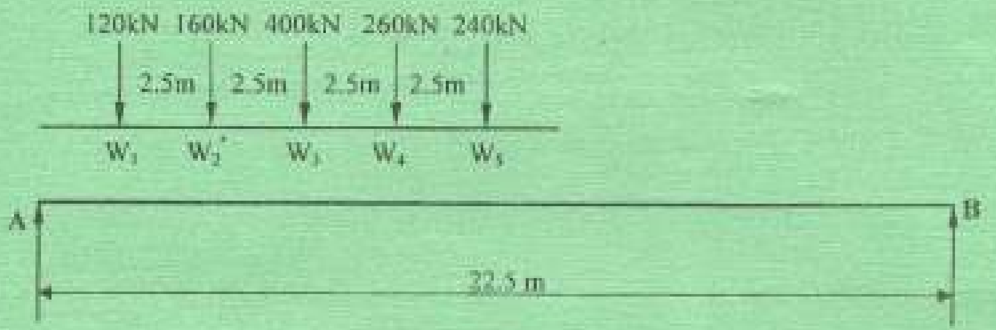


Fig. 4

6. (a) Derive the formula for Euler's buckling load for a long column of uniform cross-section with its two ends hinged. (10 marks)

(b) A round steel bar of diameter 15 mm and 2 m long is pinned at both ends. It is subjected to a gradually increasing axially compressive force.

Computer:

(i) the Euler's buckling load;

(ii) the maximum lateral deflection corresponding to the buckling conditions.

Take E - 210 kN/mm^2; Yield stress - 240 N/mm^2. (10 marks)

Figure 5 shows a cross section of a strut column made from a 200 x 150 mm I-section with a 250 mm x 12 mm plate welded on the top flange.

- Properties for the 200 x 150 mm I-section.
  - Area = 6650 mm^2
  - Ixx = 47.6 x 106 mm^4
  - Iyy = 11.9 x 106 mm^4
- A vertical load of 40 kN acts at P, the line of thrust passing 50 mm from the X-X axis and 25 mm from the Y-Y axis of the I-section.

Calculate the maximum stress developed in the section. (20 marks)

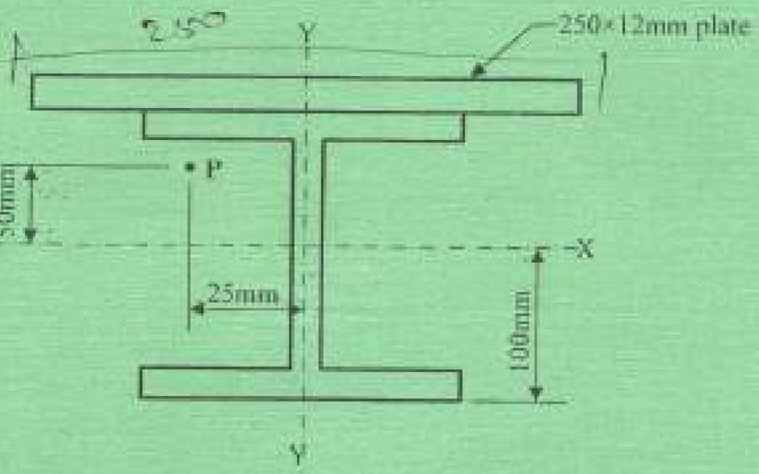


Fig. 5

8. (a) (i) State **five** factors which govern the safe load on steel stanchion. (5 marks)

(ii) A 65 x 50 x 8 mm angle tie is to be welded by the long leg to a gusset plate as shown in figure 6. It is required to transmit characteristic dead and imposed loads of 50 KN and 60 KN respectively. Design suitable 6 mm fillet welds X and Y as indicated.

Take: pw = 220 N/mm^2, fillet weld size = 6 mm. (6 marks)

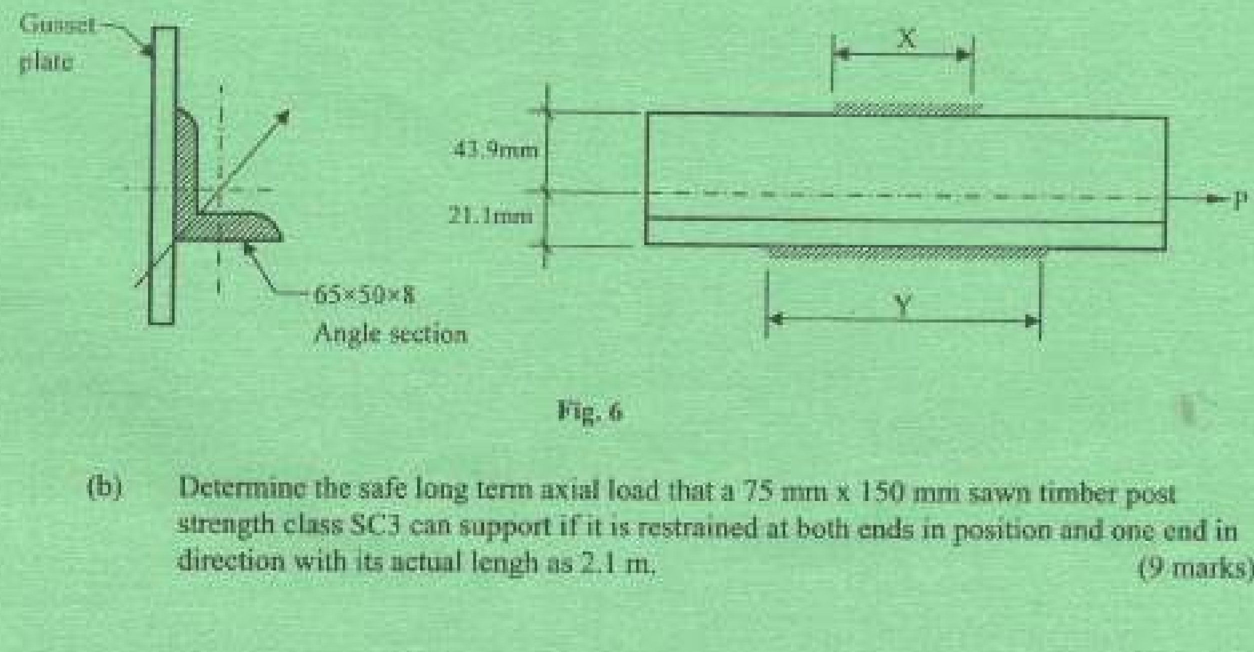


Fig. 6

(b) Determine the safe long term axial load that a 75 mm x 150 mm sawn timber post strength class SC3 can support if it is restrained at both ends in position and one end in direction with its actual lengh as 2.1 m. (9 marks)

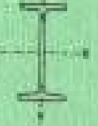
UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES

Serial Size	Mass per metre	Depth of Section D	Width of Section B	Thickness Web t	Thickness Flange T	Root Radius r	Depth between Fillets d	Area of Section
mm	kg	mm	mm	mm	mm	mm	mm	cm²
457 × 152	82	465.1	153.5	10.7	18.9	10.2	404.4	104.4
	74	461.3	152.7	9.9	17.0	10.2	404.4	94.9
	67	457.2	151.9	9.1	15.0	10.2	404.4	85.3
	60	454.7	152.9	8.0	13.3	10.2	407.7	75.9
	52	449.8	152.4	7.6	10.9	10.2	407.7	66.5
406 × 178	74	412.8	179.7	9.7	16.0	10.2	357.4	94.9
	67	409.4	178.8	8.8	14.3	10.2	357.4	85.4
	60	406.4	177.8	7.8	12.8	10.2	357.4	76.1
	54	402.6	177.6	7.6	10.9	10.2	357.4	68.3
406 × 152	74	416.3	153.7	10.1	18.1	10.2	357.4	94.8
	67	412.2	152.9	9.3	16.0	10.2	357.4	85.3
	60	407.9	152.2	8.6	13.9	10.2	357.4	75.8
406 × 140	46	402.3	142.4	6.9	11.2	10.2	357.4	58.9
	39	397.3	141.8	6.3	8.6	10.2	357.4	49.3
381 × 152	67	388.6	154.3	9.7	16.3	10.2	333.2	85.4
	60	384.8	153.4	8.7	14.4	10.2	333.2	75.9
	52	381.0	152.4	7.8	12.4	10.2	333.2	66.4
356 × 171	67	364.0	173.2	9.1	15.7	10.2	309.1	85.3
	57	358.6	172.1	8.0	13.0	10.2	309.1	72.1
	51	355.6	171.5	7.3	11.5	10.2	309.1	64.6
	45	352.0	171.0	6.9	9.7	10.2	309.1	56.9
356 × 127	39	352.8	126.0	6.5	10.7	10.2	309.1	49.3
	33	348.5	125.4	5.9	8.5	10.2	309.1	41.7
305 × 165	54	310.9	166.8	7.7	13.7	8.9	262.6	68.3
	46	307.1	165.7	6.7	11.8	8.9	262.6	58.8
	40	303.8	165.1	6.1	10.2	8.9	262.6	51.5
305 × 127	48	310.4	125.2	8.9	14.0	8.9	262.6	60.8
	42	306.6	124.3	8.0	12.1	8.9	262.6	53.1
	37	303.8	123.5	7.2	10.7	8.9	262.6	47.4
305 × 102	33	312.7	102.4	6.6	10.8	7.6	275.9	41.8
	28	308.9	101.9	6.1	8.9	7.6	275.9	36.3
	25	304.8	101.6	5.8	6.8	7.6	275.9	31.4
254 × 146	43	259.6	147.3	7.3	12.7	7.6	219.0	55.0
	37	256.0	146.4	6.4	10.9	7.6	219.0	47.4
	31	251.5	146.1	6.1	8.6	7.6	219.0	39.9
254 × 102	28	260.4	102.1	6.4	10.0	7.6	224.5	36.2
	25	257.0	101.9	6.1	8.4	7.6	224.5	32.1
	22	254.0	101.6	5.8	6.8	7.6	224.5	28.4
203 × 133	30	206.8	133.8	6.3	9.6	7.6	172.4	38.0
	25	203.2	133.4	5.8	7.8	7.6	172.4	32.3

UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES



Serial Size	Moment of Inertia Axis x-x Gross	Moment of Inertia Axis x-x Net	Moment of Inertia Axis y-y	Radius of Gyration Axis x-x	Radius of Gyration Axis y-y	Elastic Modulus Axis x-x	Elastic Modulus Axis y-y	Ratio D/T
mm	cm⁴	cm⁴	cm⁴	cm	cm	cm³	cm³	
457 × 152	36160	32058	1093	18.6	3.24	1555	142.5	24.6
	32380	28731	963	18.5	3.18	1404	126.1	27.1
	28522	25342	829	18.3	3.12	1248	109.1	30.5
	25464	22613	794	18.3	3.23	1120	104.0	34.2
	21345	19034	645	17.9	3.11	949.0	84.61	41.3
406 × 178	27279	23981	1448	17.0	3.91	1322	161.2	25.8
	24279	21357	1269	16.9	3.85	1186	141.9	28.6
	21520	18928	1108	16.8	3.82	1059	124.7	31.8
	18576	16389	922	16.5	3.67	922.8	103.9	36.9
406 × 152	26938	23811	1047	16.9	3.32	1294	136.2	23.0
	23798	21069	908	16.7	3.26	1155	118.8	25.8
	20619	18283	768	16.5	3.18	1011	100.9	29.3
406 × 140	15603	13699	500	16.3	2.88	775.6	70.26	35.9
	12408	10963	373	15.9	2.75	624.7	52.61	46.2
381 × 152	21276	18817	947	15.8	3.33	1095	122.7	23.8
	18632	16489	814	15.7	3.27	968.4	106.2	26.7
	16046	14226	685	15.5	3.21	842.3	89.96	30.7
356 × 171	19483	17002	1278	15.1	3.87	1071	147.6	23.2
	16038	14018	1026	14.9	3.77	894.3	119.2	27.8
	14118	12349	885	14.8	3.71	794.0	103.3	30.9
	12052	10578	730	14.6	3.58	684.7	85.39	36.3
356 × 127	10056	8885	333	14.3	2.60	570.0	52.87	33.0
	8167	7029	257	14.0	2.48	468.7	40.99	41.0
305 × 165	11686	10119	988	13.1	3.80	751.8	118.5	22.7
	9924	8596	825	13.0	3.74	646.4	99.54	26.0
	8500	7368	691	12.9	3.67	559.6	83.71	29.8
305 × 127	9485	8137	438	12.5	2.68	611.1	69.94	22.2
	8124	6978	367	12.4	2.63	530.0	58.99	25.3
	7143	6142	316	12.3	2.58	470.3	51.11	28.4
305 × 102	6482	5752	189	12.5	2.13	414.6	37.00	29.0
	5415	4855	153	12.2	2.05	350.7	30.01	34.7
	4381	3899	116	11.8	1.92	287.5	22.85	44.8
254 × 146	6546	5683	633	10.9	3.39	504.3	85.97	20.4
	5544	4814	528	10.8	3.34	433.1	72.11	23.5
	4427	3869	406	10.5	3.19	352.1	55.53	29.2
254 × 102	4004	3565	174	10.5	2.19	307.6	34.13	26.0
	3404	3041	144	10.3	2.11	264.9	28.23	30.6
	2863	2572	118	10.0	2.02	225.4	22.84	37.4
203 × 133	2880	2469	354	8.71	3.05	278.5	52.85	21.5
	2348	2020	280	8.53	2.94	231.1	41.92	26.1

UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES

Serial Size	Mass per metre	Depth of Section D	Width of Section B	Thickness Web t	Thickness Flange T	Root Radius r	Depth between Fillets d	Area of Section
mm	kg	mm	mm	mm	mm	mm	mm	cm²
914 × 419	388	920.5	420.5	21.5	36.6	24.1	791.5	493.9
	343	911.4	418.5	19.4	32.0	24.1	791.5	436.9
914 × 305	289	926.6	307.8	19.6	32.0	19.1	819.2	368.5
	253	918.5	305.5	17.3	27.9	19.1	819.2	322.5
	224	910.3	304.1	15.9	23.9	19.1	819.2	284.9
	201	903.0	303.4	15.2	20.2	19.1	819.2	256.1
838 × 292	226	850.9	293.8	16.1	26.8	17.8	756.4	288.4
	194	840.7	292.4	14.7	21.7	17.8	756.4	246.9
	176	834.9	291.6	14.0	18.8	17.8	756.4	223.8
762 × 267	197	769.6	268.0	15.6	25.4	16.5	681.2	250.5
	173	762.0	266.7	14.3	21.6	16.5	681.2	220.2
	147	753.9	265.3	12.9	17.5	16.5	681.2	187.8
686 × 254	170	692.9	255.8	14.5	23.7	15.2	610.6	216.3
	152	687.6	254.5	13.2	21.0	15.2	610.6	193.8
	140	683.5	253.7	12.4	19.0	15.2	610.6	178.4
	125	677.9	253.0	11.7	16.2	15.2	610.6	159.4
610 × 305	238	633.0	311.5	18.6	31.4	16.5	531.6	303.5
	179	617.5	307.0	14.1	23.6	16.5	531.6	227.7
	149	609.6	304.8	11.9	19.7	16.5	531.6	189.9
610 × 229	140	617.0	230.1	13.1	22.1	12.7	543.1	178.2
	125	611.9	229.0	11.9	19.6	12.7	543.1	159.4
	113	607.3	228.2	11.2	17.3	12.7	543.1	144.3
	101	602.2	227.6	10.6	14.8	12.7	543.1	129.0
610 × 178	91	602.5	178.4	10.6	15.0	12.7	547.1	115.8
	82	598.2	177.8	10.1	12.8	12.7	547.1	104.4
533 × 330	212	545.1	333.6	16.7	27.8	16.5	460.1	269.6
	189	539.5	331.7	14.9	25.0	16.5	460.1	241.2
	167	533.4	330.2	13.4	22.0	16.5	460.1	212.7
533 × 210	122	544.6	211.9	12.8	21.3	12.7	472.7	155.6
	109	539.5	210.7	11.6	18.8	12.7	472.7	138.4
	101	536.7	210.1	10.9	17.4	12.7	472.7	129.1
	92	533.1	209.3	10.2	15.6	12.7	472.7	117.6
	82	528.3	208.7	9.6	13.2	12.7	472.7	104.3
533 × 165	73	528.8	165.6	8.9	13.5	12.7	476.5	93.0
	66	524.8	165.1	8.8	11.5	12.7	476.5	83.5
457 × 191	98	467.4	192.8	11.4	19.6	10.2	404.4	125.2
	89	463.6	192.0	10.6	17.7	10.2	404.4	113.8
	82	460.2	191.3	9.9	16.0	10.2	404.4	104.4
	74	457.2	190.5	9.1	14.5	10.2	404.4	94.9
	67	453.6	189.9	8.5	12.7	10.2	404.4	85.4

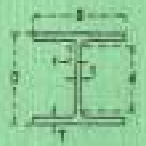
PROPERTIES OF STEEL SECTIONS

UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES

Serial Size	Moment of Inertia Axis x–x Gross	Moment of Inertia Axis x–x Net	Moment of Inertia Axis y–y	Radius of Gyration Axis x–x	Radius of Gyration Axis y–y	Elastic Modulus Axis x–x	Elastic Modulus Axis y–y	Ratio D/T
mm	cm⁴	cm⁴	cm⁴	cm	cm	cm³	cm³	
914 × 419	717325	639177	42481	38.1	9.27	15586	2021	25.2
	623866	555835	36251	37.8	9.11	13691	1733	28.5
914 × 305	503781	469903	14793	37.0	6.34	10874	961.3	29.0
	436798	406504	12512	36.8	6.23	9490	819.2	32.9
	375111	350209	10425	36.3	6.05	8241	685.6	38.1
	324715	303783	8632	35.8	5.81	7192	569.1	44.7
838 × 292	339130	315153	10661	34.3	6.08	7971	725.9	31.8
	278833	259625	8384	33.6	5.83	6633	573.6	38.7
	245412	228867	7111	33.1	5.64	5879	487.6	44.4
762 × 267	239464	221138	7699	30.9	5.54	6223	574.6	30.3
	204747	189341	6376	30.5	5.38	5374	478.1	35.3
	168535	156213	5002	30.0	5.16	4471	377.1	43.1
686 × 254	169843	158106	6225	28.0	5.30	4902	486.8	29.2
	150015	137965	5391	27.8	5.28	4364	423.7	32.7
	136673	125148	4789	27.6	5.18	3979	377.5	36.0
	117700	108580	3992	27.2	5.00	3472	315.5	41.8
610 × 305	207252	192203	14973	26.1	7.02	6549	961.3	20.2
	151312	140269	10571	25.8	6.81	4901	688.6	26.2
	124341	115233	8471	25.6	6.68	4079	555.9	30.9
610 × 229	111673	101889	4253	25.0	4.88	3620	369.6	27.9
	98408	89815	3575	24.8	4.80	3217	321.1	31.2
	87260	79645	3184	24.6	4.70	2874	279.1	35.1
	75549	69132	2555	24.2	4.54	2509	233.6	40.7
610 × 178	63970	57238	1427	23.5	3.61	2124	160.0	40.2
	55779	50076	1203	23.1	3.39	1865	135.3	46.7
533 × 330	141682	121777	16064	22.9	7.72	5199	963.3	19.6
	125618	107882	14093	22.8	7.64	4657	849.6	21.6
	109109	93447	12057	22.6	7.53	4091	730.3	24.2
533 × 210	76078	68718	3208	22.1	4.54	2794	302.8	25.6
	66610	60218	2755	21.9	4.46	2469	261.6	28.7
	61530	55671	2513	21.8	4.41	2293	239.2	30.8
	55225	50040	2212	21.7	4.34	2072	211.3	34.2
	47363	43062	1826	21.3	4.18	1793	175.0	40.0
533 × 165	40414	35752	1027	20.8	3.32	1528	124.1	39.2
	35083	31144	863	20.5	3.21	1337	104.5	45.6
457 × 191	45653	40469	2216	19.1	4.21	1954	229.9	23.8
	40956	36313	1960	19.0	4.15	1767	204.2	26.2
	37039	32869	1746	18.8	4.09	1610	182.6	28.8
	33324	29570	1547	18.7	4.04	1458	162.4	31.5
	29337	26072	1328	18.5	3.95	1293	139.9	35.7

PROPERTIES OF STEEL SECTIONS



UNIVERSAL COLUMNS

Parallel Flanges

DIMENSIONS AND PROPERTIES

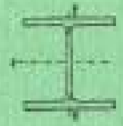
Serial Size	Mass per metre	Depth of Section D	Width of Section B	Thickness Web t	Thickness Flange T	Root Radius r	Depth between Fillets d	Area of Section
mm	kg	mm	mm	mm	mm	mm	mm	cm^2
356 × 406	634	474.7	424.1	47.6	77.0	15.2	290.1	808.1
	551	455.7	418.5	42.0	67.5	15.2	290.1	701.8
	467	436.6	412.4	35.9	58.0	15.2	290.1	595.5
	393	419.1	407.0	30.6	49.2	15.2	290.1	500.9
	340	406.4	403.0	26.5	42.9	15.2	290.1	432.7
	287	393.7	399.0	22.6	36.5	15.2	290.1	366.0
	235	381.0	395.0	18.5	30.2	15.2	290.1	299.8
Column Core	477	427.0	424.4	48.0	53.2	15.2	290.1	607.2
356 × 368	202	374.7	374.4	16.8	27.0	15.2	290.1	257.9
	177	368.3	372.1	14.5	23.8	15.2	290.1	225.7
	153	362.0	370.2	12.6	20.7	15.2	290.1	195.2
	129	355.6	368.3	10.7	17.5	15.2	290.1	164.9
305 × 305	283	365.3	321.8	26.9	44.1	15.2	246.6	360.4
	240	352.6	317.9	23.0	37.7	15.2	246.6	305.6
	198	339.9	314.1	19.2	31.4	15.2	246.6	252.3
	158	327.2	310.6	15.7	25.0	15.2	246.6	201.2
	137	320.5	308.7	13.8	21.7	15.2	246.6	174.6
	118	314.5	306.8	11.9	18.7	15.2	246.6	149.8
	97	307.8	304.8	9.9	15.4	15.2	246.6	123.3
254 × 254	167	289.1	264.5	19.2	31.7	12.7	200.2	212.4
	132	276.4	261.0	15.6	25.1	12.7	200.2	167.7
	107	266.7	258.3	13.0	20.5	12.7	200.2	136.6
	89	260.4	255.9	10.5	17.3	12.7	200.2	114.0
	73	254.0	254.0	8.6	14.2	12.7	200.2	92.9
203 × 203	86	222.3	208.8	13.0	20.5	10.2	160.8	110.1
	71	215.9	206.2	10.3	17.3	10.2	160.8	91.1
	60	209.6	205.2	9.3	14.2	10.2	160.8	75.8
	52	206.2	203.9	8.0	12.5	10.2	160.8	66.4
	46	203.2	203.2	7.3	11.0	10.2	160.8	58.8
152 × 152	37	161.8	154.4	8.1	11.5	7.6	123.4	47.4
	30	157.5	152.9	6.6	9.4	7.6	123.4	38.2
	23	152.4	152.4	6.1	6.8	7.6	123.4	29.8

PROPERTIES OF STEEL SECTIONS

UNIVERSAL COLUMNS

Parallel Flanges

DIMENSIONS AND PROPERTIES



Serial Size	Moment of Inertia Axis x–x Gross	Moment of Inertia Axis x–x Net	Moment of Inertia Axis y–y	Radius of Gyration Axis x–x	Radius of Gyration Axis y–y	Elastic Modulus Axis x–x	Elastic Modulus Axis y–y	Ratio D/T
mm	cm^4	cm^4	cm^4	cm	cm	cm^3	cm^3	
356 × 406	275140	243076	98211	18.5	11.0	11592	4632	6.2
	227023	200312	82665	18.0	10.9	9964	3951	6.8
	183118	161331	67905	17.5	10.7	8388	3293	7.5
	146765	129159	55410	17.1	10.5	7004	2723	8.5
	122474	107667	46816	16.8	10.4	6027	2324	9.5
	99994	87843	38714	16.5	10.3	5080	1940	10.8
	79110	69424	31008	16.2	10.2	4150	1570	12.6
Column Core	172391	152936	68057	16.8	10.6	8075	3207	8.0
356 × 368	66307	57806	23632	16.0	9.57	3540	1262	13.9
	57153	49798	20470	15.9	9.52	3104	1100	15.5
	48525	42250	17470	15.8	9.46	2681	943.8	17.5
	40246	35040	14555	15.6	9.39	2264	790.4	20.3
305 × 305	78777	72827	24545	14.8	8.25	4314	1525	8.3
	64177	59251	20239	14.5	8.14	3641	1273	9.4
	50832	46935	16230	14.2	8.02	2991	1034	10.8
	38740	35765	12524	13.9	7.89	2368	806.3	13.1
	32838	30314	10672	13.7	7.82	2049	691.4	14.8
	27601	25473	9006	13.6	7.75	1755	587.0	16.8
	22202	20489	7268	13.4	7.68	1442	476.9	20.0
254 × 254	29914	27171	9796	11.9	6.79	2070	740.6	9.1
	22416	20350	7444	11.6	6.66	1622	570.4	11.0
	17510	15890	5901	11.3	6.57	1313	456.9	13.0
	14307	12976	4849	11.2	6.52	1099	378.9	15.1
	11360	10297	3873	11.1	6.46	894.5	305.0	17.9
203 × 203	9462	8374	3119	9.27	5.32	851.5	298.7	10.8
	7647	6758	2536	9.16	5.28	708.4	246.0	12.5
	6088	5383	2041	8.96	5.19	581.1	199.0	14.8
	5263	4653	1770	8.90	5.16	510.4	173.6	16.5
	4564	4035	1539	8.81	5.11	449.2	151.5	18.5
152 × 152	2218	1932	709	6.84	3.87	274.2	91.78	14.1
	1742	1515	558	6.75	3.82	221.2	73.06	16.8
	1263	1104	403	6.51	3.68	165.7	52.95	22.4

Table 1: 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

Table 2: Depth factor, K7

1. $K_7 = 1.17$ *for solid beams having a depth* $< 72mm$
2. $K_7 = (300/h)^{0.11}$ for solid beams

   with $72mm < h < 300mm$
3. $K_7 = 0.81(h^2 + 92300)/(h^2 + 56800)$ for solid beams

   - with $h < 300mm$

Table 3: Grade stresses, modulus of elasticity and density for strength class SC2 for the dry exposure condition

Strength Class	*Bending parallel to grain* (Nmm^{-2})	*Tension parallel to grain* (Nmm^{-2})	*Compression parallel to grain* (Nmm^{-2})	*Compression perpendicular to grain** (Nmm^{-2})	*Shear parallel to grain* (Nmm^{-2})	*Modulus of elasticity* (E_{mean}) (Nmm^{-2})	($E_{minimum}$) (Nmm^{-2})	*Approximate Density* (kgm^{-3})
SC1	2.8	2.2	3.5	2.1	0.46	6800	4500	540
SC2	4.1	2.5	5.3	2.1	0.66	8000	5000	540
SC3	5.3	3.2	6.8	2.2	0.67	8800	5800	540
SC4	7.5	4.5	7.9	2.4	0.71	9900	6600	590
SC5	10.0	6.0	8.7	2.8	1.00	10700	7100	590/760
SC6	12.5	7.5	12.5	3.8	1.50	14100	11800	840
SC7	15.0	9.0	14.5	4.4	1.75	16200	13600	960
SC8	17.5	10.5	16.5	5.2	2.00	18700	15600	1080
SC9	20.5	12.3	19.5	6.1	2.25	21600	18000	1200

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

Table 6: 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	0.603	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

TABLE ALLOWABLE STRESS p_c ON GROSS SECTION FOR AXIAL COMPRESSION

l/r	p_c (N/mm²) for grade 43 steel									
	0	1	2	3	4	5	6	7	8	9
0	155	155	154	154	153	153	153	152	152	151
10	153	151	150	150	149	149	148	148	148	147
20	147	146	146	146	145	145	144	144	144	143
30	143	142	142	142	141	141	141	140	140	139
40	139	138	138	137	137	136	136	136	135	134
50	133	133	132	131	130	130	129	128	127	126
60	126	125	124	123	122	121	120	119	118	117
70	115	114	113	112	111	110	108	107	106	105
80	104	102	101	100	99	97	96	95	94	92
90	91	90	89	87	86	85	84	83	81	80
100	79	78	77	76	75	74	73	72	71	70
110	69	68	67	66	65	64	63	62	61	61
120	60	59	58	57	56	56	55	54	53	53
130	52	51	51	50	49	49	48	48	47	46
140	46	45	45	44	43	43	42	42	41	41
150	40	40	39	39	38	38	38	37	37	36
160	36	35	35	35	34	34	33	33	33	32
170	32	32	31	31	31	30	30	30	29	29
180	29	28	28	28	28	27	27	27	26	26
190	26	26	25	25	25	25	24	24	24	24
200	24	23	23	23	23	22	22	22	22	22
210	21	21	21	21	21	20	20	20	20	20
220	20	19	19	19	19	19	19	18	18	18
230	18	18	18	18	17	17	17	17	17	17
240	17	16	16	16	16	16	16	16	16	15
250	15									
300	11									
350	8									

Intermediate values may be obtained by linear interpolation.

THIS IS THE LAST PRINTED PAGE.