UNIVERSITY OF JOHANNESBURG

JUNE EXAM 2014

COURSE:	ENGINEERING	**TIME: 3 HOURS**
PAPER:	STRUCTURAL ENGINEERING 4A12	**MARKS: 100**
EXAMINERS	1. Prof M Dundu 2. Dr J Mahachi	25/04/2014

(THIS PAPER CONSISTS OF 4 PAGES)

ANSWER ALL QUESTIONS.

QUESTION 1 **(25)**

(a) Explain why bolted compression members are always designed on the basis that the gross-sectional area will be effective in resisting the applied load, unlike tension members?

(4)

(b) A built-up column section shown in Figure 1 is designed to support a compressive load of 1750kN. The effective length of the column is 5m. If the steel plates are of Grade 350W steel, check whether this section is able to carry the load. The properties of the section are as follows:

$I_x = 234.1\times10^6\,mm^4$; $I_y = 60.5\times10^6\,mm^4$; $J = 1303\times10^3\,mm^4$; $C_w = 335.4\times10^9\,mm^9$; $y_0 = 92.7mm$.

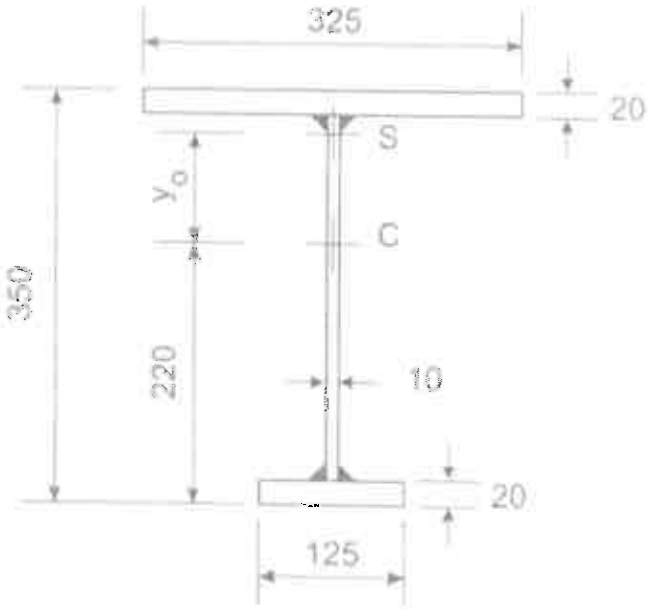

Figure 1

28/04/14.

(21)

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QUESTION 2 (20)

An ultimate load of P is applied on the top flange of a simply supported beam of length 7m, as shown in Figure 2. The beam is laterally unrestrained along its entire span and that the ends are partially restrained against lateral bending. If a 406 x 178 x 54 I-section in Grade 350W steel is chosen as the section, determine the ultimate load that the beam can carry. Hence check whether the shear and bearing capacities of the beam are adequate or not. Assume that the bearing lengths at mid-span and at the supports are 50mm and 30mm, respectively.

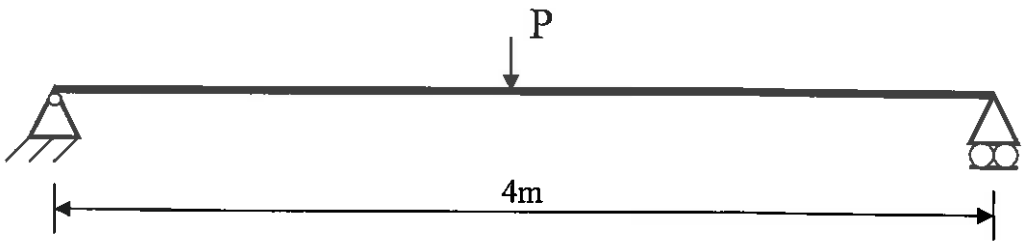

Figure 2

[20]

QUESTION 3 (30)

A 4.3m long, 310x254x86kg/m I-section of Grade 350W steel, is subjected to a load of 1400kN, as shown in Figure 3. The member is pinned at both ends and the compression flange is laterally supported at the ends only. If the member forms part of a braced structure, check the suitability of the given section.

$A = 11.0\times10^{3}\,mm^{2}$; $I_x = 199\times10^{6}\,mm^{4}$; $I_y = 44.5\times10^{6}\,mm^{4}$; $J = 877\times10^{3}\,mm^{4}$; $C_w = 961\times10^{9}\,mm^{6}$;
$Z_{plx} = 1420\times10^{3}\,mm^{3}$ $r_x = 134mm$ $r_y = 63.6mm$

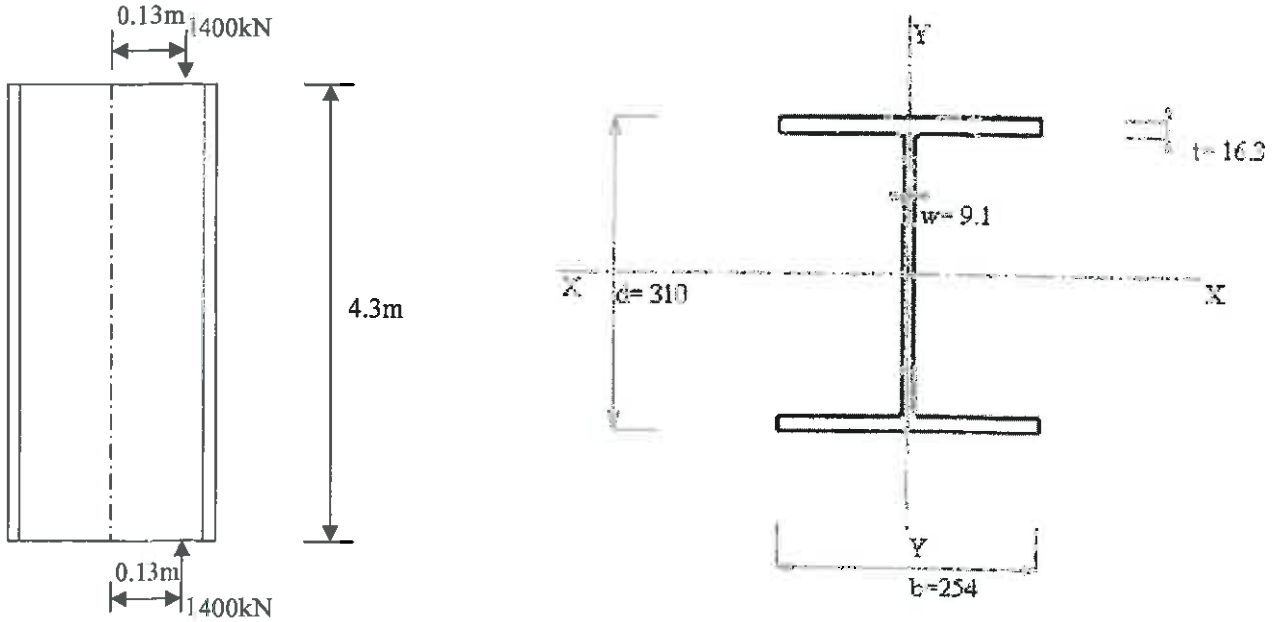

Figure 3

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QUESTION 4 **(25)**

(a) What is purpose of classifying beam sections? Why does yielding occur in lateral unsupported beams when the moment reaches 2/3 of the plastic moment or yield moment?

(4)

(b) Show that the splice connection shown in Figure 4 is suitable to resist a moment of 250kNm and a shear force of 550kN. Assume that the holes are drilled, the steel is grade 350W steel (ultimate tensile strength of plates = 480MPa) and the bolts are M20, grade 8.8 bolts (tensile strength of bolts = 800MPa).

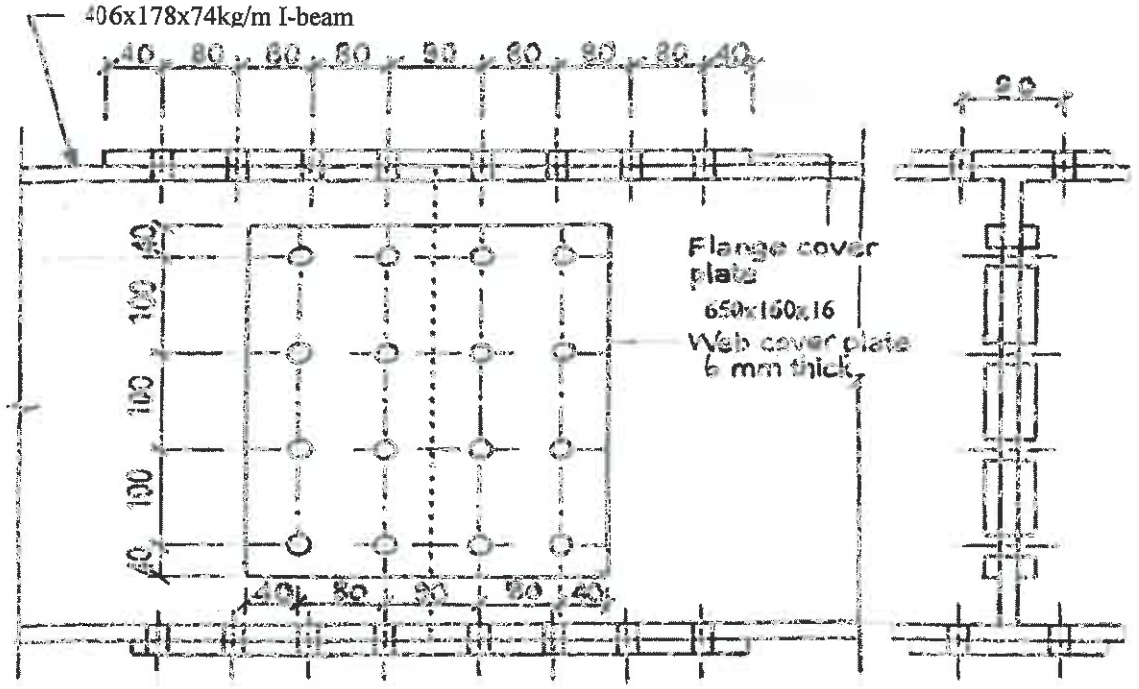

Figure 4 Spice Connection

(21)

Table 2.9 (continued)
T-SECTIONS (PARALLEL FLANGE) ('UNIVERSAL BEAMS')
DIMENSIONS AND PROPERTIES

Designation $h \times b \times m$	m	h	b	t_w	t_f	r_1	h_1	A
	kg/m	mm	mm	mm	mm	mm	mm	10^2 mm^2
305 x 165 x 40	40,3	303,8	165,1	6,1	10,2	8,9	266	5,16
46	46,1	307,1	165,7	6,7	11,8	8,9	266	5,88
54	54,0	310,9	166,8	7,7	13,7	8,9	266	6,88
356 x 171 x 45	45,0	352,0	171,0	6,9	9,7	10,2	312	5,70
51	51,0	355,6	171,5	7,3	11,5	10,2	312	6,46
57	57,0	359,6	172,1	8,0	13,0	10,2	312	7,22
67	67,1	364,0	173,2	9,1	15,7	10,2	312	8,55
406 x 140 x 39	39,0	397,2	141,8	6,3	8,6	10,2	330	4,92
46	46,0	403,2	142,4	6,9	11,2	10,2	330	5,90
406 x 178 x 54	54,1	402,6	177,6	7,6	10,9	10,2	330	6,86
60	60,1	406,4	177,8	7,8	12,8	10,2	330	7,67
67	67,1	409,4	178,8	8,8	14,3	10,2	330	8,55
74	74,2	412,8	179,7	9,7	16,0	10,2	330	9,53
457 x 191 x 67	67,1	453,6	189,9	8,5	12,7	10,2	368	8,55
74	74,3	457,2	190,5	9,1	14,5	10,2	368	9,51
82	82,0	460,2	191,3	9,9	16,0	10,2	368	10,3
89	89,3	463,6	192,0	10,6	17,7	10,2	368	11,4
98	98,3	467,6	192,8	11,4	19,6	10,2	368	12,5
533 x 210 x 82	82,2	528,3	208,7	9,6	13,2	12,7	476	10,5
92	92,1	533,1	209,3	10,2	15,6	12,7	476	11,8
101	101	536,7	210,1	10,9	17,4	12,7	476	12,9
109	109	539,5	210,7	11,6	18,8	12,7	476	13,9
122	122	544,6	211,9	12,8	21,3	12,7	477	15,6

About x-x				About y-y					
I	Z_x	Z_{px}	r	I	Z_y	Z_{py}	r	J	C_w
10^6 mm^4	10^3 mm^3	10^3 mm^3	mm	10^6 mm^4	10^3 mm^3	10^3 mm^3	mm	10^5 mm^4	10^9 mm^6
85,5	563	629	129	7,69	92,8	142	38,5	143	165
99,3	647	722	130	8,90	108	166	39,0	223	195
117	761	843	131	10,6	127	193	39,4	345	234
121	686	773	146	8,10	94,7	146	37,7	160	227
142	798	896	148	9,69	115	174	39,7	238	287
161	926	1 040	149	11,1	129	198	39,1	324	330
188	1 076	1 210	151	13,6	157	243	39,0	480	413
194	685	716	159	4,10	57,6	90,7	33,9	109	155
157	778	839	162	5,49	75,9	119	36,3	194	207
187	927	1 050	165	10,2	116	178	38,6	233	391
218	1 096	1 230	166	12,0	136	208	39,7	332	466
243	1 199	1 350	169	13,6	153	237	39,9	430	533
274	1 380	1 510	170	15,5	173	268	40,3	640	610
294	1 300	1 470	166	14,5	153	237	41,2	378	705
354	1 460	1 660	167	16,7	176	273	42,0	527	920
371	1 610	1 830	168	18,7	196	304	42,5	699	923
411	1 770	2 030	169	20,9	218	339	42,9	921	1 040
459	1 960	2 230	171	23,5	242	378	43,3	1 220	1 190
475	1 500	2 060	213	20,0	192	300	43,8	527	1 330
553	2 090	2 370	217	24,9	236	368	45,0	772	1 600
616	2 300	2 620	218	27,0	257	400	45,2	1 030	1 820
668	2 480	2 830	218	29,4	279	435	46,0	1 250	1 990
762	2 800	3 200	221	33,9	320	500	46,6	1 610	2 320