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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	ADVANCED STRUCTURE DESIGN
COURSE CODE	:	BFS 40903
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTION	:	A) ANSWER **ALL** QUESTION IN **SECTION A** AND **THREE (3)** FROM **FOUR (4)** QUESTIONS IN **SECTION B**

THIS QUESTION PAPER CONSISTS OF **FIFTEEN (15)** PAGES

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SECTION A

Q1 (a) What do you understand with concrete class C28/35

(2 marks)

(b) Describe briefly with sketching the concrete stress block for ultimate and serviceability limit state.

(5 marks)

(c) What do you understand about reinforced concrete?

(3 marks)

SECTION B

Q1 Figure **Q1** shows the cross section of cantilever wall with the detailing of the reinforcement. Previously the wall was designed to retain the backfill with 2 meters height. In a new project the height of the backfill is same but with an additional permanent surcharge of 15 kN/m^2. As an engineer you are required to check the suitability of the wall based on:

(a) The stability of the retaining wall based on sliding, overturning and settlement. Partial safety factor as in the figure.

(15 marks)

(b) The suitability of the main reinforcement (wall and base) to resist the current load

(10 marks)

(c) Give you comment for the current changes.

(5 marks)

Q2 Figure **Q2** shows a flat slab of an office where the imposed load is 5 kN/m^2. The slab is 250 mm thick and the columns are 300 mm square. Concrete cover is 30 mm, concrete is C30/37 and $f_{yk} = 500$ N/mm^2.

(a) Determine the design moment for panel AB/2-3.

(5 marks)

(b) From (a), design the main reinforcement for long span only.

(10 marks)

(c) Check for a deflection.

(5 marks)

(d) Check for punching shear 2d from the column face.

(10 marks)

Q3 (a) One of the advantages of composite construction is economical. Describe **THREE** (3) examples of economical.

(6 marks)

(b) What do you understand about partial shear connection in composite construction?

(3 marks)

(c) Figure **Q3** shows a floor composite section for a factory building. The floor will be propped during construction. The floor is to resist an imposed load of 3.5 kN/m^2, permanent ceiling load of 0.5 kN/m^2, beam self weight = 0.67 kN/m and slab self weight = 2 kN/m^2. Concrete grade C25/30. Determine:

(i) Plastic moment of resistance of composite beam and check against applied moment. ($\gamma_G = 1.35$, $\gamma_Q = 1.5$).

(8 marks)

(ii) Check for the shear of the section. ($\gamma_{MO} = 1.1$)

(4 marks)

(iii) Design the shear connectors. Use headed stud with 19 mm diameter, 100 mm height. (Assume full shear connection, $E_{cm} = 31$ kN/mm^2, $f_u = 450$ N/mm^2)

(9 marks)

Q4 (a) Figure **Q4 (a)** shows the section of wall for water retaining structures. Cover = 40 mm, f_{ck} = 30 N/mm^2, f_{yk} = 500 N/mm^2, $Ø_{bar}$ = 12 mm, E_s = 200 kN/mm^2, E_c = 33 kN/mm^2, design crack width 0.2 mm. $A_s = 1.2\ A_{smin}$

(i) Calculate the crack width due to flexural.

(15 marks)

(b) Figure **Q4 (b)** shows an arrangement of shear wall for a building. Determine the distribution of 120 kN horizontal force F into the shear wall A, B, C. D and E. The relative stiffness of each shear wall is shown in the figure in term of multiple of *k*.

(15 marks)

- END OF QUESTION -

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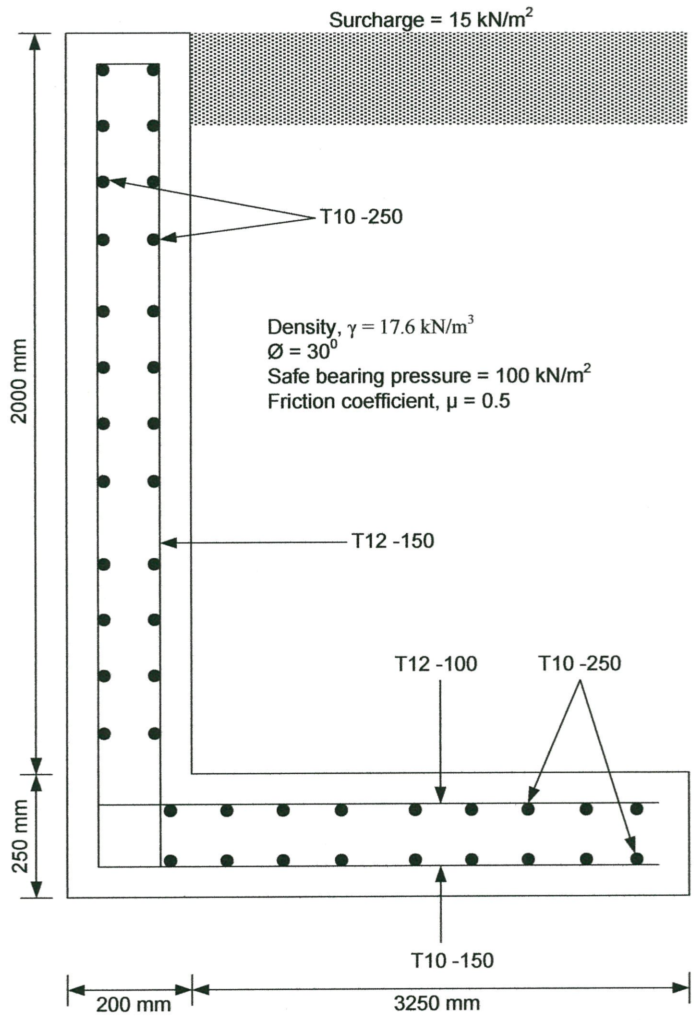

Partial safety factor, γ		
Overturning	Overturning moment = 1.1	Restraining moment = 0.9
Sliding	Sliding force = 1.35	Resisting force = 1.0

FIGURE Q1

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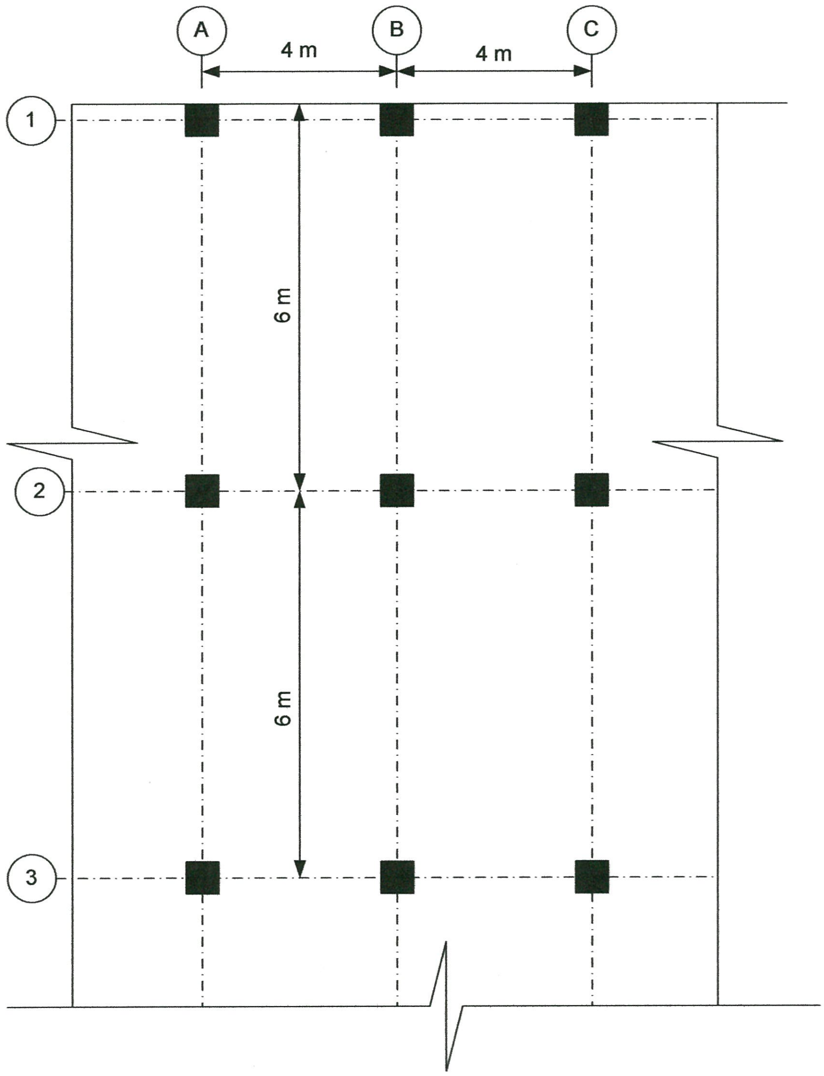

FIGURE Q2

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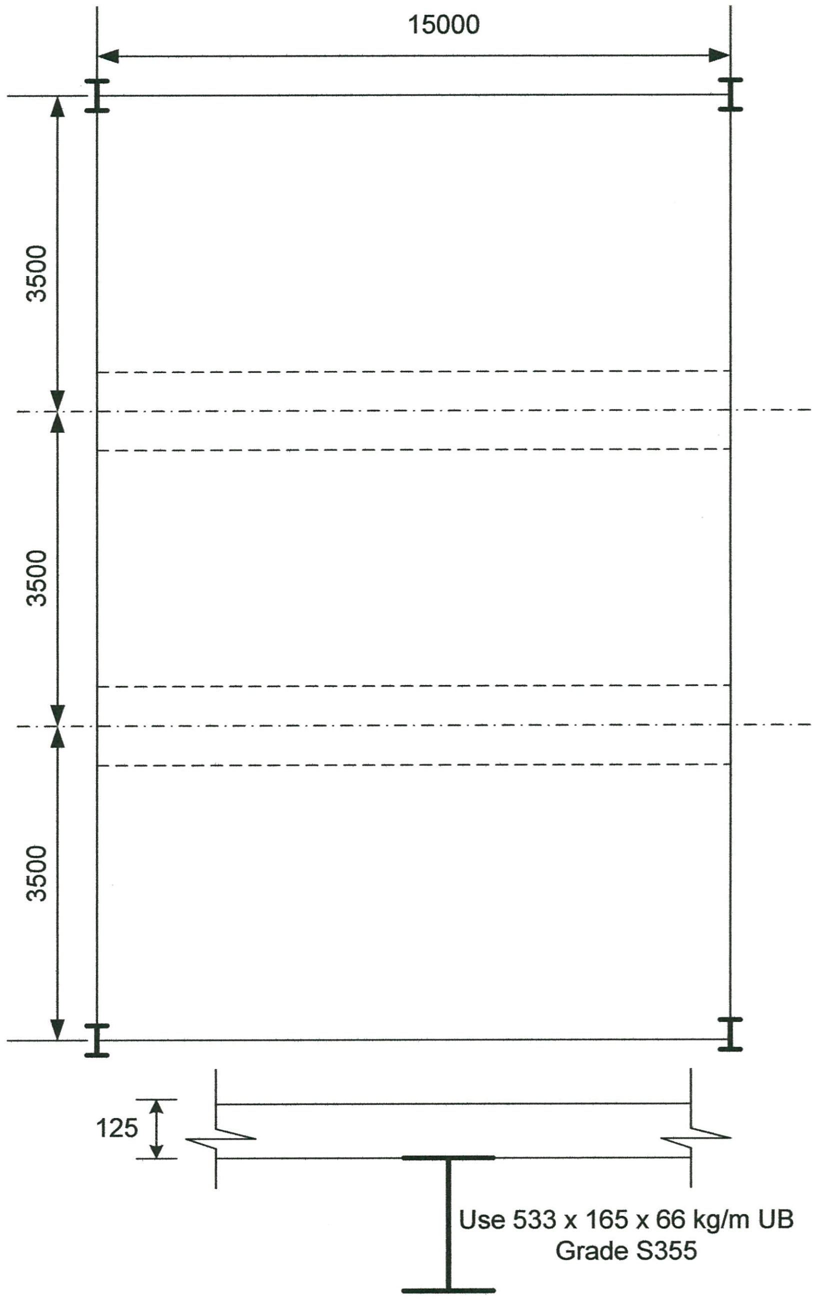

FIGURE Q3

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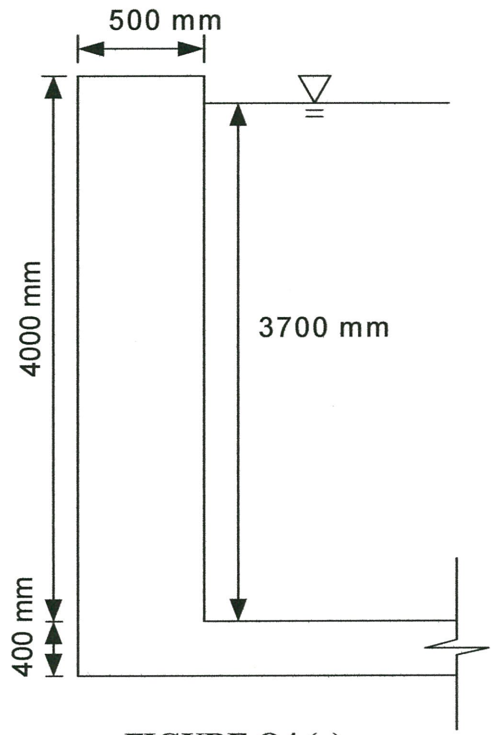

FIGURE Q4 (a)

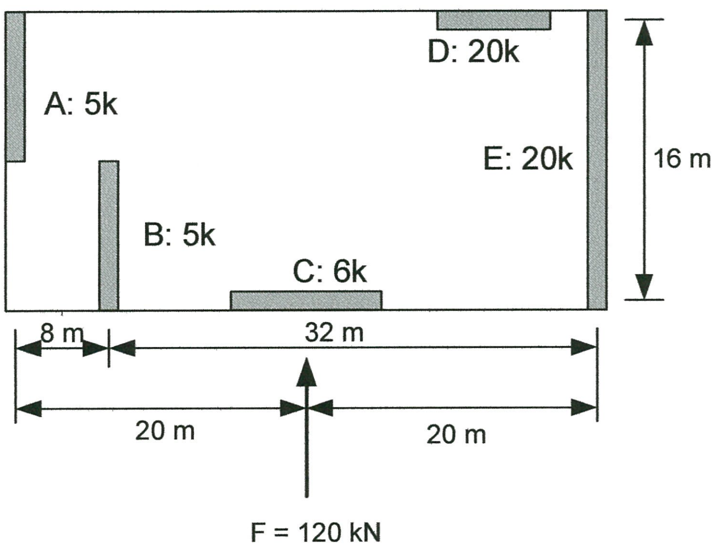

FIGURE Q4 (b)

Appendix

Ultimate Bending Moment and Shear Force Coefficient in One-Way Spanning Slab

	End support condition						
	Pinned		Continuous				
	Outer support	Near middle of end span	End support	End span	At first interior support	At middle of interior spans	At interior supports
Moment	0	0.086 *Fl*	-	0.075 *Fl*	-	0.063 *Fl*	
			0.04 *Fl*		0.086 *Fl*		0.063 *Fl*
Shear	0.4 *F*						
			0.46 *F*		0.6 *F*		0.5 *F*

l = effective span

Area of each bay ≥ 30 m^2

F = total ultimate load = 1.35 G_k + 1.5 Q_k

Span/effective depth ratios for slabs

Location	$A_s/bd \geq 1.5\%$	$A_s/bd = 0.5\%$	A_s/bd 0.15%
One-or two-way spanning slab:			
Simply supported	16	22	30
End span	20	28	38
Interior span	22	30	33
Flat slab	18	26	36
Cantilever	6	9	12

Notes to Table 5.8

1. Values may be interpolated.
2. For flanged sections where the ratio of the flange to the rib width exceeds 3, the values should be multiplied by 0.8.
3. For spans exceeding 7m, other than for flat slabs, supporting partitions liable to be damaged by excessive deflections, the value should be multiplied by 7/span (in metres).
4. The above assumes f_{yk} = 460N/mm^2. If other values of f_{yk} are used then multiply the above by 460/f_{yk}.
5. A_s/bd is calculated at the location of maximum span moment.
6. For flat slabs where the greater span exceeds 8.5m, the value should be multiplied by 8.5/span.

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Ultimate shear stress $v_{Rd,c}$ MPa

$\frac{100 A_s}{b_w d}$	Effective depth (mm)											
	150	175	200	225	250	275	300	400	500	750	1000	2000
≤0.25	0.54	0.54	0.54	0.52	0.50	0.48	0.47	0.43	0.40	0.36	0.34	0.31
0.5	0.59	0.59	0.59	0.57	0.56	0.55	0.54	0.51	0.48	0.45	0.43	0.39
0.75	0.68	0.68	0.68	0.66	0.64	0.63	0.62	0.58	0.55	0.51	0.49	0.45
1.00	0.75	0.75	0.75	0.72	0.71	0.69	0.68	0.64	0.61	0.57	0.54	0.49
1.25	0.80	0.80	0.80	0.78	0.76	0.74	0.73	0.69	0.66	0.61	0.58	0.53
1.5	0.85	0.85	0.85	0.83	0.81	0.79	0.78	0.73	0.70	0.65	0.62	0.56
≥2.00	0.94	0.94	0.94	0.91	0.89	0.87	0.85	0.80	0.77	0.71	0.68	0.62

Notes

a The tabulated values apply for f_{ck} = 30MPa. Approximate values for other concrete strengths may be used:
For f_{ck} = 25MPa the tabulated values should be multiplied by 0.95
For f_{ck} = 35MPa the tabulated values should be multiplied by 1.05
For f_{ck} = 40MPa the tabulated values should be multiplied by 1.1
For f_{ck} = 45MPa the tabulated values should be multiplied by 1.15.

b The Table does not allow for any contribution from axial loads. For an axial compression where stress of $\sigma_{cp} = (N/A_c)$ MPa, the Table values should be increased by $0.1\sigma_{cp}$, where N is the design axial load and A_c is the area of concrete section.

z/d for singly reinforced rectangular sections

K	z/d	K	z/d
≤0.05	0.950[a]	0.13	0.868
0.06	0.944	0.14	0.856
0.07	0.934	0.15	0.843
0.08	0.924	0.16	0.830
0.09	0.913	0.17	0.816
0.10	0.902	0.18	0.802
0.11	0.891	0.19	0.787
0.12	0.880	0.20	0.771

Key

a Limiting z to $0.95d$ is not a requirement of Eurocode 2, but is considered to be good practice.

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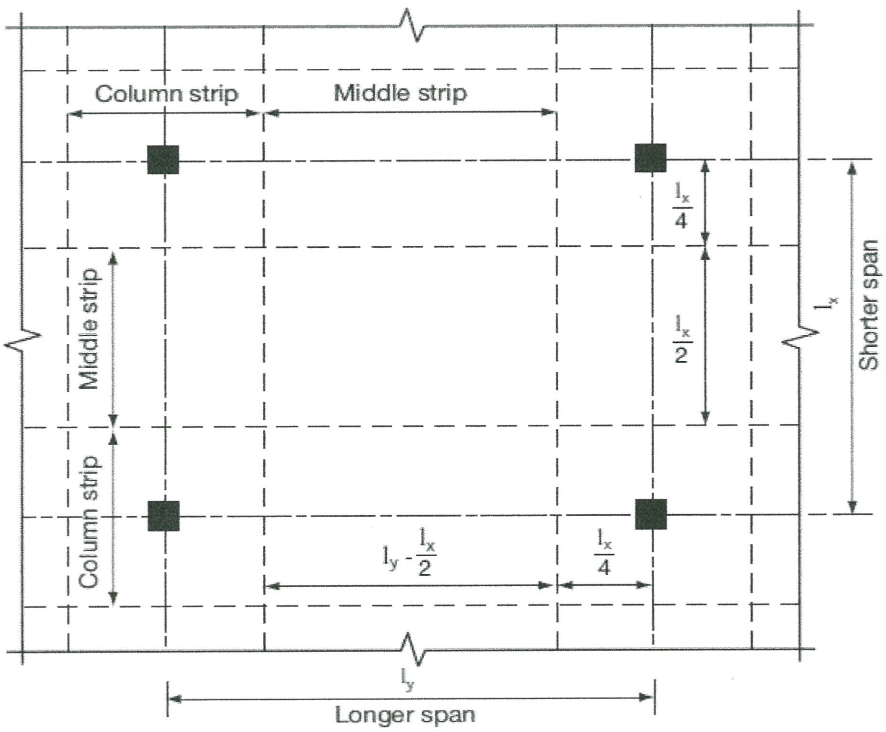
Table 5.5 Distribution of design moments of flat slabs

Design moment	Column strip %	Middle strip %
Negative	75	25
Positive	55	45

Note
For the case where the width of column strip is taken as equal to that of the drop and the middle strip is thereby increased in width, the design moments to be resisted by the middle strip should be increased in proportion to its increased width. The design moments to be resisted by the column strip may be decreased by an amount such that the total positive and the total negative design moments resisted by the column strip and middle strip together are unchanged.



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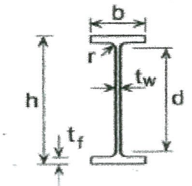

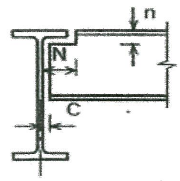

Dimensions

Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness Web	Thickness Flange	Root Radius	Depth between Fillets	Ratios for Local Buckling Flange	Ratios for Local Buckling Web	Dimensions for Detailing End Clearance	Notch		Surface Area Per Metre	Surface Area Per Tonne
		h	b	t_w	t_f	r	d	c_f/t_f	c_w/t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
533x210x138 +	138.3	549.1	213.9	14.7	23.6	12.7	476.5	3.68	32.4	9	110	38	1.90	13.7
533x210x122	122.0	544.5	211.9	12.7	21.3	12.7	476.5	4.08	37.5	8	110	34	1.89	15.5
533x210x109	109.0	539.5	210.8	11.6	18.8	12.7	476.5	4.62	41.1	8	110	32	1.88	17.2
533x210x101	101.0	536.7	210.0	10.8	17.4	12.7	476.5	4.99	44.1	7	110	32	1.87	18.5
533x210x92	92.1	533.1	209.3	10.1	15.6	12.7	476.5	5.57	47.2	7	110	30	1.86	20.2
533x210x82	82.2	528.3	208.8	9.6	13.2	12.7	476.5	6.58	49.6	7	110	26	1.85	22.5
533x165x85 +	84.8	534.9	166.5	10.3	16.5	12.7	476.5	3.96	46.3	7	90	30	1.69	19.9
533x165x75 +	74.7	529.1	165.9	9.7	13.6	12.7	476.5	4.81	49.1	7	90	28	1.68	22.5
533x165x66 +	65.7	524.7	165.1	8.9	11.4	12.7	476.5	5.74	53.5	6	90	26	1.67	25.4
457x191x161 +	161.4	492.0	199.4	18.0	32.0	10.2	407.6	2.52	22.6	11	102	44	1.73	10.7
457x191x133 +	133.3	480.6	196.7	15.3	26.3	10.2	407.6	3.06	26.6	10	102	38	1.70	12.8
457x191x106 +	105.8	469.2	194.0	12.6	20.6	10.2	407.6	3.91	32.3	8	102	32	1.67	15.8
457x191x98	98.3	467.2	192.8	11.4	19.6	10.2	407.6	4.11	35.8	8	102	30	1.67	17.0
457x191x89	89.3	463.4	191.9	10.5	17.7	10.2	407.6	4.55	38.8	7	102	28	1.66	18.6
457x191x82	82.0	460.0	191.3	9.9	16.0	10.2	407.6	5.03	41.2	7	102	28	1.65	20.1
457x191x74	74.3	457.0	190.4	9.0	14.5	10.2	407.6	5.55	45.3	7	102	26	1.64	22.1
457x191x67	67.1	453.4	189.9	8.5	12.7	10.2	407.6	6.34	48.0	6	102	24	1.63	24.3
457x152x82	82.1	465.8	155.3	10.5	18.9	10.2	407.6	3.29	38.8	7	84	30	1.51	18.4
457x152x74	74.2	462.0	154.4	9.6	17.0	10.2	407.6	3.66	42.5	7	84	28	1.50	20.2
457x152x67	67.2	458.0	153.8	9.0	15.0	10.2	407.6	4.15	45.3	7	84	26	1.50	22.3
457x152x60	59.8	454.6	152.9	8.1	13.3	10.2	407.6	4.68	50.3	6	84	24	1.49	24.9
457x152x52	52.3	449.8	152.4	7.6	10.9	10.2	407.6	5.71	53.6	6	84	22	1.48	28.3
406x178x85 +	85.3	417.2	181.9	10.9	18.2	10.2	360.4	4.14	33.1	7	96	30	1.52	17.8
406x178x74	74.2	412.8	179.5	9.5	16.0	10.2	360.4	4.68	37.9	7	96	28	1.51	20.4
406x178x67	67.1	409.4	178.8	8.8	14.3	10.2	360.4	5.23	41.0	6	96	26	1.50	22.3
406x178x60	60.1	406.4	177.9	7.9	12.8	10.2	360.4	5.84	45.6	6	96	24	1.49	24.8
406x178x54	54.1	402.6	177.7	7.7	10.9	10.2	360.4	6.86	46.8	6	96	22	1.48	27.3
406x140x53 +	53.3	406.6	143.3	7.9	12.9	10.2	360.4	4.46	45.6	6	78	24	1.35	25.3
406x140x46	46.0	403.2	142.2	6.8	11.2	10.2	360.4	5.13	53.0	5	78	22	1.34	29.1
406x140x39	39.0	398.0	141.8	6.4	8.6	10.2	360.4	6.69	56.3	5	78	20	1.33	34.1
356x171x67	67.1	363.4	173.2	9.1	15.7	10.2	311.6	4.58	34.2	7	94	26	1.38	20.6
356x171x57	57.0	358.0	172.2	8.1	13.0	10.2	311.6	5.53	38.5	6	94	24	1.37	24.1
356x171x51	51.0	355.0	171.5	7.4	11.5	10.2	311.6	6.25	42.1	6	94	22	1.36	26.7
356x171x45	45.0	351.4	171.1	7.0	9.7	10.2	311.6	7.41	44.5	6	94	20	1.36	30.2
356x127x39	39.1	353.4	126.0	6.6	10.7	10.2	311.6	4.63	47.2	5	70	22	1.18	30.2
356x127x33	33.1	349.0	125.4	6.0	8.5	10.2	311.6	5.82	51.9	5	70	20	1.17	35.4
305x165x54	54.0	310.4	166.9	7.9	13.7	8.9	265.2	5.15	33.6	6	90	24	1.26	23.3
305x165x46	46.1	306.6	165.7	6.7	11.8	8.9	265.2	5.98	39.6	5	90	22	1.25	27.1
305x165x40	40.3	303.4	165.0	6.0	10.2	8.9	265.2	6.92	44.2	5	90	20	1.24	30.8

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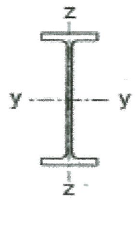

Properties

Section Designation	Second Moment of Area Axis y-y cm⁴	Second Moment of Area Axis z-z cm⁴	Radius of Gyration Axis y-y cm	Radius of Gyration Axis z-z cm	Elastic Modulus Axis y-y cm³	Elastic Modulus Axis z-z cm³	Plastic Modulus Axis y-y cm³	Plastic Modulus Axis z-z cm³	Buckling Parameter U	Torsional Index X	Warping Constant I_w dm⁶	Torsional Constant I_T cm⁴	Area of Section A cm²
533x210x138 +	86100	3860	22.1	4.68	3140	361	3610	568	0.874	24.9	2.67	250	176
533x210x122	76000	3390	22.1	4.67	2790	320	3200	500	0.878	27.6	2.32	178	155
533x210x109	66800	2940	21.9	4.60	2480	279	2830	436	0.875	30.9	1.99	126	139
533x210x101	61500	2690	21.9	4.57	2290	256	2610	399	0.874	33.1	1.81	101	129
533x210x92	55200	2390	21.7	4.51	2070	228	2360	355	0.873	36.4	1.60	75.7	117
533x210x82	47500	2010	21.3	4.38	1800	192	2060	300	0.863	41.6	1.33	51.5	105
533x165x85 +	48500	1270	21.2	3.44	1820	153	2100	243	0.861	35.5	0.857	73.8	108
533x165x75 +	41100	1040	20.8	3.30	1550	125	1810	200	0.853	41.1	0.691	47.9	95.2
533x165x66 +	35000	859	20.5	3.20	1340	104	1560	166	0.847	47.0	0.566	32.0	83.7
457x191x161 +	79800	4250	19.7	4.55	3240	426	3780	672	0.881	16.5	2.25	515	206
457x191x133 +	63800	3350	19.4	4.44	2860	341	3070	535	0.879	19.6	1.73	292	170
457x191x106 +	48900	2510	19.0	4.32	2080	259	2390	405	0.876	24.4	1.27	146	135
457x191x98	45700	2350	19.1	4.33	1960	243	2230	379	0.881	25.8	1.18	121	125
457x191x89	41000	2090	19.0	4.29	1770	218	2010	338	0.878	28.3	1.04	90.7	114
457x191x82	37100	1870	18.8	4.23	1610	196	1830	304	0.879	30.8	0.922	69.2	104
457x191x74	33300	1670	18.8	4.20	1460	176	1650	272	0.877	33.8	0.818	51.8	94.6
457x191x67	29400	1450	18.5	4.12	1300	153	1470	237	0.873	37.8	0.705	37.1	85.5
457x152x82	36600	1180	18.7	3.37	1570	153	1810	240	0.872	27.4	0.591	89.2	105
457x152x74	32700	1050	18.6	3.33	1410	136	1630	213	0.872	30.1	0.518	65.9	94.5
457x152x67	28900	913	18.4	3.27	1260	119	1450	187	0.868	33.6	0.448	47.7	85.6
457x152x60	25500	795	18.3	3.23	1120	104	1290	163	0.868	37.5	0.387	33.8	76.2
457x152x52	21400	645	17.9	3.11	950	84.6	1100	133	0.859	43.8	0.311	21.4	66.6
406x178x85 +	31700	1830	17.1	4.11	1520	201	1730	313	0.880	24.4	0.728	93.0	109
406x178x74	27300	1550	17.0	4.04	1320	172	1500	267	0.882	27.5	0.608	62.8	94.5
406x178x67	24300	1360	16.9	3.99	1190	153	1350	237	0.880	30.4	0.533	46.1	85.5
406x178x60	21600	1200	16.8	3.97	1060	135	1200	209	0.880	33.7	0.466	33.3	76.5
406x178x54	18700	1020	16.5	3.85	930	115	1050	178	0.871	38.3	0.392	23.1	69.0
406x140x53 +	18300	635	16.4	3.06	899	88.6	1030	139	0.870	34.1	0.246	29.0	67.9
406x140x46	15700	538	16.4	3.03	778	75.7	888	118	0.871	39.0	0.207	19.0	58.6
406x140x39	12500	410	15.9	2.87	629	57.8	724	90.8	0.858	47.4	0.155	10.7	49.7
356x171x67	19500	1360	15.1	3.99	1070	157	1210	243	0.886	24.4	0.412	55.7	85.5
356x171x57	16000	1110	14.9	3.91	896	129	1010	199	0.882	28.8	0.330	33.4	72.6
356x171x51	14100	968	14.8	3.86	796	113	896	174	0.881	32.1	0.286	23.8	64.9
356x171x45	12100	811	14.5	3.76	687	94.8	775	147	0.874	36.8	0.237	15.8	57.3
356x127x39	10200	358	14.3	2.68	576	56.8	659	89.0	0.871	35.2	0.105	15.1	49.5
356x127x33	8250	280	14.0	2.58	473	44.7	543	70.2	0.863	42.1	0.081	8.79	42.1
305x165x54	11700	1060	13.0	3.93	754	127	846	196	0.889	23.6	0.234	34.8	68.8
305x165x46	9900	896	13.0	3.90	646	108	720	166	0.890	27.1	0.195	22.2	58.7
305x165x40	8500	764	12.9	3.86	560	92.6	623	142	0.889	31.0	0.164	14.7	51.3

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Bar areas and perimeters

Table A.1 Sectional areas of groups of bars (mm^2)

Bar size (mm)	*Number of bars*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
6	28.3	56.6	84.9	113	142	170	198	226	255	283
8	50.3	101	151	201	252	302	352	402	453	503
10	78.5	157	236	314	393	471	550	628	707	785
12	113	226	339	452	566	679	792	905	1020	1130
16	201	402	603	804	1010	1210	1410	1610	1810	2010
20	314	628	943	1260	1570	1890	2200	2510	2830	3140
25	491	982	1470	1960	2450	2950	3440	3930	4420	4910
32	804	1610	2410	3220	4020	4830	5630	6430	7240	8040
40	1260	2510	3770	5030	6280	7540	8800	10100	11300	12600

Table A.2 Perimeters and weights of bars

Bar size (mm)	6	8	10	12	16	20	25	32	40
Perimeter (mm)	18.85	25.1	31.4	37.7	50.2	62.8	78.5	100.5	125.6
Weight (kg/m)	0.222	0.395	0.616	0.888	1.579	2.466	3.854	6.313	9.864

Bar weights based on density of 7850 kg/m^3.

Table A.3 Sectional areas per metre width for various bar spacings (mm^2)

Bar size (mm)	*Spacing of bars*								
	50	*75*	*100*	*125*	*150*	*175*	*200*	*250*	*300*
6	566	377	283	226	189	162	142	113	94
8	1010	671	503	402	335	287	252	201	168
10	1570	1050	785	628	523	449	393	314	262
12	2260	1510	1130	905	754	646	566	452	377
16	4020	2680	2010	1610	1340	1150	1010	804	670
20	6280	4190	3140	2510	2090	1800	1570	1260	1050
25	9820	6550	4910	3930	3270	2810	2450	1960	1640
32	16100	10700	8040	6430	5360	4600	4020	3220	2680
40	25100	16800	12600	10100	8380	7180	6280	5030	4190

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Equation

Water Retaining Structure

M_u: $0.157\, f_{cu}\, bd^2$

$$x = \frac{\left(1-\sqrt{1-0.7\frac{M}{M_u}}\right)}{0.9} d$$

$$x_1 = \alpha_e p\left(\sqrt{1+\frac{2}{\alpha_e p}}-1\right)d$$

$$f_s = \frac{M_s}{z\, A_s}$$

$$A_s = \frac{1.15\, M}{f_y z}$$

$$w_{max} = \frac{3a_{cr}\varepsilon_m}{1+2\left(\frac{a-c_{min}}{h-x}\right)}$$

$$\varepsilon_m = \varepsilon_1 - \varepsilon_2$$

$$\varepsilon_1 = \frac{(h-x)}{(d-x)} \times \frac{f_s}{E_s}$$

For a limiting design surface crack width of 0.2 mm:

$$\varepsilon_2 = \frac{b_t(h-x)(a'-x)}{3E_s A_s(d-x)}$$

For a limiting design surface crack width of 0.1 mm:

$$\varepsilon_2 = \frac{1.5b_t(h-x)(a'-x)}{3E_s A_s(d-x)}$$

Reinforced Concrete

$$k = \frac{M}{bd^2 f_{ck}}$$

$$A_s = \frac{M}{0.87 f_{yk} z}$$

Slab

$$V_{Rdmax} = 0.5ud\left[0.6\left(1-\frac{f_{ck}}{250}\right)\right]\frac{f_{ck}}{1.5}$$

$$V_{Rd,c} = v_{RD,c}\, u_1 d$$

Retaining wall

$$K_a = \frac{1-\sin\theta}{1+\sin\theta}$$

$$P_a = K_a \rho g h$$

$$P_{max} = \frac{\Sigma W}{A} + \frac{\Sigma M}{Z}$$

$$As_{min} = 0.15 b_t d/100$$