

Appendix 3: Numerical calculations of the fire resistance of larger profiles

The fire resistance of CFSHS columns are calculated with these parameters:

- Water content in concrete is 4% in weight;
- The quality of steel $f_y = 355$ MPa;
- Concrete strength $f_c = 40$ MPa
- Two values of column length are considered: 3 m and 4 m. The maximum value of the initial deflection is $L/500$. It has always been considered that the effect of this eccentricity and the one of loading eccentricity are cumulative.

The following symbols are used in the tables:

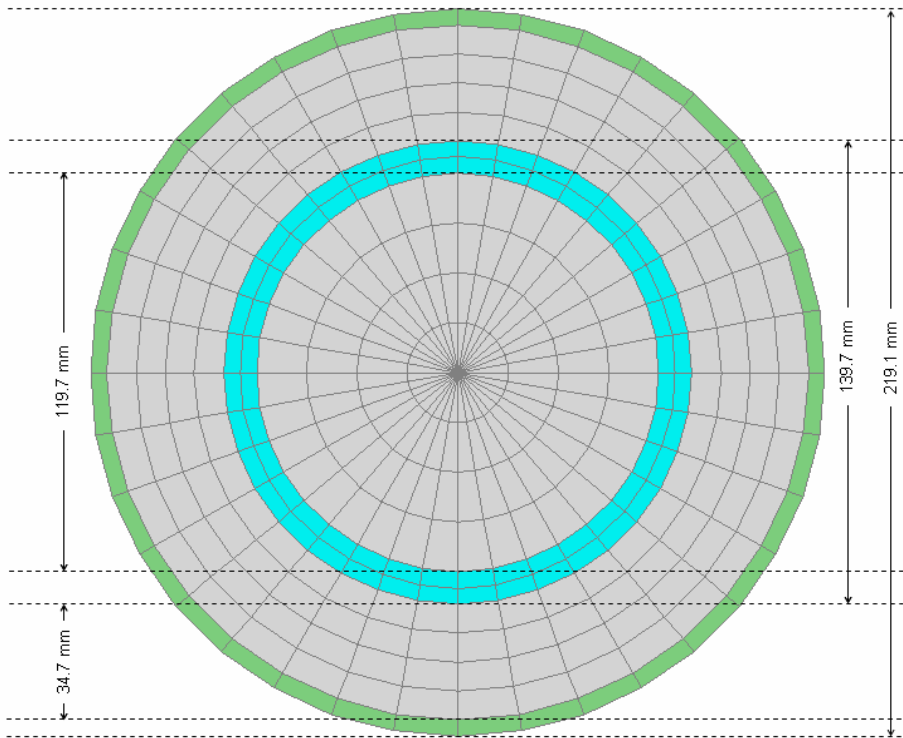
$N_{pl,Rk} = A_a \cdot f_y + A_c \cdot f_{ck} + A_s \cdot f_s$ the characteristic value of the plastic resistance to compression of the section

χ : reduction factor for flexural buckling $\chi = N_u / N_{pl,Rk}$

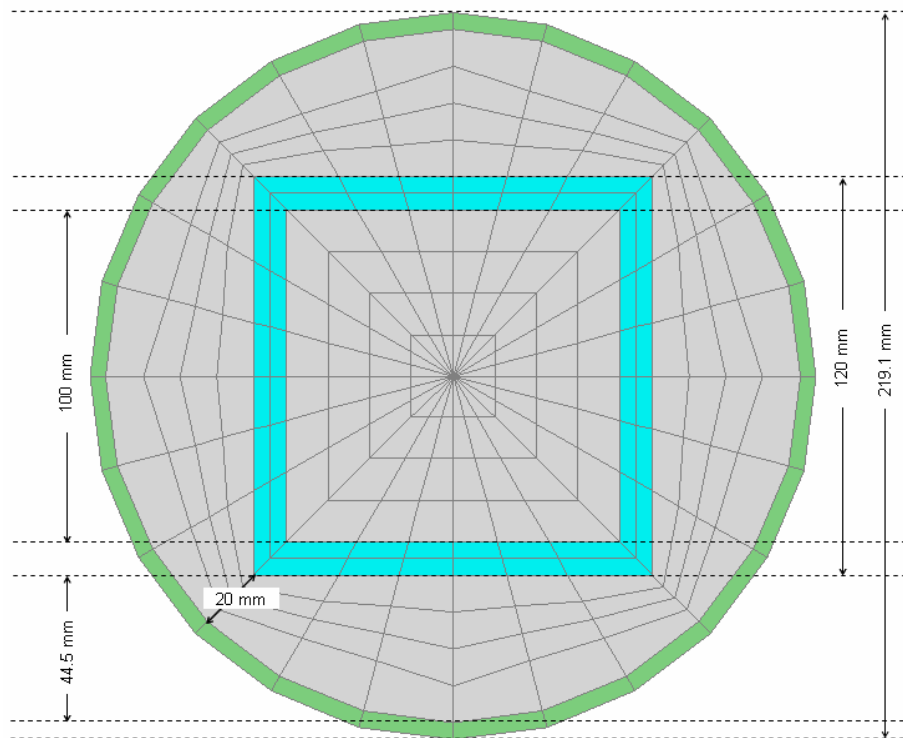
N_{fi} : the compressive load applied to the column under fire condition

N_u : the ultimate compressive load of the column at room temperature

Profile 1



Profile 2



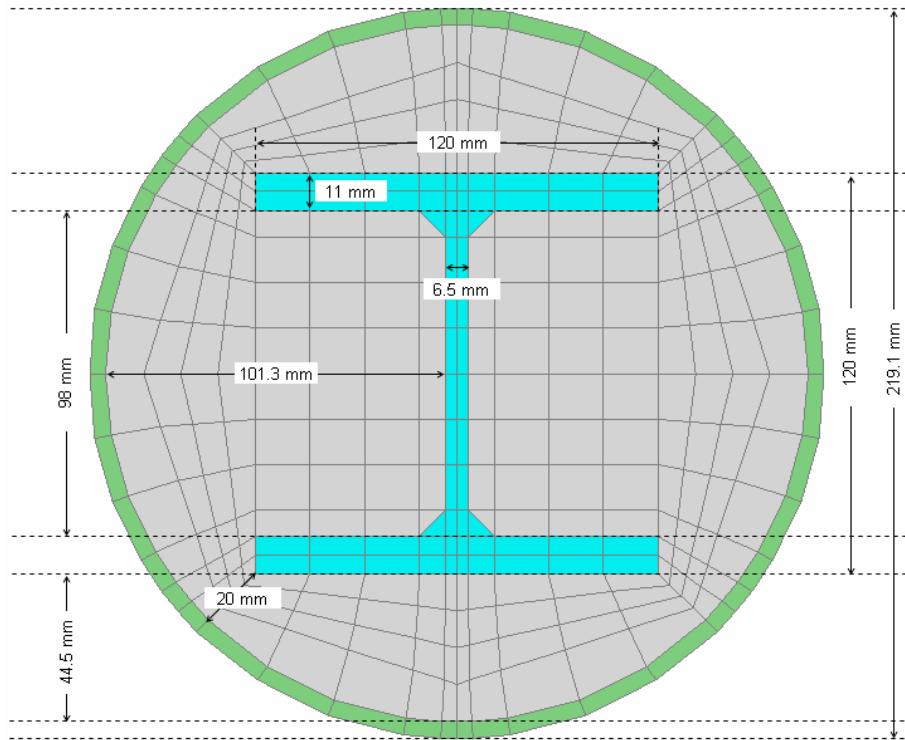
Profile 1 - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		33.46	355		
Concrete		301.12	40		
Internal steel profile		40.54	355		
N _{pl,Rk} =		3831.48 KN			
$\chi = N_u/N_{pl,Rk} =$		0.82			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
3145	0	944	0	0.30	58.17
3145	0	1258	0	0.40	39.50
3145	0	1573	0	0.50	28.56
3145	0	1887	0	0.60	19.69
2578	1	773	1	0.30	58.60
2578	1	1031	1	0.40	38.60
2578	1	1289	1	0.50	26.38
2578	1	1547	1	0.60	17.08
1596	5	479	5	0.30	61.19
1596	5	639	5	0.40	39.25
1596	5	798	5	0.50	24.50
1596	5	958	5	0.60	12.60
Profile 1 - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		33.46	355		
Concrete		301.12	40		
Internal steel profile		40.54	355		
N _{pl,Rk} =		3831.48 KN			
$\chi = N_u/N_{pl,Rk} =$		0.69			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
2648	0	794	0	0.30	50.29
2648	0	1059	0	0.40	30.85
2648	0	1324	0	0.50	17.85
2648	0	1589	0	0.60	6.23
2149	1	645	1	0.30	50.63
2149	1	860	1	0.40	31.29
2149	1	1074	1	0.50	17.67
2149	1	1289	1	0.60	7.10
1344	5	403	5	0.30	54.50
1344	5	538	5	0.40	33.44
1344	5	672	5	0.50	13.33
1344	5	806	5	0.60	9.13

Table A3.1. Characteristics and calculated fire resistances of column- profile 1.

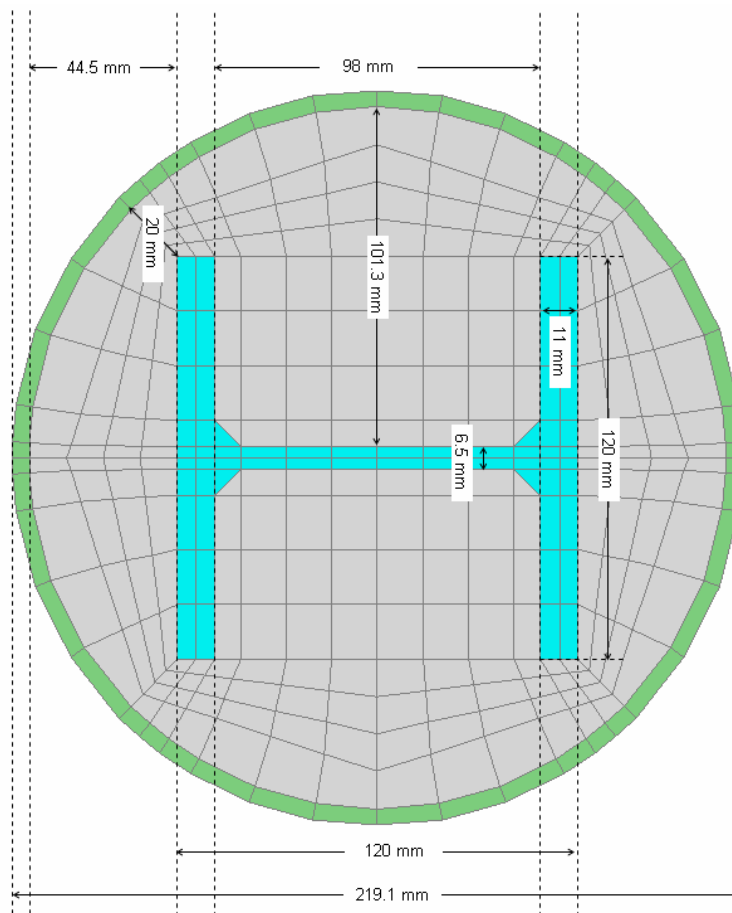
Profile 2 - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		33.41	355		
Concrete		297.21	40		
Internal steel profile		44.00	355		
Npl,Rk =		3937	KN		
$\chi = Nu/Npl,Rk =$		0.82			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	Nfi/Nu	Rf (minute)
Nu (KN)	e (cm)	Nfi (KN)	e (cm)		
3209	0	963	0	0.30	59.63
3209	0	1284	0	0.40	40.96
3209	0	1604	0	0.50	29.40
3209	0	1925	0	0.60	20.17
2620	1	786	1	0.30	60.04
2620	1	1048	1	0.40	39.85
2620	1	1310	1	0.50	27.15
2620	1	1572	1	0.60	17.63
1615	5	485	5	0.30	64.19
1615	5	646	5	0.40	42.17
1615	5	808	5	0.50	26.92
1615	5	969	5	0.60	13.63
Profile 2 - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		33.41	355		
Concrete		297.21	40		
Internal steel profile		44.00	355		
Npl,Rk =		3937	KN		
$\chi = Nu/Npl,Rk =$		0.68			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	Nfi/Nu	Rf (minute)
Nu (KN)	e (cm)	Nfi (KN)	e (cm)		
2691	0	807	0	0.30	52.13
2691	0	1077	0	0.40	32.48
2691	0	1346	0	0.50	18.65
2691	0	1615	0	0.60	6.35
2180	1	654	1	0.30	52.52
2180	1	872	1	0.40	32.98
2180	1	1090	1	0.50	18.90
2180	1	1308	1	0.60	7.63
1360	5	408	5	0.30	57.33
1360	5	544	5	0.40	36.33
1360	5	680	5	0.50	14.79
1360	5	816	5	0.60	9.56

Table A3.2. Characteristics and calculated fire resistances of column- profile 2.

Profile 3A - buckling around major axis



Profile 3B - buckling around minor axis



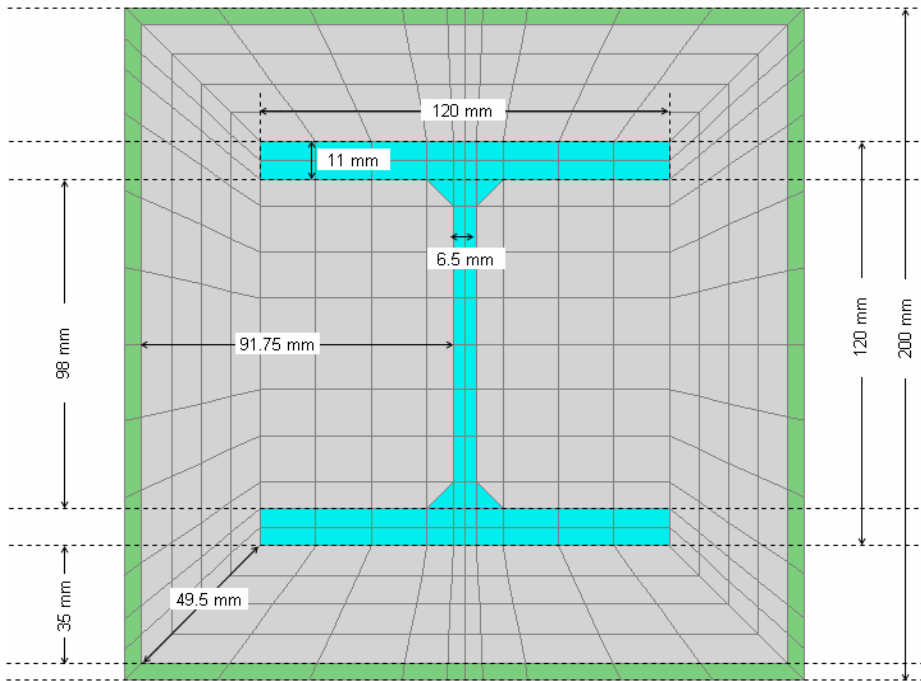
Profile 3A - buckling around the major axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		33.57	355		
Concrete		308.81	40		
Internal steel profile		34.01	355		
N _{pl,Rk} =		3634 KN			
$\chi = N_u/N_{pl,Rk} =$		0.84			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
3036	0	911	0	0.30	55.56
3036	0	1215	0	0.40	37.96
3036	0	1518	0	0.50	27.27
3036	0	1822	0	0.60	19.65
2504	1	751	1	0.30	56.67
2504	1	1002	1	0.40	37.56
2504	1	1252	1	0.50	25.88
2504	1	1502	1	0.60	17.81
1571	5	471	5	0.30	62.52
1571	5	629	5	0.40	40.02
1571	5	786	5	0.50	25.83
1571	5	943	5	0.60	13.50
Profile 3A - buckling around the major axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		33.57	355		
Concrete		308.81	40		
Internal steel profile		34.01	355		
N _{pl,Rk} =		3634 KN			
$\chi = N_u/N_{pl,Rk} =$		0.72			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
2610	0	783	0	0.30	47.77
2610	0	1044	0	0.40	31.08
2610	0	1305	0	0.50	19.65
2610	0	1566	0	0.60	10.19
2129	1	639	1	0.30	48.13
2129	1	852	1	0.40	30.85
2129	1	1064	1	0.50	19.06
2129	1	1277	1	0.60	8.56
1341	5	402	5	0.30	54.52
1341	5	537	5	0.40	42.15
1341	5	671	5	0.50	13.69
1341	5	805	5	0.60	9.67

Table A3.3. Characteristics and calculated fire resistances of column- profile 3A.

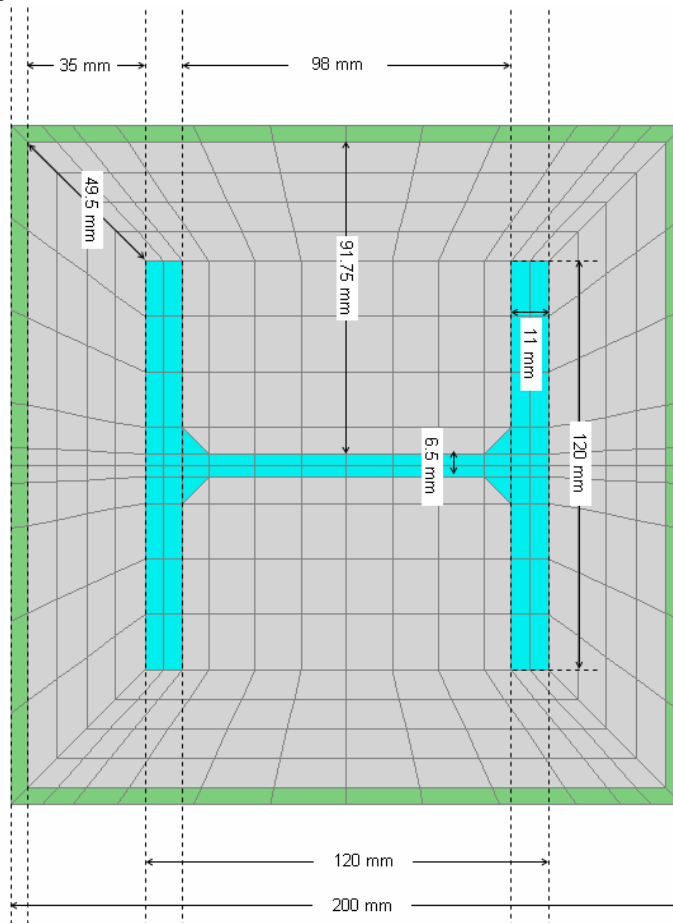
Profile 3B - buckling around the minor axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		33.57	355		
Concrete		308.81	40		
Internal steel profile		34.01	355		
N _{pl,Rk} =		3634 KN			
$\chi = N_u/N_{pl,Rk} =$		0.80			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
2904	0	871	0	0.30	37.19
2904	0	1162	0	0.40	24.63
2904	0	1452	0	0.50	16.19
2351	1	705	1	0.30	35.46
2351	1	941	1	0.40	20.56
2351	1	1176	1	0.50	11.54
Profile 3B - buckling around the minor axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		33.57	355		
Concrete		308.81	40		
Internal steel profile		34.01	355		
N _{pl,Rk} =		3634 KN			
$\chi = N_u/N_{pl,Rk} =$		0.65			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
2366	0	710	0	0.30	21.52
2366	0	947	0	0.40	9.08
2366	0	1183	0	0.50	5.90
1899	1	570	1	0.30	22.15
1899	1	760	1	0.40	10.56
1899	1	949	1	0.50	7.06

Table A3.4. Characteristics and calculated fire resistances of column- profile 3B.

Profile 4A – buckling around the major axis



Profile 4B – buckling around the minor axis



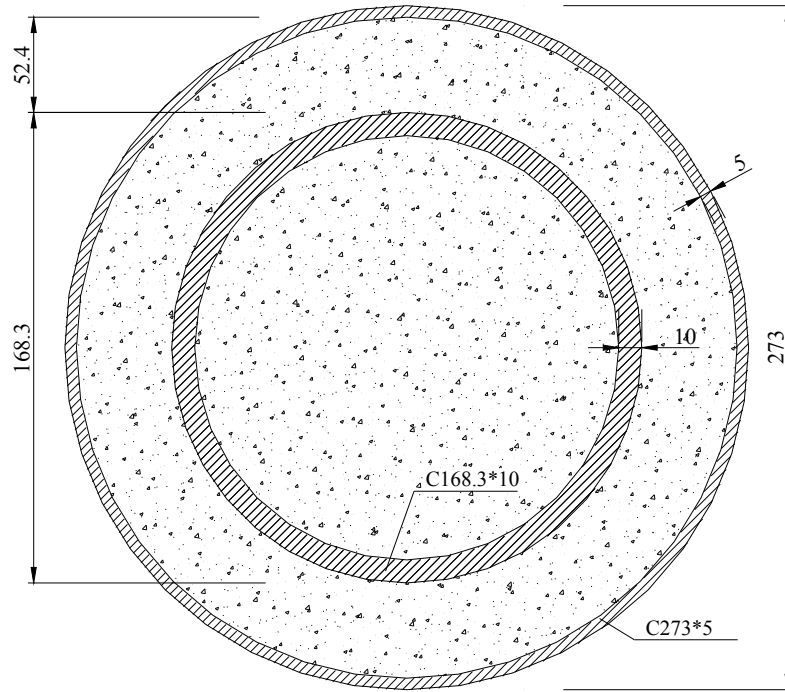
Profile 4A - buckling around the major axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		39.00	355		
Concrete		326.99	40		
Internal steel profile		34.01	355		
N _{pl,Rk} =		3900	KN		
$\chi = N_u/N_{pl,Rk} =$		0.84			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
3283	0	985	0	0.30	53.85
3283	0	1313	0	0.40	36.96
3283	0	1641	0	0.50	26.38
3283	0	1970	0	0.60	18.38
2744	1	823	1	0.30	53.79
2744	1	1098	1	0.40	35.63
2744	1	1372	1	0.50	24.13
2744	1	1646	1	0.60	16.35
1758	5	527	5	0.30	57.56
1758	5	703	5	0.40	36.40
1758	5	879	5	0.50	18.21
1758	5	1055	5	0.60	12.35
Profile 4A - buckling around the major axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		39.00	355		
Concrete		326.99	40		
Internal steel profile		34.01	355		
N _{pl,Rk} =		3900	KN		
$\chi = N_u/N_{pl,Rk} =$		0.74			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
2876	0	863	0	0.30	45.06
2876	0	1151	0	0.40	28.65
2876	0	1438	0	0.50	16.77
2876	0	1726	0	0.60	6.31
2374	1	712	1	0.30	44.54
2374	1	950	1	0.40	27.92
2374	1	1187	1	0.50	15.83
2374	1	1424	1	0.60	7.17
1519	5	456	5	0.30	49.00
1519	5	608	5	0.40	18.06
1519	5	759	5	0.50	12.65
1519	5	911	5	0.60	9.29

Table A3.5. Characteristics and calculated fire resistances of column- profile 4A.

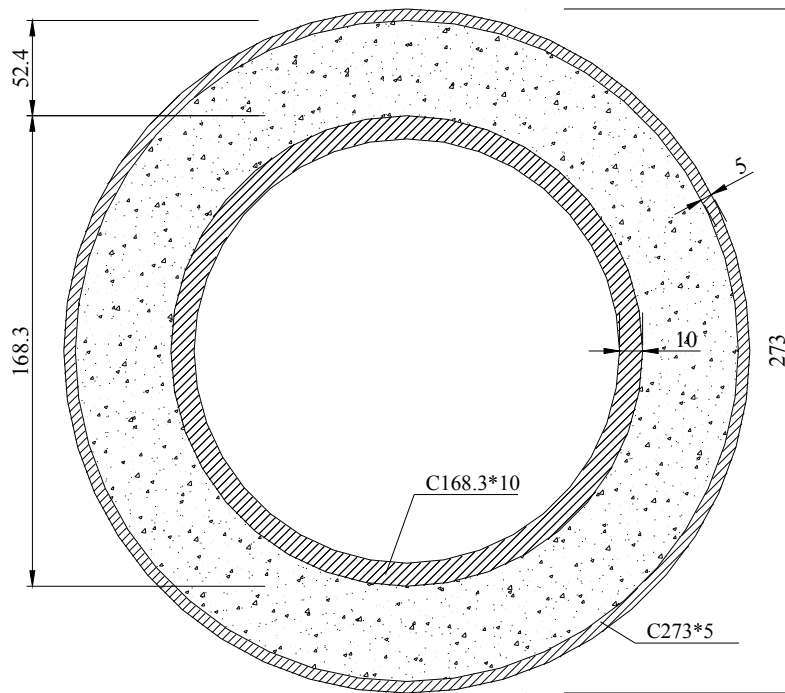
Profile 4B - buckling around the minor axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		39.00	355		
Concrete		326.99	40		
Internal steel profile		34.01	355		
N _{pl,Rk} =		3900 KN			
$\chi = N_u/N_{pl,Rk} =$		0.82			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
3216	0	965	0	0.30	36.13
3216	0	1287	0	0.40	23.88
3216	0	1608	0	0.50	16.04
2651	1	795	1	0.30	33.29
2651	1	1061	1	0.40	19.00
2651	1	1326	1	0.50	11.42
Profile 4B - buckling around the minor axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		39.00	355		
Concrete		326.99	40		
Internal steel profile		34.01	355		
N _{pl,Rk} =		3900 KN			
$\chi = N_u/N_{pl,Rk} =$		0.69			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
2708	0	812	0	0.30	18.60
2708	0	1083	0	0.40	9.08
2708	0	1354	0	0.50	5.98
2208	1	662	1	0.30	16.56
2208	1	883	1	0.40	10.40
2208	1	1104	1	0.50	7.13

Table A3.6. Characteristics and calculated fire resistances of column- profile 4B.

Profile 5



Profile 6



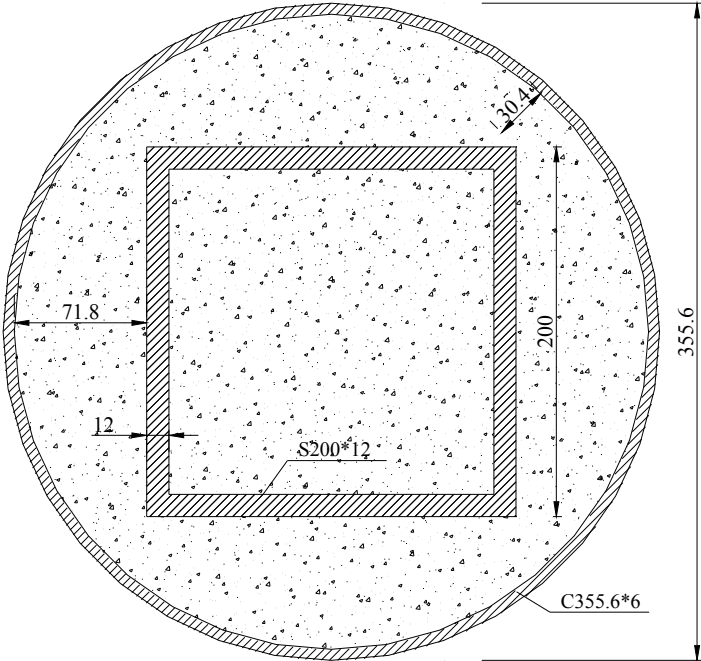
Profile 5 - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		41.84	355		
Concrete		493.09	40		
Internal steel profile		49.71	355		
N _{pl,Rk} =		5222 KN			
$\chi = N_u/N_{pl,Rk} =$		0.87			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
4559	0	1368	0	0.30	84.19
4559	0	1824	0	0.40	57.77
4559	0	2279	0	0.50	42.00
4559	0	2735	0	0.60	28.75
3923	1	1177	1	0.30	85.88
3923	1	1569	1	0.40	56.98
3923	1	1961	1	0.50	39.35
3923	1	2354	1	0.60	25.06
2598	5	779	5	0.30	86.19
2598	5	1039	5	0.40	55.83
2598	5	1299	5	0.50	35.79
2598	5	1559	5	0.60	18.63
Profile 5 - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		41.84	355		
Concrete		493.09	40		
Internal steel profile		49.71	355		
N _{pl,Rk} =		5222 KN			
$\chi = N_u/N_{pl,Rk} =$		0.79			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
4115	0	1235	0	0.30	69.83
4115	0	1646	0	0.40	47.96
4115	0	2058	0	0.50	32.77
4115	0	2469	0	0.60	19.71
3476	1	1043	1	0.30	69.31
3476	1	1391	1	0.40	45.81
3476	1	1738	1	0.50	28.56
3476	1	2086	1	0.60	16.94
2268	5	680	5	0.30	72.81
2268	5	907	5	0.40	46.79
2268	5	1134	5	0.50	25.15
2268	5	1361	5	0.60	11.13

Table A3.7. Characteristics and calculated fire resistances of column- profile 5.

Profile 6 - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		41.88	355		
Concrete		319.16	40		
Internal steel profile		49.48	355		
N _{pl,Rk} =		4520 KN			
$\chi = N_u/N_{pl,Rk} =$		0.89			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
4011	0	1203	0	0.30	68.65
4011	0	1605	0	0.40	50.02
4011	0	2006	0	0.50	38.10
4011	0	2407	0	0.60	27.29
3478	1	1043	1	0.30	68.63
3478	1	1391	1	0.40	48.94
3478	1	1739	1	0.50	36.40
3478	1	2087	1	0.60	24.23
2343	5	703	5	0.30	68.83
2343	5	937	5	0.40	48.29
2343	5	1171	5	0.50	34.15
2343	5	1406	5	0.60	19.79
Profile 6 - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		41.88	355		
Concrete		319.16	40		
Internal steel profile		49.48	355		
N _{pl,Rk} =		4520 KN			
$\chi = N_u/N_{pl,Rk} =$		0.81			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
3676	0	1103	0	0.30	60.25
3676	0	1471	0	0.40	43.79
3676	0	1838	0	0.50	31.83
3676	0	2206	0	0.60	19.85
3131	1	939	1	0.30	59.31
3131	1	1253	1	0.40	41.98
3131	1	1566	1	0.50	28.71
3131	1	1879	1	0.60	17.46
2076	5	623	5	0.30	60.42
2076	5	831	5	0.40	42.31
2076	5	1038	5	0.50	26.75
2076	5	1246	5	0.60	12.19

Table A3.8. Characteristics and calculated fire resistances of column- profile 6.

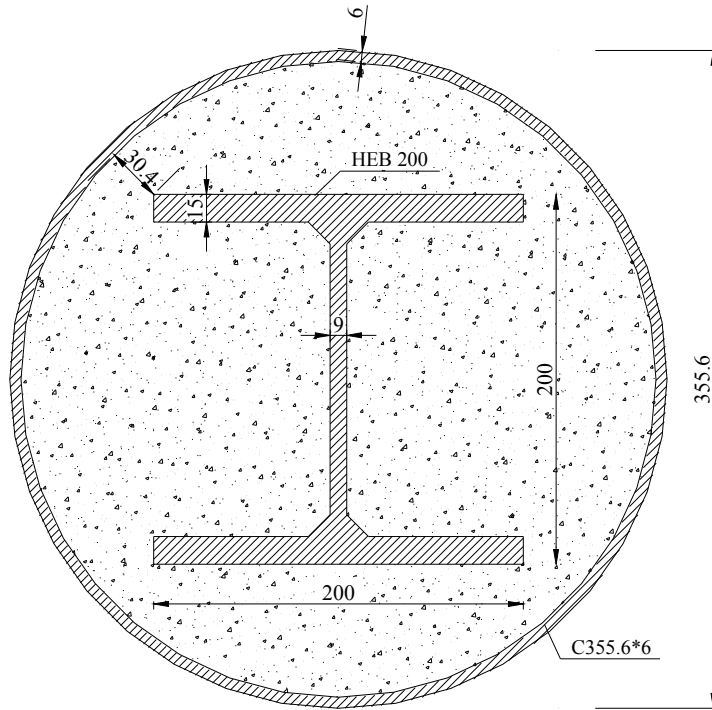
Profile 7



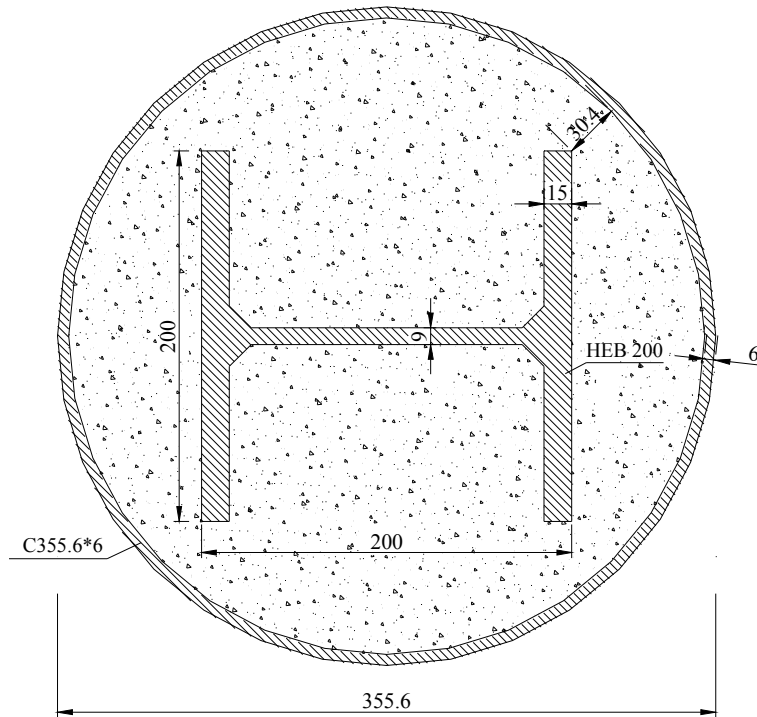
Profile 7 -column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		65.69	355		
Concrete		835.43	40		
Internal steel profile		90.24	355		
N _{pl,Rk} =		8877 KN			
$\chi = N_u/N_{pl,Rk} =$		0.92			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
8129	0	2439	0	0.30	152.21
8129	0	3252	0	0.40	101.73
8129	0	4064	0	0.50	68.77
8129	0	4877	0	0.60	46.67
7316	1	2195	1	0.30	153.29
7316	1	2927	1	0.40	101.35
7316	1	3658	1	0.50	66.96
7316	1	4390	1	0.60	43.50
5285	5	1586	5	0.30	154.42
5285	5	2114	5	0.40	102.33
5285	5	2643	5	0.50	64.27
5285	5	3171	5	0.60	37.10
Profile 7 -column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		65.69	355		
Concrete		835.43	40		
Internal steel profile		90.24	355		
N _{pl,Rk} =		8877 KN			
$\chi = N_u/N_{pl,Rk} =$		0.87			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
7693	0	2308	0	0.30	116.81
7693	0	3077	0	0.40	78.04
7693	0	3846	0	0.50	55.21
7693	0	4616	0	0.60	37.35
6820	1	2046	1	0.30	120.79
6820	1	2728	1	0.40	78.27
6820	1	3410	1	0.50	53.63
6820	1	4092	1	0.60	34.29
4828	5	1448	5	0.30	128.15
4828	5	1931	5	0.40	81.83
4828	5	2414	5	0.50	52.38
4828	5	2897	5	0.60	27.92

Table A3.9. Characteristics and calculated fire resistances of column- profile 7.

Profile 8A _buckling around the major axis



Profile 8B _buckling around the minor axis



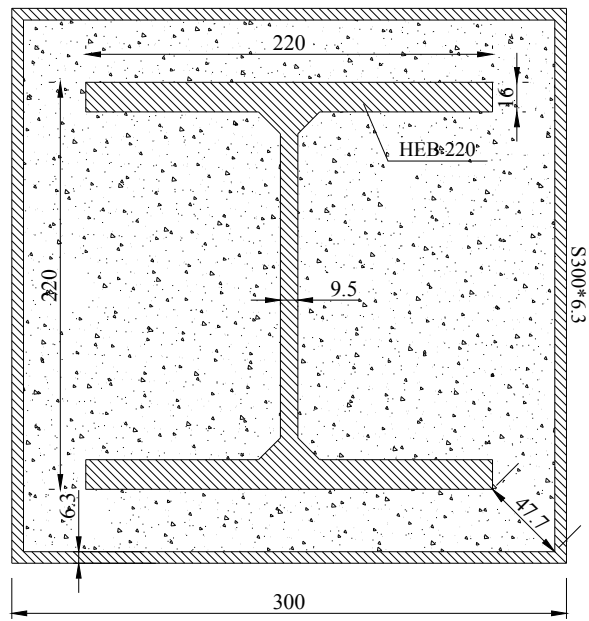
Profile 8A - buckling around the major axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		65.65	355		
Concrete		848.38	40		
Internal steel profile		78.08	355		
$N_{pl,Rk} =$		8496 KN			
$\chi = N_u/N_{pl,Rk} =$		0.92			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N_{fi}/N_u	R_f (minute)
N_u (KN)	e (cm)	N_{fi} (KN)	e (cm)		
7784	0	2335	0	0.30	157.15
7784	0	3114	0	0.40	105.38
7784	0	3892	0	0.50	68.56
7784	0	4670	0	0.60	42.52
7028	1	2108	1	0.30	157.50
7028	1	2811	1	0.40	104.23
7028	1	3514	1	0.50	66.52
7028	1	4217	1	0.60	41.92
5121	5	1536	5	0.30	163.33
5121	5	2049	5	0.40	108.29
5121	5	2561	5	0.50	64.08
5121	5	3073	5	0.60	37.00
Profile 8A - buckling around the major axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		65.65	355		
Concrete		848.38	40		
Internal steel profile		78.08	355		
$N_{pl,Rk} =$		8496 KN			
$\chi = N_u/N_{pl,Rk} =$		0.87			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N_{fi}/N_u	R_f (minute)
N_u (KN)	e (cm)	N_{fi} (KN)	e (cm)		
7391	0	2217	0	0.30	122.75
7391	0	2957	0	0.40	78.88
7391	0	3696	0	0.50	54.33
7391	0	4435	0	0.60	36.29
6585	1	1976	1	0.30	126.33
6585	1	2634	1	0.40	79.38
6585	1	3293	1	0.50	53.25
6585	1	3951	1	0.60	34.02
4715	5	1415	5	0.30	138.65
4715	5	1886	5	0.40	84.85
4715	5	2358	5	0.50	52.58
4715	5	2829	5	0.60	29.15

Table A3.10. Characteristics and calculated fire resistances of column- profile 8A.

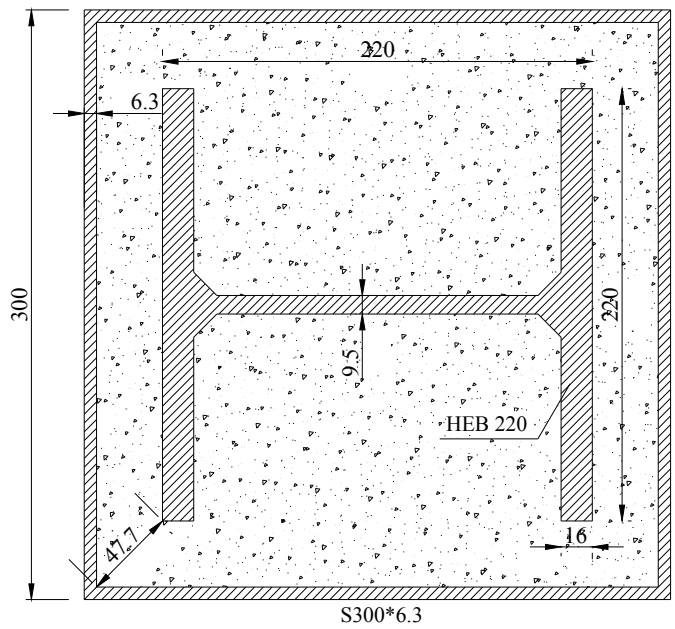
Profile 8B - buckling around the minor axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		65.65	355		
Concrete		848.38	40		
Internal steel profile		78.08	355		
N _{pl,Rk} =		8496 KN			
$\chi = N_u/N_{pl,Rk} =$		0.92			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
7776	0	2333	0	0.30	120.85
7776	0	3111	0	0.40	83.19
7776	0	3888	0	0.50	59.54
7776	0	4666	0	0.60	39.71
6980	1	2094	1	0.30	112.56
6980	1	2792	1	0.40	74.65
6980	1	3490	1	0.50	50.63
6980	1	4188	1	0.60	30.75
Profile 8B - buckling around the minor axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		65.65	355		
Concrete		848.38	40		
Internal steel profile		78.08	355		
N _{pl,Rk} =		8496 KN			
$\chi = N_u/N_{pl,Rk} =$		0.86			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
7300	0	2190	0	0.30	81.21
7300	0	2920	0	0.40	57.40
7300	0	3650	0	0.50	39.42
7300	0	4380	0	0.60	25.42
6423	1	1927	1	0.30	77.63
6423	1	2569	1	0.40	51.60
6423	1	3211	1	0.50	31.81
6423	1	3854	1	0.60	19.94

Table A3.11. Characteristics and calculated fire resistances of column- profile 8B.

Profile 9A- buckling around the major axis



Profile 9B- buckling around the minor axis



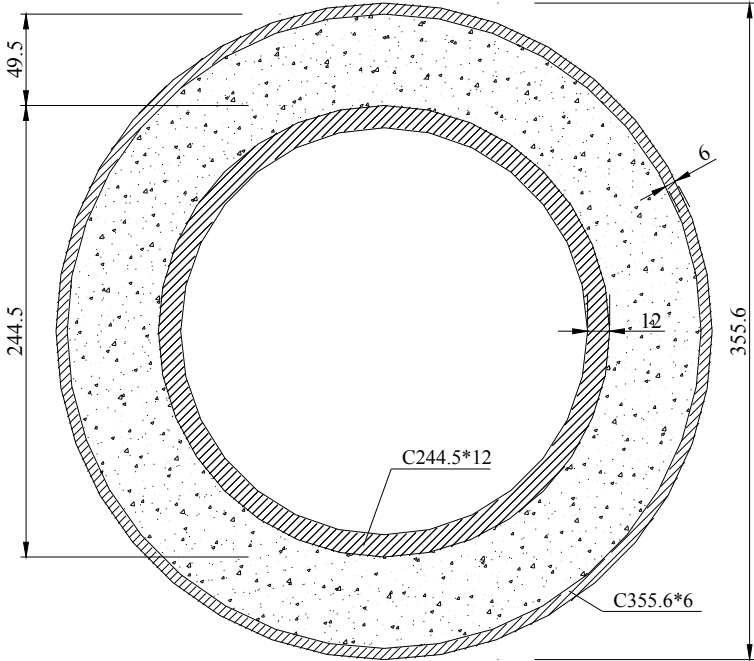
Profile 9A - buckling around the major axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		74.01	355		
Concrete		734.75	40		
Internal steel profile		91.23	355		
N _{pl,Rk} =		8805 KN			
$\chi = N_u/N_{pl,Rk} =$		0.92			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
8069	0	2421	0	0.30	127.04
8069	0	3228	0	0.40	88.56
8069	0	4034	0	0.50	54.08
8069	0	4841	0	0.60	36.10
7289	1	2187	1	0.30	127.48
7289	1	2916	1	0.40	89.27
7289	1	3644	1	0.50	53.67
7289	1	4373	1	0.60	35.21
5339	5	1602	5	0.30	133.21
5339	5	2136	5	0.40	97.65
5339	5	2669	5	0.50	55.56
5339	5	3203	5	0.60	33.81
Profile 9A - buckling around the major axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		74.01	355		
Concrete		734.75	40		
Internal steel profile		91.23	355		
N _{pl,Rk} =		8805 KN			
$\chi = N_u/N_{pl,Rk} =$		0.87			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
7694	0	2308	0	0.30	101.92
7694	0	3078	0	0.40	62.00
7694	0	3847	0	0.50	41.98
7694	0	4616	0	0.60	29.60
6864	1	2059	1	0.30	105.79
6864	1	2746	1	0.40	64.06
6864	1	3432	1	0.50	42.31
6864	1	4118	1	0.60	28.90
4953	5	1486	5	0.30	116.13
4953	5	1981	5	0.40	73.29
4953	5	2476	5	0.50	44.65
4953	5	2972	5	0.60	28.15

Table A3.12. Characteristics and calculated fire resistances of column- profile 9A.

Profile 9B - buckling around the minor axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		74.01	355		
Concrete		734.75	40		
Internal steel profile		91.23	355		
N _{pl,Rk} =		8805 KN			
$\chi = N_u/N_{pl,Rk} =$		0.91			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
8036	0	2411	0	0.30	93.44
8036	0	3215	0	0.40	62.92
8036	0	4018	0	0.50	44.60
8036	0	4822	0	0.60	31.25
7184	1	2155	1	0.30	90.29
7184	1	2874	1	0.40	58.83
7184	1	3592	1	0.50	39.92
7184	1	4310	1	0.60	26.54
Profile 9B - buckling around the minor axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		74.01	355		
Concrete		734.75	40		
Internal steel profile		91.23	355		
N _{pl,Rk} =		8805 KN			
$\chi = N_u/N_{pl,Rk} =$		0.86			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
7543	0	2263	0	0.30	62.08
7543	0	3017	0	0.40	43.44
7543	0	3771	0	0.50	31.17
7543	0	4526	0	0.60	22.04
6605	1	1982	1	0.30	61.56
6605	1	2642	1	0.40	40.98
6605	1	3303	1	0.50	27.42
6605	1	3963	1	0.60	18.40

Table A3.13. Characteristics and calculated fire resistances of column- profile 9B.

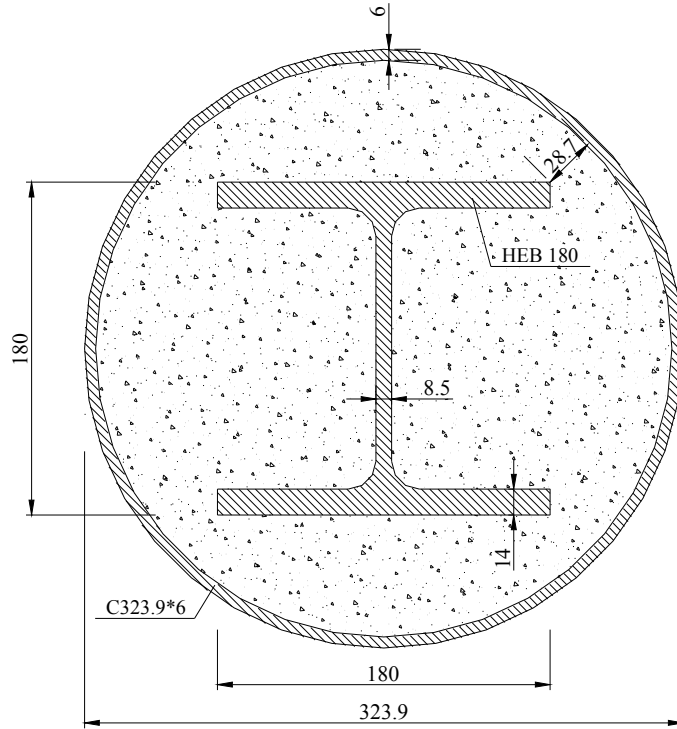
Profile 10



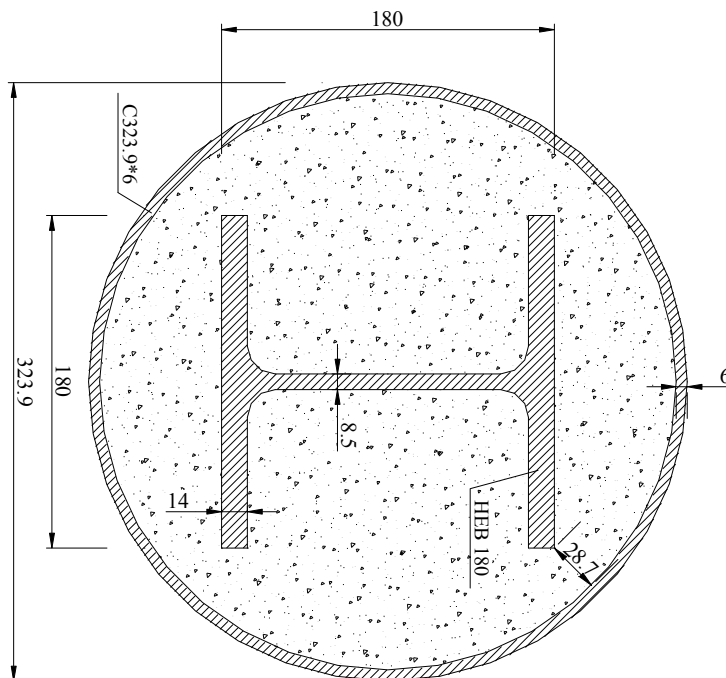
Profile 10 - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		65.56	355		
Concrete		455.42	40		
Internal steel profile		87.21	355		
N _{pl,Rk} =		7245 KN			
$\chi = N_u/N_{pl,Rk} =$		0.93			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
6730	0	2019	0	0.30	98.21
6730	0	2692	0	0.40	71.35
6730	0	3365	0	0.50	50.71
6730	0	4038	0	0.60	37.73
6109	1	1833	1	0.30	98.60
6109	1	2444	1	0.40	71.60
6109	1	3054	1	0.50	50.31
6109	1	3665	1	0.60	36.77
4511	5	1353	5	0.30	100.08
4511	5	1805	5	0.40	72.94
4511	5	2256	5	0.50	49.56
4511	5	2707	5	0.60	33.83
Profile 10 - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		65.56	355		
Concrete		455.42	40		
Internal steel profile		87.21	355		
N _{pl,Rk} =		7245 KN			
$\chi = N_u/N_{pl,Rk} =$		0.89			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
6444	0	1933	0	0.30	85.81
6444	0	2578	0	0.40	61.00
6444	0	3222	0	0.50	45.88
6444	0	3866	0	0.60	34.58
5774	1	1732	1	0.30	86.94
5774	1	2310	1	0.40	61.10
5774	1	2887	1	0.50	44.92
5774	1	3464	1	0.60	32.10
4189	5	1257	5	0.30	89.63
4189	5	1676	5	0.40	62.75
4189	5	2094	5	0.50	44.19
4189	5	2513	5	0.60	27.63

Table A3.14. Characteristics and calculated fire resistances of column- profile 10.

Profile 11A – buckling around the major axis



Profile 11B – buckling around the minor axis



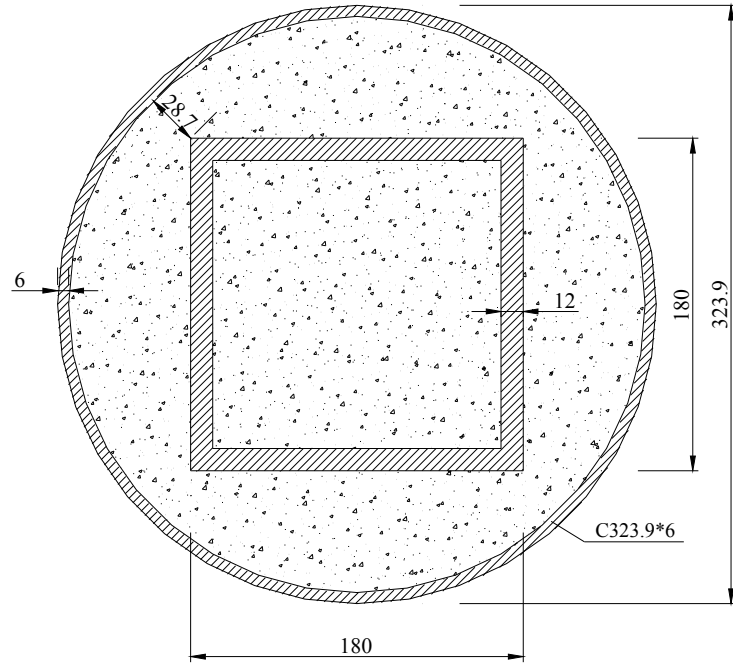
Profile 11A - buckling around the major axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		59.60	355		
Concrete		698.14	40		
Internal steel profile		65.39	355		
N _{pl,Rk} =		7230 KN			
$\chi = N_u/N_{pl,Rk} =$		0.90			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
6539	0	1962	0	0.30	126.94
6539	0	2616	0	0.40	82.27
6539	0	3269	0	0.50	55.42
6539	0	3923	0	0.60	37.35
5826	1	1748	1	0.30	128.29
5826	1	2331	1	0.40	81.67
5826	1	2913	1	0.50	53.73
5826	1	3496	1	0.60	34.83
4133	5	1240	5	0.30	134.13
4133	5	1653	5	0.40	85.02
4133	5	2066	5	0.50	51.44
4133	5	2480	5	0.60	28.73
Profile 11A - buckling around the major axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		59.60	355		
Concrete		698.14	40		
Internal steel profile		65.39	355		
N _{pl,Rk} =		7230 KN			
$\chi = N_u/N_{pl,Rk} =$		0.85			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
6146	0	1844	0	0.30	96.33
6146	0	2459	0	0.40	63.17
6146	0	3073	0	0.50	44.33
6146	0	3688	0	0.60	28.77
5394	1	1618	1	0.30	99.42
5394	1	2158	1	0.40	63.35
5394	1	2697	1	0.50	42.60
5394	1	3236	1	0.60	26.60
3758	5	1127	5	0.30	110.79
3758	5	1503	5	0.40	67.69
3758	5	1879	5	0.50	41.69
3758	5	2255	5	0.60	23.58

Table A3.15. Characteristics and calculated fire resistances of column- profile 11A.

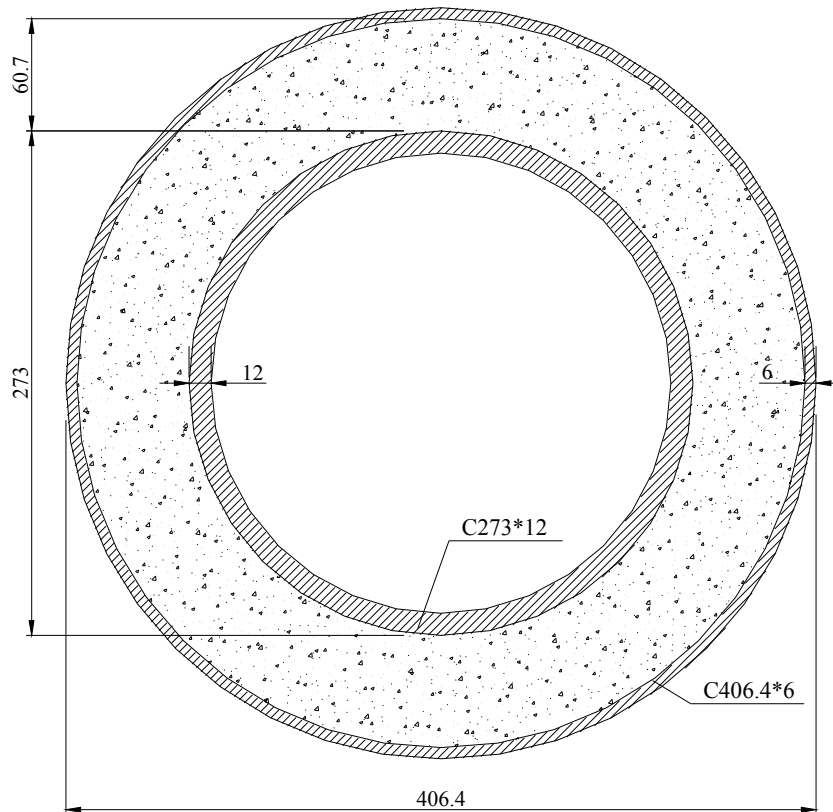
Profile 11B - buckling around the minor axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		59.60	355		
Concrete		698.14	40		
Internal steel profile		65.39	355		
N _{pl,Rk} =		7230 KN			
$\chi = N_u/N_{pl,Rk} =$		0.90			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
6523	0	1957	0	0.30	93.50
6523	0	2609	0	0.40	65.19
6523	0	3261	0	0.50	46.88
6523	0	3914	0	0.60	30.69
5770	1	1731	1	0.30	87.06
5770	1	2308	1	0.40	58.08
5770	1	2885	1	0.50	38.17
5770	1	3462	1	0.60	23.79
Profile 11B - buckling around the minor axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		59.60	355		
Concrete		698.14	40		
Internal steel profile		65.39	355		
N _{pl,Rk} =		7230 KN			
$\chi = N_u/N_{pl,Rk} =$		0.83			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
6026	0	1808	0	0.30	63.77
6026	0	2411	0	0.40	44.21
6026	0	3013	0	0.50	29.02
6026	0	3616	0	0.60	19.56
5213	1	1564	1	0.30	61.02
5213	1	2085	1	0.40	38.44
5213	1	2606	1	0.50	23.04
5213	1	3128	1	0.60	13.50

Table A3.16. Characteristics and calculated fire resistances of column- profile 11B.

Profile 12



Profile 13



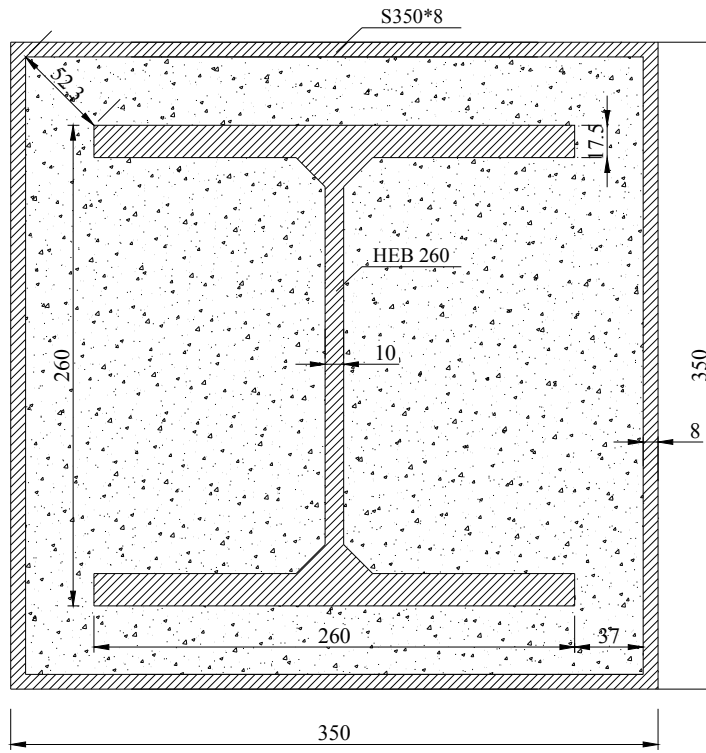
Profile 12 - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		59.75	355		
Concrete		682.27	40		
Internal steel profile		80.64	355		
$N_{pl,Rk} =$		7713 KN			
$\chi = N_u/N_{pl,Rk} =$		0.90			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N_{fi}/N_u	R_f (minute)
N_u (KN)	e (cm)	N_{fi} (KN)	e (cm)		
6966	0	2090	0	0.30	125.71
6966	0	2787	0	0.40	82.23
6966	0	3483	0	0.50	57.33
6966	0	4180	0	0.60	39.48
6179	1	1854	1	0.30	127.67
6179	1	2472	1	0.40	82.19
6179	1	3089	1	0.50	55.67
6179	1	3707	1	0.60	36.73
4334	5	1300	5	0.30	129.67
4334	5	1734	5	0.40	83.69
4334	5	2167	5	0.50	53.29
4334	5	2600	5	0.60	29.46
Profile 12 - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		59.75	355		
Concrete		682.27	40		
Internal steel profile		80.64	355		
$N_{pl,Rk} =$		7713 KN			
$\chi = N_u/N_{pl,Rk} =$		0.84			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N_{fi}/N_u	R_f (minute)
N_u (KN)	e (cm)	N_{fi} (KN)	e (cm)		
6514	0	1954	0	0.30	125.90
6514	0	2606	0	0.40	65.46
6514	0	3257	0	0.50	46.71
6514	0	3908	0	0.60	30.31
5679	1	1704	1	0.30	99.42
5679	1	2272	1	0.40	64.90
5679	1	2839	1	0.50	44.13
5679	1	3407	1	0.60	27.04
3905	5	1172	5	0.30	106.65
3905	5	1562	5	0.40	68.27
3905	5	1953	5	0.50	42.88
3905	5	2343	5	0.60	68.25

Table A3.17. Characteristics and calculated fire resistances of column- profile 12

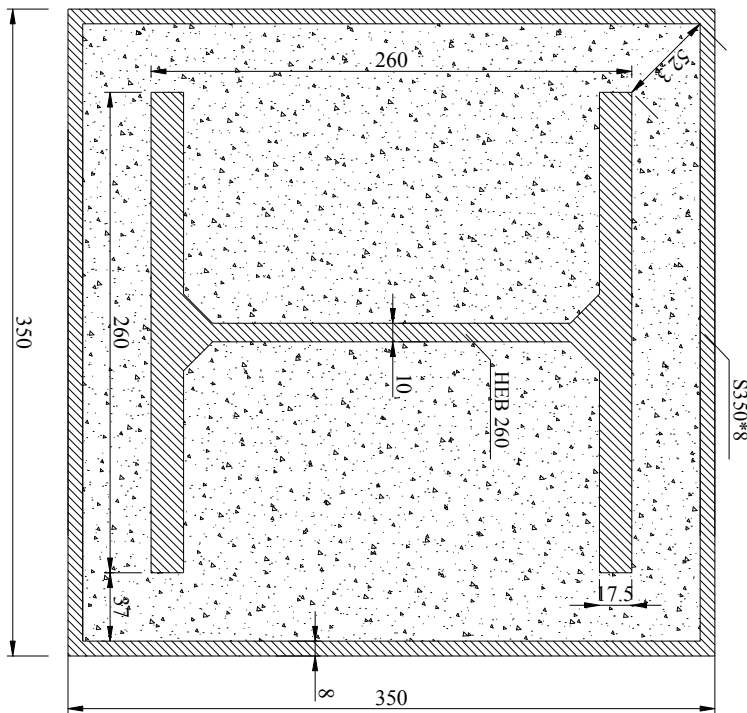
Profile 13 - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		75.52	355		
Concrete		635.17	40		
Internal steel profile		98.23	355		
N _{pl,Rk} =		8709 KN			
$\chi = N_u/N_{pl,Rk} =$		0.94			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
8191	0	2457	0	0.30	125.75
8191	0	3277	0	0.40	93.44
8191	0	4096	0	0.50	64.31
8191	0	4915	0	0.60	45.54
7555	1	2267	1	0.30	125.35
7555	1	3022	1	0.40	92.69
7555	1	3778	1	0.50	63.48
7555	1	4533	1	0.60	44.02
5789	5	1737	5	0.30	126.04
5789	5	2316	5	0.40	92.77
5789	5	2894	5	0.50	61.69
5789	5	3473	5	0.60	39.67
Profile 13 - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		75.52	355		
Concrete		635.17	40		
Internal steel profile		98.23	355		
N _{pl,Rk} =		8709 KN			
$\chi = N_u/N_{pl,Rk} =$		0.91			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
7919	0	2376	0	0.30	144.25
7919	0	3168	0	0.40	77.92
7919	0	3959	0	0.50	57.44
7919	0	4751	0	0.60	40.85
7231	1	2169	1	0.30	110.96
7231	1	2893	1	0.40	77.96
7231	1	3616	1	0.50	56.63
7231	1	4339	1	0.60	39.17
5453	5	1636	5	0.30	112.98
5453	5	2181	5	0.40	79.08
5453	5	2726	5	0.50	55.00
5453	5	3272	5	0.60	34.13

Table A3.18. Characteristics and calculated fire resistances of column- profile 13.

Profile 14A – buckling around the major axis



Profile 14B – buckling around the minor axis



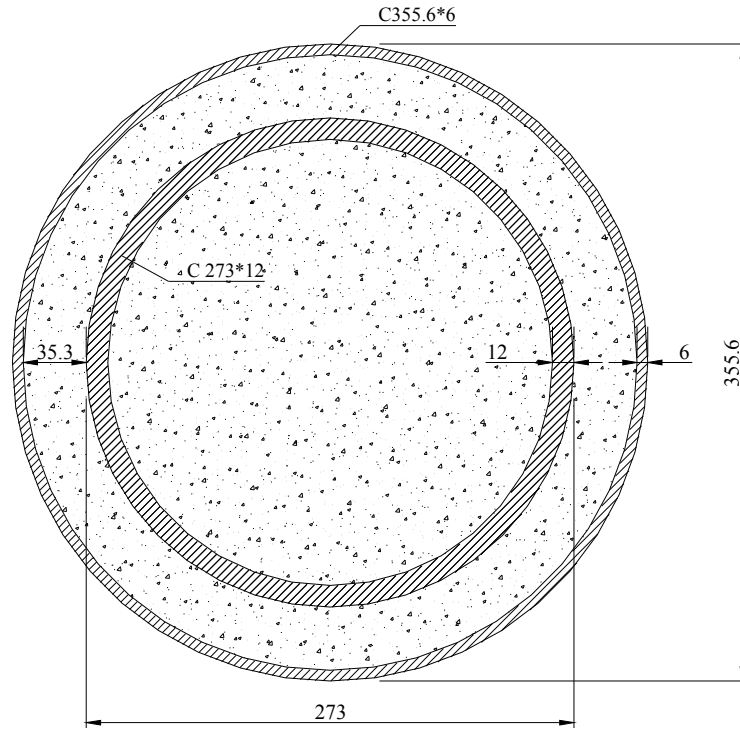
Profile 14A - buckling around the major axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		109.44	355		
Concrete		997.10	40		
Internal steel profile		118.46	355		
$N_{pl,Rk} =$	12079 KN				
$\chi = N_u/N_{pl,Rk} =$	0.93				
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
11270	0	3381	0	0.30	160.79
11270	0	4508	0	0.40	117.21
11270	0	5635	0	0.50	66.44
11270	0	6762	0	0.60	41.31
10378	1	3113	1	0.30	158.75
10378	1	4151	1	0.40	114.48
10378	1	5189	1	0.50	64.46
10378	1	6227	1	0.60	40.08
7946	5	2384	5	0.30	162.48
7946	5	3179	5	0.40	119.19
7946	5	3973	5	0.50	64.52
7946	5	4768	5	0.60	37.90
Profile 14A - buckling around the major axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		109.44	355		
Concrete		997.10	40		
Internal steel profile		118.46	355		
$N_{pl,Rk} =$	12079 KN				
$\chi = N_u/N_{pl,Rk} =$	0.90				
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
10879	0	3264	0	0.30	132.71
10879	0	4352	0	0.40	80.90
10879	0	5439	0	0.50	51.23
10879	0	6527	0	0.60	34.94
9931	1	2979	1	0.30	134.52
9931	1	3973	1	0.40	81.96
9931	1	4966	1	0.50	51.02
9931	1	5959	1	0.60	33.90
7503	5	2251	5	0.30	143.27
7503	5	3001	5	0.40	90.69
7503	5	3751	5	0.50	52.06
7503	5	4502	5	0.60	31.96

Table A3.19. Characteristics and calculated fire resistances of column- profile 14A.

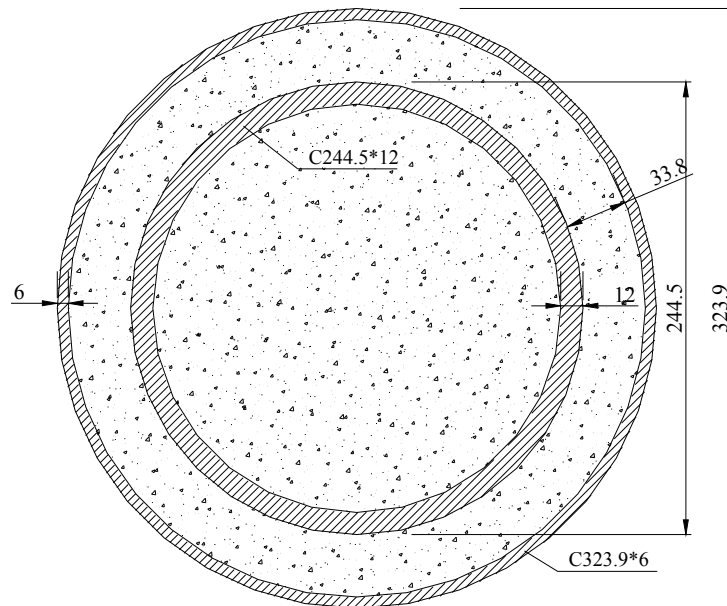
Profile 14B - buckling around the minor axis - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		109.44	355		
Concrete		997.10	40		
Internal steel profile		118.46	355		
N _{pl,Rk} =		12079 KN			
$\chi = N_u/N_{pl,Rk} =$		0.93			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
11259	0	3378	0	0.30	128.10
11259	0	4504	0	0.40	85.77
11259	0	5629	0	0.50	56.98
11259	0	6755	0	0.60	38.27
10308	1	3092	1	0.30	120.65
10308	1	4123	1	0.40	78.04
10308	1	5154	1	0.50	51.13
10308	1	6185	1	0.60	33.23
Profile 14B - buckling around the minor axis - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		109.44	355		
Concrete		997.10	40		
Internal steel profile		118.46	355		
N _{pl,Rk} =		12079 KN			
$\chi = N_u/N_{pl,Rk} =$		0.89			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
10793	0	3238	0	0.30	84.15
10793	0	4317	0	0.40	57.52
10793	0	5396	0	0.50	40.98
10793	0	6476	0	0.60	28.13
9739	1	2922	1	0.30	81.73
9739	1	3896	1	0.40	54.06
9739	1	4869	1	0.50	36.75
9739	1	5843	1	0.60	24.33

Table A3.20. Characteristics and calculated fire resistances of column- profile 14B.

Profile 15



Profile 16



Profile 15 - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		65.60	355		
Concrete		827.10	40		
Internal steel profile		98.23	355		
N _{pl,Rk} =		9124 KN			
$\chi = N_u/N_{pl,Rk} =$		0.92			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
8393	0	2518	0	0.30	136.96
8393	0	3357	0	0.40	102.40
8393	0	4196	0	0.50	64.33
8393	0	5036	0	0.60	41.85
7600	1	2280	1	0.30	137.13
7600	1	3040	1	0.40	102.69
7600	1	3800	1	0.50	64.02
7600	1	4560	1	0.60	41.23
5581	5	1674	5	0.30	137.46
5581	5	2233	5	0.40	102.81
5581	5	2791	5	0.50	119.25
5581	5	3349	5	0.60	40.58
Profile 15 - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		65.60	355		
Concrete		827.10	40		
Internal steel profile		98.23	355		
N _{pl,Rk} =		9124 KN			
$\chi = N_u/N_{pl,Rk} =$		0.87			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N _{fi} /N _u	R _f (minute)
N _u (KN)	e (cm)	N _{fi} (KN)	e (cm)		
7984	0	2395	0	0.30	108.42
7984	0	3194	0	0.40	69.79
7984	0	3992	0	0.50	47.52
7984	0	4790	0	0.60	34.48
7128	1	2138	1	0.30	111.96
7128	1	2851	1	0.40	73.40
7128	1	3564	1	0.50	48.48
7128	1	4277	1	0.60	34.19
5136	5	1541	5	0.30	117.27
5136	5	2055	5	0.40	77.96
5136	5	2568	5	0.50	51.17
5136	5	3082	5	0.60	33.98

Table A3.21. Characteristics and calculated fire resistances of column- profile 15.

Profile 16 - column 3 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		59.62	355		
Concrete		672.97	40		
Internal steel profile		87.20	355		
$N_{pl,Rk} =$		7904 KN			
$\chi = N_u/N_{pl,Rk} =$		0.91			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N_{fi}/N_u	R_f (minute)
N_u (KN)	e (cm)	N_{fi} (KN)	e (cm)		
7176	0	2153	0	0.30	116.25
7176	0	2871	0	0.40	81.58
7176	0	3588	0	0.50	52.27
7176	0	4306	0	0.60	36.44
6405	1	1922	1	0.30	118.13
6405	1	2562	1	0.40	84.19
6405	1	3203	1	0.50	52.65
6405	1	3843	1	0.60	35.96
4568	5	1370	5	0.30	120.13
4568	5	1827	5	0.40	85.77
4568	5	2284	5	0.50	53.88
4568	5	2741	5	0.60	35.10
Profile 16 - column 4 m					
		Area (cm ²)	Strength (MPa)		
External steel wall		59.62	355		
Concrete		672.97	40		
Internal steel profile		87.20	355		
$N_{pl,Rk} =$		7904 KN			
$\chi = N_u/N_{pl,Rk} =$		0.85			
Ultimate load at normal temperature		Load applied in fire		Load ratio	Fire resistance
Load	Eccentricity	Load	Eccentricity	N_{fi}/N_u	R_f (minute)
N_u (KN)	e (cm)	N_{fi} (KN)	e (cm)		
6753	0	2026	0	0.30	90.27
6753	0	2701	0	0.40	57.13
6753	0	3376	0	0.50	40.40
6753	0	4052	0	0.60	29.56
5926	1	1778	1	0.30	94.60
5926	1	2371	1	0.40	60.23
5926	1	2963	1	0.50	41.02
5926	1	3556	1	0.60	29.04
4148	5	1244	5	0.30	101.06
4148	5	1659	5	0.40	65.06
4148	5	2074	5	0.50	43.25
4148	5	2489	5	0.60	28.50

Table A3.22. Characteristics and calculated fire resistances of column- profile 16.