

C Series

Description of the towers

The series consists of five pyramidal steel structure of square section, with the four equal faces in terms of resistance and geometry.

They comply with the Specification indicated in the Recomendación Unesa-6704-A in all the aspects up to the height of 22 m. and have been tested and duly homologated. Eucomsa has deemed necessary to prolong the series to a maximum height of 30 m.

The head of the tower is constituted by a single unit, comprising welded steel angles, and allows the attachment of various crossarm configurations at different levels. The total length of the head is 4,5 m. made up of seven sections of 60 cm. and one of 30 cm. at its connection with the tower body.

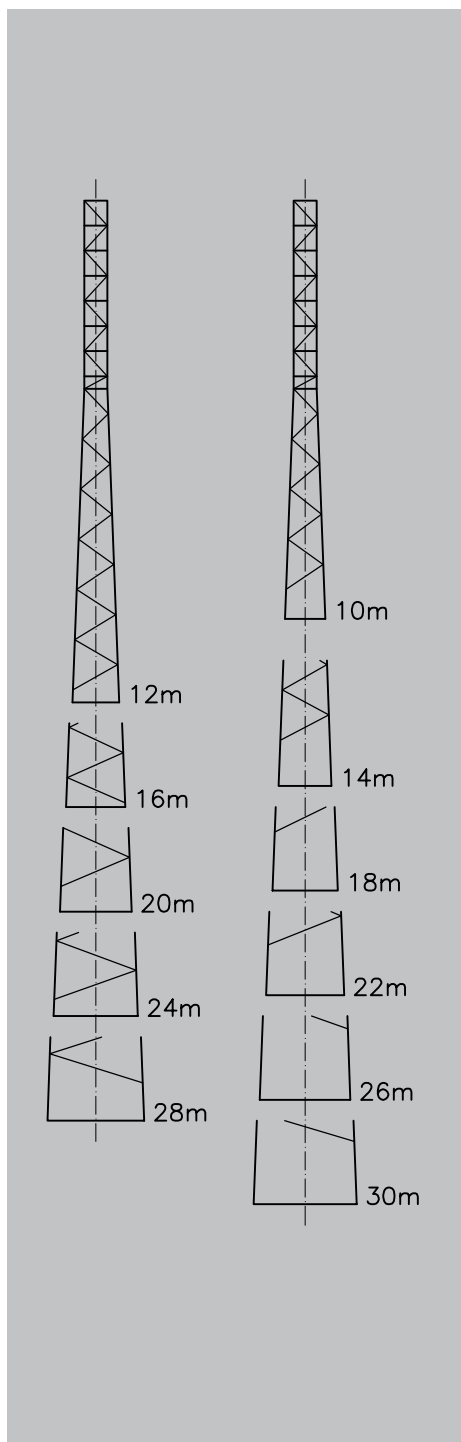
The body is made up of sections comprising angles joined at the corner legs by a single bolt. They have been designed so that the diagonals of each section have the same length, thereby minimizing the number of different members and facilitating erection.

The specified total heights are obtained either using complete sections or anchoring bodies.

It has been foreseen that dismountable section of the tower (body) may be packed inside the head, allowing an easier handling and transport.

Heights

In the following table the total and useful heights are given, (free height of the tower upon ground line) depending the last ones on the embedded portion (see table of foundations).

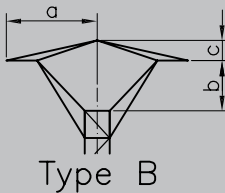
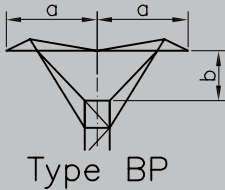
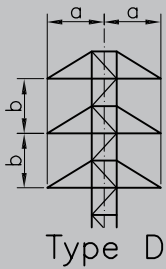
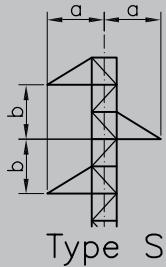
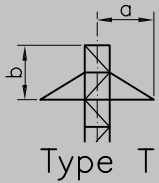
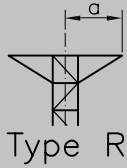


Type	Total height (m)										
	10	12	14	16	18	20	22	24	26	28	30
C500	8.75	10.65	12.60	14.60	16.55	18.50	20.50	22.45	24.45	26.40	28.40
C1000	8.50	10.45	12.40	14.35	16.35	18.30	20.25	22.25	24.20	26.20	28.20
C2000	8.30	10.25	12.25	14.20	16.20	18.15	20.15	22.15	24.15	26.10	28.10
C3000	8.15	10.10	12.05	14.00	16.00	18.00	19.95	21.95	23.95	25.90	27.90
C4500	7.90	9.85	11.85	13.80	15.80	17.75	19.75	21.70	23.70	25.70	27.70

C Series

Crossarms Configurations

The different connection points foreseen in the tower head allow other configurations, in view of the different connection points foreseen in the tower head, and different length of individual crossarms. Similarly, provision has been made for the connection of an earthwire peak of 1.5 m. height.



Type	Dimensions (m)			Weight (Kg)
	a	b	c	
R1	1.25	-	-	43
R2	1.50	-	-	49
R3	1.75	-	-	61
R4	2.00	-	-	76
T1	1.25	0.60	-	44
T2	1.50	0.60	-	50
T3	1.75	1.20	-	62
T4	2.00	1.80	-	77
S1	1.25	1.20	-	57
S2	1.50	1.20	-	65
S3	1.75	1.80	-	83
S4	2.00	1.80	-	106
D1	1.25	1.20	-	113
D2	1.50	1.20	-	130
D3	1.75	1.80	-	166
D4	2.00	1.80	-	211
BP15	1.50	1.10	-	149
BP20	2.00	1.10	-	161
BP25	2.50	1.10	-	211
BP30	3.00	1.10	-	227
B15	1.50	0.70	0.35	108
B20	2.00	1.10	0.50	148
B25	2.50	1.10	0.70	171
B30	3.00	1.10	0.70	186

C Series

This loads are combined with a vertical load of 885 Kg. for C500, C1000 and C2000 types and of 1740 Kg. for C3000 and C4500 types.

Resistance of the Towers

The working loads, (Kgs)., which can be resisted applied at the top of the tower head, are:

Working load (1,5): It is the horizontal load that the tower can resist, applied at the top of the head, with a safety factor of 1,5 and wind on the tower of 120 km/h.

Unbalance (1,5): It is the horizontal load, without wind, applied to the top of the head, with a safety factor of 1,5.

Torsion (1,2): It is the eccentric horizontal load applied at the end of a crossarm of 1,5 m. length situated at the top of the head, with a safety factor of 1,2.

	C500	C1000	C2000	C3000	C4500
Useful load (1.5)	510	1020	2040	3060	4590
Unbalance (1.5)	660	1180	2230	3200	4760
Torsion (1.2)	750	860	1600	1600	1600

Weights

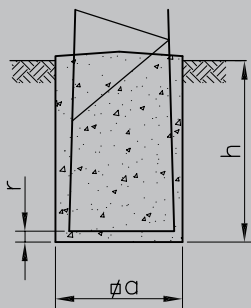
In the following table the approximate tower weights in Kgs. are given for the different total heights.

Height (m)	C500	C1000	C2000	C3000	C4500
10	239	260	358	457	580
12	281	329	454	570	778
14	336	398	549	710	962
16	389	466	661	857	1134
18	445	539	769	987	1316
20	500	625	878	1144	1540
22	565	710	1005	1309	1760
24	637	804	1130	1443	1960
26	706	901	1274	1617	2183
28	776	990	1390	1781	2387
30	856	1087	1539	1974	2614

C Series

Foundations

In the table the minimum theoretical dimensions and volumes for soils of 8, 12 y 16 Kg/cm³ of compressibility coefficient are given. The foundations have been calculated according to the Sulzberger method for a maximum turning angle whose tangent is not more than 0,01 according to the regulation of aerial high-tension lines. The volumes (v) indicated correspond to the part embedded in the ground.



The foundation protrusion should be at least 0.15 m high.

Dimension "r" must be fulfilled to reach the useful height noted in the table.

Height (m)	Dim. (m)	K=8 Kg/cm ³					K=12 Kg/cm ³					K=16 Kg/cm ³				
		500	1000	2000	3000	4500	500	1000	2000	3000	4500	500	1000	2000	3000	4500
10	a	0.76	0.76	0.90	0.90	0.90	0.76	0.76	0.90	0.90	0.90	0.76	0.76	0.90	0.90	0.90
	h	1.60	1.90	2.10	2.35	2.60	1.45	1.70	1.90	2.10	2.35	1.35	1.60	1.80	1.95	2.20
	v	0.93	1.10	1.70	1.90	2.11	0.84	0.98	1.54	1.70	1.90	0.78	0.92	1.46	1.58	1.78
	r	0.35	0.40	0.40	0.50	0.50	0.20	0.20	0.20	0.25	0.25	0.10	0.10	0.10	0.10	0.10
12	a	0.82	0.82	1.00	1.00	1.00	0.82	0.82	1.00	1.00	1.00	0.82	0.82	1.00	1.00	1.00
	h	1.70	2.00	2.15	2.40	2.65	1.55	1.80	1.95	2.15	2.40	1.45	1.65	1.85	2.00	2.25
	v	1.14	1.34	2.15	2.40	2.65	1.04	1.21	1.95	2.15	2.40	0.98	1.11	1.85	2.00	2.25
	r	0.35	0.45	0.40	0.50	0.50	0.20	0.25	0.20	0.25	0.25	0.10	0.10	0.10	0.10	0.10
14	a	0.87	0.88	1.10	1.10	1.10	0.87	0.88	1.10	1.10	1.10	0.87	0.88	1.10	1.10	1.10
	h	1.75	2.05	2.20	2.45	2.70	1.60	1.85	2.00	2.20	2.45	1.50	1.70	1.85	2.05	2.25
	v	1.33	1.59	2.66	2.96	3.27	1.21	1.43	2.42	2.66	2.96	1.14	1.32	2.24	2.48	2.72
	r	0.35	0.45	0.45	0.50	0.55	0.20	0.25	0.25	0.25	0.30	0.10	0.10	0.10	0.10	0.10
16	a	0.92	0.93	1.20	1.20	1.20	0.92	0.93	1.20	1.20	1.20	0.92	0.93	1.20	1.20	1.20
	h	1.80	2.05	2.25	2.45	2.75	1.65	1.85	2.00	2.25	2.45	1.50	1.75	1.90	2.10	2.30
	v	1.52	1.77	3.24	3.53	3.96	1.40	1.60	2.88	3.24	3.53	1.27	1.51	2.74	3.02	3.31
	r	0.40	0.40	0.45	0.45	0.55	0.25	0.20	0.20	0.25	0.25	0.10	0.10	0.10	0.10	0.10
18	a	0.98	1.00	1.30	1.30	1.30	0.98	1.00	1.30	1.30	1.30	0.98	1.00	1.30	1.30	1.30
	h	1.80	2.10	2.25	2.50	2.75	1.65	1.90	2.05	2.25	2.50	1.55	1.75	1.90	2.10	2.30
	v	1.73	2.10	3.80	4.23	4.90	1.58	1.90	3.46	3.80	4.23	1.49	1.75	3.21	3.55	3.89
	r	0.35	0.45	0.45	0.50	0.55	0.20	0.25	0.25	0.25	0.30	0.10	0.10	0.10	0.10	0.10
20	a	1.04	1.05	1.40	1.40	1.40	1.04	1.05	1.40	1.40	1.40	1.04	1.05	1.40	1.40	1.40
	h	1.85	2.15	2.30	2.50	2.80	1.70	1.95	2.05	2.30	2.50	1.60	1.80	1.95	2.10	2.35
	v	2.00	2.37	4.51	4.90	5.49	1.84	2.15	4.02	4.51	4.90	1.73	1.98	3.82	4.12	4.61
	r	0.35	0.45	0.45	0.50	0.55	0.20	0.25	0.20	0.30	0.25	0.10	0.10	0.10	0.10	0.10
22	a	1.10	1.10	1.50	1.50	1.50	1.10	1.10	1.50	1.50	1.50	1.10	1.10	1.50	1.60	1.50
	h	1.90	2.15	2.30	2.55	2.80	1.70	1.95	2.10	2.30	2.55	1.60	1.85	1.95	2.15	2.35
	v	2.30	2.60	5.18	5.74	6.30	2.06	2.36	4.73	5.18	5.74	1.94	2.24	4.99	5.50	5.29
	r	0.40	0.40	0.45	0.50	0.55	0.20	0.20	0.25	0.25	0.30	0.10	0.10	0.10	0.10	0.10
24	a	1.15	1.16	1.60	1.60	1.60	1.15	1.16	1.60	1.60	1.60	1.15	1.16	1.60	1.60	1.60
	h	1.95	2.20	2.30	2.55	2.85	1.75	2.00	2.10	2.30	2.55	1.65	1.85	1.95	2.15	2.40
	v	2.58	2.96	5.89	6.53	7.30	2.51	2.69	5.38	5.89	6.53	2.38	2.49	4.39	5.50	6.14
	r	0.40	0.45	0.45	0.50	0.55	0.20	0.25	0.25	0.25	0.25	0.10	0.10	0.10	0.10	0.10
26	a	1.20	1.22	1.70	1.70	1.70	1.20	1.22	1.70	1.70	1.70	1.20	1.22	1.70	1.70	1.70
	h	2.00	2.25	2.35	2.55	2.85	1.80	2.00	2.10	2.35	2.55	1.65	1.90	1.95	2.15	2.40
	v	2.88	3.35	6.79	7.37	8.24	2.59	2.98	6.07	6.79	7.37	2.38	2.83	5.64	6.21	6.94
	r	0.45	0.45	0.50	0.50	0.55	0.25	0.20	0.30	0.30	0.25	0.10	0.10	0.10	0.10	0.10
28	a	1.25	1.27	1.80	1.80	1.80	1.25	1.27	1.80	1.80	1.80	1.25	1.27	1.80	1.80	1.80
	h	2.00	2.25	2.35	2.60	2.85	1.80	2.05	2.10	2.35	2.60	1.70	1.90	2.00	2.20	2.40
	v	3.13	3.63	7.61	8.42	9.23	2.81	3.31	6.80	7.61	8.42	2.66	3.06	6.48	7.13	7.78
	r	0.40	0.45	0.45	0.50	0.55	0.20	0.25	0.20	0.25	0.30	0.10	0.10	0.10	0.10	0.10
30	a	1.32	1.33	1.90	1.90	1.90	1.32	1.33	1.90	1.90	1.90	1.32	1.33	1.90	1.90	1.90
	h	2.00	2.30	2.35	2.60	2.85	1.85	2.05	2.15	2.35	2.60	1.70	1.90	2.00	2.00	2.40
	v	3.48	4.07	8.48	9.39	10.29	3.22	3.63	7.76	8.48	9.39	2.96	3.36	7.22	7.94	8.66
	r	0.40	0.50	0.45	0.50	0.55	0.25	0.25	0.25	0.25	0.30	0.10	0.10	0.10	0.10	0.10

C Series

Working Loads by Phase (Kg.)

This loads are combined with a vertical load of 270 Kg. for each phase for C500, C1000, C2000 and of 410 Kg. for each phase for types C3000 and C4500.

	Horizontal + wind CS: 1.5				Horizontal w.o. wind CS: 1.5				Longitudinal w.o. wind CS:1.2				Longit. (Worst phase) CS: 1.2			
Type R																
	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4
C500	170	170	170	170	220	220	220	220	275	275	275	275	750	750	750	680
C1000	340	340	340	340	393	393	393	393	490	490	490	490	1000	860	760	680
C2000	680	680	680	680	743	743	743	743	930	930	930	930	1858	1600	1400	1245
C3000	1020	1020	1020	1020	1067	1067	1067	1067	1330	1330	1330	1330	1858	1600	1400	1245
C4500	1530	1530	1530	1530	1587	1587	1587	1587	1984	1984	1750	1560	1858	1600	1400	1245
Type T																
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2	T3	T4
C500	175	175	180	185	230	230	240	250	290	290	300	310	750	750	750	670
C1000	350	350	365	380	405	405	420	435	505	505	525	540	990	858	752	670
C2000	690	690	705	720	780	780	805	825	975	975	1005	1030	1827	1574	1364	1204
C3000	1070	1070	1130	1195	1120	1120	1180	1250	1400	1400	1475	1505	1827	1574	1364	1204
C4500	1625	1625	1695	1740	1685	1685	1780	1850	2105	1970	1705	1505	1827	1574	1364	1204
Type S																
	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
C500	185	185	190	190	255	255	270	270	320	320	340	340	750	750	726	652
C1000	390	390	410	410	455	455	480	480	570	570	535	495	954	831	726	652
C2000	735	735	760	760	850	850	875	875	1060	1060	980	900	1712	1487	1283	1152
C3000	1270	1270	1315	1315	1350	1350	1430	1430	1225	1105	980	900	1712	1487	1283	1152
C4500	1635	1635	1560	1560	1830	1830	1900	1900	1225	1105	980	900	1712	1487	1283	1152
Type D																
	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4	D1	D2	D3	D4
C500	90	90	95	95	130	130	135	135	160	160	170	170	750	750	726	652
C1000	195	195	205	205	230	230	245	245	285	285	305	305	955	831	726	652
C2000	365	365	380	380	420	420	430	430	525	525	540	540	1712	1487	1283	1152
C3000	635	635	660	660	670	670	705	705	840	840	880	880	1712	1487	1283	1152
C4500	820	820	780	780	910	910	950	950	1140	1140	1190	1190	1712	1487	1283	1152
Type B																
	B15	B20	B25	B30	B15	B20	B25	B30	B15	B20	B25	B30	B15	B20	B25	B30
C500	155	145	140	140	200	190	185	185	250	240	230	230	750	690	568	483
C1000	300	275	270	270	340	315	310	310	425	395	390	390	860	690	568	483
C2000	595	550	545	545	635	590	585	585	790	740	730	730	1600	1200	980	870
C3000	900	830	820	820	940	870	860	860	1175	1090	1075	1075	1600	1200	980	870
C4500	1280	1180	1165	1165	1320	1220	1205	1205	1650	1500	1225	1090	1600	1200	980	870

C Series

Nomenclature

We recommend for the nomenclature of the towers the following parts:

1. Tower Type (C1000, C2000, etc.)
Figures represent the tower resistance in daN.
2. Type of crossarm configuration (R, T, S, etc.)
3. Tower Height (10, 12, 14, etc.)

Example: a tower of the series with a nominal strength of 3000 daN, a single circuit crossarm with a length of 2m. referred to the tower axis and a height of 22 m. would be named:

C3000-S4-22

M Series

Description of the Towers

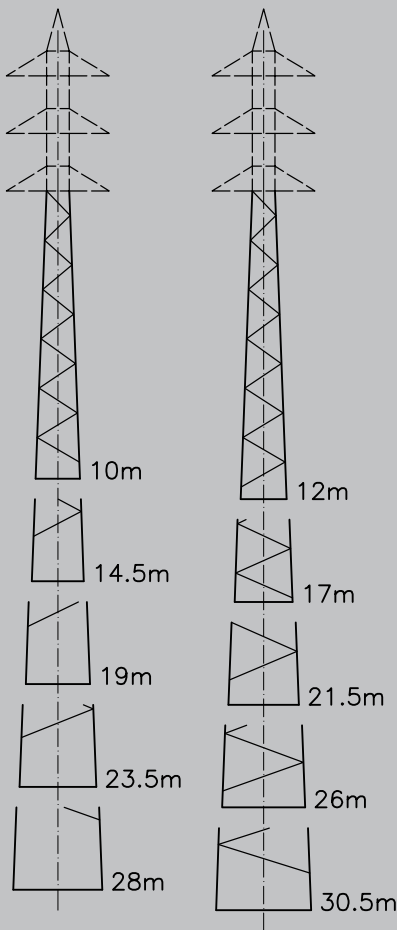
The towers of this series are appropriate for lines up to 132 KV where the ground characteristics or crossing permission demand towers with mono block foundations, narrow base and little soil occupation.

The series consists of five pyramidal steel structures of square section, with four equal faces in terms of resistance and geometry.

The head of the towers or the crossarms, which are common to the series, or the bodies, are constituted by bolted steel angles. The body is made up of sections comprising angles joined to the corner legs by a single bolt. They are identical for anyone series type and have been designed so that the diagonals of each section have the same length, thereby minimizing the number of different members, speeding up classification and facilitating erection.

Heights

The different heights are obtained throughout adding complete bodies, being embedded the last body partially in the foundation, or adding to the last section a body for anchoring to obtain a bigger range of intermediate heights.



Type	Total heights (m)									
	10	12	14.5	17	19	21.5	23.5	26	28	30.5
	Useful heights (m)									
M17	8.55	10.45	12.90	15.35	17.30	19.80	21.75	24.20	26.20	28.65
M25	8.40	10.30	12.75	15.20	17.15	19.60	21.55	24.05	26.00	28.50
M35	8.25	10.15	12.60	15.05	17.00	19.45	21.45	23.90	25.85	28.35
M47	8.10	10.05	12.50	14.90	16.85	19.35	21.30	23.75	25.75	28.10
M60	7.95	9.90	12.35	14.80	16.70	19.20	21.15	23.60	25.60	28.05

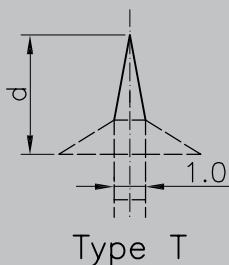
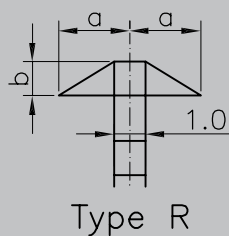
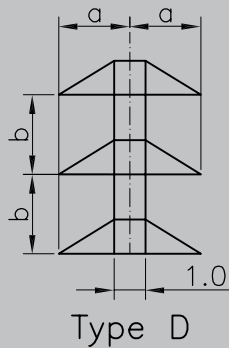
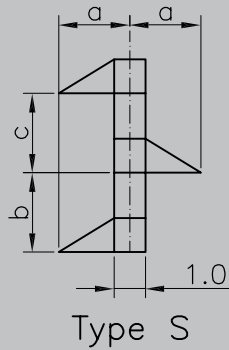
M Series

Crossarm Configurations

Considering the most common arrangements that can be mounted, and in the range of lines where these towers can be used regarding conductor disposition, a series of heads has been standardized and dimensions and weights are given in the following table.

Crossarms being independent elements can be joined to the prismatic body of the considered head in different disposals from the standardized.

As an application to pass from simple to double circuit we add or deduce the appropriate crossarms, or to combine the lengths of the crossarms given otherwise than specified.



Type	Dimensions (m)				Weight (Kg)
	a	b	c	d	
S1	2.00	0.67	1.34	-	330
S2	2.00	1.34	1.34	-	377
S3	2.00	1.36	1.99	-	412
S31	2.30	1.36	1.99	-	423
S4	2.00	2.02	2.02	-	445
S41	2.70	2.02	2.02	-	483
D1	2.00	2.02	-	-	546
D11	2.30	2.02	-	-	567
D2	2.00	2.66	-	-	610
D21	2.30	2.66	-	-	632
D3	2.30	3.30	-	-	696
D31	2.70	3.30	-	-	751
R1	2.00	0.67	-	-	170
R11	2.30	0.67	-	-	180
R12	2.70	0.67	-	-	210
T1	-	-	-	2.20	46
T2	-	-	-	2.90	63
T3	-	-	-	3.40	78
T4	-	-	-	3.90	89

M Series

This loads are combined with a vertical load of 600 Kg. at the end of the crossarm for any crossarm configuration.

Resistance of the Tower

The working loads, in Kgs., which can be resisted as applied at the top of the tower head are:

EHV (1,5): Useful load applied to 2.0 m. above the lower crossarm with a safety factor of 1,5 and wind on the tower being 120 km/h.

EH (1,5): Useful horizontal load without wind applied to 2.0 m. above the lower crossarm with a safety factor of 1,5.

T (1,2): Eccentric horizontal load applied at the end of a crossarm of 2,0 m. length situated at any of the configurations levels, with safety factor of 1,2.

	M17	M25	M35	M47	M60
Useful load (1.5)	1700	2500	3500	4700	6000
Unbalance (1.5)	2500	2950	4200	5100	6300
Torsion (1.2)	2500	2500	2500	2500	2500

Weights

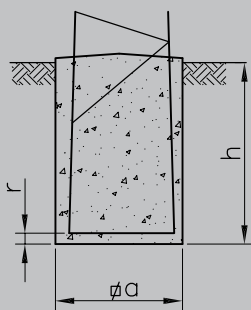
In the following table the approximate tower weights in Kgs. are given for the different total heights

Height (m)	M17	M25	M35	M47	M60
10	532	555	596	671	719
12	665	699	761	852	931
14.5	842	887	975	1079	1187
17	1019	1078	1198	1341	1516
19	1174	1244	1386	1552	1718
21.5	1363	1442	1622	1836	2045
23.5	1553	1643	1847	2099	2322
26	1758	1875	2115	2401	2704
28	1978	2117	2380	2693	3038
30.5	2202	2367	2668	3023	3449

M Series

Foundation

In the table below the minimum theoretical dimensions and volumes for soils of 8, 12 y 16 Kg/cm³ of compressibility coefficient are given. The foundations have been calculated according to the Sulzberger method for a maximum turning angle whose tangent is not more than 0,01 according to the regulation of aerial high-tension lines. The volumes (v) indicated correspond to the part embedded in the ground.



The foundation protrusion should be at least 0.15 m high.

Dimension "r" must be fulfilled to reach the useful height noted in the table.

Height (m)	Dim.	K=8 Kg/cm ³					K=12 Kg/cm ³					K=16 Kg/cm ³				
		M17	M25	M35	M47	M60	M17	M25	M35	M47	M60	M17	M25	M35	M47	M60
10	a	1.50	1.50	1.55	1.55	1.55	1.50	1.50	1.55	1.55	1.55	1.50	1.50	1.55	1.55	1.55
	h	1.85	2.05	2.20	2.35	2.55	1.65	1.85	2.00	2.15	2.30	1.55	1.70	1.85	2.00	2.15
	v	4.16	4.61	5.28	5.65	6.13	3.71	4.16	4.81	5.17	5.53	3.49	3.83	4.44	4.80	5.17
	r	0.40	0.45	0.45	0.45	0.50	0.20	0.25	0.25	0.25	0.25	0.10	0.10	0.10	0.10	0.10
12	a	1.55	1.55	1.60	1.60	1.60	1.55	1.55	1.60	1.60	1.60	1.55	1.55	1.60	1.60	1.60
	h	1.95	2.15	2.30	2.45	2.60	1.75	1.95	2.10	2.20	2.35	1.65	1.80	1.95	2.05	2.20
	v	4.68	5.16	5.89	6.27	6.66	4.20	4.68	5.38	5.63	6.02	3.96	4.32	4.99	5.25	5.63
	r	0.40	0.45	0.45	0.50	0.55	0.20	0.25	0.25	0.25	0.25	0.10	0.10	0.10	0.10	0.10
14.5	a	1.65	1.65	1.70	1.70	1.70	1.65	1.65	1.70	1.70	1.70	1.65	1.65	1.70	1.70	1.70
	h	2.00	2.20	2.35	2.50	2.70	1.80	2.00	2.15	2.30	2.45	1.70	1.85	2.00	2.10	2.25
	v	5.45	5.99	6.79	7.23	7.80	4.90	5.45	6.21	6.65	7.08	4.63	5.04	5.78	6.07	6.50
	r	0.10	0.45	0.45	0.50	0.55	0.20	0.25	0.25	0.30	0.30	0.10	0.10	0.10	0.10	0.10
17	a	1.70	1.70	1.75	1.75	1.75	1.70	1.70	1.75	1.75	1.75	1.70	1.70	1.75	1.75	1.75
	h	2.10	2.25	2.50	2.55	2.75	1.85	2.05	2.20	2.35	2.50	1.75	1.90	2.05	2.20	2.30
	v	5.92	6.50	7.66	7.80	8.42	5.35	5.92	6.73	7.20	7.66	5.06	5.49	6.28	6.74	7.04
	r	0.40	0.45	0.50	0.45	0.55	0.20	0.25	0.25	0.25	0.30	0.10	0.10	0.10	0.10	0.10
19	a	1.75	1.75	1.80	1.80	1.80	1.75	1.75	1.80	1.80	1.80	1.75	1.75	1.80	1.80	1.80
	h	2.10	2.30	2.50	2.65	2.85	1.90	2.10	2.25	2.40	2.55	1.80	1.95	2.10	2.25	2.40
	v	6.43	7.04	8.10	8.59	9.23	5.82	6.43	7.29	7.78	8.26	5.51	5.97	6.80	7.29	7.78
	r	0.40	0.45	0.50	0.50	0.55	0.20	0.20	0.25	0.25	0.25	0.10	0.10	0.10	0.10	0.10
21.5	a	1.85	1.85	1.90	1.90	1.90	1.85	1.85	1.90	1.90	1.90	1.85	1.85	1.90	1.90	1.90
	h	2.15	2.35	2.50	2.70	2.85	1.95	2.10	2.30	2.45	2.60	1.80	2.00	2.15	2.25	2.40
	v	7.36	8.04	9.02	9.75	10.29	6.67	7.19	8.30	8.84	9.39	6.16	6.85	7.76	8.12	8.66
	r	0.45	0.45	0.45	0.55	0.55	0.25	0.20	0.25	0.30	0.30	0.10	0.10	0.10	0.10	0.10
23.5	a	1.90	1.90	1.95	1.95	1.95	1.90	1.90	1.95	1.95	1.95	1.90	1.90	1.95	1.95	1.95
	h	2.20	2.40	2.55	2.75	2.90	2.00	2.15	2.30	2.50	2.65	1.85	2.05	2.15	2.30	2.45
	v	7.94	8.66	9.70	10.46	11.03	7.22	7.76	8.75	9.50	10.08	6.68	7.40	8.18	8.75	9.32
	r	0.45	0.45	0.50	0.55	0.55	0.25	0.20	0.25	0.30	0.30	0.10	0.10	0.10	0.10	0.10
26	a	1.95	1.95	2.00	2.00	2.00	1.95	1.95	2.00	2.00	2.00	1.95	1.95	2.00	2.00	2.00
	h	2.25	2.45	2.60	2.80	2.95	2.05	2.20	2.40	2.55	2.70	1.90	2.05	2.20	2.35	2.50
	v	8.56	9.32	10.40	11.20	11.80	7.80	8.37	9.60	10.20	10.80	7.22	7.80	8.80	9.40	10.00
	r	0.45	0.50	0.50	0.55	0.55	0.25	0.25	0.30	0.30	0.30	0.10	0.10	0.10	0.10	0.10
28	a	2.05	2.05	2.10	2.10	2.10	2.05	2.05	2.10	2.10	2.10	2.05	2.05	2.10	2.10	2.10
	h	2.25	2.45	2.65	2.80	3.00	2.05	2.25	2.40	2.55	2.70	1.90	2.10	2.25	2.35	2.50
	v	9.46	10.30	11.69	12.35	13.23	8.61	9.46	10.58	11.25	11.91	7.98	8.83	9.92	10.36	11.03
	r	0.46	0.45	0.50	0.55	0.60	0.25	0.25	0.25	0.30	0.30	0.10	0.10	0.10	0.10	0.10
30.5	a	2.10	2.10	2.15	2.15	2.15	2.10	2.10	2.15	2.15	2.15	2.10	2.10	2.15	2.15	2.15
	h	2.30	2.50	2.70	2.95	3.05	2.10	2.25	2.45	2.70	2.70	1.95	2.10	2.25	2.50	2.55
	v	10.14	11.03	12.48	13.63	14.10	9.26	9.92	11.33	12.48	12.71	8.60	9.26	10.40	11.56	11.79
	r	0.45	0.50	0.55	0.55	0.60	0.25	0.25	0.30	0.30	0.30	0.10	0.10	0.10	0.10	0.10

M Series

Working Loads by Phase (Kg.)

This loads are combined with a vertical load of 600 Kg. by phase

	Horizontal + wind CS: 1.5			Horizontal w.o. wind CS: 1.5			Longitudinal w.o. wind CS:1.2			Longit. (Worst phase) CS: 1.2		
Type R												
	R1	R11	R12	R1	R11	R12	R1	R11	R12	R1	R11	R12
M17	660	660	660	940	940	940	1175	1175	1175	2500	2270	2030
M25	930	930	930	1110	1110	1110	1390	1390	1390	2500	2270	2030
M35	1270	1270	1270	1590	1590	1590	1980	1980	1980	2500	2270	2030
M47	1720	1720	1720	1930	1930	1930	2410	2410	2410	2500	2270	2030
M60	1980	1980	1980	2060	2060	2060	2570	2570	2570	2500	2270	2030
Type S												
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
M17	640	620	600	915	900	890	1140	1120	1100	2500	2500	2500
M25	900	880	865	1075	1045	1030	1340	1310	1290	2500	2500	2500
M35	1230	1200	1180	1540	1480	1450	1535	1550	1550	2500	2500	2500
M47	1670	1630	1600	1875	1795	1760	1535	1550	1550	2500	2500	2500
M60	1990	1990	1980	2070	2080	2070	1535	1550	1550	2500	2500	2500
Type S												
	S31	S4	S41	S31	S4	S41	S31	S4	S41	S31	S4	S41
M17	600	580	580	890	840	840	1100	1050	1050	2270	2500	2270
M25	865	840	840	1030	1000	1000	1290	1250	1250	2270	2500	2270
M35	1180	1170	1170	1450	1400	1400	1460	1560	1475	2270	2500	2270
M47	1600	1570	1570	1760	1700	1700	1460	1560	1475	2270	2500	2270
M60	1980	2000	2000	2070	2100	2100	1460	1560	1475	2270	2500	2270
Type D												
	D1	D11	D2	D1	D11	D2	D1	D11	D2	D1	D11	D2
M17	290	290	280	420	420	390	525	525	490	2500	2270	2500
M25	420	420	400	500	500	460	625	625	575	2500	2270	2500
M35	585	585	550	700	700	640	875	875	800	2500	2270	2500
M47	785	785	720	850	850	790	1060	1060	990	2500	2270	2500
M60	1000	1000	910	1050	1050	970	1310	1310	1210	2500	2270	2500
Type D												
	D21	D3	D31	D21	D3	D31	D21	D3	D31	D21	D3	D31
M17	280	250	250	390	360	360	490	450	450	2270	2270	2030
M25	400	360	360	460	420	420	575	525	525	2270	2270	2030
M35	550	510	510	640	580	580	800	725	725	2270	2270	2030
M47	720	650	650	790	720	720	990	900	900	2270	2270	2030
M60	910	800	800	970	870	870	1210	1085	1085	2270	2270	2030

M Series

Nomenclature

We use for the nomenclature of the towers the following parts:

1. Tower Type (M17, M25, etc.)
Figures represent the maximum capacity of the tower with wind.
2. Type of crossarm configuration (S1, S3, D2, etc.) with indication of earthwire support if required (S1T2, D2T3, etc.)
3. Tower Height (17, 19, 21.5, etc.)

Example: a tower of the series M with a maximum capacity of 2500 Kg., single circuit crossarm with a vertical length between phases of 2.2 m. an horizontal distance between phases referred to the tower axis of 2.0 m., an earthwire peak of 2.90 m. height referred to the upper crossarm, and a total height of 21.5 m. would be named:

M25 - S4T2 - 21.5

R Series

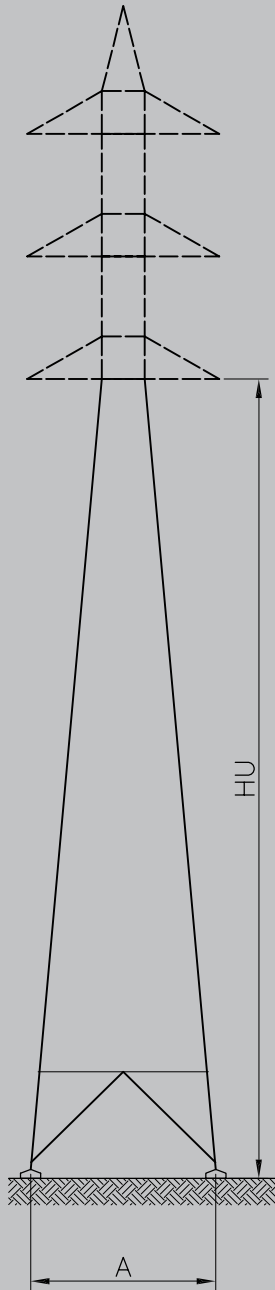
Description of the Towers

The towers of this series have been designed for lines from 66 to 220 KV.

The series consists of five different types classified by loads and made up by a troncopyramidal body, and a head with prismatic crossarm of square section, both composed by profiles wholly bolted.

Heights

The different heights are obtained varying the different bodies that compose troncopyramidal part of the tower. The following table indicates the different distances that can be obtained between the lower crossarm and soil (HU) taking into account a foundation protrude of 35 cm. so as theoretical dimensions of the bases (A) according to the referred height.

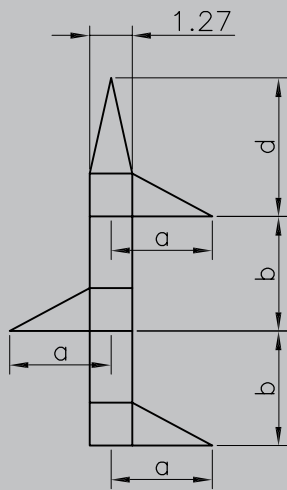


HU (m)	9.8	12.1	14.3	16.6	18.8	21.1	23.3	25.6	27.8
A (m)	2.51	2.82	3.13	3.45	3.76	4.07	4.38	4.69	5.00

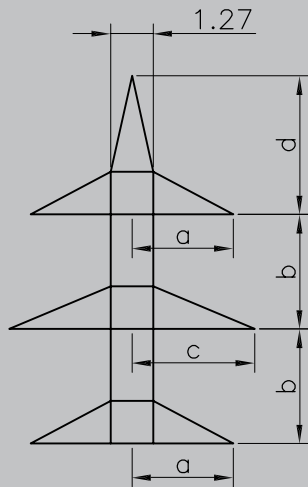
R Series

Crossarm Configurations

Considering the most common arrangements that can be found, in the range of tensions and circuits, a serial of heads has been standardized and, their dimensions are indicated in the following table. The crossarms and the earthwire peaks, as they are independent, can be joined to the head in order to obtain different disposals to the ones indicated. As an example, we can switch from a single to a double circuit tower by adding or eliminating the proper crossarms or matching the lengths anyhow to the specified one.



Type S



Type D

Type	Dimensions (m)			
	a	b	c	d
S4	2.4	2.0	-	3.7
S41	2.9	2.0	-	4.3
S6	2.4	3.0	-	3.7
S61	2.9	3.0	-	4.3
D3	2.4	3.0	2.9	3.7
D4	2.9	4.0	3.6	4.3

R Series

Resistance of the Towers

The working loads, in Kgs., which can be resisted as applied to the top of the tower head are::

- EHV** Useful transversal horizontal load applied to a middle crossarm level with a safety factor of 1,5 and wind on the tower of 120 km/h
- ES** Useful longitudinal horizontal load without wind and with a safety factor of 1,5
- Tc** Useful longitudinal load applied at the end of any crossarm, with a safety factor of 1,2
- Tt** Useful longitudinal load applied at the end of the earthwire peaks of the earthwire, with a safety factor of 1,2

The stress is calculated applying at the same time the following loads at the ends of crossarms and earth wire peak:

EHV: 700 Kg. by phase
250 Kg. by earth wire

ES: 1270 Kg. by phase
750 Kg. by earth wire

Tc: 1270 Kg. by phase
750 Kg. by earth wire

Tt: 1270 Kg. by phase
750 Kg. by earth wire

X-Arm Type	Useful Load (Kg)	R30	R60	R90	R140	R180
S4	EHV	3150	6200	9100	14150	18000
	ES	3560	6600	9550	14450	18000
	Tc	2650	2650	5150	5150	5150
	Tt	2300	2300	2300	2300	2300
S41	EHV	3150	6200	9100	14100	18000
	ES	3560	6600	9550	14450	18000
	Tc	2320	2320	4550	4550	4550
	Tt	2300	2300	2300	2300	2300
S6	EHV	2900	5800	8200	13600	16000
	ES	3200	6000	8500	14200	16700
	Tc	2650	2650	5150	5150	5150
	Tt	2300	2300	2300	2300	2300
S61	EHV	2900	5800	8200	13600	16000
	ES	3200	6000	8500	14200	16700
	Tc	2320	2320	4550	4550	4550
	Tt	2300	2300	2300	2300	2300
D3	EHV	2900	5800	8200	13600	16000
	ES	3200	6000	8500	14200	16700
	Tc	2320	2320	4550	4550	4550
	Tt	2300	2300	2300	2300	2300
D4	EHV	2500	5300	6500	12800	15000
	ES	2800	5700	7200	13200	15700
	Tc	2000	2000	3900	3900	3900
	Tt	2300	2300	2300	2300	2300

R Series

Weights

In the following table the approximate tower weights in Kgs. for the different total heights so as each crossarm. are given The total weight of the tower is composed by the sum of both.

Weight of bodies, including stubs (Kg.)

Height HU (m)	R30	R60	R90	R140	R180
9.8	720	891	1128	1491	1935
12.1	867	1080	1344	1761	2045
14.3	1062	1293	1577	2099	2470
16.6	1239	1510	1788	2395	2995
18.8	1494	1801	2191	2836	3255
21.1	1767	2113	2560	3275	3730
23.3	1972	2348	2803	3573	4060
25.6	2304	2692	3221	4089	4611
27.8	2526	2936	3502	4379	5007

Weight of Crossarms (Kg.)

Tower Type	Crossarm configuration					
	S4	S41	S6	S61	D3	D4
R30	614	661	737	785	899	1081
R60	630	678	748	796	908	1081
R90	760	827	936	1003	1107	1394
R140	834	909	978	1049	1162	1454
R180	875	950	1017	1089	1201	1512

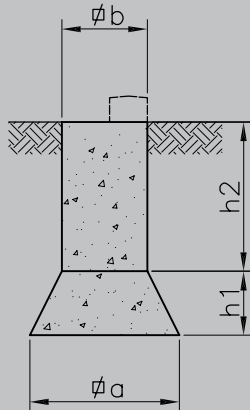
R Series

Foundation

Four square blocks of foundations compose the foundations of these towers.

In the following table working loads (without safety factor) that towers transmit to the foundations for the different useful heights are given.

Tower Type	Load (Kg)	HU (m)			
		14.3	18.8	23.3	27.8
R30	Compression	12100	12950	13900	14850
	Uplift	9980	10700	11400	12100
R60	Compression	20300	21550	22850	24000
	Uplift	18250	19250	20300	21300
R90	Compression	27800	29400	31100	32600
	Uplift	25900	27300	29850	31250
R140	Compression	42700	44750	46900	48750
	Uplift	40850	42350	43900	45350
R180	Compression	52350	54900	57600	59900
	Uplift	50250	52450	54750	56750



In the following table the dimensions of each block for a soil of 2.0 Kg/cm² of allowable load, frustum angle of 30° and safety factor to the same of 1.5 are given

Tower Type	HU (m)	Dimensions (m)				Excav. Vol. (m ³)
		a	b	h1	h2	
R30	9.8-14.3	1.10	0.80	0.30	1.50	1.23
	16.6-18.8				1.60	1.30
	21.1-23.3				1.65	1.33
	25.6-27.8				1.70	1.36
R60	9.8-14.3	1.25	0.90	0.35	1.95	1.99
	16.6-18.8				2.00	2.03
	21.1-23.3				2.10	2.11
	25.6-27.8				2.15	2.15
R90	9.8-14.3	1.40	1.00	0.40	2.20	2.78
	16.6-18.8				2.25	2.83
	21.1-23.3				2.40	2.98
	25.6-27.8				2.45	3.03
R140	9.8-14.3	1.70	1.10	0.60	2.35	4.04
	16.6-18.8				2.40	4.10
	21.1-23.3				2.50	4.22
	25.6-27.8				2.55	4.28
R180	9.8-14.3	1.90	1.20	0.70	2.40	5.17
	16.6-18.8				2.50	5.31
	21.1-23.3				2.55	5.38
	25.6-27.8				2.65	5.53

R Series

Working Loads by Conductor and Earthwire (Kg.)

The stress is calculated applying at the same time the following loads at the ends of crossarms and earth wire peak:

Horizontal + Wind
 700 Kg. by conductor
 250 Kg. by earth wire

Longitudinal without wind
 1270 Kg. by conductor
 750 Kg. by earth wire

Broken conductor
 1270 Kg. by conductor
 750 Kg. by earth wire

Broken earth wire
 1270 Kg. by conductor
 750 Kg. by earth wire

Tower Type	Horizontal+wind CS:1.5		Longitudinal w.o. wind CS:1.5		Broken conductor CS:1.2		Broken earth wire CS:1.2					
	S4	S41	S4	S41	S4	S41	S4	S41				
R30	Hc	820	820	Lc	930	930	Tc	2650	2320	Tc	-	-
	Ht	570	570	Lt	650	650	Tt	-	-	Tt	2300	2300
R60	Hc	1620	1620	Lc	1720	1720	Tc	2650	2320	Tc	-	-
	Ht	1130	1130	Lt	1200	1200	Tt	-	-	Tt	2300	2300
R90	Hc	2340	2340	Lc	2480	2480	Tc	5150	4550	Tc	-	-
	Ht	1640	1640	Lt	1740	1740	Tt	-	-	Tt	2300	2300
R140	Hc	3650	3650	Lc	3760	3760	Tc	5150	4550	Tc	-	-
	Ht	2560	2560	Lt	2640	2640	Tt	-	-	Tt	2300	2300
R180	Hc	4700	4700	Lc	4700	4700	Tc	5150	4550	Tc	-	-
	Ht	3290	3290	Lt	3290	3290	Tt	-	-	Tt	2300	2300
	S6	S61	S6	S61	S6	S61	S6	S61	S6	S61		
R30	Hc	750	750	Lc	830	830	Tc	2650	2320	Tc	-	-
	Ht	530	530	Lt	580	580	Tt	-	-	Tt	2300	2300
R60	Hc	1500	1500	Lc	1560	1560	Tc	2650	2320	Tc	-	-
	Ht	1050	1050	Lt	1100	1100	Tt	-	-	Tt	2300	2300
R90	Hc	2120	2120	Lc	2200	2200	Tc	5150	4550	Tc	-	-
	Ht	1490	1490	Lt	1550	1550	Tt	-	-	Tt	2300	2300
R140	Hc	3520	3520	Lc	3670	3670	Tc	5150	4550	Tc	-	-
	Ht	2460	2460	Lt	2570	2570	Tt	-	-	Tt	2300	2300
R180	Hc	4140	4140	Lc	4320	4320	Tc	5150	4550	Tc	-	-
	Ht	2900	2900	Lt	3020	3020	Tt	-	-	Tt	2300	2300
	D3	D4	D3	D4	D3	D4	D3	D4	D3	D4		
R30	Hc	420	370	Lc	470	410	Tc	2320	2000	Tc	-	-
	Ht	300	260	Lt	330	285	Tt	-	-	Tt	2300	2300
R60	Hc	850	770	Lc	875	830	Tc	2320	2000	Tc	-	-
	Ht	590	540	Lt	610	580	Tt	-	-	Tt	2300	2300
R90	Hc	1200	950	Lc	1240	1050	Tc	4550	4000	Tc	-	-
	Ht	840	670	Lt	870	740	Tt	-	-	Tt	2300	2300
R140	Hc	1985	1860	Lc	2070	1920	Tc	4550	4000	Tc	-	-
	Ht	1390	1300	Lt	1450	1340	Tt	-	-	Tt	2300	2300
R180	Hc	2335	2180	Lc	2440	2280	Tc	4550	4000	Tc	-	-
	Ht	1635	1520	Lt	1710	1600	Tt	-	-	Tt	2300	2300

R Series

Nomenclature

We use for the nomenclature of the towers the following parts:

1. Tower Type (R30, R60, R90, etc.)
Figures represent the maximum capacity of the tower
2. Type of crossarm configuration (S4, S41, D3, etc.)
3. Tower Height (9.8, 12.1, 27.8, etc.)

Example: a tower of this series with an useful load of 6200 Kg., a single circuit crossarm of 4.0 m. of distance between phases with crossarms of 2.4 m. length referred to the tower axis and an useful height (HU) of 14.3 m. would be named:

R60-S4-14.3

T Series

Description of the Towers

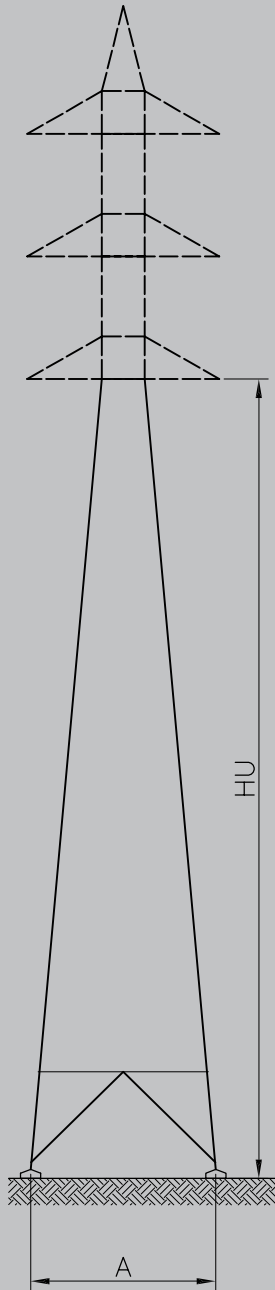
The towers of this series have been designed for lines from 132 to 220 KV.

The series consists of five different types classified following load and a troncopyramidal body, a head or a prismatic crossarm of square section, both of profiles wholly bolted, makes them up.

Heights

The different heights may be obtained composing the bodies of the troncopyramidal body.

The following table indicates the different distances to be obtained between the lower crossarm and the soil (HU) considering a foundation protrude of 30 cm. So as the bases theoretical dimensions (A) following the referred height.

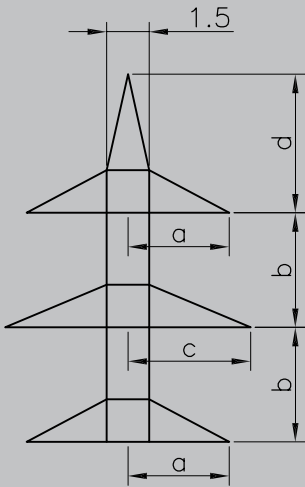


HU (m)	12.3	15.3	18.3	21.3	24.3	27.3	30.3	33.3	36.3
A (m)	3.38	3.84	4.30	4.75	5.21	5.67	6.13	6.59	7.05

T Series

Crossarm Configurations

Considering the most common arrangements that can be present, in the practice and in the range of tension and circuits' configuration, we have standardized a head series whose dimensions are indicated in the following table. So the crossarms as the earthwire peak, as they are independent elements, could be joined to the head to obtain other different disposal than those indicated hereby. For example, we could go from a single circuit to a double circuit or viceversa through the sum or deduction of the proper crossarms, or combine lengths of the same with another form than the specified one.



Type	Dimensions (m)			
	a	b	c	d
D3	3.0	3.3	3.2	4.3
D4	4.1	4.4	4.3	6.0
D5	4.1	5.5	4.3	6.0

T Series

Weights

In the following table the weights of the bodies for the different types and heights so as each crossarm are given. The total weight is constituted by the sum of both.

Weight of bodies, including stubs (Kg.)

Height HU (m)	T35	T50	T70	T120	T180	T280
12.3	1125	1225	1370	1860	2320	3065
15.3	1335	1470	1650	2250	2835	3720
18.3	1720	1880	2100	2800	3550	4680
21.3	2035	2250	2455	3310	4170	5370
24.3	2500	2700	3020	3890	4920	6300
27.3	2890	3130	3430	4400	5500	7055
30.3	3440	3710	4045	5410	6340	8170
33.3	3840	4125	4490	5715	7000	8910
36.3	4460	4800	5210	6535	7930	10060

Weight of Crossarms (Kg.)

Tower Type	X-Arm Configuration		
	D3	D4	D5
T35	1195	1450	1585
T50	1195	1450	1610
T70	1210	1485	1630
T120	1430	1995	2210
T180	1500	2120	2360
T280	1650	2400	2820

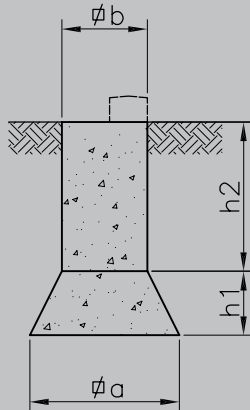
T Series

Foundation

Four square blocks of foundations compose the foundations of these towers.

In the following table working loads (without safety factor) that towers transmit to the foundations for the different useful heights are given.

Tower Type	Load (Kg)	HU (m)		
		18.3	27.3	36.3
T35	Compression	15360	17500	19550
	Uplift	11370	12530	13700
T50	Compression	20350	22390	24640
	Uplift	15460	16850	18210
T70	Compression	25830	28400	30940
	Uplift	20930	22840	24560
T120	Compression	39860	43200	46100
	Uplift	34560	36940	39100
T180	Compression	56610	60620	64300
	Uplift	50900	53860	56540
T280	Compression	84350	89630	94020
	Uplift	78100	82200	85400



In the following table the dimensions of each block for a soil of 2.0Kg/cm² of allowable load, frustum angle of 30° and safety factor to the same of 1.5 are given

Tower Type	HU (m)	Dimensions (m)				Excav. Vol. (m ³)
		a	b	h1	h2	
T35	12.3-18.3	1.10	0.80	0.30	1.65	1.33
	21.3-27.3				1.75	1.39
	30.3-36.3				1.85	1.46
T50	12.3-18.3	1.20	0.80	0.40	1.75	1.53
	21.3-27.3				1.85	1.59
	30.3-36.3				1.95	1.65
T70	12.3-18.3	1.35	0.90	0.45	1.95	2.16
	21.3-27.3				2.05	2.24
	30.3-36.3				2.15	2.32
T120	12.3-18.3	1.70	1.00	0.70	2.05	3.35
	21.3-27.3				2.15	3.45
	30.3-36.3				2.20	3.50
T180	12.3-18.3	1.95	1.10	0.85	2.20	4.69
	21.3-27.3				2.35	4.87
	30.3-36.3				2.40	4.93
T280	12.3-18.3	2.35	1.20	1.15	2.35	7.13
	21.3-27.3				2.45	7.28
	30.3-36.3				2.50	7.35

T Series

Working Loads by Conductor and Earth Wire (Kg.)

The stress is calculated applying at the same time the following loads at the ends of crossarms and earth wire peak:

Horizontal + Wind

750 Kg. by conductor
300 Kg. by earth wire

Longitudinal without wind

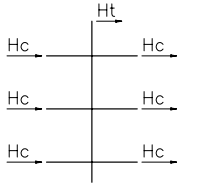
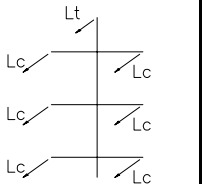
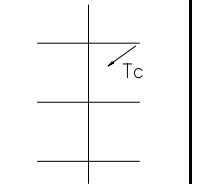
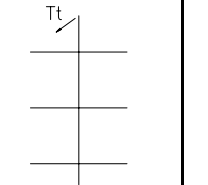
1300 Kg. by conductor
750 Kg. by earth wire

Broken conductor

1300 Kg. by conductor
750 Kg. by earth wire

Broken earth wire

1300 Kg. by conductor
750 Kg. by earth wire

		Horizontal+wind CS:1.5			Longitudinal w.o. wind CS:1.5			Broken conductor CS:1.2			Broken earth wire CS:1.2					
Tower Type																
			D3	D4	D5		D3	D4	D5		D3	D4	D5		D3	D4
T35	Hc	530	510	420	Lc	530	510	420	Tc	3200	2500	2500	Tc	-	-	-
	Ht	370	360	300	Lt	370	360	300	Tt	-	-	-	Tt	2300	2300	2300
T50	Hc	770	730	670	Lc	770	730	670	Tc	3200	2500	2500	Tc	-	-	-
	Ht	540	510	470	Lt	540	510	470	Tt	-	-	-	Tt	2300	2300	2300
T70	Hc	1100	1020	950	Lc	1100	1020	950	Tc	3200	2500	2500	Tc	-	-	-
	Ht	770	720	660	Lt	770	720	660	Tt	-	-	-	Tt	2300	2300	2300
T120	Hc	1830	1750	1630	Lc	1830	1750	1630	Tc	6350	5000	5000	Tc	-	-	-
	Ht	1280	1220	1140	Lt	1280	1220	1140	Tt	-	-	-	Tt	2300	2300	2300
T180	Hc	2750	2620	2470	Lc	2750	2620	2470	Tc	6350	5000	5000	Tc	-	-	-
	Ht	1930	1840	1730	Lt	1930	1840	1730	Tt	-	-	-	Tt	2300	2300	2300
T280	Hc	4210	4070	3850	Lc	4210	4070	3850	Tc	7600	6000	6000	Tc	-	-	-
	Ht	2950	2850	2700	Lt	2950	2850	2700	Tt	-	-	-	Tt	2300	2300	2300

T Series

Nomenclature

We use for the nomenclature of the towers the following parts:

1. Tower Type (T35, T50, etc.)
Figures represent the maximum capacity of the tower
2. Type of crossarm configuration (D3, D4, D5, etc.)
3. Tower Height (12.3, 15.3, etc..)

Example: a tower of this series with an useful load EHV of 5000 Kg., a double circuit crossarm of 4.4 m. of distance between phases with crossarms of 4.1 m. length referred to the tower axis and an useful height (HU) of 21.3 m. would be named:

T50-D4-21.3