Standard Ct and Power Curve, Rev 0, Modes AM 0 - AM-6, N1 - N7

SG 6.2-170

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1. Standard Power Curve, Application Modes AM 0 – AM-6, Noise Reduction System ® Modes N1 – N7

Air density= [1.06, 1.27] kg/m^3

Validity range:

Wind Shear (10min average)	≤ 0.3
Turbulence intensity TI [%] for bin i	$5\%\frac{(0.75\mathrm{v_i}+5.6)}{\mathrm{v_i}} < \mathrm{TI_i} < 12\%\frac{(0.75\mathrm{v_i}+5.6)}{\mathrm{v_i}}$
Terrain	Not complex according to IEC 61400-12-1
Upflow β [°]	-2° ≤ β ≤ +2°
Grid frequency [Hz]	± 0.5 Hz

Other considerations: Clean rotor blades, substantially horizontal, undisturbed air flow, turbine operated within nominal limits according to the Electrical Specification.

Next table shows the electrical power as a function of wind speed in hub height, averaged in ten minutes, for air density = 1.225 kg/m^3. The power curve does not include losses in the transformer and high voltage cables.

For a detailed description of Application Modes and Noise Reduction System ® Modes, please refer to latest version of Flexible Rating Specification (D2316244).

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SG 6.2-170 Application Modes (AM) Power curves [kW]							
Ws hub [m/s]	Application mode						
	AM 0	AM-1	AM-2	AM-3	AM-4	AM-5	AM-6
3.0	89	89	89	89	89	89	89
3.5	178	178	178	178	178	178	178
4.0	328	328	328	328	328	328	328
4.5	522	522	522	522	522	522	522
5.0	758	758	758	758	758	758	758
5.5	1040	1040	1040	1040	1040	1040	1040
6.0	1376	1376	1376	1376	1376	1376	1376
6.5	1771	1771	1771	1771	1771	1771	1771
7.0	2230	2230	2230	2230	2230	2230	2230
7.5	2758	2758	2758	2758	2758	2758	2757
8.0	3351	3351	3350	3349	3348	3346	3344
8.5	3988	3985	3980	3975	3969	3962	3953
9.0	4617	4605	4590	4574	4556	4536	4512
9.5	5166	5138	5107	5072	5035	4996	4952
10.0	5584	5536	5485	5430	5373	5313	5249
10.5	5862	5796	5726	5654	5580	5504	5425
11.0	6028	5947	5864	5780	5694	5607	5518
11.5	6117	6027	5936	5844	5751	5658	5563
12.0	6161	6067	5971	5875	5779	5682	5584
12.5	6183	6085	5987	5889	5791	5692	5593
13.0	6192	6093	5994	5895	5796	5697	5597
13.5	6197	6097	5998	5898	5798	5699	5599
14.0	6199	6099	5999	5899	5799	5699	5599
14.5	6199	6099	6000	5900	5800	5700	5600
15.0	6200	6100	6000	5900	5800	5700	5600
15.5	6200	6100	6000	5900	5800	5700	5600
16.0	6200	6100	6000	5900	5800	5700	5600
16.5	6200	6100	6000	5900	5800	5700	5600
17.0	6200	6100	6000	5900	5800	5700	5600
17.5	6200	6100	6000	5900	5800	5700	5600
18.0	6200	6100	6000	5900	5800	5700	5600
18.5	6200	6100	6000	5900	5800	5700	5600
19.0	6200	6100	6000	5900	5800	5700	5600
19.5	6200	6100	6000	5900	5800	5700	5600
20.0	6200	6100	6000	5900	5800	5700	5600
20.5	6080	6080	6000	5900	5800	5700	5600
21.0	5956	5956	5956	5900	5800	5700	5600
21.5	5832	5832	5832	5832	5800	5700	5600
22.0	5708	5708	5708	5708	5708	5700	5600
22.5	5584	5584	5584	5584	5584	5584	5584
23.0	5460	5460	5460	5460	5460	5460	5460
23.5	5336	5336	5336	5336	5336	5336	5336
24.0	5212	5212	5212	5212	5212	5212	5212
24.5	5088	5088	5088	5088	5088	5088	5088
25.0	4964	4964	4964	4964	4964	4964	4964

SG 6.2-170 Noise Reduction System Modes ® (NRS) Power curves [kW]								
Ws hub [m/s]	Noise Reduction System ® Mode							
	AM 0	N1	N2	N3	N4	N5	N6	N7
3.0	89	89	89	88	89	89	89	89
3.5	178	176	176	175	176	176	176	176
4.0	328	325	325	325	325	325	325	325
4.5	522	520	520	519	520	520	520	520
5.0	758	756	756	756	756	756	756	756
5.5	1040	1039	1038	1038	1038	1038	1038	1038
6.0	1376	1375	1373	1373	1373	1373	1372	1369
6.5	1771	1772	1768	1768	1768	1764	1754	1740
7.0	2230	2232	2227	2222	2218	2202	2167	2125
7.5	2758	2760	2749	2722	2708	2660	2582	2494
8.0	3351	3350	3316	3238	3207	3109	2976	2817
8.5	3988	3976	3893	3733	3677	3519	3328	3073
9.0	4617	4582	4430	4171	4087	3871	3629	3260
9.5	5166	5097	4884	4528	4417	4160	3876	3384
10.0	5584	5476	5231	4795	4665	4385	4073	3463
10.5	5862	5720	5470	4979	4840	4553	4224	3514
11.0	6028	5861	5621	5096	4955	4673	4335	3547
11.5	6117	5934	5708	5164	5028	4753	4410	3568
12.0	6161	5970	5754	5202	5070	4804	4458	3582
12.5	6183	5987	5778	5221	5094	4834	4487	3590
13.0	6192	5994	5790	5231	5107	4851	4503	3595
13.5	6197	5998	5795	5236	5114	4861	4511	3597
14.0	6199	5999	5798	5238	5117	4865	4516	3599
14.5	6199	6000	5799	5239	5119	4868	4518	3599
15.0	6200	6000	5800	5240	5119	4869	4519	3600
15.5	6200	6000	5800	5240	5120	4869	4520	3600
16.0	6200	6000	5800	5240	5120	4870	4520	3600
16.5	6200	6000	5800	5240	5120	4870	4520	3600
17.0	6200	6000	5800	5240	5120	4870	4520	3600
17.5	6200	6000	5800	5240	5120	4870	4520	3600
18.0	6200	6000	5800	5240	5120	4870	4520	3600
18.5	6200	6000	5800	5240	5120	4870	4520	3600
19.0	6200	6000	5800	5240	5120	4870	4520	3600
19.5	6200	6000	5800	5240	5120	4870	4520	3600
20.0	6200	6000	5800	5240	5120	4870	4520	3600
20.5	6080	5898	5721	5208	5105	4870	4520	3600
21.0	5956	5788	5637	5172	5081	4870	4520	3600
21.5	5832	5678	5553	5137	5057	4870	4520	3600
22.0	5708	5568	5469	5101	5033	4870	4520	3600
22.5	5584	5458	5385	5066	5009	4870	4520	3600
23.0	5460	5348	5301	5030	4985	4870	4520	3600
23.5	5336	5237	5217	4995	4961	4870	4520	3600
24.0	5212	5128	5134	4959	4936	4870	4520	3600
24.5	5088	5017	5051	4924	4912	4870	4520	3600
25.0	4964	4907	4967	4888	4888	4870	4520	3600

The annual energy production data for different annual mean wind speeds in hub height are calculated from the above power curve assuming a Weibull wind speed distribution with a K-factor of 2.0, 100 percent availability, and no reductions due to array losses, grid losses, or other external factors affecting the production.

AEP [MWh]		Annual Average Wind Speed [m/s] at Hub Height										
		5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
Application Modes	AM 0	11514	14363	17198	19937	22528	24939	27150	29151	30937	32503	33853
	AM-1	11474	14296	17098	19801	22355	24728	26904	28872	30627	32168	33496
	AM-2	11431	14226	16995	19661	22177	24512	26651	28585	30310	31825	33130
	AM-3	11387	14153	16888	19518	21994	24291	26392	28292	29986	31473	32755
	AM-4	11341	14078	16778	19370	21807	24065	26129	27993	29656	31115	32372
	AM-5	11293	14000	16666	19219	21617	23834	25860	27689	29319	30750	31982
	AM-6	11242	13919	16548	19063	21420	23598	25585	27378	28975	30376	31583

AEP [MWh]		Annual Average Wind Speed [m/s] at Hub Height										
		5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
Noise Reduction System ® Modes	AM 0	11514	14363	17198	19937	22528	24939	27150	29151	30937	32503	33853
	N1	11420	14213	16981	19646	22160	24492	26628	28557	30276	31783	33079
	N2	11215	13913	16580	19144	21560	23802	25855	27711	29366	30819	32070
	N3	10813	13308	15747	18074	20252	22262	24097	25750	27223	28514	29626
	N4	10692	13131	15512	17779	19900	21857	23641	25251	26685	27943	29027
	N5	10396	12712	14965	17105	19105	20949	22632	24151	25505	26696	27723
	N6	10026	12190	14283	16263	18107	19803	21347	22738	23977	25064	26000
	N7	9379	11228	12969	14577	16044	17369	18556	19610	20536	21338	22019

Annual Production [MWh] SG 6.2-170 Rev 0, wind turbine for the standard version, as a function of the annual mean wind speed at hub height, and for Weibull parameter k=2. Air Density 1.225kg/m^3

2. Standard Ct Curve, Application Modes AM 0 – AM-6, Noise Reduction System ® Modes N1 – N7

Air density= [1.06, 1.27] kg/m^3

Validity range:

Wind Shear (10min average)	≤ 0.3
Turbulence intensity TI [%] for bin i	$5\% \frac{(0.75\mathrm{v_i}+5.6)}{\mathrm{v_i}} < \mathrm{TI_i} < 12\% \frac{(0.75\mathrm{v_i}+5.6)}{\mathrm{v_i}}$
Terrain	Not complex according to IEC 61400-12-1
Upflow β [°]	-2° ≤ β ≤ +2°
Grid frequency [Hz]	± 0.5 Hz

Other considerations: Clean rotor blades, substantially horizontal, undisturbed air flow, turbine operated within nominal limits according to the Electrical Specification.

The thrust coefficient Ct is used for the calculation of the wind speed deficit in the wake of a wind turbine.

Ct is defined by the following expression:

Ct = F / (0.5 * ad * w2 * A)

where

F = Rotor force [N]

ad = Air density [kg/m3]

w = Wind speed [m/s]

A = Swept area of rotor [m^2]

For a detailed description of Application Modes and Noise Reduction System ® Modes, please refer to latest version of Flexible Rating Specification (D2316244).

SG 6.2-170 Application Modes (AM) Ct curves [-]							
Ws hub [m/s]	Application Mode						
	AM 0	AM-1	AM-2	AM-3	AM-4	AM-5	AM-6
3.0	0.953	0.953	0.953	0.953	0.953	0.953	0.953
3.5	0.880	0.880	0.880	0.880	0.880	0.880	0.880
4.0	0.847	0.847	0.847	0.847	0.847	0.847	0.847
4.5	0.828	0.828	0.828	0.828	0.828	0.828	0.828
5.0	0.824	0.824	0.824	0.824	0.824	0.824	0.824
5.5	0.828	0.828	0.828	0.828	0.828	0.828	0.828
6.0	0.833	0.833	0.833	0.833	0.833	0.833	0.833
6.5	0.836	0.836	0.836	0.836	0.836	0.836	0.836
7.0	0.837	0.837	0.837	0.837	0.837	0.837	0.837
7.5	0.835	0.835	0.835	0.835	0.835	0.835	0.835
8.0	0.825	0.825	0.825	0.824	0.824	0.824	0.823
8.5	0.802	0.801	0.800	0.799	0.797	0.795	0.793
9.0	0.759	0.757	0.754	0.751	0.747	0.743	0.737
9.5	0.696	0.692	0.687	0.681	0.675	0.668	0.660
10.0	0.620	0.614	0.607	0.599	0.591	0.583	0.574
10.5	0.541	0.533	0.525	0.517	0.509	0.500	0.491
11.0	0.466	0.459	0.451	0.443	0.436	0.428	0.419
11.5	0.402	0.395	0.388	0.381	0.374	0.367	0.359
12.0	0.347	0.341	0.335	0.329	0.323	0.317	0.311
12.5	0.303	0.297	0.292	0.287	0.282	0.276	0.271
13.0	0.266	0.261	0.256	0.252	0.247	0.243	0.238
13.5	0.235	0.231	0.227	0.223	0.219	0.215	0.211
14.0	0.209	0.206	0.202	0.199	0.195	0.192	0.189
14.5	0.187	0.184	0.181	0.178	0.175	0.172	0.169
15.0	0.169	0.166	0.163	0.161	0.158	0.155	0.153
15.5	0.153	0.150	0.148	0.145	0.143	0.141	0.138
16.0	0.139	0.137	0.135	0.132	0.130	0.128	0.126
16.5	0.127	0.125	0.123	0.121	0.119	0.117	0.115
17.0	0.117	0.115	0.113	0.111	0.109	0.108	0.106
17.5	0.108	0.106	0.104	0.103	0.101	0.100	0.098
18.0	0.100	0.098	0.097	0.095	0.094	0.092	0.091
18.5	0.093	0.092	0.090	0.089	0.088	0.086	0.085
19.0	0.087	0.086	0.085	0.083	0.082	0.081	0.079
19.5	0.082	0.081	0.080	0.078	0.077	0.076	0.075
20.0	0.077	0.076	0.075	0.074	0.073	0.072	0.070
20.5	0.066	0.066	0.065	0.064	0.063	0.062	0.061
21.0	0.060	0.060	0.060	0.060	0.059	0.058	0.057
21.5	0.055	0.055	0.055	0.055	0.055	0.054	0.053
22.0	0.051	0.051	0.051	0.051	0.051	0.051	0.050
22.5	0.047	0.047	0.047	0.047	0.047	0.047	0.047
23.0	0.043	0.043	0.043	0.043	0.043	0.043	0.043
23.5	0.040	0.040	0.040	0.040	0.040	0.040	0.040
24.0	0.037	0.037	0.037	0.037	0.037	0.037	0.037
24.5	0.034	0.034	0.034	0.034	0.034	0.034	0.034
25.0	0.032	0.032	0.032	0.032	0.032	0.032	0.032

SG 6.2-170 Noise Reduction System Modes ® (NRS) Ct curves [-]								
Ws hub [m/s]	Noise Reduction System ® Mode							
	AM 0	N1	N2	N3	N4	N5	N6	N7
3.0	0.953	0.914	0.953	0.963	0.953	0.953	0.953	0.953
3.5	0.880	0.859	0.880	0.886	0.880	0.880	0.880	0.880
4.0	0.847	0.841	0.847	0.850	0.847	0.847	0.847	0.847
4.5	0.828	0.830	0.828	0.829	0.828	0.828	0.828	0.828
5.0	0.824	0.821	0.824	0.824	0.824	0.824	0.824	0.824
5.5	0.828	0.816	0.828	0.828	0.828	0.828	0.827	0.825
6.0	0.833	0.814	0.833	0.833	0.832	0.830	0.824	0.815
6.5	0.836	0.813	0.836	0.833	0.830	0.822	0.803	0.784
7.0	0.837	0.813	0.835	0.822	0.815	0.795	0.762	0.732
7.5	0.835	0.811	0.825	0.795	0.782	0.750	0.706	0.666
8.0	0.825	0.803	0.799	0.750	0.734	0.691	0.641	0.593
8.5	0.802	0.783	0.754	0.691	0.674	0.626	0.575	0.519
9.0	0.759	0.742	0.694	0.625	0.606	0.559	0.510	0.448
9.5	0.696	0.679	0.625	0.556	0.538	0.494	0.451	0.385
10.0	0.620	0.602	0.553	0.489	0.472	0.434	0.396	0.330
10.5	0.541	0.523	0.484	0.427	0.412	0.381	0.348	0.285
11.0	0.466	0.450	0.420	0.371	0.359	0.334	0.306	0.247
11.5	0.402	0.387	0.365	0.323	0.313	0.293	0.270	0.215
12.0	0.347	0.334	0.318	0.283	0.274	0.258	0.238	0.189
12.5	0.303	0.291	0.278	0.248	0.241	0.228	0.210	0.167
13.0	0.266	0.256	0.245	0.219	0.213	0.202	0.186	0.148
13.5	0.235	0.227	0.217	0.195	0.190	0.180	0.166	0.132
14.0	0.209	0.202	0.194	0.174	0.170	0.161	0.149	0.119
14.5	0.187	0.181	0.174	0.156	0.152	0.145	0.134	0.107
15.0	0.169	0.163	0.157	0.141	0.138	0.131	0.121	0.097
15.5	0.153	0.148	0.142	0.128	0.125	0.118	0.110	0.088
16.0	0.139	0.134	0.129	0.116	0.114	0.108	0.100	0.081
16.5	0.127	0.123	0.118	0.106	0.104	0.099	0.092	0.074
17.0	0.117	0.113	0.109	0.098	0.096	0.091	0.084	0.068
17.5	0.108	0.104	0.100	0.091	0.088	0.084	0.078	0.063
18.0	0.100	0.097	0.093	0.084	0.082	0.078	0.073	0.059
18.5	0.093	0.090	0.087	0.078	0.077	0.073	0.068	0.055
19.0	0.087	0.084	0.081	0.073	0.072	0.068	0.064	0.052
19.5	0.082	0.079	0.076	0.069	0.068	0.064	0.060	0.049
20.0	0.077	0.075	0.072	0.065	0.064	0.061	0.056	0.046
20.5	0.066	0.064	0.062	0.056	0.055	0.053	0.049	0.040
21.0	0.060	0.059	0.057	0.052	0.052	0.049	0.046	0.038
21.5	0.055	0.054	0.053	0.049	0.048	0.046	0.043	0.036
22.0	0.051	0.050	0.049	0.046	0.045	0.044	0.041	0.034
22.5	0.047	0.046	0.045	0.043	0.042	0.041	0.038	0.032
23.0	0.043	0.043	0.042	0.040	0.040	0.039	0.036	0.030
23.5	0.040	0.039	0.039	0.038	0.037	0.037	0.034	0.029
24.0	0.037	0.037	0.037	0.035	0.035	0.035	0.033	0.027
24.5	0.034	0.034	0.034	0.033	0.033	0.033	0.031	0.026
25.0	0.032	0.032	0.032	0.032	0.032	0.031	0.029	0.025

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Standard Ct and Power Curve, Rev. 0, Mode AM 0 – Air Density

SG 6.2-170

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1. Standard Power Curve, Application Mode - AM 0

Air density= [1.06, 1.27] kg/m^3

Validity range:

Wind Shear (10min average)	≤ 0.3
Turbulence intensity TI [%] for bin i	$5\% \frac{(0.75v_i + 5.6)}{v_i} < TI_i < 12\% \frac{(0.75v_i + 5.6)}{v_i}$
Terrain	Not complex according to IEC 61400-12-1
Upflow β [°]	-2° ≤ β ≤ +2°
Grid frequency [Hz]	± 0.5 Hz

Other considerations: Clean rotor blades, substantially horizontal, undisturbed air flow, turbine operated within nominal limits according to the Electrical Specification.

Next table shows the electrical power as a function of wind speed in hub height, averaged in ten minutes, for air density range = [1.06, 1.27] kg/m^3. The power curve does not include losses in the transformer and high voltage cables.

For a detailed description of Application Mode – AM 0, please refer to latest version of Flexible Rating Specification (D2316244).

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SG 6.2-170 Mode AM 0 Power curves [kW]									
Ws hub [m/s]	Air density [kg/m³]								
	1.225	1.06	1.09	1.12	1.15	1.18	1.21	1.24	1.27
3.0	89	75	77	80	82	85	88	90	93
3.5	178	145	151	157	163	169	175	181	187
4.0	328	272	282	292	302	312	323	333	343
4.5	522	439	454	470	485	500	515	530	545
5.0	758	644	665	686	706	727	748	769	789
5.5	1040	888	916	944	971	999	1027	1054	1082
6.0	1376	1179	1215	1250	1286	1322	1358	1394	1430
6.5	1771	1521	1566	1612	1657	1703	1748	1794	1839
7.0	2230	1919	1976	2032	2089	2146	2202	2259	2315
7.5	2758	2377	2446	2516	2585	2654	2723	2793	2862
8.0	3351	2893	2977	3060	3144	3227	3310	3392	3474
8.5	3988	3455	3553	3652	3749	3846	3941	4035	4127
9.0	4617	4033	4145	4255	4363	4467	4568	4664	4756
9.5	5166	4586	4706	4820	4928	5029	5122	5208	5288
10.0	5584	5074	5191	5296	5390	5475	5549	5616	5675
10.5	5862	5466	5567	5652	5725	5786	5839	5884	5922
11.0	6028	5753	5830	5891	5940	5981	6013	6040	6063
11.5	6117	5944	5997	6036	6067	6090	6109	6124	6136
12.0	6161	6061	6094	6117	6135	6148	6157	6165	6171
12.5	6183	6128	6147	6160	6169	6176	6181	6184	6187
13.0	6192	6164	6174	6181	6186	6189	6191	6193	6194
13.5	6197	6182	6188	6191	6194	6195	6196	6197	6198
14.0	6199	6192	6194	6196	6197	6198	6198	6199	6199
14.5	6199	6196	6197	6198	6199	6199	6199	6199	6200
15.0	6200	6198	6199	6199	6199	6200	6200	6200	6200
15.5	6200	6199	6199	6200	6200	6200	6200	6200	6200
16.0	6200	6200	6200	6200	6200	6200	6200	6200	6200
16.5	6200	6200	6200	6200	6200	6200	6200	6200	6200
17.0	6200	6200	6200	6200	6200	6200	6200	6200	6200
17.5	6200	6200	6200	6200	6200	6200	6200	6200	6200
18.0	6200	6200	6200	6200	6200	6200	6200	6200	6200
18.5	6200	6200	6200	6200	6200	6200	6200	6200	6200
19.0	6200	6200	6200	6200	6200	6200	6200	6200	6200
19.5	6200	6200	6200	6200	6200	6200	6200	6200	6200
20.0	6200	6200	6200	6200	6200	6200	6200	6200	6200
20.5	6080	6080	6080	6080	6080	6080	6080	6080	6080
21.0	5956	5956	5956	5956	5956	5956	5956	5956	5956
21.5	5832	5832	5832	5832	5832	5832	5832	5832	5832
22.0	5708	5708	5708	5708	5708	5708	5708	5708	5708
22.5	5584	5584	5584	5584	5584	5584	5584	5584	5584
23.0	5460	5460	5460	5460	5460	5460	5460	5460	5460
23.5	5336	5336	5336	5336	5336	5336	5336	5336	5336
24.0	5212	5212	5212	5212	5212	5212	5212	5212	5212
24.5	5088	5088	5088	5088	5088	5088	5088	5088	5088
25.0	4964	4964	4964	4964	4964	4964	4964	4964	4964

The annual energy production data for different annual mean wind speeds in hub height are calculated from the above power curve assuming a Weibull wind speed distribution with a K-factor of 2.0, 100 percent availability, and no reductions due to array losses, grid losses, or other external factors affecting the production.

AEP [MWh]		Annual Average Wind Speed [m/s] at Hub Height										
		5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
Density [kg/m³]	1.225	11514	14363	17198	19937	22528	24939	27150	29151	30937	32503	33853
	1.06	10152	12804	15493	18136	20675	23069	25292	27325	29156	30780	32191
	1.09	10413	13107	15829	18495	21049	23449	25673	27702	29526	31139	32540
	1.12	10667	13401	16151	18838	21403	23808	26030	28054	29871	31474	32862
	1.15	10916	13685	16463	19167	21741	24149	26369	28387	30195	31788	33165
	1.18	11159	13962	16763	19483	22065	24475	26692	28704	30503	32085	33451
	1.21	11397	14231	17055	19788	22376	24787	27000	29005	30795	32367	33722
	1.24	11630	14493	17338	20083	22676	25086	27295	29293	31074	32635	33979
	1.27	11859	14750	17613	20368	22966	25375	27580	29570	31341	32893	34225

Annual Production [MWh] SG 6.2-170 Rev 0, Mode AM 0 wind turbine for the standard version, as a function of the annual mean wind speed at hub height, and for Weibull parameter k=0.

2. Standard Ct Curve, Application Mode - AM 0

Air density= [1.06, 1.27] kg/m^3

Validity range:

Wind Shear (10min average)	≤ 0.3
Turbulence intensity TI [%] for bin i	$5\%\frac{(0.75v_i + 5.6)}{v_i} < TI_i < 12\%\frac{(0.75v_i + 5.6)}{v_i}$
Terrain	Not complex according to IEC 61400-12-1
Upflow β [°]	-2° ≤ β ≤ +2°
Grid frequency [Hz]	± 0.5 Hz

Other considerations: Clean rotor blades, substantially horizontal, undisturbed air flow, turbine operated within nominal limits according to the Electrical Specification.

The thrust coefficient Ct is used for the calculation of the wind speed deficit in the wake of a wind turbine.

Ct is defined by the following expression:

Ct = F / (0.5 * ad * w2 * A)

where

F = Rotor force [N]

ad = Air density [kg/m3]

w = Wind speed [m/s]

A = Swept area of rotor [m^2]

For a detailed description of Application Mode - AM 0, please refer to latest version of Flexible Rating Specification (D2316244).

SG 6.2-170 Mode AM 0 ct curves [-]									
Ws hub [m/s]	Air density [kg/m^3]								
	1.225	1.06	1.09	1.12	1.15	1.18	1.21	1.24	1.27
3.0	0.953	0.953	0.953	0.953	0.953	0.953	0.953	0.953	0.953
3.5	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880	0.880
4.0	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847
4.5	0.828	0.828	0.828	0.828	0.828	0.828	0.828	0.828	0.828
5.0	0.824	0.824	0.824	0.824	0.824	0.824	0.824	0.824	0.824
5.5	0.828	0.828	0.828	0.828	0.828	0.828	0.828	0.828	0.828
6.0	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833
6.5	0.836	0.836	0.836	0.836	0.836	0.836	0.836	0.836	0.836
7.0	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837
7.5	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835
8.0	0.825	0.825	0.825	0.825	0.825	0.825	0.825	0.825	0.825
8.5	0.802	0.804	0.804	0.804	0.803	0.803	0.802	0.801	0.800
9.0	0.759	0.767	0.767	0.766	0.765	0.763	0.761	0.757	0.753
9.5	0.696	0.716	0.715	0.712	0.709	0.705	0.699	0.693	0.686
10.0	0.620	0.654	0.651	0.646	0.640	0.633	0.625	0.615	0.605
10.5	0.541	0.588	0.582	0.575	0.566	0.556	0.546	0.535	0.524
11.0	0.466	0.521	0.513	0.503	0.493	0.483	0.472	0.461	0.450
11.5	0.402	0.458	0.448	0.438	0.428	0.417	0.407	0.396	0.386
12.0	0.347	0.401	0.391	0.381	0.371	0.361	0.352	0.343	0.334
12.5	0.303	0.351	0.342	0.333	0.324	0.315	0.307	0.299	0.291
13.0	0.266	0.309	0.300	0.292	0.284	0.276	0.269	0.262	0.256
13.5	0.235	0.273	0.265	0.258	0.251	0.244	0.238	0.232	0.226
14.0	0.209	0.243	0.236	0.229	0.223	0.217	0.212	0.207	0.202
14.5	0.187	0.217	0.211	0.205	0.200	0.195	0.190	0.185	0.181
15.0	0.169	0.195	0.190	0.185	0.180	0.175	0.171	0.167	0.163
15.5	0.153	0.176	0.171	0.167	0.163	0.158	0.155	0.151	0.147
16.0	0.139	0.160	0.156	0.152	0.148	0.144	0.141	0.137	0.134
16.5	0.127	0.146	0.142	0.138	0.135	0.132	0.128	0.125	0.123
17.0	0.117	0.134	0.130	0.127	0.124	0.121	0.118	0.115	0.113
17.5	0.108	0.124	0.120	0.117	0.114	0.112	0.109	0.106	0.104
18.0	0.100	0.115	0.112	0.109	0.106	0.104	0.101	0.099	0.097
18.5	0.093	0.107	0.104	0.101	0.099	0.096	0.094	0.092	0.090
19.0	0.087	0.100	0.097	0.095	0.093	0.090	0.088	0.086	0.084
19.5	0.082	0.094	0.091	0.089	0.087	0.085	0.083	0.081	0.079
20.0	0.077	0.088	0.086	0.084	0.082	0.080	0.078	0.076	0.075
20.5	0.066	0.075	0.073	0.071	0.069	0.068	0.066	0.065	0.064
21.0	0.060	0.068	0.067	0.065	0.064	0.062	0.061	0.060	0.058
21.5	0.055	0.063	0.061	0.060	0.058	0.057	0.056	0.055	0.054
22.0	0.051	0.058	0.056	0.055	0.054	0.053	0.051	0.050	0.049
22.5	0.047	0.053	0.052	0.051	0.050	0.048	0.047	0.046	0.046
23.0	0.043	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042
23.5	0.040	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.039

24.0	0.037	0.042	0.041	0.040	0.039	0.038	0.037	0.037	0.036
24.5	0.034	0.039	0.038	0.037	0.036	0.035	0.035	0.034	0.033
25.0	0.032	0.036	0.035	0.034	0.034	0.033	0.032	0.032	0.031

SIEMENS Gamesa
RENEWABLE ENERGY

Generic Site Roads and Hardstands requirements

SG 6.2-170

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1. Aim and scope

The aim of this specification is to describe the minimum geometrical requirements of the roads and platforms required for a safe component transportation and assembly of the wind turbines. Additionally, it includes the minimum deliverables that will be needed from SGRE to start with the transportation and erection works. The scope includes all W.F. with the following WTG models and erection strategies:

Tower	No. of tubular steel section	Power	Blade
T100	4	6.2	SG170
T101.5	6	6.2	
T115	5	6.2	
T135	6	6.2	
T145	8	6.2	
T155	8	6.2	
T165MB	2	6.2	

Table 1 WTG models

Tower	STG3	STG4 (SGRE Standard)
T100	✓	✓
T101.5	✓	✓
T115	✓	✓
T135	✓	✓
T145	✓	✓
T155	✓	✓
T165MB	✓	✓

Table 2 SGRE strategies

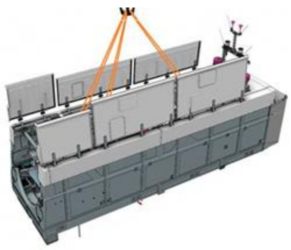
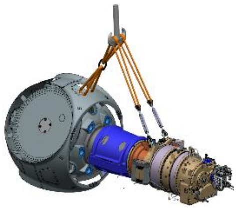
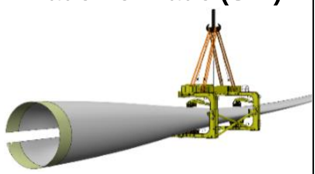
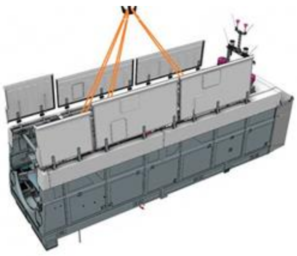
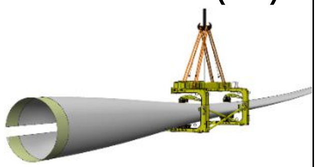
<table>
<tr><th>Strategy</th><th>Nacelle</th><th>DT</th><th>Hub</th><th>Blade</th></tr>
<tr><td>Strategy 3</td><td>Modular
</td><td colspan="2">DT/Hub
</td><td>Blade To Blade (SBI)
</td></tr>
<tr><td>Strategy 4</td><td>Modular
</td><td>DT
</td><td>Hub
</td><td>BladeTo Blade (SBI)
</td></tr>
</table>

Table 3 components of each strategy

Note:

This specification sets a guide to be followed for the design and construction of a wind farm civil engineering project. The project undertaken in accordance with this specification must be reviewed and approved by SGRE prior to execution. However, the civil designer is solely responsible for making sure that the design complies with this specification, the contract requirements and local norms and standards.

2. Definitions and acronyms

Acronyms	Definition
SGRE	Siemens Gamesa Renewable Energy
Main crane	Capable of lifting any component to the highest point of the wind turbine.
Pre-installation crane	Used for installing elements at the lower part of the tower.
Tailing crane	Supports the main and pre-installation crane for mounting and unloading components.
Mobile crane	Telescopic mobile crane
	Lattice boom mobile crane
NTC	Narrow-Track Crawler Crane
WTC	Wide-Track Crawler Crane
Intermediate hardstand	The work area for wind turbine assembly is parallel and close to the internal roads of the wind farm.
End-of-road hardstand	Work area for wind turbine assembly at the end of internal wind farm roads.
Wind farm access roads	These roads do not pass by asphalt roads and they are used to transport components and disassembled cranes.
Wind farm internal roads	Roads that pass between wind turbines for the transportation of components and with the capacity for transporting cranes.
SP	Standard Proctor
MP	Modified Proctor
WTG	Wind Turbine Generator

Table 4 Acronyms and definitions

3. Description

3.1. Roads

3.1.1. Reference legislation

The legislation of the corresponding country on the design of civil engineering must be applied. If there is no such legislation, the legislation given as a reference in the annexes should be followed as a guide.

3.1.2. Design of the windfarm internal roads

In case there is no legislation for the road design the dimensioning of the road pavement should be based on the AASHTO method for roads with a low volume of traffic (Part 2, Chapter 4). This methodology is based on an empirical formula that relates the characteristics of the pavement layers with their performance, in order to determine whether the road pavement section will be capable of bearing the traffic loads to which it will be applied.

The design of the road and the geotechnical report will be provided to Siemens Gamesa together with the quality control of the roads during the handover of the civil works and before starting with the transportation and the erection process.

3.1.3. Road composition and structure

Wind farm access roads must support a **minimum load** of 12t per axle corresponding to the transportation of wind turbine elements and crane elements.

Internal wind farm roads must support a **minimum load** of:

- Without mounted crane movement:
  - 1.4 kg per cm² in the case of crawler cranes (NTC and WTC).
  - 22.5t per axle in the case of mobile cranes.
- With mounted crane movement:
  - 2.45 kg per cm² in the case of crawler cranes (NTC and WTC).
  - 22.5t per axle in the case of lattice boom mobile cranes.
  - 24.5t per axle in the case of telescopic mobile cranes.
  - 14.7t per axle in the case of pre-installation telescopic mobile cranes.

The dimensions of the roadbed must be in accordance with the number of WTGs at the wind farm, allowing for the number of transport vehicles per WTG.

Tests must be carried out on the material used for the subgrade and for the roadbed, in order to control the compaction of the different layers and ensure that the civil works are correctly executed. The quality control and the requirements for the civil works design is defined according to the ***5.3 Quality tests and requirements for civil works plan projects.***

With the trace material, once analyzed, suitable compaction means must be used to find a subgrade of enough elasticity modulus value. The elasticity module will be measured from the compressibility module of the second cycle of the loading plate test as per DIN 18134 (or in its absence, NLT-357), the acceptance criteria will be indicated in the road section design.

The dry density required after compaction for the different types of materials forming the roadbed is 98% of that obtained in the PM test or above.

Fill material will be compacted in layers to a maximum thickness of 30 cm to ensure the effectiveness of the machinery along the entire section.

Where expansive material (expansive clay, etc.) or loose soil conditions are indicated in the geotechnical report, the use of geosynthetics is strongly recommended (at least with the soil reinforcement and separation functions).

The elasticity module of the finished roadbed must be measured based on the compressibility module of the second cycle of the load plate test as per DIN 18134 (or in its absence, NLT-357), and the result must never be less than Ev2=80 MPa (*). Likewise, the relation between the first and second load cycle must be less than 3.

(*) In countries where the load plate is not usually used, use the following relationship to obtain the acceptance criteria for the roadbed built:

$$E = \frac{\pi \cdot (1 - v^2)}{3} \cdot Ev_2$$

- E: elasticity module
- v: Poisson's ratio
- Ev2: second plate loading test cycle compressibility module

Additionally, remember that the dry density required after compaction for the different types of materials forming the roadbed is 98% of that obtained in the MP test or above.

3.1.4. Road width

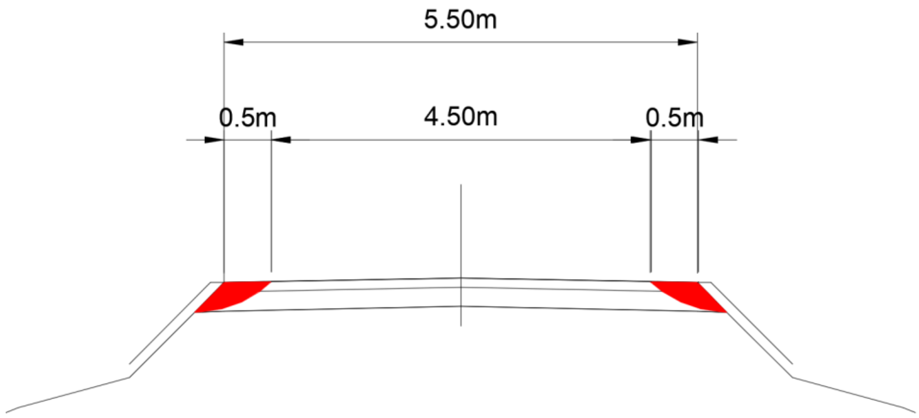
The road width will vary for curves according to the following section 3.1.5. Curve widening – General.

<table>
<tr><th colspan="2">Minimum road width</th></tr>
<tr><td>A. Wind farm access road transportation of components</td><td>As a minimum and usable 4.5m* + 2 x 0.50m free of obstacles.

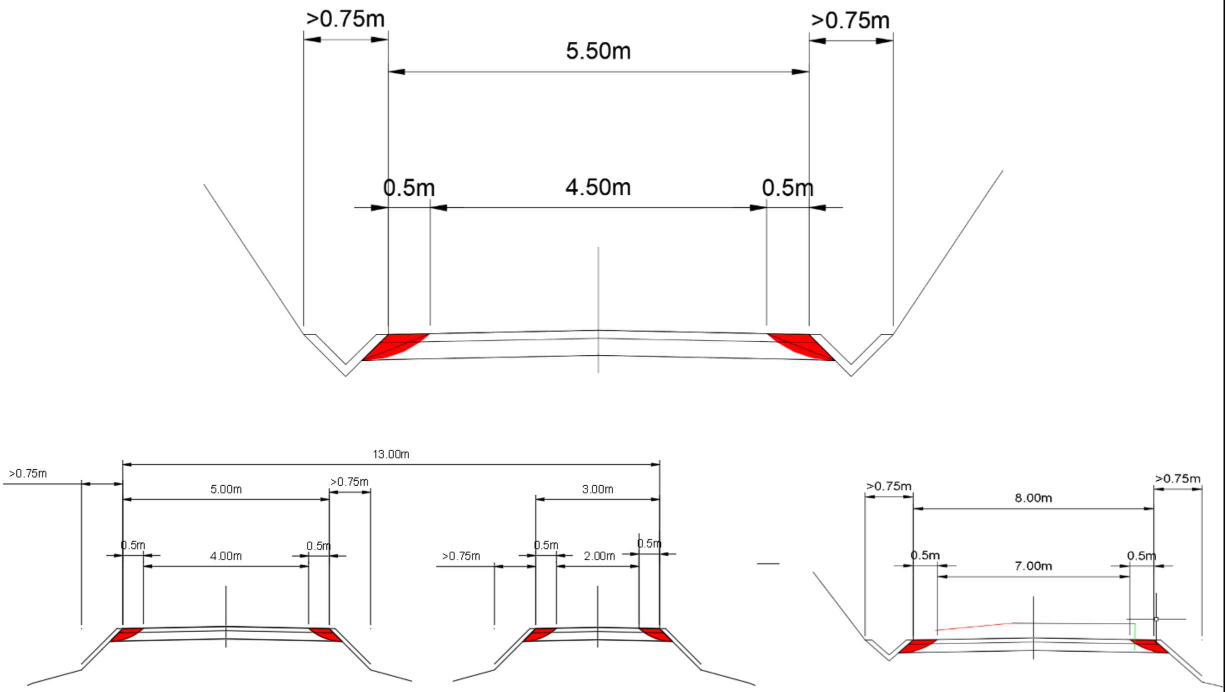
As a minimum and usable 5.5m + 2 x 0.5m free of obstacles in case of reverse driving.</td></tr>
<tr><td rowspan="3">B. Internal wind farm road with crane movement</td><td>Pneumatic Crane
As a minimum and usable 4.5m + 2 x 0.75m free of obstacles</td></tr>
<tr><td>WTC
• Usable 12 to 14m*
• 4m + 3m parallel tread (making 12 to 14 m)</td></tr>
<tr><td>NTC
As a minimum and usable 7m</td></tr>
<tr><td>C. Access road to the wind farm Transportation of components and Internal roads of the wind farm without crane movement. (Wind Farms in the United States)</td><td>As a minimum and usable 5m + 2 x 0.8m free of obstacles</td></tr>
<tr><td colspan="2">Note:
Usable m (meters) - Space capable of bearing the loads to which the road will be submitted without the risk of caving-in, sliding or sinking. Furthermore, the last 50cm prior to the curbs on these roads (not included in the usable meters) are not valid for withstanding weights, due to the danger of horizontal creep of the ground. Thus, the carrier transporting the nacelle and heavy haulers in general must never go beyond these limits under any circumstances whatsoever.
This table marks the minimum requirement for the road width as general.
They may vary considering the regions and specific conditions for each project.
*Width based on crane model</td></tr>
</table>

Table 5 Minimum road width in access and internal roads

A. Wind farm access road Transportation of components



B. Internal wind farm road with crane movement



C. Access road to the wind farm. Transportation of components and Internal wind farm road without circulation of cranes (e.g wind farms in the United States)

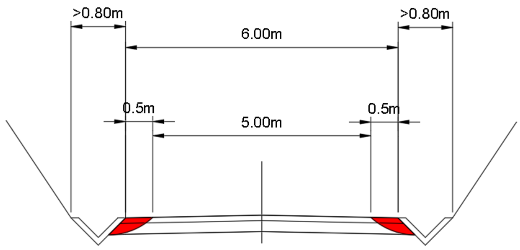


Figure 1 Minimum road width in access and internal roads

For curves with an interior cleared profile, the inside curb of the curve must be pipelined or have a maximum depth of 10 cm.

The slope of cutting on internal roads must be limited in accordance with the wind farm's geotechnical survey and determined by the crane being used for assembly. The most restrictive case is movement of NTC without dismounting.

3.1.5. Curve widening – General

The smaller the curve radius of the alignment curve, the greater the road width must be (difference between outside and inside radius) at the curve.

Blade transportation is considered a limiting element in the calculation of curve widening.

The following example table is completed for each model with these widths:

- A: Road width
- SAE: Exterior widening
- SAI: Interior widening

RADIUS - ANGLES			
	90º		
	A	SAe	SAi
R30	9	9,01	5,51
R35			
R40			

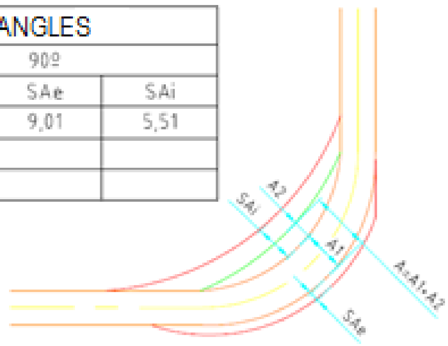


Figure 2 Curve widening

The conclusions of the study will be reflected in a table where:

- A: is the width of the road necessary for transport (A = A1 + A2)
- A1: represents the road width (at least 5 m at each point of trajectory = baseline), which may be increased depending on the width necessary for maneuvering the vehicle
- A2: Is the occupation of the vehicle when maneuvering cannot adjust to the A1 road width
- SAi: Is the maximum interior sweep of the vehicle or its cargo
- SAe: Is the maximum exterior sweep of the vehicle or its cargo
- R30: Represents the curve radius at the center of the road
- 90º: Represents the angle formed by two straight sections of road joined by a curve of a given radius

This study was make taking in to account an estimate vehicle (General vehicle). Later, each region will carry out a study of curve radius with its most restrictive vehicles. The general results analysis for turbine model is defined according to the ***5.2 Transport requirements.***

Besides, per each specific project, inner and outer widening for each curve along the route should be studied per transport simulation.

3.1.6. Gradients and grade changes

	Longitudinal Gradients (%)				Transversal Gradients (%)	
	Maximum		Minimums		Maximum	Minimum
	Straight section	Curved section	Straight section	Curved section	Straight/ curved section	
Wind farm access road and internal wind farm road	>10 and ≤13 without concreting if gradient < 200 m. (1) >10 and ≤13 improved concreting or paving if gradient > 200 m.(1) >13 and ≤15 improved concreting or paving + 6x6 tractor unit >15 need for towing study	Up to 7 without concreting (1) >7 and ≤10 improved concreting or paving (1) >10 need for towing study	0.50	0.50	2	0.20
Access and internal roads reverse driving	≤ 3 up to a max. of 1000 m without concreting. >3 and ≤5 max. 1000m improved concreting or paving	<2 up to max. 500 m without concreting. ≥2 and ≤3 max. 500 m improved concreting or paving	0.50	0.50	2	0.20

(1) SGRE standard values are ≤13 % for longitudinal gradients and <10 % for curved sections.
(2) Improved paving: Roadbed with friction coefficient of at least 0.35

Table 6 Gradients and grade changes

The transport vehicles used to transport various components of the turbine up to the site must be equipped with self-steering rear axles.

For gradients near 10% without concreting, 6 x 4 tractor units or four-wheel drive truck will be required.

In the specified cases in which road paving must be improved, the solution to be used and the envisaged friction coefficient must be submitted so that transport can be executed.

In the specified cases in which road paving must be improved, the technical characteristics of the solution to be used must be submitted, as well as the friction coefficient for the roadway layer envisaged for said solution, thereby ensuring that all components are transported correctly.

If the longitudinal gradient is >13% and ≤15%, improved concreting or paving will be required, and a 6 x 6 tractor unit used. This means that the slope will also have to be reviewed since it is not within SGRE standards.

In the extreme case that a longitudinal gradient in a straight section is >15% and/or is >10% in a curved section, a towing study must be conducted in addition to improving the road paving along the affected section. This study must be conducted by the logistics company in charge of supplying the wind farm with the wind turbine components.

Regarding to guarantee the proper transitions between gradient changes, the minimum straight-line total length of the convoy must be kept in mind. According to the complexity of the wind farm project, these points must be analyzed and discussed to find the proper solution.

Ltot: Total length of the convoy.

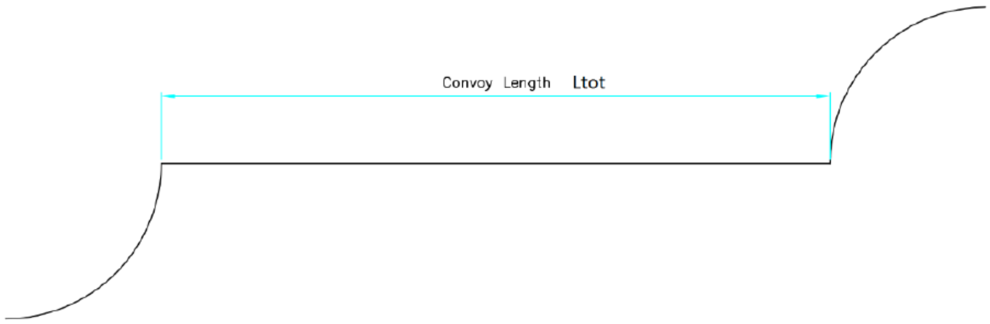


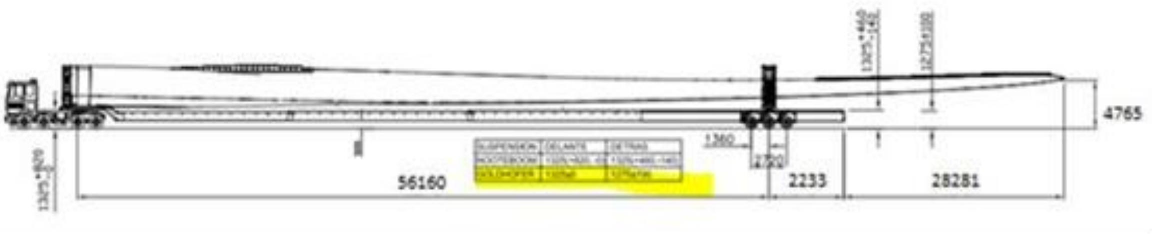
Figure 3 Transitions between gradient changes

For the calculation of the more restrictive KV that appears in this document, estimated generic vehicles have been considered. This does not mean that there are not others that improve or even worsen the KV figure. It is advisable to carry out a specific study in each region of the SGRE, with the vehicles planned to be used in local projects.

The kv value considered in the wind farm design for this WTG model shall be, **as a minimum:**

KV= 770m

With the information we have now, **the most restrictive transport would be the SG170 blade on dolly.** Bearing in mind that all the axles of the platform would be in contact with the ground. Considering that all the axles of the platform would be in contact with the ground and a rear overhang of 15,64m. Which of course will be different considering the restrictions of each country. The overhang may differ according to the restrictions of each country, which should be considered.



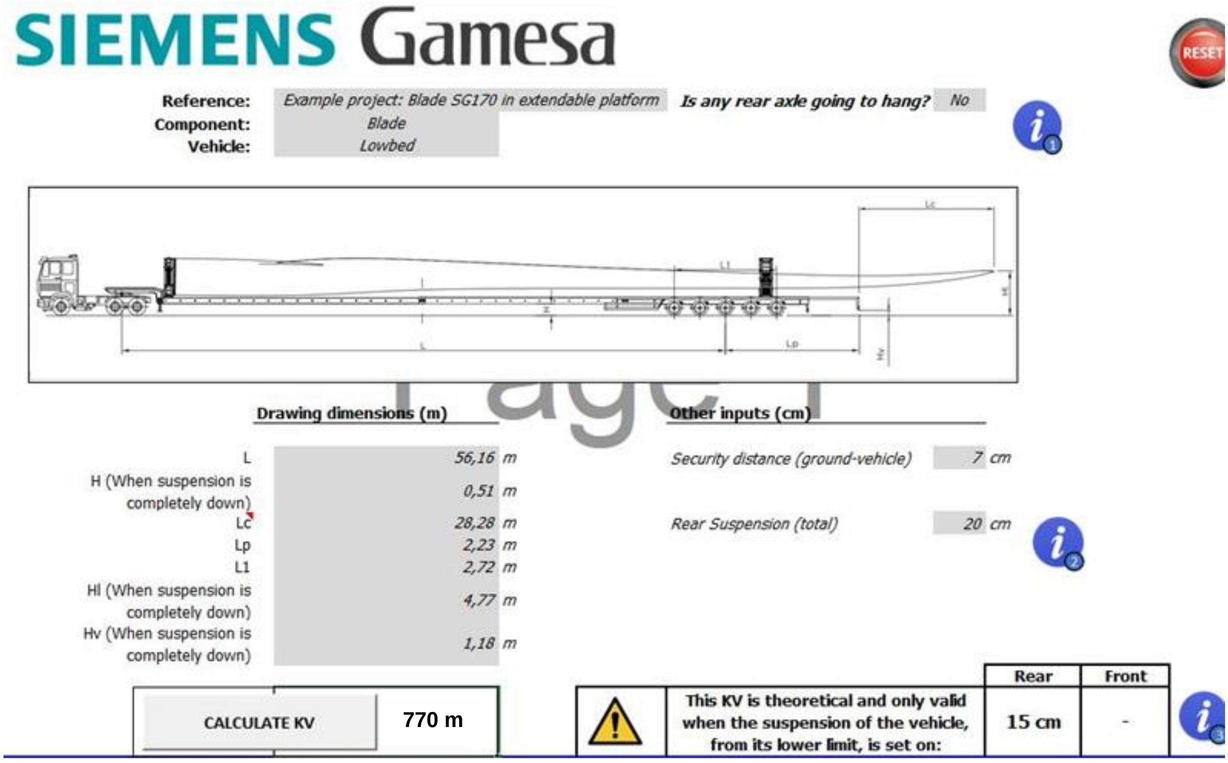


Figure 4 The most restrictive transport and its respective KV

The value above is for reference only. Depending on the complexity of the terrain, the KV value that minimizes LCoE (levelized cost of energy) might be higher (flat wind farm) or lower (mountainous wind farm). Prior to signing the contract, a specific study shall be done in order to define the proper KV for the wind farm, considering development constraints in force and locally available transports in order to adapt logistics means accordingly.

The specific study could include nonstandard solutions and extra resources for each solution.

The roads must be smooth, removing, as far as possible, any protrusions such as stones, rocks, etc., which could damage the nacelle platform or the tower sections and hinder transportation.

3.1.7. Passing areas and turning points

Passing areas will be created at intervals of approximately 5 km, attempting to take advantage of the areas where there are less actions to be performed if possible and they must have an extra width of 5 m with a minimum length equal to the total length of the convoy (Ltot) with a greater length. It is important to consider the entry and exit areas to facility access to the area. The waiting areas must be clear of any obstacle, leveled, compacted and drained. QHSE will determine the number of rest areas that must be created.

The turning points must be defined according with the maximum allowed reverse maneuver as described at the item ***3.1.5 Gradients and grade changes.***

Where dead end roads are constructed or where loaded transports must turn around prior to delivery to the Installation Area, turning Areas are required to avoid long reverse driving. For each wind farm project, these points must be analyzed to find the proper solution.

(Note) Truck length* - The turning area will be different considering two situations: Loaded truck and empty truck. The additional area must be considered around the turning point - cleared of obstacles and levelled to allow oversail/ overhang during transportation. The turning point could be adapted regarding the orography and/or complexity of the windfarm terrain, the new geometry must be approved by SGRE in order to comply with the transport requirements.

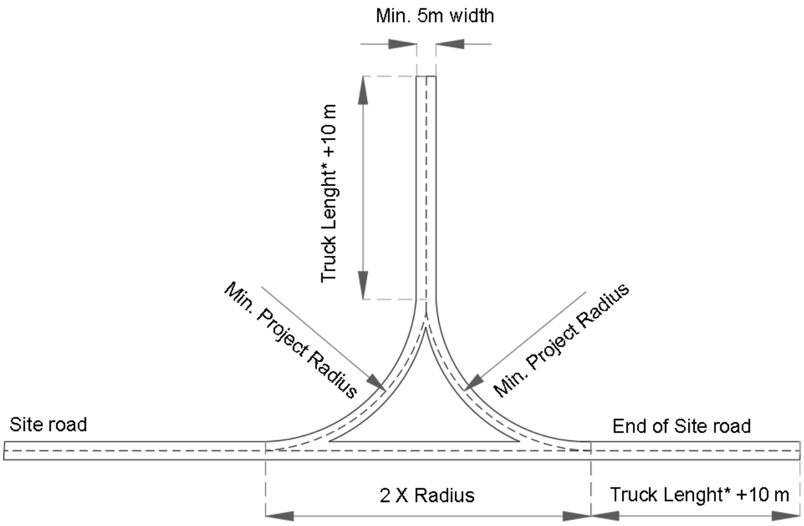


Figure 5 Turning point geometry suggestion

3.1.8. Drainage

The surface drainage system must be of a size to collect any rainwater from the roadway layer as well as any water collected from small flows of runoff water intercepted by the road or even, where applicable, to provide continuity for any larger natural watercourses also intercepted. The calculation will be considered for a return period of 25 years for transverse drainage and 10 years for longitudinal drainage works.

3.2. Hardstands

The hardstands will include a crane work area and areas defined as storage areas. The main components will be stored on the storage area and they will be hoisted by the cranes from the hardstand – crane work area, as a standard concept. Regarding the high-power and communications networks avoid placing them across the hardstand. If this cannot be avoided, then the network must be pipelined, and the pipes covered with concrete.

3.2.1. Hardstand design

The design of the hardstand section must be done based on the geotechnical report and the load transferred by the crane support legs, also it must be considered the use of crane mats if any, under the crane support.

The structural verifications that must be performed and the criteria to be used is as follows:

- For the bearing capacity analysis, Meyerhof and Hanna (1978) methodology will be used.
- The safety factor for the verification of the bearing capacity will be 2, for both long term and short term.
- For the analytical calculation of the settlements, the Steinbrenner methodology will be used.
- The maximum differential settlement under the crane support leg will be 40 mm.

When it comes to unfavorable geotechnical conditions, in addition to the verifications carried out with analytical methodologies, described above, it will be necessary to develop a finite element model (FEM) to compare and contrast the results obtained with analytical methodologies.

The design of the hardstand and the geotechnical report will be provided to Siemens Gamesa together with the quality control of the hardstand, during the handover of the civil works and before starting with the erection process.

3.2.2. Bearing capacity

	Crane work area	Component storage area	Boom assembly area
SGRE standard	2.5	2	2
Without crane mats	3 (T100m) 3 (T101.5m) 3 (T115m) 4 (T135m) 5 (T145m) 5 (T155m) 5 (T165m)	2	2

Table 7 Load- bearing capacity (kg/cm2)

The composition of the crane work area must have a good subgrade, Ev2=60MPa or above. Transmitted loads must be 2.5kg/cm2 (approx 0.2MPa). A surface of 30 m² must be laid, 6 crane mats (5 m x 1 m) per crane leg or crane chain.

If opting not to use crane mats, the necessary bearing capacity will be 3 kg/cm² for T100m, T101.5m and T115m, 4 kg/cm² for T135m and 5 kg/cm² for T145m, T155m and T165m tower models. The possible supply of crane mats is not included in the scope of SGRE, whereby if opting to use crane mats, the cost thereof shall be incurred by the Contracting Party.

3.2.3. Hardstand composition and structure

In the hardstand, the upper level of the subgrade must be above the highest foreseeable level of the water table. Where expansive material (expansive clay, etc.) or loose soil conditions are indicated in the geotechnical report, the use of geosynthetics is strongly recommended (at least with the soil reinforcement and separation functions).

The fill material will be compacted on the hardstands and in the storage areas in layers to a maximum thickness of 30 cm to ensure the effectiveness of the machinery along the entire section. The compaction level will be such that the dry density after compaction is 95% MP or higher. The elasticity module of the subgrade must be measured based on the compressibility module of the second cycle of the load plate test as per DIN 18134 (or in its absence, NLT-357), 600 o 762mm plate will be used for this test, the acceptance criteria will be indicated in the hardstands section design.

Regarding the finished hardstand, the compaction level will be such that the dry density after compaction is 98% MP or higher. The elasticity module of the finished hardstand surface must be measured based on the compressibility module of the second cycle of the load plate test as per DIN 18134 (or in its absence, NLT-357), and the result must never be less than Ev2>80 MPa. Likewise, the relation between the first and second load cycle must be less than 3.

In case there is a doubt about the hardstand capacity, it will be necessary to execute at least one borehole, in the center of the crane area, with core recovery and a depth of 8m. During the execution of the borehole, the following works should be conducted:

- SPT: from the surface where a test must be performed every meter.
- Extracting non-disturbed samples, plus laboratory test (triaxial tests or direct shear tests).
- Determining the ground water level depth, if encountered.
- Collect sampling for laboratory characterization of all the encountered materials.

The storage areas that are at the same level and position of the crane work area (for towers and nacelle), the requirements for the subgrade and finished layer are the same as above-mentioned. For the blade storage areas, the compaction level of the subgrade will be such that the dry density after compaction is 95% MP or higher. In case of need of granular layer, the compaction level will be such that the dry density after compaction is 98% MP or higher.

In case the subgrade of the storage areas is good enough to withstand the loads, no layer of granular material will be needed, but this must be justified accordingly in the design.

Tests must be carried out on the material used for the subgrade and for the roadbed, in order to control the compaction of the different layers and ensure that the civil works are correctly executed. The quality control and the requirements for the civil works design is defined according to the ***5.3 Quality tests and requirements for civil works plan projects.***

Before the arrival of the transport vehicles and crane, the hardstand must be accepted by SGRE for the works to commence.

3.2.4. Hardstand gradients

Crane Type	Hardstand gradients (%) Crane work area		Component storage area	
	Maximum	Minimum	Maximum	Minimum
NTC or Mobile cranes	1.5	0.2	1	0.2
WTC	0.5			

Table 8 Hardstand gradients (%)

The minimum slope in the crane work area as well as the storage area is 0.2%, for the drainage of surface water; concave areas that may result in the formation of pools and the consequential drift of material under heavy loads cannot be accepted. Furthermore, take care that the hardstand or storage area surface must not drain off onto its access road.

3.2.5. Hardstand dimensions

Hardstand layout considers standard SGRE assembly strategy 4.

Foundation diameter subject to change. In case of using special foundation solution (uplifted, braced foundation, etc.), the hardstand dimension must be evaluated and approved by specific study.

(Note) – Following hardstand layouts covering tailing crane offloading and self-offloading transports

Use of clamp system doesn't require cranes for off-loading but additional space for maneuvering of trailers to release the tower sections is needed. The system is not available for all regions and must confirmed by SGRE before building the windfarm. Bear in mind, once chose the hardstands without to consult or to require a confirmation from SGRE, the decision is responsibility of the civil designer. The different concept reflects an impact in hardstand layout, assembly phase and costs. Unusual situations must be evaluated and approved project specific.

Position of blade fingers is depending on location of transport equipment (TEQ) on blade -> Use of TEQ concept and/or positioning on blade might be different per region. Final location of blade fingers must be evaluated and approved project specific.

Area	Description
q1	Hardstand for main crane
q2	Hardstand for assistant crane
q3	Storage area for containers and miscellaneous items
q4	Blade storage area (including the blade fingers position)
q5	Storage area for components
q6	Hardstand for boom assembly
q7	Free obstacles area for rotation superlift ballast or suspended ballast of main crane

Table 9 Installation area codes and description

The platform drawings can be found in annexes, section *5.2 hardstand dimensions*.

In all hardstands, 2 additional areas of 19 m x 12 m and 16 m x 12 m will be required for storing the containers and miscellaneous items. These areas must be close to the hardstand. They can be positioned alongside the foundation providing they remain accessible for removing material by boom truck or telescopic forklift.

The blade storage area will be formed by two different zones in q4. The first zone are two reinforced and levelled “fingers” where blades are supported. The second zone is the surrounding area of blade fingers in q4. As a standard, the entire area of q4 should be levelled with road and/or hardstand next to it and cleaned from obstacles (working area).

In order to avoid blade touching the ground and be able to operate the blade lifting yoke (clamper), CNS tool-kit is used for blades storage in 10°. According respective OP PREP BLADE SG5.x (D2472922) the extra height for the clamp is achieved with TK FA SPT BLADES ROOT 2.3-4.0M (GP520915).

If the blade fingers area is higher or lower than the adjoining road, this must be approved by Siemens Gamesa as it will have an impact on the delivery of the blades.

In addition, a work area must be secured at least 1m between and around to the blades. In addition, a work area must be secured at least 1m between and around to the blades.

The dimensions of the vehicle and crane work areas as well as the storage areas inevitably determine the configurations of the equipment used for assembly. For this reason, this section also defines some of the standard or normal conditions used to define the basic prices as well as relevant exceptional cases.

The recommendable distance from the center of the ring to the start of the useable surface of the hardstand will be 5 m. (Each specific case may be studied).

The concrete foundation pedestal and hardstand must have the same level where possible.

It can be lower with prior approval from SGRE.

If design requirements call for the foundation pedestal level to differ from the ground surface potentially the level of standard hardstand layout will differ from foundation pedestal, too. In case of a project specific evaluation together with SGRE is required (e.g adaptation of hardstand level to foundation pedestal level or change of crane set up and updated of size of the hardstand).

(Note: If opting for an elevated foundation due to design reasons, its height in relation to the hardstand should be considered as tower height.)

Intermediate hardstand adjacent to the road, but at a different level, must have a separate hardstand entrance and exit. Otherwise it must be considered end-of-road hardstand.

For end-of-road hardstands, the foundation should be at the end of the hardstand, avoiding having the foundation at the entrance of the hardstand as much as possible.

The hardstand and road must be at the same level to be able to operate support cranes located partially on hardstand and road.

3.2.6. Requirements for tower assembly with T-flange configuration between section 1 and 2

A compacted area around the tower (on top of foundation) need to be prepared in advance of start of 1st tower section installation. This is needed to enable tower access from all sides for installation of T-flange bolt joints with e.g. cherry picker (man basket).

The compacted area needs to have a minimum width of 10m for operation of cherry picker.

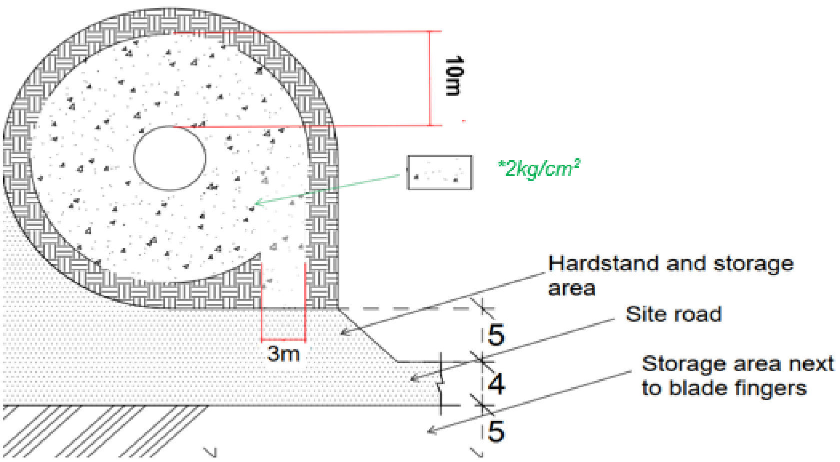


Figure 6 Example of hardstand layout and access road/ramp

Note:

> If an elevated foundation is applicable a road/ramp for access to compacted must be created, too. Maximum gradient of 15% must be considered.
>
> *The bearing capacity for the backfilling is a recommendation for complying with the CNS requirements. This number needs to fulfill also the foundation design requirements.

3.2.7. Requirements for assembly the main crane

If there are several branches far away from one another, an area must be prepared for assembling and disassembling the boom of the main crane at the beginning and end of each wind farm branch or on each hardstand depending on the crane model to be used.

The boom assembly configuration and area may vary according to the crane models to be used.

If there are very steep gradients, power lines, etc., more assembly and disassembly areas for the boom of the main crane may be needed on each hardstand.

This area must have a minimum length in a straight line equal to:

- 100m tower: Tower height + 19m and a minimum width of 3m, with two 6m x 6m supporting areas (depending on the crane, the location of the crane and the boom configuration)
- 101.5m tower: Tower height + 19m and a minimum width of 3m, with two 6m x 6m supporting areas (depending on the crane, the location of the crane and the boom configuration)
- 115m tower: Tower height + 19m and a minimum width of 3m, with two 6m x 6m supporting areas (depending on the crane, the location of the crane and the boom configuration)
- 135m tower: Tower height + 15m and a minimum width of 3m, with two 6m x 6m supporting areas (depending on the crane, the location of the crane and the boom configuration)
- 145m tower: Tower height + 15m and a minimum width of 3m, with two 6m x 6m supporting areas (depending on the crane, the location of the crane and the boom configuration)
- 155m tower: Tower height + 12m and a minimum width of 3m, with two 6m x 6m supporting areas (depending on the crane, the location of the crane and the boom configuration)
- 165m tower: Tower height + 12m and a minimum width of 3m, with two 6m x 6m supporting areas (depending on the crane, the location of the crane and the boom configuration)

		T100m	T101.5m	T115m	T135m	T145m	T155m	T165m MB
Mobile/ Crawler cranes	Wheeler Crane	Area for assembly and disassembly on each hardstand and along site road						
	NTC							
	WTC	Assembly area at the beginning and end of the Wind Farm or each branch						
Dimensions	In a straight line	119m	120.5m	134m	150m	160m	167m	177m
	Wide	3m	3m	3m	3m	3m	3m	3m

Table 10 Requirements for assembly the main crane

There must be areas without vegetation, flat and compacted with a surface area of 10 m x 12 m + 7m x 12m / 2, every 30 m along the boom for assembly for the tailing cranes operation:

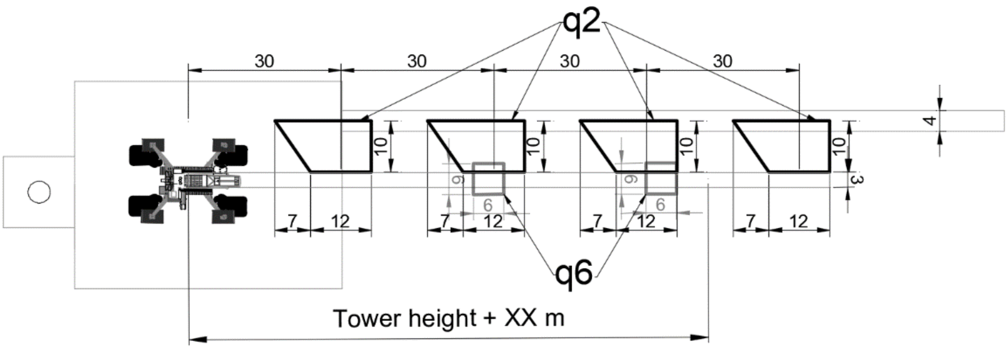


Figure 7 Distribution areas for main crane boom assembly

This area must also be as horizontal as possible, and any gradient should preferably be upward (in the direction in which the boom assembly advances). Were it downward, the boom assembly conditions would be more complex, increasing the crane means required for the assembly process. This would not be a SGRE standard and a specific study would need to be done.

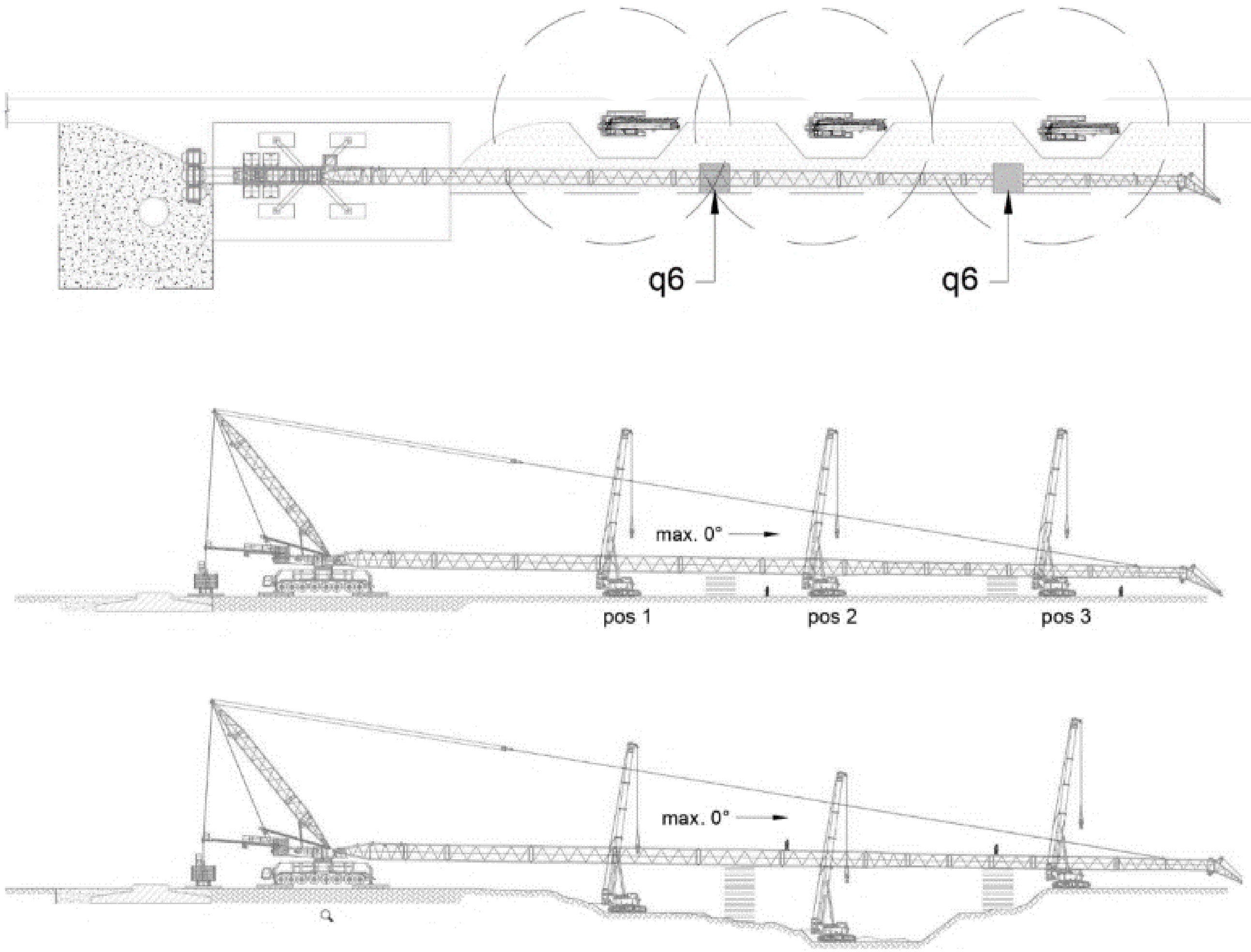


Figure 8 Boom assembly on flat and hilly terrain

Furthermore, the subgrade for assembly and disassembly of the boom, including the pre-installation crane positioning areas, must have a supporting capacity over the entire area at work level of 2 kg/cm² (approx. 0.2 MPa).

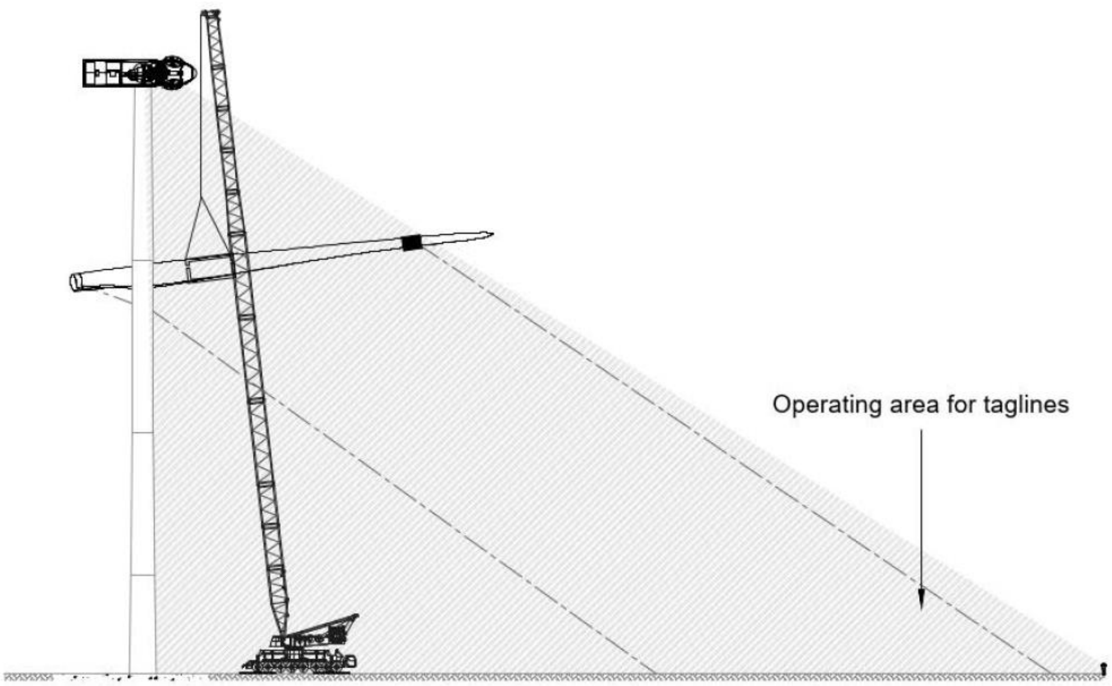
The areas for mounting and dismounting the main crane should be next to a hardstand but not overlap the hardstand area. Furthermore, they will be laid out as parallel as possible to the road reaching the hardstand, but without overlapping it, **in order to avoid invading the outgoing WF road in case of.**

3.2.8. Areas for Tag Lines

Rotor Assembly and Single blade Installation Methods (see Figure 9) require special attention for ensuring a cleared area for the safe use of tag lines.

The Employer shall ensure that the areas around the hardstand, rotor assembly area, and operating area for tag lines are prepared to allow rotor assembly and installation, or single blade installation to be completed safely. An example of the area required is shown in Figure 9. This area shall be prepared as a Working Area (free from trees, obstacles and trip hazards and prepared as to allow persons to move freely and safely). Once the Employer's civil design is finalised, the Contractor shall work with the Employer to further define and optimize these areas in order to minimise the felling and ground preparation works to be carried out by the Employer. Prior to turbine erection, the Employer and Contractor shall together survey the area to be used for tag lines and identify any safety hazards (e.g. holes, level changes, marsh etc.). The Employer and Contractor will mutually agree appropriate mitigations measures, which will be carried out by the Employer, to ensure Safe Working Access.

The drawings below are indicative only and can be furthered refined during the site visit. This is relevant for rotor assembly only.



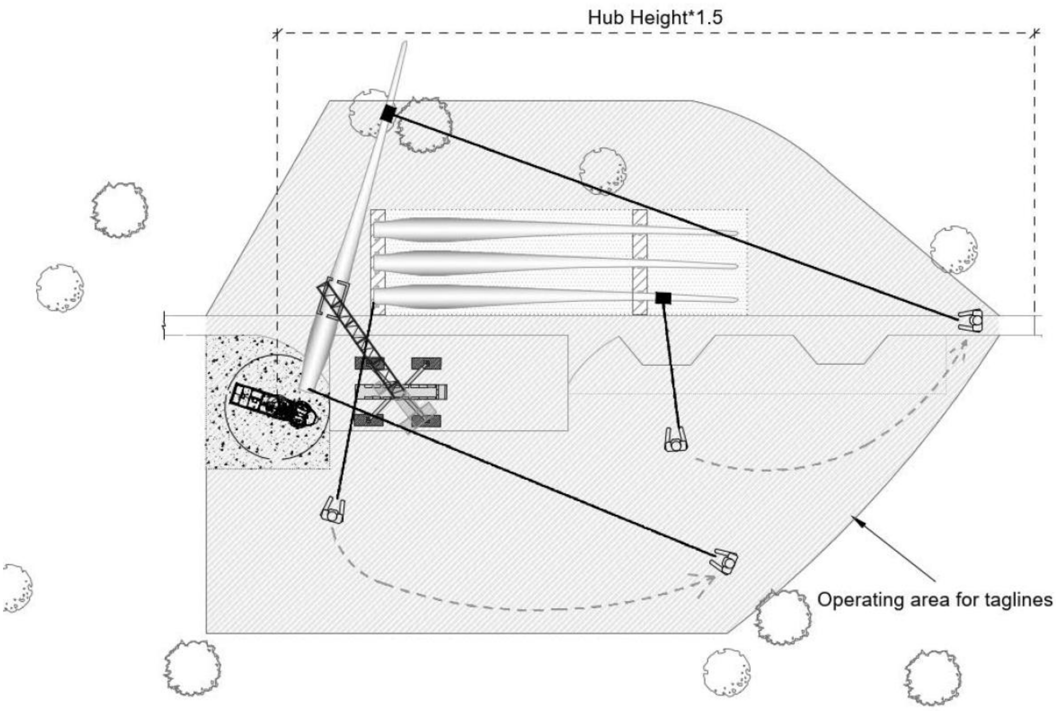


Figure 9 Indicative drawing of area requirements for the use of tag lines with single blade installation method.

3.3. Minimum Requirements for temporary site compounds of wind farms

Temporary site compound includes the area of the site office sheds, parking area for light vehicles and the storage area for minor materials. Normally all these areas form a single space that is divided into the pertinent specific areas, usually called “site compound”.

The site compound is a need for the construction of a wind farm, and each area must be in good conditions for each specific purpose. Therefore, these temporary areas must be built in accordance with some specific requirements.

The location of the site compound must be carefully studied, avoiding areas susceptible of suffering flood events and avoiding areas near to important natural slopes or great embankments. The best location is on areas as flat as possible with easy access by car or truck.

The design of this site compound must consider a minimum slope (always higher than 1%) to allow a correct drainage of the rainwater. If necessary, temporary drain ditches or culverts should also be designed to collect the rainwater to the appropriate discharge points.

The construction of these temporary areas will require the following activities:

1- The area must be cleared to eliminate the topsoil, trees, stumps, weeds, etc. The topsoil can be stockpiled in small piles next to for later use in landscape restoration if required.
2- Embankments. If some embankments are necessary to build any platform, at least the following requirements are recommended meeting:

- Before the construction of the embankment, natural subgrade must be compacted until reaching 95% of the maximum dry unit weight from the Modified Proctor test (M.P.).
- Embankment construction must be carried out filling with soil layers of 30cm thick, and compacting this filling material until reaching 95% of its maximum dry unit weight from the M.P.
- It is recommended using filling material with a CBR ≥4% at 95% M.P, free of organic matter, LL<50, non-collapsible, free swelling <3%.

3- Excavations. If some excavations are necessary to build any platform, the natural subgrade must be compacted until reaching 95% of the maximum dry unit weight from M.P., once the excavation is over.

4- Pavement. The pavement will depend on the use of each area but, as a general approach, it is recommended the use of granular material with a fine content ≤ 20%, CBR≥ 40% at 98% M.P and maximum size of 32mm. This material must also be correctly compacted in layers of 30cm thick until reaching at least 98% of the maximum dry unit weight from M.P.

The thickness of the pavement will be determined by the site soil conditions and it will be evaluated adequately with the detailed geotechnical information. There may even be the case that the use of geotextiles could be necessary.

The thickness of pavement in each area is indicated below. They must be considered as a minimum and obviously they can also be increased if the site soil conditions are not good enough.

- Temporary office area*:* it is recommended 10cm of well compacted granular material. Plain concrete is recommended for sidewalks connecting the different offices access, toilets, etc.
- Parking area for light vehicles*:* it is recommended 15cm of well compacted granular material.
- Storage area for minor materials and access road: trucks are going to use these areas. Therefore, the thickness of pavement will depend on the quality of the natural soil (subsoil):
  - Poor subsoil conditions (CBR at 95% P.M <2%): it is recommended at least 30cm of well compacted granular material.
  - Fair subsoil conditions (2<CBR at 95% P.M <7): it is recommended at least 20cm of well compacted granular material.
  - Good subsoil conditions (CBR at 95% P.M >7): it is recommended at least 15cm of well compacted gravel.
  - If rock or rocky soils are encountered, it would be enough with 10cm of well compacted granular material for all the areas to build uniform and plain platform.

Previous recommendations must be understood as a general guide or a first approach to the final design of the temporary platforms.

In any case, it is always necessary to maintain adequately the pavements, and if necessary, add and spread more granular material correctly compacted during the use of these temporary areas.

If the temporary areas are going to be used as storage of the turbine components and/or very heavy items that require the use of cranes, they will be considered as a usual hardstand of a WTG and they will be analysed and designed in accordance with the Site Specific Requirements (SSR) of each project.

3.4. Safety distance from power lines

The Orders and Regulations in force in each country must be considered where high and low-voltage lines pass over the internal wind farm roads or wind farm access roads.

Distance limits for working areas are included as a reference.

U_n	D_{PEL-1}	D_{PEL-2}	D_{PROX-1}	D_{PROX-2}
≤ 1	50	50	70	300
3	62	52	112	300
6	62	53	112	300
10	65	55	115	300
15	66	57	116	300
20	72	60	122	300
30	82	66	132	300
45	98	73	148	300
66	120	85	170	300
110	160	100	210	500
132	180	110	330	500
220	260	160	410	500
380	390	250	540	700

Table 11 Safety distance from power lines to work areas

(Note)

The distances for intermediate voltage values will be calculated using linear interpolation.

Where:

- U_n - Rated voltage of the installation (kW).
- D_{PEL-1} - Distance to the outer limit of the danger area whenever there is a risk of voltage stressing due to lightning (cm).
- D_{PEL-2} - Distance to the outer limit of the danger area when there is no risk of overvoltage due to lightning (cm).
- D_{PROX-1} - Distance to the outer limit of the danger area whenever it is possible to mark out the work area accurately and control that this is not exceeded during the carrying-out of the work (cm).
- D_{PROX-2} - Distance to the outer limit of the danger area whenever it is not possible to mark out the work area accurately and control that this is not exceeded during the carrying-out of the work (cm).

4. Additional documentation

This document is of a general character and it is necessary to include another document (e.g. External Note) specifying any additional requirements or revision/confirmation of the parameters of this document, in addition to:

- Number of WTGs.
- Turbine type. If there is more than one type, this should be specified position by position.
- Installation strategy and storage conditions. If there is more than one type, this should be specified position by position.
- Main, pre-assembly and assist crane proposed.
- Road width in the access road and between positions.
- Semi – mounted crane movement road requirements and affected road sections.
- Auxiliary means for transports as pull units. This should also include the road sections in which this auxiliary means are needed.
- Additional platforms, in case needed (temporary storage).
- Confirmation of the widening curves table.
- Revision/confirmation of the parameters, e.g. KV, longitudinal gradients…
- Specification of dimension and other requirements of site facilities.
- Any other project specific requirements.

To define the above information, receiving the Layout of the WF and other information is required.

This data will give a visualization of each wind turbine of the wind farm and it will convey any needed extra methods or measures in addition to the SGRE standards.

5. Annexes

5.1. Weights and dimensions for SG 6.2-170

For further information about different configurations or a site-specific tower, please contact to the Sales Technical team from the regions. The towers from the self-offloading hardstands are available for NEME region.

This document covers the key models from the Extended Tower Portfolio.

100m tower

Element	W (kg)	L (m)	Ø Lower flange (m)	Ø Upper Flange (m)
Section 1	84,030	14.30	4.70	4.70
Section 2	79,750	21.56	4.70	4.49
Section 3	76,060	26.88	4.49	4.49
Section 4	75,790	34.45	4.49	3.50

Table 12 Weights and dimensions of T100m

101.5m tower

Element	W (kg)	L (m)	Ø Lower flange	Ø Upper Flange
Section 1	61,270	8.460	4.50	4.30
Section 2	69,800	14.840	4.30	4.50
Section 3	57,630	15.120	4.50	4.50
Section 4	53,450	17.640	4.50	4.50
Section 5	48,050	21.000	4.50	4.10
Section 6	49,720	21.850	4.10	3.50

Table 13 Weights and dimensions of T101.5m

115m tower

Element		W (kg)	L (m)	Ø Lower flange (m)	Ø Upper Flange (m)
50A	Section 1	85,640	13.29	4.70	4.70
	Section 2	85,140	18.20	4.70	4.44
	Section 3	85,410	23.80	4.44	4.43
	Section 4	73,230	27.16	4.43	4.02
	Section 5	64,920	29.97	4.02	3.50
51A	Section 1	86,800	11.78	4.80	4.80
	Section 2	84,640	17.92	4.80	4.80
	Section 3	81,560	21.84	4.80	4.80

	Section 4	77,290	28.00	4.80	4.80
	Section 5	72,510	32.77	4.80	3.50
53A	Section 1	84,370	12.29	4.50	4.50
	Section 2	82,590	16.52	4.50	4.39
	Section 3	81,820	21.28	4.39	4.39
	Section 4	80,440	30.24	4.39	4.02
	Section 5	70,030	32.08	4.02	3.50

Table 14 Weights and dimensions of T115m

135m tower

Element		W (kg)	L (m)	Ø Lower flange (m)	Ø Upper Flange (m)
50A	Section 1	91,070	15.00	6.00	5.68
	Section 2	84,190	18.20	5.68	5.68
	Section 3	84,470	21.28	5.68	4.83
	Section 4	81,540	24.92	4.83	4.42
	Section 5	68,370	26.88	4.42	4.42
	Section 6	58,390	26.13	4.42	3.50

Table 15 Weights and dimensions of T135m

145m tower

Element	W (kg)	L (m)	Ø Lower flange (m)	Ø Upper Flange (m)
Section 1	83,350	12.32	6.40	6.40
Section 2	82,480	14.00	6.40	6.40
Section 3	83,110	15.68	6.40	6.40
Section 4	83,910	18.20	6.40	6.40
Section 5	73,260	18.48	6.40	5.75
Section 6	62,220	18.48	5.75	5.10
Section 7	50,400	18.48	5.10	4.45
Section 8	64,480	26.89	4.45	3.50

Table 16 Weights and dimensions of T145m

155m tower

Element	W (kg)	L (m)	Ø Lower flange (m)	Ø Upper Flange (m)
Section 1	83,980	12.32	6.60	6.58
Section 2	82,320	13.44	6.58	6.58
Section 3	82,350	14.56	6.58	6.58

Section 4	82,980	16.24	6.58	6.58
Section 5	80,910	18.48	6.58	6.58
Section 6	70,170	18.48	5.98	5.38
Section 7	83,270	28.84	5.38	4.44
Section 8	70,760	29.97	4.44	3.50

Table 17 Weights and dimensions of T155m

165 MB tower

Element	W (kg)	L (m)	Ø Lower flange (m)	Ø Upper Flange (m)
Concrete (MB)	-	99.80	9.29	4.53
Section 1	81,020	29.71	4.30	4.29
Section 2	69,830	36.00	4.29	3.50

Table 18 Weights and dimensions of T165 MB

165 WT tower

Element	W (kg)	L (m)	Ø Lower flange (m)	Ø Upper Flange (m)
Concrete (WT)	-	108.00	9.40	4.92
Section 1	68,680	26.32	4.50	4.27
Section 2	59,340	28.38	4.27	3.50

Table 19 Weights and dimensions of T165 MB

100m tower – Self offloading

Element	W (kg)	L (m)	Ø Lower flange	Ø Upper Flange
Section 1	64,420	10.27	4.50	4.50
Section 2	59,950	13.10	4.50	4.50
Section 3	51,990	15.21	4.50	4.49
Section 4	55,470	19.10	4.49	4.48
Section 5	51,190	21.30	4.48	4.02
Section 6	50,410	18.70	4.02	3.57

Table 20 Weights and dimensions of T100m – Self offloading

115m tower – Self offloading

Element	W (kg)	L (m)	Ø Lower flange	Ø Upper Flange
Section 1	84,940	13.54	4.70	4.67
Section 2	85,090	18.19	4.67	4.44
Section 3	84,980	23.74	4.44	4.43

Section 4	74,190	27.00	4.43	3.56
Section 5	65,520	29.95	3.56	3.36

Table 21 Weights and dimensions of T115m – Self offloading

135m tower – Self offloading

Element	W (kg)	L (m)	Ø Lower flange	Ø Upper Flange
Section 1	94,850	15.00	6.00	5.68
Section 2	84,970	18.20	5.68	5.68
Section 3	84,460	21.28	5.68	4.83
Section 4	79,360	24.92	4.83	4.42
Section 5	72,250	26.88	4.42	4.42
Section 6	62,390	26.13	4.42	3.50

Table 22 Weights and dimensions of T135m – Self offloading

145m tower – Self offloading

Element	W (kg)	L (m)	Ø Lower flange	Ø Upper Flange
Section 1	83,350	12.32	6.40	6.40
Section 2	82,480	14.00	6.40	6.40
Section 3	83,110	15.68	6.40	6.40
Section 4	83,910	18.20	6.40	6.40
Section 5	73,260	18.48	6.40	5.75
Section 6	62,220	18.48	5.75	5.10
Section 7	50,400	18.48	5.10	4.45
Section 8	64,480	26.89	4.45	3.50

Table 23 Weights and dimensions of T145m – Self offloading

155m tower – Self offloading

Element	W (kg)	L (m)	Ø Lower flange	Ø Upper Flange
Section 1	70,760	29.97	6.60	6.58
Section 2	83,270	58.84	6.58	6.58
Section 3	70,170	18.48	6.58	6.58
Section 4	80,910	18.48	6.58	6.58
Section 5	82,980	16.24	6.58	5.98
Section 6	82,350	14.56	5.98	5.38
Section 7	82,320	13.44	5.38	4.44
Section 8	83,980	12.32	4.44	3.50

Table 24 Weights and dimensions of T155m – Self offloading

165 MB tower – Self offloading

Element	W (kg)	L (m)	Ø Lower flange (m)	Ø Upper Flange (m)
Concrete (MB)	-	86.27	7.89	4.67
Section 1	78,490	21.84	4.30	4.29
Section 2	57,330	23.52	4.29	4.28
Section 3	58,110	29.45	4.28	3.57

Table 25 Weights and dimensions of T165m MB – Self offloading

Nacelle, incl. TU and GEN

Element	W (kg)	L (m)	Width (m)	Height (m)
Nacelle	103,508	15.03	4.20	3.50

Table 26 Weights and dimensions of Nacelle

Full Drive Train

Element	W (kg)	L (m)	Width (m)	Height (m)
Drive Train	80,790	7.60	3.20	3.13

Table 27 Weights and dimensions of Full Drive Train

Hub

Element	W (kg)	L (m)	Width (m)	Height (m)
Hub	55,000	5.20	4.72	4.10

Table 28 Weights and dimensions of HUB

Blades

Element	W (kg)	L (m)	Width (m)	Height (m)
Blade SG5.X-170	25,000	83.50	4.50	3.40

Table 29 Weights and dimensions of Blades

Transformer Unit

Element	W (kg)	L (m)	Width (m)	Height (m)
TU	16,300	-	-	-

Table 30 Weights and dimensions of Transformer unit

Generator

Element	W (kg)	L (m)	Width (m)	Height (m)
GEN	16,500	-	-	-

Table 31 Weights and dimensions of Generator

5.2. Transport requirements

(Note): The data represented below is the result of the of the study was obtained from the modelling, showing the following widening according to the cargo and bed. The values are a reference considering the transport from the item ***3.1.5 Gradients and grade changes.*** For each windfarm and region, please bear in mind some changes could be possible. Concerning this, a new study must be done by Logistics department according with the transport available per region/project to avoid some nonconformities.

SIEMENS Gamesa RENEWABLE ENERGY

VEHICLE: SG170, LEFT TURN

Radios (m)	10º			20º			30º			40º			50º			60º		
	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai
5	5	1,5	1,5	6	1,5	4,5	6	1,5	8	6	4	11	7	5,5	15	7	7	19
10	5	1,5	1,5	6	1,5	4,5	6	1,5	8	6	3,5	11	7	5,5	14,5	7	7	18
15	5	1,5	1,5	6	1,5	4,5	6	1,5	7,5	6	3,5	10,5	7	5	14	7	6,5	17,5
20	5	1,5	1,5	6	1,5	4,5	6	1,5	7,5	6	3,5	10,5	7	5	13,5	7	6	16,5
25	5	1,5	1	6	1,5	4,5	6	1,5	7,5	6	3	10	7	4,5	13	7	6	16
30	5	1,5	1	5	1,5	4,5	6	1,5	7	6	3	10	7	4,5	12,5	7	5,5	15
35	5	1,5	1	5	1,5	4	6	1,5	7	6	3	9,5	6	4	12	7	5,5	14,5
40	5	1,5	1	5	1,5	4	6	1,5	7	6	2,5	9	6	4	11,5	7	5	13,5
45	5	1,5	1	5	1,5	4	6	1,5	6,5	6	2,5	9	6	3,5	11	7	4,5	13
50	5	1,5	1	5	1,5	4	6	1,5	6,5	6	2,5	8,5	6	3,5	10,5	6	4,5	12
55	5	1,5	1	5	1,5	4	6	1,5	6	6	2,5	8	6	3,5	10	6	4	11,5
60	5	1,5	1	5	1,5	4	6	1,5	6	6	2	8	6	3	9,5	6	4	10,5
65	5	1,5	1	5	1,5	3,5	6	1,5	6	6	2	7,5	6	3	9	6	3,5	9,5
70	5	1,5	1	5	1,5	3,5	6	1,5	5,5	6	1,5	7,5	6	2,5	8,5	6	3,5	9
75	5	1,5	1	5	1,5	3,5	6	1,5	5,5	6	1,5	7	6	2,5	8	6	3	8
80	5	1,5	1	5	1,5	3,5	6	1,5	5,5	6	1,5	6,5	6	2	7,5	6	2,5	7,5
85	5	1,5	1	5	1,5	3,5	6	1,5	5	6	1,5	6,5	6	2	7	6	2	7
90	5	1,5	1	5	1,5	3,5	6	1,5	5	6	1,5	6	6	1,5	6,5	6	1,5	6,5

Radios (m)	70º			80º			90º			100º			110º			120º		
	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai
5	8	8	23,5	11	8	28	15	8	34	6	0	0	6	0	0	6	0	0
10	8	8	22	10	8	26,5	13	8	31,5	18	8	37,5	6	0	0	6	0	0
15	8	8	21	9	8	25	12	8	29,5	16	8	35	6	0	0	6	0	0
20	8	7,5	20	8	8	23,5	10	8	27,5	14	8	32	18	8	37,5	6	0	0
25	7	7	19	8	8	22	9	8	25	12	8	29	15	8	33	6	0	0
30	7	6,5	17,5	8	7,5	20,5	8	8	23	10	8	26	13	8	29	16	8,5	33
35	7	6,5	16,5	7	7	19	8	8	21	8	8	23,5	10	8	26	12	8,5	28
40	7	6	15,5	7	7	17,5	7	7,5	19	8	8	20,5	8	8	22	8	8,5	23
45	7	5,5	14,5	7	6	16	7	7	17	7	7	18	7	7,5	18,5	7	7,5	18,5
50	7	5	13,5	7	5,5	14,5	7	6	15	7	6,5	15,5	7	6,5	15,5	7	6,5	15,5
55	7	4,5	12,5	7	5	13	7	5,5	13	7	5,5	13	7	5,5	13	7	5,5	13
60	6	4,5	11	6	4,5	11,5	6	5	11,5	6	5	11,5	6	5	11,5	6	5	11,5
65	6	4	10	6	4	10	6	4	10	6	4	10	6	4	10	6	4	10
70	6	3,5	9	6	3,5	9	6	3,5	9	6	3,5	9	6	3,5	9	6	3,5	9
75	6	3	8,5	6	3	8,5	6	3	8,5	6	3	8,5	6	3	8,5	6	3	8,5
80	6	2,5	7,5	6	2,5	7,5	6	2,5	7,5	6	2,5	7,5	6	2,5	7,5	6	2,5	7,5
85	6	2	7	6	2	7	6	2	7	6	2	7	6	2	7	6	2	7
90	6	1,5	6,5	6	1,5	6,5	6	1,5	6,5	6	1,5	6,5	6	1,5	6,5	6	1,5	6,5

Radios (m)	130º			140º			150º			160º			170º			180º		
	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai
5	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0
10	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0
15	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0
20	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0
25	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0
30	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0	6	0	0
35	15	8,5	31	19	8,5	35	6	0	0	6	0	0	6	0	0	6	0	0
40	9	8,5	24	11	8,5	25,5	12	8,5	26	14	8,5	27,5	16	8,5	29	18	8,5	31
45	7	7,5	18,5	7	7,5	18,5	8	7,5	18,5	8	7,5	18,5	8	7,5	18,5	8	7,5	18,5
50	7	6,5	15,5	7	6,5	15,5	7	6,5	15,5	7	6,5	15,5	7	6,5	15,5	7	6,5	15,5
55	7	5,5	13	7	5,5	13	7	5,5	13	7	5,5	13	7	5,5	13	7	5,5	13
60	6	5	11,5	6	5	11,5	6	5	11,5	6	5	11,5	6	5	11,5	6	5	11,5
65	6	4	10	6	4	10	6	4	10	6	4	10	6	4	10	6	4	10
70	6	3,5	9	6	3,5	9	6	3,5	9	6	3,5	9	6	3,5	9	6	3,5	9
75	6	3	8,5	6	3	8,5	6	3	8,5	6	3	8,5	6	3	8,5	6	3	8,5
80	6	2,5	7,5	6	2,5	7,5	6	2,5	7,5	6	2,5	7,5	6	2,5	7,5	6	2,5	7,5
85	6	2	7	6	2	7	6	2	7	6	2	7	6	2	7	6	2	7
90	6	1,5	6,5	6	1,5	6,5	6	1,5	6,5	6	1,5	6,5	6	1,5	6,5	6	1,5	6,5

VEHICLE: SG170, RIGHT TURN

Radios (m)	10º			20º			30º			40º			50º			60º		
	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai
5	5	4	2,5	6	6	5,5	6	7,5	8,5	6	9	11,5	7	10	15,5	7	10,5	19
10	5	4	2,5	6	6	5,5	6	7,5	8,5	6	8,5	11,5	7	9,5	15	7	10,5	18
15	5	4	2,5	6	5,5	5	6	7,5	8,5	6	8,5	11	7	9,5	14	7	10,5	17,5
20	5	4	2	6	5,5	5	6	7,5	8	6	8,5	11	7	9,5	14	7	10	16,5
25	5	4	2	6	5,5	5	6	7,5	8	6	8,5	10,5	7	9,5	13,5	7	10	16
30	5	4	2	5	5,5	5	6	7	7,5	6	8,5	10,5	7	9	13	7	10	15,5
35	5	4	2	5	5,5	5	6	7	7,5	6	8	10	6	9	12,5	7	9,5	14,5
40	5	4	2	5	5,5	5	6	7	7,5	6	8	9,5	6	9	12	7	9,5	14
45	5	4	2	5	5,5	5	6	7	7,5	6	8	9,5	6	8,5	11,5	7	9,5	13,5
50	5	4	2	5	5,5	4,5	6	7	7	6	8	9	6	8,5	11	6	9	12,5
55	5	4	2	5	5,5	4,5	6	7	7	6	8	9	6	8,5	10,5	6	9	11,5
60	5	4	2	5	5,5	4,5	6	6,5	6,5	6	7,5	8,5	6	8,5	10	6	9	11
65	5	4	2	5	5,5	4,5	6	6,5	6,5	6	7,5	8	6	8	9,5	6	8,5	10,5
70	5	4	2	5	5,5	4,5	6	6,5	6,5	6	7,5	8	6	8	9	6	8,5	9,5
75	5	4	2	5	5,5	4,5	6	6,5	6	6	7	7,5	6	7,5	8,5	6	8	9
80	5	4	2	5	5,5	4,5	5	6,5	6	5	7	7,5	6	7,5	8	6	7,5	8
85	5	4	2	5	5,5	4	5	6,5	6	5	7	7	6	7,5	7,5	6	7,5	7,5
90	5	4	2	5	5,5	4	5	6,5	5,5	5	7	6,5	6	7	7	6	7	7

Radios (m)	70º			80º			90º			100º			110º			120º		
	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai
5	8	11	23,5	11	11	28	15	11	34									
10	8	11	22	10	11	26,5	13	11	31,5	18	11	37,5						
15	8	10,5	21	9	11	25	12	11	29,5	16	11	35						
20	8	10,5	20	8	11	23,5	10	11	27,5	14	11	32	18	11	37,5			
25	7	10,5	19	8	11	22	9	11	25	12	11	29	15	11	33			
30	7	10,5	17,5	8	10,5	20,5	8	11	23	10	11	26	13	11	29	16	11	33
35	7	10	16,5	7	10,5	19	8	11	21	8	11	23,5	10	11	26	12	11	28
40	7	10	15,5	7	10,5	17,5	7	10,5	19	8	11	20,5	8	11	22	8	11	23
45	7	9,5	14,5	7	10	16	7	10,5	17	7	10,5	18	7	10,5	18,5	7	10,5	18,5
50	7	9,5	13,5	7	9,5	14,5	7	10	15,5	7	10	15,5	7	10	15,5	7	10	15,5
55	7	9,5	12,5	7	9,5	13,5	7	9,5	13,5	7	9,5	13,5	7	9,5	13,5	7	9,5	13,5
60	6	9	11,5	6	9	12	6	9	12	6	9	12	6	9	12	6	9	12
65	6	8,5	10,5	6	8,5	10,5	6	9	10,5	6	9	10,5	6	9	10,5	6	9	10,5
70	6	8,5	9,5	6	8,5	9,5	6	8,5	9,5	6	8,5	9,5	6	8,5	9,5	6	8,5	9,5
75	6	8	9	6	8	9	6	8	9	6	8	9	6	8	9	6	8	9
80	6	7,5	8,5	6	8	8,5	6	8	8,5	6	8	8,5	6	8	8,5	6	8	8,5
85	6	7,5	7,5	6	7,5	7,5	6	7,5	7,5	6	7,5	7,5	6	7,5	7,5	6	7,5	7,5
90	6	7	7	6	7	7	6	7	7	6	7	7	6	7	7	6	7	7

Radios (m)	130º			140º			150º			160º			170º			180º		
	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai	A	Sae	Sai
5																		
10																		
15																		
20																		
25																		
30																		
35	15	11	31	19	11	35												
40	9	11	24	11	11	25,5	12	11	26	14	11	27	16	11	29	18	11	31
45	7	10,5	18,5	7	10,5	18,5	8	10,5	18,5	8	10,5	18,5	8	10,5	18,5	8	10,5	18,5
50	7	10	15,5	7	10	15,5	7	10	15,5	7	10	15,5	7	10	15,5	7	10	15,5
55	7	9,5	13,5	7	9,5	13,5	7	9,5	13,5	7	9,5	13,5	7	9,5	13,5	7	9,5	13,5
60	6	9	12	6	9	12	6	9	12	6	9	12	6	9	12	6	9,5	12
65	6	9	10,5	6	9	10,5	6	9	10,5	6	9	10,5	6	9	10,5	6	9	10,5
70	6	8,5	9,5	6	8,5	9,5	6	8,5	9,5	6	8,5	9,5	6	8,5	9,5	6	8,5	10
75	6	8	9	6	8	9	6	8	9	6	8	9	6	8	9	6	8	9
80	6	8	8,5	6	8	8,5	6	8	8,5	6	8	8,5	6	8	8,5	6	8	8,5
85	6	7,5	7,5	6	7,5	7,5	6	7,5	7,5	6	7,5	7,5	6	7,5	7,5	6	7,5	7,5
90	6	7	7	6	7	7	6	7	7	6	7	7	6	7	7	6	7,5	7

5.3. Quality tests and requirements for civil works projects

The quality control and the requirements for the civil works design is defined according to the ***GD483525-EN, Quality Test Plan for Roads and Hardstands.***

5.4. Legislations

Siemens Gamesa and its affiliates reserve the right to change the above specifications without prior notice.

5.5. Hardstand dimensions

5.5.1. T100m tubular steel tower Hardstand with strategy 3

- Tailing crane offloading T100m

Storage conditions	Width x length
Total Storage	q1 .... 29m x 18m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 29m x 44m + (39m x 44m)/2 – q1 +88m x 5m + reinforced road part* q2/q6........ dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 .... 29m x 18m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 26m x 44m + (35m x 44m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6........ dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 32 Dimensions of the areas of model T100m with strategy 3 – Tailing crane offloading

- Total storage – Assembly in 1 phase

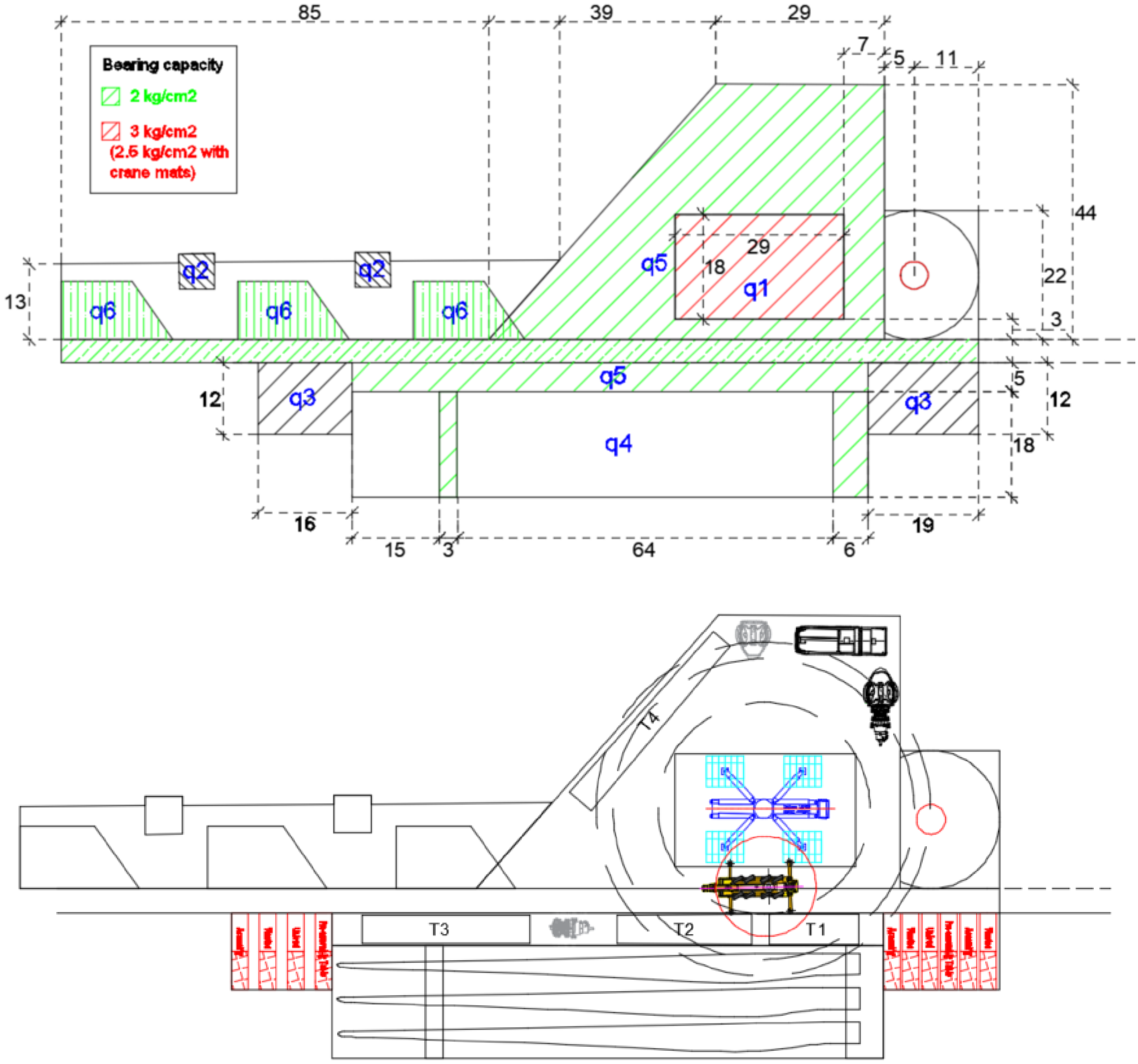


Figure 10 Model T100m – Total storage assembling with strategy 3 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE Standard)

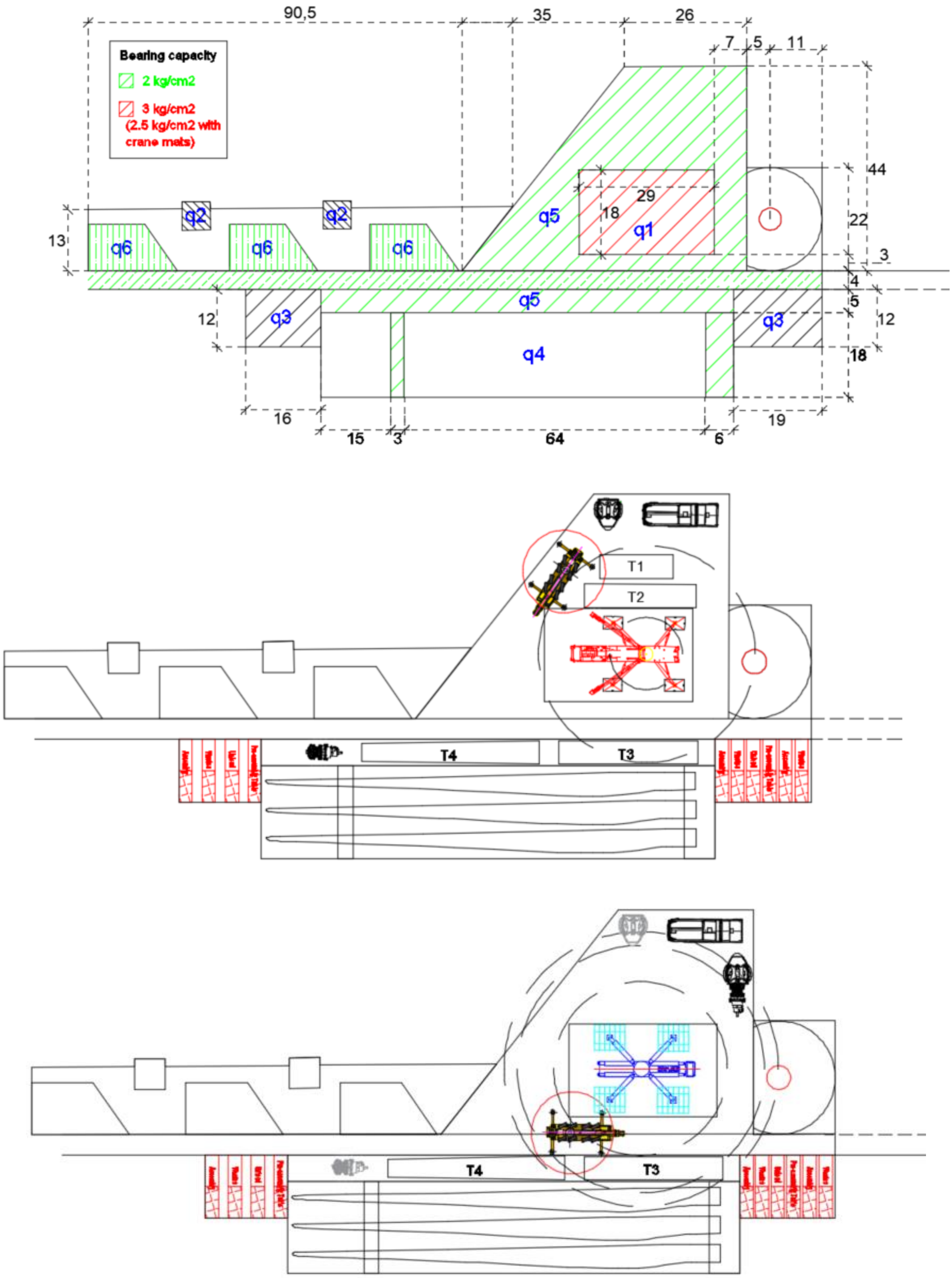


Figure 11 Model T100m – Partial storage assembling with strategy 3 in 2 phases

5.5.2. T100m tubular steel tower Hardstand with strategy 4

- Tailing crane offloading T100m

Storage conditions	Width x length
Total Storage	q1 .... 29m x 18m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 37m x 37m + (31m x 37m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6........ dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 .... 29m x 18m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 29m x 39m + (32m x 39m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6........ dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 33 Dimensions of the areas of model T100m with strategy 4 – Tailing crane offloading

- Total storage – Assembly in 1 phase

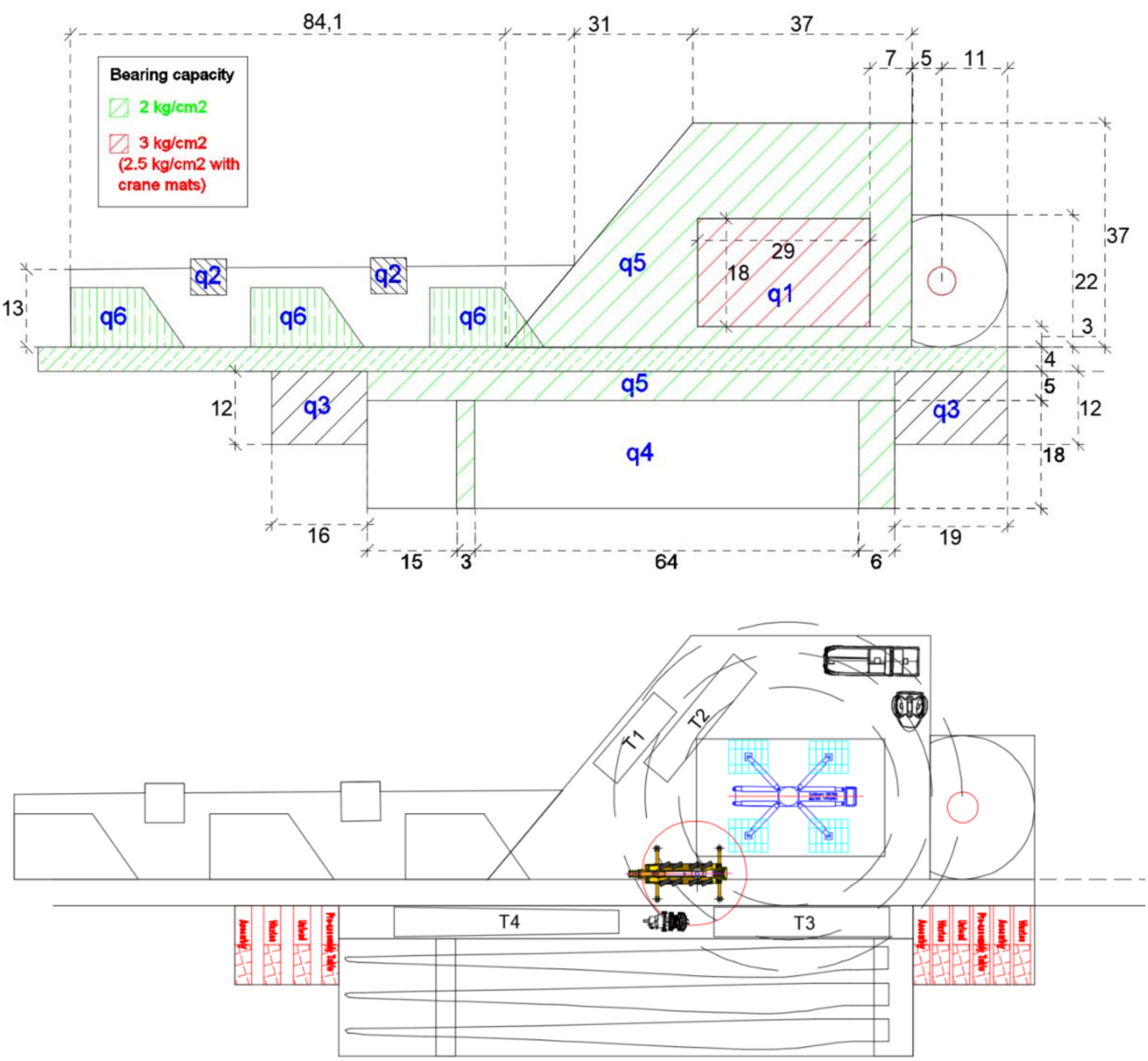


Figure 12 Model T100m – Total storage assembling with strategy 4 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard)

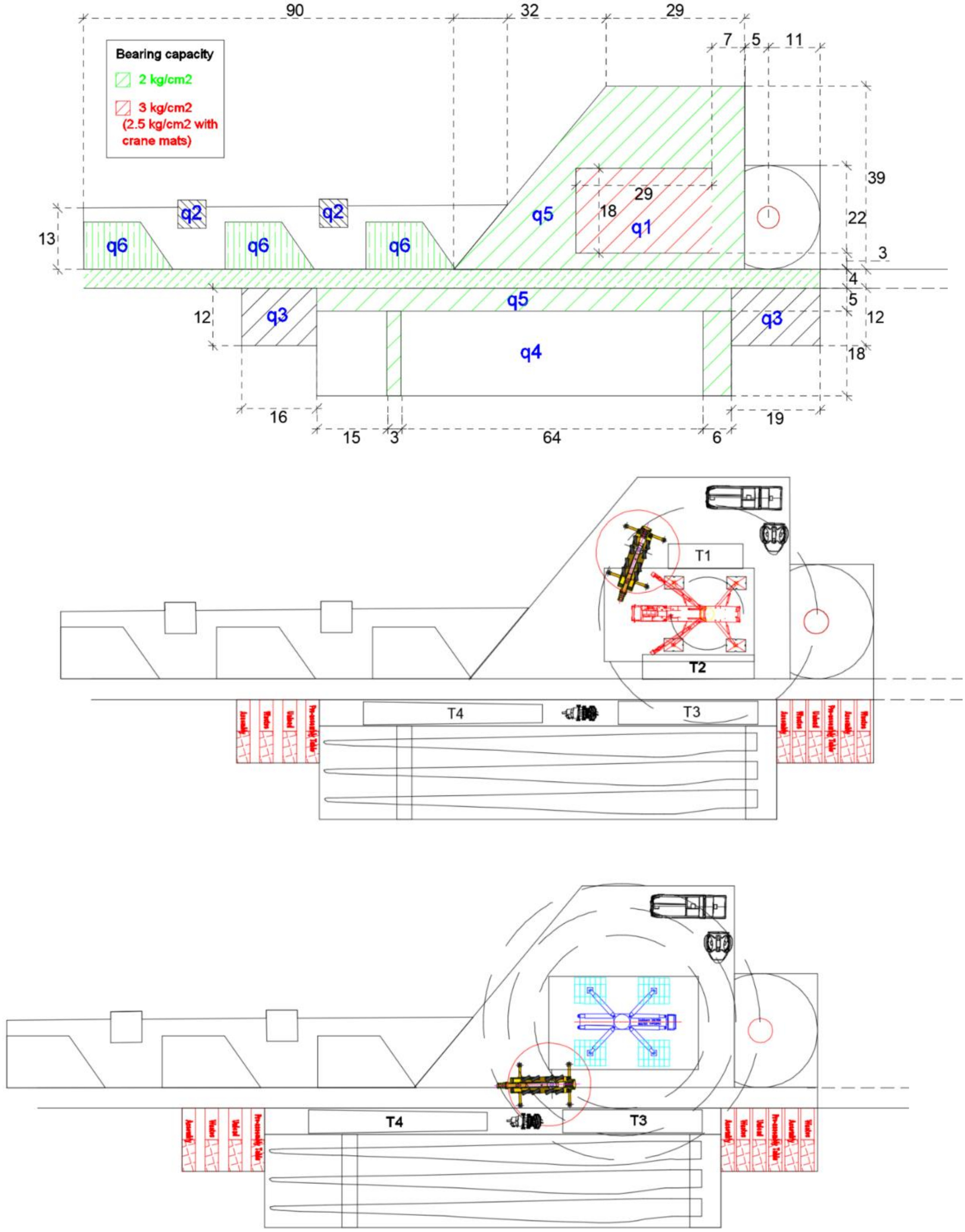


Figure 13 Model T100m – Partial storage assembling with strategy 4 in 2 phases

5.5.3. T101.5m tubular steel tower Hardstand with strategy 3

- Tailing crane offloading 101.5m

Storage conditions	Width x length
Total Storage	q1 .... 29m x 18m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 33m x 44m + (31m x 44m)/2 – q1 +88m x 5m + reinforced road part* q2/q6........ dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 .... 29m x 18m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 27m x 44m + (30m x 44m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6........ dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 34 Dimensions of the areas of model T101.5m with strategy 3 – Tailing crane offloading

- Total storage – Assembly in 1 phase

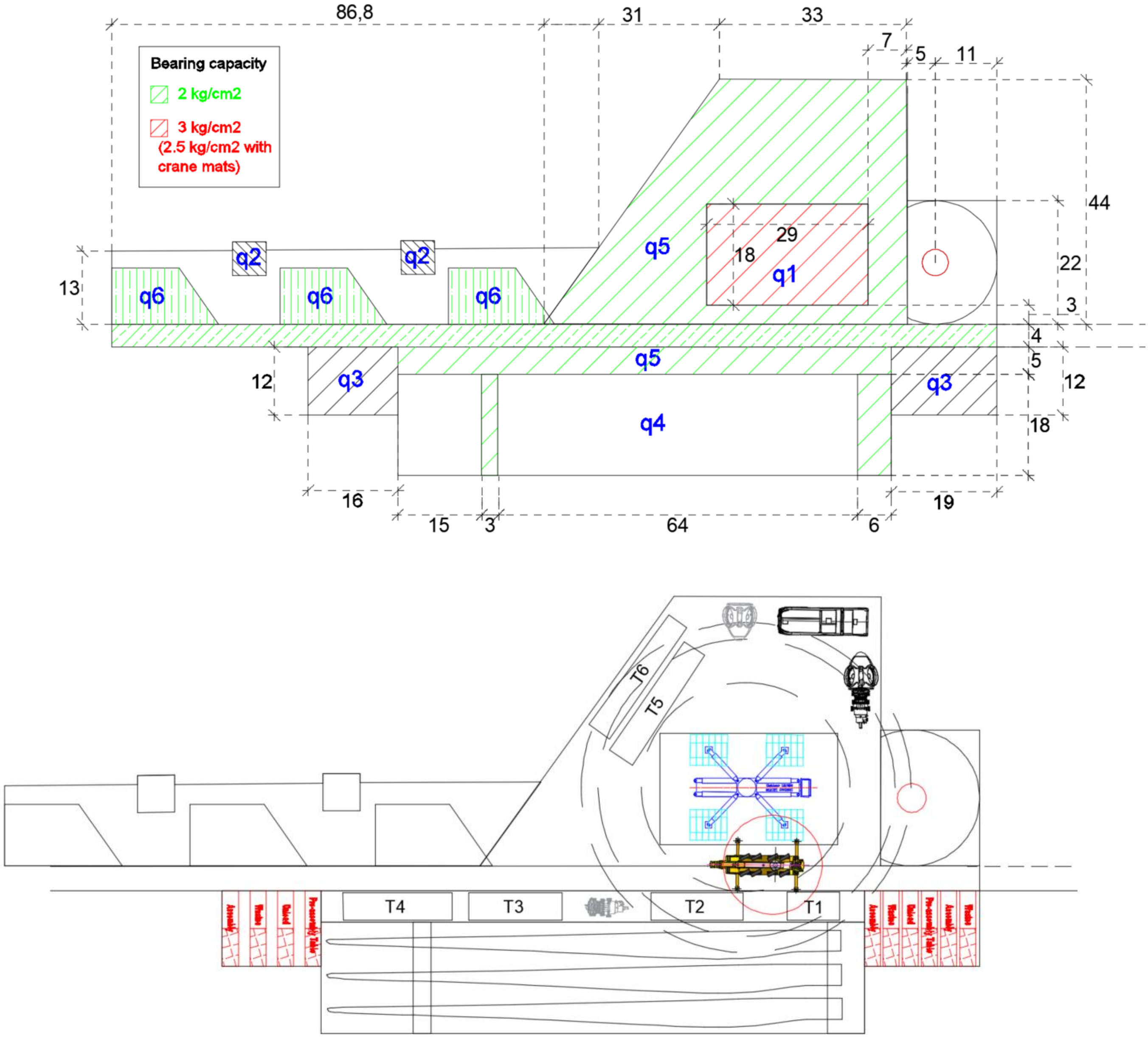


Figure 14 Model T101.5m – Total storage assembling with strategy 3 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE Standard)

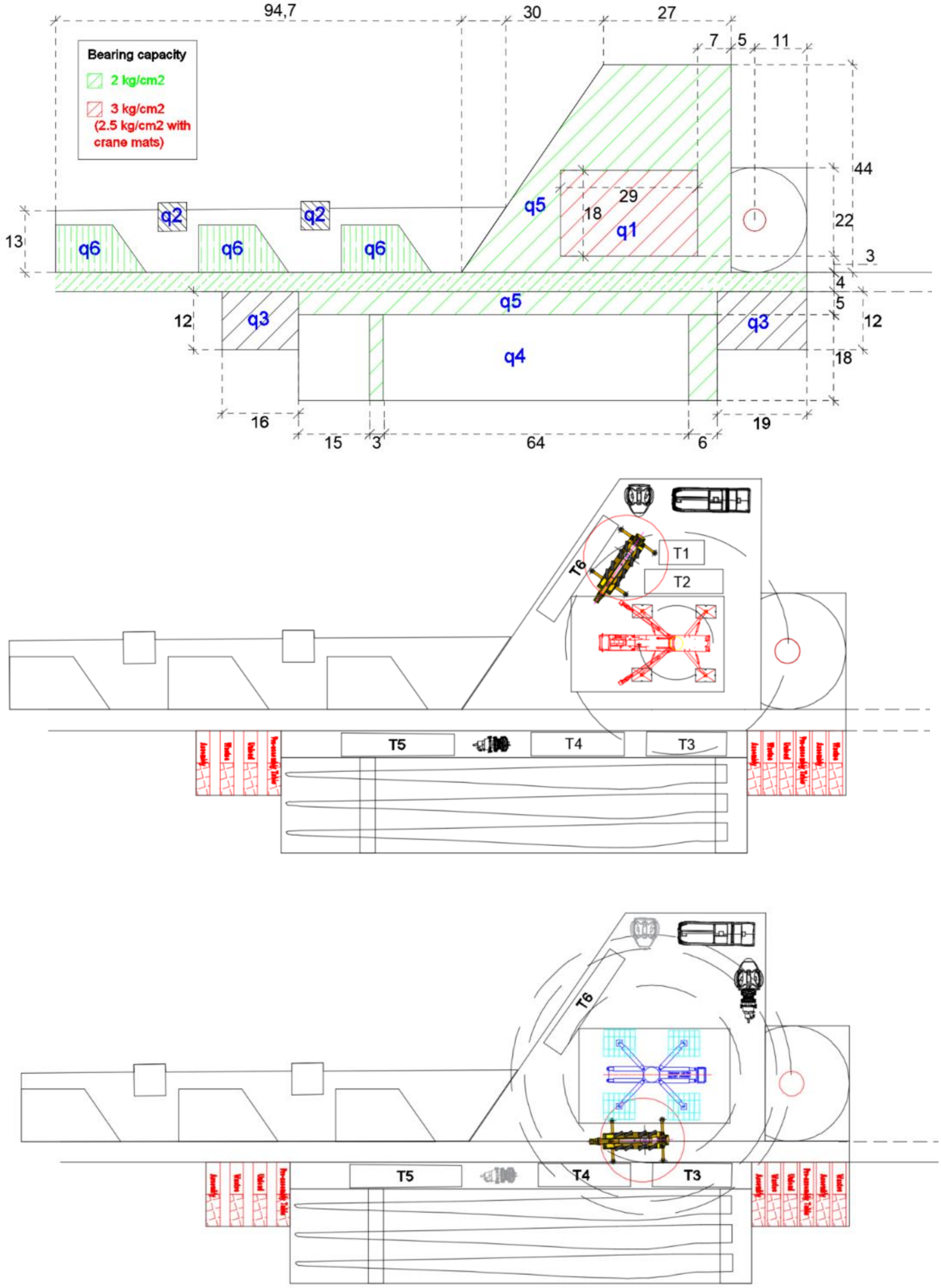


Figure 15 Model T101.5m – Partial storage assembling with strategy 3 in 2 phases

5.5.4. T101.5m tubular steel tower Hardstand with strategy 4

- Tailing crane offloading T101.5m

Storage conditions	Width x length
Total Storage	q1 ....29m x 18m q3 ....16m x 12m + 19m x 12m q4 ....88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 ....36m x 37m + (35m x 37m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6.... dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 ....29m x 18m q3 ....16m x 12m + 19m x 12m q4 ....88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 ....28m x 37m + (35m x 37m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6.... dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 35 Dimensions of the areas of model T101.5m with strategy 4 – Tailing crane offloading

- Total storage – Assembly in 1 phase

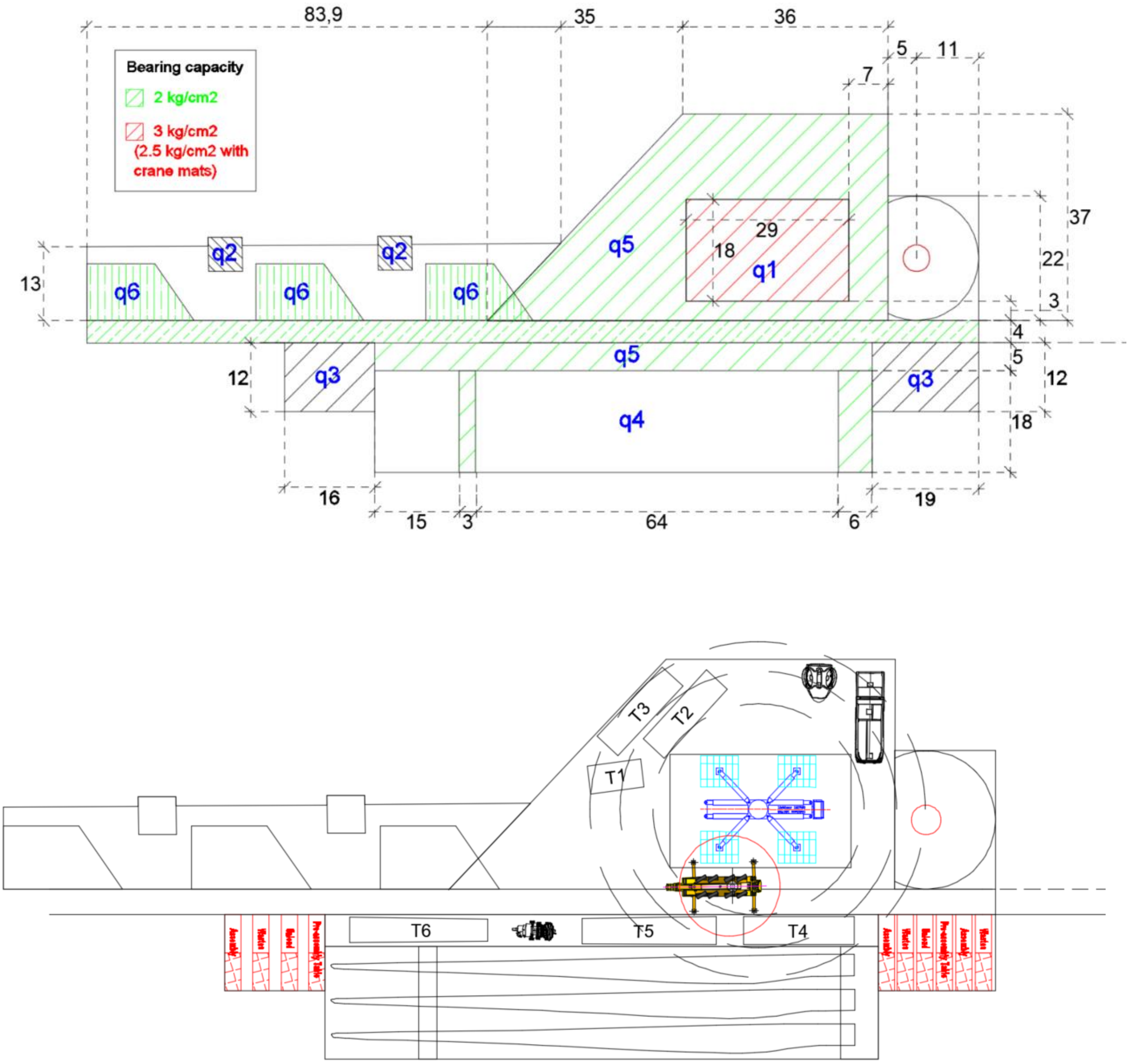


Figure 16 Model T101.5m – Total storage assembling with strategy 4 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard)

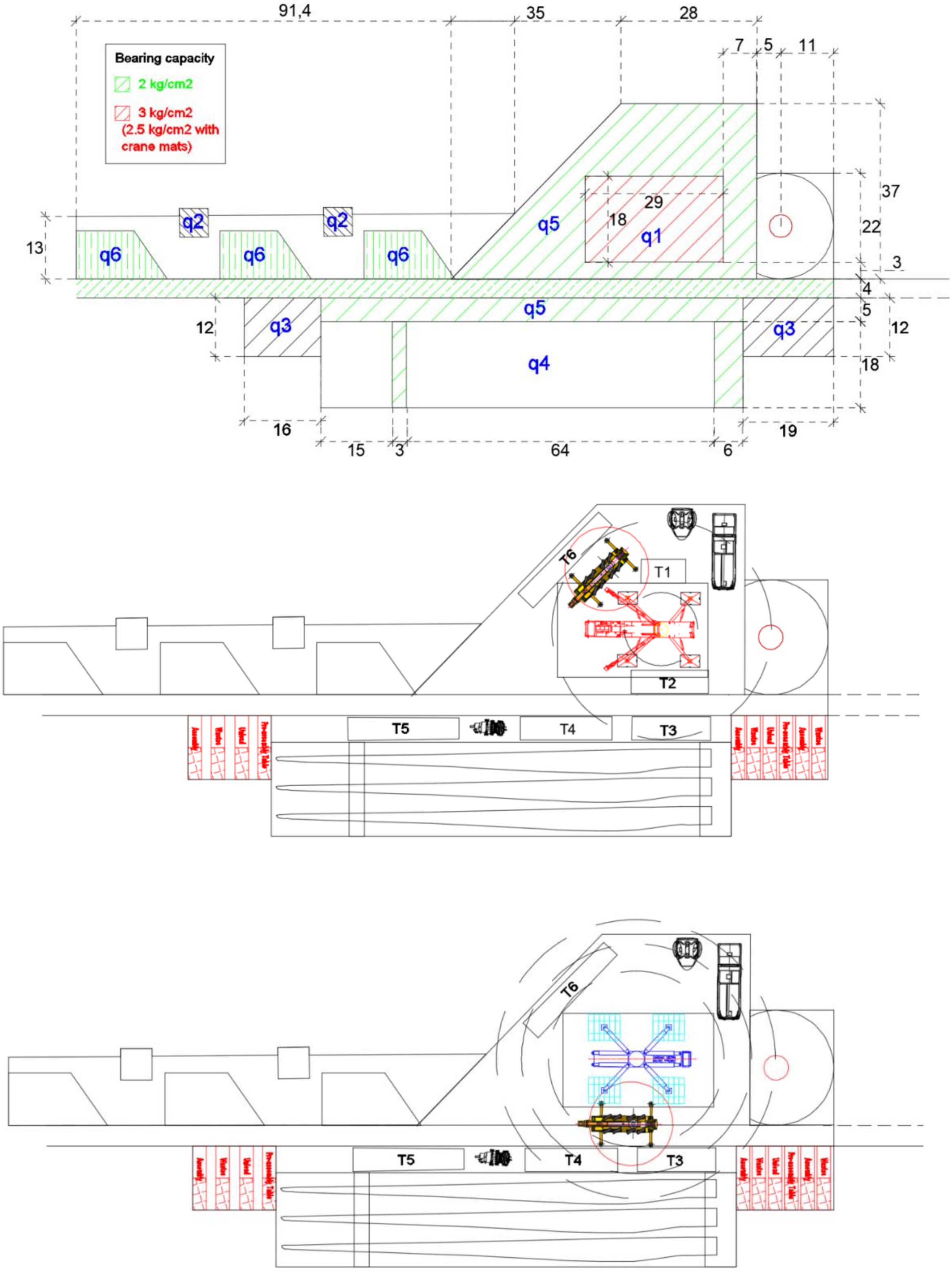


Figure 17 Model T101.5m – Parcial storage assembling with strategy 4 in 1 phase

5.5.5. T115m tubular tower Hardstand with strategy 3

- Tailing crane offloading

Storage conditions	Width x length
Total Storage	q1 ....29m x 18m q3 ....16m x 12m + 19m x 12m q4 ....88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 ....34m x 43m + (46m x 43m)/2 – q1 +88m x 5m + reinforced road part* q2/q6........dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 ....29m x 18m q3 ....16m x 12m + 19m x 12m q4 ....88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 ....33m x 43m + (36m x 43m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6........dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 36 Dimensions of the areas of model T115m with strategy 3 – Tailing crane offloading

- Total storage – assembly in 1 phase

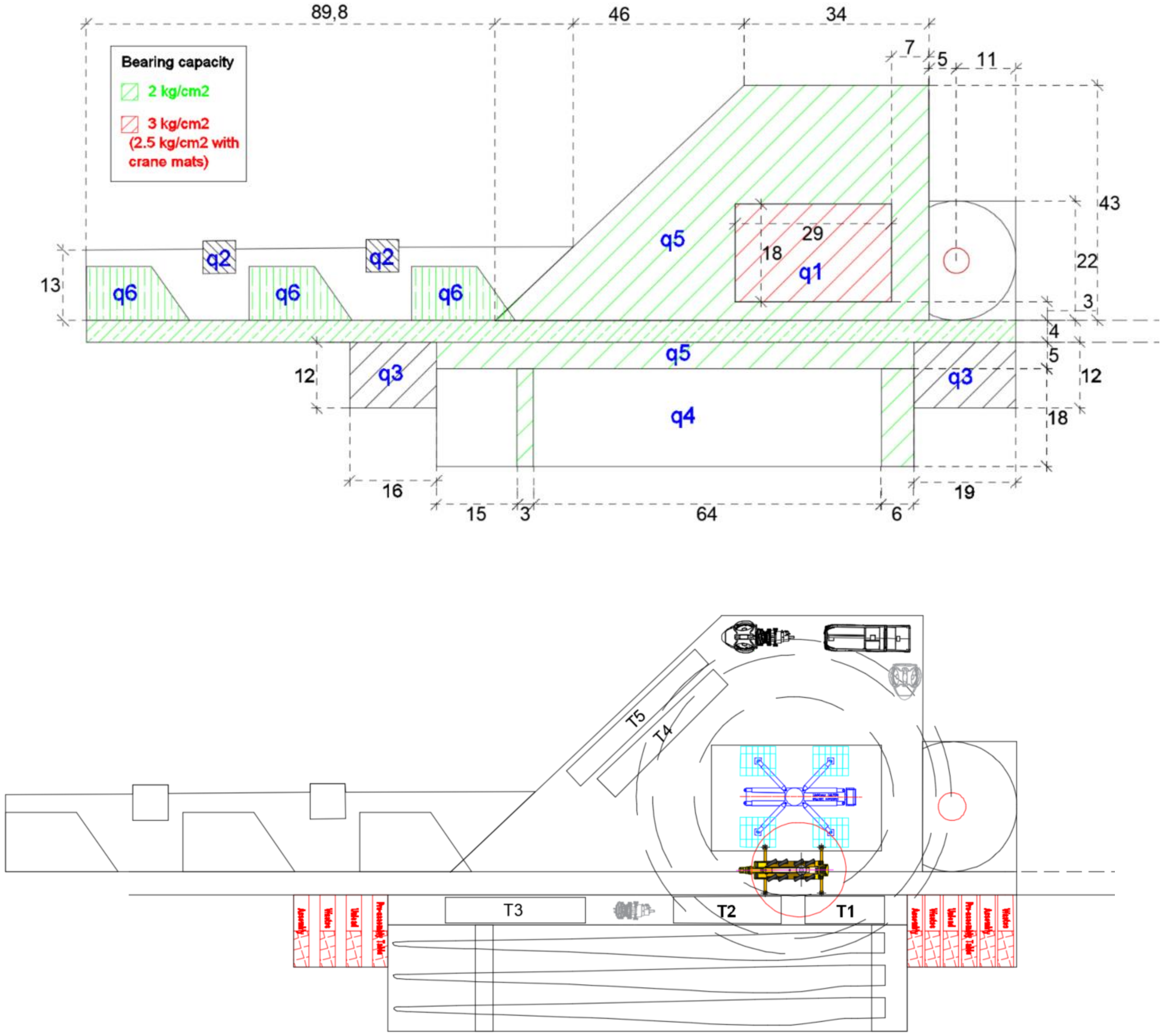


Figure 18 Model T115m – Total storage assembling with strategy 3 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard)

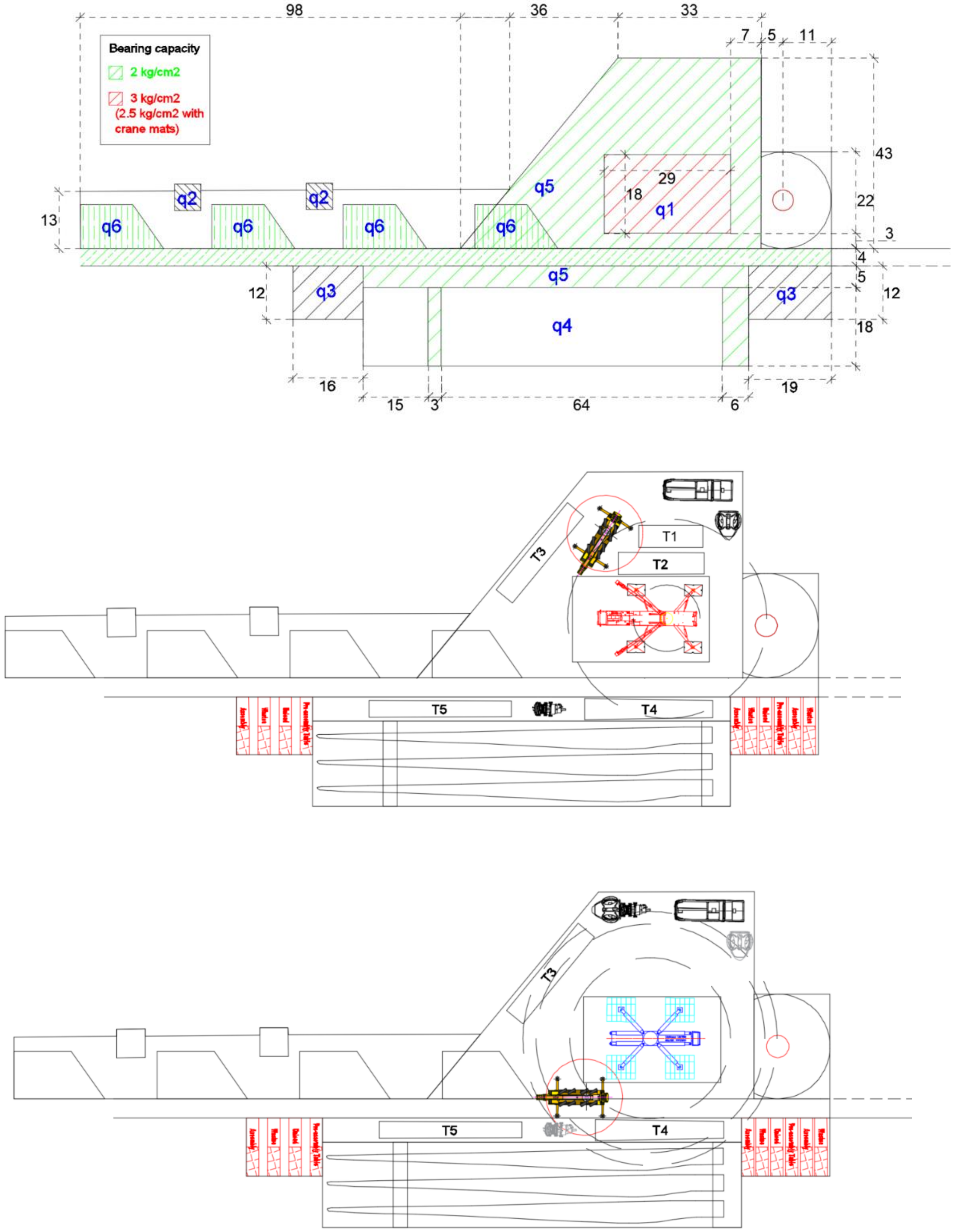


Figure 19 Model T115m – Partial storage assembling with strategy 3 in 2 phases

5.5.6. T115m tubular steel tower Hardstand with strategy 4

- Tailing crane offloading T115m

Storage conditions	Width x length
Total Storage	q1 ....29m x 18m q3 ....16m x 12m + 19m x 12m q4 ....88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 ....33m x 40m + (33m x 40m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6....dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 ....29m x 18m q3 ....16m x 12m + 19m x 12m q4 ....88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 ....30m x 38m + (31m x 38m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6....dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 37 Dimensions of the areas of model T115m with strategy 4 – Tailing crane offloading

- Total storage – Assembly strategy in 1 phase

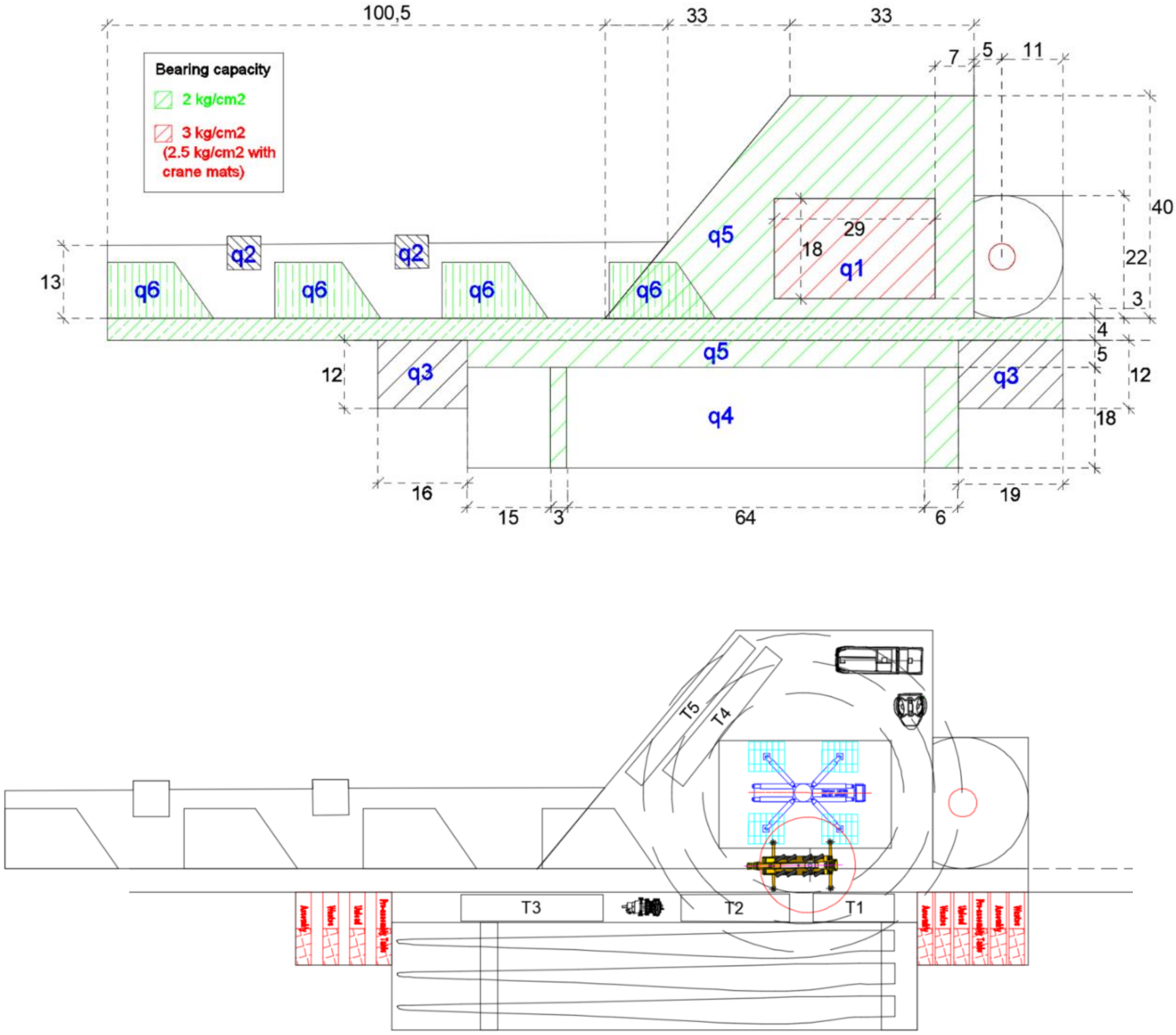


Figure 20 Model T115m – Total storage assembling with strategy 4 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard)

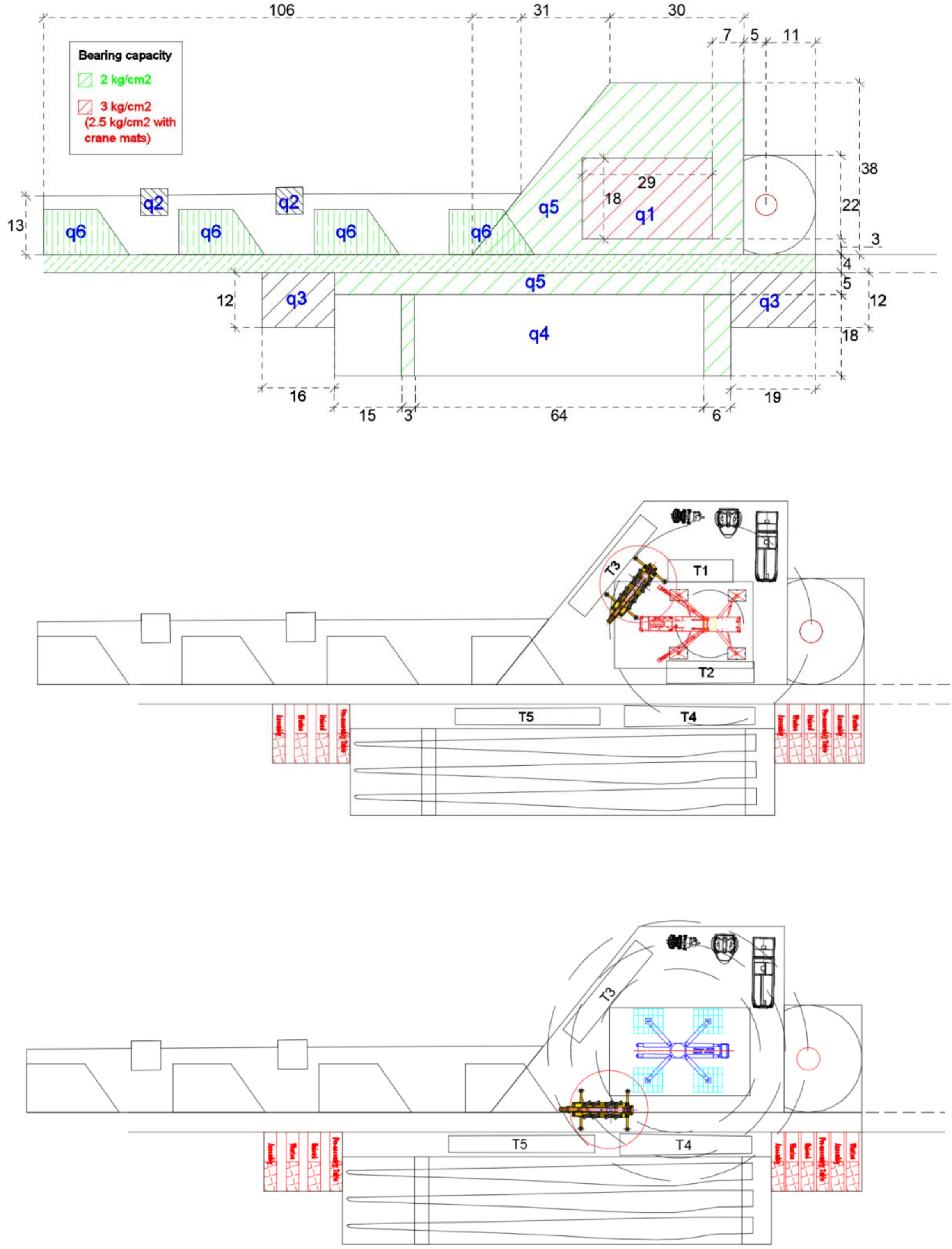


Figure 21 Model T115m – Partial storage assembling with strategy 4 in 2 phases

5.5.7. T135m tubular steel tower Hardstand with strategy 3

- Tailing crane offloading T135m

Storage conditions	Width x length
Total Storage	q1 .... 29m x 18m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 50m x 44m + (45m x 44m)/2 – q1 +88m x 5m + reinforced road part* q2/q6 .... dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 .... 29m x 18m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 41m x 45m + (28m x 45m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6 .... dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 38 Dimensions of the areas of model T135m with strategy 3 – Tailing crane offloading

- Total storage – Assembly in 1 phase – STD tower

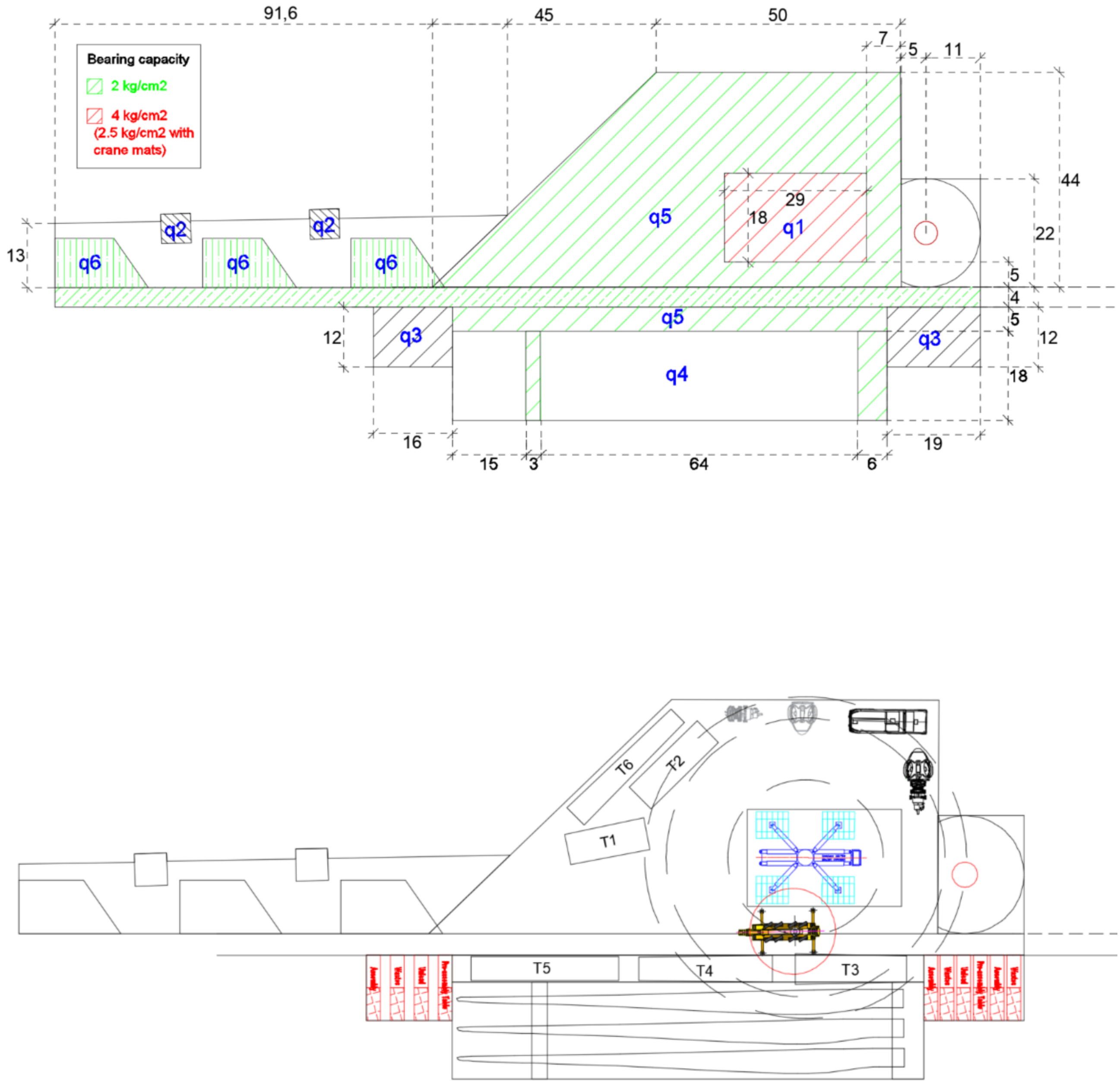


Figure 22 Model T135m – Total storage assembling with strategy 3 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard) – STD tower

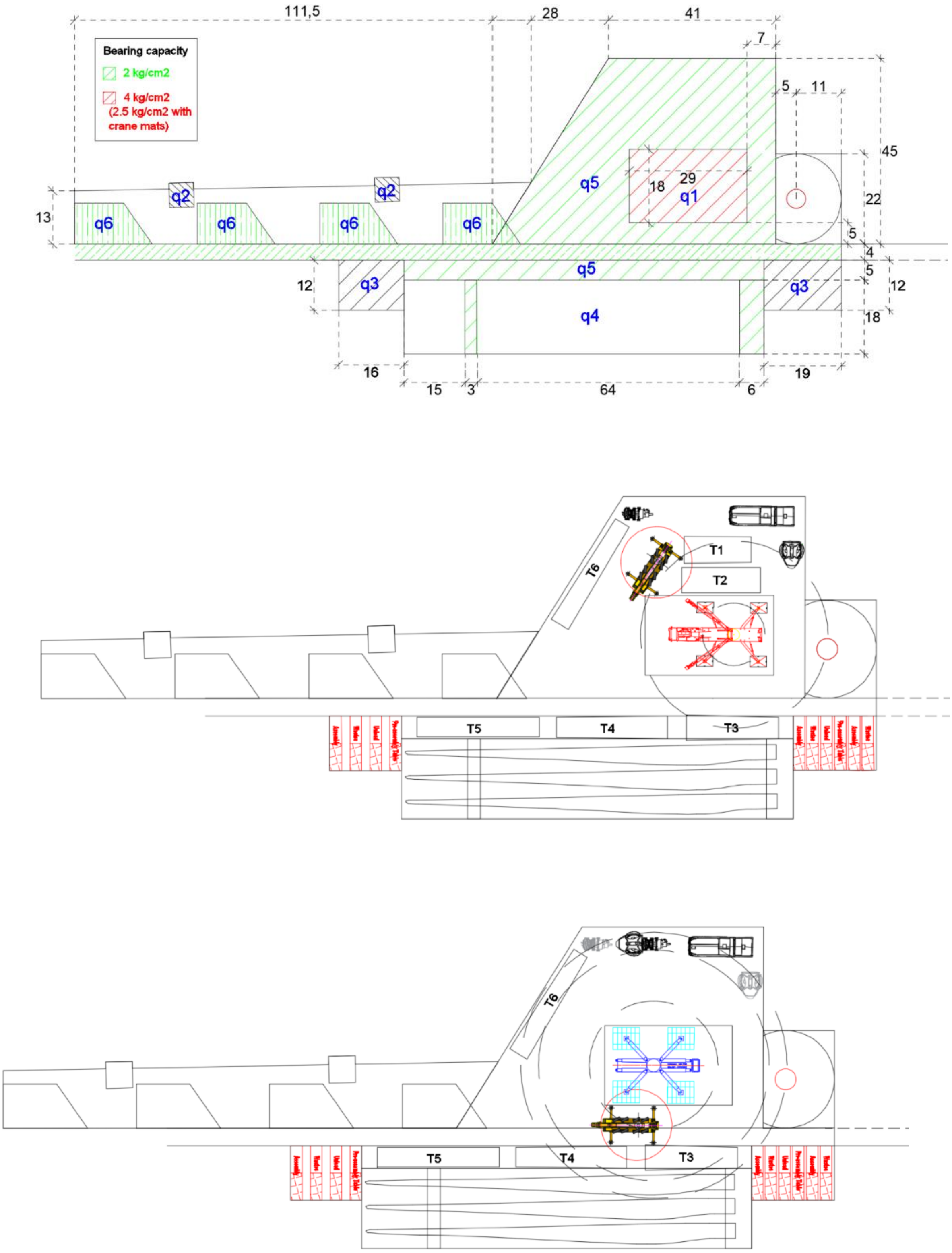


Figure 23 Model T135m -.Partial storage assembling with strategy 3 in 2 phases

5.5.8. T135m tubular steel tower Hardstand with strategy 4

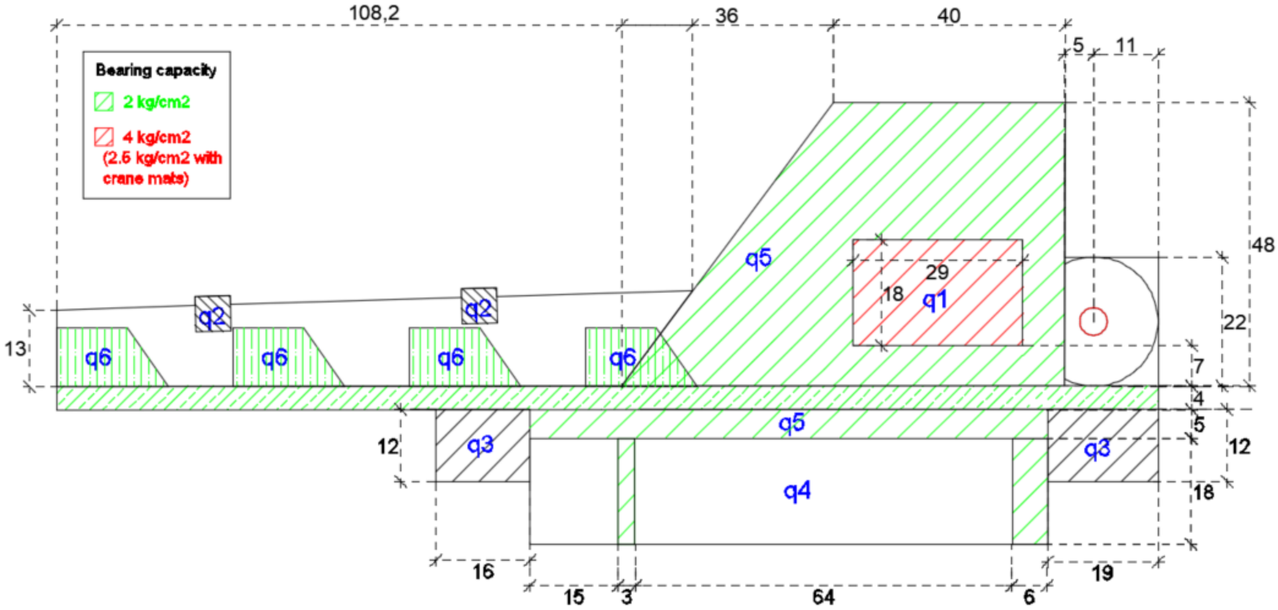
- Tailing crane offloading

Storage conditions	Width x length
Total Storage	q1 .... 29m x 18m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 40m x 48m + (36m x 48m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6 .... dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 .... 29m x 18m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 32m x 48m + (36m x 48m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6 .... dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 39 Dimensions of the areas of model T135m with strategy 4 – Tailing crane offloading

- Total storage – Assembly in 1 phase – STD tower



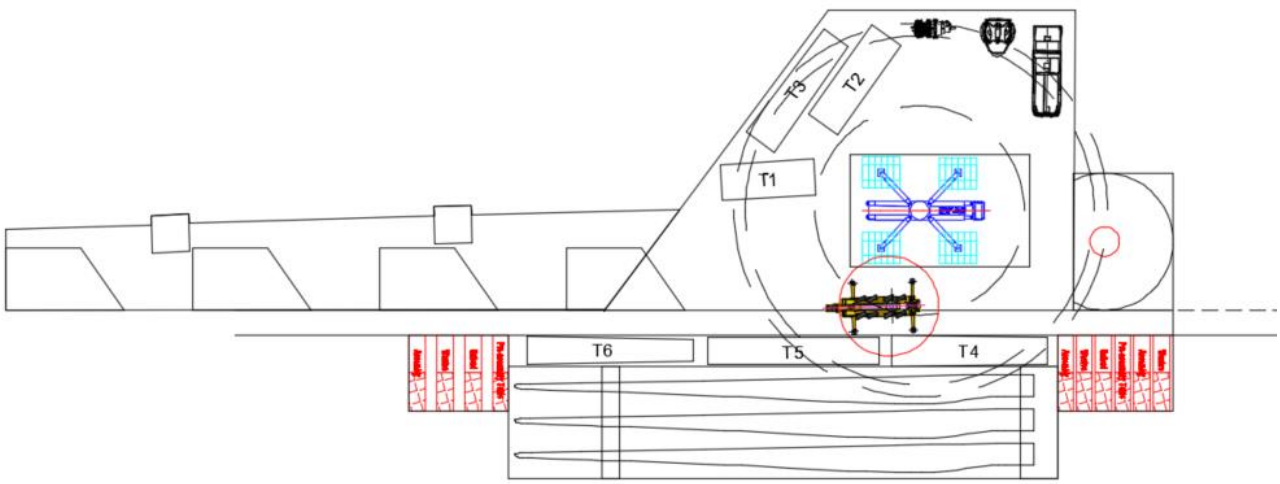


Figure 24 Model T135m – Total storage assembling with strategy 4 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard) – STD tower

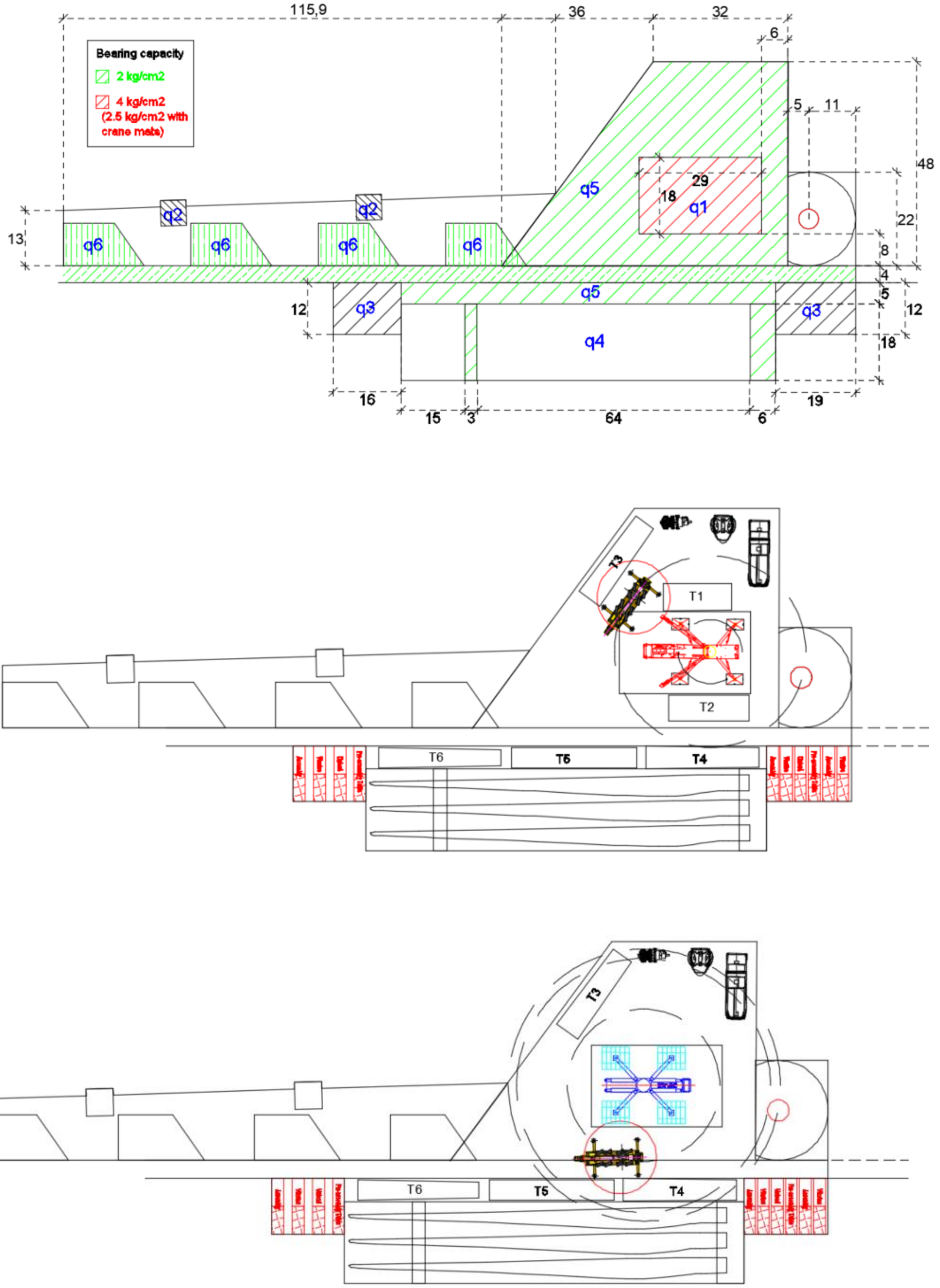


Figure 25 Model T135m -.Partial storage assembling with strategy 4 in 2 phases

5.5.9. T145m steel tower Hardstand with strategy 3

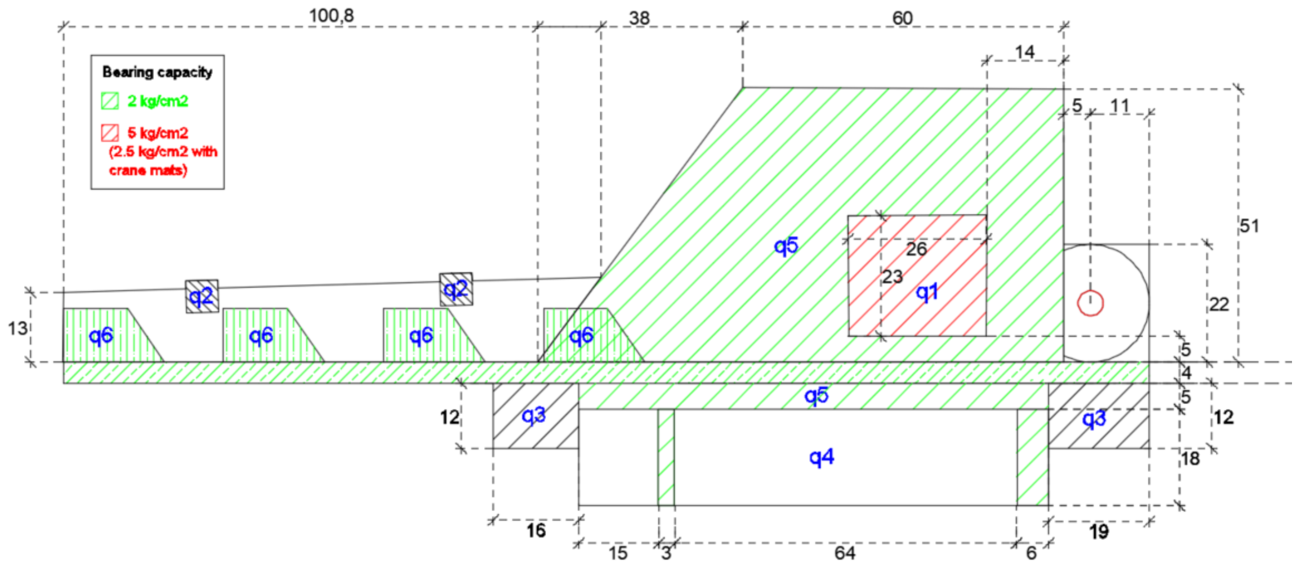
- Tailing crane offloading

Storage conditions	Width x length
Total Storage	q1 .... 26m x 23m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 60m x 51m + (38m x 51m)/2 – q1 +88m x 5m + reinforced road part* q2/q6 .... dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 .... 34m x 23m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 47m x 52m + (44m x 52m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6 .... dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 40 Dimensions of the areas of model T145m with strategy 3 – Tailing crane offloading

- Total storage – Assembly in 1 phase – STD tower



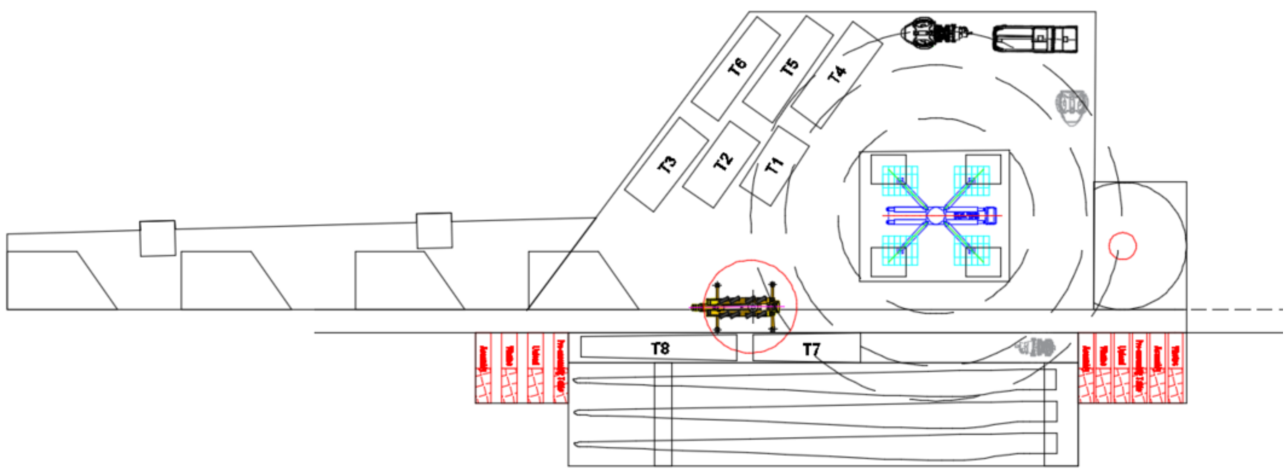
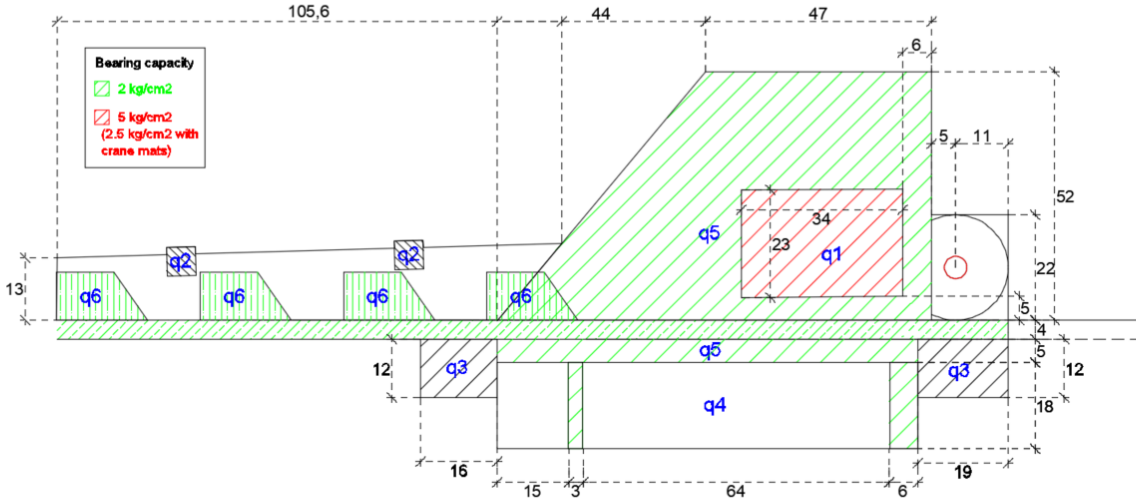
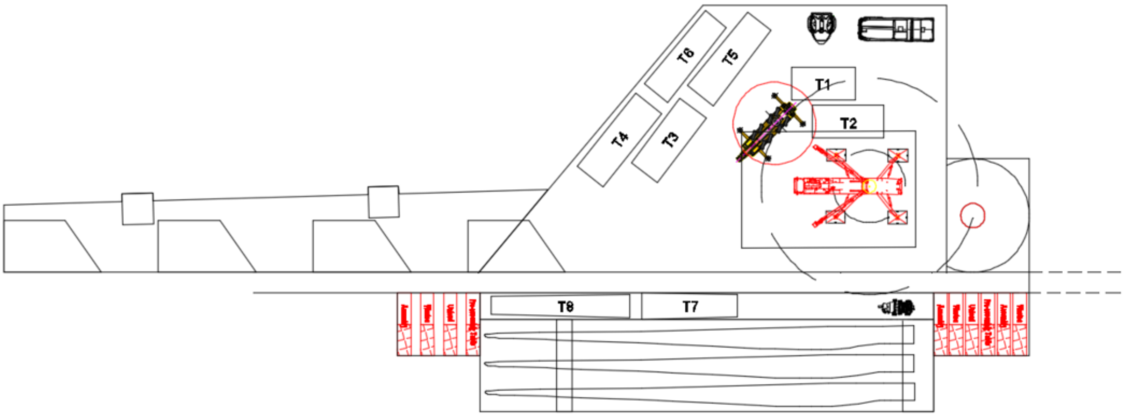


Figure 26 Model T145m – Total storage assembling with strategy 3 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard) – STD tower





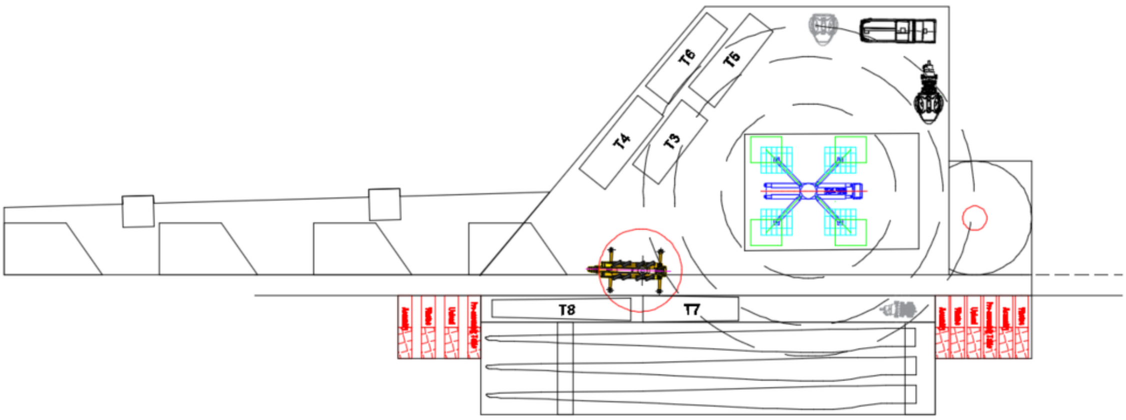


Figure 27 Model T145m -.Partial storage assembling with strategy 3 in 2 phases

5.5.10. T145m tubular steel tower Hardstand with strategy 4

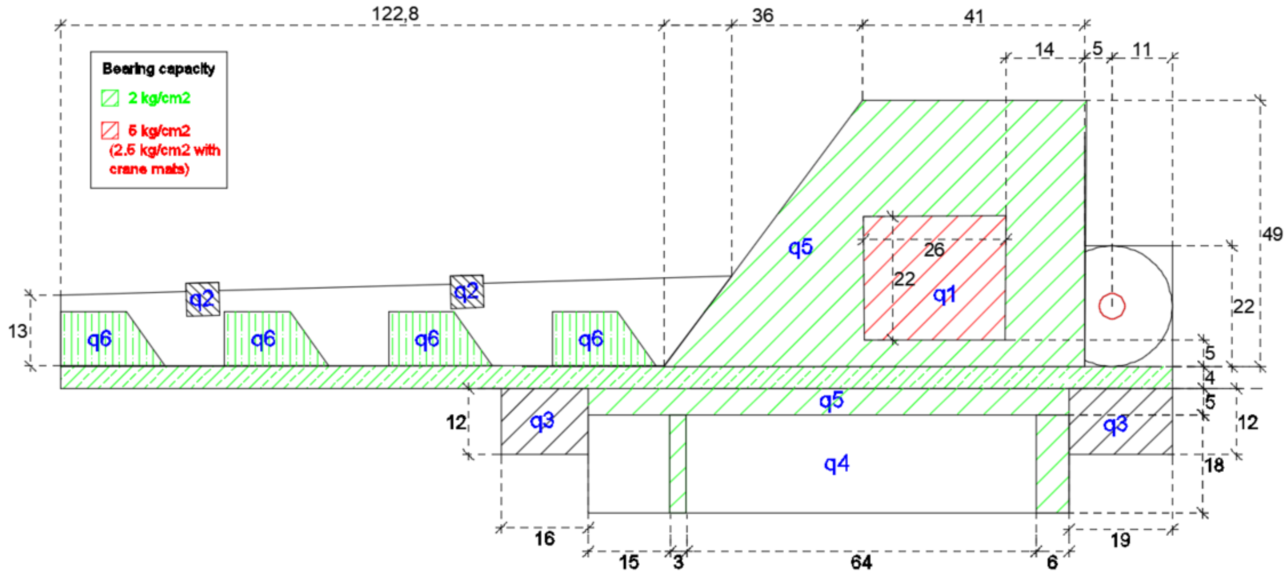
- Tailing crane offloading

Storage conditions	Width x length
Total Storage	q1 .... 26m x 22m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 41m x 49m + (36m x 49m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6 .... dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 .... 34m x 23m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 39m x 49m + (41m x 49m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6 .... dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 41 Dimensions of the areas of model T145m with strategy 4 – Tailing crane offloading

- Total storage – Assembly in 1 phase – STD tower



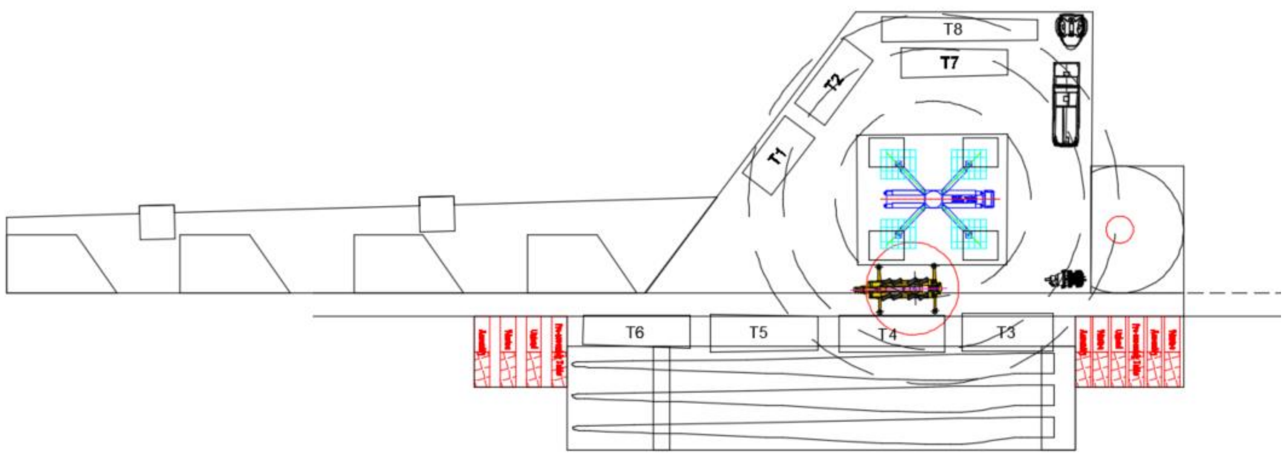


Figure 28 Model T145m – Total storage assembling with strategy 4 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard) – STD tower

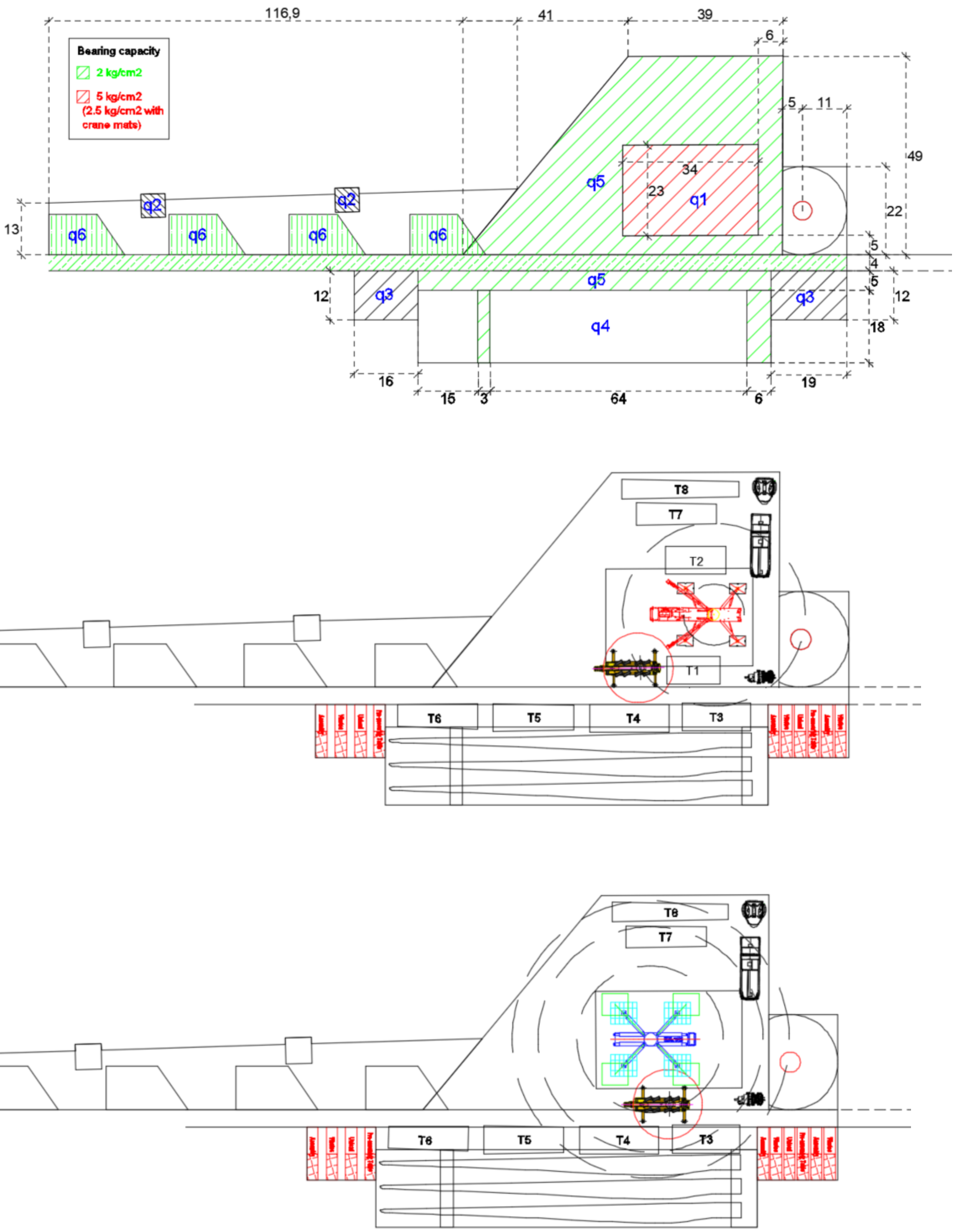


Figure 29 Model T145m -.Partial storage assembling with strategy 4 in 2 phases

5.5.11. T155m tubular steel tower Hardstand with strategy 3

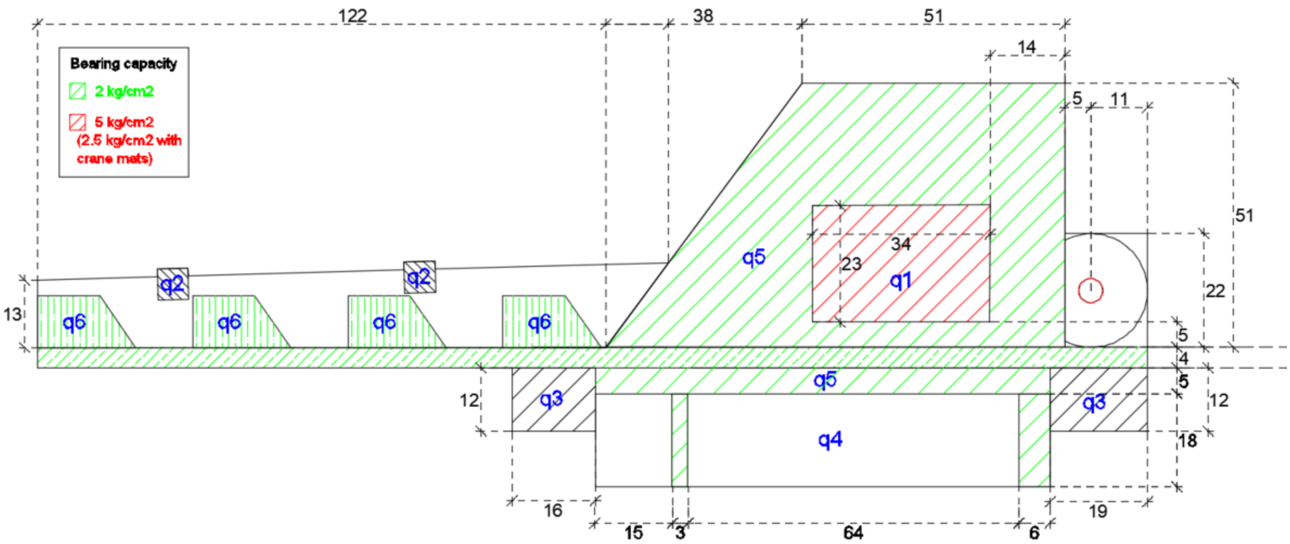
- Tailing crane offloading

Storage conditions	Width x length
Total Storage	q1 .... 34m x 23m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 51m x 51m + (38m x 51m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6........ dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 .... 34m x 23m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 53m x 46m + (38m x 56m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6........ dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 42 Dimensions of the areas of model T155m with strategy 3 – Tailing crane offloading

- Total storage – Assembly in 1 phase – STD tower



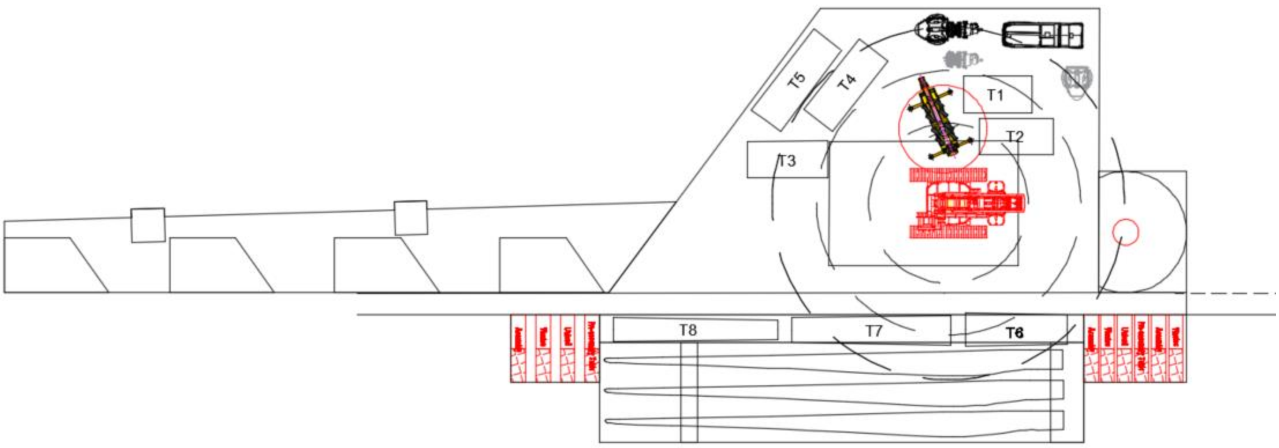


Figure 30 Model T155m – Total storage assembling with strategy 3 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard) – STD tower

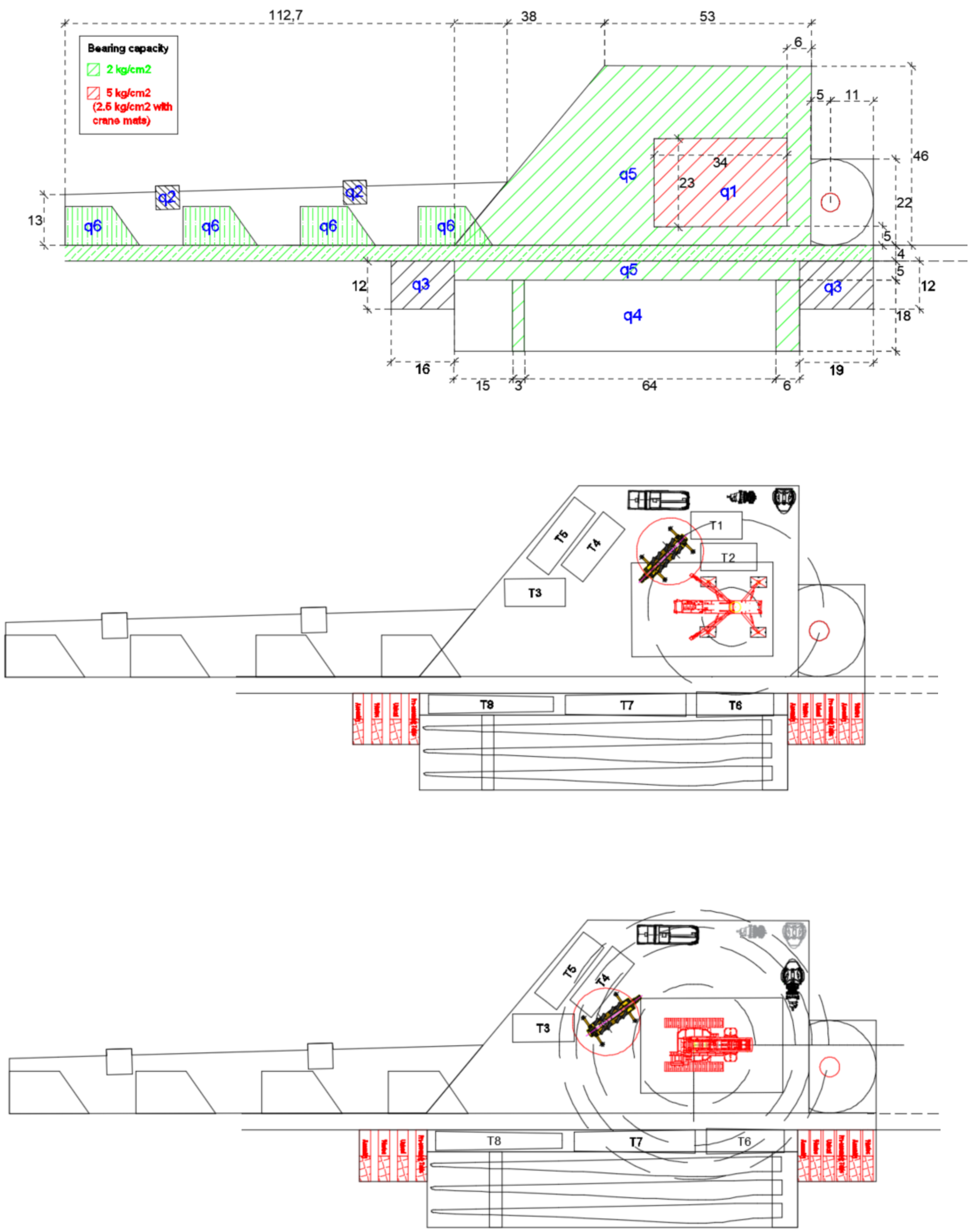


Figure 31 Model T155m -.Partial storage assembling with strategy 3 in 2 phases

5.5.12. T155m tubular steel tower Hardstand with strategy 4

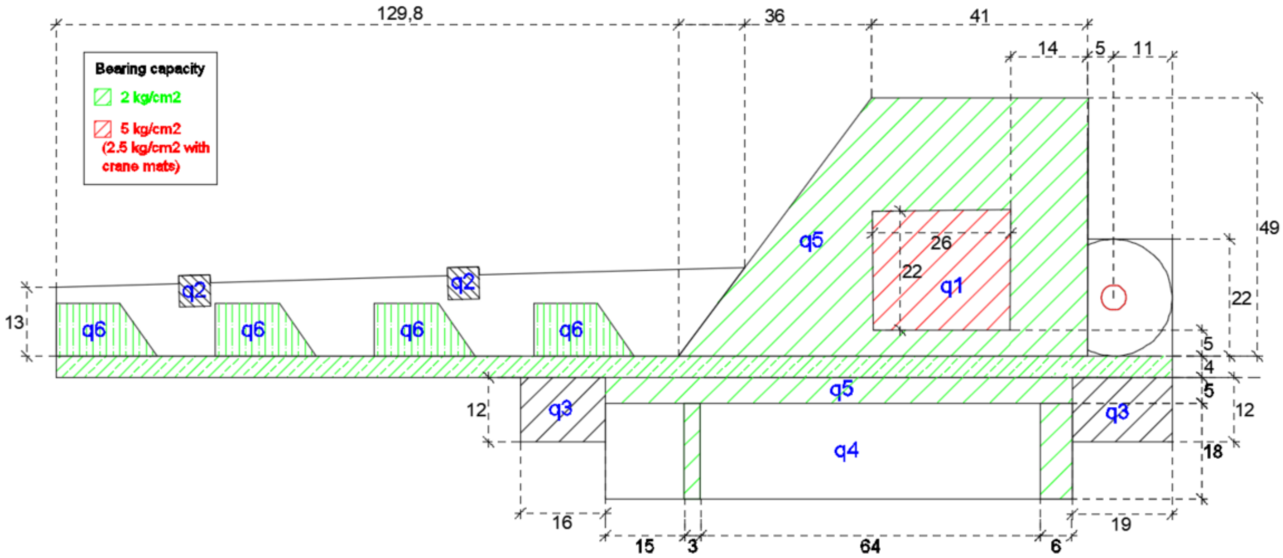
- Tailing crane offloading

Storage conditions	Width x length
Total Storage	q1 .... 26m x 22m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 41m x 49m + (36m x 49m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6........ dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 .... 26m x 22m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 41m x 49m + (36m x 49m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6........dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 43 Dimensions of the areas of model T155m with strategy 4 – Tailing crane offloading

- Total storage – Assembly in 1 phase – STD tower



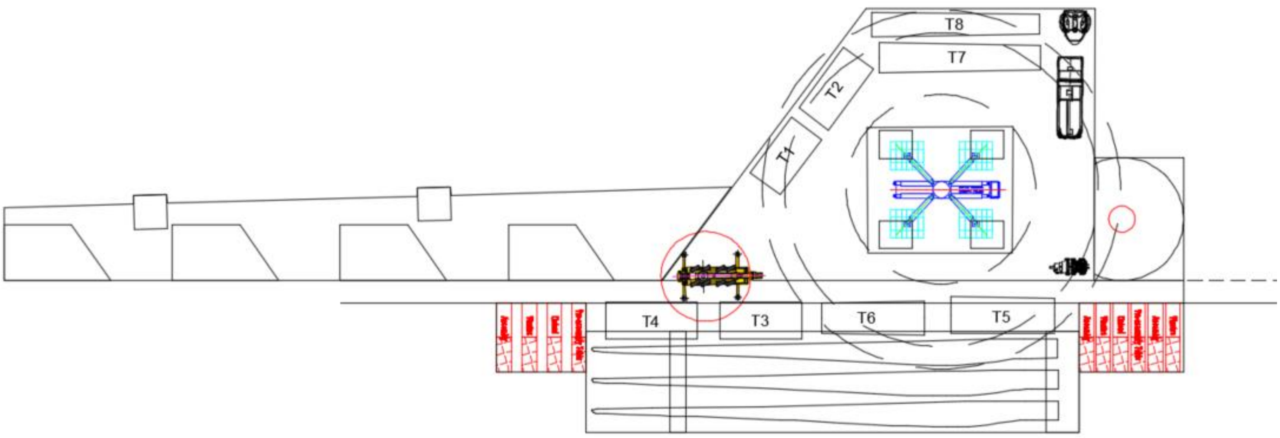


Figure 32 Model T155m – Total storage assembling with strategy 4 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard) – STD tower

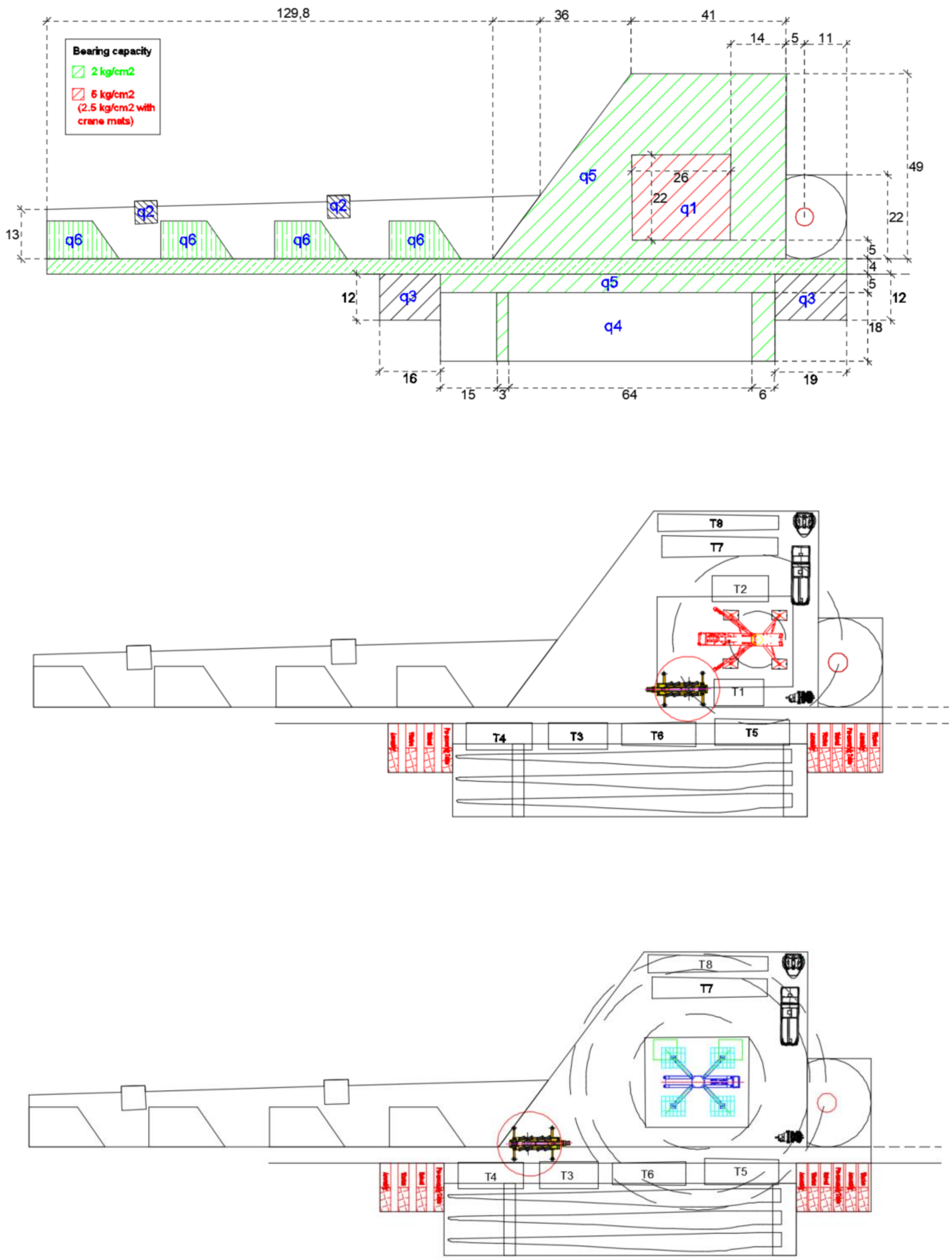


Figure 33 Model T155m -.Partial storage assembling with strategy 4 in 2 phases

5.5.13. T165m MB - WT tubular steel tower Hardstand with strategy 3

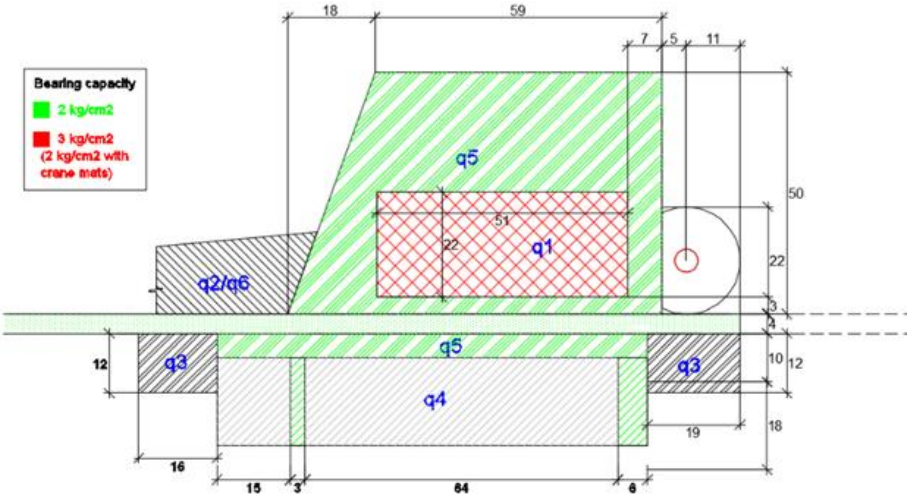
- Tailing crane offloading

Storage conditions	Width x length
Total Storage	q1 .... 51m x 22m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 59m x 50m + (18m x 50m)/2 + 8m x 10m – q1 + 88m x 5m + reinforced road part* q2/q6........ dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 .... 51m x 22m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 53m x 42m + (14m x 42m)/2 + 8m x 10m – q1 + 88m x 5m + reinforced road part* q2/q6........ dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 44 Dimensions of the areas of model T165m MB – WT with strategy 3 – Tailing crane offloading

- Total storage – Assembly in 1 phase



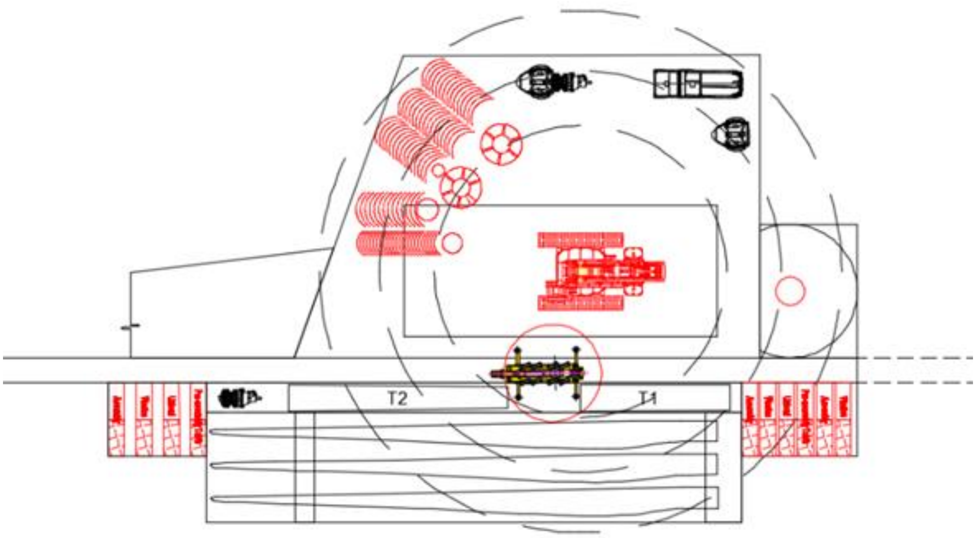


Figure 34 Model T165m MB – WT – Total storage assembling with strategy 3 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard)

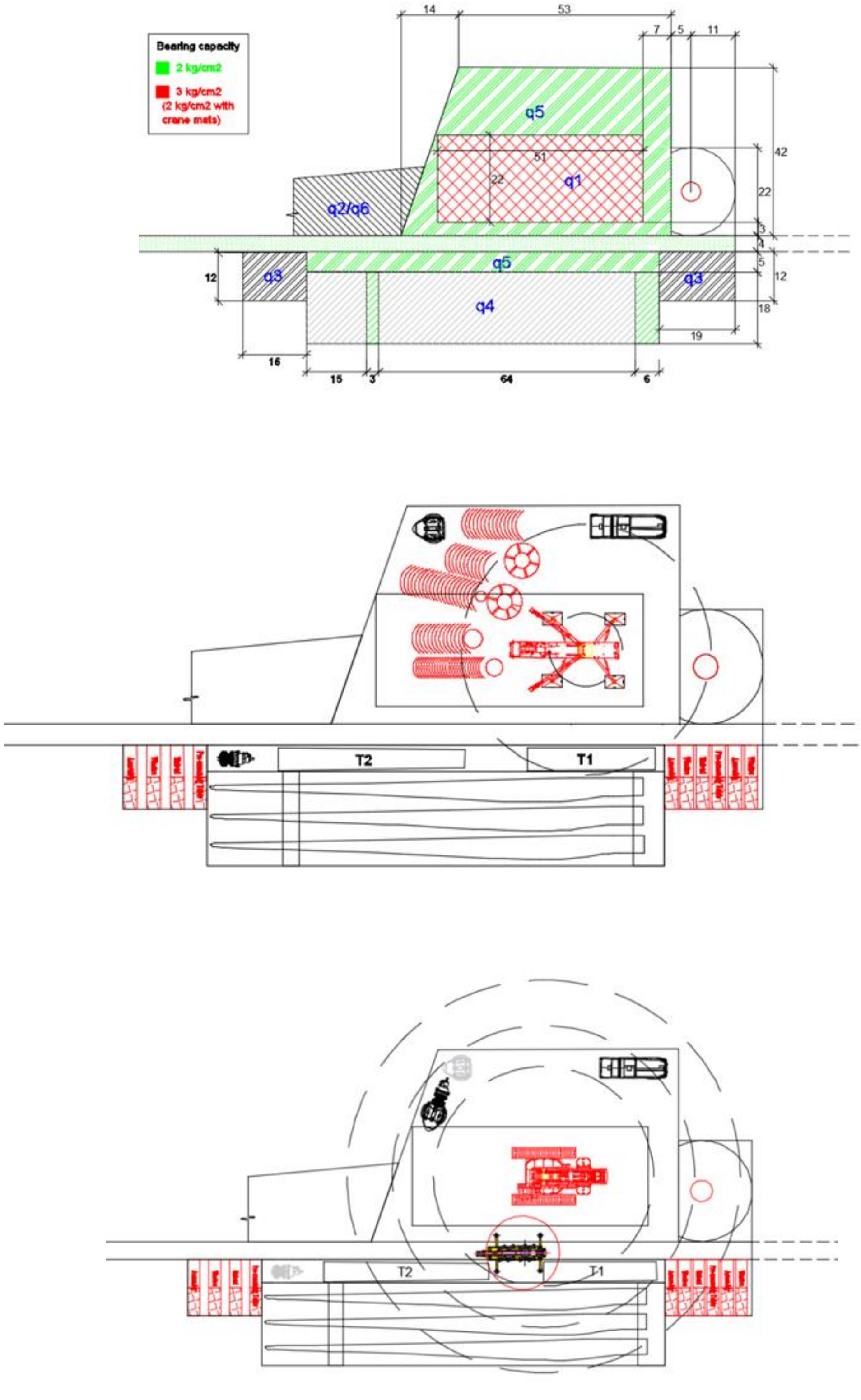


Figure 35 Model T165m MB – WT – Partial storage assembling with strategy 3 in 2 phases

5.5.14. T165m MB – WT tubular steel tower Hardstand with strategy 4

- Tailing crane offloading

Storage conditions	Width x length
Total Storage	q1 .... 33m x 28m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 70m x 50m + (25m x 50m)/2 + 8m x 10m – q1 + 88m x 5m + reinforced road part* q2/q6 .... dimensions according to the 3.2.7. Requirements for assembly the main crane
Partial storage (SGRE standard)	q1 .... 33m x 28m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 51m x 50m + (29m x 50m)/2 + 8m x 10m – q1 + 88m x 5m + reinforced road part* q2/q6 .... dimensions according to the 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

Table 45 Dimensions of the areas of model T165m MB – WT with strategy 4 – Tailing crane offloading

- Total storage – Assembly in 1phase

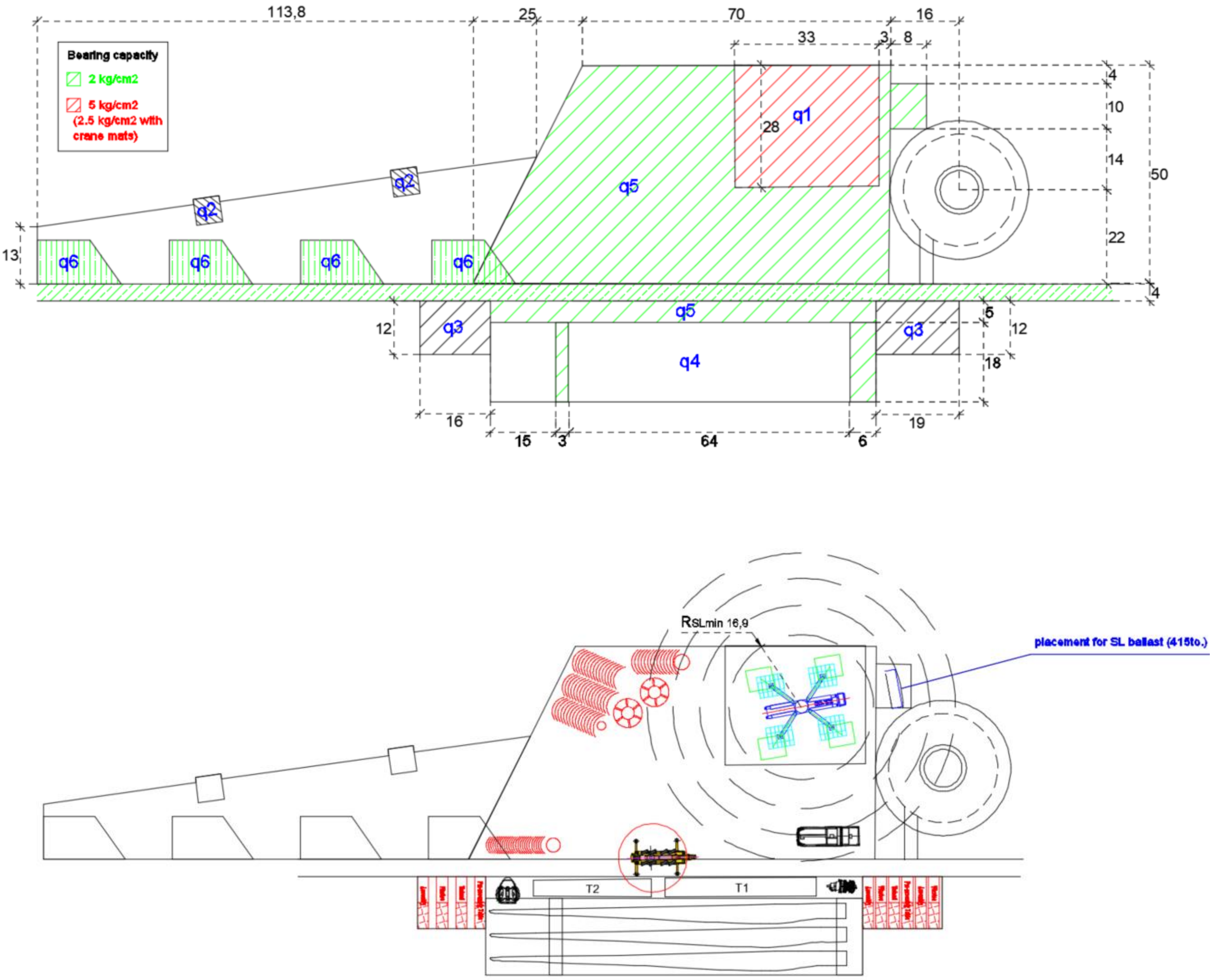


Figure 36 Model T165m MB – WT – Total storage assembling with strategy 4 in 1 phase

- Partial storage – Assembly in 2 phases (SGRE standard)

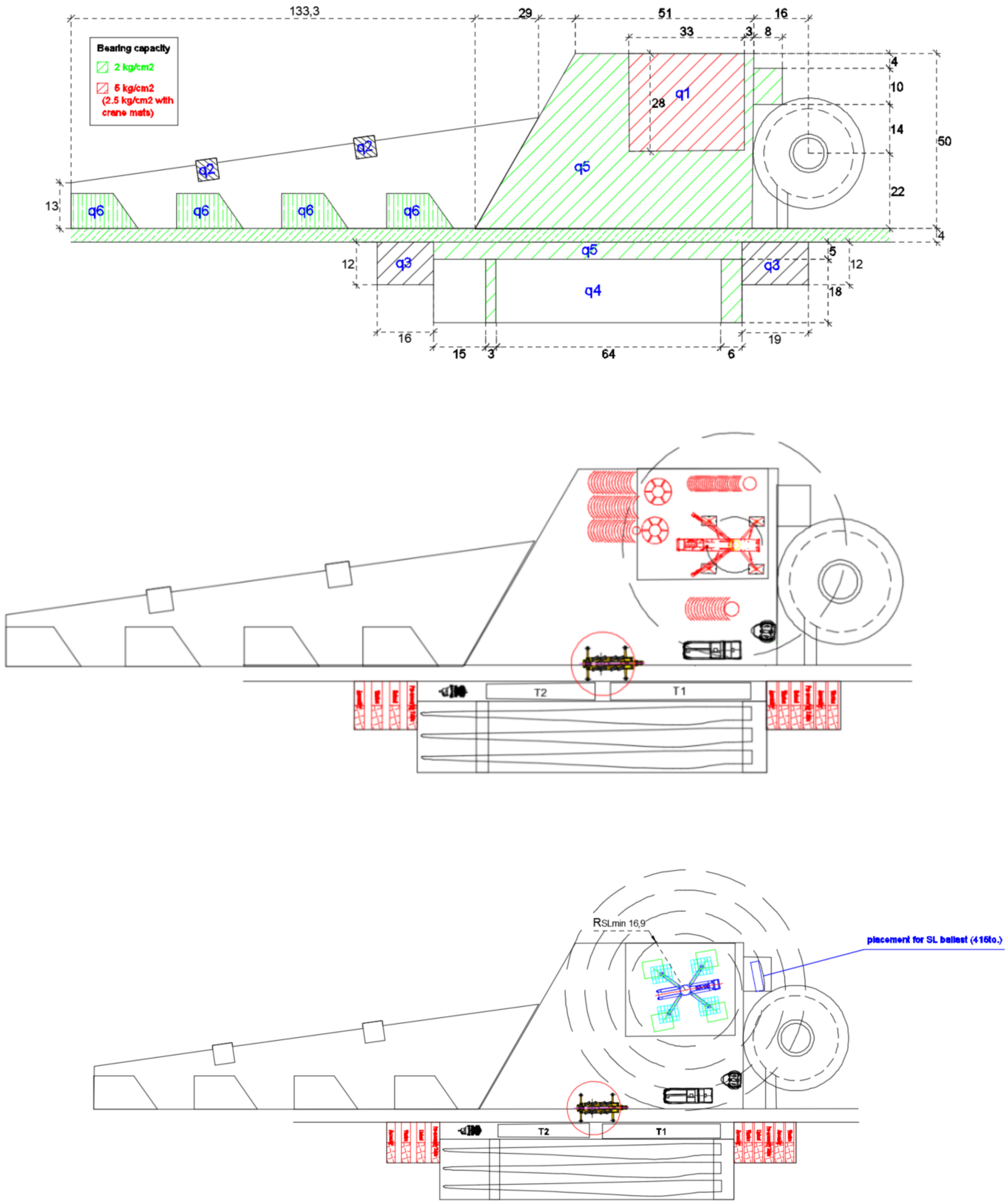


Figure 37 Model T165m MB – WT – Partial storage assembling with strategy 4 in 2 phases

5.5.15. JIT storage tubular steel tower Hardstand

- Tailing crane offloading

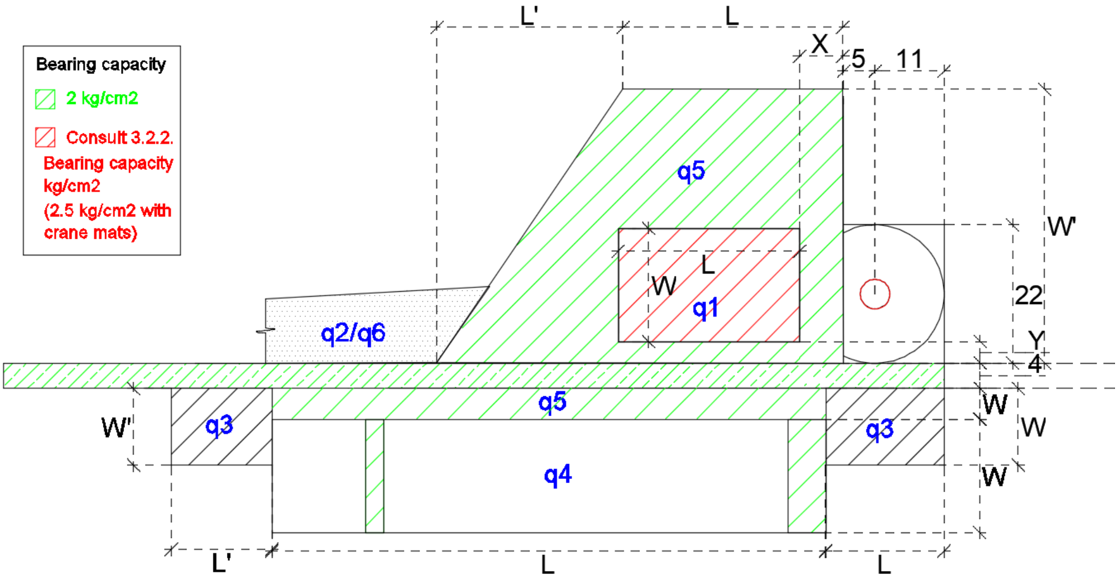
Storage conditions	HH	Width x length
JIT	100 101.5 115 135 **	q1 .... 29m x 18m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 35m x 44m + (30m x 44m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6.......... dimensions according to the 3.2.7. Requirements for assembly the main crane
JIT	145 155	q1 .... 34m x 23m q3 .... 16m x 12m + 19m x 12m q4 .... 88m x 18m (with fingers of q5 hardstand 3m x 18m + 6m x 18m) q5 .... 35m x 44m + (30m x 44m)/2 – q1 + 88m x 5m + reinforced road part* q2/q6.......... dimensions according to the .... 3.2.7. Requirements for assembly the main crane

*Referred to 3.1.4 Road width

** The required dimensions for SE&A JIT hardstands tower height T115m and T135m can be found in document reference INS-62237 Site JIT hardstands in SE&A wind farms.

Table 46 Dimensions of the areas of JIT storage – Tailing crane offloading

- Total storage – Assembly in 1 phase



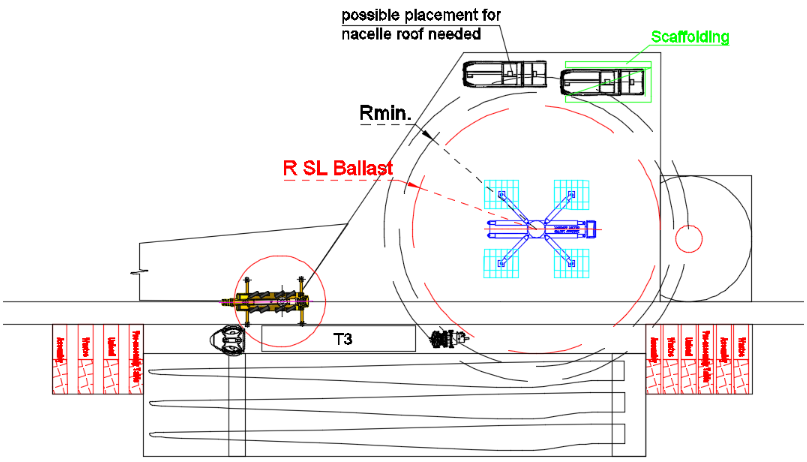


Figure 38 JIT storage reference hardstand

5.5.16. T100m tubular steel tower Hardstand with strategy 4 – Self offloading**

Storage conditions	Width x length
Partial storage (SGRE standard)	q1 .... 50m x 20m + 3m x 15m q2 .... 2 x 6m x 6m q3 .... 20m x 12m q4 .... 88m x 20m (with fingers of q5 hardstand 3m x 20m + 6m x 20m) q5 .... 91m x 10m + 32m x 5m + 5m x 5m + reinforced road part* q6 .... 2 x (12m x 11m + 7m x 11m / 2) q7 .... 40m x 12m

*Referred to 3.1.4 Road width

** This hardstand is available for specific Regions, consult with SGRE if your Region is considered in this group.

Table 47 Dimensions of the areas of model T100m with strategy 4 – Self offloading

- Partial storage – Assembly in 2 phases (SGRE standard)

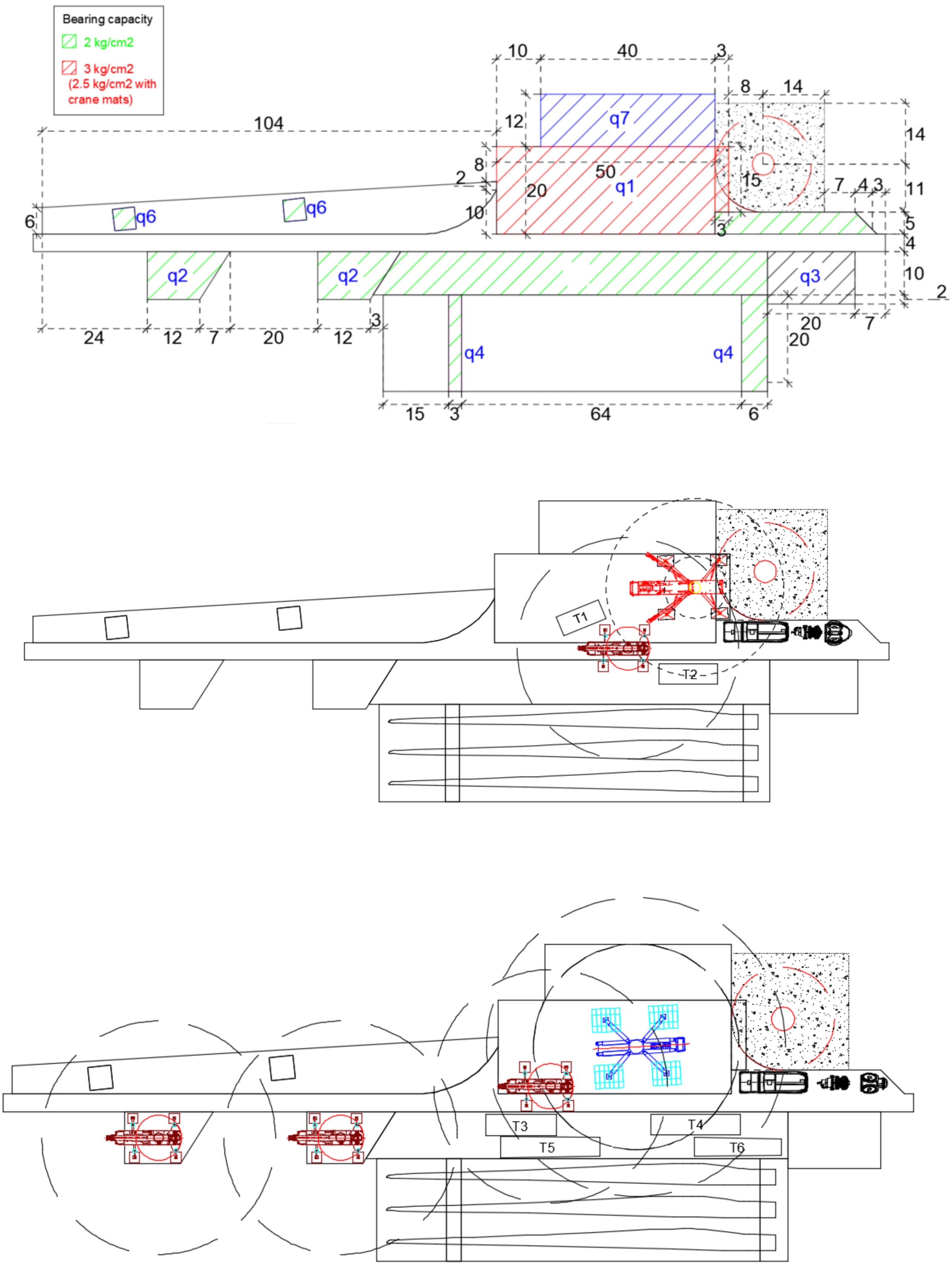


Figure 39 Model T100m – Partial storage assembling with strategy 4 in 2 phases – Self offloading

5.5.17. T115m tubular steel tower Hardstand with strategy 4 – Self offloading**

Storage conditions	Width x length
Partial storage (SGRE standard)	q1 .... 50m x 20m + 3m x 15m q2 .... 2 x 6m x 6m q3 .... 20m x 12m q4 .... 88m x 20m (with fingers of q5 hardstand 3m x 20m + 6m x 20m) q5 .... 103m x 10m + 32m x 5m + 5m x 5m + reinforced road part* q6 .... 2 x (12m x 11m + 7m x 11m / 2) q7 .... 40m x 12m

*Referred to 3.1.4 Road width

** This hardstand is available for specific Regions, consult with SGRE if your Region is considered in this group

Table 48 Dimensions of the areas of model T115m with strategy 4 – Self offloading

- Partial storage – Assembly in 2 phases (SGRE standard)

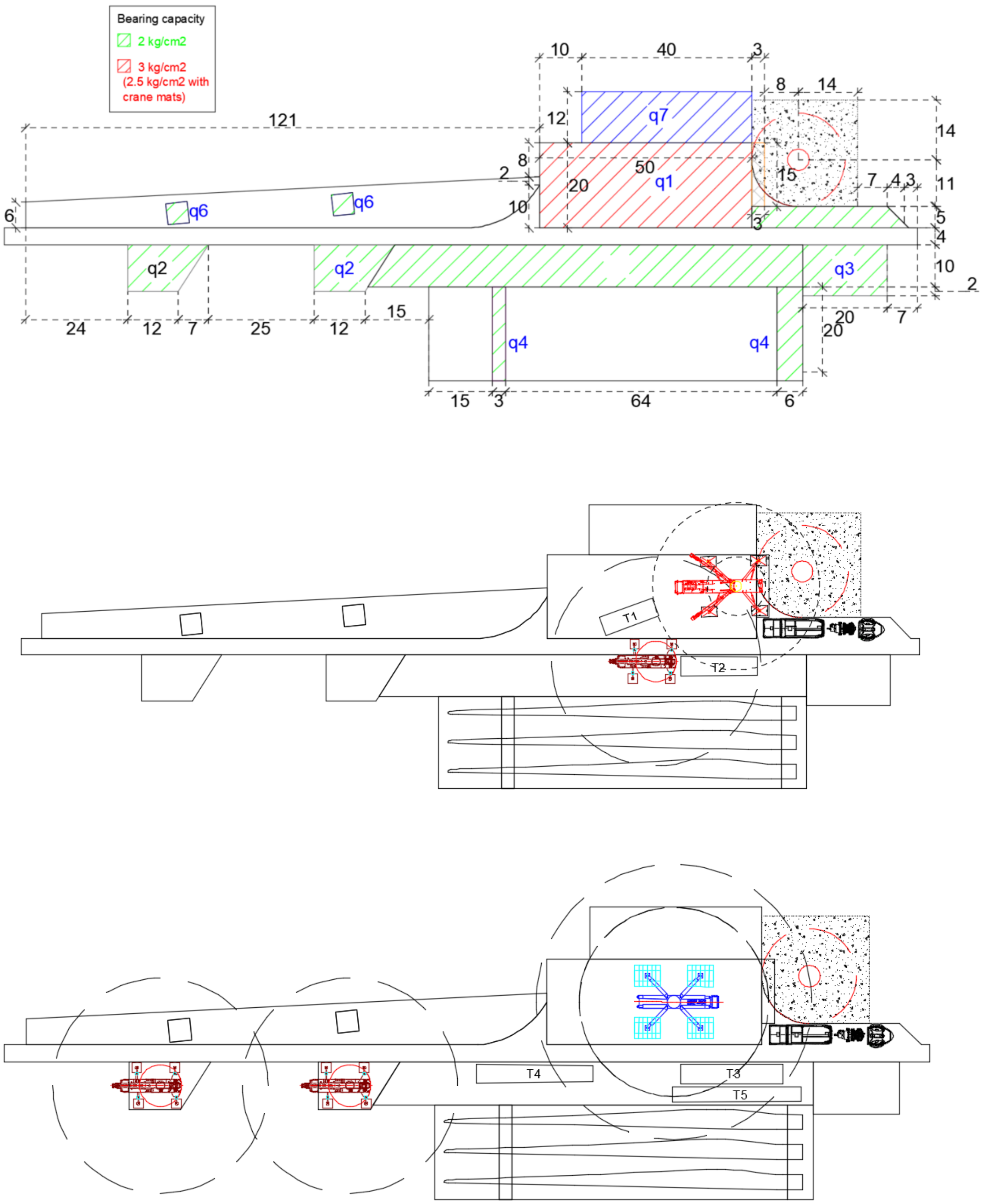


Figure 40 Model T115m – Partial storage assembling with strategy 4 in 2 phases – Self offloading

5.5.18. T135m tubular steel tower Hardstand with strategy 4 – Self offloading**

Storage conditions	Width x length
Partial storage (SGRE standard)	q1 .... 50m x 20m + 3m x 15m q2 .... 2 x 6m x 6m q3 .... 20m x 12m q4 .... 88m x 20m (with fingers of q5 hardstand 3m x 20m + 6m x 20m) q5 .... 103m x 11m + 32m x 5m + 5m x 5m + reinforced road part* q6 .... 2 x (12m x 11m + 7m x 11m / 2) q7 .... 40m x 12m

*Referred to 3.1.4 Road width

** This hardstand is available for specific Regions, consult with SGRE if your Region is considered in this group

Table 49 Dimensions of the areas of model T135m with strategy 4 – Self offloading

- Partial storage – Assembly in 2 phases (SGRE standard)

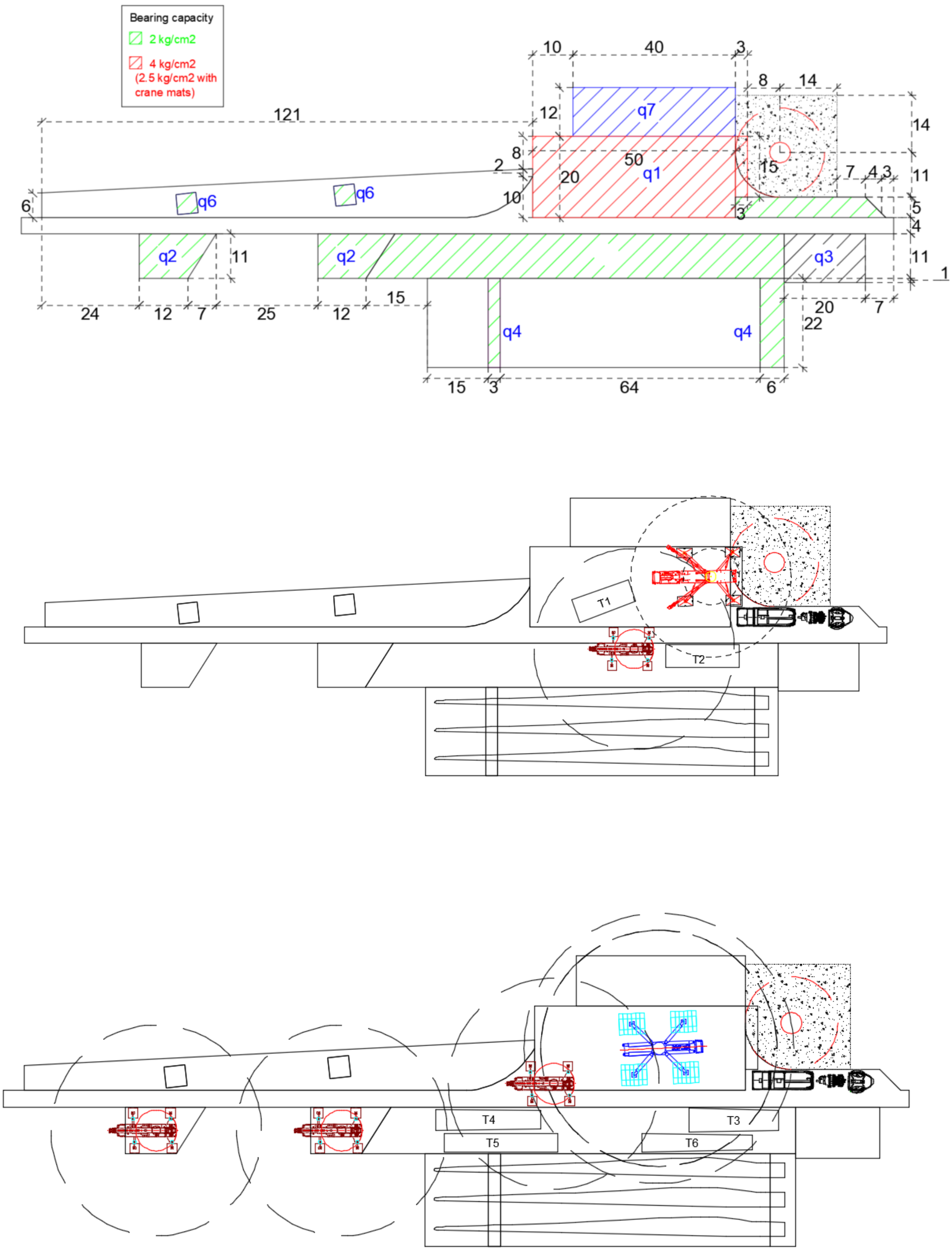


Figure 41 Model T135m – Partial storage assembling with strategy 4 in 2 phases – Self offloading

5.5.19. T145m tubular steel tower Hardstand with strategy 4 – Self offloading**

Storage conditions	Width x length
Partial storage (SGRE standard)	q1 .... 50m x 20m + 3m x 15m q2 .... 3 x 6m x 6m q3 .... 20m x 12m q4 .... 88m x 22m (with fingers of q5 hardstand 3m x 22m + 6m x 22m) q5 .... 88m x 20m + 39m x 5m + 5m x 5m + reinforced road part* q6 .... 3 x (12m x 11m + 7m x 11m / 2) q7 .... 40m x 12m

*Referred to 3.1.4 Road width

** This hardstand is available for specific Regions, consult with SGRE if your Region is considered in this group

Table 50 Dimensions of the areas of model T145m with strategy 4 – Self offloading

- Partial storage – Assembly in 2 phases (SGRE standard)

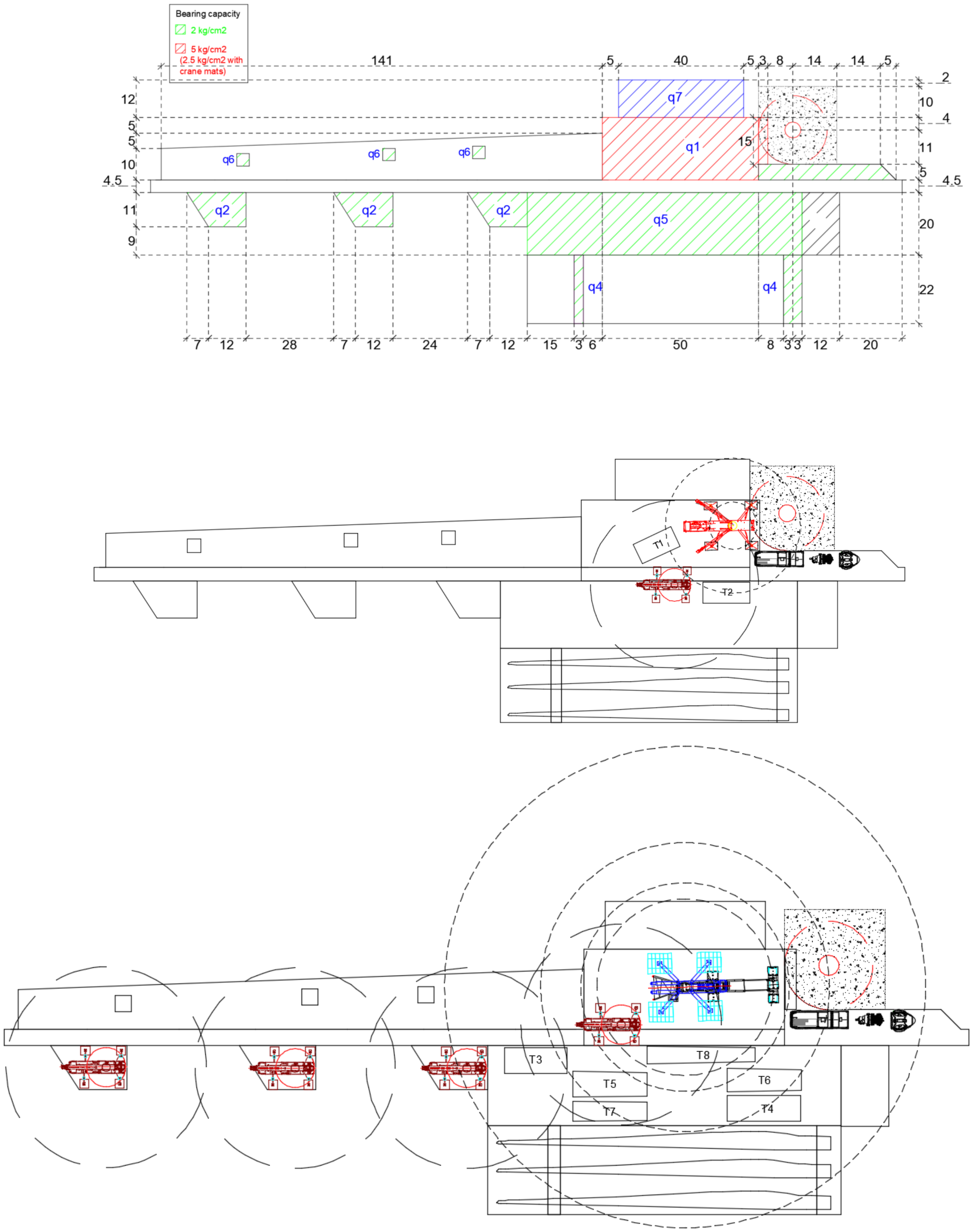


Figure 42 Model T145m – Partial storage assembling with strategy 4 in 2 phases – Self offloading

5.5.20. T155m tubular steel tower Hardstand with strategy 4 – Self offloading**

Storage conditions	Width x length
Partial storage (SGRE standard)	q1 .... 50m x 20m + 3m x 15m q2 .... 3 x 6m x 6m q3 .... 16m x 21m q4 .... 88m x 22m (with fingers of q5 hardstand 3m x 22m + 6m x 22m) q5 .... 88m x 21m + 39m x 5m + 5m x 5m + reinforced road part* q6 .... 3 x (12m x 11m + 7m x 11m / 2) q7 .... 40m x 12m

*Referred to 3.1.4 Road width

** This hardstand is available for specific Regions, consult with SGRE if your Region is considered in this group

Table 51 Dimensions of the areas of model T155m with strategy 4 – Self offloading

- Partial storage – Assembly in 2 phases (SGRE standard)

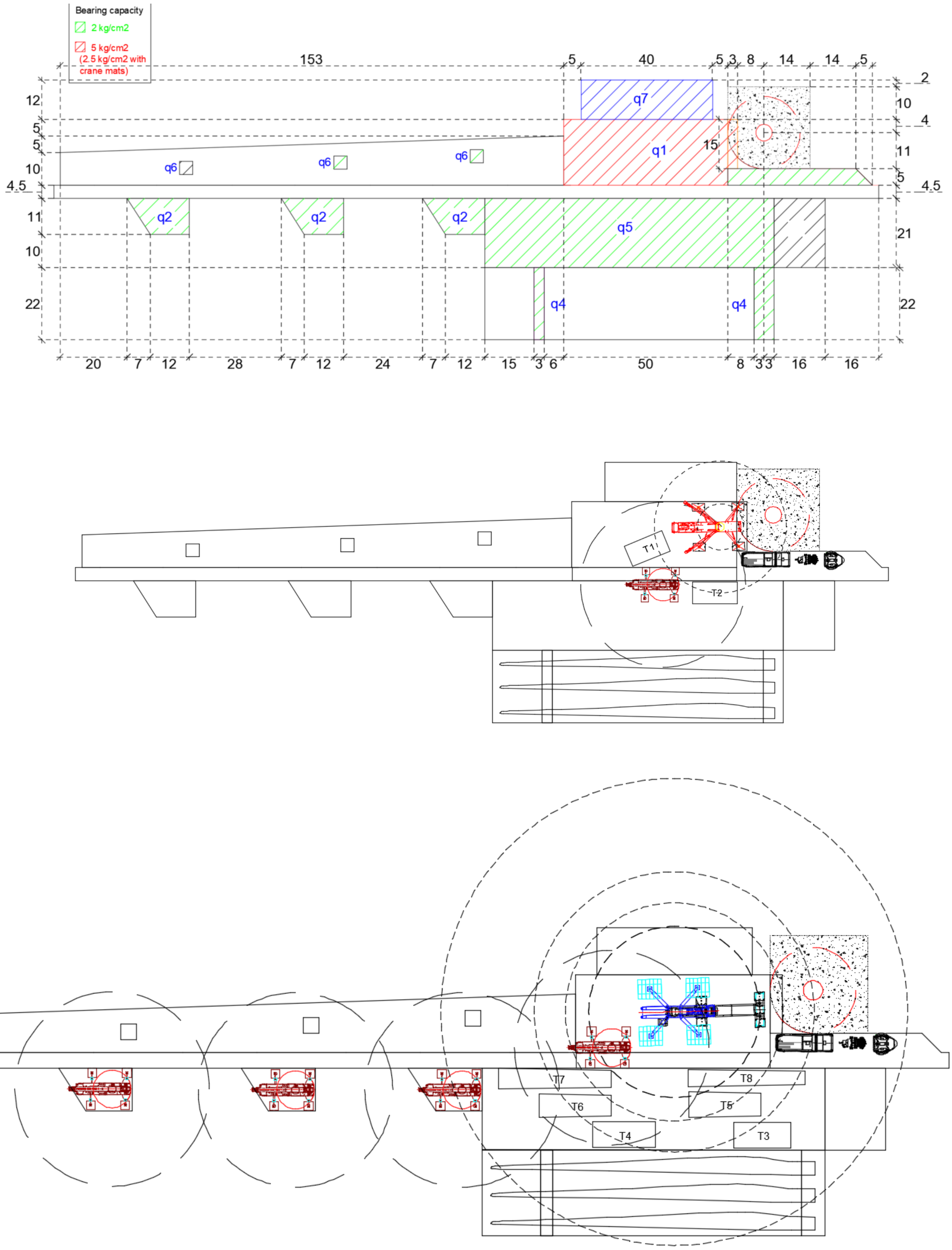


Figure 43 Model T155m – Partial storage assembling with strategy 4 in 2 phases – Self offloading

5.5.21. T165m MB tubular steel tower Hardstand with strategy 4 – Self offloading**

Storage conditions	Width x length
Partial storage (SGRE standard)	q1 .... 57m x 38m q2 .... 2 x 6m x 6m q3 .... 20m x 12m q4 .... 88m x 22m (with fingers of q5 hardstand 3m x 22m + 6m x 22m) q5 .... 88m x 10m + 32m x 5m + 5m x 5m + reinforced road part* q6 .... 3 x (12m x 11m + 7m x 11m / 2) q7 .... 39m x 13m

*Referred to 3.1.4 Road width

** This hardstand is available for specific Regions, consult with SGRE if your Region is considered in this group

Table 52 Dimensions of the areas of model T165m MB with strategy 4 – Self offloading

- Partial storage – Assembly in 2 phases (SGRE standard)

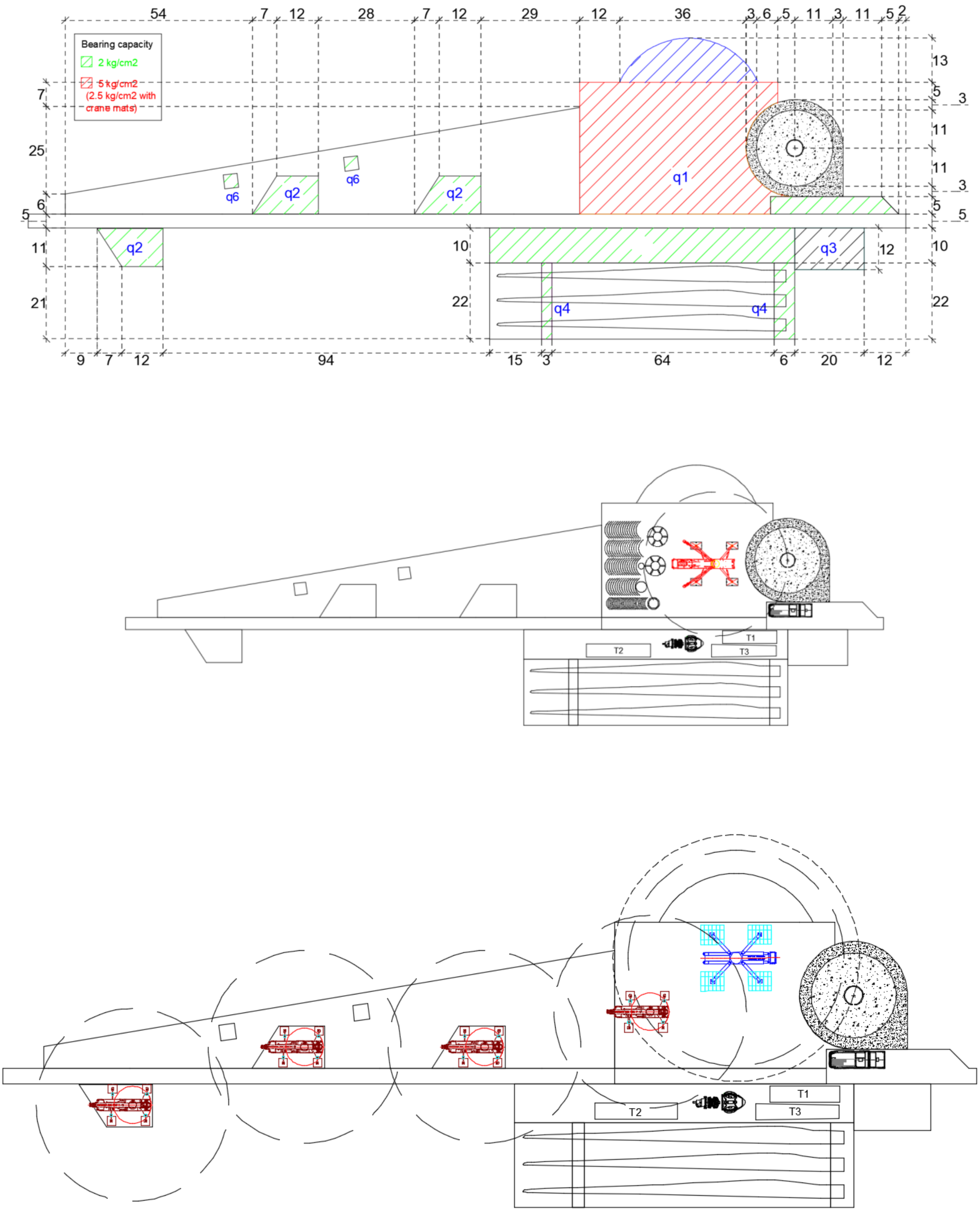


Figure 44 Model T165m MB – Partial storage assembling with strategy 4 in 2 phases – Self