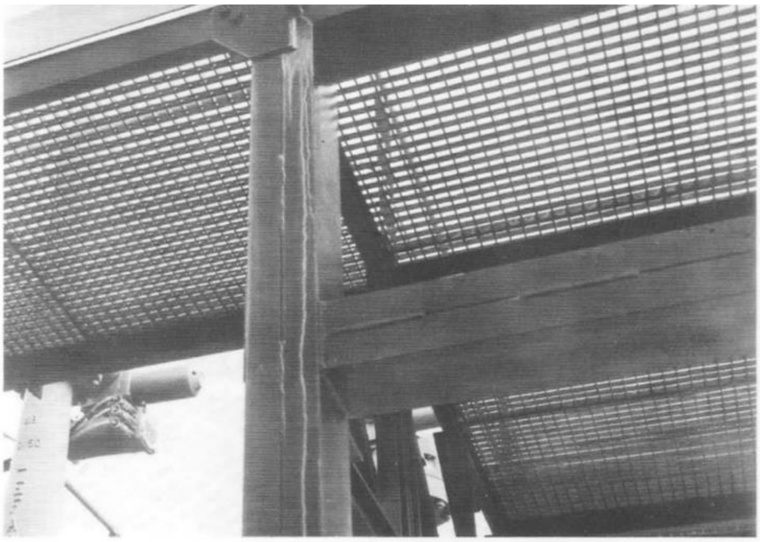
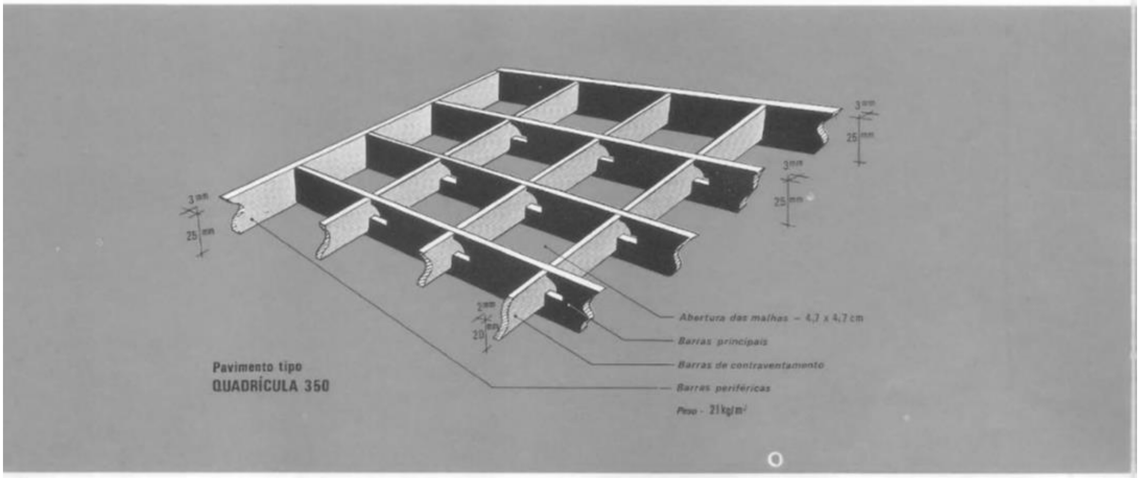
ANEXOS

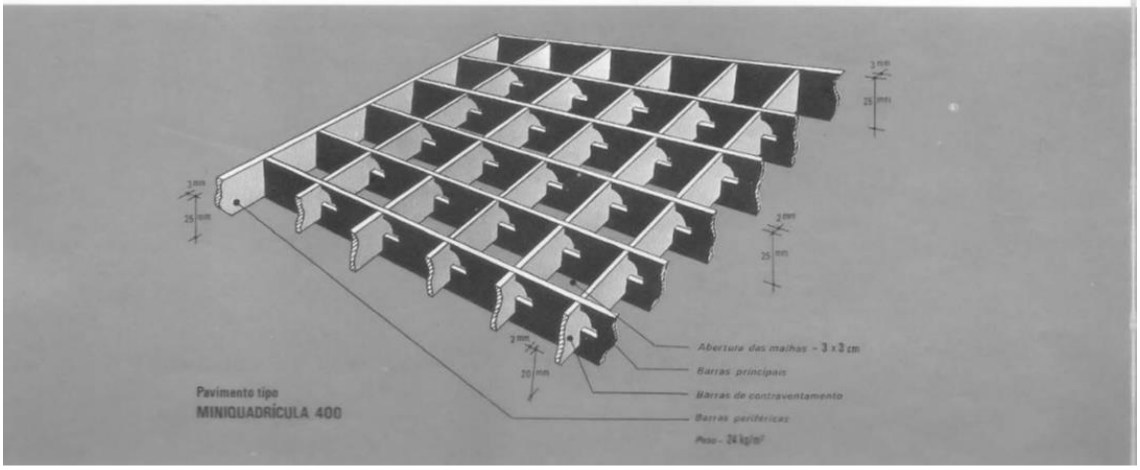
ANEXO I

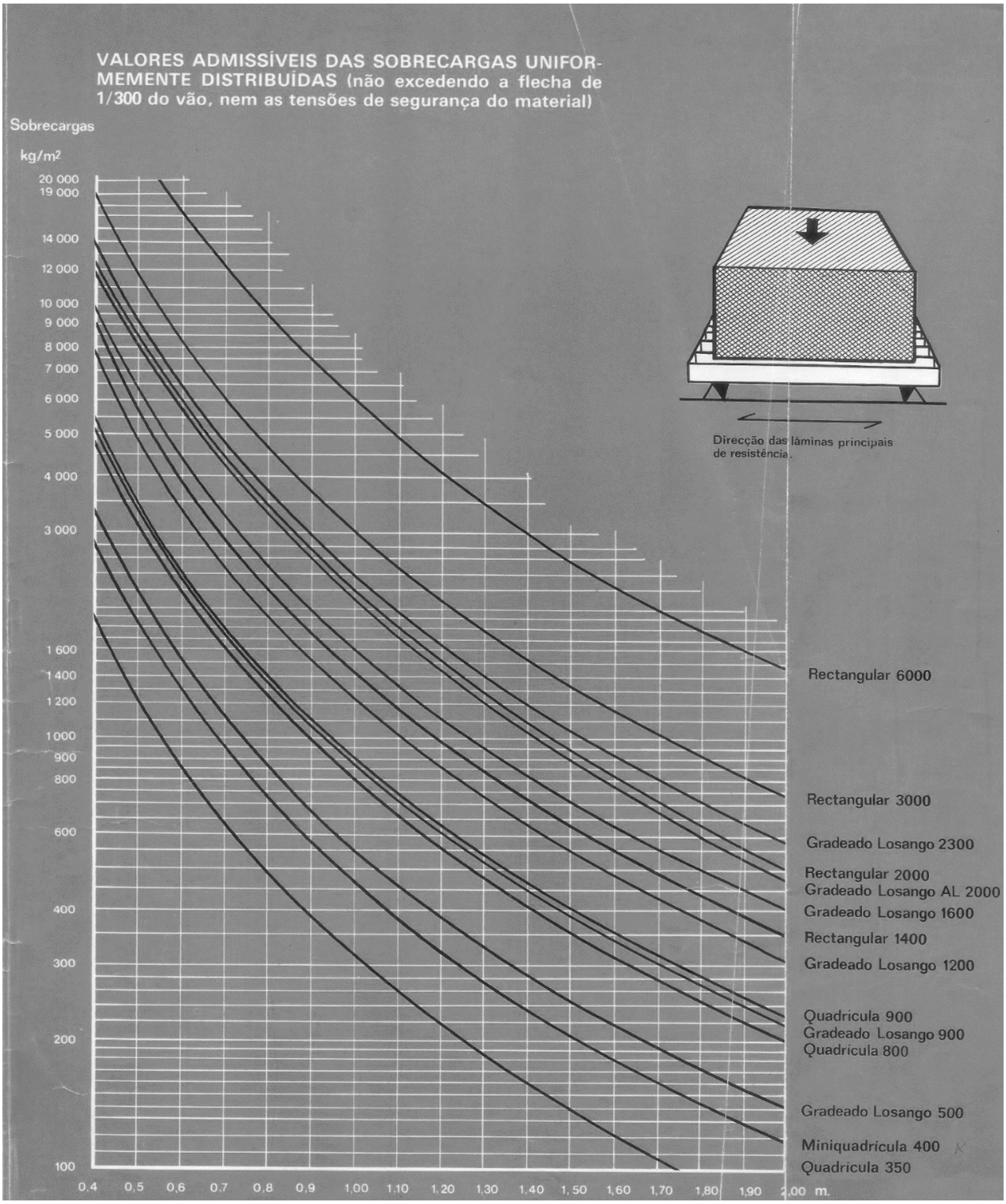
Catálogos



PASSERELLE EM QUADRÍCULA






VALORES ADMISSÍVEIS DAS SOBRECARGAS UNIFORMEMENTE DISTRIBUÍDAS (não excedendo a flecha de 1/300 do vão, nem as tensões de segurança do material)
Sobrecargas
kg/m2
20 000
19 000
14 000
12 000
10 000
9 000
8 000
7 000
6 000
5 000
4 000
3 000
1 600
1 400
1 200
1 000
900
800
600
400
300
200
100
0,4
0,5
0,6
0,7
0,8
0,9
1,00
1,10
1,20
1,30
1,40
1,50
1,60
1,70
1,80
1,90
2,00 m.
Direcção das lâminas principais de resistência.
Rectangular 6000
Rectangular 3000
Gradeado Losango 2300
Rectangular 2000
Gradeado Losango AL 2000
Gradeado Losango 1600
Rectangular 1400
Gradeado Losango 1200
Quadricula 900
Gradeado Losango 900
Quadricula 800
Gradeado Losango 500
Miniquadrícula 400
Quadricula 350

ANEXO II

Determinação dos Coeficientes Estruturais

Coeficiente Estrutural – Direção y (W_y e W_{yy})				
	Z_1=35.25	**Z_2=28.59**	**Z_3=17.31**	**UN**
z	35.26	28.59	17.31	m
z_s	21.16	17.15	10.39	m
L_t	300.00	300.00	300.00	m
z_t	200.00	200.00	200.00	m
α	0.67	0.67	0.67	
$L(z_s)$	66.60	57.87	41.35	
b	3.00	3.00	3.00	m
B^2	1.00	1.00	1.00	
$c_r(z_s)$	0.72	0.67	0.55	
v_b	30.00	30.00	30.00	m/s
σ_v	7.03	7.03	7.03	m/s
$v_m(z_s)$	21.45	19.98	16.45	m/s
$I_v(z_s)$	0.33	0.35	0.43	
x_1	0.002	0.001	0.002	m
$n_{1,x}$	1.63	1.63	1.63	Hz
$f_L(z_s,n)$	5.06	4.72	4.10	
$S_L(z_s,n)$	0.05	0.05	0.05	
η_h	12.32	10.73	7.89	
η_b	12.32	10.73	7.89	
R_h	0.078	0.089	0.119	
R_b	0.078	0.089	0.119	
cf	1.90	2.30	2.30	
μ_e	219.00	9281.00	9281.00	Kg/m^2
δ_a	0.07	0.00	0.00	
δ_s	0.05	0.08	0.08	
δ_d	0.00	0.00	0.00	
δ	0.12	0.08	0.08	
R^2	0.0115	0.0232	0.0454	
ν	0.17	0.25	0.34	Hz
T	600.00	600.00	600.00	s
k_p	3.25	3.35	3.45	
c_d	0.95	0.98	1.00	
c_s	1.00	1.00	1.00	
$c_s \cdot c_d$	0.95	0.98	1.00	

	Coeficiente Estrutural Direção z (W_{zz})			Coeficiente Estrutural Direção z (W_z)			UN
	Z_1=35.25	Z_2=28.59	Z_3=17.31	Z_1=35.25	Z_2=28.59	Z_3=17.31	
z	35.26	28.59	17.31	35.26	28.59	17.31	m
$\mathbf{z_s}$	21.16	17.15	10.39	21.16	17.15	10.39	m
$\mathbf{L_t}$	300.0	300.0	300.0	300.0	300.0	300.0	m
$\mathbf{z_t}$	200.0	200.0	200.0	200.0	200.0	200.0	m
$\boldsymbol{\alpha}$	0.67	0.67	0.67	0.67	0.67	0.67	
$\mathbf{L(z_s)}$	66.60	57.87	41.35	66.60	57.87	41.35	
b	2.80	2.80	2.80	2.80	2.80	2.80	m
$\mathbf{B^2}$	1.00	1.00	1.00	1.00	1.00	1.00	
$\mathbf{c_r(z_s)}$	0.72	0.67	0.55	0.72	0.67	0.55	
$\boldsymbol{\nu_b}$	30.00	30.00	30.00	30.00	30.00	30.00	m/s
$\boldsymbol{\sigma_v}$	7.03	7.03	7.03	7.03	7.03	7.03	m/s
$\boldsymbol{\nu_m(z_s)}$	21.45	19.98	16.45	21.45	19.98	16.45	m/s
$\mathbf{I_v(z_s)}$	0.33	0.35	0.43	0.33	0.35	0.43	
$\mathbf{x_1}$	0.002	0.001	0.002	0.002	0.001	0.002	m
$\mathbf{n_{1,x}}$	1.63	1.63	1.63	1.63	1.63	1.63	Hz
$\mathbf{f_L(z_s,n)}$	5.06	4.72	4.10	5.06	4.72	4.10	
$\mathbf{S_L(z_s,n)}$	0.05	0.05	0.05	0.05	0.05	0.05	
$\boldsymbol{\eta_h}$	12.32	10.73	7.89	12.32	10.73	7.89	
$\boldsymbol{\eta_b}$	12.32	10.73	7.89	12.32	10.73	7.89	
$\mathbf{R_h}$	0.078	0.089	0.119	0.078	0.089	0.119	
$\mathbf{R_b}$	0.078	0.089	0.119	0.078	0.089	0.119	
cf	2.70	2.40	2.40	2.30	2.10	2.00	
$\boldsymbol{\mu_e}$	219.0	9281.0	9281.0	219.0	9281.0	9281.0	Kg/m^2
$\boldsymbol{\delta_a}$	0.10	0.00	0.00	0.09	0.00	0.00	
$\boldsymbol{\delta_s}$	0.05	0.08	0.08	0.05	0.08	0.08	
$\boldsymbol{\delta_d}$	0.00	0.00	0.00	0.00	0.00	0.00	
$\boldsymbol{\delta}$	0.15	0.08	0.08	0.14	0.08	0.08	
$\mathbf{R^2}$	0.0092	0.0231	0.0454	0.0102	0.0232	0.0455	
$\boldsymbol{\nu}$	0.16	0.25	0.34	0.16	0.25	0.34	Hz
T	600.0	600.0	600.0	600.00	600.00	600.00	s
$\mathbf{k_p}$	3.21	3.35	3.44	3.23	3.35	3.45	
$\mathbf{c_d}$	0.95	0.98	1.00	0.95	0.98	1.00	
$\mathbf{c_s}$	1.00	1.00	1.00	1.00	1.00	1.00	
$\mathbf{c_s \cdot c_d}$	0.95	0.98	1.00	0.95	0.98	1.00	

ANEXO III

Dimensionamento das Diagonais e Prumos das barras dos Painéis Verticais

Painéis Verticais	Perfil	Nº da Barra	A [cm²]	L_{barras} [m]	L_{crz} [m]	L_{cry} [m]	Esforços de Cálculo				Esforços Resistentes			Rácios de Tração		Rácios de Compressão	
							Combinação Condicionantes 1	N_{Ed} (Tração) [kN]	Combinação Condicionante 2	N_{Ed} (Compressão) [kN]	$N_{t.Rd}$ [kN]	$N_{brd,z}$ [kN]	$N_{brd,y}$ [kN]	$\frac{N_{Ed}}{N_{t,Rd}}$	Obs.	(*)	Obs.
Diagonais	HEB200	22	78.08	4.2	4.2	4.2	ELU. W_y ($T^+.SC_2$)	107.1	-	-	1835	1110	1599	0.058	**ok**	-	**-**
	HEB200	36	78.08	4.2	4.2	4.2	ELU. W_{yy} ($T^+.SC_2$)	120.3	-	-	1835	1110	1599	0.066	**ok**	-	**-**
	2L50x6	137	11.38	4.2	4.2	4.2	ELU. W_{yy} ($T^-.SC_2$)	75.6	ELU. W_y ($T^+.SC_1$)	-8.4	267	41	80	0.283	**ok**	0.105	**ok**
	2L50X6	138	11.38	4.2	4.2	4.2	ELU. W_{yy} ($T^-.SC_2$)	137.0	-	-	267	41	80	0.512	**ok**	-	**ok**
	2L50x6	139	11.38	4.2	4.2	4.2	ELU. Wyy ($T^-.SC_2$)	193.8	ELU. W_y ($T^+.SC_1$)	-	267	41	80	0.725	**ok**	-	**-**
	2L50x6	140	11.38	3.3	3.3	3.3	ELU. Wyy ($T^-.SC_2$)	116.3	-	-	267	62	116	0.435	**ok**	-	**-**
	2L50x6	141	11.38	3.4	3.4	3.4	-	-	ELU. W_y ($T^+.SC_2$)	-39.3	267	60	113	-	**-**	0.348	**ok**
	2L50x6	144	11.38	4.2	4.2	4.2	ELU. W_y ($T^-.SC_2$)	69.4	ELU. W_{yy} ($T^+.SC_1$)	-11.6	267	41	80	0.260	**ok**	0.145	**ok**
	2L50x6	145	11.38	4.2	4.2	4.2	ELU. W_y ($T^-.SC_2$)	123.1	-	-	267	41	80	0.460	**ok**	-	**ok**
	2L50x6	146	11.38	4.2	4.2	4.2	ELU. W_y ($T^-.SC_2$)	175.6			267	41	80	0.657	**ok**	-	**-**
	2L50x6	148	11.38	3.4	3.4	3.4			ELU. W_{yy} ($T^+.SC_2$)	-34.3	267	60	113	-	**-**	0.304	**ok**
	2L75x7	78	20.20	4.2	4.2	4.2	ELU. W_y ($T^+.SC_2$)	439.1			475	151	230	0.925	**ok**	-	**-**
	2L75x7	80	20.20	4.2	4.2	4.2	ELU. W_y ($T^+.SC_2$)	358.5			475	151	230	0.755	**ok**	-	**-**
	2L75 x7	81	20.20	4.2	4.2	4.2	ELU. W_y ($T^+.SC_2$)	301.3			475	151	230	0.635	**ok**	-	**-**
	2L75x7	82	20.20	4.2	4.2	4.2	ELU. W_y ($T^+.SC_2$)	232.9			475	151	230	0.491	**ok**	-	**-**
	2L75x7	92	20.20	3.0	3.0	3.0			ELU. W_y ($T^-.SC_2$)	-111.8	475	251	332	-	**-**	0.337	**ok**
	2L75x7	93	20.20	4.2	4.2	4.2	ELU. W_{yy} ($T^+.SC_2$)	402.5			475	151	230	0.848	**ok**	-	**-**
	2L75 x7	94	20.20	4.2	4.2	4.2	ELU. W_{yy} ($T^+.SC_2$)	391.6			475	151	230	0.825	**ok**	-	**-**
	2L75 x	95	20.20	4.2	4.2	4.2	ELU. W_{yy} ($T^+.SC_2$)	330.1			475	151	230	0.695	**ok**	-	**-**
	2L75 x7	96	20.20	4.2	4.2	4.2	ELU. W_{yy} ($T^+.SC_2$)	280.3			475	151	230	0.591	**ok**	-	**-**
	2L75x7	97	20.20	4.2	4.2	4.2	ELU. W_{yy} ($T^+.SC_2$)	216.7			475	151	230	0.457	**ok**	-	**-**
	2L75x7	149	20.20	3.8	3.8	3.8			ELU. W_x	-265.8	267	179	263	-	**-**	1.000	**ok**

Nota: (*) $\frac{N_{Ed}}{\text{máx}\left\{N_{bRd,z};N_{bRd,y}\right\}}$

Painéis Verticais	Perfil	Nº da Barra	A [cm²]	L_{barras} [m]	L_{crz} [m]	L_{cry} [m]	Esforços de Cálculo				Esforços Resistentes			Rácios de Tração		Rácios de Compressão	
							Combinação Condicionantes 1	N_{Ed} (Tração) [kN]	Combinação Condicionante 2	N_{Ed} (Compressão) [kN]	$N_{t.Rd}$ [kN]	$N_{brd,z}$ [kN]	$N_{brd,y}$ [kN]	$\frac{N_{Ed}}{N_{t,Rd}}$	Obs.	(*)	Obs.
Diagonais	2L80x8	150	24.60	4.2	4.2	4.2			ELU. Wyy (T^-.SC_2)	-355.1	578	203	306	-	-	1.000	ok
	2L90x9	153	31.00	4.2	4.2	4.2			ELU. W_{xx}+W_{zz} (T^+.SC_2)	-346.7	729	307	434	-	-	0.798	ok
	2L90x9	156	31.00	4.2	4.2	4.2			ELU. W_y (T^+.SC_2)	-111.4	729	307	434	0.000	ok	0.256	ok
	2L90x9	157	31.00	4.2	4.2	4.2	ELU. W_{yy} (T^-.SC_1)	25.3	ELU. W_y (T^+.SC_2)	-60.2	729	307	434	0.035	ok	0.139	ok
	2L90x9	161	31.00	4.4	4.4	4.4	ELU. W_y (T^+.SC_2)	326.6			729	292	419	0.448	ok	-	-
	2L90x9	162	31.00	4.4	4.4	4.4	ELU. W_y (T^+.SC_2)	246.8			729	292	419	0.339	ok	-	-
	2L90x9	165	31.00	4.4	4.4	4.4			ELU. W_y (T^+.SC_2)	-112.5	729	292	419	0.000	ok	0.269	ok
	2L90x9	166	31.00	4.4	4.4	4.4	ELU. W_{yy} (T^-.SC_1)	12.7	ELU. Wy (T^+.SC_2)	-55.9	729	292	419	0.017	ok	0.133	ok
	2L90x9	169	31.00	4.2	4.2	4.2			ELU. W_{xx} +	-315.7	729	307	434	-	-	0.727	ok
	2L90x9	172	31.00	4.2	4.2	4.2			ELU. W_{yy} (T^+.SC_2)	-108.0	729	307	434	0.000	ok	0.249	ok
	2L90x9	173	31.00	4.2	4.2	4.2	ELU. W_y (T^-.SC_1)	23.9	ELU. W_{yy} (T^+.SC_2)	-61.9	729	307	434	0.033	ok	0.143	ok
	2L90x9	177	31.00	4.4	4.4	4.4	ELU. W_{yy}	298.5			729	292	419	0.410	ok	-	-
	2L90x9	178	31.00	4.4	4.4	4.4	ELU. W_{yy}	225.4			729	292	419	0.309	ok	-	-
	2L90x9	180	31.00	4.4	4.4	4.4			ELU. W_{xx} + W_{zz}	-83.6	729	292	419	-	-	0.200	ok
	2L90x9	181	31.00	4.4	4.4	4.4			ELU. W_{yy} (T^+.SC_2)	-104.8	729	292	419	0.000	ok	0.250	ok
	2L90x9	182	31.00	4.4	4.4	4.4	ELU. W_y (T^-.SC_1)	13.7	ELU. W_{yy} (T^+.SC_2)	-53.5	729	292	419	0.019	ok	0.128	ok
	2L90x9	302	31.00	2.1	4.2	2.1	ELU. W_y (T^+.SC_2)	105.0			729	307	644	0.144	ok	-	ok
	2L90x9	304	31.00	2.1	4.2	2.1	ELU. W_y (T^+.SC_2)	104.7	ELU. W_y (T^+.SC_2)	-90.1	729	307	419	0.144	ok	0.140	ok
	2L90x9	306	31.00	2.1	4.2	2.1			ELU. W_y (T^+.SC_2)	-90.1	729	307	419	-	-	0.140	ok
	2L90x9	307	31.00	2.1	4.2	2.1			ELU. W_y (T^+.SC_2)	-89.1	729	307	419	-	-	0.138	ok
	2L90x9	312	31.00	2.1	4.2	2.1			ELU. W_{yy} (T^+.SC_2)	-83.9	729	307	419	-	-	0.130	ok
	2L90x9	314	31.00	2.1	4.2	2.1			ELU. W_{yy} (T^+.SC_2)	-82.8	729	307	419	-	-	0.129	ok

Nota: (*) $\text{Rácio} = \frac{N_{Ed}}{\text{máx}\left\{N_{bRd,z};N_{bRd,y}\right\}}$

Painéis Verticais	Perfil	Nº da Barra	A [cm²]	L_{barra} [m]	L_{crz} [m]	L_{cry} [m]	Esforços de Cálculo				Esforços Resistentes			Rácios de Tração		Rácios de Compressão	
							Combinação Condicionantes 1	N_{Ed} (Tração) [kN]	Combinação Condicionantes 2	N_{Ed} (Compressão) [kN]	$N_{t.Rd}$ [kN]	$N_{brd,z}$ [kN]	$N_{brd,y}$ [kN]	$\frac{N_{Ed}}{N_{t,Rd}}$	Obs.	(*)	Obs.
Prumos	HEB200	13	78.08	3.1	3.1	3.1	-	-	ELU. W_{yy} ($T^-.SC_2$)	-116.6	1835	838	1137	-	-	0.103	**ok**
	HEB200	20	78.08	3.1	3.1	3.1	-	-	ELU. ET_{1x} (SC_1)	-103.1	1835	838	1137	-	-	0.091	**ok**
	2L40x4	135	8.96	1.6	1.6	1.6	ELU. W_y (T +.SC_2)	36.0	ELU. ET_{2x} (SCC_2)	-	211	162	143	0.171	**ok**	-	**ok**
	2L40x4	136	8.96	1.6	1.6	1.6	ELU. W_{yy} (T +.SC_2)	31.1	-	-	211	162	143	0.148	**ok**	-	**ok**
	2L40x6	183	8.96	3.0	3.0	3.0	-	-	ELU. W_y ($T^+.SC_2$)	-67.0	211	86	65	-	**ok**	0.775	**ok**
	2L40x6	184	8.96	3.0	3.0	3.0	ELU. W_y (T +.SC_2)	50.8	-	-	211	86	65	0.241	**ok**	-	**ok**
	2L40x6	185	8.96	3.0	3.0	3.0	ELU. W_y (T +.SC_2)	78.2	-	-	211	86	65	0.371	**ok**	-	**ok**
	2L40x6	186	8.96	3.0	3.0	3.0	ELU. W_y (T +.SC_2)	38.1	ELU. W_{yy} ($T^-.SC_1$)	-19.5	211	86	65	0.181	**ok**	0.226	**ok**
	2L40x6	187	8.96	3.0	3.0	3.0	-	-	ELU. W_{yy} ($T^+.SC_2$)	-64.7	211	86	65	-	**ok**	0.748	**ok**
	2L40x6	188	8.96	3.0	3.0	3.0	ELU. W_{yy} (T +.SC_2)	47.4	-	-	211	86	65	0.225	**ok**	-	**ok**
	2L40x6	189	8.96	3.0	3.0	3.0	ELU. W_{yy} (T +.SC_2)	75.1	-	-	211	86	65	0.357	**ok**	-	**ok**
	2L40x6	190	8.96	3.0	3.0	3.0	ELU. W_{yy} (T +.SC_2)	39.9	ELU. W_y ($T^-.SC_1$)	-18.7	211	86	65	0.189	**ok**	0.216	**ok**
	2L75x7	72	20.20	3.0	3.0	3.0	-	-	ELU. W_y ($T^+.SC_2$)	-257.8	475	251	332	-	-	0.777	**ok**
	2L75x7	73	20.20	3.0	3.0	3.0	-	-	ELU. W_y ($T^+.SC_2$)	-214.9	475	251	332	-	-	0.647	**ok**
	2L75x7	74	20.20	3.0	3.0	3.0	-	-	ELU. W_y ($T^+.SC_2$)	-172.1	475	251	332	-	-	0.519	**ok**
	2L75x7	75	20.20	3.0	3.0	3.0	ELU. W_y (T +.SC_1)	4.75	ELU. W_{yy} ($T^-.SC_2$)	-57.1	475	251	332	0.010	**ok**	0.172	**ok**
	2L75x7	76	20.20	3.0	3.0	3.0	-	-	ELU. W_{yy} ($T^-.SC_2$)	-101.3	475	251	332	-	**ok**	0.305	**ok**
	2L75x7	77	20.20	3.0	3.0	3.0	-	-	ELU. W_{yy} ($T^-.SC_2$)	-122.6	475	251	332	-	-	0.369	**ok**
	2L75x7	83	20.20	3.0	3.0	3.0	ELU. T+ (W_y.SC_2)	51.8	-	-	475	251	332	0.109	**ok**	-	**ok**
	2L75x7	84	20.20	3.0	3.0	3.0	ELU. W_y ($T^+.SC_2$)	75.8	-	-	475	251	332	0.160	**ok**	-	**ok**

Nota: (*) $\text{Rácio} = \dfrac{N_{Ed}}{\text{máx}\left\{N_{bRd,z};N_{bRd,y}\right\}}$

Painéis Verticais	Perfil	Nº da Barra	A [cm²]	L_{barra} [m]	L_{crz} [m]	L_{cry} [m]	Esforços de Cálculo: Combinação Condicionantes 1	Esforços de Cálculo: N_{Ed} (Tração) [kN]	Esforços de Cálculo: Combinação Condicionantes 2	Esforços de Cálculo: N_{Ed} (Compressão) [kN]	Esforços Resistentes: $N_{t.Rd}$ [kN]	Esforços Resistentes: $N_{brd,z}$ [kN]	Esforços Resistentes: $N_{brd,y}$ [kN]	Rácios de Tração: $\frac{N_{Ed}}{N_{t,Rd}}$	Rácios de Tração: Obs.	Rácios de Compressão: (*)	Rácios de Compressão: Obs.
Prumos	2L75x7	85	20.20	3.0	3.0	3.0	ELU. W_y ($T^-.SC_2$)	241.1	-	-	475	251	332	0.508	**ok**	-	**ok**
	2L75x7	87	20.20	3.0	3.0	3.0	-	-	ELU. W_{yy} ($T^+.SC_2$)	-237.4	475	251	332	-	-	0.715	**ok**
	2L75x7	88	20.20	3.0	3.0	3.0	-	-	ELU. W_{yy} ($T^+.SC_2$)	-200.3	475	251	332	-	-	0.603	**ok**
	2L75x7	89	20.20	3.0	3.0	3.0	-	-	ELU. W_{yy} ($T^+.SC_2$)	-160.4	475	251	332	-	-	0.483	**ok**
	2L75x7	90	20.20	3.0	3.0	3.0	ELU. W_{yy} ($T^+.SC_1$)	6.3	ELU. W_y ($T^-.SC_2$)	-52.7	475	251	332	0.013	**ok**	0.159	**ok**
	2L75x7	91	20.20	3.0	3.0	3.0	-	-	ELU. W_y ($T^-.SC_2$)	-91.3	475	251	332	-	**ok**	0.275	**ok**
	2L75x7	92	20.20	3.0	3.0	3.0	-	-	ELU. W_y ($T^-.SC_2$)	-111.8	475	251	332	-	-	0.337	**ok**
	2L90x9	151	31.00	3.0	3.0	3.0	-	-	ELU. W_y ($T^+.SC_2$)	-379.8	729	469	568	-	-	0.669	**ok**
	2L90x9	152	31.00	3.0	3.0	3.0	-	-	ELU. W_y ($T^+.SC_2$)	-291.4	729	469	568	-	-	0.513	**ok**
	2L90x9	159	31.00	3.0	3.0	3.0	-	-	ELU. W_y ($T^+.SC_2$)	-174.0	729	469	568	-	-	0.307	**ok**
	2L90x9	160	31.00	3.0	3.0	3.0	-	-	ELU. W_y ($T^+.SC_2$)	-73.1	729	469	568	-		0.129	**ok**
	2L90x9	167	31.00	3.0	3.0	3.0	-	-	ELU. W_{yy} ($T^+.SC_2$)	-352.4	729	469	568	-	-	0.621	**ok**
	2L90x9	168	31.00	3.0	3.0	3.0	-	-	ELU. W_{yy} ($T^+.SC_2$)	-352.4	729	469	568	-	-	0.621	**ok**
	2L90x9	174	31.00	3.0	3.0	3.0	-	-	ELU. W_{yy} ($T^+.SC_2$)	-352.4	729	469	568	-	**ok**	0.621	**ok**
	2L90x9	175	31.00	3.0	3.0	3.0	-	-	ELU. W_{yy} ($T^+.SC_2$)	-158.8	729	469	568	-	-	0.280	**ok**
	2L90x9	176	31.00	3.0	3.0	3.0	-	-	ELU. W_{yy} ($T^+.SC_2$)	-70.4	729	469	568	-	**ok**	0.124	**ok**

Nota: (*) $\text{Rácio} = \dfrac{N_{Ed}}{\text{máx}\left\{N_{bRd,z};N_{bRd,y}\right\}}$

ANEXO IV

Dimensionamento das Ligações Soldadas

Tabela 1

Nº Barra	Esforço Máximo de Cálculo [kN]	**Dimensionamento das soldaduras dos *Goussets* aos Cordões da Ponte**						Rácio
		f_u [N/mm²]	L [mm]	a [mm]	β_w	γ_{MW}	$F_{w,Rd}$ [kN]	$\frac{F_{W,Ed}}{F_{W,Rd}}$
15	15.0	360	2x60	4	0.8	1.25	99.8	0.15
23	14.3		2x60	4			99.8	0.14
72	155.8		2x60	4			99.8	1.56
73	132.4		2x60	4			99.8	1.33
74	109.9		2x60	4			99.8	1.10
75	41.7		2x60	4			99.8	0.42
76	65.4		2x60	4			99.8	0.66
77	74.9		2x60	4			99.8	0.75
83	29.3		2x60	4			99.8	0.29
84	50.1		2x60	4			99.8	0.50
85	97.2		2x60	4			99.8	0.95
86	16.1		2x60	4			99.8	0.16
87	95.5		2x60	4			99.8	0.90
88	99.0		2x60	4			99.8	0.96
89	99.5		2x60	4			99.8	1.00
90	41.2		2x60	4			99.8	0.41
91	62.7		2x60	4			99.8	0.63
92	72.5		2x60	4			99.8	0.73
98	28.3		2x60	4			99.8	0.28
99	48.2		2x60	4			99.8	0.48
100	85.2		2x60	4			99.8	0.82
101	15.6		2x60	4			99.8	0.16
135	18.2		2x60	4			99.8	0.18
136	17.5		2x60	4			99.8	0.18
152	45.5		2x60	4			99.8	0.55
158	33.7		2x60	4			99.8	0.34
159	99.2		2x60	4			99.8	0.95
160	49.4		2x60	4			99.8	0.49
168	32.5		2x60	4			99.8	0.2
174	34.1		2x60	4			99.8	0.34
175	25.6		2x60	4			99.8	0.34
176	50.8		2x60	4			99.8	0.51
183	45.8		2x60	4			99.8	0.46
184	31.4		2x60	4			99.8	0.31
185	55.7		2x60	4			99.8	0.56
186	33.9		2x60	4			99.8	0.34
187	46.7		2x60	4			99.8	0.47
188	29.7		2x60	4			99.8	0.30
189	54.7		2x60	4			99.8	0.55
190	34.9		2x60	4			99.8	0.35

Nomenclatura:

L Comprimento dos cordões de soldadura

A Espessura do cordão de soldadura

β_w Fator de correlação

γ_{MW} Coeficiente parcial de segurança do aço da soldadura.

Tabela 2

Nº Barra	Esforço Máximo de Cálculo [kN]	Dimensionamento das soldaduras dos *Goussets* aos Cordões da Ponte						Rácio
		f_u [N/mm²]	L [mm]	a [mm]	β_w	Υ_{MW}	Fw,Rd [kN]	$\frac{F_{W,Ed}}{F_{W,Rd}}$
78	56.0	360	2x60	4	0.8	1.25	99.8	0.62
79	98.7		2x60	4			99.8	0.92
80	98.5		2x60	4			99.8	0.96
81	89.4		2x60	4			99.8	0.85
82	97.5		2x60	4			99.8	1.52
92	72.5		2x60	4			99.8	0.71
93	59.6		2x60	4			99.8	0.54
94	99.0		2x60	4			99.8	0.97
95	72.5		2x60	4			99.8	2.18
96	96.6		2x60	4			99.8	0.96
97	42.3		2x60	4			99.8	0.43
137	53.5		2x60	4			99.8	0.55
138	86.8		2x60	4			99.8	0.94
139	72.0		2x60	4			99.8	0.61
140	98.4		2x60	4			99.8	0.92
141	21.2		2x60	4			99.8	0.23
142	54.1		2x60	4			99.8	1.58
143	92.7		2x60	4			99.8	2.17
144	52.8		2x60	4			99.8	0.59
146	78.2		2x60	4			99.8	0.95
147	94.2		2x60	4			99.8	0.92
148	20.5		2x60	4			99.8	0.23
149	96.5		2x60	4			99.8	0.98
150	-48.9		2x60	4			99.8	0.41
153	88.1		2x60	4			99.8	0.74
156	-80.6		2x60	4			99.8	0.89
157	-54.6		2x60	4			99.8	0.56
161	70.6		2x60	4			99.8	0.68
162	99.8		2x60	4			99.8	1.00
163	69.7		2x60	4			99.8	0.78
165	-76.8		2x60	4			99.8	0.86
166	-45.9		2x60	4			99.8	0.55
169	-72.4		2x60	4			99.8	0.45
172	-80.1		2x60	4			99.8	0.82
173	-55.2		2x60	4			99.8	0.62
177	87.5		2x60	4			99.8	0.83
178	99.0		2x60	4			99.8	0.95
179	70.9		2x60	4			99.8	0.78
180	-53.8		2x60	4			99.8	0.55
181	75.1		2x60	4			99.8	0.82
182	45.3		2x60	4			99.8	0.53
302	69.3		2x60	4			99.8	0.76
304	69.9		2x60	4			99.8	0.79
306	58.1		2x60	4			99.8	0.67
307	57.2		2x60	4			99.8	0.64
308	70.7		2x60	4			99.8	0.71
309	70.8		2x60	4			99.8	0.72

A nomenclatura é a mesma da Tabela 1.

Tabela 3

Nº Barra	Esforço Máximo de Cálculo [kN]	Dimensionamento das soldaduras dos *Goussets* aos Cordões do Pilar						Rácio
		f_u [N/mm²]	L [mm]	a [mm]	β_w	Υ_{MW}	$F_{w,Rd}$ [kN]	$\frac{F_{W,Ed}}{F_{W,Rd}}$
12	83.8	360	2x60	4	0.8	1.25	99.8	0.84
14	83.0		2x60	4			99.8	0.83
18	82.6		2x60	4			99.8	0.82
19	81.8		2x60	4			99.8	0.82
102	99.5		2x60	4			99.8	0.99
103	99.2		2x60	4			99.8	0.98
154	40.5		2x60	4			99.8	0.48
155	45.9		2x60	4			99.8	0.58
170	72.2		2x60	4			99.8	0.72
171	71.7		2x60	4			99.8	0.71
232	89.8		2x60	4			99.8	0.90
256	89.0		2x60	4			99.8	0.89
257	88.0		2x60	4			99.8	0.88
258	87.4		2x60	4			99.8	0.87
259	99.3		2x60	4			99.8	0.99
260	98.5		2x60	4			99.8	0.98
261	98.0		2x60	4			99.8	0.982
262	0.8		2x60	4			99.8	0.00
263	96.8		2x60	4			99.8	0.97
264	0.8		2x60	4			99.8	0.08
265	42.4		2x60	4			99.8	0.42
266	41.9		2x60	4			99.8	0.42
267	43.3		2x60	4			99.8	0.43
268	42.7		2x60	4			99.8	0.42
269	0.7		2x60	4			99.8	0.01
270	0.8		2x60	4			99.8	0.01
271	85.2		2x60	4			99.8	0.85
272	0.7		2x60	4			99.8	0.01
273	0.8		2x60	4			99.8	0.01
274	99.5		2x60	4			99.8	0.99
275	82.5		2x60	4			99.8	0.86
277	0.7		2x60	4			99.8	0.01
278	0.7		2x60	4			99.8	0.01
280	0.6		2x60	4			99.8	0.01
281	0.5		2x60	4			99.8	0.01
294	84.5		2x60	4			99.8	0.87
298	31.5		2x60	4			99.8	0.316
316	31.1		2x60	4			99.8	0.311

A nomenclatura é a mesma das Tabelas 1 e 2.

ANEXO V

Relatório das ligações aparafusadas do "*Robot Structural Analyses*"

GENERAL

Connection name: Base da coluna encastrada

GEOMETRY

COLUMN

Section: HEB 450

L_c =	5.00	[m]	Column length
a =	0.0	[Deg]	Inclination angle
h_c =	450	[mm]	Height of column section
b_{fc} =	300	[mm]	Width of column section
t_{wc} =	14	[mm]	Thickness of the web of column section
t_{fc} =	26	[mm]	Thickness of the flange of column section
r_c =	27	[mm]	Radius of column section fillet
A_c =	217.98	[cm^2]	Cross-sectional area of a column
I_{yc} =	79887.60	[cm^4]	Moment of inertia of the column section

Material: S235

f_{yc} =	235.00	[MPa]	Resistance
f_{uc} =	235.00	[MPa]	Yield strength of a material

COLUMN BASE

l_{pd} =	850	[mm]	Length
b_{pd} =	650	[mm]	Width
t_{pd} =	30	[mm]	Thickness

Material: S235

f_{ypd} =	235.00	[MPa]	Resistance
f_{upd} =	235.00	[MPa]	Yield strength of a material

ANCHORAGE

The shear plane passes through the UNTHREADED portion of the bolt.

Class =	10.9		Anchor class
f_{yb} =	900.00	[MPa]	Yield strength of the anchor material
f_{ub} =	1000.00	[MPa]	Tensile strength of the anchor material
d =	36	[mm]	Bolt diameter
A_s =	8.17	[cm^2]	Effective section area of a bolt
A_v =	10.18	[cm^2]	Area of bolt section
n_H =	4		Number of bolt columns
n_V =	3		Number of bolt rows

Horizontal spacing e_{Hi} = 240;240 [mm]

Vertical spacing e_{Vi} = 240 [mm]

Anchor dimensions

L_1 =	100	[mm]
L_2 =	1000	[mm]
L_3 =	200	[mm]
L_4 =	200	[mm]

Washer

l_{wd} =	50	[mm]	Length
b_{wd} =	60	[mm]	Width
t_{wd} =	10	[mm]	Thickness

STIFFENER

l_s =	850	[mm]	Length
w_s =	650	[mm]	Width
h_s =	500	[mm]	Height
t_s =	20	[mm]	Thickness
d_1 =	50	[mm]	Cut
d_2 =	50	[mm]	Cut

MATERIAL FACTORS

γ_{M0} =	1.00		Partial safety factor
γ_{M2} =	1.25		Partial safety factor
γ_{C} =	1.50		Partial safety factor

SPREAD FOOTING

L =	900	[mm]	Spread footing length
B =	700	[mm]	Spread footing width
H =	1500	[mm]	Spread footing height

Concrete

Class			C30/37
f_{ck} =	382.50	[MPa]	Characteristic resistance for compression

Grout layer

t_g =	30	[mm]	Thickness of leveling layer (grout)
$f_{ck,g}$ =	12.00	[MPa]	Characteristic resistance for compression
$C_{f,d}$ =	0.30		Coeff. of friction between the base plate and concrete

WELDS

a_p =	12	[mm]	Footing plate of the column base
a_s =	6	[mm]	Stiffeners

LOADS

Case: Manual calculations.

$N_{j,Ed}$ =	-429.00	[kN]	Axial force
$V_{j,Ed,y}$ =	17.00	[kN]	Shear force
$V_{j,Ed,z}$ =	24.00	[kN]	Shear force
$M_{j,Ed,y}$ =	155.00	[kN*m]	Bending moment
$M_{j,Ed,z}$ =	25.00	[kN*m]	Bending moment

RESULTS

COMPRESSION ZONE

COMPRESSION OF CONCRETE

f_{cd} = 255.00 [MPa] Design compressive resistance
f_j = 181.53 [MPa] Design bearing resistance under the base plate
$c = t_p \sqrt{(f_{yp}/(3*f_j*\gamma_{M0}))}$
c = 20 [mm] Additional width of the bearing pressure zone0
b_{eff} = 65 [mm] Effective width of the bearing pressure zone under the flange
l_{eff} = 339 [mm] Effective length of the bearing pressure zone under the flange
A_{c0} = 222.02 [cm^2] Area of the joint between the base plate and the foundation
A_{c1} = 1373.69 [cm^2] Maximum design area of load distribution
$F_{rdu} = A_{c0}*f_{cd}*\sqrt{(A_{c1}/A_{c0})} \le 3*A_{c0}*f_{cd}$
F_{rdu} = 14082.63 [kN] Bearing resistance of concrete
β_j = 0.67 Reduction factor for compression
$f_{jd} = \beta_j*F_{rdu}/(b_{eff}*l_{eff})$
f_{jd} = 422.86 [MPa] Design bearing resistance
$A_{c,n}$ = 1864.02 [cm^2] Bearing area for compression
$A_{c,y}$ = 620.81 [cm^2] Bearing area for bending My
$A_{c,z}$ = 665.78 [cm^2] Bearing area for bending Mz
$F_{c,Rd,i} = A_{C,i}*f_{jd}$
$F_{c,Rd,n}$ = 78821.37 [kN] Bearing resistance of concrete for compression
$F_{c,Rd,y}$ = 26251.4 [kN] Bearing resistance of concrete for bending My
$F_{c,Rd,z}$ = 28153.10 [kN] Bearing resistance of concrete for bending Mz

COLUMN FLANGE AND WEB IN COMPRESSION

CL = 1.00 Section class
$W_{pl,y}$ = 13873.57 [cm^3] Plastic section modulus
$M_{c,Rd,y}$ = 3260.29 [kN*m] Design resistance of the section for bending
$h_{f,y}$ = 509 [mm] Distance between the centroids of flanges
$F_{c,fc,Rd,y} = M_{c,Rd,y} / h_{f,y}$
$F_{c,fc,Rd,y}$ = 6404.89 [kN] Resistance of the compressed flange and web
$W_{pl,z}$ = 9458.67 [cm^3] Plastic section modulus
$M_{c,Rd,z}$ = 2222.79 [kN*m] Design resistance of the section for bending
$h_{f,z}$ = 367 [mm] Distance between the centroids of flanges
$F_{c,fc,Rd,z} = M_{c,Rd,z} / h_{f,z}$
$F_{c,fc,Rd,z}$ = 6056.38 [kN] Resistance of the compressed flange and web

RESISTANCES OF SPREAD FOOTING IN THE COMPRESSION ZONE

$N_{j,Rd} = F_{c,Rd,n}$
$N_{j,Rd}$ = 78821.37 [kN] Resistance of a spread footing for axial compression
$F_{C,Rd,y} = \min(F_{c,Rd,y},F_{c,fc,Rd,y})$
$F_{C,Rd,y}$ = 6404.89 [kN] Resistance of spread footing in the compression zone
$F_{C,Rd,z} = \min(F_{c,Rd,z},F_{c,fc,Rd,z})$

$F_{C,Rd,z}$ = 6056.38 [kN] Resistance of spread footing in the compression zone

<u>TENSION ZONE</u>

STEEL FAILURE

A_b = 8.17 [cm^2] Effective anchor area

f_{ub} = 1000.00 [MPa] Tensile strength of the anchor material

Beta = 0.85 Reduction factor of anchor resistance

$F_{t,Rd,s1} = beta*0.9*f_{ub}*A_b/\gamma_{M2}$

$F_{t,Rd,s1}$ = 500.00 [kN] Anchor resistance to steel failure

γ_{Ms} = 1.20 Partial safety factor

f_{yb} = 900.00 [MPa] Yield strength of the anchor material

$F_{t,Rd,s2} = f_{yb}*A_b/\gamma_{Ms}$

$F_{t,Rd,s2}$ = 612.75 [kN] Anchor resistance to steel failure

$F_{t,Rd,s} = \min(F_{t,Rd,s1},F_{t,Rd,s2})$

$F_{t,Rd,s}$ = 500.00 [kN] Anchor resistance to steel failure

PULL-OUT FAILURE

f_{ck} = 382.50 [MPa] Characteristic compressive strength of concrete

$f_{ctd} = 0.7*0.3*f_{ck}^{2/3}/\square_C$

f_{ctd} = 7.38 [MPa] Design tensile resistance

η_1 = 1.00 Coeff. related to the quality of the bond conditions and concreting conditions

η_2 = 0.96 Coeff. related to the bar diameter

$f_{bd} = 2.25*\eta_1*\eta_2*f_{ctd}$

f_{bd} = 15.93 [MPa] Design value of the ultimate bond stress

h_{ef} = 1000 [mm] Effective anchorage depth

$F_{t,Rd,p} = \pi*d*h_{ef}*f_{bd}$

$F_{t,Rd,p}$ = 1802.14 [kN] Design uplift capacity

CONCRETE CONE FAILURE

h_{ef} = 73 [mm] Effective anchorage depth

$N_{Rk,c}^0 = 7.5[N^{0.5}/mm^{0.5}]*f_{ck}*h_{ef}^{1.5}$

$N_{Rk,c}^0$ = 92.11 [kN] Characteristic resistance of an anchor

$s_{cr,N}$ = 220 [mm] Critical width of the concrete cone

$c_{cr,N}$ = 110 [mm] Critical edge distance

$A_{c,N0}$ = 484.00 [cm^2] Maximum area of concrete cone

$A_{c,N}$ = 440.00 [cm^2] Actual area of concrete cone

$\psi_{A,N} = A_{c,N}/A_{c,N0}$

$\psi_{A,N}$ = 0.91 Factor related to anchor spacing and edge distance

c = 90 [mm] Minimum edge distance from an anchor

$\psi_{s,N} = 0.7 + 0.3*c/c_{cr.N} \leq 1.0$

$\psi_{s,N}$ = 0.95 Factor taking account the influence of edges of the concrete member on the distribution of stresses in the concrete

$\psi_{ec,N}$ = 1.00 Factor related to distribution of tensile forces acting on anchors

$\psi_{re,N} = 0.5 + h_{ef}[mm]/200 \leq 1.0$

$\psi_{re,N}$ = 1.00 Shell spalling factor

$\psi_{ucr,N}$ = 1.00 Factor taking into account whether the anchorage is in cracked or non-cracked concrete

γ_{Mc} = 2.16 Partial safety factor

$F_{t,Rd,c} = N_{Rk,c}^{0} * \psi_{A,N} * \psi_{s,N} * \psi_{ec,N} * \psi_{re,N} * \psi_{ucr,N} / \gamma_{Mc}$

$F_{t,Rd,c}$ = 36.65 [kN] Design anchor resistance to concrete cone failure

SPLITTING FAILURE

h_{ef} = 1000 [mm] Effective anchorage depth

$N_{Rk,c}^{0} = 7.5[N^{0.5}/mm^{0.5}] * f_{ck} * h_{ef}^{1.5}$

$N_{Rk,c}^{0}$ = 4638.49 [kN] Design uplift capacity

$s_{cr,N}$ = 2000 [mm] Critical width of the concrete cone

$c_{cr,N}$ = 1000 [mm] Critical edge distance

$A_{c,N0}$ = 67456.00 [cm^2] Maximum area of concrete cone

$A_{c,N}$ = 6300.00 [cm^2] Actual area of concrete cone

$\psi_{A,N} = A_{c,N}/A_{c,N0}$

$\psi_{A,N}$ = 0.09 Factor related to anchor spacing and edge distance

c = 90 [mm] Minimum edge distance from an anchor

$\psi_{s,N} = 0.7 + 0.3 * c/c_{cr.N} \leq 1.0$

$\psi_{s,N}$ = 0.73 Factor taking account the influence of edges of the concrete member on the distribution of stresses in the concrete

$\psi_{ec,N}$ = 1.00 Factor related to distribution of tensile forces acting on anchors

$\psi_{re,N} = 0.5 + h_{ef}[mm]/200 \leq 1.0$

$\psi_{re,N}$ = 1.00 Shell spalling factor

$\psi_{ucr,N}$ = 1.00 Factor taking into account whether the anchorage is in cracked or non-cracked concrete

$\psi_{h,N} = (h/(2*h_{ef}))^{2/3} \leq 1.2$

$\psi_{h,N}$ = 0.83 Coeff. related to the foundation height

$\gamma_{M,sp}$ = 2.16 Partial safety factor

$F_{t,Rd,sp} = N_{Rk,c}^{0} * \psi_{A,N} * \psi_{s,N} * \psi_{ec,N} * \psi_{re,N} * \psi_{ucr,N} * \psi_{h,N} / \gamma_{M,sp}$

$F_{t,Rd,sp}$ = 120.36 [kN] Design anchor resistance to splitting of concrete

TENSILE RESISTANCE OF AN ANCHOR

$F_{t,Rd} = \min(F_{t,Rd,s}, F_{t,Rd,p}, F_{t,Rd,c}, F_{t,Rd,sp})$

$F_{t,Rd}$ = 36.65 [kN] Tensile resistance of an anchor

BENDING OF THE BASE PLATE

Bending moment $M_{j,Ed,y}$

$l_{eff,1}$ = 546 [mm] Effective length for a single bolt for mode 1

$l_{eff,2}$ = 546 [mm] Effective length for a single bolt for mode 2

m = 136 [mm] Distance of a bolt from the stiffening edge

$M_{pl,1,Rd}$ = 28.85 [kN*m] Plastic resistance of a plate for mode 1

$M_{pl,2,Rd}$ = 28.85 [kN*m] Plastic resistance of a plate for mode 2

$F_{T,1,Rd}$ = 846.00 [kN] Resistance of a plate for mode 1

$F_{T,2,Rd}$ = 249.09 [kN] Resistance of a plate for mode 2
$F_{T,3,Rd}$ = 109.96 [kN] Resistance of a plate for mode 3
$F_{t,pl,Rd,y} = \min(F_{T,1,Rd}, F_{T,2,Rd}, F_{T,3,Rd})$
$F_{t,pl,Rd,y}$ = 109.96 [kN] Tension resistance of a plate

Bending moment $M_{j,Ed,z}$

$l_{eff,1}$ = 548 [mm] Effective length for a single bolt for mode 1
$l_{eff,2}$ = 548 [mm] Effective length for a single bolt for mode 2
m = 99 [mm] Distance of a bolt from the stiffening edge
$M_{pl,1,Rd}$ = 28.96 [kN*m] Plastic resistance of a plate for mode 1
$M_{pl,2,Rd}$ = 28.96 [kN*m] Plastic resistance of a plate for mode 2
$F_{T,1,Rd}$ = 1165.09 [kN] Resistance of a plate for mode 1
$F_{T,2,Rd}$ = 340.36 [kN] Resistance of a plate for mode 2
$F_{T,3,Rd}$ = 146.62 [kN] Resistance of a plate for mode 3
$F_{t,pl,Rd,z} = \min(F_{T,1,Rd}, F_{T,2,Rd}, F_{T,3,Rd})$
$F_{t,pl,Rd,z}$ = 146.62 [kN] Tension resistance of a plate

RESISTANCES OF SPREAD FOOTING IN THE TENSION ZONE

$F_{T,Rd,y} = F_{t,pl,Rd,y}$
$F_{T,Rd,y}$ = 109.96 [kN] Resistance of a column base in the tension zone
$F_{T,Rd,z} = F_{t,pl,Rd,z}$
$F_{T,Rd,z}$ = 146.62 [kN] Resistance of a column base in the tension zone

<u>CONNECTION CAPACITY CHECK</u>

$N_{j,Ed} / N_{j,Rd} \leq 1,0$ (6.24)			0.01 < 1.00	verified
e_y =	361	[mm]	Axial force eccentricity	
$z_{c,y}$ =	255	[mm]	Lever arm $F_{C,Rd,y}$	
$z_{t,y}$ =	360	[mm]	Lever arm $F_{T,Rd,y}$	
$M_{j,Rd,y}$ =	228.62	[kN*m]	Connection resistance for bending	
$M_{j,Ed,y} / M_{j,Rd,y} \leq 1,0$ (6.23)			0.68 < 1.00	verified
e_z =	58	[mm]	Axial force eccentricity	
$z_{c,z}$ =	184	[mm]	Lever arm $F_{C,Rd,z}$	
$z_{t,z}$ =	240	[mm]	Lever arm $F_{T,Rd,z}$	
$M_{j,Rd,z}$ =	535.74	[kN*m]	Connection resistance for bending	
$M_{j,Ed,z} / M_{j,Rd,z} \leq 1,0$ (6.23)			0.05 < 1.00	verified
$M_{j,Ed,y} / M_{j,Rd,y} + M_{j,Ed,z} / M_{j,Rd,z} \leq 1,0$			0.72 < 1.00	verified

<u>SHEAR</u>

BEARING PRESSURE OF AN ANCHOR BOLT ONTO THE BASE PLATE

Shear force $V_{j,Ed,y}$

$\alpha_{d,y}$ = 0.75 Coeff. taking account of the bolt position - in the direction of shear
$\alpha_{b,y}$ = 0.75 Coeff. for resistance calculation $F_{1,vb,Rd}$
$k_{1,y}$ = 2.50 Coeff. taking account of the bolt position - perpendicularly to the direction of shear
$F_{1,vb,Rd,y} = k_{1,y} * \alpha_{b,y} * f_{up} * d * t_p / \gamma_{M2}$

$F_{1,vb,Rd,y}$ = 378.47 [kN] Resistance of an anchor bolt for bearing pressure onto the base plate

Shear force $V_{j,Ed,z}$

$\alpha_{d,z}$ = 0.57 Coeff. taking account of the bolt position - in the direction of shear

$\alpha_{b,z}$ = 0.57 Coeff. for resistance calculation $F_{1,vb,Rd}$

$k_{1,z}$ = 2.50 Coeff. taking account of the bolt position - perpendicularly to the direction of shear

$F_{1,vb,Rd,z} = k_{1,z}*\alpha_{b,z}*f_{up}*d*t_p / \gamma_{M2}$

$F_{1,vb,Rd,z}$ = 289.42 [kN] Resistance of an anchor bolt for bearing pressure onto the base plate

SHEAR OF AN ANCHOR BOLT

α_b = 0.25 Coeff. for resistance calculation $F_{2,vb,Rd}$

A_{vb} = 10.18 [cm^2] Area of bolt section

f_{ub} = 1000.00 [MPa] Tensile strength of the anchor material

γ_{M2} = 1.25 Partial safety factor

$F_{2,vb,Rd} = \alpha_b*f_{ub}*A_{vb}/\gamma_{M2}$

$F_{2,vb,Rd}$ = 201.95 [kN] Shear resistance of a bolt - without lever arm

α_M = 2.00 Factor related to the fastening of an anchor in the foundation

$M_{Rk,s}$ = 6.18 [kN*m] Characteristic bending resistance of an anchor

l_{sm} = 63 [mm] Lever arm length

γ_{Ms} = 1.20 Partial safety factor

$F_{v,Rd,sm} = \alpha_M*M_{Rk,s}/(l_{sm}*\gamma_{Ms})$

$F_{v,Rd,sm}$ = 163.59 [kN] Shear resistance of a bolt - with lever arm

CONCRETE PRY-OUT FAILURE

$N_{Rk,c}$ = 79.17 [kN] Design uplift capacity

k_3 = 2.00 Factor related to the anchor length

γ_{Mc} = 2.16 Partial safety factor

$F_{v,Rd,cp} = k_3*N_{Rk,c}/\gamma_{Mc}$

$F_{v,Rd,cp}$ = 73.31 [kN] Concrete resistance for pry-out failure

CONCRETE EDGE FAILURE

Shear force $V_{j,Ed,y}$

$V_{Rk,c,y}^0$ = 513.24 [kN] Characteristic resistance of an anchor

$\psi_{A,V,y}$ = 0.55 Factor related to anchor spacing and edge distance

$\psi_{h,V,y}$ = 1.00 Factor related to the foundation thickness

$\psi_{s,V,y}$ = 0.86 Factor related to the influence of edges parallel to the shear load direction

$\psi_{ec,V,y}$ = 1.00 Factor taking account a group effect when different shear loads are acting on the individual anchors in a group

$\psi_{\alpha,V,y}$ = 1.00 Factor related to the angle at which the shear load is applied

$\psi_{ucr,V,y}$ = 1.00 Factor related to the type of edge reinforcement used

γ_{Mc} = 2.16 Partial safety factor

$F_{v,Rd,c,y} = V_{Rk,c,y}^0*\psi_{A,V,y}*\psi_{h,V,y}*\psi_{s,V,y}*\psi_{ec,V,y}*\psi_{\alpha,V,y}*\psi_{ucr,V,y}/\gamma_{Mc}$

$F_{v,Rd,c,y}$ =	111.93	[kN]	Concrete resistance for edge failure

Shear force $V_{j,Ed,z}$

$V_{Rk,c,z}^{0}$ =	379.83	[kN]	Characteristic resistance of an anchor
$\psi_{A,V,z}$ =	0.81		Factor related to anchor spacing and edge distance
$\psi_{h,V,z}$ =	1.00		Factor related to the foundation thickness
$\psi_{s,V,z}$ =	0.94		Factor related to the influence of edges parallel to the shear load direction
$\psi_{ec,V,z}$ =	1.00		Factor taking account a group effect when different shear loads are acting on the individual anchors in a group
$\psi_{\alpha,V,z}$ =	1.00		Factor related to the angle at which the shear load is applied
$\psi_{ucr,V,z}$ =	1.00		Factor related to the type of edge reinforcement used
γ_{Mc} =	2.16		Partial safety factor

$F_{v,Rd,c,z} = V_{Rk,c,z}^{0} * \psi_{A,V,z} * \psi_{h,V,z} * \psi_{s,V,z} * \psi_{ec,V,z} * \psi_{\alpha,V,z} * \psi_{ucr,V,z} / \gamma_{Mc}$

$F_{v,Rd,c,z}$ =	135.32	[kN]	Concrete resistance for edge failure

SPLITTING RESISTANCE

$C_{f,d}$ =	0.30		Coeff. of friction between the base plate and concrete
$N_{c,Ed}$ =	429.00	[kN]	Compressive force

$F_{f,Rd} = C_{f,d} * N_{c,Ed}$

$F_{f,Rd}$ =	128.70	[kN]	Slip resistance

SHEAR CHECK

$V_{j,Rd,y} = n_b * \min(F_{1,vb,Rd,y}, F_{2,vb,Rd}, F_{v,Rd,sm}, F_{v,Rd,cp}, F_{v,Rd,c,y}) + F_{f,Rd}$

$V_{j,Rd,y}$ =	861.78	[kN]	Connection resistance for shear

$V_{j,Ed,y} / V_{j,Rd,y} \leq 1,0$	0.02 < 1.00	verified

$V_{j,Rd,z} = n_b * \min(F_{1,vb,Rd,z}, F_{2,vb,Rd}, F_{v,Rd,sm}, F_{v,Rd,cp}, F_{v,Rd,c,z}) + F_{f,Rd}$

$V_{j,Rd,z}$ =	861.78	[kN]	Connection resistance for shear

$V_{j,Ed,z} / V_{j,Rd,z} \leq 1,0$	0.03 < 1.00	verified
$V_{j,Ed,y} / V_{j,Rd,y} + V_{j,Ed,z} / V_{j,Rd,z} \leq 1,0$	0.05 < 1.00	verified

STIFFENER CHECK

Trapezoid plate parallel to the column web

M_1 =	11.95	[kN*m]	Bending moment acting on a stiffener
Q_1 =	119.48	[kN]	Shear force acting on a stiffener
z_s =	149	[mm]	Location of the neutral axis (from the plate base)
I_s =	55574.50	[cm^4]	Moment of inertia of a stiffener
σ_d =	2.56	[MPa]	Normal stress on the contact surface between stiffener and plate
σ_g =	8.19	[MPa]	Normal stress in upper fibers
τ =	11.95	[MPa]	Tangent stress in a stiffener
σ_z =	20.85	[MPa]	Equivalent stress on the contact surface between stiffener and plate

$\max(\sigma_g, \tau / (0.58), \sigma_z) / (f_{yp}/\gamma_{M0}) \leq 1.0$ (6.1)	0.09 < 1.00	verified

Stiffener perpendicular to the web (along the extension of the column flanges)

M_1 = 7.18 [kN*m] Bending moment acting on a stiffener
Q_1 = 92.59 [kN] Shear force acting on a stiffener
z_s = 131 [mm] Location of the neutral axis (from the plate base)
I_s = 60285.83 [cm^4] Moment of inertia of a stiffener
σ_d = 1.21 [MPa] Normal stress on the contact surface between stiffener and plate
σ_g = 4.74 [MPa] Normal stress in upper fibers
τ = 9.26 [MPa] Tangent stress in a stiffener
σ_z = 16.08 [MPa] Equivalent stress on the contact surface between stiffener and plate

max (σ_g, τ / (0.58), σ_z) / (f_{yp}/γ_{M0}) ≤ 1.0 (6.1) 0.07 < 1.00 verified

WELDS BETWEEN THE COLUMN AND THE BASE PLATE

$\sigma_\perp$ = 19.98 [MPa] Normal stress in a weld
$\tau_\perp$ = 19.98 [MPa] Perpendicular tangent stress
τ_{yII} = 0.76 [MPa] Tangent stress parallel to $V_{j,Ed,y}$
τ_{zII} = 0.80 [MPa] Tangent stress parallel to $V_{j,Ed,z}$
β_W = 0.80 Resistance-dependent coefficient

$\sigma_\perp$ / (0.9*f_u/γ_{M2})) ≤ 1.0 (4.1) 0.12 < 1.00 verified
$\sqrt{}(\sigma_\perp^2 + 3.0 (\tau_{yII}^2 + \tau_\perp^2))$ / ($f_u/(\beta_W*\gamma_{M2})$)) ≤ 1.0 (4.1) 0.17 < 1.00 verified
$\sqrt{}(\sigma_\perp^2 + 3.0 (\tau_{zII}^2 + \tau_\perp^2))$ / ($f_u/(\beta_W*\gamma_{M2})$)) ≤ 1.0 (4.1) 0.12 < 1.00 verified

VERTICAL WELDS OF STIFFENERS

Trapezoid plate parallel to the column web

$\sigma_\perp$ = 0.00 [MPa] Normal stress in a weld
$\tau_\perp$ = 0.00 [MPa] Perpendicular tangent stress
τ_{II} = 42.31 [MPa] Parallel tangent stress
σ_z = 0.00 [MPa] Total equivalent stress
β_W = 0.80 Resistance-dependent coefficient

max ($\sigma_\perp$, $\tau_{II} * \sqrt{3}$, σ_z) / ($f_u/(\beta_W*\gamma_{M2})$) ≤ 1.0 (4.1) 0.31 < 1.00 verified

Stiffener perpendicular to the web (along the extension of the column flanges)

$\sigma_\perp$ = 10.15 [MPa] Normal stress in a weld
$\tau_\perp$ = 10.15 [MPa] Perpendicular tangent stress
τ_{II} = 15.43 [MPa] Parallel tangent stress
σ_z = 33.56 [MPa] Total equivalent stress
β_W = 0.80 Resistance-dependent coefficient

max ($\sigma_\perp$, $\tau_{II} * \sqrt{3}$, σ_z) / ($f_u/(\beta_W*\gamma_{M2})$) ≤ 1.0 (4.1) 0.14 < 1.00 verified

TRANSVERSAL WELDS OF STIFFENERS

Trapezoid plate parallel to the column web

$\sigma_\perp$ = 35.20 [MPa] Normal stress in a weld
$\tau_\perp$ = 35.20 [MPa] Perpendicular tangent stress
τ_{II} = 24.19 [MPa] Parallel tangent stress
σ_z = 81.93 [MPa] Total equivalent stress

β_W =	0.80		Resistance-dependent coefficient	
max ($\sigma_\perp$, τ_{II} * $\sqrt{3}$, σ_z) / (f_u/(β_W*γ_{M2})) ≤ 1.0 (4.1)			0.35 < 1.00	verified

Stiffener perpendicular to the web (along the extension of the column flanges)

$\sigma_\perp$ =	35.20	[MPa]	Normal stress in a weld	
$\tau_\perp$ =	35.20	[MPa]	Perpendicular tangent stress	
τ_{II} =	19.81	[MPa]	Parallel tangent stress	
σ_z =	78.32	[MPa]	Total equivalent stress	
β_W =	0.80		Resistance-dependent coefficient	
max ($\sigma_\perp$, τ_{II} * $\sqrt{3}$, σ_z) / (f_u/(β_W*γ_{M2})) ≤ 1.0 (4.1)			0.33 < 1.00	verified

CONNECTION STIFFNESS

Bending moment $M_{j,Ed,y}$

b_{eff} = 65 [mm] Effective width of the bearing pressure zone under the flange

l_{eff} = 339 [mm] Effective length of the bearing pressure zone under the flange

$k_{13,y} = E_c*\sqrt{(b_{eff}*l_{eff})}/(1.275*E)$

$k_{13,y}$ = 117 [mm] Stiffness coeff. of compressed concrete

l_{eff} = 546 [mm] Effective length for a single bolt for mode 2

m = 136 [mm] Distance of a bolt from the stiffening edge

$k_{15,y} = 0.850*l_{eff}*t_p^3/(m^3)$

$k_{15,y}$ = 5 [mm] Stiffness coeff. of the base plate subjected to tension

L_b = 376 [mm] Effective anchorage depth

$k_{16,y} = 1.6*A_b/L_b$

$k_{16,y}$ = 3 [mm] Stiffness coeff. of an anchor subjected to tension

$\lambda_{0,y}$ = 0.28 Column slenderness

$S_{j,ini,y}$ = 467739.48 [kN*m] Initial rotational stiffness

$S_{j,rig,y}$ = 1006583.76 [kN*m] Stiffness of a rigid connection

$S_{j,ini,y} < S_{j,rig,y}$ SEMI-RIGID

Bending moment $M_{j,Ed,z}$

$k_{13,z} = E_c*\sqrt{(A_{c,z})}/(1.275*E)$

$k_{13,z}$ = 202 [mm] Stiffness coeff. of compressed concrete

l_{eff} = 548 [mm] Effective length for a single bolt for mode 2

m = 99 [mm] Distance of a bolt from the stiffening edge

$k_{15,z} = 0.850*l_{eff}*t_p^3/(m^3)$

$k_{15,z}$ = 13 [mm] Stiffness coeff. of the base plate subjected to tension

L_b = 376 [mm] Effective anchorage depth

$k_{16,z} = 1.6*A_b/L_b$

$k_{16,z}$ = 3 [mm] Stiffness coeff. of an anchor subjected to tension

$\lambda_{0,z}$ = 0.73 Column slenderness

$S_{j,ini,z}$ = 2862294.44 [kN*m] Initial rotational stiffness

$S_{j,rig,z}$ = 147688.38 [kN*m] Stiffness of a rigid connection

$S_{j,ini,z} < S_{j,rig,z}$ RIGID

Connection conforms to the code	Ratio	0.72

ANEXO VI

Relatório do "*Robot Structural Analyses*"
do Dimensionamento da Sapata para a Combinação 2

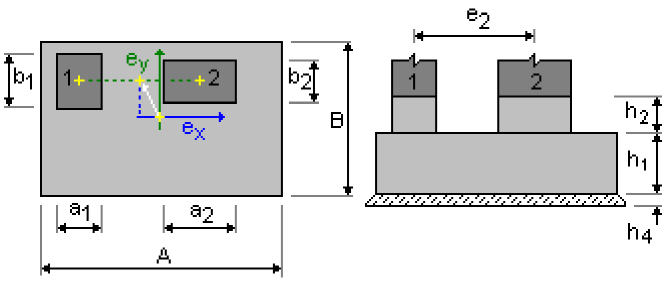
Combinação 2

1.1 Elementos de dimensionamento

1.1.1 Regulamentação

- Cálculos geotécnicos de acordo com a EN 1997-1:2008
- Cálculos de betão de acordo com a EN 1992-1-1:2004 AC:2008

1.1.2 Geometria da Fundação



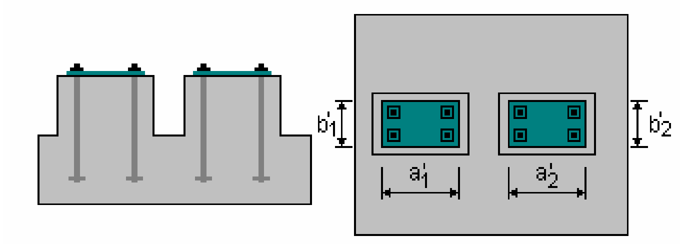
A = 7.00 m | a_1 = 0.70 m | a_2 = 0.70 m

B = 3.00 m | b_1 = 0.90 m | b_2 = 0.90 m

h_1 = 1.60 m | e_2 = 5.00 m

h_2 = 1.50 m | e_x = 0.00 m | e_y = 0.00 m

h_4 = 0.05 m



a_1' = 60.0 cm | a_2' = 60.0 cm

b_1' = 80.0 cm) | b_2' = 80.0 cm

c_{nom1} = 6.0 cm

c_{nom2} = 6.0 cm

1.1.3 Materiais

- Betão : Classe de Resistência – C30/37

  Peso unitário = 2501.36 (kG/m^3)
  Distribuição de tensões retangulares
- Armaduras longitudinais do tipo A500
- Armaduras transversais do tipo A500
- Armaduras complementares do tipo A500

1.1.4 Ações

Superestrutura

Esforços	Pilar	N kN	F_x kN	F_y kN	M_x kN.m	M_y kN.m
Combinação	1	429.0	-17. 0	24.0	-155.0	-25.0
	2	408.0	17.00	24.0	-155.0	25.0

1.1.5 Combinações de Ações

1/ ULS: Combinação 2 N = 837.0 M_x = -310.0 M_y = -52.5 F_y = 48.0
2/* ULS: Combinação 2 N = 837.0 M_x = -310.0 M_y = -52.5 F_y = 48.0

1.2 Dados Geotécnicos

1.2.1 Valores

- Coeficiente coesão: 0.06 Mpa
- Elementos geotécnicos

A1 + M1 + R1	A2 + M2 + R1
γ_{ϕ}' = 1.00	γ_{ϕ}' =1.25
γ_c' = 1.00	γ_c' =1.25
γ_{cu} = 1.00	γ_{cu} =1.40
γ_{qu} = 1.00	γ_{qu} =1.40
$\gamma\gamma$ = 1.00	$\gamma\gamma$ =1.00
$\gamma_{R,v}$ = 1.00	$\gamma_{R,v}$ =1.00
$\gamma_{R,h}$ = 1.00	$\gamma_{R,h}$ = 1.00

1.2.2 Cotas do Terreno de Fundação

Nível do solo:
N_1 = -0.20 m
Nível do pilar da coluna: N_a = 0.00 m
Nível mínimo de referência: N_f = -5.00 m

Caraterísticas do Terreno de Fundação

- Nível do solo: -0.20 m
- Peso unitário: 2243.38 kG/m^3
- Peso da unidade de sólido: 2753.23 kG/m^3
- Ângulo de atrito interno: 25.0 Deg
- Coesão: 0.06 Mpa

1.2.3 Estados Limites

Combinação ao **ELS**
Combinação 2 N = 837.0 M_x = -310.0 M_y = -52.50 F_y = 48.0
Coeficientes de segurança: 1.35 x Peso da fundação

1.35 x Peso do solo

Resultados do cálculo ao nível da fundação

Peso da fundação e do terreno sobre a sapata: G_r = 1937.43 kN

Ações:

N_r = 2774.43 kN M_x = -458.80 KN.m   My = -52.50 KN.m

Excentricidades:

e_B = -0.02 m e_L = 0.17 m

Dimensões da Fundação "equivalente":

B' = B - 2|e_B| = 3.00 m

L' = L - 2|e_L| = 6.96 m

Profundidade da fundação: D_{min} = 2.90 m

Método de Cálculo da Tensão Tolerável: "Semi-Empírico - Limite de Tensão"

q_u = 0.75 Mpa

p_{le}* = 0.50 Mpa

$D_e = D_{min}$ - d = 2.90 m

k_p = 0.95

q'_0 = 0.06 Mpa

$q_u = k_p * (p_{le}*) + q'_0$ = 0.54 Mpa

Tensão no solo: q_{ref} = 0.18 Mpa

Rácio: q_{lim} / q_{ref} = 3.011 > 1

Levantamento

Levantamento ao ELU

Combinação do projeto

Combinação 1 N = 837.0 M_x = -310.0 M_y = -52.50 F_y = 48.0

Coeficientes de segurança: 1.00 x Peso da fundação

1.00 x Peso do solo

Área de contato: s = 0.07

s_{lim} = 0.17

Deslizamento

Combinação ao **ELS**

Combinação 1 N = 837.0 M_x = -310.0 M_y = -52.50 F_y = 48.0

Coeficientes de segurança: 1.00 x Peso da fundação

1.00 x Peso do solo

Peso da fundação e do terreno sobre a sapata: G_r = 1435.13 kN

Ações:

N_r = 2272.1 kN M_x = -458.80 kN.m M_y = -52.5 kN.m

Dimensões da fundação equivalente: A = 7.00 m   B = 3.00 m

Área de deslizamento: 21.00 m^2

Coeficiente de atrito do solo/fundação: tan δ_d = 0.30

Coesão: c_u = 0.06 Mpa

Tensão no solo considerada:

H_x = 0.00 kN H_y = 48.00 kN

P_{px} = 0.00 kN P_{py} = -1274.93 kN

P_{ax} = 0.00 kN P_{ay} = 210.01 kN

Força de deslizamento H_d = 0.00 kN

Força que impede o deslizamento da fundação

Ao nível da fundação: R_d = 680.23 kN
Fator de segurança ao deslizamento: $\propto$

Derrubamento

Em torno do Eixo OX

Combinação ao **ULU**
Combinação N = 837.0 M_x = -310.0 M_y = -52.5 F_y = 48.0
Coeficientes de segurança: 1.00 x Peso da fundação
1.00 x Peso do solo
Peso da fundação e do terreno sobre a sapata: G_r = 1435.13 kN
Ações:
N_r = 2272.1 kN M_x = -458.8 kN.m M_y = -52.5 kN.m
Momento estabilizante: M_{stab} = 3408.20 kN.m
Momento derrubante: M_{derr} = 458.80 kN.m
Fator de segurança ao derrubamento: 7.429 > 1.5

Em torno do Eixo OY

Combinação do projeto **ULS**
Combinação N = 837.0 M_x = -310.0 M_y = -52.5 F_y = 48.0
Coeficientes de segurança: 1.00 x Peso da fundação
1.00 x Peso do solo
Peso da fundação e do terreno sobre a sapata: G_r = 1435.13 kN
Ações:
N_r = 2272.1 kN M_x = -458.8 kN.m M_y = -52.5 kN.m
Momento estabilizante: M_{stab} = 7952.47 kN.m
Momento derrubante: M_{derr} = 52.50 kN.m
Fator de segurança ao derrubamento: 151.5 > 1.5

1.3 Outras Verificações

- Exposição : X0
- Classe de estrutura : S1

1.3.1 Verificação do Punçoamento e Corte

Combinação ao **ELU**
Combinação N = 837.0 M_x = -310.0 M_y = -52.50 F_y = 48.0
Coeficientes de segurança: 1.35 x Peso da fundação
1.35 x Peso do solo
Ações:
N_r = 2774.4 kN M_x = -458.8 kN.m M_y = -52.5 kN.m
Comprimento da circunferência crítica: 7.05 m
Força de punçoamento: 264.21 kN
Altura de seção efetiva h_{eff} = 1.53 m
Taxa de armadura: ρ = 0.15 %
Tensão de corte: 0.14 Mpa
Tensão de corte admissivel: 1.52 Mpa
Fator de segurança ao punçoamento: 10.87 > 1.5

1.3.2 Armaduras

Sapata

Inferiores

ULS : Combinação 2 N =837.0 M_x = -310.0 M_y = -52.5 F_y = 48.0
M_y = 80.4 kN.m A_{sx} = 23.07 cm^2/m
ULS : Combinação 2 N = 837.0 M_x = -310.0 M_y = -52.50 F_y = 48.0
M_x = 358.5 kN.m A_{sy} = 23.07 cm^2/m
$A_{s\ minn}$ = 23.07 cm^2/m

Superiores

ULS: Combinação 2 N = 837.0 M_x = -310.0 M_y = -52.5 F_y = 48.0
M_y = -322.6 kN.m A'_{sx} = 23.07 cm^2/m
A'_{sy} = 0.00 cm^2/m
$A_{s\ min}$ = 23.07 cm^2/m

Armaduras dos Plintos

Plinto P1

Armaduras longitudinais A = 12.60 cm^2 $A_{mín.}$ = 12.60 cm^2
A = 2 * (A_{sx1} + A_{sy1})
A_{sx1} = 1.14 cm^2 A_{sy1} = 5.16 cm^2

Plinto P2
Armaduras longitudinais A = 12.60 cm^2 $A_{mín.}$ = 12.60 cm^2
A = 2 * (A_{sx2} + A_{sy2})
A_{sx2} = 1.12 cm^2 A_{sy2} = 5.18 cm^2

ANEXO VII

Resultados da Análise Modal

TABLE: Modal Participating Mass Ratios									
OutputCase	**StepType**	**StepNum**	**Frequência**	**UX**	**UY**	**UZ**	**SumUX**	**SumUY**	**SumUZ**
Text	Text	Unitless	Hz	Unitless	Unitless	Unitless	Unitless	Unitless	Unitless
MODAL	Mode	1	1.63	0.00	0.68	0.00	0.00	0.68	0.00
MODAL	Mode	2	2.53	0.00	0.00	0.00	0.00	0.68	0.00
MODAL	Mode	3	2.73	0.00	0.00	0.25	0.00	0.68	0.25
MODAL	Mode	4	2.87	0.09	0.00	0.00	0.09	0.68	0.25
MODAL	Mode	5	2.95	0.00	0.02	0.00	0.09	0.71	0.25
MODAL	Mode	6	3.16	0.00	0.00	0.00	0.09	0.71	0.25
MODAL	Mode	7	4.11	0.00	0.00	0.04	0.10	0.71	0.29
MODAL	Mode	8	4.39	0.00	0.02	0.00	0.10	0.73	0.29
MODAL	Mode	9	4.73	0.52	0.00	0.02	0.62	0.73	0.31
MODAL	Mode	10	4.99	0.01	0.00	0.00	0.63	0.73	0.32
MODAL	Mode	11	5.10	0.00	0.00	0.00	0.63	0.73	0.32
MODAL	Mode	12	5.52	0.00	0.00	0.01	0.63	0.73	0.33
MODAL	Mode	13	5.62	0.02	0.01	0.18	0.65	0.74	0.51
MODAL	Mode	14	5.65	0.01	0.02	0.08	0.66	0.76	0.59
MODAL	Mode	15	6.31	0.00	0.02	0.00	0.66	0.78	0.59
MODAL	Mode	16	6.39	0.00	0.00	0.00	0.66	0.78	0.59
MODAL	Mode	17	6.65	0.04	0.00	0.03	0.70	0.78	0.62
MODAL	Mode	18	6.92	0.00	0.00	0.00	0.71	0.78	0.62
MODAL	Mode	19	6.96	0.01	0.00	0.00	0.71	0.78	0.62
MODAL	Mode	20	7.04	0.00	0.00	0.00	0.71	0.78	0.62
MODAL	Mode	21	7.12	0.00	0.00	0.03	0.71	0.78	0.65
MODAL	Mode	22	7.13	0.00	0.00	0.01	0.71	0.78	0.66
MODAL	Mode	23	7.15	0.00	0.00	0.00	0.71	0.78	0.66
MODAL	Mode	24	7.16	0.00	0.00	0.00	0.71	0.78	0.66

TABLE: Modal Participating Mass Ratios									
OutputCase	**StepType**	**StepNum**	**Frequência**	**UX**	**UY**	**UZ**	**SumUX**	**SumUY**	**SumUZ**
Text	Text	Unitless	Hz	Unitless	Unitless	Unitless	Unitless	Unitless	Unitless
MODAL	Mode	25	7.18	0.00	0.00	0.00	0.71	0.78	0.66
MODAL	Mode	26	7.23	0.00	0.00	0.00	0.71	0.78	0.66
MODAL	Mode	27	7.25	0.01	0.00	0.00	0.73	0.78	0.66
MODAL	Mode	28	7.27	0.00	0.00	0.00	0.73	0.78	0.66
MODAL	Mode	29	7.29	0.01	0.00	0.00	0.74	0.78	0.66
MODAL	Mode	30	7.30	0.00	0.00	0.00	0.74	0.78	0.66
MODAL	Mode	31	7.35	0.00	0.00	0.01	0.74	0.78	0.67
MODAL	Mode	32	7.37	0.00	0.00	0.00	0.74	0.78	0.67
MODAL	Mode	33	7.39	0.00	0.00	0.00	0.74	0.78	0.67
MODAL	Mode	34	7.45	0.00	0.00	0.00	0.75	0.78	0.67
MODAL	Mode	35	7.50	0.00	0.00	0.00	0.75	0.78	0.67
MODAL	Mode	36	7.55	0.04	0.00	0.00	0.79	0.78	0.67
MODAL	Mode	37	7.56	0.00	0.00	0.00	0.79	0.78	0.67
MODAL	Mode	38	7.57	0.00	0.00	0.00	0.79	0.78	0.67
MODAL	Mode	39	7.96	0.00	0.00	0.00	0.79	0.79	0.67
MODAL	Mode	40	7.97	0.00	0.00	0.00	0.80	0.79	0.68
MODAL	Mode	41	8.16	0.00	0.01	0.00	0.80	0.80	0.68
MODAL	Mode	42	8.63	0.01	0.00	0.03	0.81	0.80	0.71
MODAL	Mode	43	8.74	0.01	0.00	0.00	0.81	0.80	0.71
MODAL	Mode	44	8.83	0.00	0.00	0.00	0.81	0.80	0.71
MODAL	Mode	45	9.49	0.00	0.00	0.00	0.81	0.80	0.71
MODAL	Mode	46	9.64	0.00	0.00	0.00	0.81	0.80	0.71
MODAL	Mode	47	9.73	0.00	0.01	0.00	0.81	0.81	0.71
MODAL	Mode	48	9.93	0.00	0.00	0.01	0.82	0.81	0.72
MODAL	Mode	49	10.00	0.00	0.00	0.00	0.82	0.81	0.72

TABLE: Modal Participating Mass Ratios									
OutputCase	**StepType**	**StepNum**	**Frequência**	**UX**	**UY**	**UZ**	**SumUX**	**SumUY**	**SumUZ**
Text	Text	Unitless	Hz	Unitless	Unitless	Unitless	Unitless	Unitless	Unitless
MODAL	Mode	50	10.23	0.00	0.00	0.00	0.82	0.81	0.72
MODAL	Mode	51	10.31	0.02	0.00	0.00	0.84	0.81	0.72
MODAL	Mode	52	10.33	0.01	0.00	0.01	0.85	0.81	0.73
MODAL	Mode	53	10.39	0.00	0.00	0.00	0.85	0.81	0.73
MODAL	Mode	54	10.44	0.00	0.00	0.00	0.85	0.81	0.74
MODAL	Mode	55	10.59	0.00	0.00	0.00	0.85	0.81	0.74
MODAL	Mode	56	10.77	0.00	0.00	0.00	0.85	0.81	0.74
MODAL	Mode	57	10.86	0.00	0.00	0.00	0.85	0.81	0.74
MODAL	Mode	58	10.91	0.00	0.01	0.00	0.85	0.81	0.74
MODAL	Mode	59	10.92	0.00	0.03	0.00	0.85	0.84	0.74
MODAL	Mode	60	10.95	0.00	0.00	0.00	0.85	0.84	0.74
MODAL	Mode	61	11.00	0.02	0.00	0.01	0.87	0.84	0.75
MODAL	Mode	62	11.11	0.00	0.00	0.00	0.87	0.84	0.75
MODAL	Mode	63	11.18	0.00	0.00	0.00	0.87	0.84	0.75
MODAL	Mode	64	11.35	0.00	0.00	0.00	0.87	0.84	0.75
MODAL	Mode	65	11.36	0.00	0.00	0.00	0.87	0.84	0.75
MODAL	Mode	66	11.44	0.00	0.03	0.01	0.87	0.88	0.76
MODAL	Mode	67	11.47	0.00	0.02	0.00	0.87	0.89	0.76
MODAL	Mode	68	11.65	0.00	0.00	0.01	0.87	0.89	0.77
MODAL	Mode	69	11.73	0.00	0.00	0.00	0.87	0.89	0.77
MODAL	Mode	70	11.84	0.00	0.00	0.00	0.87	0.90	0.77
MODAL	Mode	71	11.89	0.00	0.00	0.00	0.87	0.90	0.78
MODAL	Mode	72	12.12	0.00	0.00	0.00	0.87	0.90	0.78
MODAL	Mode	73	12.35	0.00	0.00	0.00	0.87	0.90	0.78
MODAL	Mode	74	12.69	0.00	0.00	0.00	0.87	0.90	0.78

TABLE:Modal Participating Mass Ratios									
OutputCase	**StepType**	**StepNum**	**Frequência**	**UX**	**UY**	**UZ**	**SumUX**	**SumUY**	**SumUZ**
Text	Text	Unitless	Hz	Unitless	Unitless	Unitless	Unitless	Unitless	Unitless
MODAL	Mode	75	12.91	0.01	0.00	0.01	0.88	0.90	0.78
MODAL	Mode	76	13.24	0.00	0.00	0.00	0.88	0.90	0.78
MODAL	Mode	77	13.45	0.00	0.00	0.00	0.88	0.90	0.78
MODAL	Mode	78	13.48	0.00	0.00	0.00	0.88	0.90	0.78
MODAL	Mode	79	13.50	0.00	0.00	0.00	0.88	0.90	0.78
MODAL	Mode	80	13.72	0.02	0.00	0.00	0.90	0.90	0.79
MODAL	Mode	81	13.88	0.00	0.00	0.00	0.90	0.90	0.79
MODAL	Mode	82	13.99	0.00	0.00	0.03	0.90	0.90	0.81
MODAL	Mode	83	14.09	0.00	0.00	0.00	0.90	0.90	0.81
MODAL	Mode	84	15.21	0.00	0.00	0.01	0.90	0.90	0.82
MODAL	Mode	85	15.33	0.00	0.00	0.00	0.90	0.90	0.82
MODAL	Mode	86	15.43	0.00	0.00	0.00	0.90	0.90	0.82
MODAL	Mode	87	16.73	0.02	0.00	0.00	0.92	0.90	0.82
MODAL	Mode	88	16.98	0.00	0.00	0.00	0.92	0.90	0.82
MODAL	Mode	89	18.15	0.00	0.00	0.00	0.92	0.90	0.82
MODAL	Mode	90	18.39	0.00	0.00	0.00	0.92	0.91	0.82
MODAL	Mode	91	19.04	0.00	0.01	0.00	0.92	0.91	0.82
MODAL	Mode	92	20.29	0.00	0.00	0.00	0.92	0.91	0.82
MODAL	Mode	93	20.37	0.00	0.00	0.00	0.92	0.91	0.82
MODAL	Mode	94	20.78	0.00	0.00	0.00	0.92	0.91	0.82
MODAL	Mode	95	20.98	0.00	0.00	0.00	0.92	0.91	0.82
MODAL	Mode	96	21.08	0.00	0.00	0.01	0.92	0.91	0.84
MODAL	Mode	97	21.27	0.00	0.00	0.00	0.92	0.91	0.84
MODAL	Mode	98	21.61	0.00	0.00	0.00	0.92	0.91	0.84
MODAL	Mode	99	21.74	0.00	0.00	0.00	0.92	0.92	0.84
MODAL	Mode	100	21.98	0.00	0.00	0.00	0.92	0.92	0.84