

## **MEMORIAL DE CÁLCULO ESTRUTURA METÁLICA**

OBRA: PORTICO SECUNDÁRIO TREVO DE IBIRUBÁ ACESSO BANGU

CONTRATANTE: PREFEITURA MUNICIPAL DE IBIRUBÁ

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## 1.- GEOMETRIA

### 1.1- Barras

#### 1.2.1.- Materiais utilizados

Materiais utilizados							
Material		E	$\nu$	G	$f_y$	$\alpha_t$	$\gamma$
Tipo	Designação	(kgf/cm <sup>2</sup> )		(kgf/cm <sup>2</sup> )	(kgf/cm <sup>2</sup> )	(m/m°C)	(t/m <sup>3</sup> )
Aço laminado	A-36 250Mpa	2100000.0	0.300	807692.3	2548.4	0.000012	7.850
<i>Notação:</i> <i>E: Módulo de elasticidade</i> <i><math>\nu</math>: Módulo de poisson</i> <i>G: Módulo de corte</i> <i><math>f_y</math>: Limite elástico</i> <i><math>\alpha_t</math>: Coeficiente de dilatação</i> <i><math>\gamma</math>: Peso específico</i>							

#### 1.2.2.- Características mecânicas

Características mecânicas									
Material		Ref.	Descrição	A	Avy	Avz	Iyy	Izz	It
Tipo	Designação			(cm <sup>2</sup> )	(cm <sup>2</sup> )	(cm <sup>2</sup> )	(cm <sup>4</sup> )	(cm <sup>4</sup> )	(cm <sup>4</sup> )
Aço laminado	A-36 250Mpa	1	L 76x76x4.8, (Cantoneiras de abas iguais)	7.00	3.43	3.43	40.00	40.00	0.54
		2	L 51x51x4.8, (Cantoneiras de abas iguais)	4.58	2.21	2.21	11.70	11.70	0.36
		3	L 76x76x7.9, (Cantoneiras de abas iguais)	11.50	5.40	5.40	62.00	62.00	2.37
<i>Notação:</i> <i>Ref.: Referência</i> <i>A: Área da seção transversal</i> <i>Avy: Área de esforço cortante da seção segundo o eixo local 'Y'</i> <i>Avz: Área de esforço cortante da seção segundo o eixo local 'Z'</i> <i>Iyy: Inércia da seção em torno do eixo local 'Y'</i> <i>Izz: Inércia da seção em torno do eixo local 'Z'</i> <i>It: Inércia à torção</i> <i>As características mecânicas das peças correspondem à seção no ponto médio das mesmas.</i>									

## 2.- RESULTADOS

### 2.1- Barras

#### 2.1.1.- Resistência

Referências:

- N: Esforço axial (t)
- Vy: Esforço cortante segundo o eixo local Y da barra. (t)
- Vz: Esforço cortante segundo o eixo local Z da barra. (t)
- Mt: Momento torsor (t·m)
- My: Momento fletor no plano 'XZ' (rotação da seção em relação ao eixo local 'Y' da barra). (t·m)
- Mz: Momento fletor no plano 'XY' (rotação da seção em relação ao eixo local 'Z' da barra). (t·m)

Os esforços indicados são os correspondentes à combinação desfavorável, ou seja, aquela que solicita a máxima resistência da seção.

Origem dos esforços desfavoráveis:

- G: Verticais
- GV: Verticais + vento

- GSis: Verticais + sismo
- GVSis: Verticais + vento + sismo

$\eta$ : Aproveitamento da resistência. A barra cumpre as condições de resistência da Norma se cumprir que  $\eta \leq 100 \%$ .

Verificação de resistência										
Barra	$\eta$ (%)	Posição (m)	Esforços desfavoráveis						Origem	Estado
			N (t)	Vy (t)	Vz (t)	Mt (t·m)	My (t·m)	Mz (t·m)		
N7/N23	99.06	1.200	-7.096	-0.004	-0.007	0.000	0.011	0.013	GV	Passa
N23/N25	77.75	0.000	-5.751	0.009	-0.002	0.000	0.005	0.012	GV	Passa
N25/N27	41.72	1.200	-2.988	-0.003	-0.002	0.000	0.005	0.006	GV	Passa
N27/N29	25.60	0.200	-1.965	0.002	-0.002	0.000	0.002	0.004	GV	Passa
N29/N31	5.89	1.200	-0.450	-0.002	-0.002	0.000	0.003	0.002	GV	Passa
N31/N33	8.03	1.200	0.872	-0.006	0.000	0.000	0.003	0.004	GV	Passa
N33/N35	9.25	0.000	0.911	-0.003	-0.008	0.000	-0.005	-0.004	GV	Passa
N35/N37	15.13	0.000	2.101	-0.008	-0.011	0.000	-0.005	-0.007	GV	Passa
N37/N39	11.51	0.000	1.160	-0.004	-0.008	0.000	-0.006	-0.005	GV	Passa
N39/N41	13.40	0.000	2.085	-0.006	-0.008	0.000	-0.004	-0.006	GV	Passa
N41/N43	7.69	1.200	-0.615	-0.005	0.000	0.000	0.002	0.003	GV	Passa
N43/N2	44.79	0.800	1.139	0.059	0.036	0.000	-0.021	-0.036	GV	Passa
N2/N162	83.17	0.000	0.133	-0.134	-0.061	0.000	-0.038	-0.075	GV	Passa
N162/N4	60.62	0.600	0.149	-0.104	-0.048	0.000	0.024	0.051	GV	Passa
N8/N125	23.19	0.000	0.044	-0.007	0.039	0.000	0.011	-0.004	GV	Passa
N125/N9	23.04	0.600	-0.025	0.005	-0.040	0.000	0.012	-0.003	GV	Passa
N10/N163	20.51	0.000	0.038	-0.004	0.037	0.000	0.011	-0.002	GV	Passa
N163/N11	21.97	0.600	-0.040	-0.002	-0.042	0.000	0.013	0.001	GV	Passa
N12/N164	15.06	0.000	0.052	-0.005	0.024	0.000	0.007	-0.002	GV	Passa
N164/N13	18.52	0.600	-0.031	-0.002	-0.027	0.000	0.010	0.002	GV	Passa
N14/N165	21.88	0.000	0.070	-0.010	0.033	0.000	0.009	-0.004	GV	Passa
N165/N15	32.40	0.600	-0.026	-0.008	-0.042	0.000	0.015	0.006	GV	Passa
N16/N166	14.97	0.000	0.068	-0.013	0.013	0.000	0.003	-0.006	GV	Passa
N166/N17	26.36	0.600	-0.054	-0.009	-0.023	0.000	0.010	0.007	GV	Passa
N18/N167	20.45	0.000	0.132	-0.024	0.005	0.000	-0.001	-0.012	GV	Passa
N167/N19	43.08	0.600	-0.059	-0.022	-0.028	0.000	0.013	0.014	GV	Passa
N20/N168	36.58	0.000	0.146	-0.028	-0.012	0.000	-0.007	-0.016	GV	Passa
N168/N21	40.33	0.600	-0.126	-0.025	-0.017	0.000	0.010	0.015	GV	Passa
N4/N5	12.43	0.000	0.362	-0.011	0.001	0.000	-0.005	-0.010	GV	Passa
N7/N22	26.73	0.000	-1.536	0.011	0.013	0.000	0.010	0.010	GV	Passa
N23/N22	17.72	0.000	1.067	0.012	0.010	0.000	0.009	0.009	GV	Passa
N23/N24	26.06	0.000	-1.481	0.009	0.016	0.000	0.012	0.008	GV	Passa
N25/N24	13.18	0.000	1.046	0.009	0.004	0.000	0.005	0.008	GV	Passa
N25/N26	18.77	0.000	-1.346	0.004	0.009	0.000	0.008	0.005	GV	Passa
N27/N26	11.98	0.000	1.016	0.008	0.002	0.000	0.004	0.007	GV	Passa
N27/N28	19.31	0.000	-1.272	0.004	0.008	0.000	0.008	0.006	GV	Passa
N29/N28	7.73	0.000	0.988	0.003	-0.001	0.000	0.001	0.004	GV	Passa
N29/N30	14.02	0.000	-1.150	0.002	0.004	0.000	0.004	0.004	GV	Passa

Verificação de resistência										
Barra	$\eta$ (%)	Posição (m)	Esforços desfavoráveis						Origem	Estado
			N (t)	Vy (t)	Vz (t)	Mt (t·m)	My (t·m)	Mz (t·m)		
N31/N30	7.28	0.000	1.072	0.004	-0.005	0.000	0.000	0.005	GV	Passa
N31/N32	14.58	0.000	-1.057	0.002	0.002	0.000	0.005	0.005	GV	Passa
N33/N32	9.04	1.342	0.979	-0.003	-0.002	0.000	0.003	0.004	GV	Passa
N33/N34	11.45	0.000	-0.939	0.002	0.001	0.000	0.002	0.003	GV	Passa
N35/N34	8.70	1.342	0.871	-0.001	-0.004	0.000	0.005	0.002	GV	Passa
N35/N36	10.54	0.447	-0.832	0.000	0.000	0.000	0.003	0.003	GV	Passa
N37/N36	8.78	1.342	0.765	-0.003	-0.002	0.000	0.004	0.004	GV	Passa
N37/N38	9.87	0.000	-0.810	-0.001	-0.001	0.000	0.001	0.002	GV	Passa
N39/N38	6.94	1.342	0.799	0.001	-0.004	0.000	0.005	0.001	GV	Passa
N39/N40	12.99	1.342	-0.686	-0.006	-0.001	0.000	0.004	0.007	GV	Passa
N41/N40	10.08	0.000	0.794	0.008	0.000	0.000	0.002	0.007	GV	Passa
N41/N42	11.91	1.342	-0.805	-0.010	0.000	0.000	0.000	0.008	GV	Passa
N43/N42	12.73	0.000	0.549	0.016	-0.001	0.000	0.001	0.012	GV	Passa
N43/N161	17.58	0.000	-0.949	-0.013	-0.007	0.000	-0.004	-0.011	GV	Passa
N50/N66	55.55	0.000	6.317	0.004	0.006	0.000	0.015	0.008	GV	Passa
N66/N68	36.11	0.000	3.445	0.006	0.009	0.000	0.013	0.007	GV	Passa
N68/N70	19.98	0.000	3.207	0.003	0.003	0.000	0.007	0.003	GV	Passa
N70/N72	9.94	0.000	1.596	0.001	0.001	0.000	0.003	0.000	GV	Passa
N72/N74	6.78	0.000	1.089	0.004	0.003	0.000	0.003	0.001	GV	Passa
N74/N76	8.58	0.000	0.563	-0.001	-0.006	0.000	-0.005	-0.004	GV	Passa
N76/N78	8.26	0.000	-0.748	0.000	-0.001	0.000	-0.002	-0.001	GV	Passa
N78/N80	14.41	0.000	-0.306	-0.004	-0.010	0.000	-0.009	-0.008	GV	Passa
N80/N82	16.24	0.000	-1.471	-0.001	-0.004	0.000	-0.004	-0.002	GV	Passa
N82/N84	14.57	0.000	-0.347	-0.004	-0.009	0.000	-0.009	-0.008	GV	Passa
N84/N86	15.87	0.000	-1.438	-0.003	-0.009	0.000	-0.006	-0.003	GV	Passa
N86/N45	25.29	0.800	-0.471	0.000	0.031	0.000	-0.023	-0.008	GV	Passa
N45/N155	38.07	0.600	-0.609	0.023	-0.014	0.000	-0.028	-0.021	GV	Passa
N155/N47	44.18	0.600	-0.160	-0.047	-0.127	0.000	0.043	0.011	GV	Passa
N51/N128	25.25	0.000	-0.104	0.047	-0.004	0.000	-0.002	0.013	GV	Passa
N128/N52	26.14	0.600	0.075	-0.048	0.005	0.000	-0.003	0.014	GV	Passa
N53/N131	19.63	0.600	-0.100	0.030	-0.002	0.000	-0.002	-0.010	GV	Passa
N131/N54	19.58	0.000	0.080	-0.032	0.000	0.000	-0.002	-0.011	GV	Passa
N55/N134	77.11	0.600	-0.130	0.061	0.061	0.000	-0.025	-0.023	GV	Passa
N134/N56	77.16	0.000	0.049	-0.067	-0.070	0.000	-0.026	-0.023	GV	Passa
N57/N137	79.44	0.600	-0.138	0.058	0.060	0.000	-0.027	-0.023	GV	Passa
N137/N58	79.74	0.000	0.064	-0.066	-0.074	0.000	-0.027	-0.023	GV	Passa
N59/N140	77.02	0.600	-0.145	0.053	0.054	0.000	-0.026	-0.022	GV	Passa
N140/N60	78.31	0.000	0.072	-0.068	-0.085	0.000	-0.027	-0.022	GV	Passa
N61/N145	70.25	0.600	-0.170	0.034	0.049	0.000	-0.027	-0.017	GV	Passa
N145/N62	72.12	0.000	0.103	-0.055	-0.088	0.000	-0.028	-0.018	GV	Passa
N63/N150	65.48	0.600	-0.103	0.024	0.036	0.000	-0.025	-0.016	GV	Passa
N150/N64	88.57	0.600	0.265	-0.063	-0.105	0.000	0.035	0.020	GV	Passa
N47/N48	11.65	0.000	0.552	-0.007	-0.008	0.000	-0.010	-0.004	GV	Passa
N50/N65	24.27	1.342	-0.740	-0.002	0.000	0.000	0.000	0.002	G	Passa
N66/N65	16.87	0.000	-0.586	0.001	-0.001	0.000	0.000	0.001	GV	Passa

Verificação de resistência										
Barra	$\eta$ (%)	Posição (m)	Esforços desfavoráveis						Origem	Estado
			N (t)	Vy (t)	Vz (t)	Mt (t·m)	My (t·m)	Mz (t·m)		
N66/N67	18.93	0.000	-0.658	0.001	0.000	0.000	0.000	0.000	G	Passa
N68/N67	18.21	0.000	-0.633	0.004	0.001	0.000	0.001	0.003	GV	Passa
N68/N69	16.18	0.000	-0.563	0.000	-0.001	0.000	-0.001	-0.001	G	Passa
N70/N69	19.52	0.000	-0.679	0.003	0.001	0.000	0.001	0.003	GV	Passa
N70/N71	12.67	0.000	-0.440	0.001	0.000	0.000	0.000	0.000	G	Passa
N72/N71	27.16	0.000	-0.721	0.003	0.002	0.000	0.002	0.003	GV	Passa
N72/N73	9.50	0.000	-0.330	0.001	-0.001	0.000	-0.001	0.000	G	Passa
N74/N73	26.84	0.000	-0.758	0.002	0.001	0.000	0.001	0.002	GV	Passa
N74/N75	8.88	0.000	0.768	0.003	0.001	0.000	0.002	0.002	GV	Passa
N76/N75	28.79	0.000	-0.790	0.002	0.002	0.000	0.002	0.002	GV	Passa
N76/N77	9.43	0.000	0.801	0.003	0.001	0.000	0.002	0.002	GV	Passa
N78/N77	29.07	0.000	-0.829	0.002	0.001	0.000	0.001	0.002	GV	Passa
N78/N79	8.38	0.000	0.836	0.003	0.001	0.000	0.001	0.001	GV	Passa
N80/N79	33.39	0.000	-0.923	0.002	0.002	0.000	0.003	0.002	GV	Passa
N80/N81	9.15	0.000	0.942	0.003	0.000	0.000	0.001	0.002	GV	Passa
N82/N81	38.62	0.000	-1.027	0.004	0.002	0.000	0.003	0.003	GV	Passa
N82/N83	10.11	1.342	1.063	-0.002	-0.002	0.000	0.002	0.000	GV	Passa
N84/N83	49.16	0.000	-1.156	0.007	0.006	0.000	0.005	0.005	GV	Passa
N84/N85	19.75	1.342	1.064	-0.004	-0.007	0.000	0.006	0.003	GV	Passa
N86/N85	66.20	0.000	-1.323	0.014	0.009	0.000	0.007	0.010	GV	Passa
N86/N156	22.11	1.442	1.496	-0.006	-0.009	0.000	0.006	0.003	GV	Passa
N1/N51	93.69	0.000	-3.059	0.000	0.001	0.000	0.006	0.003	GV	Passa
N51/N8	25.84	0.000	-0.045	0.010	0.033	0.000	0.012	0.004	GV	Passa
N53/N10	20.48	0.700	-0.136	0.005	0.026	0.000	-0.009	-0.003	GV	Passa
N55/N12	18.60	0.000	-0.002	-0.010	0.017	0.000	0.004	-0.008	GV	Passa
N57/N14	19.70	0.700	-0.197	-0.009	0.015	0.000	-0.008	-0.003	GV	Passa
N59/N16	24.64	0.700	-0.008	0.003	0.019	0.000	-0.009	-0.007	GV	Passa
N61/N18	29.75	0.700	-0.185	0.011	0.017	0.000	-0.008	-0.010	GV	Passa
N63/N20	45.17	0.700	0.015	0.030	0.029	0.000	-0.013	-0.016	GV	Passa
N51/N10	34.30	1.221	2.976	0.000	0.003	0.000	-0.003	-0.001	GV	Passa
N10/N55	76.65	1.221	-2.736	-0.002	-0.006	0.000	0.004	0.000	GV	Passa
N55/N14	32.10	0.000	2.364	-0.003	-0.002	0.000	-0.003	-0.004	GV	Passa
N14/N59	56.77	1.221	-2.054	-0.001	-0.002	0.000	0.003	0.000	GV	Passa
N59/N18	16.32	1.221	1.715	0.001	0.001	0.000	-0.001	-0.002	GV	Passa
N18/N63	43.58	0.000	-1.457	0.003	0.002	0.000	0.003	0.002	GV	Passa
N63/N2	15.54	1.221	1.060	0.000	-0.005	0.000	0.006	0.001	GV	Passa
N3/N52	100.99	0.000	-3.404	0.003	0.002	0.000	0.007	0.005	GV	Passa
N52/N9	25.84	0.000	-0.050	-0.036	-0.008	0.000	-0.003	-0.013	GV	Passa
N54/N11	20.91	0.700	-0.140	-0.028	-0.002	0.000	0.002	0.010	GV	Passa
N56/N13	22.41	0.000	0.003	-0.013	0.021	0.000	0.012	-0.003	GV	Passa
N58/N15	30.89	0.000	-0.208	-0.006	0.030	0.000	0.017	0.001	GV	Passa
N60/N17	29.75	0.000	0.009	0.000	0.036	0.000	0.017	0.002	GV	Passa
N62/N19	52.42	0.000	-0.222	0.010	0.052	0.000	0.025	0.007	GV	Passa

Verificação de resistência										
Barra	$\eta$ (%)	Posição (m)	Esforços desfavoráveis						Origem	Estado
			N (t)	Vy (t)	Vz (t)	Mt (t·m)	My (t·m)	Mz (t·m)		
N64/N21	52.66	0.000	0.035	0.019	0.064	0.000	0.025	0.008	GV	Passa
N52/N11	43.64	1.221	3.351	0.005	0.006	0.000	-0.005	-0.004	GV	Passa
N11/N56	89.51	0.000	-3.088	0.007	0.001	0.000	0.002	0.004	GV	Passa
N56/N15	38.64	1.221	2.723	0.008	0.008	0.000	-0.005	-0.004	GV	Passa
N15/N60	70.37	1.221	-2.336	0.008	0.004	0.000	-0.001	-0.006	GV	Passa
N60/N19	30.89	0.000	1.943	-0.011	-0.008	0.000	-0.006	-0.008	GV	Passa
N19/N64	55.08	1.221	-1.508	0.011	0.005	0.000	-0.003	-0.008	GV	Passa
N64/N4	45.70	1.221	1.052	-0.024	-0.019	0.000	0.011	0.015	GV	Passa
N65/N22	14.87	0.700	-0.024	-0.048	-0.005	0.000	0.002	0.017	GV	Passa
N66/N23	8.93	0.700	0.032	0.011	0.019	0.000	-0.007	-0.005	GV	Passa
N67/N24	22.06	0.700	-0.140	-0.052	-0.010	0.000	0.006	0.021	GV	Passa
N69/N26	16.30	0.000	0.000	-0.049	-0.011	0.000	-0.004	-0.018	GV	Passa
N71/N28	16.11	0.700	-0.141	-0.040	-0.006	0.000	0.004	0.015	GV	Passa
N73/N30	13.16	0.000	0.007	-0.039	-0.009	0.000	-0.003	-0.015	GV	Passa
N75/N32	11.00	0.700	-0.137	-0.030	-0.002	0.000	0.002	0.011	GV	Passa
N77/N34	9.50	0.000	0.009	-0.028	-0.005	0.000	-0.002	-0.011	GV	Passa
N79/N36	8.36	0.700	-0.137	-0.022	-0.002	0.000	0.001	0.008	GV	Passa
N81/N38	7.61	0.000	0.010	-0.020	-0.008	0.000	-0.003	-0.008	GV	Passa
N83/N40	13.64	0.700	-0.144	-0.019	-0.018	0.000	0.009	0.008	GV	Passa
N85/N42	19.73	0.700	0.037	-0.026	-0.034	0.000	0.015	0.009	GV	Passa
N156/N161	31.74	0.700	0.004	0.018	-0.085	0.000	0.037	-0.002	GV	Passa
N48/N5	29.56	0.700	0.022	0.041	0.012	0.000	-0.004	-0.015	GV	Passa
N65/N6	36.46	0.922	-2.090	0.017	0.024	0.000	-0.017	-0.019	GV	Passa
N65/N24	23.38	0.000	3.009	0.006	0.004	0.000	0.006	0.011	GV	Passa
N69/N24	45.32	1.389	-2.715	0.007	0.013	0.000	-0.007	-0.009	GV	Passa
N69/N28	15.23	0.000	2.446	0.004	-0.002	0.000	0.000	0.004	GV	Passa
N73/N28	32.16	0.000	-2.167	0.004	0.001	0.000	0.004	0.003	GV	Passa
N73/N32	13.54	1.389	1.871	0.005	0.009	0.000	-0.006	-0.005	GV	Passa
N77/N32	25.82	0.000	-1.629	0.001	-0.001	0.000	0.004	0.003	GV	Passa
N77/N36	13.71	1.389	1.327	0.005	0.009	0.000	-0.006	-0.007	GV	Passa
N81/N36	14.45	1.158	-1.114	-0.003	0.003	0.000	0.004	0.005	GV	Passa
N81/N40	11.78	1.389	0.776	0.004	0.007	0.000	-0.006	-0.007	GV	Passa
N85/N40	14.72	1.389	-0.506	-0.005	0.000	0.000	0.007	0.007	GV	Passa
N85/N161	9.78	1.565	0.074	0.005	0.004	0.000	-0.004	-0.009	GV	Passa
N66/N7	26.49	1.389	-1.314	0.004	0.013	0.000	-0.011	-0.012	GV	Passa
N68/N25	10.75	0.700	-0.130	-0.019	-0.006	0.000	0.005	0.008	GV	Passa
N66/N25	12.06	0.000	0.998	0.005	0.000	0.000	0.003	0.008	GV	Passa
N70/N25	9.86	1.389	-0.772	0.001	0.008	0.000	-0.003	-0.004	GV	Passa
N72/N29	4.59	0.700	-0.138	-0.007	-0.002	0.000	0.002	0.003	GV	Passa
N70/N29	4.25	0.000	0.497	0.002	-0.001	0.000	0.000	0.003	GV	Passa
N74/N29	5.82	0.000	-0.219	0.004	-0.003	0.000	0.002	0.003	GV	Passa
N76/N33	3.36	0.700	-0.147	0.005	0.005	0.000	-0.001	-0.002	GV	Passa
N74/N33	4.08	1.389	-0.027	0.001	0.005	0.000	-0.003	-0.002	GV	Passa
N78/N33	7.93	0.000	0.335	0.004	-0.003	0.000	0.003	0.006	GV	Passa
N80/N37	6.02	0.700	-0.146	0.015	0.004	0.000	-0.001	-0.006	GV	Passa

Verificação de resistência										
Barra	$\eta$ (%)	Posição (m)	Esforços desfavoráveis						Origem	Estado
			N (t)	Vy (t)	Vz (t)	Mt (t·m)	My (t·m)	Mz (t·m)		
N78/N37	9.63	0.000	-0.559	-0.002	-0.006	0.000	-0.004	-0.004	GV	Passa
N82/N37	9.34	0.463	0.876	0.003	-0.002	0.000	0.004	0.004	GV	Passa
N84/N41	12.12	0.700	-0.127	0.018	-0.020	0.000	0.009	-0.006	GV	Passa
N82/N41	14.65	0.000	-1.097	-0.001	-0.007	0.000	-0.006	-0.004	GV	Passa
N86/N41	14.22	1.389	1.312	-0.003	-0.001	0.000	0.007	0.005	GV	Passa
N82/N39	6.18	0.000	-0.007	0.015	-0.008	0.000	-0.002	0.006	GV	Passa
N78/N35	3.70	0.700	-0.002	0.010	0.005	0.000	-0.002	-0.003	GV	Passa
N74/N31	0.76	0.350	-0.010	0.000	-0.001	0.000	0.001	0.000	G	Passa
N70/N27	5.02	0.700	-0.001	-0.011	-0.003	0.000	0.002	0.004	GV	Passa
N86/N43	23.34	0.700	0.034	-0.015	-0.041	0.000	0.020	0.009	GV	Passa
N86/N2	35.86	1.063	-1.328	0.029	0.008	0.000	-0.012	-0.027	GV	Passa
N42/N161	21.50	1.400	0.718	-0.004	-0.015	0.000	0.015	0.009	GV	Passa
N40/N42	8.85	0.000	1.422	-0.002	-0.003	0.000	0.000	0.000	GV	Passa
N38/N40	16.59	1.200	0.641	-0.004	-0.012	0.000	0.011	0.007	GV	Passa
N36/N38	11.89	0.000	-1.077	-0.001	0.007	0.000	0.005	0.002	GV	Passa
N34/N36	17.64	1.200	-0.166	-0.006	-0.015	0.000	0.012	0.009	GV	Passa
N32/N34	12.85	0.000	-1.164	-0.001	0.008	0.000	0.005	0.002	GV	Passa
N30/N32	22.77	1.200	-1.539	-0.006	-0.016	0.000	0.010	0.007	GV	Passa
N28/N30	13.23	0.000	-0.576	-0.011	-0.010	0.000	-0.008	-0.006	GV	Passa
N26/N28	51.67	0.000	-3.501	-0.012	-0.013	0.000	-0.011	-0.007	GV	Passa
N24/N26	44.91	0.000	-2.481	-0.013	-0.016	0.000	-0.015	-0.010	GV	Passa
N22/N24	95.81	0.000	-6.568	-0.011	-0.013	0.000	-0.018	-0.012	GV	Passa
N6/N22	75.19	0.000	-4.775	-0.025	-0.051	0.000	-0.034	-0.021	GV	Passa
N85/N156	29.92	1.400	-0.893	-0.015	-0.019	0.000	0.013	0.016	GV	Passa
N83/N85	16.55	0.000	-1.499	0.000	0.001	0.000	0.000	0.002	GV	Passa
N81/N83	36.38	1.200	-2.475	-0.009	-0.011	0.000	0.005	0.007	GV	Passa
N79/N81	18.86	0.000	-1.708	-0.001	0.002	0.000	0.001	0.002	GV	Passa
N77/N79	37.37	1.200	-2.482	-0.012	-0.011	0.000	0.005	0.009	GV	Passa
N75/N77	13.71	1.200	-1.099	0.009	0.001	0.000	-0.004	-0.006	GV	Passa
N73/N75	15.84	1.200	-1.194	-0.013	-0.011	0.000	0.004	0.008	GV	Passa
N71/N73	14.04	0.000	2.046	-0.010	-0.001	0.000	-0.003	-0.008	GV	Passa
N69/N71	15.69	0.000	1.448	-0.012	-0.002	0.000	-0.005	-0.010	GV	Passa
N67/N69	47.15	0.000	5.518	-0.014	0.001	0.000	-0.004	-0.015	GV	Passa
N65/N67	51.01	0.000	5.298	-0.014	-0.003	0.000	-0.010	-0.018	GV	Passa
N49/N65	74.92	0.000	9.089	-0.031	0.018	0.000	-0.003	-0.025	GV	Passa
N45/N2	23.68	0.700	-0.055	0.038	-0.001	0.000	0.002	-0.013	GV	Passa
N47/N4	96.20	0.000	-0.270	0.048	0.118	0.000	0.043	0.017	GV	Passa
N4/N48	21.31	1.389	-0.394	0.007	0.007	0.000	-0.005	-0.005	GV	Passa
N12/N123	79.10	0.000	-7.603	-0.042	-0.015	0.000	-0.016	-0.014	GV	Passa
N123/N14	68.93	0.000	-7.671	-0.007	-0.015	0.000	-0.008	-0.006	GV	Passa
N14/N181	44.87	0.000	-3.914	-0.025	-0.009	0.000	-0.011	-0.011	GV	Passa
N181/N16	38.30	0.000	-3.950	-0.001	-0.009	0.000	-0.007	-0.005	GV	Passa
N16/N179	41.21	0.000	-3.778	-0.021	-0.019	0.000	-0.012	-0.007	GV	Passa

Verificação de resistência										
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			N (t)	Vy (t)	Vz (t)	Mt (t·m)	My (t·m)	Mz (t·m)		
N179/N18	34.70	0.500	-3.800	-0.002	-0.019	0.000	0.007	0.000	GV	Passa
N3/N111	95.40	0.000	-12.426	0.052	0.071	0.000	0.043	0.059	GV	Passa
N111/N9	76.26	0.000	-12.504	0.053	0.024	0.000	0.021	0.033	GV	Passa
N9/N112	68.73	0.000	-12.403	0.012	0.047	0.000	0.018	0.019	GV	Passa
N112/N11	62.72	0.000	-12.477	0.012	0.004	0.000	0.009	0.013	GV	Passa
N13/N124	76.15	0.000	-7.138	0.012	0.041	0.000	0.014	0.014	GV	Passa
N124/N15	66.20	0.000	-7.204	0.012	0.008	0.000	0.006	0.008	GV	Passa
N15/N184	39.46	0.000	-3.091	0.006	0.026	0.000	0.012	0.010	GV	Passa
N184/N17	32.87	0.000	-3.125	0.006	0.006	0.000	0.005	0.007	GV	Passa
N17/N178	34.84	0.000	-3.218	0.005	0.025	0.000	0.009	0.005	GV	Passa
N178/N19	28.92	0.000	-3.251	0.005	0.008	0.000	0.002	0.003	GV	Passa
N55/N121	49.01	0.000	5.065	-0.006	-0.034	0.000	-0.015	-0.012	GV	Passa
N121/N57	42.53	0.000	5.122	-0.006	-0.011	0.000	-0.007	-0.009	GV	Passa
N57/N143	42.01	0.000	4.905	-0.001	-0.028	0.000	-0.011	-0.007	GV	Passa
N143/N59	38.36	0.000	4.956	-0.001	-0.009	0.000	-0.005	-0.006	GV	Passa
N59/N148	16.44	0.000	1.462	-0.010	-0.015	0.000	-0.008	-0.008	GV	Passa
N148/N61	10.42	0.500	1.673	-0.008	-0.009	0.000	0.002	0.001	GV	Passa
N46/N109	98.20	0.000	14.381	0.088	0.057	0.000	0.061	0.048	GV	Passa
N109/N52	76.78	0.000	14.488	0.036	0.059	0.000	0.033	0.022	GV	Passa
N52/N110	48.58	0.000	9.021	0.038	0.007	0.000	0.018	0.018	GV	Passa
N110/N54	44.56	0.000	9.091	0.004	0.008	0.000	0.015	0.011	GV	Passa
N56/N122	49.65	0.000	4.525	0.039	0.006	0.000	0.013	0.018	GV	Passa
N122/N58	41.27	0.000	4.585	0.015	0.005	0.000	0.010	0.008	GV	Passa
N58/N142	42.80	0.000	4.698	0.038	0.001	0.000	0.005	0.014	GV	Passa
N142/N60	36.42	0.000	4.758	0.019	0.000	0.000	0.005	0.005	GV	Passa
N60/N147	20.10	0.000	1.463	0.029	0.001	0.000	0.005	0.014	GV	Passa
N147/N62	12.65	0.000	1.527	0.019	0.000	0.000	0.005	0.005	GV	Passa
N53/N118	46.51	0.000	9.402	-0.001	-0.029	0.000	-0.013	-0.014	GV	Passa
N118/N55	44.69	0.000	9.463	-0.001	-0.005	0.000	-0.008	-0.014	GV	Passa
N11/N113	45.20	0.000	-7.157	0.011	0.032	0.000	0.016	0.019	GV	Passa
N113/N13	40.43	0.000	-7.202	0.011	0.001	0.000	0.010	0.013	GV	Passa
N54/N117	47.41	0.000	9.113	0.041	0.006	0.000	0.015	0.017	GV	Passa
N117/N56	42.86	0.000	9.181	0.014	0.005	0.000	0.012	0.008	GV	Passa
N10/N114	48.43	0.000	-7.726	-0.034	-0.011	0.000	-0.019	-0.018	GV	Passa
N114/N12	43.27	0.000	-7.774	-0.002	-0.011	0.000	-0.014	-0.010	GV	Passa
N61/N152	8.70	0.500	1.397	-0.004	-0.006	0.000	0.000	-0.001	GV	Passa
N152/N63	8.77	0.500	1.408	-0.004	-0.006	0.000	0.002	0.001	GV	Passa
N63/N157	10.92	0.000	-1.195	-0.021	0.006	0.000	0.001	-0.008	GV	Passa
N157/N45	21.44	0.500	-1.196	-0.021	0.017	0.000	-0.008	0.013	GV	Passa
N62/N151	14.51	0.000	1.824	0.027	-0.004	0.000	-0.003	0.009	GV	Passa
N151/N64	15.10	0.500	1.799	0.022	-0.006	0.000	0.003	-0.010	GV	Passa
N64/N160	14.68	0.000	0.418	0.034	-0.009	0.000	-0.003	0.014	GV	Passa
N160/N47	18.19	0.500	0.457	0.035	-0.011	0.000	0.007	-0.015	GV	Passa
N18/N175	8.14	0.000	-1.021	0.004	-0.003	0.000	-0.005	0.001	GV	Passa
N175/N20	9.95	0.500	-0.999	0.010	0.001	0.000	-0.003	-0.005	GV	Passa



Verificação de resistência										
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			N (t)	Vy (t)	Vz (t)	Mt (t·m)	My (t·m)	Mz (t·m)		
N20/N171	15.48	0.500	-0.673	-0.015	-0.049	0.000	0.010	0.006	GV	Passa
N171/N2	42.98	0.500	-0.659	-0.014	-0.050	0.000	0.035	0.015	GV	Passa
N19/N174	7.88	0.000	-0.620	-0.005	0.013	0.000	0.006	0.001	GV	Passa
N174/N21	7.07	0.000	-0.647	-0.005	0.005	0.000	0.003	0.003	GV	Passa
N21/N170	10.43	0.000	-0.947	-0.007	0.017	0.000	0.004	-0.005	GV	Passa
N170/N4	10.89	0.500	-0.960	-0.008	0.012	0.000	-0.007	0.002	GV	Passa
N44/N120	94.10	0.000	14.615	-0.049	-0.074	0.000	-0.041	-0.056	GV	Passa
N120/N51	76.65	0.000	14.716	-0.051	-0.027	0.000	-0.021	-0.031	GV	Passa
N51/N119	49.69	0.000	9.572	-0.007	-0.031	0.000	-0.015	-0.018	GV	Passa
N119/N53	46.65	0.000	9.639	-0.008	0.000	0.000	-0.010	-0.015	GV	Passa
N1/N116	93.93	0.000	-12.553	-0.069	-0.048	0.000	-0.056	-0.040	GV	Passa
N116/N8	76.04	0.000	-12.630	-0.022	-0.048	0.000	-0.032	-0.021	GV	Passa
N8/N115	68.84	0.000	-12.463	-0.046	-0.010	0.000	-0.019	-0.018	GV	Passa
N115/N10	63.34	0.000	-12.536	-0.005	-0.010	0.000	-0.014	-0.009	GV	Passa
N1/N127	19.93	0.583	-0.229	0.006	-0.012	0.000	0.008	0.004	GV	Passa
N127/N125	11.50	0.000	-0.903	0.000	0.005	0.000	0.002	0.000	GV	Passa
N3/N126	24.14	0.000	-0.116	-0.006	-0.021	0.000	-0.008	-0.007	GV	Passa
N126/N125	16.47	0.000	0.050	-0.006	-0.016	0.000	-0.007	-0.004	GV	Passa
N126/N111	23.20	0.300	0.047	0.000	-0.085	0.000	0.015	0.000	GV	Passa
N116/N127	22.94	0.000	0.046	0.000	0.084	0.000	0.014	0.000	GV	Passa
N46/N130	19.85	0.583	-0.052	-0.007	0.017	0.000	-0.009	-0.003	GV	Passa
N130/N128	11.19	0.000	-0.166	-0.005	0.009	0.000	0.003	-0.003	GV	Passa
N44/N129	24.92	0.000	0.333	0.007	0.022	0.000	0.008	0.007	GV	Passa
N129/N128	16.26	0.000	0.230	0.005	0.014	0.000	0.007	0.003	GV	Passa
N120/N129	27.29	0.000	-0.047	-0.002	-0.096	0.000	-0.017	-0.001	GV	Passa
N130/N109	29.33	0.300	-0.052	0.002	0.104	0.000	-0.018	-0.001	GV	Passa
N52/N133	10.08	0.583	-0.119	-0.002	0.012	0.000	-0.005	-0.001	GV	Passa
N133/N131	7.02	0.000	-0.193	-0.001	0.007	0.000	0.003	-0.001	GV	Passa
N51/N132	11.49	0.000	0.309	0.003	0.012	0.000	0.004	0.002	GV	Passa
N132/N131	9.24	0.000	-0.725	0.000	0.002	0.000	0.000	0.000	GV	Passa
N119/N132	17.73	0.000	-0.031	-0.001	-0.063	0.000	-0.011	0.000	GV	Passa
N133/N110	18.94	0.300	-0.034	0.001	0.067	0.000	-0.012	0.000	GV	Passa
N54/N136	15.53	0.583	-0.084	-0.004	0.012	0.000	-0.007	-0.003	GV	Passa
N136/N134	6.97	0.000	-0.152	-0.004	0.003	0.000	0.001	-0.003	GV	Passa
N53/N135	18.14	0.000	0.324	0.005	0.014	0.000	0.005	0.005	GV	Passa
N135/N134	10.76	0.000	0.267	0.005	0.007	0.000	0.004	0.002	GV	Passa
N118/N135	15.86	0.000	-0.024	0.000	-0.057	0.000	-0.010	0.000	GV	Passa
N136/N117	17.68	0.300	-0.027	0.000	0.064	0.000	-0.011	0.000	GV	Passa
N56/N139	12.76	0.583	-0.117	-0.002	0.014	0.000	-0.006	-0.002	GV	Passa
N139/N137	6.46	0.000	-0.178	-0.002	0.005	0.000	0.002	-0.002	GV	Passa
N55/N138	14.64	0.000	0.355	0.003	0.014	0.000	0.005	0.003	GV	Passa
N138/N137	8.14	0.000	0.305	0.003	0.007	0.000	0.003	0.001	GV	Passa
N121/N138	14.43	0.000	-0.022	0.000	-0.054	0.000	-0.009	0.000	GV	Passa

Verificação de resistência										
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			N (t)	Vy (t)	Vz (t)	Mt (t·m)	My (t·m)	Mz (t·m)		
N139/N122	15.70	0.300	-0.024	0.000	0.058	0.000	-0.010	0.000	GV	Passa
N58/N141	11.31	0.583	-0.131	0.001	0.017	0.000	-0.006	-0.001	GV	Passa
N141/N140	5.31	0.583	-0.187	0.000	0.006	0.000	-0.001	-0.001	GV	Passa
N57/N144	9.34	0.583	0.305	0.001	0.014	0.000	-0.004	-0.001	GV	Passa
N144/N140	5.64	0.583	0.275	0.001	0.006	0.000	-0.001	-0.001	GV	Passa
N141/N142	15.82	0.300	-0.019	-0.001	0.058	0.000	-0.010	0.000	GV	Passa
N143/N144	13.32	0.000	-0.019	0.000	-0.049	0.000	-0.008	0.000	GV	Passa
N60/N146	10.78	0.583	-0.229	-0.001	0.011	0.000	-0.004	-0.002	GV	Passa
N146/N145	6.62	0.583	-0.260	-0.002	0.005	0.000	-0.002	-0.001	GV	Passa
N59/N149	4.74	0.583	0.307	0.001	0.006	0.000	-0.002	-0.001	GV	Passa
N149/N145	5.73	0.583	0.355	0.002	0.004	0.000	-0.001	-0.001	GV	Passa
N146/N147	9.49	0.300	-0.011	-0.001	0.035	0.000	-0.006	0.000	GV	Passa
N148/N149	4.34	0.000	-0.006	0.000	-0.017	0.000	-0.003	0.000	GV	Passa
N62/N153	10.54	0.583	-0.286	0.002	0.013	0.000	-0.004	-0.002	GV	Passa
N153/N150	7.84	0.583	-0.312	0.001	0.003	0.000	-0.002	-0.002	GV	Passa
N61/N154	8.59	0.583	0.350	0.000	0.003	0.000	-0.002	-0.002	GV	Passa
N154/N150	7.97	0.000	0.404	0.000	-0.002	0.000	-0.002	-0.002	GV	Passa
N153/N151	9.49	0.300	-0.004	-0.001	0.032	0.000	-0.006	0.000	GV	Passa
N152/N154	2.86	0.000	0.010	0.000	0.010	0.000	0.002	0.000	GV	Passa
N64/N159	14.67	0.000	-0.671	-0.009	0.008	0.000	0.001	-0.005	GV	Passa
N159/N155	20.36	0.583	-0.577	-0.010	-0.006	0.000	0.004	0.006	GV	Passa
N63/N158	14.67	0.000	0.232	0.001	-0.008	0.000	-0.005	-0.004	GV	Passa
N158/N155	18.13	0.583	0.240	0.001	0.009	0.000	-0.005	-0.005	GV	Passa
N45/N156	57.12	0.000	-1.155	-0.009	-0.021	0.000	-0.013	-0.006	GV	Passa
N156/N48	31.56	0.000	0.067	-0.034	-0.020	0.000	-0.017	-0.026	GV	Passa
N155/N48	12.16	0.000	-0.423	0.001	0.000	0.000	0.001	0.001	GV	Passa
N155/N156	35.61	0.000	-0.362	0.014	0.008	0.000	0.007	0.012	GV	Passa
N157/N158	3.65	0.000	-0.010	0.000	0.008	0.000	0.002	0.000	GV	Passa
N159/N160	9.69	0.300	0.001	-0.001	0.031	0.000	-0.006	0.000	GV	Passa
N2/N161	44.49	0.000	0.311	-0.036	-0.053	0.000	-0.035	-0.024	GV	Passa
N161/N5	26.13	0.000	0.250	-0.030	-0.019	0.000	-0.013	-0.022	GV	Passa
N162/N161	32.19	0.000	0.269	0.019	0.008	0.000	0.014	0.025	GV	Passa
N162/N5	19.70	0.000	-0.432	0.008	0.006	0.000	0.009	0.012	GV	Passa
N8/N189	12.52	0.583	-0.237	0.001	-0.015	0.000	0.006	0.001	GV	Passa
N189/N163	9.40	0.000	-0.738	0.001	0.002	0.000	0.000	0.000	GV	Passa
N9/N190	10.44	0.583	-0.099	0.000	-0.015	0.000	0.006	0.000	GV	Passa
N190/N163	7.12	0.000	0.060	0.000	-0.010	0.000	-0.004	0.000	GV	Passa
N10/N188	8.23	0.583	-0.202	0.001	-0.009	0.000	0.004	0.001	GV	Passa
N188/N164	6.70	0.000	-0.526	0.000	0.002	0.000	0.000	0.000	GV	Passa
N11/N187	8.72	0.000	-0.046	-0.002	-0.011	0.000	-0.003	-0.002	GV	Passa
N187/N164	8.05	0.000	0.084	-0.002	-0.009	0.000	-0.004	-0.001	GV	Passa
N12/N185	12.31	0.583	-0.225	0.002	-0.013	0.000	0.006	0.001	GV	Passa
N185/N165	6.20	0.000	-0.147	0.002	-0.006	0.000	-0.003	0.001	GV	Passa
N13/N186	10.56	0.583	-0.068	-0.001	-0.016	0.000	0.005	-0.001	GV	Passa
N186/N165	8.13	0.000	0.078	-0.001	-0.007	0.000	-0.004	-0.001	GV	Passa

Verificação de resistência										
Barra	$\eta$ (%)	Posição (m)	Esforços desfavoráveis						Origem	Estado
			N (t)	Vy (t)	Vz (t)	Mt (t·m)	My (t·m)	Mz (t·m)		
N14/N182	6.33	0.583	-0.156	0.001	-0.007	0.000	0.003	0.000	GV	Passa
N182/N166	4.67	0.000	-0.172	0.001	-0.005	0.000	-0.002	0.000	GV	Passa
N15/N183	13.75	0.000	0.084	-0.003	-0.011	0.000	-0.005	-0.004	GV	Passa
N183/N166	9.36	0.000	0.129	-0.003	-0.007	0.000	-0.003	-0.002	GV	Passa
N16/N180	5.59	0.583	-0.182	0.001	-0.004	0.000	0.002	-0.001	GV	Passa
N180/N167	5.94	0.000	-0.189	0.001	-0.003	0.000	-0.002	-0.001	GV	Passa
N17/N177	9.20	0.000	0.121	0.000	-0.010	0.000	-0.003	-0.002	GV	Passa
N177/N167	7.57	0.000	0.163	-0.001	-0.004	0.000	-0.002	-0.002	GV	Passa
N18/N176	5.07	0.583	-0.267	0.000	0.003	0.000	-0.001	-0.001	GV	Passa
N176/N168	5.03	0.000	-0.268	0.000	-0.001	0.000	-0.001	-0.001	GV	Passa
N19/N173	16.61	0.000	0.235	-0.003	-0.008	0.000	-0.005	-0.005	GV	Passa
N173/N168	10.46	0.000	0.256	-0.004	-0.005	0.000	-0.003	-0.003	GV	Passa
N20/N172	13.51	0.583	-0.359	0.006	0.010	0.000	-0.003	-0.004	GV	Passa
N172/N162	20.89	0.583	-0.353	0.006	0.005	0.000	-0.005	-0.007	GV	Passa
N21/N169	23.97	0.000	0.322	-0.012	-0.015	0.000	-0.007	-0.008	GV	Passa
N169/N162	18.50	0.583	0.344	-0.013	-0.007	0.000	0.004	0.007	GV	Passa
N169/N170	5.86	0.300	0.005	-0.001	-0.018	0.000	0.003	0.000	GV	Passa
N171/N172	4.38	0.000	0.001	-0.001	-0.013	0.000	-0.003	0.000	GV	Passa
N173/N174	5.35	0.300	0.008	0.000	-0.017	0.000	0.003	0.000	GV	Passa
N175/N176	3.23	0.000	0.010	0.000	0.011	0.000	0.002	0.000	GV	Passa
N177/N178	10.29	0.300	0.016	0.000	-0.037	0.000	0.007	0.000	GV	Passa
N179/N180	8.01	0.000	0.019	0.000	0.030	0.000	0.005	0.000	GV	Passa
N181/N182	10.53	0.000	0.023	0.000	0.039	0.000	0.007	0.000	GV	Passa
N183/N184	10.69	0.300	0.020	0.000	-0.038	0.000	0.007	0.000	GV	Passa
N123/N185	19.40	0.000	0.035	0.000	0.071	0.000	0.012	0.000	GV	Passa
N186/N124	19.37	0.300	0.034	0.000	-0.071	0.000	0.012	0.000	GV	Passa
N187/N113	14.32	0.300	0.031	0.000	-0.051	0.000	0.009	0.000	GV	Passa
N114/N188	14.75	0.000	0.032	0.000	0.054	0.000	0.009	0.000	GV	Passa
N115/N189	22.03	0.000	0.041	0.001	0.079	0.000	0.014	0.000	GV	Passa
N190/N112	22.26	0.300	0.043	0.000	-0.080	0.000	0.014	0.000	GV	Passa