

# **BARRAFERROS**



PERFIS EM AÇO GALVANIZADO ENFORMADO A FRIO  
*COLD-FORMED GALVANIZED STEEL SECTIONS*

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## DESCRIÇÃO

Este documento apresenta as propriedades dos perfis em aço galvanizado enformado a frio OMEGA OB fabricados pela **Barraferros, Lda**.

Os valores de cálculo dos esforços resistentes e os valores máximos de carga foram determinados para aço S220GD+Z ( $f_{yb} = 220 \text{ N/mm}^2$ ,  $f_u = 300 \text{ N/mm}^2$ ), S280GD+Z ( $f_{yb} = 280 \text{ N/mm}^2$ ,  $f_u = 360 \text{ N/mm}^2$ ), S320GD+Z ( $f_{yb} = 320 \text{ N/mm}^2$ ,  $f_u = 390 \text{ N/mm}^2$ ) e S350GD+Z ( $f_{yb} = 350 \text{ N/mm}^2$ ,  $f_u = 420 \text{ N/mm}^2$ ) de qualidade estrutural revestido a zinco por imersão a quente em contínuo (EN 10346). Os valores do peso por metro (P) indicados são teóricos e podem variar de acordo com as tolerâncias do fornecedor (siderurgia).

As propriedades da secção transversal bruta e efetiva, os valores de cálculo dos esforços resistentes e os valores máximos de carga foram determinados de acordo com as especificações do Eurocódigo 3 – Projeto de estruturas de aço (EN 1993) e partes correspondentes para secções de classe 3 e 4. A verificação das secções ao Estado Limite Último tem em conta a influência da Encurvadura Lateral.

Os valores máximos de carga ( $Q_z$ ) determinados na verificação ao Estado Limite Último (ELU) têm em conta o peso próprio do perfil (G) majorado por  $\gamma_G=1,35$  para cargas descendentes e  $\gamma_G=1,00$  para cargas ascendentes. As cargas Q (sobrecargas, restantes cargas permanentes, vento, etc.) são majoradas por  $\gamma_Q=1,50$ . Os valores máximos de carga ( $Q_z$ ) determinados na verificação ao Estado Limite de Serviço (ELS) consideram o peso próprio do perfil (G) majorado por  $\gamma_G=1,0$ . O valor limite de deformação é igual a  $\frac{1}{200}$  para carregamentos descendentes e  $\frac{1}{150}$  para carregamentos ascendentes. A restrição dada pelas chapas de cobertura não foi considerada para cargas ascendentes.

Os perfis podem ser fabricados em aço S220GD+Z ( $f_{yb} = 220 \text{ N/mm}^2$ ,  $f_u = 300 \text{ N/mm}^2$ ), S280GD+Z ( $f_{yb} = 280 \text{ N/mm}^2$ ,  $f_u = 360 \text{ N/mm}^2$ ), S320GD+Z ( $f_{yb} = 320 \text{ N/mm}^2$ ,  $f_u = 390 \text{ N/mm}^2$ ) e S350GD+Z ( $f_{yb} = 350 \text{ N/mm}^2$ ,  $f_u = 420 \text{ N/mm}^2$ ) de qualidade estrutural revestido a zinco por imersão a quente em contínuo (EN 10346).

## DESCRIPTION

*This document presents the properties of the cold-formed galvanized steel sections manufactured by **Barraferros, Lda**.*

*The values of the tensile stresses and the maximum values of load were determined in from S220GD+Z ( $f_{yb} = 220 \text{ N/mm}^2$ ,  $f_u = 300 \text{ N/mm}^2$ ), S280GD+Z ( $f_{yb} = 280 \text{ N/mm}^2$ ,  $f_u = 360 \text{ N/mm}^2$ ), S320GD+Z ( $f_{yb} = 320 \text{ N/mm}^2$ ,  $f_u = 390 \text{ N/mm}^2$ ) and S350GD+Z ( $f_{yb} = 350 \text{ N/mm}^2$ ,  $f_u = 420 \text{ N/mm}^2$ ) continuous hot dip zinc coated carbon steel of structural quality (EN 10346). The values of weight per meter (P) are theoretical and may vary according to the steel supplier tolerances.*

*The properties of the gross and effective cross section, the design values of resistance and the maximum loads were determined according to the specifications of Eurocode 3 – Design of steel structures (EN 1993) and corresponding parts for class 3 and 4 cross sections. The verification to the Ultimate Limit State (ULS) takes into account the influence of Lateral Buckling.*

*The maximum loads ( $Q_z$ ) determined from the verification to the Ultimate Limit State (ULS) consider the self-weight of the section (G) multiplied by  $\gamma_G=1.35$  for descendent loads and  $\gamma_G=1.00$  for ascendant loads. The loads Q (overload, finishing, wind, etc.) are multiplied by  $\gamma_Q=1.50$ . The maximum loads ( $Q_z$ ) determined from the verification to the Serviceability Limit State (SLS) consider the self-weight of the section (G) multiplied by  $\gamma_G=1.00$ . The deformation limit  $\delta$  is equal to  $\frac{1}{200}$  for descendent loads and  $\frac{1}{150}$  for ascendant loads. The roof sheeting restrain was not considered for ascendant loads.*

*The cold-formed galvanized steel sections may be manufactured in S220GD+Z ( $f_{yb} = 220 \text{ N/mm}^2$ ,  $f_u = 300 \text{ N/mm}^2$ ), S280GD+Z ( $f_{yb} = 280 \text{ N/mm}^2$ ,  $f_u = 360 \text{ N/mm}^2$ ), S320GD+Z ( $f_{yb} = 320 \text{ N/mm}^2$ ,  $f_u = 390 \text{ N/mm}^2$ ) and S350GD+Z ( $f_{yb} = 350 \text{ N/mm}^2$ ,  $f_u = 420 \text{ N/mm}^2$ ) continuous hot dip zinc coated carbon steel of structural quality (EN 10346).*

## SÍMBOLOS / SYMBOLS

A	Área da secção bruta / <i>Gross section área</i>
$A_{eff}$	Área da secção efetiva / <i>Effective section área</i>
$I_y / I_z$	Momento de inércia / <i>Second moment of area</i>
$I_{eff,y} / I_{eff,z}$	Momento de inércia da secção efetiva / <i>Second moment of area of the effective section</i>
$I_t$	Constante de torção / <i>Torsional constant</i>
$I_w$	Constante de empenamento / <i>Warping constant</i>
L	Comprimento do elemento / <i>Member length</i>
$L_{cr}$	Comprimento de encurvadura / <i>Buckling length</i>
$M_{c,Rd,y+}$	Momento fletor resistente (compressão fibras superiores) / <i>Resistance to bending moment (compression in upper fibres)</i>
$M_{c,Rd,y-}$	Momento fletor resistente (compressão fibras inferiores) / <i>Resistance to bending moment (compression in lower fibres)</i>
$M_{c,Rd,z+}$	Momento fletor resistente (compressão fibras da esquerda) / <i>Resistance to bending moment (compression in left fibres)</i>
$M_{c,Rd,z-}$	Momento fletor resistente (compressão fibras da direita) / <i>Resistance to bending moment (compression in right fibres)</i>
$N_{c,Rd}$	Esforço normal resistente à compressão / <i>Resistance to compression</i>
$N_{b,Rd}$	Esforço normal resistente à encurvadura de um elemento à compressão / <i>Buckling resistance of a compression member</i>
$N_{t,Rd}$	Esforço normal resistente à tração / <i>Resistance to tension</i>
P	Peso por metro / <i>Weight per metre</i>
$R_{w,Rd}$	Esforço transversal local da alma: C1 – Categoria 1; C2 – Categoria 2; C2,Sob – Categoria 2 com sobreposição <i>Local transverse resistance of the web: C1 – Category 1; C2 – Category 2; C2,Sob – Category 2 with overlap</i>
$V_{b,Rd}$	Esforço transversal resistente / <i>Resistance to shear</i>
$W_y / W_z$	Módulo de flexão / <i>Section modulus</i>
$W_{eff,y,+}$	Módulo de flexão da secção efetiva (compressão fibras superiores) / <i>Section modulus of the effective section (compression in upper fibres)</i>
$W_{eff,y,-}$	Módulo de flexão da secção efetiva (compressão fibras inferiores) / <i>Section modulus of the effective section (compression in lower fibres)</i>
$W_{eff,z,+}$	Módulo de flexão da secção efetiva (compressão fibras esquerda) / <i>Section modulus of the effective section (compression in left fibres)</i>
$W_{eff,z,-}$	Módulo de flexão da secção efetiva (compressão nas fibras direita) / <i>Section modulus of the effective section (compression in right fibres)</i>
$f_{yb}$	Tensão de cedência base / <i>Basic yield strength</i>
$f_u$	Tensão última / <i>Ultimate strength</i>
p	Carga distribuída / <i>Distributed load</i>
$y_G / z_G$	Posição do centro de gravidade / <i>Position of the centre of gravity</i>
$y_{eff,G} / z_{eff,G}$	Posição do centro de gravidade secção efetiva (compressão uniforme) / <i>Position of the centre of gravity of the effective section (uniform compression)</i>
$y_s / z_s$	Posição do centro de corte / <i>Position of the shear centre</i>

### Madres para edifícios industriais

A configuração das secções permite a sobreposição vertical com as seguintes vantagens:

- Aumento da resistência na zona de sobreposição;
- Redução do volume do lote de perfis no transporte;
- Facilidade de montagem e ligação dos perfis em obra.

Esquema de sobreposição recomendado:

- Vãos internos – comprimento de sobreposição nos apoios igual a 20% do vão ( $L$ ), sendo 10% para cada lado do apoio;
- Vãos de extremidade – comprimento de sobreposição nos apoios igual a 25% do vão ( $L$ ), sendo 10% no vão de extremidade e 15% no vão interno adjacente.

Furos ovais 14.5x13.5 mm nas abas e almas com 50 mm de afastamento.

### Purlins for industrial buildings

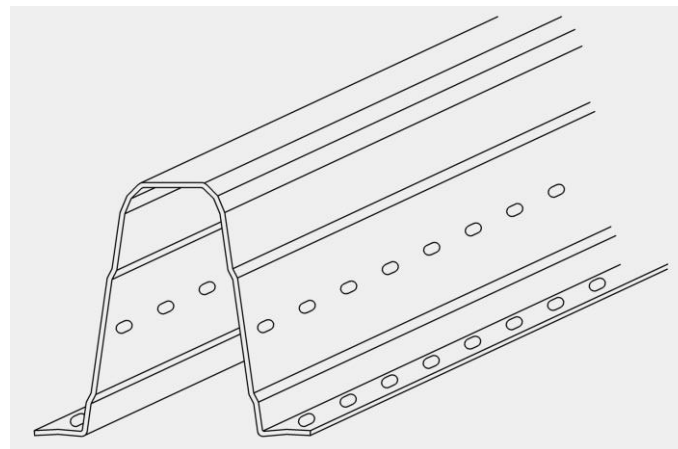
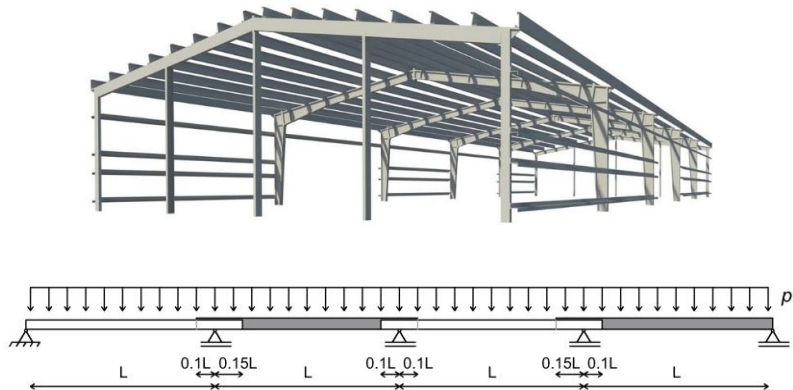
The configuration of the sections allows vertical overlap with the following advantages:

- Increase of the resistance in the overlap area;
- Reduction of the profile set volume for transport;
- Easy installation and connection of profiles on site.

Recommended overlap scheme:

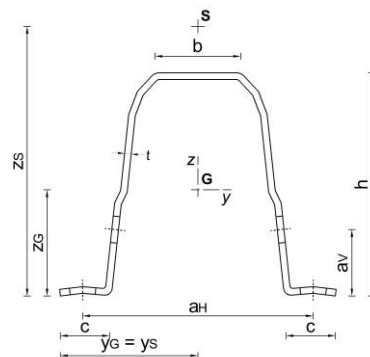
- Internal spans – overlapping length at the supports equal to 20% of the span ( $L$ ), 10% for each side of the support;
- End spans – overlapping length at the supports equal to 25% of the span ( $L$ ), being 10% at the end span and 15% at the adjacent internal span.

Oval holes 14.5x13.5 mm in the lower flanges and webs with 50 mm spanning.

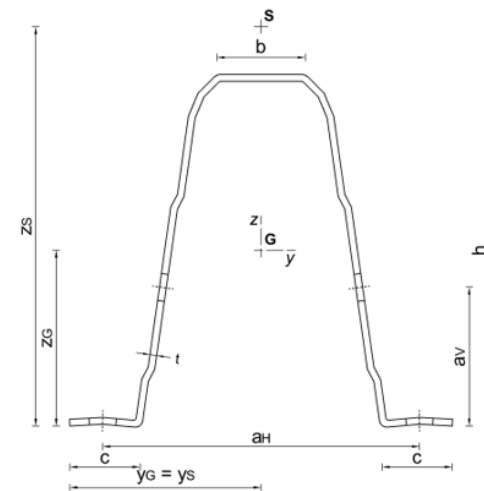


OMEGA OB 145, 180, 200, 220, 250

Furações / Holes 14.5x13.5 mm // 50 mm		
Secção Section	a <sub>H</sub> (mm)	a <sub>V</sub> (mm)
OB 145	150	37
OB 180	150	34
OB 200	200	95
OB 220	200	80
OB 250	200	78



OMEGA OB 145, OB 180



OMEGA OB 200, OB 220, OB 250

1. Propriedades da secção bruta

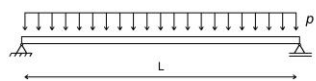
1. Properties of the gross section

Secção Section	h (mm)	b (mm)	c (mm)	t (mm)	A (mm <sup>2</sup> )	P (kg/m)	y <sub>G</sub> (mm)	z <sub>G</sub> (mm)	I <sub>y</sub> (mm <sup>4</sup> )	W <sub>y</sub> (mm <sup>3</sup> )	I <sub>z</sub> (mm <sup>4</sup> )	W <sub>z</sub> (mm <sup>3</sup> )	y <sub>s</sub> (mm)	z <sub>s</sub> (mm)	I <sub>t</sub> (mm <sup>4</sup> )	I <sub>w</sub> (mm <sup>6</sup> )
OB 145x1.5	145.0	56.0	32.0	1.5	623.1	4.9	89.8	72.4	1609309	22224	1588458	17697	89.8	192.5	465	1046474343
OB 145x2.0	145.0	56.0	32.0	2.0	830.8	6.5	89.8	72.8	2135735	29340	2108887	23495	89.8	192.8	1102	1395299124
OB 145x2.5	145.0	56.0	32.0	2.5	1038.5	8.1	89.8	73.2	2657148	36312	2624821	29243	89.8	193.0	2152	1744123906
OB 180x1.5	180.0	56.0	38.0	1.5	761.5	5.9	92.7	89.5	3081209	33355	1904627	20545	92.7	245.6	564	2654895897
OB 180x2.0	180.0	56.0	38.0	2.0	1015.4	7.9	92.7	89.9	4091242	44229	2530476	27296	92.7	245.9	1337	3539861196
OB 180x2.5	180.0	56.0	38.0	2.5	1269.2	9.9	92.7	90.3	5092758	54983	3151853	33999	92.7	246.1	2610	4424826495
OB 200x1.5	200.0	56.0	44.0	1.5	830.8	6.5	120.8	94.1	3843003	38349	3416771	28277	120.8	245.4	616	3296757959
OB 200x2.0	200.0	56.0	44.0	2.0	1107.7	8.6	120.8	94.5	5106592	50901	4540892	37581	120.8	245.6	1459	4395677279
OB 200x2.5	200.0	56.0	44.0	2.5	1384.6	10.8	120.8	94.9	6361455	63338	5657645	46823	120.8	245.9	2850	5494596599
OB 220x1.5	220.0	56.0	44.0	1.5	907.7	7.1	120.8	106.7	5249783	46335	3666972	30346	120.8	280.0	672	4791887075
OB 220x2.0	220.0	56.0	44.0	2.0	1210.3	9.4	120.8	107.1	6975501	61511	4874313	40337	120.8	280.3	1593	6389182766
OB 220x2.5	220.0	56.0	44.0	2.5	1512.8	11.8	120.8	107.5	8682084	76507	6078447	50302	120.8	280.5	3111	7986478458
OB 250x1.5	250.0	56.0	48.0	1.5	1007.7	7.9	122.9	119.8	7322685	56598	4033820	32835	122.9	316.8	744	7577833971
OB 250x2.0	250.0	56.0	48.0	2.0	1343.6	10.5	122.9	120.2	9734677	75175	5364153	43663	122.9	317.1	1763	10103778629
OB 250x2.5	250.0	56.0	48.0	2.5	1679.5	13.1	122.9	120.5	12132190	93608	6687404	54434	122.9	317.3	3444	12629723286

**2. Valores de cálculo dos esforços resistentes e propriedades da secção efetiva**  
**2. Design values of resistance and properties of the effective section**

Secção Section	N <sub>t,Rd</sub> (kN)	y <sub>G,eff</sub> (mm)	z <sub>G,eff</sub> (mm)	N <sub>c,Rd</sub> (kN)	W <sub>eff,y,+</sub> (mm <sup>3</sup> )	M <sub>c,Rd,y+</sub> (kNm)	W <sub>eff,y,-</sub> (mm <sup>3</sup> )	M <sub>c,Rd,y-</sub> (kNm)	W <sub>eff,z,+</sub> (mm <sup>3</sup> )	M <sub>c,Rd,z+</sub> (kNm)	W <sub>eff,z,-</sub> (mm <sup>3</sup> )	M <sub>c,Rd,z-</sub> (kNm)	V <sub>b,Rd,y</sub> (kN)	V <sub>b,Rd,z</sub> (kN)	R <sub>w,Rd,z</sub> (kN)		
															C1	C2	C2,Sob
OB 145x1.5	141.24	89.8	72.4	135.08	22224	4.89	22224	4.89	17697	3.89	17697	3.89	10.54	56.12	4.04	15.59	51.22
OB 145x2.0	190.48	89.8	72.8	179.53	29340	6.45	29340	6.45	23495	5.17	23495	5.17	14.05	74.83	6.88	25.49	84.34
OB 145x2.5	240.80	89.8	73.2	223.69	36312	7.99	36312	7.99	29243	6.43	29243	6.43	17.57	93.54	10.41	37.40	124.48
OB 180x1.5	170.12	92.7	94.3	147.49	33355	7.34	33355	7.34	18941	4.17	18941	4.17	10.52	70.18	4.14	15.97	52.49
OB 180x2.0	228.94	92.7	91.8	209.76	44229	9.73	44229	9.73	26658	5.86	26658	5.86	14.03	93.58	7.05	26.13	86.44
OB 180x2.5	288.82	92.7	90.3	271.71	54983	12.10	54983	12.10	33999	7.48	33999	7.48	17.54	116.97	10.67	38.33	127.58
OB 200x1.5	185.78	120.8	94.2	178.07	38349	8.44	38349	8.44	28277	6.22	28277	6.22	10.54	74.32	3.99	15.40	50.60
OB 200x2.0	250.01	120.8	94.5	238.66	50901	11.20	50901	11.20	37581	8.27	37581	8.27	14.05	99.09	6.79	25.19	83.33
OB 200x2.5	315.39	120.8	94.9	297.66	63338	13.93	63338	13.93	46823	10.30	46823	10.30	17.56	123.87	10.28	36.95	122.99
OB 220x1.5	202.29	120.8	109.1	175.68	46335	10.19	46335	10.19	28270	6.22	28270	6.22	10.54	84.12	4.04	15.59	51.22
OB 220x2.0	272.02	120.8	108.2	248.08	61511	13.53	61511	13.53	39372	8.66	39372	8.66	14.06	112.16	6.88	25.49	84.34
OB 220x2.5	342.90	120.8	107.6	323.32	76507	16.83	76507	16.83	50302	11.07	50302	11.07	17.57	140.20	10.41	37.40	124.48
OB 250x1.5	223.36	122.9	120.3	196.77	56598	12.45	56450	12.42	30801	6.78	30801	6.78	10.54	94.51	4.09	15.78	51.85
OB 250x2.0	300.09	122.9	120.4	276.20	75175	16.54	75175	16.54	43406	9.55	43406	9.55	14.05	126.02	6.69	24.79	85.37
OB 250x2.5	377.96	122.9	120.6	358.46	93608	20.59	93608	20.59	54434	11.98	54434	11.98	17.56	157.52	10.02	36.01	126.01

**3. Valores máximos de carga (Q<sub>z</sub>) não majorada (kN/m)**  
**3. Maximum load (Q<sub>z</sub>) without enhancement factors (kN/m)**

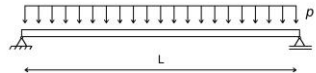


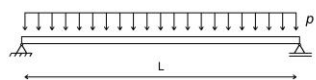
$p = \gamma_G \times G + \gamma_Q \times Q$

ELU / ULS  
 ELS / SLS

Secção Section	L (m)	4	5	6	7	8	9	10	11	12
OB 145x1.5	D ↓	1.30	0.66	0.37	0.22	0.14	0.09	0.06	0.03	0.02
	A ↑	0.28	0.15	0.10	0.07	0.06	0.05	0.05	0.04	0.04
	A ↑*	0.75	0.38	0.22	0.14	0.10	0.08	0.06	0.06	0.05
	A ↑**	--	0.51	0.30	0.19	0.13	0.10	0.08	0.06	0.06
OB 145x2.0	D ↓	1.75	0.88	0.49	0.29	0.18	0.12	0.07	0.04	0.03
	A ↑	0.43	0.24	0.15	0.11	0.09	0.08	0.07	0.06	0.06
	A ↑*	1.05	0.54	0.31	0.21	0.15	0.11	0.09	0.08	0.07
	A ↑**	--	0.72	0.42	0.27	0.19	0.14	0.11	0.09	0.08
OB 145x2.5	D ↓	2.18	1.09	0.61	0.36	0.23	0.14	0.09	0.06	0.03
	A ↑	0.62	0.35	0.23	0.17	0.14	0.11	0.10	0.09	0.08
	A ↑*	1.37	0.72	0.43	0.28	0.21	0.16	0.13	0.11	0.10
	A ↑**	--	0.94	0.55	0.36	0.25	0.19	0.15	0.12	0.11



3. Valores máximos de carga ( $Q_z$ ) não majorada (kN/m)		 $p = \gamma_G \times G + \gamma_Q \times Q$									
3. Maximum load ( $Q_z$ ) without enhancement factors (kN/m)		<div style="display: flex; justify-content: space-between;"> <span>□ ELU / ULS</span> <span>■ ELS / SLS</span> </div>									
Secção Section	L (m)	4	5	6	7	8	9	10	11	12	
OB 180x1.5	D ↓	1.33	1.05	0.73	0.45	0.29	0.19	0.13	0.09	0.06	
	A ↑	0.49	0.25	0.15	0.10	0.08	0.07	0.06	0.05	0.05	
	A ↑*	1.29	0.67	0.38	0.24	0.16	0.12	0.09	0.08	0.07	
	A ↑**	--	0.88	0.51	0.33	0.22	0.16	0.12	0.09	0.08	
OB 180x2.0	D ↓	2.28	1.71	0.97	0.59	0.38	0.25	0.17	0.11	0.08	
	A ↑	0.70	0.36	0.22	0.15	0.12	0.10	0.09	0.08	0.07	
	A ↑*	1.79	0.93	0.53	0.33	0.23	0.17	0.13	0.11	0.10	
	A ↑**	--	1.21	0.71	0.46	0.31	0.22	0.17	0.13	0.11	
OB 180x2.5	D ↓	3.47	2.13	1.20	0.74	0.47	0.31	0.21	0.14	0.10	
	A ↑	0.96	0.50	0.31	0.22	0.17	0.14	0.13	0.11	0.10	
	A ↑*	2.31	1.21	0.69	0.44	0.31	0.23	0.18	0.15	0.13	
	A ↑**	--	1.57	0.92	0.60	0.40	0.29	0.22	0.17	0.15	
OB 200x1.5	D ↓	1.27	1.01	0.83	0.56	0.36	0.24	0.17	0.11	0.08	
	A ↑	0.59	0.29	0.17	0.12	0.09	0.07	0.06	0.06	0.05	
	A ↑*	1.37	0.82	0.45	0.28	0.19	0.14	0.11	0.09	0.08	
	A ↑**	--	1.11	0.64	0.40	0.27	0.19	0.14	0.11	0.09	
OB 200x2.0	D ↓	2.19	1.74	1.22	0.75	0.48	0.32	0.22	0.15	0.10	
	A ↑	0.83	0.42	0.25	0.18	0.13	0.11	0.10	0.09	0.08	
	A ↑*	2.19	1.12	0.63	0.39	0.27	0.20	0.15	0.13	0.11	
	A ↑**	--	1.51	0.87	0.55	0.37	0.27	0.20	0.15	0.13	
OB 200x2.5	D ↓	3.33	2.65	1.51	0.93	0.60	0.40	0.27	0.19	0.13	
	A ↑	1.13	0.58	0.35	0.25	0.19	0.16	0.13	0.12	0.11	
	A ↑*	2.79	1.45	0.82	0.52	0.36	0.27	0.21	0.17	0.15	
	A ↑**	--	1.91	1.11	0.71	0.48	0.35	0.26	0.20	0.17	
OB 220x1.5	D ↓	1.29	1.02	0.84	0.71	0.51	0.34	0.24	0.17	0.12	
	A ↑	0.73	0.35	0.20	0.14	0.10	0.08	0.07	0.07	0.06	
	A ↑*	1.39	1.02	0.56	0.35	0.23	0.17	0.13	0.10	0.09	
	A ↑**	--	1.12	0.79	0.50	0.33	0.24	0.18	0.13	0.11	
OB 220x2.0	D ↓	2.21	1.75	1.45	1.03	0.67	0.45	0.31	0.22	0.16	
	A ↑	1.03	0.51	0.30	0.20	0.16	0.12	0.11	0.10	0.09	
	A ↑*	2.35	1.39	0.78	0.48	0.32	0.24	0.18	0.15	0.13	
	A ↑**	--	1.85	1.08	0.68	0.45	0.32	0.24	0.18	0.16	

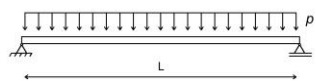
3. Valores máximos de carga ( $Q_z$ ) não majorada (kN/m)		 $p = \gamma_G \times G + \gamma_Q \times Q$								
3. Maximum load ( $Q_z$ ) without enhancement factors (kN/m)		<div style="display: flex; justify-content: space-between;"> <span>□ ELU / ULS</span> <span>■ ELS / SLS</span> </div>								
Secção Section	L (m)	4	5	6	7	8	9	10	11	12
OB 220x2.5	D ↓	3.37	2.67	2.09	1.29	0.84	0.57	0.39	0.28	0.19
	A ↑	1.37	0.69	0.41	0.28	0.21	0.17	0.15	0.13	0.12
	A ↑*	3.43	1.79	1.01	0.63	0.43	0.31	0.24	0.20	0.17
	A ↑**	--	2.34	1.37	0.88	0.58	0.42	0.31	0.23	0.20
OB 250x1.5	D ↓	1.30	1.02	0.84	0.71	0.61	0.49	0.34	0.25	0.18
	A ↑	0.98	0.47	0.26	0.17	0.13	0.10	0.09	0.08	0.07
	A ↑*	1.41	1.14	0.75	0.46	0.31	0.22	0.16	0.13	0.11
	A ↑**	--	1.14	0.96	0.66	0.44	0.31	0.23	0.17	0.14
OB 250x2.0	D ↓	2.14	1.69	1.40	1.18	0.96	0.65	0.46	0.33	0.24
	A ↑	1.37	0.66	0.38	0.25	0.18	0.15	0.12	0.11	0.10
	A ↑*	2.30	1.84	1.03	0.64	0.42	0.30	0.23	0.18	0.15
	A ↑**	--	1.85	1.41	0.90	0.60	0.42	0.31	0.23	0.19
OB 250x2.5	D ↓	3.23	2.56	2.11	1.80	1.19	0.81	0.57	0.41	0.29
	A ↑	1.79	0.88	0.51	0.34	0.25	0.20	0.17	0.15	0.13
	A ↑*	3.42	2.34	1.32	0.82	0.55	0.39	0.30	0.24	0.20
	A ↑**	--	2.76	1.79	1.15	0.76	0.54	0.40	0.29	0.25

D – Carga descendente / Descendent load; A – Carga ascendente / Ascendant load; \* Tirante  $1/2$  / Anti-sag rod at  $1/2$ ; \*\* Tirante  $1/3$  e  $2/3$  / Anti-sag rod at  $1/3$  and  $2/3$

**2. Valores de cálculo dos esforços resistentes e propriedades da secção efetiva**  
**2. Design values of resistance and properties of the effective section**

Secção Section	N <sub>t,Rd</sub> (kN)	y <sub>G,eff</sub> (mm)	z <sub>G,eff</sub> (mm)	N <sub>c,Rd</sub> (kN)	W <sub>eff,y,+</sub> (mm <sup>3</sup> )	M <sub>c,Rd,y+</sub> (kNm)	W <sub>eff,y,-</sub> (mm <sup>3</sup> )	M <sub>c,Rd,y-</sub> (kNm)	W <sub>eff,z,+</sub> (mm <sup>3</sup> )	M <sub>c,Rd,z+</sub> (kNm)	W <sub>eff,z,-</sub> (mm <sup>3</sup> )	M <sub>c,Rd,z-</sub> (kNm)	V <sub>b,Rd,y</sub> (kN)	V <sub>b,Rd,z</sub> (kN)	R <sub>w,Rd,z</sub> (kN)		
															C1	C2	C2,Sob
OB 145x1.5	178.08	89.8	72.7	169.26	22165	6.21	22224	6.22	17670	4.93	17670	4.93	13.41	71.43	4.56	17.58	57.78
OB 145x2.0	239.44	89.8	72.8	228.49	29340	8.22	29340	8.22	23495	6.58	23495	6.58	17.88	95.24	7.76	28.76	95.14
OB 145x2.5	301.81	89.8	73.2	284.70	36312	10.17	36312	10.17	29243	8.19	29243	8.19	22.36	119.05	11.74	42.19	140.43
OB 180x1.5	214.84	92.7	95.3	182.06	33169	9.29	32574	9.12	18487	5.18	18487	5.18	13.39	89.32	4.67	18.02	59.22
OB 180x2.0	288.40	92.7	92.9	259.71	44229	12.38	44229	12.38	26037	7.29	26037	7.29	17.86	119.10	7.95	29.48	97.51
OB 180x2.5	362.92	92.7	91.2	340.52	54983	15.40	54983	15.40	33952	9.48	33952	9.48	22.32	148.87	12.03	43.24	143.93
OB 200x1.5	234.71	120.8	94.6	221.57	38077	10.66	38196	10.69	27749	7.77	27749	7.77	13.41	94.59	4.50	17.37	57.09
OB 200x2.0	315.10	120.8	94.5	303.75	50901	14.25	50901	14.25	37581	10.52	37581	10.52	17.88	126.12	7.66	28.41	94.00
OB 200x2.5	396.57	120.8	94.9	378.84	63338	17.73	63338	17.73	46823	13.11	46823	13.11	22.35	157.65	11.60	41.69	138.75
OB 220x1.5	255.72	120.8	109.9	216.65	46029	12.89	46154	12.92	27499	7.70	27499	7.70	13.42	104.75	4.56	17.58	57.78
OB 220x2.0	343.12	120.8	108.7	307.94	61511	17.22	61511	17.22	38610	10.81	38610	10.81	17.89	142.75	7.76	28.76	95.14
OB 220x2.5	431.58	120.8	108.1	402.09	76507	21.42	76507	21.42	79600	22.29	79600	22.29	22.37	178.43	11.74	42.19	140.43
OB 250x1.5	282.54	122.9	121.5	241.53	70246	19.67	56154	15.72	29897	8.37	29897	8.37	13.41	118.09	4.61	17.80	58.49
OB 250x2.0	378.85	122.9	120.5	343.72	75175	21.05	75175	21.05	43205	12.10	43205	12.10	17.88	160.38	7.54	27.97	96.31
OB 250x2.5	476.23	122.9	120.7	446.82	93608	26.21	93608	26.21	54320	15.12	54320	15.12	22.35	200.48	11.30	40.63	142.16

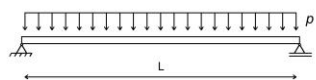
**3. Valores máximos de carga (Q<sub>z</sub>) não majorada (kN/m)**  
**3. Maximum load (Q<sub>z</sub>) without enhancement factors (kN/m)**

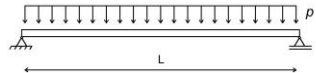


$p = \gamma_G \times G + \gamma_Q \times Q$

ELU / ULS  
 ELS / SLS

Secção Section	L (m)	4	5	6	7	8	9	10	11	12
OB 145x1.5	D ↓	1.32	0.66	0.37	0.22	0.14	0.09	0.06	0.03	0.02
	A ↑	0.29	0.15	0.10	0.07	0.06	0.05	0.05	0.04	0.04
	A ↑*	0.79	0.39	0.22	0.14	0.10	0.08	0.06	0.06	0.05
	A ↑**	--	0.54	0.31	0.20	0.13	0.10	0.08	0.06	0.06
OB 145x2.0	D ↓	1.75	0.88	0.49	0.29	0.18	0.12	0.07	0.04	0.03
	A ↑	0.44	0.24	0.15	0.11	0.09	0.08	0.07	0.06	0.06
	A ↑*	1.12	0.56	0.32	0.21	0.15	0.12	0.10	0.08	0.07
	A ↑**	--	0.77	0.44	0.28	0.19	0.14	0.11	0.09	0.08
OB 145x2.5	D ↓	2.18	1.09	0.61	0.36	0.23	0.14	0.09	0.06	0.03
	A ↑	0.63	0.36	0.23	0.17	0.14	0.12	0.10	0.09	0.08
	A ↑*	1.47	0.76	0.44	0.29	0.21	0.16	0.13	0.11	0.10
	A ↑**	--	1.01	0.58	0.37	0.26	0.19	0.15	0.12	0.11

3. Valores máximos de carga ( $Q_z$ ) não majorada (kN/m)		 $p = \gamma_G \times G + \gamma_Q \times Q$									
3. Maximum load ( $Q_z$ ) without enhancement factors (kN/m)		<div style="display: flex; justify-content: space-between;"> <span>□ ELU / ULS</span> <span>■ ELS / SLS</span> </div>									
Secção Section	L (m)	4	5	6	7	8	9	10	11	12	
OB 180x1.5	D ↓	1.51	1.19	0.73	0.45	0.29	0.19	0.13	0.09	0.06	
	A ↑	0.50	0.25	0.15	0.10	0.08	0.07	0.06	0.05	0.05	
	A ↑*	1.38	0.70	0.39	0.24	0.16	0.12	0.10	0.08	0.07	
	A ↑**	--	0.94	0.54	0.34	0.23	0.16	0.12	0.09	0.08	
OB 180x2.0	D ↓	2.58	1.71	0.97	0.59	0.38	0.25	0.17	0.11	0.08	
	A ↑	0.72	0.37	0.22	0.16	0.12	0.10	0.09	0.08	0.07	
	A ↑*	1.94	0.98	0.55	0.34	0.23	0.17	0.14	0.11	0.10	
	A ↑**	--	1.32	0.75	0.48	0.32	0.23	0.17	0.13	0.12	
OB 180x2.5	D ↓	3.93	2.13	1.20	0.74	0.47	0.31	0.21	0.14	0.10	
	A ↑	0.98	0.51	0.31	0.22	0.17	0.14	0.13	0.11	0.10	
	A ↑*	2.52	1.28	0.72	0.46	0.32	0.23	0.19	0.15	0.13	
	A ↑**	--	1.71	0.98	0.62	0.42	0.30	0.23	0.17	0.15	
OB 200x1.5	D ↓	1.44	1.14	0.92	0.56	0.36	0.24	0.17	0.11	0.08	
	A ↑	0.60	0.29	0.17	0.12	0.09	0.07	0.07	0.06	0.05	
	A ↑*	1.54	0.86	0.47	0.29	0.19	0.14	0.11	0.09	0.08	
	A ↑**	--	1.22	0.68	0.42	0.28	0.20	0.15	0.11	0.10	
OB 200x2.0	D ↓	2.48	1.97	1.22	0.75	0.48	0.32	0.22	0.15	0.10	
	A ↑	0.85	0.43	0.25	0.18	0.14	0.11	0.10	0.09	0.08	
	A ↑*	2.40	1.19	0.65	0.41	0.27	0.20	0.16	0.13	0.11	
	A ↑**	--	1.66	0.93	0.58	0.38	0.27	0.20	0.15	0.13	
OB 200x2.5	D ↓	3.77	2.67	1.51	0.93	0.60	0.40	0.27	0.14	0.13	
	A ↑	1.15	0.59	0.36	0.25	0.19	0.16	0.14	0.12	0.11	
	A ↑*	3.06	1.54	0.86	0.54	0.37	0.27	0.21	0.17	0.15	
	A ↑**	--	2.12	1.20	0.75	0.50	0.35	0.27	0.20	0.18	
OB 220x1.5	D ↓	1.46	1.15	0.95	0.78	0.51	0.34	0.24	0.17	0.12	
	A ↑	0.75	0.36	0.21	0.14	0.10	0.08	0.07	0.07	0.06	
	A ↑*	1.56	1.07	0.59	0.36	0.24	0.17	0.13	0.11	0.09	
	A ↑**	--	1.26	0.84	0.52	0.34	0.24	0.18	0.13	0.11	
OB 220x2.0	D ↓	2.50	1.99	1.64	1.03	0.67	0.45	0.31	0.22	0.16	
	A ↑	1.05	0.52	0.30	0.20	0.16	0.12	0.11	0.10	0.09	
	A ↑*	2.65	1.48	0.81	0.50	0.33	0.24	0.18	0.15	0.13	
	A ↑**	--	2.05	1.15	0.72	0.47	0.33	0.25	0.18	0.16	

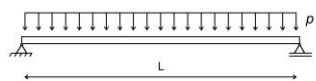
3. Valores máximos de carga ( $Q_z$ ) não majorada (kN/m)		 $p = \gamma_G \times G + \gamma_Q \times Q$								
3. Maximum load ( $Q_z$ ) without enhancement factors (kN/m)		<div style="display: flex; justify-content: space-between;"> <span>□ ELU / ULS</span> <span>■ ELS / SLS</span> </div>								
Secção Section	L (m)	4	5	6	7	8	9	10	11	12
OB 220x2.5	D ↓	3.81	3.03	2.09	1.29	0.84	0.57	0.39	0.28	0.19
	A ↑	1.40	0.70	0.42	0.29	0.21	0.17	0.15	0.13	0.12
	A ↑*	3.79	1.90	1.05	0.65	0.44	0.32	0.25	0.20	0.17
	A ↑**	--	2.61	1.48	0.92	0.61	0.43	0.32	0.24	0.21
OB 250x1.5	D ↓	1.47	1.16	0.96	0.81	0.70	0.49	0.34	0.25	0.18
	A ↑	1.01	0.48	0.27	0.17	0.13	0.10	0.09	0.08	0.07
	A ↑*	1.59	1.28	0.79	0.48	0.31	0.22	0.17	0.13	0.11
	A ↑**	--	1.28	1.08	0.70	0.45	0.32	0.23	0.17	0.14
OB 250x2.0	D ↓	2.42	1.92	1.59	1.35	0.96	0.65	0.46	0.33	0.24
	A ↑	1.40	0.67	0.38	0.25	0.18	0.15	0.12	0.11	0.10
	A ↑*	2.58	1.97	1.08	0.66	0.43	0.31	0.23	0.18	0.15
	A ↑**	--	2.08	1.53	0.96	0.62	0.44	0.32	0.23	0.20
OB 250x2.5	D ↓	3.66	2.90	2.40	1.82	1.19	0.81	0.57	0.41	0.29
	A ↑	1.84	0.90	0.52	0.34	0.25	0.20	0.17	0.15	0.13
	A ↑*	3.85	2.52	1.39	0.85	0.56	0.40	0.30	0.24	0.20
	A ↑**	--	3.10	1.95	1.22	0.80	0.56	0.41	0.30	0.26

D – Carga descendente / Descendent load; A – Carga ascendente / Ascendant load; \* Tirante  $1/2$  / Anti-sag rod at  $1/2$ ; \*\* Tirante  $1/3$  e  $2/3$  / Anti-sag rod at  $1/3$  and  $2/3$

**2. Valores de cálculo dos esforços resistentes e propriedades da secção efetiva**  
**2. Design values of resistance and properties of the effective section**

Secção Section	N <sub>t,Rd</sub> (kN)	y <sub>G,eff</sub> (mm)	z <sub>G,eff</sub> (mm)	N <sub>c,Rd</sub> (kN)	W <sub>eff,y,+</sub> (mm <sup>3</sup> )	M <sub>c,Rd,y+</sub> (kNm)	W <sub>eff,y,-</sub> (mm <sup>3</sup> )	M <sub>c,Rd,y-</sub> (kNm)	W <sub>eff,z,+</sub> (mm <sup>3</sup> )	M <sub>c,Rd,z+</sub> (kNm)	W <sub>eff,z,-</sub> (mm <sup>3</sup> )	M <sub>c,Rd,z-</sub> (kNm)	V <sub>b,Rd,y</sub> (kN)	V <sub>b,Rd,z</sub> (kN)	R <sub>w,Rd,z</sub> (kN)		
															C1	C2	C2,Sob
OB 145x1.5	71.60	52.0	26.2	60.28	3142	1.01	2734	0.87	3247	1.04	3247	1.04	9.14	22.22	3.42	13.61	44.53
OB 145x2.0	146.18	59.5	50.9	133.97	11388	3.64	10497	3.36	6569	2.10	6569	2.10	11.14	48.62	5.09	19.63	64.51
OB 145x2.5	201.87	89.8	73.4	191.61	22068	7.06	22224	7.11	17614	5.58	17614	5.58	15.33	81.63	4.87	18.80	61.77
OB 180x1.5	270.72	89.8	72.8	261.13	29340	9.39	29340	9.39	23495	7.52	23495	7.52	20.44	108.84	8.29	30.74	101.71
OB 180x2.0	340.34	89.8	73.2	325.37	36312	11.62	36312	11.62	29243	9.36	29243	9.36	25.55	136.05	12.55	45.10	150.12
OB 180x2.5	243.88	92.7	96.2	205.48	32832	10.51	31903	10.21	18244	5.84	18244	5.84	15.31	99.68	4.99	19.27	63.31
OB 200x1.5	326.66	92.7	93.6	292.23	44229	14.15	44229	14.15	25694	8.22	25694	8.22	20.41	136.11	8.50	31.51	104.25
OB 200x2.0	410.19	92.7	91.8	383.60	54983	17.59	54983	17.59	33822	10.70	33822	10.70	25.51	170.14	12.86	46.23	153.86
OB 200x2.5	266.53	120.8	95.3	250.66	37646	12.05	38075	12.18	27350	8.75	27350	8.75	15.33	108.10	4.81	18.57	61.03
OB 220x1.5	357.08	120.8	94.5	347.14	50901	16.29	50901	16.29	37581	12.03	37581	12.03	20.44	144.14	8.19	30.38	100.49
OB 220x2.0	448.47	120.8	94.9	432.96	63338	20.27	63338	20.27	46823	14.98	46823	14.98	25.55	180.17	12.40	44.56	148.33
OB 220x2.5	290.55	120.8	110.9	244.07	45552	14.58	46013	14.72	26996	8.64	26996	8.64	15.34	116.18	4.87	18.80	61.77
OB 250x1.5	389.09	120.8	109.0	347.06	61511	19.68	61511	19.68	38191	12.22	38191	12.22	20.45	163.14	8.29	30.74	101.71
OB 250x2.0	488.49	120.8	108.4	453.40	76507	24.48	76507	24.48	77735	24.88	77735	24.88	25.56	203.93	12.55	45.10	150.12
OB 250x2.5	321.20	122.9	122.1	273.25	69106	22.11	55963	17.91	29415	9.41	29415	9.41	15.33	131.43	4.93	19.03	62.53

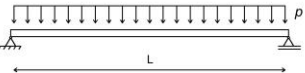
**3. Valores máximos de carga (Q<sub>z</sub>) não majorada (kN/m)**  
**3. Maximum load (Q<sub>z</sub>) without enhancement factors (kN/m)**

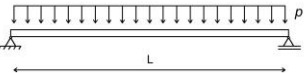


$p = \gamma_G \times G + \gamma_Q \times Q$

ELU / ULS  
 ELS / SLS

Secção Section	L (m)	4	5	6	7	8	9	10	11	12
OB 145x1.5	D ↓	1.32	0.66	0.37	0.22	0.14	0.09	0.06	0.03	0.02
	A ↑	0.29	0.15	0.10	0.07	0.06	0.05	0.05	0.04	0.04
	A ↑*	0.81	0.40	0.23	0.15	0.10	0.08	0.06	0.06	0.05
	A ↑**	--	0.56	0.31	0.20	0.14	0.10	0.08	0.06	0.06
OB 145x2.0	D ↓	1.75	0.88	0.49	0.29	0.18	0.12	0.07	0.04	0.03
	A ↑	0.44	0.24	0.16	0.12	0.09	0.08	0.07	0.06	0.06
	A ↑*	1.15	0.57	0.33	0.21	0.15	0.12	0.10	0.08	0.07
	A ↑**	--	0.79	0.44	0.28	0.19	0.14	0.11	0.09	0.08
OB 145x2.5	D ↓	2.18	1.09	0.61	0.36	0.23	0.14	0.09	0.06	0.03
	A ↑	0.64	0.36	0.23	0.17	0.14	0.12	0.10	0.09	0.08
	A ↑*	1.52	0.77	0.45	0.30	0.21	0.16	0.13	0.12	0.10
	A ↑**	--	1.04	0.59	0.38	0.26	0.19	0.15	0.12	0.11

3. Valores máximos de carga ( $Q_z$ ) não majorada (kN/m)		 $p = \gamma_G \times G + \gamma_Q \times Q$									
3. Maximum load ( $Q_z$ ) without enhancement factors (kN/m)		<div style="display: flex; justify-content: space-between;"> <span>□ ELU / ULS</span> <span>■ ELS / SLS</span> </div>									
Secção Section	L (m)	4	5	6	7	8	9	10	11	12	
OB 180x1.5	D ↓	1.61	1.28	0.73	0.45	0.29	0.19	0.13	0.09	0.06	
	A ↑	0.50	0.25	0.15	0.10	0.08	0.07	0.06	0.05	0.05	
	A ↑*	1.42	0.71	0.39	0.24	0.17	0.12	0.10	0.08	0.07	
	A ↑**	--	0.97	0.55	0.35	0.23	0.17	0.13	0.09	0.08	
OB 180x2.0	D ↓	2.76	1.71	0.97	0.59	0.38	0.25	0.17	0.11	0.08	
	A ↑	0.73	0.37	0.22	0.16	0.12	0.10	0.09	0.08	0.07	
	A ↑*	2.01	1.00	0.55	0.35	0.24	0.17	0.14	0.11	0.10	
	A ↑**	--	1.37	0.77	0.49	0.32	0.23	0.18	0.13	0.12	
OB 180x2.5	D ↓	4.20	2.13	1.20	0.74	0.47	0.31	0.21	0.14	0.10	
	A ↑	0.99	0.52	0.32	0.22	0.17	0.14	0.13	0.11	0.10	
	A ↑*	2.62	1.31	0.73	0.46	0.32	0.24	0.19	0.15	0.13	
	A ↑**	--	1.79	1.01	0.64	0.42	0.31	0.23	0.18	0.15	
OB 200x1.5	D ↓	1.55	1.23	0.92	0.56	0.36	0.24	0.17	0.11	0.08	
	A ↑	0.60	0.30	0.17	0.12	0.09	0.07	0.07	0.06	0.05	
	A ↑*	1.65	0.88	0.48	0.29	0.20	0.14	0.11	0.09	0.08	
	A ↑**	--	1.27	0.70	0.43	0.28	0.20	0.15	0.11	0.10	
OB 200x2.0	D ↓	2.66	2.11	1.22	0.75	0.48	0.32	0.22	0.15	0.10	
	A ↑	0.86	0.43	0.26	0.18	0.14	0.11	0.10	0.09	0.08	
	A ↑*	2.49	1.22	0.66	0.41	0.28	0.20	0.16	0.13	0.11	
	A ↑**	--	1.74	0.96	0.59	0.39	0.28	0.21	0.15	0.13	
OB 200x2.5	D ↓	4.04	2.67	1.51	0.93	0.60	0.40	0.27	0.14	0.13	
	A ↑	1.17	0.60	0.36	0.25	0.19	0.16	0.14	0.12	0.11	
	A ↑*	3.20	1.58	0.87	0.54	0.37	0.27	0.21	0.18	0.15	
	A ↑**	--	2.22	1.23	0.77	0.50	0.36	0.27	0.20	0.18	
OB 220x1.5	D ↓	1.56	1.24	1.02	0.78	0.51	0.34	0.24	0.17	0.12	
	A ↑	0.75	0.36	0.21	0.14	0.10	0.08	0.07	0.07	0.06	
	A ↑*	1.67	1.10	0.60	0.36	0.24	0.17	0.13	0.11	0.09	
	A ↑**	--	1.34	0.87	0.53	0.35	0.24	0.18	0.13	0.11	
OB 220x2.0	D ↓	2.68	2.13	1.68	1.03	0.67	0.45	0.31	0.22	0.16	
	A ↑	1.06	0.52	0.30	0.20	0.16	0.12	0.11	0.10	0.09	
	A ↑*	2.82	1.52	0.83	0.50	0.34	0.24	0.19	0.15	0.13	
	A ↑**	--	2.15	1.19	0.74	0.48	0.34	0.25	0.18	0.16	

3. Valores máximos de carga ( $Q_z$ ) não majorada (kN/m)		 $p = \gamma_G \times G + \gamma_Q \times Q$								
3. Maximum load ( $Q_z$ ) without enhancement factors (kN/m)										
Secção Section	L (m)	4	5	6	7	8	9	10	11	12
OB 220x2.5	D ↓	4.08	3.25	2.09	1.29	0.84	0.57	0.39	0.28	0.19
	A ↑	1.42	0.71	0.42	0.29	0.22	0.17	0.15	0.13	0.12
	A ↑*	3.96	1.96	1.07	0.66	0.44	0.32	0.25	0.20	0.17
	A ↑**	--	2.74	1.53	0.95	0.62	0.44	0.32	0.24	0.21
OB 250x1.5	D ↓	1.58	1.25	1.03	0.87	0.72	0.49	0.34	0.25	0.18
	A ↑	1.02	0.48	0.27	0.17	0.13	0.10	0.09	0.08	0.07
	A ↑*	1.69	1.37	0.80	0.48	0.32	0.22	0.17	0.13	0.11
	A ↑**	--	1.37	1.15	0.72	0.46	0.32	0.24	0.17	0.14
OB 250x2.0	D ↓	2.60	2.06	1.70	1.45	0.96	0.65	0.46	0.33	0.24
	A ↑	1.42	0.68	0.38	0.25	0.18	0.15	0.12	0.11	0.10
	A ↑*	2.75	2.03	1.10	0.67	0.44	0.31	0.23	0.19	0.15
	A ↑**	--	2.22	1.59	0.98	0.64	0.44	0.32	0.23	0.20
OB 250x2.5	D ↓	3.92	3.11	2.57	1.82	1.19	0.81	0.57	0.41	0.29
	A ↑	1.86	0.91	0.52	0.35	0.25	0.20	0.17	0.15	0.13
	A ↑*	4.11	2.60	1.42	0.87	0.57	0.41	0.31	0.24	0.20
	A ↑**	--	3.31	2.03	1.26	0.82	0.57	0.42	0.30	0.26

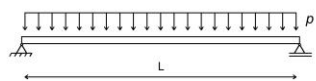
D – Carga descendente / Descendent load; A – Carga ascendente / Ascendant load; \* Tirante  $L/2$  / Anti-sag rod at  $L/2$ ; \*\* Tirante  $L/3$  e  $2L/3$  / Anti-sag rod at  $L/3$  and  $2L/3$



**2. Valores de cálculo dos esforços resistentes e propriedades da secção efetiva**  
**2. Design values of resistance and properties of the effective section**

Secção Section	N <sub>t,Rd</sub> (kN)	y <sub>G,eff</sub> (mm)	z <sub>G,eff</sub> (mm)	N <sub>c,Rd</sub> (kN)	W <sub>eff,y,+</sub> (mm <sup>3</sup> )	M <sub>c,Rd,y+</sub> (kNm)	W <sub>eff,y,-</sub> (mm <sup>3</sup> )	M <sub>c,Rd,y-</sub> (kNm)	W <sub>eff,z,+</sub> (mm <sup>3</sup> )	M <sub>c,Rd,z+</sub> (kNm)	W <sub>eff,z,-</sub> (mm <sup>3</sup> )	M <sub>c,Rd,z-</sub> (kNm)	V <sub>b,Rd,y</sub> (kN)	V <sub>b,Rd,z</sub> (kN)	R <sub>w,Rd,z</sub> (kN)		
															C1	C2	C2,Sob
OB 145x1.5	78.02	52.0	26.3	64.04	3106	1.09	2683	0.94	3214	1.12	3214	1.12	9.99	24.31	3.58	14.23	46.57
OB 145x2.0	159.44	59.5	51.1	145.78	11388	3.99	10338	3.62	6499	2.27	6499	2.27	12.18	53.18	5.32	20.53	67.47
OB 145x2.5	220.29	89.8	72.7	204.41	22002	7.70	22224	7.78	17573	6.06	17573	6.06	16.77	89.29	5.09	19.66	64.60
OB 180x1.5	295.20	89.8	72.8	285.61	29340	10.27	29340	10.27	23495	8.22	23495	8.22	22.36	119.05	8.67	32.15	106.37
OB 180x2.0	370.84	89.8	73.2	355.87	36312	12.71	36312	12.71	29243	10.23	29243	10.23	27.94	148.81	13.13	47.17	157.00
OB 180x2.5	266.24	92.7	95.8	217.91	32627	11.42	31263	10.94	17999	6.30	17999	6.30	16.74	106.58	5.22	20.15	66.21
OB 200x1.5	356.39	92.7	94.1	316.30	44229	15.48	44229	15.48	25462	8.91	25462	8.91	22.32	148.87	8.89	32.95	109.02
OB 200x2.0	447.24	92.7	92.2	415.41	54983	19.24	54983	19.24	33731	11.61	33731	11.61	27.90	186.09	13.45	48.35	160.92
OB 200x2.5	290.99	120.8	94.5	267.74	37350	13.07	37995	13.30	27084	9.48	27084	9.48	16.77	118.24	5.03	19.42	63.83
OB 220x1.5	389.62	120.8	94.5	379.46	50901	17.82	50901	17.82	37581	13.15	37581	13.15	22.35	157.65	8.57	31.77	105.10
OB 220x2.0	489.06	120.8	94.9	473.55	63338	22.17	63338	22.17	46823	16.39	46823	16.39	27.94	197.06	12.97	46.61	155.12
OB 220x2.5	317.26	120.8	109.9	259.89	45229	15.83	45920	16.07	26654	9.33	26654	9.33	16.77	124.62	5.09	19.66	64.60
OB 250x1.5	424.64	120.8	109.2	376.08	61511	21.53	61511	21.53	37912	13.27	37912	13.27	22.37	178.43	8.67	32.15	106.37
OB 250x2.0	532.83	120.8	108.4	491.36	76507	26.78	76507	26.78	76478	26.77	76478	26.77	27.96	223.04	13.13	47.17	157.00
OB 250x2.5	350.79	122.9	122.3	287.42	68324	23.91	55849	19.55	45850	16.05	45850	16.05	16.76	141.30	5.16	19.90	65.39

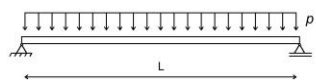
**3. Valores máximos de carga (Q<sub>z</sub>) não majorada (kN/m)**  
**3. Maximum load (Q<sub>z</sub>) without enhancement factors (kN/m)**

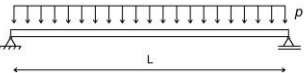


$p = \gamma_G \times G + \gamma_Q \times Q$

ELU / ULS  
 ELS / SLS

Secção Section	L (m)	4	5	6	7	8	9	10	11	12
OB 145x1.5	D ↓	1.32	0.66	0.37	0.22	0.14	0.09	0.06	0.03	0.02
	A ↑	0.29	0.16	0.10	0.07	0.06	0.05	0.05	0.04	0.04
	A ↑*	0.82	0.41	0.23	0.15	0.10	0.08	0.06	0.06	0.05
	A ↑**	--	0.56	0.32	0.20	0.14	0.10	0.08	0.06	0.06
OB 145x2.0	D ↓	1.75	0.88	0.49	0.29	0.18	0.12	0.07	0.04	0.03
	A ↑	0.45	0.24	0.16	0.12	0.09	0.08	0.07	0.06	0.06
	A ↑*	1.17	0.58	0.33	0.21	0.15	0.12	0.10	0.08	0.07
	A ↑**	--	0.80	0.45	0.29	0.20	0.14	0.11	0.09	0.08
OB 145x2.5	D ↓	2.18	1.09	0.61	0.36	0.23	0.14	0.09	0.06	0.03
	A ↑	0.64	0.36	0.23	0.17	0.14	0.12	0.10	0.09	0.08
	A ↑*	1.55	0.78	0.45	0.30	0.21	0.17	0.14	0.12	0.10
	A ↑**	--	1.06	0.60	0.38	0.26	0.20	0.15	0.12	0.11

3. Valores máximos de carga ( $Q_z$ ) não majorada (kN/m)		 $p = \gamma_G \times G + \gamma_Q \times Q$									
3. Maximum load ( $Q_z$ ) without enhancement factors (kN/m)		<div style="display: flex; justify-content: space-between;"> <span>□ ELU / ULS</span> <span>■ ELS / SLS</span> </div>									
Secção Section	L (m)	4	5	6	7	8	9	10	11	12	
OB 180x1.5	D ↓	1.69	1.29	0.73	0.45	0.29	0.19	0.13	0.09	0.06	
	A ↑	0.51	0.25	0.15	0.10	0.08	0.07	0.06	0.05	0.05	
	A ↑*	1.44	0.72	0.40	0.25	0.17	0.12	0.10	0.08	0.07	
	A ↑**	--	0.99	0.55	0.35	0.23	0.17	0.13	0.10	0.08	
OB 180x2.0	D ↓	2.89	1.71	0.97	0.59	0.38	0.25	0.17	0.11	0.08	
	A ↑	0.73	0.37	0.22	0.16	0.12	0.10	0.09	0.08	0.07	
	A ↑*	2.06	1.02	0.56	0.35	0.24	0.18	0.14	0.11	0.10	
	A ↑**	--	1.40	0.79	0.49	0.33	0.23	0.18	0.13	0.12	
OB 180x2.5	D ↓	4.21	2.13	1.20	0.74	0.47	0.31	0.21	0.14	0.10	
	A ↑	1.00	0.52	0.32	0.22	0.17	0.14	0.13	0.11	0.10	
	A ↑*	2.68	1.33	0.74	0.47	0.32	0.24	0.19	0.16	0.13	
	A ↑**	--	1.83	1.03	0.64	0.43	0.31	0.23	0.18	0.15	
OB 200x1.5	D ↓	1.62	1.29	0.92	0.56	0.36	0.24	0.17	0.11	0.08	
	A ↑	0.61	0.30	0.17	0.12	0.09	0.07	0.07	0.06	0.06	
	A ↑*	1.72	0.89	0.48	0.29	0.20	0.14	0.11	0.09	0.08	
	A ↑**	--	1.31	0.71	0.44	0.28	0.20	0.15	0.11	0.10	
OB 200x2.0	D ↓	2.78	2.14	1.22	0.75	0.48	0.32	0.22	0.15	0.10	
	A ↑	0.87	0.43	0.26	0.18	0.14	0.11	0.10	0.09	0.08	
	A ↑*	2.56	1.24	0.67	0.41	0.28	0.20	0.16	0.13	0.11	
	A ↑**	--	1.78	0.98	0.60	0.39	0.28	0.21	0.15	0.13	
OB 200x2.5	D ↓	4.23	2.67	1.51	0.93	0.60	0.40	0.27	0.14	0.13	
	A ↑	1.18	0.60	0.36	0.25	0.19	0.16	0.14	0.12	0.11	
	A ↑*	3.28	1.60	0.88	0.55	0.37	0.27	0.21	0.18	0.15	
	A ↑**	--	2.28	1.26	0.78	0.51	0.36	0.27	0.20	0.18	
OB 220x1.5	D ↓	1.64	1.30	1.07	0.78	0.51	0.34	0.24	0.17	0.12	
	A ↑	0.76	0.36	0.21	0.14	0.10	0.08	0.07	0.07	0.06	
	A ↑*	1.74	1.12	0.60	0.37	0.24	0.17	0.13	0.11	0.09	
	A ↑**	--	1.40	0.88	0.54	0.35	0.25	0.18	0.13	0.11	
OB 220x2.0	D ↓	2.81	2.23	1.68	1.03	0.67	0.45	0.31	0.22	0.16	
	A ↑	1.07	0.52	0.30	0.21	0.16	0.13	0.11	0.10	0.09	
	A ↑*	2.95	1.54	0.83	0.51	0.34	0.24	0.19	0.15	0.13	
	A ↑**	--	2.21	1.21	0.75	0.48	0.34	0.25	0.18	0.16	

3. Valores máximos de carga ( $Q_z$ ) não majorada (kN/m)		 $p = \gamma_G \times G + \gamma_Q \times Q$								
3. Maximum load ( $Q_z$ ) without enhancement factors (kN/m)		<div style="display: flex; justify-content: space-between;"> <span>□ ELU / ULS</span> <span>■ ELS / SLS</span> </div>								
Secção Section	L (m)	4	5	6	7	8	9	10	11	12
OB 220x2.5	D ↓	4.27	3.40	2.09	1.29	0.84	0.57	0.39	0.28	0.19
	A ↑	1.43	0.71	0.42	0.29	0.22	0.18	0.15	0.13	0.12
	A ↑*	4.07	1.99	1.09	0.67	0.45	0.32	0.25	0.20	0.17
	A ↑**	--	2.82	1.56	0.96	0.63	0.44	0.33	0.24	0.21
OB 250x1.5	D ↓	1.65	1.31	1.08	0.91	0.72	0.49	0.34	0.25	0.18
	A ↑	1.03	0.48	0.27	0.18	0.13	0.10	0.09	0.08	0.07
	A ↑*	1.77	1.43	0.81	0.49	0.32	0.22	0.17	0.13	0.11
	A ↑**	--	1.43	1.19	0.73	0.47	0.33	0.24	0.17	0.15
OB 250x2.0	D ↓	2.72	2.16	1.78	1.46	0.96	0.65	0.46	0.33	0.24
	A ↑	1.43	0.68	0.38	0.25	0.19	0.15	0.12	0.11	0.10
	A ↑*	2.88	2.07	1.12	0.67	0.44	0.31	0.23	0.19	0.15
	A ↑**	--	2.32	1.63	1.00	0.64	0.45	0.33	0.24	0.20
OB 250x2.5	D ↓	4.10	3.26	2.70	1.82	1.19	0.81	0.57	0.41	0.29
	A ↑	1.88	0.91	0.52	0.35	0.25	0.20	0.17	0.15	0.13
	A ↑*	4.30	2.65	1.44	0.87	0.58	0.41	0.31	0.25	0.20
	A ↑**	--	3.45	2.07	1.28	0.83	0.58	0.42	0.30	0.26

D – Carga descendente / Descendent load; A – Carga ascendente / Ascendant load; \* Tirante  $1/2$  / Anti-sag rod at  $1/2$ ; \*\* Tirante  $1/3$  e  $2/3$  / Anti-sag rod at  $1/3$  and  $2/3$