

ArcelorMittal Sheet Piling



ArcelorMittal

Steel Foundation Solutions

General Catalogue 2014





Manalapan Seawall
Storm Protection / Erosion Control
Palm Beach | Florida | USA
AZ 26-700 | 870 t
AZ 19-700 | 210 t



Steel Foundation Solutions

Steel Sheet Piling

General Catalogue 2014



New app for iPad™
and Android™ tablets

Links to the online stores on
sheetpiling.arcelormittal.com



New
GU 7HWS, GU 28N,
GU 32N

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Deepwater port, Northport, New Zealand

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Introduction

Hot rolled steel sheet piles have been widely used worldwide for the construction of quay walls and breakwaters in harbours, of locks, and of bank reinforcement on rivers and canals. Typical applications are also temporary cofferdams in land and in water, permanent bridge abutments, retaining walls for underpasses or underground car parks, impervious containment walls, etc.

ArcelorMittal is the largest steel and mining company in the world, and was created by the merger of Arcelor and Mittal Steel back in 2006. **ArcelorMittal is also the world's largest manufacturer of hot-rolled steel sheet piles.**

ArcelorMittal Sheet Piling is in charge of the sales, marketing and promotion of foundation solutions produced by following ArcelorMittal mills:

- hot rolled steel sheet piles: Belval and Differdange in Luxembourg, Dabrowa in Poland,
- cold formed steel sheet piles: 'Palfroid' in Messempré, France,
- steel tubes (for foundations): Dintelmond, The Netherlands (for EU markets),
- steel bearing piles: Belval and Differdange in Luxembourg.

Additionally, ArcelorMittal Sheet Piling can supply a complete package and accessories, including anchorage material, walers, fabricated piles, coated piles, driving caps, etc.

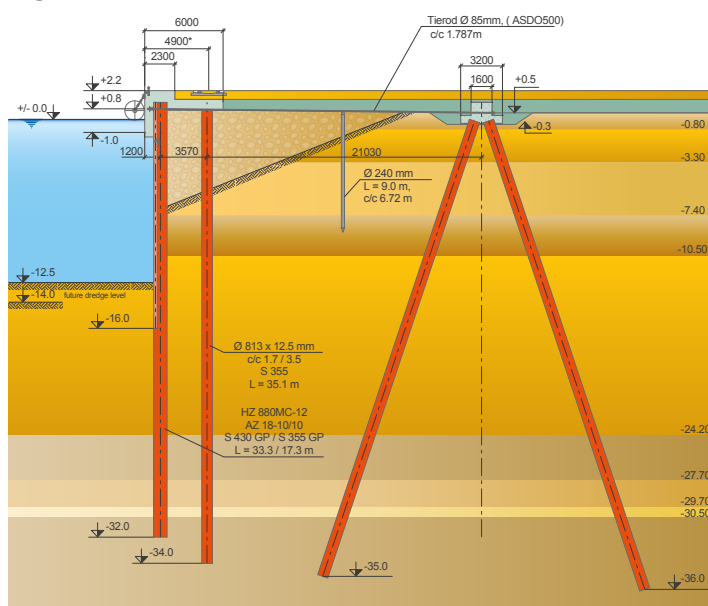
ArcelorMittal Belval is the world's largest rolling mill of hot rolled steel sheet piles and has been playing a leading role in the development of piling technology for over 100 years. The first steel sheet piles were rolled in 1911 and 1912: the 'Ransome' and 'Terre Rouge' piles. Since then the production program of ArcelorMittal's mill in Belval has undergone constant improvement and development to include U-type sections with widths of up to 750 mm (AU) and AZ® sections up to 700 / 770 mm wide (AZ-700, AZ-770). One rolling mill in Belval is dedicated to the sole production of steel sheet piles. ArcelorMittal introduced in the early 1990's the revolutionary, and yet unmatched AZ® profiles.

ArcelorMittal Differdange produces the biggest HZ® sections to form the most competitive HZ/AZ high section modulus combined wall system.

ArcelorMittal Dabrowa manufactures hot rolled U-type sheet piles.

ArcelorMittal's piling series are especially **suitable for building quickly and reliably cost-effective structures**. They are characterised by excellent section properties, for instance a high ratio section modulus to weight, as well as high moments of inertia. Steel sheet piles and foundation products are manufactured according to the European standards, but can also be supplied according to some other international standards (ASTM, ...).

The Technical Department offers comprehensive services throughout the world with customised support to all the parties involved in the design, specification and installation of sheet and bearing piles, e.g. consulting engineers, architects, regional authorities, contractors, academics and students.



Belval steel works, Luxembourg, 1930s



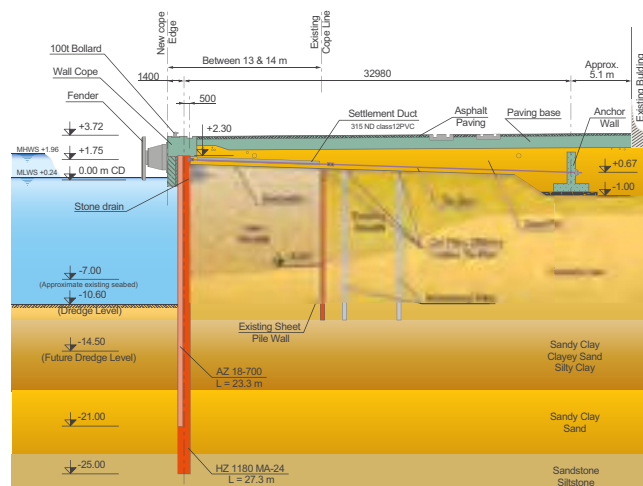
Sheet pile catalogues, 1910s

In-house design team

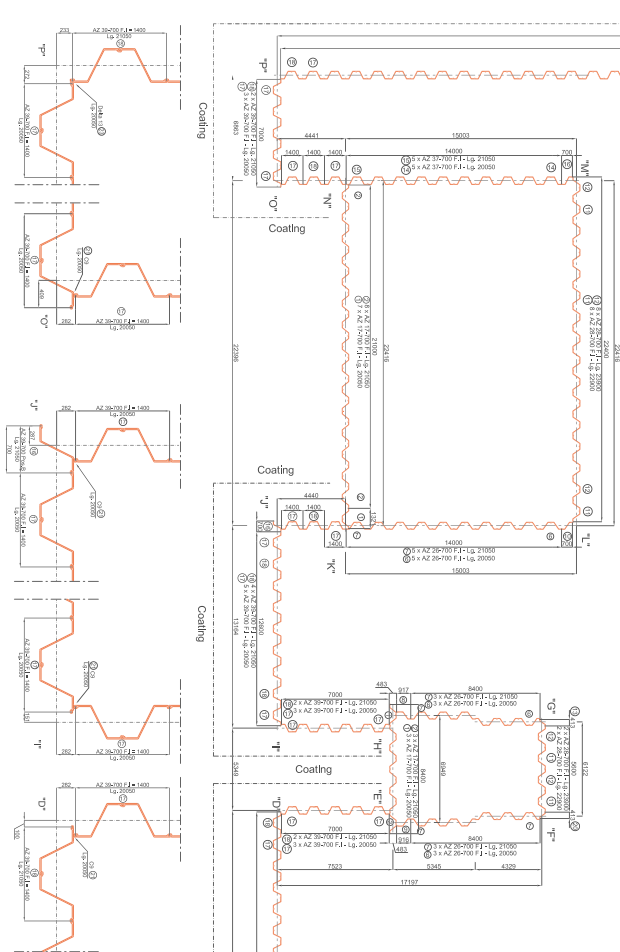
Services provided free of charge by ArcelorMittal's in-house design and support teams are:

- preliminary designs of complete solutions including anchorage systems and lifetime calculations,
- project optimizations offered to end-users to provide the most competitive piling package,
- elaboration of detailed project layouts and supply chains,
- assistance and recommendations on pile installation methods and driving equipment,
- promotion of "green sheet piles", including Life Cycle Assessment.

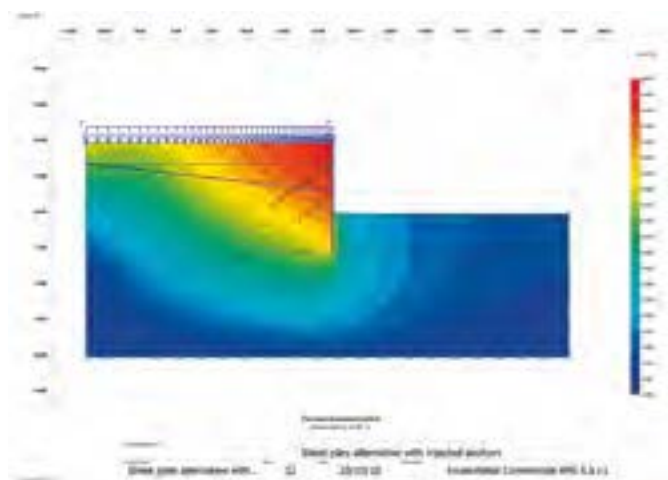
Please note that the legal responsibility for the final structure remains with the owner.



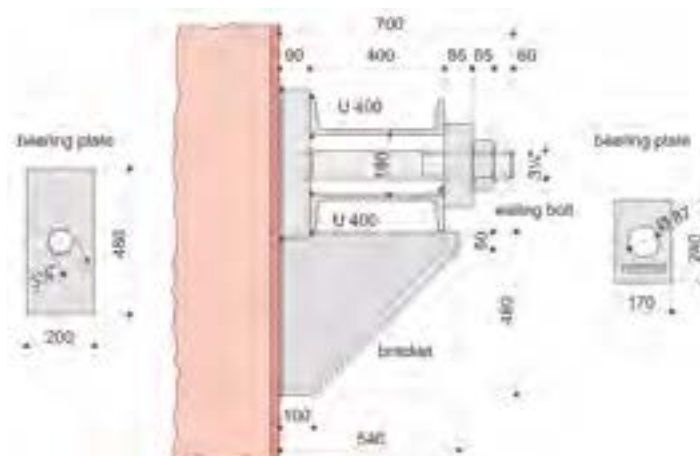
Feasibility studies



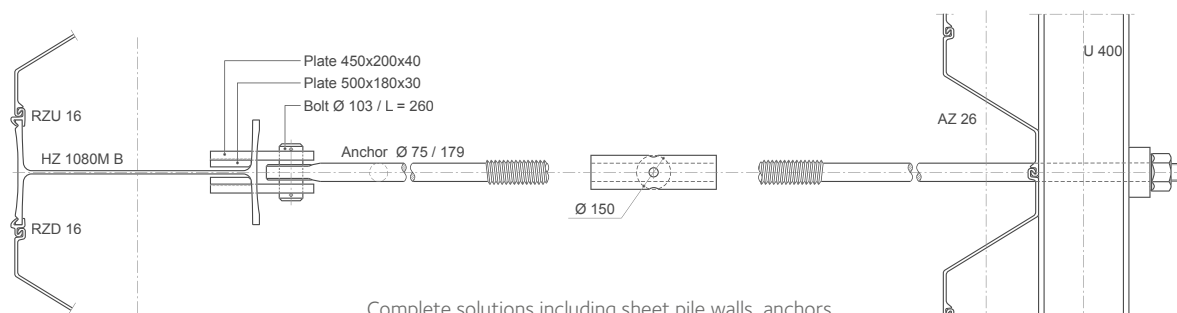
Sheet pile installation drawings



Preliminary designs

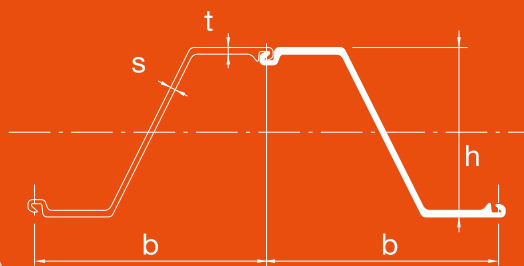


Solutions for execution details



Complete solutions including sheet pile walls, anchors, corner layouts and special piles.

Z-Sections



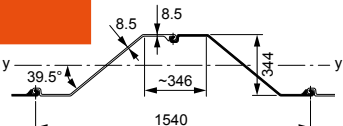
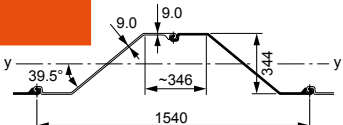
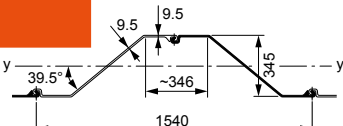
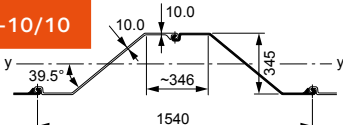
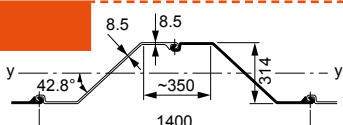
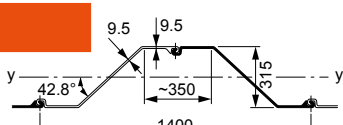
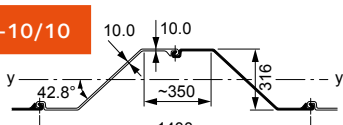
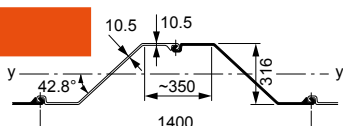
The essential characteristics of Z-sections are the continuous form of the web and the location of the interlock symmetrically on each side of the neutral axis. Both aspects have a positive influence on the section modulus. The AZ® series, a section with extraordinary characteristics and the proven qualities of the Larssen interlock, has the following advantages:

- Extremely competitive section-modulus-to-mass ratio.
- Increased inertia for reduced deflection.
- Large width, resulting in good installation performance.
- Good corrosion resistance, the steel being thickest at the critical corrosion points.

Section	Width	Height	Thickness		Sectional area	Mass		Moment of inertia	Elastic section modulus	Static moment	Plastic section modulus	Class ¹⁾							
			b mm	h mm		t mm	s mm					cm ² /m	single pile kg/m	wall kg/m ²	cm ⁴ /m	cm ³ /m	cm ³ /m	cm ³ /m	S 240 GP
AZ®-700 and AZ®-770																			
AZ 12-770	770	344	8.5	8.5	120	72.6	94	21430	1245	740	1480	2	2	3	3	3	3	3	3
AZ 13-770	770	344	9.0	9.0	126	76.1	99	22360	1300	775	1546	2	2	3	3	3	3	3	3
AZ 14-770	770	345	9.5	9.5	132	79.5	103	23300	1355	805	1611	2	2	2	2	3	3	3	3
AZ 14-770-10/10	770	345	10.0	10.0	137	82.9	108	24240	1405	840	1677	2	2	2	2	2	3	3	3
AZ 12-700	700	314	8.5	8.5	123	67.7	97	18880	1205	710	1415	2	2	3	3	3	3	3	3
AZ 13-700	700	315	9.5	9.5	135	74.0	106	20540	1305	770	1540	2	2	2	3	3	3	3	3
AZ 13-700-10/10	700	316	10.0	10.0	140	77.2	110	21370	1355	800	1600	2	2	2	2	3	3	3	3
AZ 14-700	700	316	10.5	10.5	146	80.3	115	22190	1405	835	1665	2	2	2	2	2	3	3	3
AZ 17-700	700	420	8.5	8.5	133	73.1	104	36230	1730	1015	2027	2	2	3	3	3	3	3	3
AZ 18-700	700	420	9.0	9.0	139	76.5	109	37800	1800	1060	2116	2	2	3	3	3	3	3	3
AZ 19-700	700	421	9.5	9.5	146	80.0	114	39380	1870	1105	2206	2	2	2	3	3	3	3	3
AZ 20-700	700	421	10.0	10.0	152	83.5	119	40960	1945	1150	2296	2	2	2	2	2	3	3	3
AZ 24-700	700	459	11.2	11.2	174	95.7	137	55820	2430	1435	2867	2	2	2	2	2	2	3	3
AZ 26-700	700	460	12.2	12.2	187	102.9	147	59720	2600	1535	3070	2	2	2	2	2	2	2	2
AZ 28-700	700	461	13.2	13.2	200	110.0	157	63620	2760	1635	3273	2	2	2	2	2	2	2	2
AZ 24-700N	700	459	12.5	9.0	163	89.7	128	55890	2435	1405	2810	2	2	2	2	2	2	2	2
AZ 26-700N	700	460	13.5	10.0	176	96.9	138	59790	2600	1510	3015	2	2	2	2	2	2	2	2
AZ 28-700N	700	461	14.5	11.0	189	104.1	149	63700	2765	1610	3220	2	2	2	2	2	2	2	2
AZ 36-700N	700	499	15.0	11.2	216	118.6	169	89610	3590	2055	4110	2	2	2	2	2	2	2	2
AZ 38-700N	700	500	16.0	12.2	230	126.4	181	94840	3795	2180	4360	2	2	2	2	2	2	2	2
AZ 40-700N	700	501	17.0	13.2	244	134.2	192	100080	3995	2305	4605	2	2	2	2	2	2	2	2
AZ 42-700N	700	499	18.0	14.0	259	142.1	203	104930	4205	2425	4855	2	2	2	2	2	2	2	2
AZ 44-700N	700	500	19.0	15.0	273	149.9	214	110150	4405	2550	5105	2	2	2	2	2	2	2	2
AZ 46-700N	700	501	20.0	16.0	287	157.7	225	115370	4605	2675	5350	2	2	2	2	2	2	2	2
AZ®																			
AZ 18 ²⁾	630	380	9.5	9.5	150	74.4	118	34200	1800	1050	2104	2	2	2	3	3	3	3	3
AZ 18-10/10	630	381	10.0	10.0	157	77.8	123	35540	1870	1095	2189	2	2	2	2	3	3	3	3
AZ 26 ²⁾	630	427	13.0	12.2	198	97.8	155	55510	2600	1530	3059	2	2	2	2	2	2	2	2
AZ 46	580	481	18.0	14.0	291	132.6	229	110450	4595	2650	5295	2	2	2	2	2	2	2	2
AZ 48	580	482	19.0	15.0	307	139.6	241	115670	4800	2775	5553	2	2	2	2	2	2	2	2
AZ 50	580	483	20.0	16.0	322	146.7	253	121060	5015	2910	5816	2	2	2	2	2	2	2	2

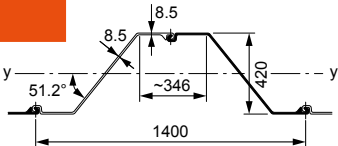
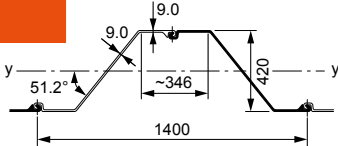
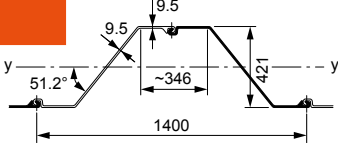
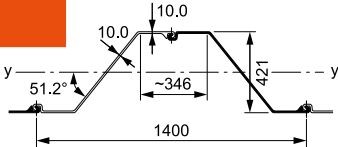
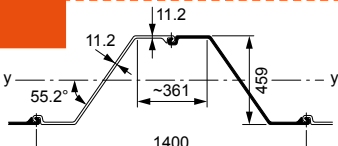
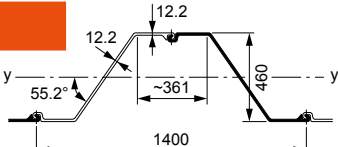
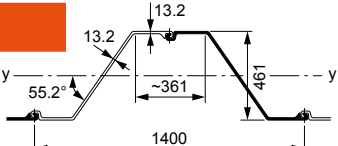
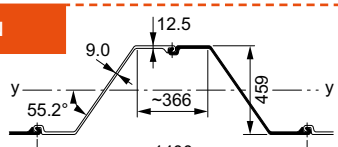
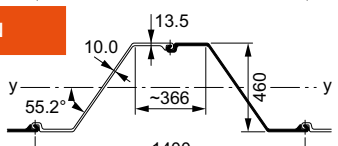
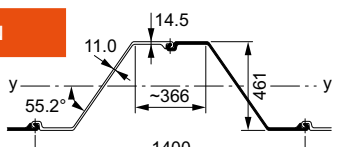
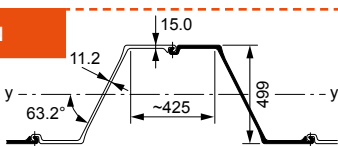
¹⁾ Classification according to EN 1993-5. Class 1 is obtained by verification of the rotation capacity for a class-2 cross-section. A set of tables with all the data required for design in accordance with EN 1993-5 is available from our Technical Department. Steel grade S 460 AP following specifications of the mill is available on request.

²⁾ AZ® sections can be rolled-up or down by 0.5 mm and 1.0 mm on request.

Section		S = Single pile D = Double pile	Sectional area	Mass	Moment of inertia	Elastic section modulus	Radius of gyration	Coating area ¹⁾
			cm ²	kg/m	cm ⁴	cm ³	cm	m ² /m
AZ®-700 and AZ®-770								
AZ 12-770		Per S	92.5	72.6	16500	960	13.36	0.93
		Per D	185.0	145.2	33000	1920	13.36	1.85
		Per m of wall	120.1	94.3	21430	1245	13.36	1.20
AZ 13-770		Per S	96.9	76.1	17220	1000	13.33	0.93
		Per D	193.8	152.1	34440	2000	13.33	1.85
		Per m of wall	125.8	98.8	22360	1300	13.33	1.20
AZ 14-770		Per S	101.3	79.5	17940	1040	13.31	0.93
		Per D	202.6	159.0	35890	2085	13.31	1.85
		Per m of wall	131.5	103.2	23300	1355	13.31	1.20
AZ 14-770-10/10		Per S	105.6	82.9	18670	1085	13.30	0.93
		Per D	211.2	165.8	37330	2165	13.30	1.85
		Per m of wall	137.2	107.7	24240	1405	13.30	1.20
AZ 12-700								
AZ 12-700		Per S	86.2	67.7	13220	840	12.38	0.86
		Per D	172.5	135.4	26440	1685	12.38	1.71
		Per m of wall	123.2	96.7	18880	1205	12.38	1.22
AZ 13-700		Per S	94.3	74.0	14370	910	12.35	0.86
		Per D	188.5	148.0	28750	1825	12.35	1.71
		Per m of wall	134.7	105.7	20540	1305	12.35	1.22
AZ 13-700-10/10		Per S	98.3	77.2	14960	945	12.33	0.86
		Per D	196.6	154.3	29910	1895	12.33	1.71
		Per m of wall	140.4	110.2	21370	1355	12.33	1.22
AZ 14-700		Per S	102.3	80.3	15530	980	12.32	0.86
		Per D	204.6	160.6	31060	1965	12.32	1.71
		Per m of wall	146.1	114.7	22190	1405	12.32	1.22

¹⁾ One side, excluding inside of interlocks.



Section		S = Single pile D = Double pile	Sectional area	Mass	Moment of inertia	Elastic section modulus	Radius of gyration	Coating area ¹⁾
			cm ²	kg/m	cm ⁴	cm ³	cm	m ² /m
AZ 17-700		Per S	93.1	73.1	25360	1210	16.50	0.93
		Per D	186.2	146.2	50720	2420	16.50	1.86
		Per m of wall	133.0	104.4	36230	1730	16.50	1.33
AZ 18-700		Per S	97.5	76.5	26460	1260	16.47	0.93
		Per D	194.9	153.0	52920	2520	16.47	1.86
		Per m of wall	139.2	109.3	37800	1800	16.47	1.33
AZ 19-700		Per S	101.9	80.0	27560	1310	16.44	0.93
		Per D	203.8	160.0	55130	2620	16.44	1.86
		Per m of wall	145.6	114.3	39380	1870	16.44	1.33
AZ 20-700		Per S	106.4	83.5	28670	1360	16.42	0.93
		Per D	212.8	167.0	57340	2725	16.42	1.86
		Per m of wall	152.0	119.3	40960	1945	16.42	1.33
AZ 24-700		Per S	121.9	95.7	39080	1700	17.90	0.97
		Per D	243.8	191.4	78150	3405	17.90	1.93
		Per m of wall	174.1	136.7	55820	2430	17.90	1.38
AZ 26-700		Per S	131.0	102.9	41800	1815	17.86	0.97
		Per D	262.1	205.7	83610	3635	17.86	1.93
		Per m of wall	187.2	146.9	59720	2600	17.86	1.38
AZ 28-700		Per S	140.2	110.0	44530	1930	17.83	0.97
		Per D	280.3	220.1	89070	3865	17.83	1.93
		Per m of wall	200.2	157.2	63620	2760	17.83	1.38
AZ 24-700N		Per S	114.3	89.7	39120	1705	18.50	0.96
		Per D	228.6	179.5	78240	3410	18.50	1.92
		Per m of wall	163.3	128.2	55890	2435	18.50	1.37
AZ 26-700N		Per S	123.5	96.9	41850	1820	18.41	0.96
		Per D	247.0	193.9	83710	3640	18.41	1.92
		Per m of wall	176.4	138.5	59790	2600	18.41	1.37
AZ 28-700N		Per S	132.6	104.1	44590	1935	18.33	0.96
		Per D	265.3	208.2	89170	3870	18.33	1.92
		Per m of wall	189.5	148.7	63700	2765	18.33	1.37
AZ 36-700N		Per S	151.1	118.6	62730	2510	20.37	1.03
		Per D	302.2	237.3	125450	5030	20.37	2.05
		Per m of wall	215.9	169.5	89610	3590	20.37	1.47

¹⁾ One side, excluding inside of interlocks.

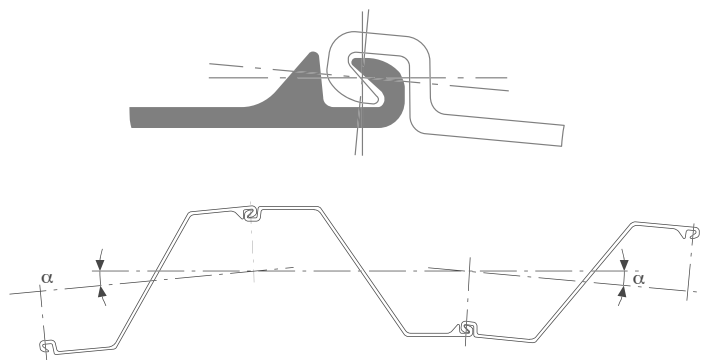
Section		S = Single pile D = Double pile	Sectional area cm ²	Mass kg/m	Moment of inertia cm ⁴	Elastic section modulus cm ³	Radius of gyration cm	Coating area ¹⁾ m ² /m
AZ 38-700N		Per S Per D Per m of wall	161.0 322.0 230.0	126.4 252.8 180.6	66390 132780 94840	2655 5310 3795	20.31 20.31 20.31	1.03 2.05 1.47
AZ 40-700N		Per S Per D Per m of wall	170.9 341.9 244.2	134.2 268.4 191.7	70060 140110 100080	2795 5595 3995	20.25 20.25 20.25	1.03 2.05 1.47
AZ 42-700N		Per S Per D Per m of wall	181.1 362.1 258.7	142.1 284.3 203.1	73450 146900 104930	2945 5890 4205	20.14 20.14 20.14	1.03 2.06 1.47
AZ 44-700N		Per S Per D Per m of wall	191.0 382.0 272.8	149.9 299.8 214.2	77100 154210 110150	3085 6170 4405	20.09 20.09 20.09	1.03 2.06 1.47
AZ 46-700N		Per S Per D Per m of wall	200.9 401.8 287.0	157.7 315.4 225.3	80760 161520 115370	3220 6450 4605	20.05 20.05 20.05	1.03 2.06 1.47
AZ[®]								
AZ 18		Per S Per D Per m of wall	94.8 189.6 150.4	74.4 148.8 118.1	21540 43080 34200	1135 2270 1800	15.07 15.07 15.07	0.86 1.71 1.35
AZ 18-10/10		Per S Per D Per m of wall	99.1 198.1 157.2	77.8 155.5 123.4	22390 44790 35540	1175 2355 1870	15.04 15.04 15.04	0.86 1.71 1.35
AZ 26		Per S Per D Per m of wall	124.6 249.2 197.8	97.8 195.6 155.2	34970 69940 55510	1640 3280 2600	16.75 16.75 16.75	0.90 1.78 1.41
AZ 46		Per S Per D Per m of wall	168.9 337.8 291.2	132.6 265.2 228.6	64060 128120 110450	2665 5330 4595	19.48 19.48 19.48	0.95 1.89 1.63
AZ 48		Per S Per D Per m of wall	177.8 355.6 306.5	139.6 279.2 240.6	67090 134180 115670	2785 5570 4800	19.43 19.43 19.43	0.95 1.89 1.63
AZ 50		Per S Per D Per m of wall	186.9 373.8 322.2	146.7 293.4 252.9	70215 140430 121060	2910 5815 5015	19.38 19.38 19.38	0.95 1.89 1.63

¹⁾ One side, excluding inside of interlocks.

Interlock



AZ® Larssen interlock in accordance with EN 10248.
All available AZ sheet piles can be interlocked.
Theoretical interlock swing: $\alpha_{\max} = 5^\circ$.



Delivery form

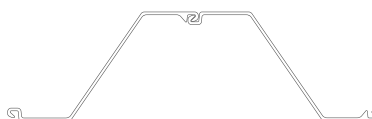
Single Pile
Position A



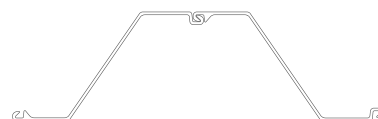
Single Pile
Position B



Double Pile
Form I standard

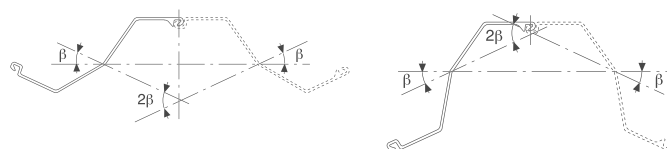


Double Pile
Form II on request



Bent piles

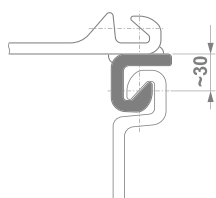
Maximum bending angle: $\beta = 25^\circ$. Z-piles are bent in the middle of the web. They are generally delivered as single piles. Double piles are available upon request.



Corner sections

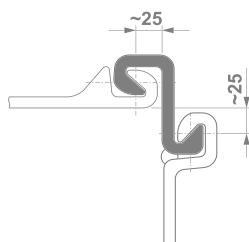
C 9

Mass ~ 9.3 kg/m



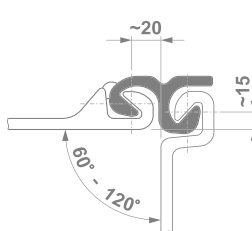
C 14

Mass ~ 14.4 kg/m



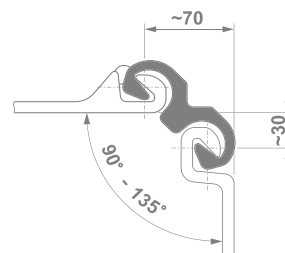
DELTA 13

Mass ~ 13.1 kg/m



OMEGA 18

Mass ~ 18.0 kg/m

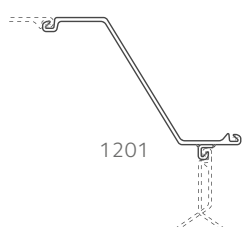


Special corner sections interlocking with Z-sections make it possible to form corner or junction piles without using fabricated special piles. Corner sections are fixed to the sheet pile in accordance with EN 12063.

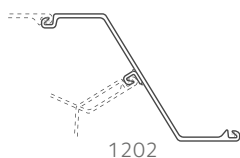
Different welding specifications are available on request. The corner sections are threaded and welded with a 200 mm setback from the top of the piles.

Corner and junction piles

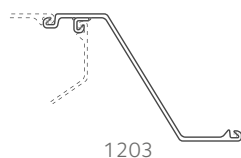
The following special piles, among others, are available as single and double piles on request.



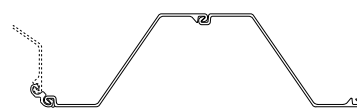
1201



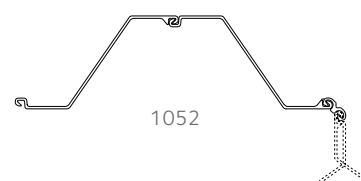
1202



1203



1051



1052

Crimping

Threaded AZ® double piles are recommended for facilitating the installation process. AZ double piles are not crimped for statical reasons. However, due to customer demand, most of our AZ piles are crimped according to our standard specification, for the following reasons:

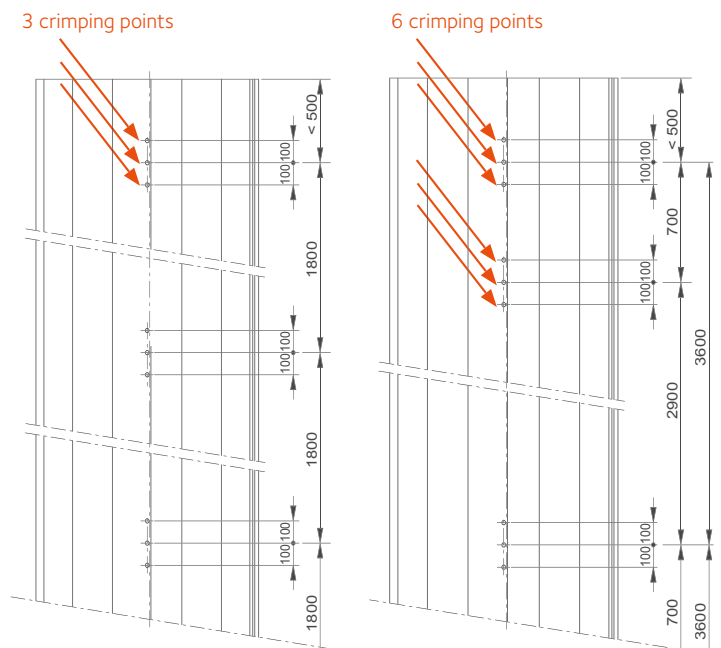
- Single piles easily bend around the weak axis under driving.
- Faster installation progress with double piles.



¹⁾ Amount and layout of crimping points may differ at both ends.
Special crimping on request.

Pile length < 6 m:
3 crimping points per 1.8 m
= 1.7 crimping points per m¹⁾

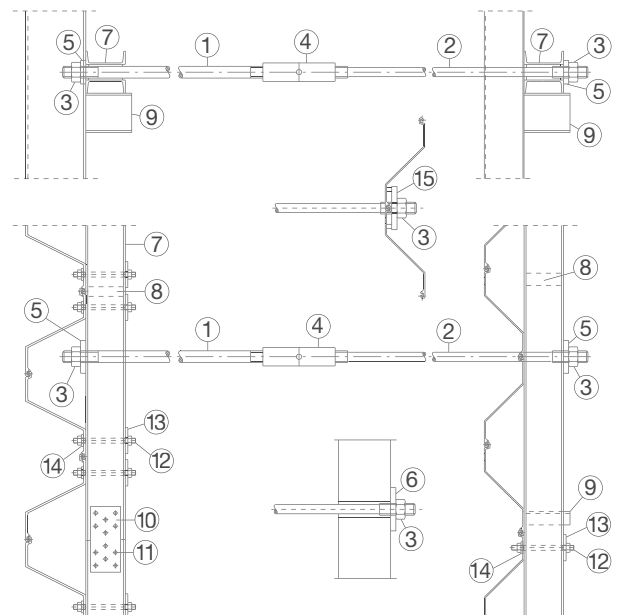
Pile length ≥ 6 m:
6 crimping points per 3.6 m
= 1.7 crimping points per m¹⁾



Tie back system

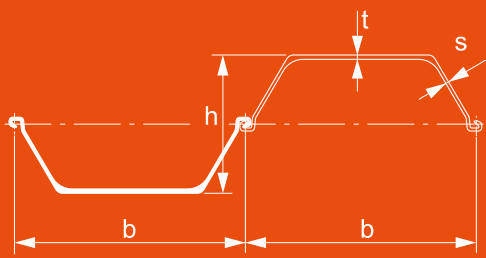
Most sheet pile retaining walls need supplementary support at the top, in addition to embedment in the soil. Temporary cofferdams generally use waler and strut bracing inside the excavation. Permanent or large retaining walls are often tied back to an anchor wall installed a certain distance behind the main wall. Other anchor systems, like injection anchors or anchor piles, can also be used. The drawing shows a typical horizontal tie-rod connection for sheet pile walls. The following components can be seen:

- | | |
|-----------------------------|----------------------|
| 1 Plain tie-rod | 7 Waling |
| 2 Upset end tie-rod | 8 Spacer |
| 3 Nut | 9 Supporting bracket |
| 4 Turnbuckle | 10 Splicing plate |
| 5 Bearing plate | 11 Splicing bolt |
| 6 Bearing plate on concrete | 12 Fixing bolt |
| | 13 Fixing plate |
| | 14 |
| | 15 |



U-Sections

New
GU 7HWS, GU 28N, GU 32N



The advantages of U-sections are multiple:

- A wide range of sections forming several series with various geometrical characteristics, allowing a technically and economically optimum choice for each specific project.
- Combination of great profile depth with large flange thickness giving excellent statical properties.
- The symmetrical form of the single element has made these sheet piles particularly convenient for re-use.
- The possibility of assembling and crimping the piles into pairs at the mill improves installation quality and performance.
- Easy fixing of tie-rods and swivelling attachments, even under water.
- Good corrosion resistance, the steel being thickest at the critical corrosion points.

Section	Width	Height	Thickness		Sectional area	Mass		Moment of inertia	Elastic section modulus	Static moment	Plastic section modulus	Class ¹⁾								
			b mm	h mm		t mm	s mm					cm ² /m	single pile kg/m	wall kg/m ²	cm ⁴ /m	cm ³ /m	cm ³ /m	cm ³ /m	S 240 GP	S 270 GP
AU™ sections																				
AU 14	750	408	10.0	8.3	132	77.9	104	28680	1405	820	1663	2	2	3	3	3	3	3	3	3
AU 16	750	411	11.5	9.3	147	86.3	115	32850	1600	935	1891	2	2	2	2	2	3	3	3	3
AU 18	750	441	10.5	9.1	150	88.5	118	39300	1780	1030	2082	2	3	3	3	3	3	3	3	3
AU 20	750	444	12.0	10.0	165	96.9	129	44440	2000	1155	2339	2	2	2	3	3	3	3	3	3
AU 23	750	447	13.0	9.5	173	102.1	136	50700	2270	1285	2600	2	2	2	3	3	3	3	3	3
AU 25	750	450	14.5	10.2	188	110.4	147	56240	2500	1420	2866	2	2	2	2	2	3	3	3	3
PU® sections																				
PU 12	600	360	9.8	9.0	140	66.1	110	21600	1200	715	1457	2	2	2	2	2	2	2	3	3
PU 12-10/10	600	360	10.0	10.0	148	69.6	116	22580	1255	755	1535	2	2	2	2	2	2	2	2	2
PU 18 ⁻¹	600	430	10.2	8.4	154	72.6	121	35950	1670	980	1988	2	2	2	2	2	3	3	3	3
PU 18	600	430	11.2	9.0	163	76.9	128	38650	1800	1055	2134	2	2	2	2	2	2	2	2	2
PU 18 ⁺¹	600	430	12.2	9.5	172	81.1	135	41320	1920	1125	2280	2	2	2	2	2	2	2	2	2
PU 22 ⁻¹	600	450	11.1	9.0	174	81.9	137	46380	2060	1195	2422	2	2	2	2	2	3	3	3	3
PU 22	600	450	12.1	9.5	183	86.1	144	49460	2200	1275	2580	2	2	2	2	2	2	2	2	2
PU 22 ⁺¹	600	450	13.1	10.0	192	90.4	151	52510	2335	1355	2735	2	2	2	2	2	2	2	2	2
PU 28 ⁻¹	600	452	14.2	9.7	207	97.4	162	60580	2680	1525	3087	2	2	2	2	2	2	2	2	2
PU 28	600	454	15.2	10.1	216	101.8	170	64460	2840	1620	3269	2	2	2	2	2	2	2	2	2
PU 28 ⁺¹	600	456	16.2	10.5	226	106.2	177	68380	3000	1710	3450	2	2	2	2	2	2	2	2	2
PU 32 ⁻¹	600	452	18.5	10.6	233	109.9	183	69210	3065	1745	3525	2	2	2	2	2	2	2	2	2
PU 32	600	452	19.5	11.0	242	114.1	190	72320	3200	1825	3687	2	2	2	2	2	2	2	2	2
PU 32 ⁺¹	600	452	20.5	11.4	251	118.4	197	75410	3340	1905	3845	2	2	2	2	2	2	2	2	2
GU® sections																				
GU 6N	600	309	6.0	6.0	89	41.9	70	9670	625	375	765	3	3	3	4	4	4	4	4	4
GU 7N	600	310	6.5	6.4	94	44.1	74	10450	675	400	825	3	3	3	3	3	4	4	4	4
GU 7S	600	311	7.2	6.9	100	46.3	77	11540	740	440	900	2	2	3	3	3	3	3	3	3
GU 7HWS	600	312	7.3	6.9	101	47.4	79	11620	745	445	910	2	2	3	3	3	3	3	3	3
GU 8N	600	312	7.5	7.1	103	48.5	81	12010	770	460	935	2	2	3	3	3	3	3	3	3
GU 8S	600	313	8.0	7.5	108	50.8	85	12800	820	490	995	2	2	2	3	3	3	3	3	3

Section	Width	Height	Thickness		Sectional area	Mass		Moment of inertia	Elastic section modulus	Static moment	Plastic section modulus	Class ¹⁾							
			b mm	h mm		t mm	s mm					cm ² /m	single pile kg/m	wall kg/m ²	cm ⁴ /m	cm ³ /m	cm ³ /m	cm ³ /m	S 240 GP
GU® sections																			
GU 13N	600	418	9.0	7.4	127	59.9	100	26590	1270	755	1535	2	2	2	2	2	3	3	
GU 14N	600	420	10.0	8.0	136	64.3	107	29410	1400	830	1685	2	2	2	2	2	2	2	
GU 15N	600	422	11.0	8.6	146	68.7	115	32260	1530	910	1840	2	2	2	2	2	2	2	
GU 16N	600	430	10.2	8.4	154	72.6	121	35950	1670	980	1988	2	2	2	2	2	3	3	
GU 18N	600	430	11.2	9.0	163	76.9	128	38650	1800	1055	2134	2	2	2	2	2	2	2	
GU 20N	600	430	12.2	9.5	172	81.1	135	41320	1920	1125	2280	2	2	2	2	2	2	2	
GU 21N	600	450	11.1	9.0	174	81.9	137	46380	2060	1195	2422	2	2	2	2	2	3	3	
GU 22N	600	450	12.1	9.5	183	86.1	144	49460	2200	1275	2580	2	2	2	2	2	2	2	
GU 23N	600	450	13.1	10.0	192	90.4	151	52510	2335	1355	2735	2	2	2	2	2	2	2	
GU 27N	600	452	14.2	9.7	207	97.4	162	60580	2680	1525	3087	2	2	2	2	2	2	2	
GU 28N	600	454	15.2	10.1	216	101.8	170	64460	2840	1620	3269	2	2	2	2	2	2	2	
GU 30N	600	456	16.2	10.5	226	106.2	177	68380	3000	1710	3450	2	2	2	2	2	2	2	
GU 31N	600	452	18.5	10.6	233	109.9	183	69210	3065	1745	3525	2	2	2	2	2	2	2	
GU 32N	600	452	19.5	11.0	242	114.1	190	72320	3200	1825	3687	2	2	2	2	2	2	2	
GU 33N	600	452	20.5	11.4	251	118.4	197	75410	3340	1905	3845	2	2	2	2	2	2	2	
GU 16-400	400	290	12.7	9.4	197	62.0	155	22580	1560	885	1815	2	2	2	2	2	2	—	
GU 18-400	400	292	15.0	9.7	221	69.3	173	26090	1785	1015	2080	2	2	2	2	2	2	—	

The moment of inertia and section moduli values given assume correct shear transfer across the interlock.

¹⁾ Classification according to EN 1993-5.

Class 1 is obtained by verification of the rotation capacity for a class 2 cross-section.

A set of tables with all the data required for design in accordance with EN 1993-5 is available from our Technical Department.

All PU® sections can be rolled-up or -down by 0.5 mm and 1.0 mm. Other sections on request.

Characteristics – AU™ sections

A weight reduction of about 10% compared to the 600 mm PU series has been achieved by optimising the geometric dimensions. The increased width **allows faster installation**, reduces the amount of coating required, due to the smaller perimeter, and increases watertightness thanks to fewer interlocks per metre of wall. Despite their greater width, the driving energy required for AU piles is no higher, thanks to their smooth and open shape and the patented radii at the web/flange connection.

Characteristics – PU® sections

PU sections are 600 mm wide U-piles manufactured in Belval. The shape of the **PU 18**, **PU 22** and **PU 28** has been engineered with 'reinforced shoulders' yielding the optimum section geometry **for hard driving conditions** as well as for **multiple re-use**. Re-using steel sheet piles improves drastically the environmental impact of a steel solution.

Characteristics – GU® sections

ArcelorMittal's rolling mill in Dabrowa, Poland, produces hot rolled U-shaped steel sheet piles. The rolling mill added during the last years new sections to their portfolio: GU 7N, GU 14N, GU 18N, and in 2014 the **GU 28N** and **GU 32N** range.

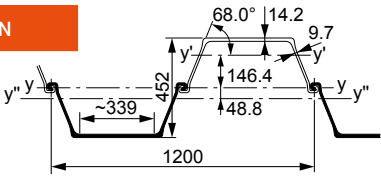
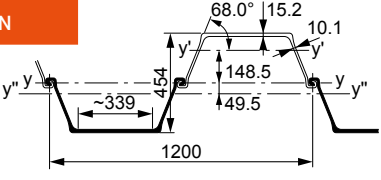
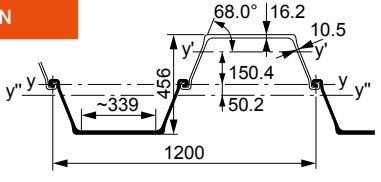
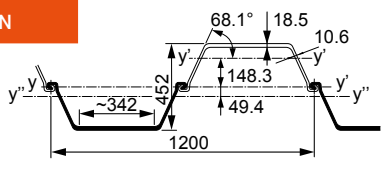
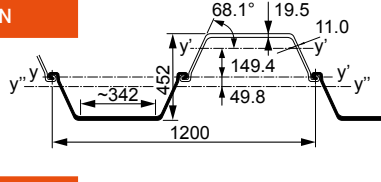
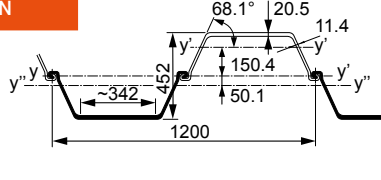
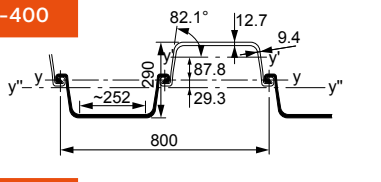
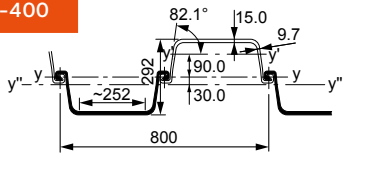
¹⁾ One side, excluding inside of interlocks.

Section		S = Single pile D = Double pile T = Triple pile	Sectional area	Mass	Moment of inertia	Elastic section modulus	Radius of gyration	Coating area ¹⁾
			cm ²	kg/m	cm ⁴	cm ³	cm	m ² /m
PU® sections								
PU 18⁻¹		Per S	92.5	72.6	6960	475	8.67	0.87
		Per D	185.0	145.2	43140	2005	15.30	1.72
		Per T	277.5	217.8	59840	2330	14.69	2.58
		Per m of wall	154.2	121.0	35950	1670	15.30	1.43
PU 18		Per S	98.0	76.9	7220	485	8.58	0.87
		Per D	196.0	153.8	46380	2160	15.38	1.72
		Per T	294.0	230.7	64240	2495	14.78	2.58
		Per m of wall	163.3	128.2	38650	1800	15.38	1.43
PU 18⁺¹		Per S	103.4	81.1	7480	495	8.51	0.87
		Per D	206.8	162.3	49580	2305	15.49	1.72
		Per T	310.2	243.5	68600	2655	14.87	2.58
		Per m of wall	172.3	135.2	41320	1920	15.49	1.43
PU 22⁻¹		Per S	104.3	81.9	8460	535	9.01	0.90
		Per D	208.7	163.8	55650	2475	16.33	1.79
		Per T	313.0	245.7	77020	2850	15.69	2.68
		Per m of wall	173.9	136.5	46380	2060	16.33	1.49
PU 22		Per S	109.7	86.1	8740	546	8.93	0.90
		Per D	219.5	172.3	59360	2640	16.45	1.79
		Per T	329.2	258.4	82060	3025	15.79	2.68
		Per m of wall	182.9	143.6	49460	2200	16.45	1.49
PU 22⁺¹		Per S	115.2	90.4	9020	555	8.85	0.90
		Per D	230.4	180.9	63010	2800	16.54	1.79
		Per T	345.6	271.3	87020	3205	15.87	2.68
		Per m of wall	192.0	150.7	52510	2335	16.54	1.49
PU 28⁻¹		Per S	124.1	97.4	9740	576	8.86	0.93
		Per D	248.2	194.8	72700	3215	17.12	1.85
		Per T	372.3	292.2	100170	3645	16.40	2.77
		Per m of wall	206.8	162.3	60580	2680	17.12	1.54
PU 28		Per S	129.7	101.8	10070	589	8.81	0.93
		Per D	259.4	203.6	77350	3405	17.27	1.85
		Per T	389.0	305.4	106490	3850	16.55	2.77
		Per m of wall	216.1	169.6	64460	2840	17.27	1.54
PU 28⁺¹		Per S	135.3	106.2	10400	600	8.77	0.93
		Per D	270.7	212.5	82060	3600	17.41	1.85
		Per T	406.0	318.7	112870	4060	16.67	2.77
		Per m of wall	225.6	177.1	68380	3000	17.41	1.54

¹⁾ One side, excluding inside of interlocks.

Section	S = Single pile D = Double pile T = Triple pile	Sectional area	Mass	Moment of inertia	Elastic section modulus	Radius of gyration	Coating area ¹⁾
		cm ²	kg/m	cm ⁴	cm ³	cm	m ² /m
PU® sections							
PU 32⁻¹ 	Per S	140.0	109.9	10740	625	8.76	0.92
	Per D	280.0	219.8	83050	3675	17.22	1.83
	Per T	420.0	329.7	114310	4150	16.50	2.74
	Per m of wall	233.3	183.2	69210	3065	17.22	1.52
PU 32 	Per S	145.4	114.1	10950	633	8.68	0.92
	Per D	290.8	228.3	86790	3840	17.28	1.83
	Per T	436.2	342.4	119370	4330	16.54	2.74
	Per m of wall	242.3	190.2	72320	3200	17.28	1.52
PU 32⁺¹ 	Per S	150.8	118.4	11150	640	8.60	0.92
	Per D	301.6	236.8	90490	4005	17.32	1.83
	Per T	452.4	355.2	124370	4505	16.58	2.74
	Per m of wall	251.3	197.3	75410	3340	17.32	1.52
GU® sections							
GU 6N 	Per S	53.4	41.9	2160	215	6.36	0.76
	Per D	106.8	83.8	11610	750	10.43	1.51
	Per T	160.2	125.7	16200	890	10.06	2.26
	Per m of wall	89.0	69.9	9670	625	10.43	1.26
GU 7N 	Per S	56.2	44.1	2250	220	6.33	0.76
	Per D	112.4	88.2	12540	810	10.56	1.51
	Per T	168.6	132.4	17470	955	10.18	2.26
	Per m of wall	93.7	73.5	10450	675	10.56	1.26
GU 7S 	Per S	60.2	46.3	2370	225	6.28	0.76
	Per D	120.3	92.5	13850	890	10.73	1.51
	Per T	180.5	138.8	19260	1045	10.33	2.26
	Per m of wall	100.3	77.1	11540	740	10.73	1.26
GU 7HWS 	Per S	60.4	47.4	2380	225	6.28	0.76
	Per D	120.9	94.9	13940	895	10.74	1.51
	Per T	181.3	142.3	19390	1050	10.34	2.26
	Per m of wall	100.7	79.1	11620	745	10.74	1.26
GU 8N 	Per S	61.8	48.5	2420	225	6.26	0.76
	Per D	123.7	97.1	14420	925	10.80	1.51
	Per T	185.5	145.6	20030	1080	10.39	2.26
	Per m of wall	103.1	80.9	12010	770	10.80	1.26
GU 8S 	Per S	64.7	50.8	2510	230	6.23	0.76
	Per D	129.3	101.5	15360	980	10.90	1.51
	Per T	194.0	152.3	21320	1145	10.48	2.26
	Per m of wall	107.8	84.6	12800	820	10.90	1.26

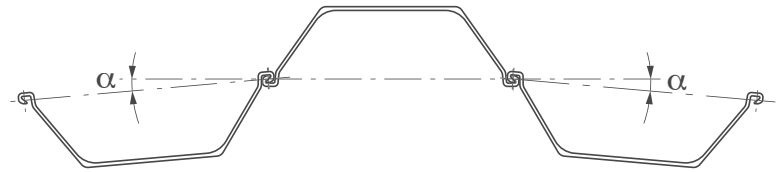
¹⁾ One side, excluding inside of interlocks.

Section	S = Single pile D = Double pile T = Triple pile	Sectional area	Mass	Moment of inertia	Elastic section modulus	Radius of gyration	Coating area ¹⁾
		cm ²	kg/m	cm ⁴	cm ³	cm	m ² /m
GU® sections							
GU 27N 	Per S	124.1	97.4	9740	576	8.86	0.93
	Per D	248.2	194.8	72700	3215	17.12	1.85
	Per T	372.3	292.2	100170	3645	16.40	2.77
	Per m of wall	206.8	162.3	60580	2680	17.12	1.54
GU 28N 	Per S	129.7	101.8	10070	589	8.81	0.93
	Per D	259.4	203.6	77350	3405	17.27	1.85
	Per T	389.0	305.4	106490	3850	16.55	2.77
	Per m of wall	216.1	169.6	64460	2840	17.27	1.54
GU 30N 	Per S	135.3	106.2	10400	600	8.77	0.93
	Per D	270.7	212.5	82060	3600	17.41	1.85
	Per T	406.0	318.7	112870	4060	16.67	2.77
	Per m of wall	225.6	177.1	68380	3000	17.41	1.54
GU 31N 	Per S	140.0	109.9	10740	625	8.76	0.92
	Per D	280.0	219.8	83050	3675	17.22	1.83
	Per T	420.0	329.7	114310	4150	16.50	2.74
	Per m of wall	233.3	183.2	69210	3065	17.22	1.52
GU 32N 	Per S	145.4	114.1	10950	633	8.68	0.92
	Per D	290.8	228.3	86790	3840	17.28	1.83
	Per T	436.2	342.4	119370	4330	16.54	2.74
	Per m of wall	242.3	190.2	72320	3200	17.28	1.52
GU 33N 	Per S	150.8	118.4	11150	640	8.60	0.92
	Per D	301.6	236.8	90490	4005	17.32	1.83
	Per T	452.4	355.2	124370	4505	16.58	2.74
	Per m of wall	251.3	197.3	75410	3340	17.32	1.52
GU 16-400 	Per S	78.9	62.0	2950	265	6.11	0.65
	Per D	157.9	123.9	18060	1245	10.70	1.28
	Per T	236.8	185.9	25060	1440	10.29	1.92
	Per m of wall	197.3	154.9	22580	1560	10.70	1.60
GU 18-400 	Per S	88.3	69.3	3290	290	6.10	0.65
	Per D	176.7	138.7	20870	1430	10.87	1.28
	Per T	265.0	208.0	28920	1645	10.45	1.92
	Per m of wall	220.8	173.3	26090	1785	10.87	1.60

Interlock

All AU™, PU® and GU® sheet piles feature Larssen interlocks in accordance with EN 10248. AU, PU and GU-N (exception: GU-400 range) sheet piles can be interlocked with each other.

Theoretical interlock swing: $\alpha_{\max} = 5^\circ$



Delivery form

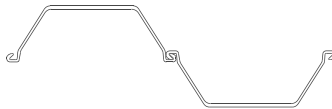
Single Pile



Double Pile
Standard S-Form



Double Pile
Z-Form on request

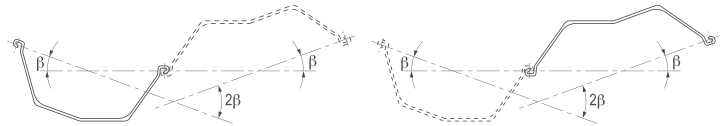


Triple Pile



Bent piles

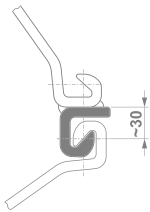
Maximum bending angle: $\beta = 25^\circ$. U-piles are bent in the middle of the flange. They are generally delivered as single piles. Double piles are available upon request.



Corner sections

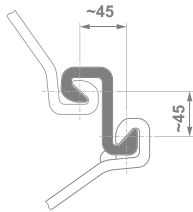
C 9

Mass ~ 9.3 kg/m



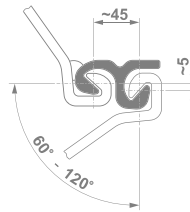
C 14

Mass ~ 14.4 kg/m



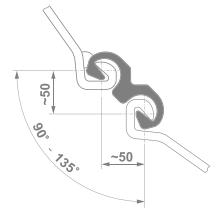
DELTA 13

Mass ~ 13.1 kg/m



OMEGA 18

Mass ~ 18.0 kg/m



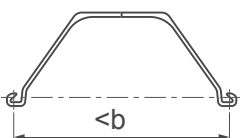
Special corner sections interlocking with U-sections make it possible to form corner or junction piles without using fabricated special piles. Corner sections are fixed to the sheet pile in accordance with EN 12063.

Different welding specifications are available on request. The corner sections are threaded and welded with a 200 mm setback from the top of the piles.

Fabricated piles, corner and junction piles

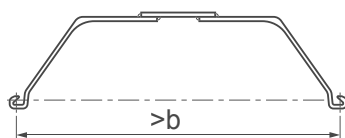
On request, arrangements can be made for widened or narrowed fabricated piles. The following special piles, among others, are available on request as single and double piles.

Narrowed pile



2501

Widened pile

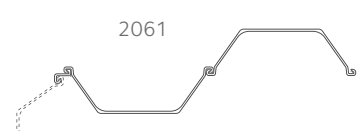


2511

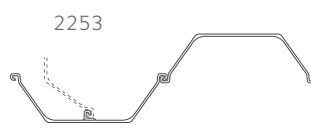
2251



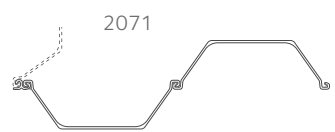
2061



2253



2071



2257



2151



Crimping

Contrary to Z-piles, the interlocks of U-piles have to transmit shear forces. To guarantee proper shear force transmission, the interlocks of ArcelorMittal's U-sections can be delivered as crimped double piles. See sketch for ArcelorMittal's standard crimping pattern. The allowable shear force per crimping point depends on the section and steel grade. A resistance per crimp of minimum 75 kN at a displacement of up to 5 mm can be achieved for most sections. The theoretical section properties of a continuous wall may have to be reduced even for double piles crimped²⁾.



¹⁾ Amount and layout of crimping points may differ at both ends. Special crimping on request.

²⁾ based on EN1993-5. Please consult our Technical Department for more information.

AU standard crimping:

3 crimping points per 0.75 m

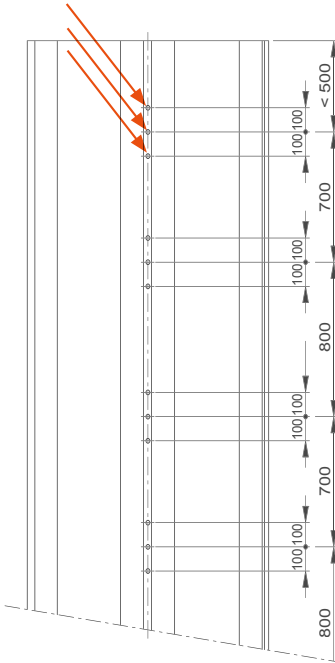
= 4 crimping points per m¹⁾

PU/GU standard crimping:

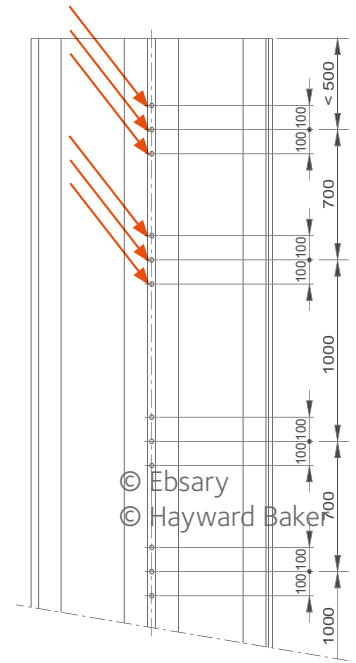
6 crimping points per 1.7 m

= 3.5 crimping points per m¹⁾

3 crimping points

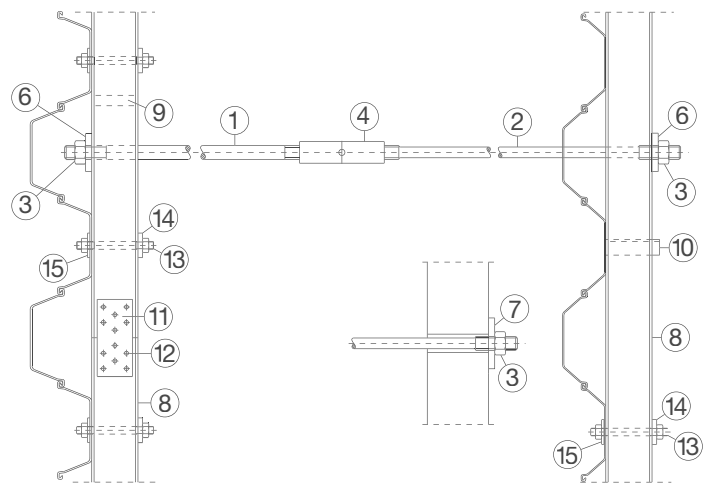
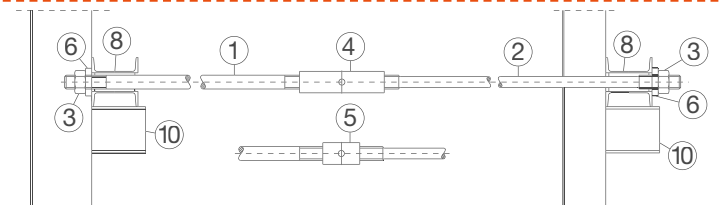


6 crimping points



Tie back system

Most sheet pile retaining walls need supplementary support at the top, in addition to embedment in the soil. Temporary cofferdams generally use walers and struts for cross-bracing inside the excavation. Permanent or large retaining walls are often tied back to an anchor wall installed a certain distance behind the main wall. Injection anchors and anchor piles can also be used. The drawing shows a typical horizontal tie-rod connection for U-section sheet pile walls.



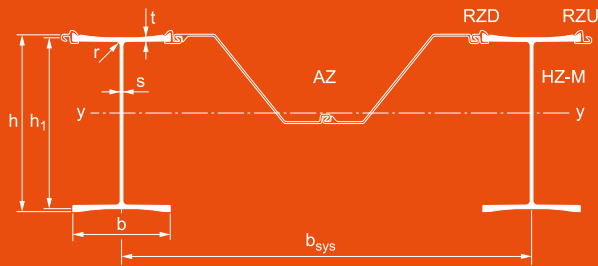
- 1 Plain tie-rod
- 2 Upset end tie-rod
- 3 Nut
- 4 Turnbuckle
- 5 Coupling sleeve
- 6 Bearing plate

- 7 Bearing plate on concrete
- 8 Waling
- 9 Spacer
- 10 Supporting bracket
- 11 Splicing plate

- 12 Splicing bolt
- 13 Fixing bolt
- 14 Fixing plate
- 15 Fixing plate



HZ® / AZ® combined wall system



The revolutionary HZ®-M wall is an extremely economical combined wall system launched in 2008 to replace the former HZ/AZ system, and consists of:

- HZ®-M king piles.
- A pair of AZ® sheet piles as intermediary elements.
- Special connectors (RH, RZD, RZU).

The HZ-M king piles, with milled grooves on the flanges and thicknesses up to 40 mm, fulfill two different structural functions:

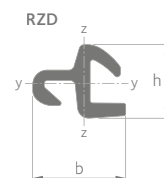
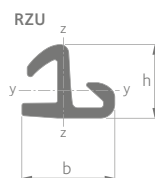
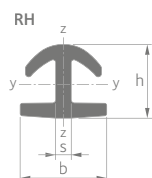
- Retaining members for soil and hydrostatic pressures.
- Bearing piles for vertical loads.

The combinations are based on the same principle: structural supports comprising 1 or 2 HZ-M king pile sections alternating with or without intermediary double AZ sheet pile sections. The intermediary sheet piles have a soil-retaining and load-transferring function and are generally shorter than the HZ-M king piles. Depending on the combinations and steel grades adopted, the achievable bending moment capacity lies above 21 000 kNm/m (W_x up to 46 500 cm³/m).

Section (Sol. 102)	Dimensions							Sectional area	Mass	Moment of inertia	Elastic section modulus	Coating area	Connectors
	h	h ₁	b	t _{max}	t	s	r						
	mm	mm	mm	mm	mm	mm	mm	cm ²	kg/m	y-y cm ⁴	y-y cm ³	m ² /m	
HZ 680M LT	631.8	599.9	460	29.0	16.9	14.0	20	257.8	202.4	177370	5840	3.05	A
HZ 880M A	831.3	803.4	458	29.0	18.9	13.0	20	292.4	229.5	351350	8650	3.44	A
HZ 880M B	831.3	807.4	460	29.0	20.9	15.0	20	324.7	254.9	386810	9480	3.45	A
HZ 880M C	831.3	811.4	460	29.0	22.9	15.0	20	339.2	266.3	410830	10025	3.45	A
HZ 1080M A	1075.3	1047.4	454	29.0	19.6	16.0	35	371.1	291.3	696340	13185	3.87	A
HZ 1080M B	1075.3	1053.4	454	29.0	22.6	16.0	35	394.1	309.4	760600	14315	3.87	A
HZ 1080M C	1075.3	1059.4	456	29.0	25.7	18.0	35	436.1	342.4	839020	15715	3.87	A
HZ 1080M D	1075.3	1067.4	457	30.7	29.7	19.0	35	470.1	369.0	915420	17025	3.87	A
HZ 1180M A	1075.4	-	458	34.7	31.0	20.0	35	497.3	390.4	973040	17970	3.88	A
HZ 1180M B	1079.4	-	458	36.7	33.0	20.0	35	514.5	403.9	1022780	18785	3.89	A
HZ 1180M C	1083.4	-	459	38.7	35.0	21.0	35	543.6	426.8	1086840	19895	3.90	B
HZ 1180M D	1087.4	-	460	40.7	37.0	22.0	35	570.5	447.8	1144400	20795	3.91	B

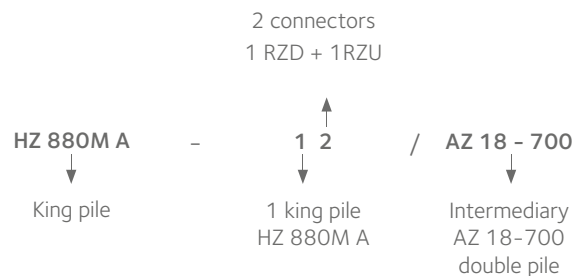
Connectors

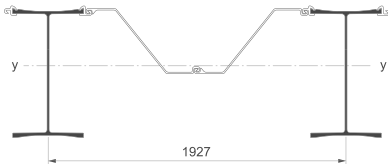
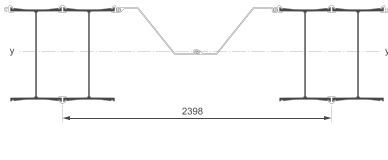
RH 16	61.8		68.2			12.2		20.1	15.8	83	25		A
RZD 16	61.8		80.5					20.7	16.2	57	18		
RZU 16	61.8		80.5					20.4	16.0	68	18		
RH 20	67.3		79.2			14.2		25.2	19.8	122	33		B
RZD 18	67.3		85.0					23.0	18.0	78	22		
RZU 18	67.3		85.0					22.6	17.8	92	22		



The outstanding feature of the HZ/AZ combined wall system is the extensive range of possible combinations using the entire AZ sheet pile offer, including the latest wide AZ-700 range, as well as all rolled-up and rolled-down AZ sections. The table below contains but a small sample of the available systems. **Please refer to our brochure “The HZ®-M Steel Wall System - 2014” for detailed information on the entire HZ®/AZ® range.**

Denomination of the HZ/AZ system:



	Section	Sectional area	Moment of inertia	Elastic ¹⁾ section modulus	Elastic ²⁾ section modulus	Mass ³⁾		Coating area ⁴⁾ Water side	
						Mass ₁₀₀ kg/m ²	Mass ₆₀ kg/m ²		
		cm ² /m	cm ⁴ /m	cm ³ /m	cm ³ /m			m ² /m	
 $b_{sys} = 1.927 \text{ m}$	Combination HZ ... M - 12 / AZ 18-700	HZ 680M LT	256.3	136700	4045	4585	201	163	2.48
		HZ 880M A	274.1	240500	5380	6160	215	177	2.48
		HZ 880M B	290.5	259000	5820	6560	228	190	2.48
		HZ 880M C	298.0	271570	6100	6850	234	196	2.48
		HZ 1080M A	315.5	443030	7745	8690	248	209	2.47
		HZ 1080M B	327.5	476790	8340	9295	257	219	2.47
		HZ 1080M C	349.0	517420	9065	10010	274	235	2.48
		HZ 1080M D	366.4	557070	9735	10720	288	249	2.48
		HZ 1180M A	380.4	586870	10220	11255	299	260	2.48
		HZ 1180M B	389.3	613030	10680	11705	306	267	2.48
		HZ 1180M C	406.5	651410	11275	12410	319	280	2.49
		HZ 1180M D	420.2	681600	11830	12895	330	291	2.50
 $b_{sys} = 2.398 \text{ m}$	Combination HZ ... M - 24 / AZ 18-700	HZ 680M LT	327.5	197520	6155	5525	257	226	3.00
		HZ 880M A	356.1	363720	8525	7885	280	249	3.00
		HZ 880M B	382.2	392360	9200	8550	300	269	3.01
		HZ 880M C	394.2	412400	9645	9005	309	279	3.01
		HZ 1080M A	423.2	688290	12515	11775	332	301	2.99
		HZ 1080M B	442.1	741310	13440	12715	347	316	2.99
		HZ 1080M C	476.4	805720	14585	13870	374	343	3.00
		HZ 1080M D	504.4	868900	15660	15000	396	365	3.00
		HZ 1180M A	526.6	916220	16425	15845	413	383	3.00
		HZ 1180M B	540.0	955000	17075	16535	424	393	3.00
		HZ 1180M C	569.5	1022790	18200	17595	447	416	3.02
		HZ 1180M D	589.3	1064090	18895	18330	463	431	3.03

1) Referring outside of HZ flanges

¹⁾ Referring outside of HZ-flange.

²⁾ Referring outside of RH / RZ.

³⁾ $L_{RH} = L_{HZ}$; $L_{RZU} = L_{RZD} = L_{AZ}$; $Mass_{100}$: $L_{AZ} = 100\% L_{HZ}$; $Mass_{60}$: $L_{AZ} = 60\% L_{HZ}$

⁴⁾ Excluding inside of interlocks, per system width.

AS 500® straight web sections

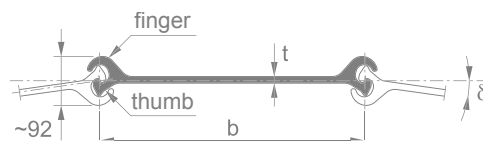
AS 500 straight web sheet piles are designed to form closed cylindrical structures retaining a soil fill. The stability of the cells consisting of a steel envelope and an internal body of soil is guaranteed by their own weight. Straight web sheet piles are mostly used on projects where rock layers are close to ground level or where anchoring would be difficult or impossible. Straight web sheet pile structures are made of circular cells or diaphragm cells, depending on the site characteristics or the particular requirements of the project. The forces developing in these sheet pile sections are essentially horizontal tensile forces requiring an interlock strength corresponding to the horizontal force in the web of the pile. AS 500 interlocks comply with EN 10248. **Please refer to our brochure "AS 500® Straight web steel sheet piles – design & execution manual" for further details.**

Section	Nominal width ¹⁾ b mm	Web thickness t mm	Deviation angle ²⁾ δ °	Perimeter cm	Steel section	Mass kg/m	Mass per m ² of wall kg/m ²	Moment of inertia cm ⁴	Section modulus (single pile) cm ³	Coating area ³⁾ m ² /m
					(single pile) cm ²					
AS 500-9.5	500	9.5	4.5	138	81.3	63.8	128	168	46	0.58
AS 500-11.0	500	11.0	4.5	139	90.0	70.6	141	186	49	0.58
AS 500-12.0	500	12.0	4.5	139	94.6	74.3	149	196	51	0.58
AS 500-12.5	500	12.5	4.5	139	97.2	76.3	153	201	51	0.58
AS 500-12.7	500	12.7	4.5	139	98.2	77.1	154	204	51	0.58

¹⁾ The effective width to be taken into account for design purposes (lay-out) is 503 mm for all AS 500 sheet piles.

²⁾ Max. deviation angle 4.0° for pile length > 20 m.

³⁾ One side, excluding inside of interlocks.



General cargo berth, Bal Haf, Yemen



The following interlock strengths can be achieved for an S 355 GP steel grade:

Section	F_{max} [kN/m]
AS 500-9.5	3000
AS 500-11.0	3500
AS 500-12.0	4500*
AS 500-12.5	5500
AS 500-12.7	5500

* F_{max} = 5000 kN/m upon request

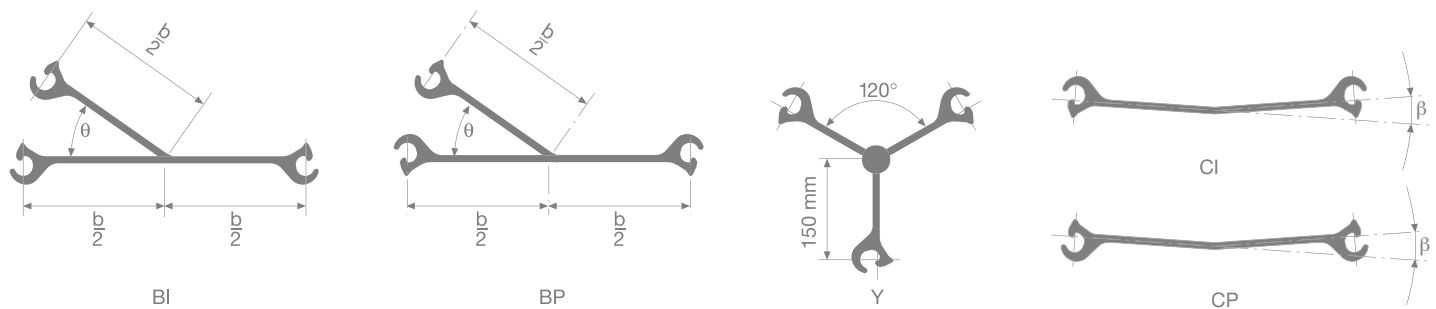
For verification of the strength of piles, both yielding of the web and failure of the interlock should be considered.

Bridge construction, South Korea

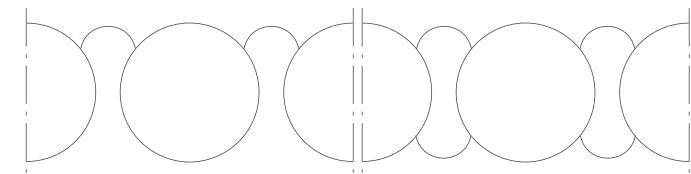


Junction piles and bent piles

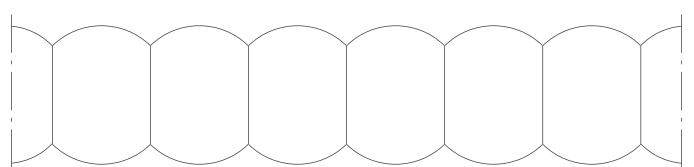
Junction piles that join circular cells and intermediary arcs can be provided. Bent piles are pre-bent at the mill. If the deviation angle exceeds 4.5° (4.0° if $L > 20$ m), bent piles can be used to set up structures with small radii.



Types of cells



Circular cells with 35° junction piles and one or two connecting arcs.



Diaphragm cells with 120° junction piles.

Berthing facility, Canada



Lock, Arkansas, USA



Circular cell construction



1. Installation of template



2. Threading until cell closure



3. Driving

Equivalent width

The equivalent width w_e which is required for stability verification determines the geometry of the chosen cellular construction.

• for circular cells

The equivalent width w_e is defined as:

$$w_e = \frac{\text{Area within 1 cell} + \text{Area within 1 (or 2) arc(s)}}{\text{System length } x}$$

The ratio R_a indicates how economical the chosen circular cell will be.

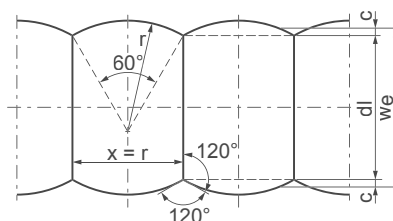
It is defined as follows

$$R_a = \frac{\text{Development 1 cell} + \text{Development 1 (or 2) arc(s)}}{\text{System length } x}$$

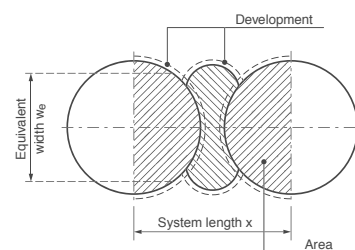
• for diaphragm cells

The equivalent width w_e is defined as:

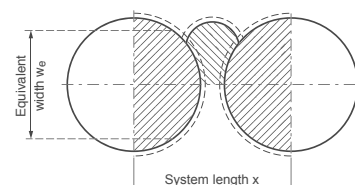
$$w_e = \text{diaphragm wall length (dl)} + 2 \cdot c$$



circular cell with 2 arcs

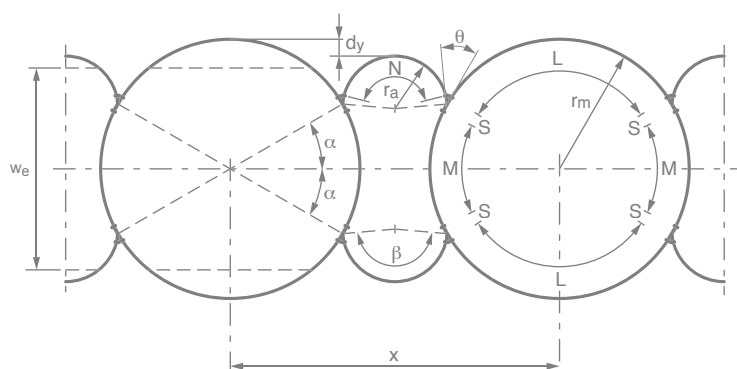


circular cell with 1 arc

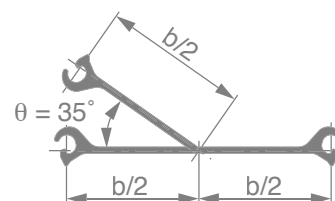


Geometry of circular cells

Once the equivalent width has been determined, the geometry of the cells can be defined. This can be done with the help of tables or with computer programs.



Standard solution



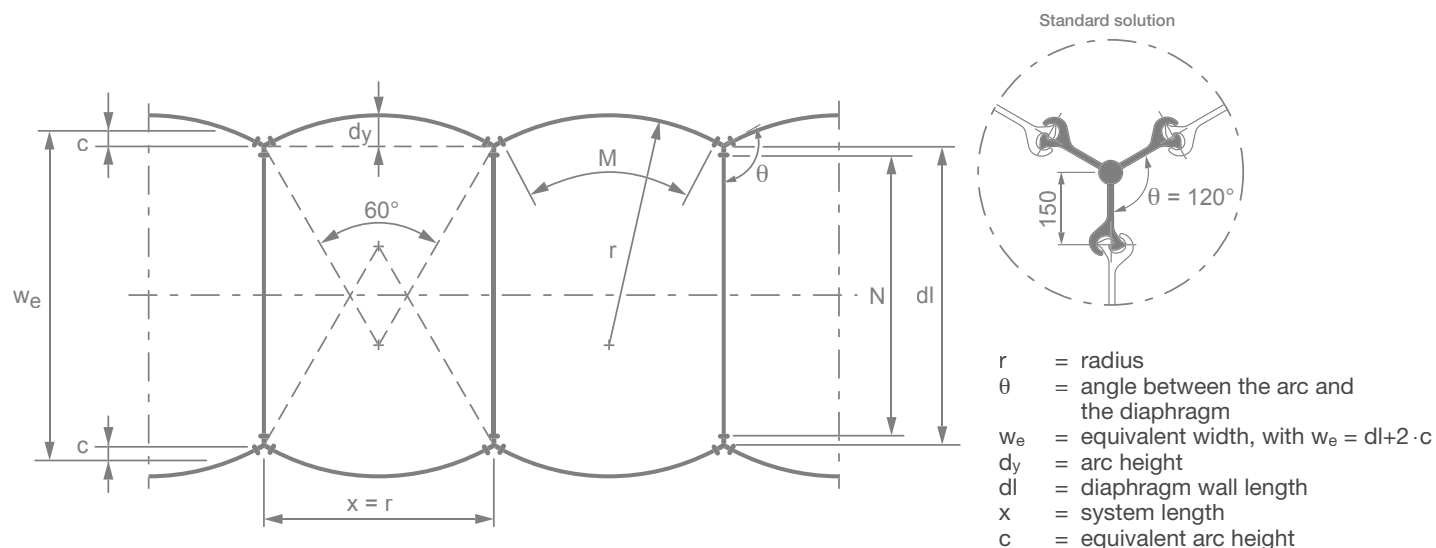
- r_m = radius of the main cell
- r_a = radius of the connecting arcs
- θ = angle between the main cell and the connecting arc
- x = system length
- d_y = positive or negative offset between the connecting arcs and the tangent planes of the main cells
- w_e = equivalent width

Junction piles with angles θ between 30° and 45° , as well as $\theta = 90^\circ$, are available on request.

The table below shows a short selection of circular cells with 2 arcs and standard junction piles with $\theta = 35^\circ$.

Nb. of piles per						Geometrical values					Interlock deviation		Design values		
Cell						Arc					Cell		2 Arcs		
Total pcs.	L pcs.	M pcs.	S pcs.	N pcs.	System pcs.	$d = 2 \cdot r_m$	r_a	x	d_y	α	β	δ_m	δ_a	w_e	R_a
100	33	15	1	25	150	16.01	4.47	22.92	0.16	28.80	167.60	3.60	6.45	13.69	3.34
104	35	15	1	27	158	16.65	4.88	24.42	0.20	27.69	165.38	3.46	5.91	14.14	3.30
108	37	15	1	27	162	17.29	4.94	25.23	0.54	26.67	163.33	3.33	5.83	14.41	3.27
112	37	17	1	27	166	17.93	4.81	25.25	0.33	28.93	167.86	3.21	6.00	15.25	3.35
116	37	19	1	27	170	18.57	4.69	25.27	0.13	31.03	172.07	3.10	6.15	16.08	3.42
120	39	19	1	29	178	19.21	5.08	26.77	0.16	30.00	170.00	3.00	5.67	16.54	3.38
124	41	19	1	29	182	19.85	5.14	27.59	0.50	29.03	168.06	2.90	5.60	16.82	3.35
128	43	19	1	31	190	20.49	5.55	29.09	0.53	28.13	166.25	2.81	5.20	17.27	3.32
132	43	21	1	31	194	21.13	5.42	29.11	0.33	30.00	170.00	2.73	5.31	18.10	3.39
136	45	21	1	33	202	21.77	5.82	30.61	0.36	29.12	168.24	2.65	4.95	18.56	3.35
140	45	23	1	33	206	22.42	5.71	30.62	0.17	30.86	171.71	2.57	5.05	19.39	3.42
144	47	23	1	33	210	23.06	5.76	31.45	0.50	30.00	170.00	2.50	5.00	19.67	3.39
148	47	25	1	35	218	23.70	5.99	32.13	0.00	31.62	173.24	2.43	4.81	20.67	3.44
152	49	25	1	35	222	24.31	6.05	32.97	0.34	30.79	171.58	2.37	4.77	20.95	3.42

Geometry of diaphragm cells



Tugboat berth, Panama Canal, Panama



Marina breakwater, Costa Rica



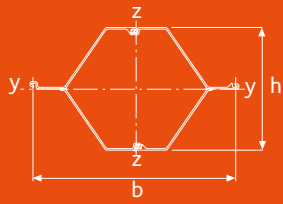
Geometry diaphragm wall

Number of piles	Wall length
N pcs.	dl m
11	5.83
13	6.84
15	7.85
17	8.85
19	9.86
21	10.86
23	11.87
25	12.88
27	13.88
29	14.89
31	15.89
33	16.90
35	17.91
37	18.91
39	19.92
41	20.92
43	21.93
45	22.94
47	23.94
49	24.95
51	25.95
53	26.96
55	27.97
57	28.97
59	29.98

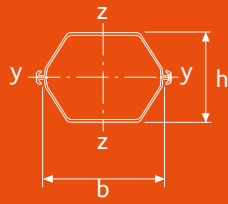
Geometry arc (Standard solution)

Number of piles	Radius System length	Arc height	Equivalent arc height	Interlock deviation
M pcs.	$x=r$ m	d_y m	c m	δ_a °
11	5.57	0.75	0.51	5.17
13	6.53	0.87	0.59	4.41
15	7.49	1.00	0.68	3.85
17	8.45	1.13	0.77	3.41
19	9.41	1.26	0.86	3.06
21	10.37	1.39	0.94	2.78
23	11.33	1.52	1.03	2.54
25	12.29	1.65	1.12	2.34
27	13.26	1.78	1.20	2.17
29	14.22	1.90	1.29	2.03
31	15.18	2.03	1.38	1.90
33	16.14	2.16	1.46	1.79
35	17.10	2.29	1.55	1.69
37	18.06	2.42	1.64	1.60
39	19.02	2.55	1.73	1.52
41	19.98	2.68	1.81	1.44
43	20.94	2.81	1.90	1.38

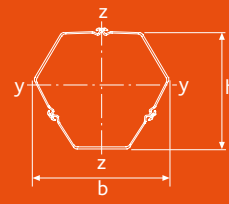
Box piles



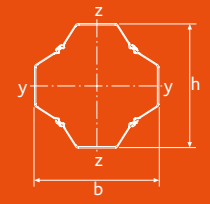
Z-box pile



Double U box pile



Triple U box pile



Quadruple U box pile

Section	Width	Height	Perimeter	Sectional area	Total section	Mass ¹⁾	Moment of inertia		Elastic section modulus		Min. radius of gyration	Coating area ²⁾
	b mm	h mm	cm	cm ²	cm ²	kg/m	y-y cm ⁴	z-z cm ⁴	y-y cm ³	z-z cm ³	cm	m ² /m
CAZ-700 and CAZ-770 box piles												
CAZ 12-770	1540	687	389	328	5431	257	175060	557990	5075	6985	23.1	3.67
CAZ 13-770	1540	688	389	344	5446	270	183440	584640	5310	7320	23.1	3.67
CAZ 14-770	1540	689	390	360	5461	283	191840	611300	5545	7655	23.1	3.67
CAZ 14-770-10/10	1540	690	390	376	5476	295	200280	637960	5780	7995	23.1	3.67
CAZ 12-700	1400	628	360	303	4524	238	137770	421600	4365	5785	21.3	3.39
CAZ 13-700	1400	630	361	332	4552	261	150890	461210	4765	6335	21.3	3.39
CAZ 13-700-10/10	1400	631	361	347	4565	272	157530	481090	4965	6610	21.3	3.39
CAZ 14-700	1400	632	361	362	4579	284	164130	500820	5165	6885	21.3	3.39
CAZ 17-700	1400	839	391	330	6015	259	265280	457950	6300	6285	28.3	3.69
CAZ 18-700	1400	840	391	347	6029	272	277840	479790	6590	6590	28.3	3.69
CAZ 20-700	1400	842	392	379	6058	297	303090	523460	7170	7195	28.3	3.69
CAZ 24-700	1400	918	407	436	6616	342	412960	596900	8965	8260	30.8	3.85
CAZ 26-700	1400	920	407	469	6645	368	444300	641850	9625	8900	30.8	3.85
CAZ 28-700	1400	922	408	503	6674	395	475810	686880	10285	9510	30.8	3.85
CAZ 24-700N	1400	918	407	401	6596	315	397130	550030	8620	7655	31.5	3.85
CAZ 26-700N	1400	920	407	434	6625	341	428490	594860	9280	8280	31.4	3.85
CAZ 28-700N	1400	922	408	468	6654	367	460020	639700	9940	8905	31.4	3.85
CAZ 36-700N	1400	998	434	534	7215	419	627000	710770	12525	9895	34.3	4.12
CAZ 38-700N	1400	1000	435	570	7245	447	667900	757530	13315	10550	34.2	4.12
CAZ 40-700N	1400	1002	436	606	7275	476	709010	804300	14105	11205	34.2	4.12
CAZ 42-700N	1400	998	433	646	7267	507	744440	855860	14870	11915	34.0	4.11
CAZ 44-700N	1400	1000	434	682	7298	535	785620	902800	15660	12570	33.9	4.11
CAZ 46-700N	1400	1002	434	718	7328	564	827030	949760	16455	13225	33.9	4.11

¹⁾ The mass of the welds is not taken into account.

²⁾ Outside surface, excluding inside of interlocks.

Section	Width	Height	Perimeter	Sectional area	Total section	Mass ¹⁾	Moment of inertia		Elastic section modulus		Min. radius of gyration	Coating area ²⁾
	b mm	h mm	cm	cm ²	cm ²	kg/m	y-y cm ⁴	z-z cm ⁴	y-y cm ³	z-z cm ³	cm	m ² /m
CAZ box piles												
CAZ 18	1260	760	361	333	4925	261	222930	365500	5840	5560	25.9	3.41
CAZ 26	1260	854	377	440	5566	346	366820	480410	8555	7385	28.9	3.57
CAZ 46	1160	962	401	595	5831	467	645940	527590	13380	8825	32.9	3.81
CAZ 48	1160	964	402	628	5858	493	681190	556070	14080	9300	32.9	3.81
CAZ 50	1160	966	402	661	5884	519	716620	584560	14780	9780	32.9	3.81
CAU double box piles												
CAU 14-2	750	451	230	198	2598	155.8	54400	121490	2415	3095	16.6	2.04
CAU 16-2	750	454	231	220	2620	172.5	62240	130380	2745	3325	16.8	2.04
CAU 18-2	750	486	239	225	2888	177.0	73770	142380	3035	3625	18.1	2.14
CAU 20-2	750	489	240	247	2910	193.8	83370	151220	3405	3850	18.4	2.14
CAU 23-2	750	492	244	260	3013	204.2	94540	157900	3845	4020	19.1	2.19
CAU 25-2	750	495	245	281	3034	220.8	104810	166600	4235	4240	19.3	2.19
CU double box piles												
CU 12-2	600	403	198	168	1850	132.2	34000	70000	1685	2205	14.2	1.72
CU 12 -10/10-2	600	403	198	177	1850	139.2	35580	73460	1765	2315	14.2	1.72
CU 18-2	600	473	212	196	2184	153.8	58020	78300	2455	2470	17.2	1.86
CU 22-2	600	494	220	219	2347	172.3	73740	88960	2985	2800	18.3	1.94
CU 28-2	600	499	226	259	2468	203.6	96000	103560	3850	3260	19.2	2.00
CU 32-2	600	499	223	291	2461	228.3	108800	109200	4360	3435	19.3	1.97
CGU double box piles												
CGU 7N-2	600	348	187	112	1596	88.2	16510	48530	950	1535	12.1	1.62
CGU 7S-2	600	349	188	120	1604	92.5	18210	50630	1045	1605	12.3	1.62
CGU 14N-2	600	461	205	164	2079	128.6	44070	65550	1910	2075	16.4	1.79
CGU 18N-2	600	473	212	196	2184	153.8	58020	78300	2455	2470	17.2	1.86
CGU 22N-2	600	494	220	219	2347	172.3	73740	88960	2985	2800	18.3	1.94
CGU 28N-2	600	499	226	259	2468	203.6	96000	103560	3850	3260	19.2	2.00
CGU 32N-2	600	499	223	291	2461	228.3	108800	109200	4360	3435	19.3	1.97
CGU 16-400	400	336	169	158	1170	123.9	25270	31900	1505	1465	12.7	1.40

¹⁾ The mass of the welds is not taken into account.

²⁾ Outside surface, excluding inside of interlocks.

Section	Width	Height	Perimeter	Sectional area	Total section	Mass ¹⁾	Moment of inertia		Elastic section modulus		Min. radius of gyration	Coating area ²⁾
	b mm	h mm	cm	cm ²	cm ²	kg/m	y-y cm ⁴	z-z cm ⁴	y-y cm ³	z-z cm ³	cm	m ² /m
CAU triple box piles												
CAU 14-3	957	908	341	298	6454	233.7	300330		6510	6275	31.7	3.03
CAU 16-3	960	910	342	330	6486	258.7	333640		7235	6955	31.8	3.03
CAU 18-3	1009	927	355	338	6886	265.5	363690		7825	7205	32.8	3.17
CAU 20-3	1012	928	356	370	6919	290.7	399780		8570	7900	32.9	3.17
CAU 23-3	1036	930	361	390	7073	306.3	431940		9235	8340	33.3	3.24
CAU 25-3	1038	931	364	422	7106	331.3	469030		9995	9035	33.3	3.24
CU triple box piles												
CU 12-3	800	755	293	253	4431	198.3	173100		4555	4325	26.2	2.54
CU 12-10/10-3	800	755	293	266	4432	208.8	182100		4790	4555	26.2	2.54
CU 18-3	877	790	315	294	4931	230.7	227330		5475	5185	27.8	2.76
CU 22-3	912	801	326	329	5174	258.4	268440		6310	5890	28.6	2.87
CU 28-3	938	817	336	389	5356	305.4	330290		7720	7040	29.1	2.96
CU 32-3	926	809	331	436	5345	342.4	367400		8585	7935	29.0	2.92
CGU triple box piles												
CGU 14N-3	844	781	305	246	4763	192.8	182730		4475	4330	27.3	2.65
CGU 18N-3	877	790	315	294	4931	230.7	227330		5475	5185	27.8	2.76
CGU 22N-3	912	801	326	329	5174	258.4	268440		6310	5890	28.6	2.87
CGU 28N-3	938	817	336	389	5356	305.4	330290		7720	7040	29.1	2.96
CGU 32N-3	926	809	331	436	5345	342.4	367400		8585	7935	29.0	2.92

¹⁾ The mass of the welds is not taken into account.

²⁾ Outside surface, excluding inside of interlocks.



Rheinhafen Neuss, Germany

Section	Width	Height	Perimeter	Sectional area	Total section	Mass ¹⁾	Moment of inertia		Elastic section modulus		Min. radius of gyration	Coating area ²⁾
	b	h					y-y	z-z	y-y	z-z		
	mm	mm	cm	cm ²	cm ²	kg/m	cm ⁴	cm ⁴	cm ³	cm ³	cm	m ² /m

CAU quadruple box piles

CAU 14-4	1222	1222	453	397	11150	311.6	692030		11325		41.7	4.02
CAU 16-4	1225	1225	454	440	11193	345.0	770370		12575		41.8	4.02
CAU 18-4	1258	1258	471	451	11728	354.0	826550		13140		42.8	4.20
CAU 20-4	1261	1261	472	494	11771	387.6	910010		14430		42.9	4.20
CAU 23-4	1263	1263	481	520	11977	408.4	979870		15510		43.4	4.30
CAU 25-4	1266	1266	482	563	12020	441.6	1064910		16820		43.5	4.30

CU quadruple box piles

CU 12-4	1025	1025	388	337	7565	264.4	394000		7690		34.2	3.36
CU 12-10/10-4	1025	1025	388	355	7565	278.4	414830		8095		34.2	3.36
CU 18-4	1095	1095	417	392	8231	307.6	507240		9270		36.0	3.65
CU 22-4	1115	1115	432	439	8556	344.6	593030		10635		36.8	3.80
CU 28-4	1120	1120	445	519	8799	407.2	725730		12955		37.4	3.93
CU 32-4	1120	1120	440	582	8782	456.6	811100		14480		37.3	3.87

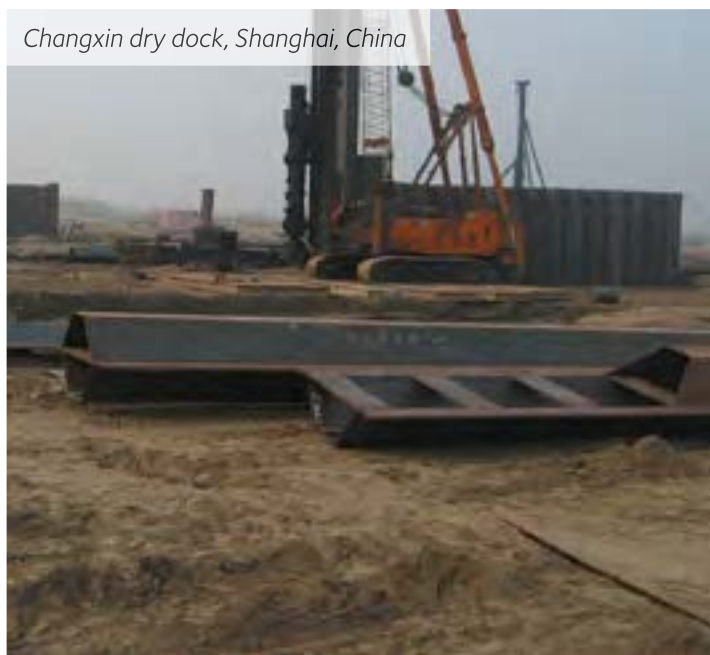
CGU quadruple box piles

CGU 14N-4	1081	1081	404	328	7997	257.1	409870		7585		35.4	3.51
CGU 18N-4	1095	1095	417	392	8231	307.6	507240		9270		36.0	3.65
CGU 22N-4	1115	1115	432	439	8556	344.6	593030		10635		36.8	3.80
CGU 28N-4	1120	1120	445	519	8799	407.2	725730		12955		37.4	3.93
CGU 32N-4	1120	1120	440	582	8782	456.6	811100		14480		37.3	3.87

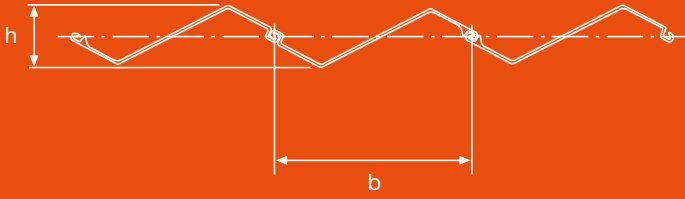
¹⁾ The mass of the welds is not taken into account.

²⁾ Outside surface, excluding inside of interlocks.

Changxin dry dock, Shanghai, China



Jagged wall



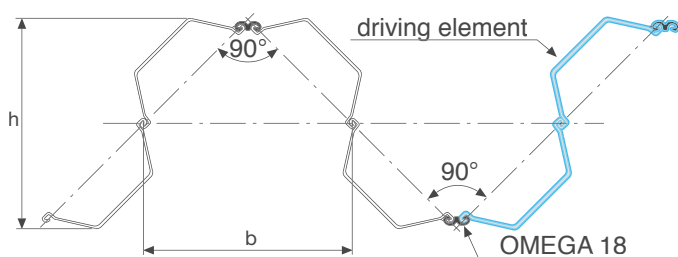
AZ® jagged wall: AZ® sections threaded in reverse may form arrangements for special applications. The jagged wall arrangement represents a very economical solution for sealing screens (reduced height, reliable thickness, low driving resistance).

AZ® jagged wall

Section	Width	Height	Sectional area	Mass	Moment of inertia	Elastic section modulus	Coating area ¹⁾
	b mm	h mm	cm ² /m	kg/m ²	cm ⁴ /m	cm ³ /m	m ² /m ²
AZ-700 and AZ-770							
AZ 12-770	826	181	112	88	2330	255	1.12
AZ 13-770	826	182	117	92	2460	270	1.12
AZ 14-770	826	182	123	96	2600	285	1.12
AZ 14-770-10/10	826	183	128	100	2730	300	1.12
AZ 12-700	751	182	115	90	2410	265	1.13
AZ 13-700	751	183	126	99	2690	295	1.13
AZ 13-700-10/10	751	183	131	103	2830	310	1.13
AZ 14-700	751	184	136	107	2970	325	1.13
AZ 17-700	795	212	117	92	3690	330	1.16
AZ 18-700	795	212	123	96	3910	350	1.16
AZ 19-700	795	213	128	101	4120	365	1.16
AZ 20-700	795	214	134	105	4330	385	1.16
AZ 24-700	813	241	150	118	5970	495	1.19
AZ 26-700	813	242	161	127	6500	535	1.19
AZ 28-700	813	243	172	135	7030	580	1.19
AZ 24-700N	813	237	141	110	5580	470	1.19
AZ 26-700N	813	238	152	119	6100	510	1.19
AZ 28-700N	813	239	163	128	6630	555	1.19
AZ 36-700N	834	296	181	142	11900	805	1.23
AZ 38-700N	834	298	193	152	12710	855	1.23
AZ 40-700N	834	299	205	161	13530	905	1.23
AZ 42-700N	834	300	217	170	14650	975	1.24
AZ 44-700N	834	301	229	180	15460	1025	1.24
AZ 46-700N	834	302	241	189	16280	1075	1.24
AZ							
AZ 18	714	225	133	104	4280	380	1.19
AZ 18-10/10	714	225	139	109	4500	400	1.19
AZ 26	736	238	169	133	6590	555	1.21
AZ 46	725	308	233	183	16550	1070	1.30
AZ 48	725	310	245	193	17450	1125	1.30
AZ 50	725	312	258	202	18370	1180	1.30

¹⁾ One side, excluding inside of interlocks.

U jagged wall



An arrangement of U-sheet piles forming a jagged wall offers economic solutions where high inertia and section modulus are needed. The final choice of section has to include drivability criteria. The statical values given below assume the solidarisation of the driving element, i.e. double pile. The OMEGA 18 section is normally threaded and welded at the mill, either by tack weld

(no contribution to the section modulus of the jagged wall) or by an appropriately designed weld (full contribution to the section modulus). For walls with an anchorage or strut system, stiffeners have to be provided at the support levels.



Section	Width	Height	Mass	Moment of inertia ¹⁾		Elastic section modulus ¹⁾		Static moment	
	b mm	h mm		without Omega 18 cm ⁴ /m	with Omega 18 cm ⁴ /m	without Omega 18 cm ³ /m	with Omega 18 cm ³ /m	without Omega 18 cm ³ /m	with Omega 18 cm ³ /m

AU™ jagged wall

AU 14	1135	1115	153	275830	334350	5075	5995	6160	7250
AU 16	1135	1115	168	307000	365520	5650	6555	6870	7960
AU 18	1135	1136	172	329320	387840	5795	6825	7180	8270
AU 20	1135	1139	187	362510	421030	6365	7395	7920	9005
AU 23	1135	1171	196	390650	449160	6675	7675	8470	9560
AU 25	1135	1173	211	424510	483020	7240	8235	9215	10300

PU® jagged wall

PU 12	923	903	163	189000	229900	4275	5090	5175	6245
PU 12-10/10	923	903	170	198850	245250	4495	5430	5450	6525
PU 18	923	955	186	244340	290750	5120	6090	6430	7500
PU 22	923	993	206	285880	332290	5760	6690	7380	8450
PU 28	923	1028	240	349710	396110	6805	7710	8925	10000
PU 32	923	1011	267	389300	432400	7705	8560	10025	11095

GU® jagged wall

GU 14N	923	920	159	198710	245140	4320	5330	5285	6360
GU 18N	923	955	186	244340	290750	5120	6090	6430	7500
GU 22N	923	993	206	285880	332290	5760	6690	7380	8450
GU 28N	923	1028	240	349710	396110	6805	7710	8925	10000
GU 32N	923	1011	267	389300	432400	7705	8560	10025	11095

¹⁾ The moment of inertia and elastic section moduli assume correct shear force transfer across the interlock on the neutral axis.

Combined walls

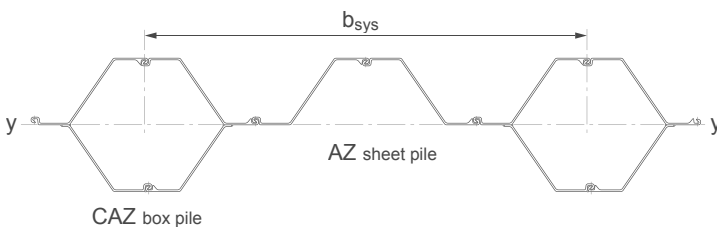
Steel sheet piles can easily be combined to form special arrangements and create systems with large bending resistance:

- box piles / sheet piles,
- HZ king piles / sheet piles,
- tubular king piles / sheet piles.

The primary piles or "king piles" of combined walls can also be used as bearing piles submitted to high vertical loads, e.g. crane loads. The intermediary sheet piles act mainly as soil-retaining and load-transferring elements.

Equivalent elastic section modulus

The equivalent elastic section modulus W_{sys} per linear metre of combined wall is based on the assumption that the deflections of king piles and intermediary steel sheet piles are the same, leading to the following formulas:



$$I_{sys} = \frac{I_{king\ pile} + I_{ssp}}{b_{sys}}$$

$$W_{sys} = \frac{W_{king\ pile}}{b_{sys}} \times \left(\frac{I_{king\ pile} + I_{ssp}}{I_{king\ pile}} \right)$$

I_{sys}	[cm ⁴ /m]:	Moment of inertia of combined wall
W_{sys}	[cm ³ /m]:	Elastic section modulus of combined wall
$I_{king\ pile}$	[cm ⁴]:	Moment of inertia of king pile
I_{ssp}	[cm ⁴]:	Moment of inertia of intermediary sheet pile
$W_{king\ pile}$	[cm ³]:	Elastic section modulus of king pile
b_{sys}	[m]:	System width

CAZ box piles – AZ® sheet piles

Combination	System width b_{sys} mm	Mass ₁₀₀ ¹⁾ kg/m ²	Mass ₆₀ ¹⁾ kg/m ²	Moment of inertia I_{sys} cm ⁴ /m	Elastic section modulus W_{sys} cm ³ /m
AZ-700 and AZ-770					
CAZ 13-770 / AZ 13-770	3080	137	117	70740	2045
CAZ 13-700 / AZ 13-700	2800	146	125	64160	2025
CAZ 18-700 / AZ 13-770	2940	144	124	106220	2520
CAZ 18-700 / AZ 13-700	2800	150	129	109500	2595
CAZ 18-700 / AZ 18-700	2800	152	130	118130	2800
CAZ 26-700 / AZ 13-770	2940	177	156	162840	3530
CAZ 26-700 / AZ 13-700	2800	185	163	168950	3660
CAZ 26-700 / AZ 18-700	2800	186	164	177580	3845
CAZ 26-700N / AZ 13-770	2940	168	147	157460	3410
CAZ 26-700N / AZ 13-700	2800	175	154	163300	3535
CAZ 26-700N / AZ 18-700	2800	176	155	171930	3725
CAZ 38-700N / AZ 13-770	2940	204	183	238890	4760
CAZ 38-700N / AZ 13-700	2800	213	192	248800	4960
CAZ 38-700N / AZ 18-700	2800	214	193	257440	5130
CAZ 44-700N / AZ 13-770	2940	234	213	278930	5560
CAZ 44-700N / AZ 13-700	2800	244	223	290850	5800
CAZ 44-700N / AZ 18-700	2800	246	224	299480	5970

AZ

CAZ 18 / AZ 18	2520	163	139	105560	2765
CAZ 26 / AZ 18	2520	196	173	162660	3795
CAZ 48 / AZ 18	2420	265	241	299290	6190

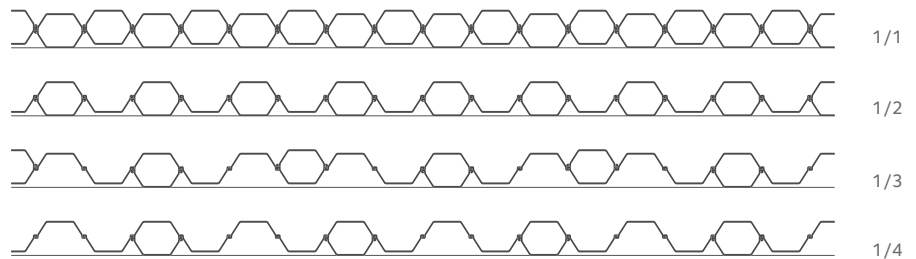
¹⁾ Mass₁₀₀: L_{AZ} = 100% L_{box pile}; Mass₆₀: L_{AZ} = 60% L_{box pile}

U box piles – U sheet piles

Type of reinforcement:

- Heightwise: full or partial height.
- Lengthwise: total length 1/1 or partial length 1/2, 1/3, 1/4.

Please contact our Technical Department for other combinations (e.g. 2/4).



Section	1 / 1			1 / 2			1 / 3			1 / 4		
	Mass	Moment of inertia	Elastic section modulus	Mass	Moment of inertia	Elastic section modulus	Mass	Moment of inertia	Elastic section modulus	Mass	Moment of inertia	Elastic section modulus
	kg/m ²	cm ⁴ /m	cm ³ /m	kg/m ²	cm ⁴ /m	cm ³ /m	kg/m ²	cm ⁴ /m	cm ³ /m	kg/m ²	cm ⁴ /m	cm ³ /m

CAU box piles / AU™ sheet piles

AU 14	208	72530	3220	156	40660	1805	139	43300	1920	130	37980	1550
AU 16	230	82990	3660	173	46230	2035	153	49560	2185	144	43440	1755
AU 18	236	98360	4045	177	55020	2260	157	58990	2425	148	51760	1950
AU 20	258	111160	4545	194	61830	2525	172	66680	2725	162	58460	2180
AU 23	272	126050	5125	204	69580	2830	182	75820	3080	170	66410	2435
AU 25	294	139750	5645	221	76800	3105	196	84080	3395	184	73590	2675

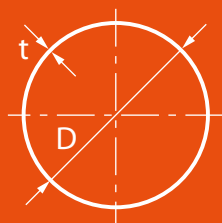
CU box piles / PU® sheet piles

PU 12	220	56670	2810	165	32080	1590	147	33290	1650	138	29190	1370
PU 12-10/10	232	59300	2945	174	33480	1660	155	34820	1730	145	30520	1430
PU 18	256	96700	4090	192	54370	2300	171	58000	2450	160	50940	1980
PU 22	287	122900	4975	215	68730	2785	192	73940	2995	180	64920	2395
PU 28	339	160000	6415	255	88390	3545	226	96310	3860	212	84370	3050
PU 32	381	181330	7270	285	99790	4000	254	108660	4355	238	95070	3445

CGU box piles / GU® sheet piles

GU 7N	147	27520	1585	110	15630	900	98	16140	930	92	14160	775
GU 7S	154	30350	1740	116	17150	985	103	17810	1020	96	15610	845
GU 14N	214	73440	3185	161	41520	1800	143	44090	1915	134	38760	1550
GU 18N	256	96700	4090	192	54370	2300	171	58000	2450	160	50940	1980
GU 22N	287	122900	4975	215	68730	2785	192	73940	2995	180	64920	2395
GU 28N	339	160000	6415	255	88390	3545	226	96310	3860	212	84370	3050
GU 32N	381	181330	7270	285	99790	4000	254	108660	4355	238	95070	3445
GU 16-400	310	63180	3760	232	35270	2100	207	36110	2150	194	31460	1805

Steel tubes for foundations



ArcelorMittal manufactures spirally welded tubular foundation piles according to EN 10204 – 2004. The tube mill is located in Dintelmond, The Netherlands, and can produce tubes with diameters up to 3 000 mm, wall thicknesses up to 25 mm, and lengths up to 53 m (without butt-welding). Additionally, it is located on the waterfront and owns a deep-water quay wall. Tubular piles are available in numerous European and US steel grades thanks to ArcelorMittal's worldwide network of coil producers. Tubes can be coated on the premises on request. The table below gives an overview of steel tubes used in foundations (bearing piles, combined walls, etc). Other dimensions on request.

Steel tubes can also be provided with C9 connectors welded on the tube to form combined wall systems. Tubular piles are the main retaining elements of the combined wall, carrying horizontal loads from soil and water pressures, and vertical loads from the anchors and superstructure. The intermediary sheet piles (preferably

AZ sheet piles) transfer horizontal loads to the tubular piles. Please refer to our brochure “**AZ® sheet piles in combined walls**” for more information on the infill sheet piles.

Please refer to our brochure “**Spirally welded steel pipes**” for further details.

Diameter	Thickness	Moment of inertia	Elastic section modulus	Sectional area	Mass
D mm	t mm	I cm ⁴	W cm ³	A cm ²	G kg/m
864	10.0	244620	5665	268.3	210.6
864	12.0	291510	6750	321.2	252.1
864	14.0	337720	7820	373.8	293.5
914	10.0	290150	6350	284.0	222.9
914	12.0	345890	7570	340.0	266.9
914	14.0	400890	8770	395.8	310.7
1016	12.0	476980	9390	378.5	297.1
1016	14.0	553190	10890	440.7	346.0
1016	16.0	628480	12370	502.7	394.6
1219	14.0	962070	15785	530.0	416.0
1219	16.0	1094090	17950	604.7	474.7
1219	18.0	1224780	20095	679.1	533.1
1422	16.0	1746590	24565	706.7	554.8
1422	18.0	1956610	27520	793.9	623.2
1422	20.0	2164820	30450	880.9	691.5
1524	16.0	2154930	28280	758.0	595.0
1524	18.0	2414730	31690	851.6	668.5
1524	20.0	2672450	35070	945.0	741.8
1626	18.0	2939310	36155	909.3	713.8
1626	20.0	3253820	40020	1009.1	792.1
1626	22.0	3565970	43860	1108.6	870.3
1829	18.0	4198850	45915	1024.1	803.9
1829	20.0	4650060	50850	1136.6	892.3
1829	22.0	5098250	55750	1248.9	980.4
2032	20.0	6397590	62970	1264.2	992.4
2032	22.0	7016540	69060	1389.2	1090.5
2032	24.0	7631750	75115	1514.0	1188.5
2540	21.0	13182380	103800	1661.9	1304.6
2540	23.0	14403690	113415	1818.7	1427.7
2540	25.0	15619130	122985	1975.3	1550.6
2997	21.0	21737000	145060	1963.4	1541.2
2997	23.0	23759460	158555	2148.9	1686.9
2997	25.0	25773720	171995	2334.2	1832.3



Driving caps

A driving cap is a very important accessory, providing good energy transfer between the hammer and the sheet pile section, thus preventing damage to the pile. Impact hammers need special driving caps. Driving caps for diesel hammers are generally made of cast steel, with an arrangement of guiding grooves for the different sheet pile sections on its lower side. A dolly is fitted into a recess on the top of the driving cap. Dollies are normally made of wooden or plastic components or a combination of several different elements. Each driving cap generally fits several sheet pile sections, thus reducing the number of required driving caps for a given sheet pile range.

Sheet pile sections and corresponding driving caps

Section	Arrangement	Driving caps
AU 14/16/18/20/23/25	single	AUS 14-26
AU 14/16	double/box pile	AUD 12-16
AU 18/20/23/25	double/box pile	AUD 20-32
PU 12/18/22/28/32, GU 18N/22N/28N/32N	single	PUS
PU 12/28/32, GU 28N/32N	single	US-B
PU 12	double/triple/box pile	UD 1
PU 18/22/32, GU 18N/22N/32N	double/triple/box pile	UD 2
PU 18/22/28/32, GU 18N/22N/28N/32N	double/box pile	PUD 17-33
AZ 12-700 to AZ 14-700	double	AZD 12-14
AZ 12-770 to AZ 14-770-10/10	double	AZD 12-14 L
AZ 17-700 to AZ 20-700/AZ 24-700(N) to AZ 28-700(N)	double	UZD 14-28
AZ 36-700N to AZ 46-700N	double	AZD 36-40
AZ 18/26	double	A 18/26
AZ 46/48/50	double	A 48

Single and box piles can be driven to the top of the neighbouring pile when using UD driving caps.

For other driving elements (HZ, built-up box piles, triple piles, etc.) please contact our Technical Department.

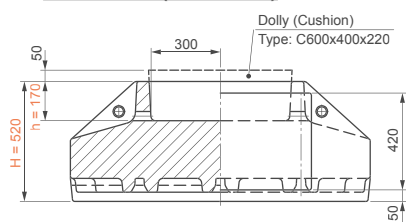
Driving cap dimensions

Driving caps	AUS 14-26	AUD 12-16	AUD 20-32	PUS	US-B	UD 1	UD 2
A/B/H	740/580/370	1540/750/520	1570/750/520	680/600/320	680/600/320	1250/610/420	1250/720/420
C	350	430	430	290	290	260	315
Mass [kg]	650	1900	2100	300	300	1000	1250
a/b (or Ø) / h ¹⁾	500/300/120	600/400/170	600/400/170	380/380/120	380/380/120	Ø400/170	Ø500/170
Driving caps	PUD 17-33	A 18/26	A 48	AZD 12-14 L	UZD 14-28	AZD 36-40	
A/B/H	1250/720/420	1160/660/420	1080/730/470	1440/590/520	1300/705/520	1320/750/520	
C	315	390	430	360	420	440	
Mass [kg]	1250	1150	1400	1750	1900	2050	
a/b (or Ø) / h ¹⁾	Ø500/170	600/400/170	600/400/170	600/300/170	600/400/170	600/400/170	

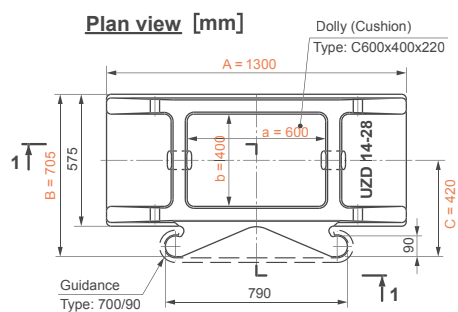
¹⁾ Dimensions of the dolly recess.

Driving caps - Examples

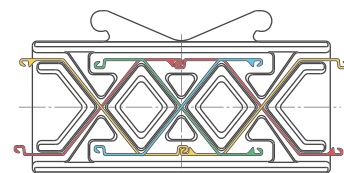
Section 1-1 (UZD 14-28) [mm]



Plan view [mm]

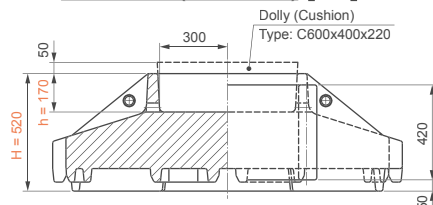


Bottom view

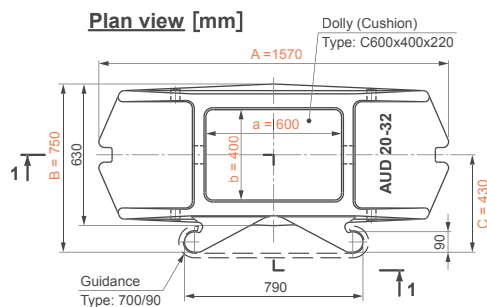


Position of section AZ 17-700 AZ 28-700
as double and single pile

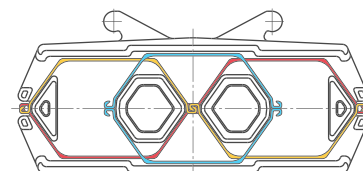
Section 1-1 (AUD 20-32) [mm]



Plan view [mm]

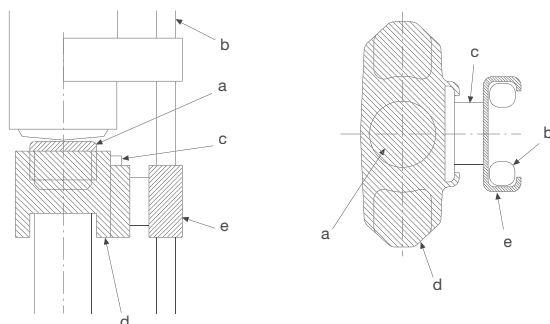


Bottom view



Position of section AU 18 / 20 / 23 / 25
as double, single and box pile

Arrangement of driving caps



a = dolly/cushion
b = leader
c = sliding guide
d = driving cap
e = leader slide

The leader slide is not provided by ArcelorMittal.

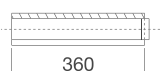
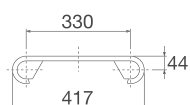


Sliding guides

Sliding guides are designed to guide the driving cap along the lead, thus guaranteeing proper alignment of the

hammer and the centre of the driving cap. Their adaptation to the leader is normally carried out in situ.

Dimensions

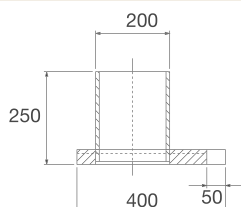
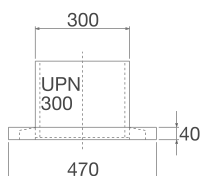


Designation

330/50

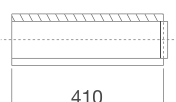
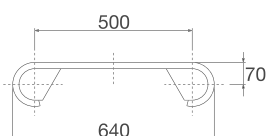
Corresponding driving caps

PUS and US-B



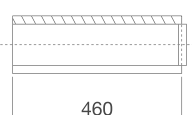
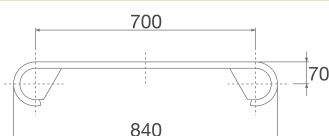
30

UD



500/90

A and AUS



700/90

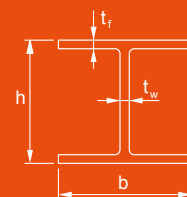
AUD and AZD

HP piles

HP piles are special H-shaped bearing piles with webs and flanges of the same thickness. They are used as bearing piles for foundation projects such as bridges and industrial facilities or as anchoring piles for quay or excavation walls.

HP piles have the following common characteristics:

- Guaranteed pile integrity after installation. No length limitations due to trimming or splicing.
- Easy to store, handle and install. Easy connection to superstructure.
- Bearing capacity available right after installation, capacity can be determined during installation.
- Excellent durability. Corrosion rates of embedded HP piles are extremely low.
- HP piles are able to take high tensile and bending forces.



HP bearing piles range from HP 200 to HP 400. They are available in structural steel grades (yield strength 235 – 355 MPa) as well as in high-strength steel grades (yield strength 355 – 460 MPa) including HISTAR quality.

Rolling tolerances on dimensions, shape, weight and length are fixed in accordance with EN 10034.

Minimum delivery length is 8 m, maximum delivery length is 24.1 m for HP 200/220/260 and 33.0 m for HP 305/320/360/400.

The table below contains but a small extract of the available piles. **Please refer to the brochure “Wide flange bearing piles” for detailed information on the entire HP range.**

Section	Mass kg/m	Dimensions				Sectional area cm ²	Total area A _{tot} = hxb cm ²	Perimeter P m	Moment of inertia		Elastic section modulus	
		h mm	b mm	t _w mm	t _f mm				y-y cm ⁴	z-z cm ⁴	y-y cm ³	z-z cm ³
HP 200 x 43	42.5	200	205	9.0	9.0	54.1	410	1.18	3888	1294	389	126
HP 220 x 57	57.2	210	225	11.0	11.0	72.9	472	1.27	5729	2079	546	185
HP 260 x 75	75.0	249	265	12.0	12.0	95.5	660	1.49	10650	3733	855	282
HP 305 x 110	110	308	311	15.3	15.4	140	955	1.80	23560	7709	1531	496
HP 320 x 117	117	311	308	16.0	16.0	150	958	1.78	25480	7815	1638	508
HP 360 x 152	152	356	376	17.8	17.9	194	1338	2.15	43970	15880	2468	845
HP 400 x 213	213	368	400	24.0	24.0	271	1472	2.26	63920	25640	3474	1282

t_w = t_{web} t_f = t_{flange}

Deurganckdock CT, Antwerp, Belgium



Durability of steel sheet piles

Unprotected steel in the atmosphere, water or soil is subject to corrosion that may lead to damage. Local weakening and rusting-through are normally considered to be maintenance problems that can be remedied locally. Depending on life-time requirements and accessibility of the structure, the service life of a steel structure can be achieved by one or a combination of following methods:

- protection by coating (typically only in high corrosion zones),
- use of a stronger section or a higher steel grade to create a 'statical reserve',

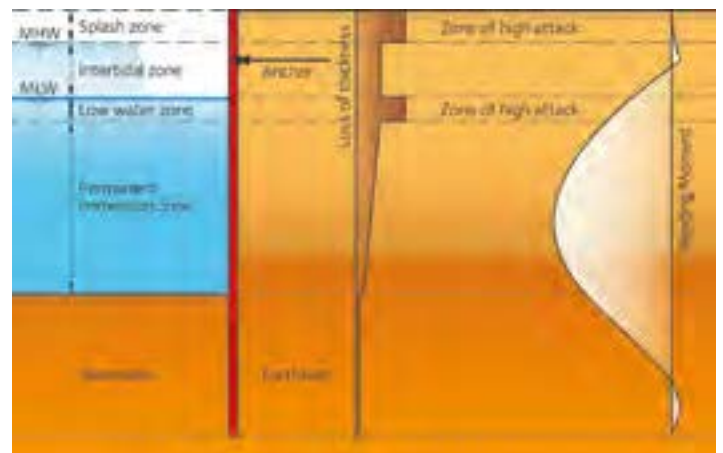
- use of Marine Grade Steel ASTM A690 (splash zone),
- avoiding important bending moments in the high corrosion zones,
- extension of the concrete capping beam below the low-water level,
- cathodic protection by impressed current or by sacrificial anodes (protects the surface constantly in contact with water),
- use of AMLoCor® steel grade (permanent immersion zone and low water zone).

Corrosion rates



The maximum steel stress in most maritime sheet pile structures is situated within the permanent immersion zone. The loss of thickness in this zone is considerably lower than in the high corrosion zones. Steel stress is generally very low in the maximum corrosion zones: splash zone & low water zone. These locations are therefore not the critical part of the structure despite their negative appearance if unprotected.

Typical loss of thickness due to corrosion and moment distribution for anchored sheet pile wall in marine environment:



The use of a new steel grade AMLoCor® significantly increases the design life of marine structures. Please refer to EC 3 Part 5 (EN 1993-5) for details on loss of steel thickness as a result of exposure in different media.

Surface coating

The classical corrosion protection for steel sheet piling is surface coating. EN ISO 12944 deals with protection by paint systems and its various parts cover all the features that are important in achieving adequate corrosion protection. It is essential that the steel surface is properly prepared: removal of millscale by abrasive blasting (cf. ISO 8501-1) before applying a coating system. Most systems consist of one or two primers, an intermediate coat and a topcoat. Zinc primers are used frequently due to their good corrosion-inhibiting properties.

Intermediate coats increase the total thickness and thus increase the distance for moisture diffusion to the surface. Topcoats are chosen for colour and gloss retention, for chemical resistance, or for additional resistance to mechanical damage. Epoxies are generally used for seawater immersion and chemical resistance, polyurethanes for colour and gloss retention. In the following, paint systems are proposed for different environments according to classifications of EN ISO 12944.

Metro Copenhagen, Denmark



Atmospheric exposure

In applications such as retaining walls, the aesthetic and functional look of the sheet piles is important, so polyurethane finishes – which are easy to apply and maintain – are the most common choice due to their good gloss and colour retention characteristics.

Proposal (EN ISO 12944 – Table A4, corrosivity category C4):

Epoxy primer
Recoatable epoxy intermediate coating
Aliphatic polyurethane topcoat

Nominal dry-film thickness of the system: 240 µm



Dyke, Hamburg, Germany

Sea water & fresh water immersion Im1 / Im2

For long-term performance of steel structures immersed in sea water and in fresh water there should be no compromise on quality as abrasion and impact may damage the coating system. The application must be properly carried out and inspected on a regular basis. Cathodic protection is sometimes specified in combination with a (fully compatible) coating system.

Proposal (EN ISO 12944 – Table A6, corrosivity category Im2)

Epoxy primer

Solvent-free epoxy coating or epoxy glass flake

Nominal dry-film thickness of the system: 450 µm

Lock, Venice, Italy



Waste disposal

Excellent protection is essential due to exposure to highly aggressive substances. The coating system must have outstanding resistance to mineral and organic acids and other chemicals as well as capacity to withstand abrasion and impacts.

Proposal

Micaceous iron oxide pigmented polyamide cured epoxy primer
Polyamide-cured-epoxy coating with increased chemical resistance

Nominal dry-film thickness of the system: 480 µm

Waste disposal, Horn, Austria

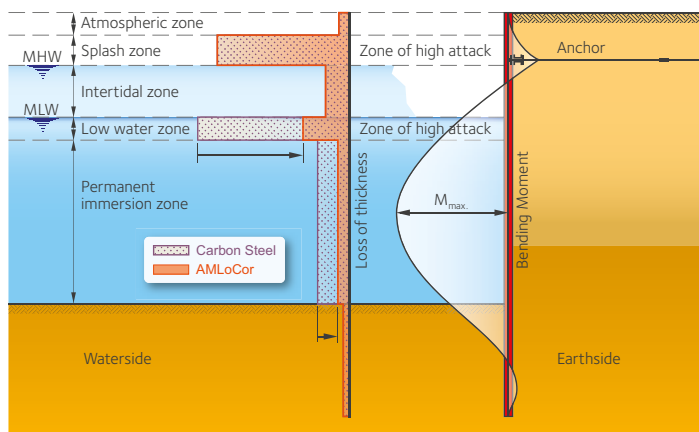


AMLoCor®

New corrosion resistant steel grade for marine applications

AMLoCor® is ArcelorMittal's new 'low corrosion' steel grade that will revolutionize the design of port structures in the future.

The **key advantage of AMLoCor®** is a significant reduction of the corrosion rates in the 'Low Water Zone' (LWZ) and in the 'Permanent Immersion Zone' (PIZ), which is normally the location of the maximum bending moments, and consequently highest steel stresses. This new steel grade is the solution from our R&D department to address the major concern of designers and port authorities: **durability of marine structures** like quay walls, breakwaters, jetties.

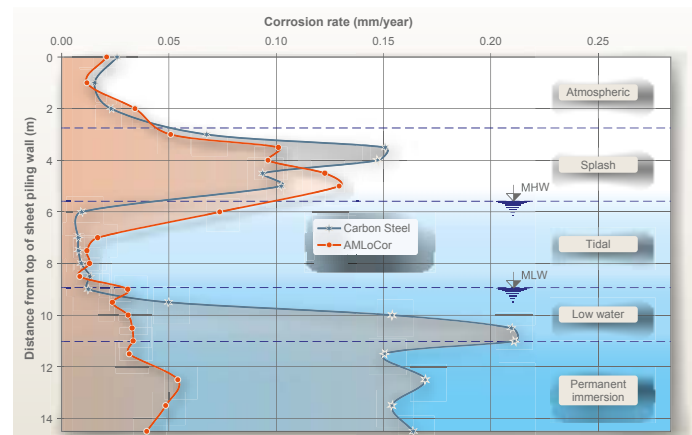


Typical loss of steel thickness in a marine environment: regular carbon steel vs. AMLoCor®

Eurocode 3 Part 5 contains reference tables with typical corrosion rates valid for standard carbon steel in northern European countries. In-situ tests have proven that the **loss of steel thickness of AMLoCor is reduced by a factor 3 (PIZ) to 5 (LWZ) compared to standard structural steel** in the critical zones.

AMLoCor leads to considerable savings in steel weight compared to the unprotected carbon steel piling solution, as soon as loss of steel thickness due to corrosion in the immersion zone is significant. Cathodic protection or coatings can be used to increase the service life of the sheet pile structure. However, **AMLoCor® will in many cases yield the most cost-effective solution in the long-term.** AMLoCor is compatible with cathodic protection and coatings.

In addition AMLoCor protects steel from "ALWC" (Accelerated Low Water Corrosion) which is related to biological activity enhancing degradation of steel in the low water zone.

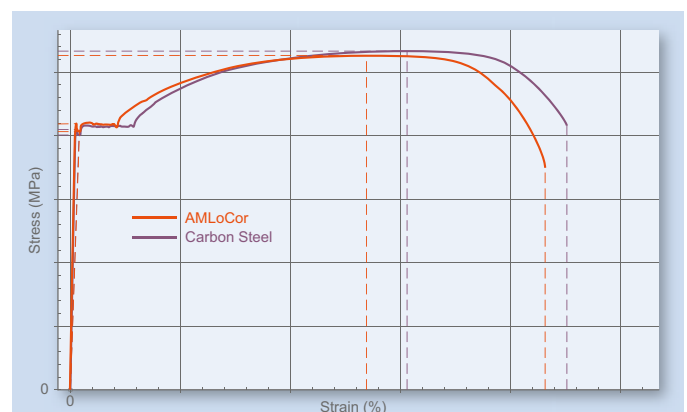


The mechanical properties of AMLoCor steel are fully equivalent to standard piling grades, so that structural resistance can be determined according to all relevant design codes used for steel sheet piling structures, like EN 1993-5:2007 in European countries.

Some AZ sections are already available in AMLoCor steel grades, ranging from **AMLoCor Blue 320 to Blue 390** (yield strength 320 MPa up to 390 MPa). Please check our website for regular updates on available sections.

A driving test was performed in very compact soil in Denmark. Sheet piles in S 355 GP and AMLoCor Blue 355 were driven into very hard soils with some boulders. The sheet piles were monitored during driving, then pulled out and inspected. This test has demonstrated that the behaviour of AMLoCor sheet piles is as good as regular carbon steel sheet piles.

For more detailed information (e.g. on welding) please check our **new brochure 'AMLoCor®', part 1 to 3.**



Typical Stress - Strain diagram of carbon steel & AMLoCor®

Watertightness

Steel sheet piles are completely impervious. The only possibility of water infiltrating through a sheet pile wall is by flowing through the interlock. Due to its shape the Larssen interlock naturally provides high seepage resistance. Sealing systems are therefore not necessary for applications such as temporary retaining walls where moderate rates of seepage are acceptable. If medium to high seepage resistance is required, e.g. cut-off walls for contaminated sites, retaining structures for bridge abutments or tunnels, double sheet piles with sealed or welded joints are recommended. **Please refer to our brochure “The impervious sheet pile walls” for further details.**

The following sealing systems are used to increase the watertightness of sheet pile walls:

- Bituminous filler: **Beltan® Plus**.
Maximal water pressure: 100 kPa.
- Wax & mineral-oil-based filler: **Arcoseal™**.
Maximal water pressure: 100 kPa.
- Water-swelling product: **ROXAN® Plus** System.
Maximal water pressure: 200 kPa.
- **AKILA®** System.
Maximal water pressure: 300 kPa.
- Welding: 100% watertight.

As Darcy's law for discharge through homogenous structures is not applicable to leakage phenomenon through sheet pile interlocks, a new concept of 'joint resistance' has been developed by GeoDelft (Deltares).

$$q(z) = \rho \cdot \Delta p(z) / \gamma$$

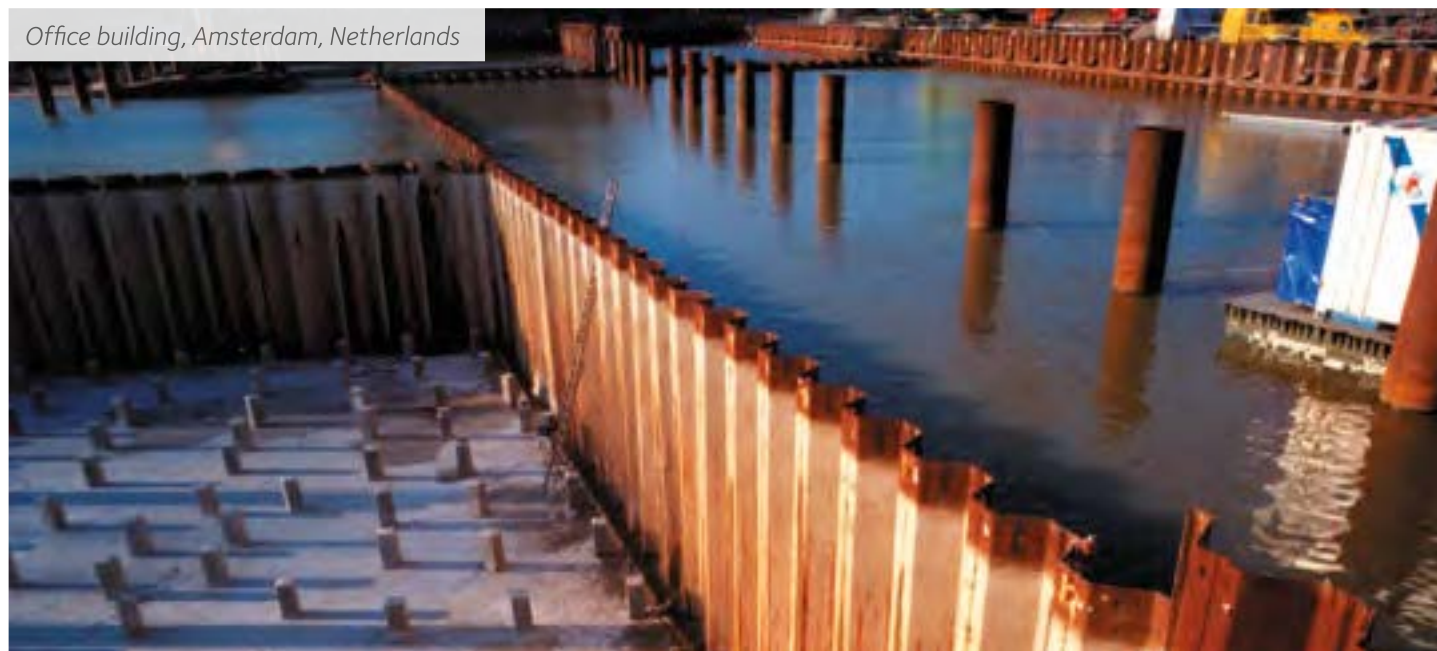
$q(z)$ water discharge [$\text{m}^3/\text{s}/\text{m}$]
 ρ inverse joint resistance [m/s]
 $\Delta p(z)$ pressure drop at level z [kPa]
 γ unit weight of water [kN/m^3]

Sealing system/method	ρ [10^{-10}m/s]			Application of the system	Cost ratio ¹⁾
	100 kPa	200 kPa	300 kPa		
No sealant	> 1000	–	–	–	0
Beltan® Plus	< 600	not recommended	–	easy	1.0
Arcoseal™	< 600	not recommended	–	easy	1.2
ROXAN® Plus	0.5	0.5	–	with care	1.8
AKILA®	0.3	0.3	0.5	with care	2.1
Welded interlocks	0	0	0	²⁾	5.0

¹⁾ Cost ratio = $\frac{\text{Cost of sealing system}}{\text{Cost of bituminous sealing system}}$

²⁾ After excavation for the interlock to be threaded on jobsite.

Office building, Amsterdam, Netherlands

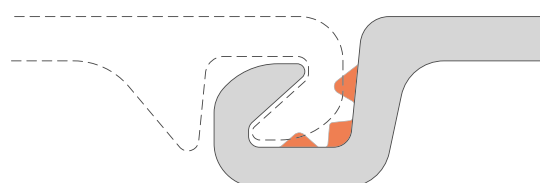


AKILA® sealing system

AKILA® is a **brand new environmentally friendly high performance sealing system** for ArcelorMittal steel sheet piles. The system is based on three sealing 'lips' mechanically extruded into the free interlocks using a product called MSP-1. The common interlock of double piles is sealed with a second product called MSP-2.

MSP-1 and MSP-2 belong to the family of **silane modified polymers** (MS-Polymers). Both products resist to humidity and weathering. Their main characteristics are:

- **single component elastic sealants** with a density of
 - 1.41 g/cm³ for MSP-1
 - 1.48 g/cm³ for MSP-2
- UV-stable
- **excellent adhesion to steel**
- resist to temperatures between -40°C and +90°C (up to 120°C for short periods)
- elongation at break > 380%
- Shore A hardness after complete polymerization
 - 58 for MSP-1
 - 44 for MSP-2 (after 14 days)
- durable in contact with freshwater, seawater, as well as various hydrocarbons, bases and acids (depending on concentration – a complete list is available on request).



Sketch of MSP-1 product extruded into the free interlock

MS-Polymers are solvent free and do not contain isocyanates. They can be considered as environmentally friendly products. AKILA® is certified by the 'Hygiene-Institut des Ruhrgebiets' in Germany as suitable for use in contact with groundwater.

The interlocks of the free interlocks have to be chamfered at the top (see sketch). Penetration of soil into the interlocks during driving should be prevented, for instance by inserting a bolt at the bottom of the interlock (bolt tack welded).

The ambient temperature during installation must be above 0°C. Additionally, to improve the sliding of the interlocks, an environmentally friendly lubricant must be applied to the sealant in the interlocks prior to driving. The layout and driving direction of the sheet pile wall shall be determined before ordering the sheet piles (delivery form of double piles, chamfering of interlocks, etc).

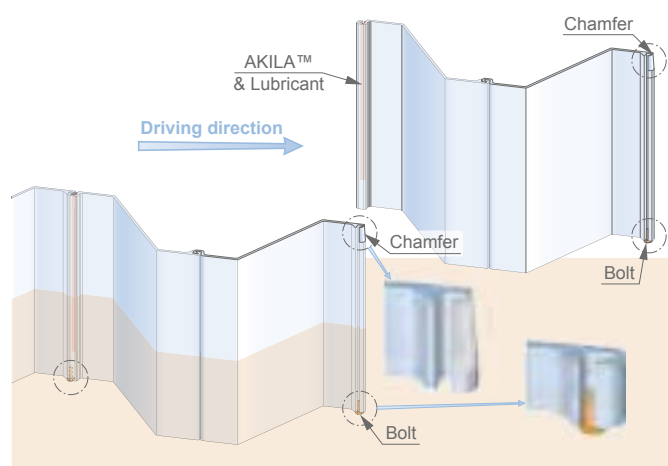
Inverse joint resistance ρ_m

A series of in-situ tests were carried out in stiff clays and in soft sandy soils. Single and crimped double sheet piles fitted out with the AKILA® system were driven into the ground using an impact hammer as well as a vibratory hammer.

In case of vibrodriving, sheet piles were driven continuously at a minimum penetration rate of 3 meters per minute. After installation, watertightness was tested at **water pressures of 2 and 3 bar**, according to a procedure developed by Delft Geotechnics (Deltares) and ArcelorMittal. The testing and the results were witnessed and certified by 'Germanischer Lloyd', an independent third party.

The average **inverse joint resistance ρ_m** was determined according to EN 12063.

	ρ_m (m/s)	
water pressure	200 kPa	300 kPa
single piles (MSP-1)	4.9×10^{-11}	8.6×10^{-11}
double piles (MSP-1 & MSP-2)	3.3×10^{-11}	4.7×10^{-11}



Installation recommendations (driving direction, chamfer, etc)

For more information contact our technical department.

Environmental product declaration

ArcelorMittal is the first steel manufacturer in the world that has performed a Life Cycle Assessment (LCA) study dedicated to steel sheet piles¹, which has been peer reviewed to be in compliance with the ISO standards 14 040 and 14 044.

For detailed information, please consult our brochure "Environmental product declaration for Steel Sheet Piling structures".

Environment has become a major focus in the construction industry. Public authorities and private investors are seeking more environmentally-friendly construction methods and products. Environmental factors already influence the choice of the construction solution in some countries.

The results of a LCA are related to a feature representative of the product and the service being expected from it. The **functional unit** is used to describe the primary functions to be fulfilled by a product system. When comparing several products, it is necessary to consider an identical functional unit for both products.

The major benefit of steel sheet piles versus alternative solutions is the fact that **besides being 100% recyclable, steel sheet piles can be reused multiple times, hence decreasing its environmental burden.**

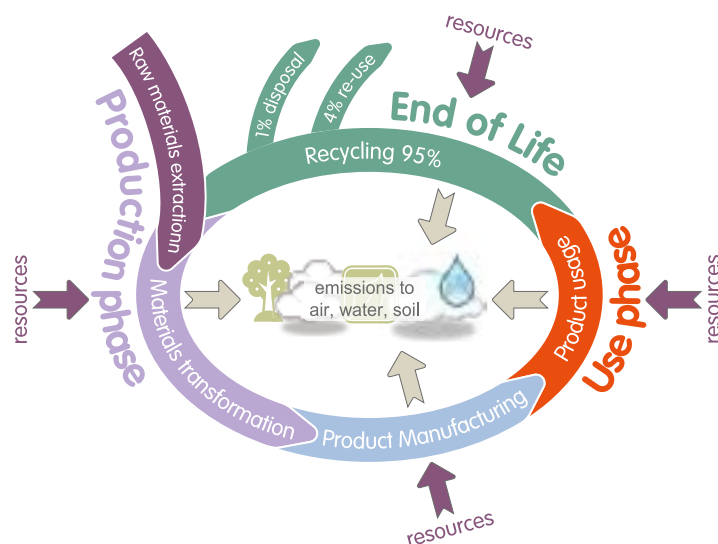
Environmental indicators

LCA practitioners usually assess some common **environmental indicators**. Generally, several substances contribute to a given environmental impact. For example, carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O) and some other components all contribute to greenhouse gases emissions, respectively with different weights according to academic models, and the resulting impact is expressed as "CO₂ equivalent" emissions because CO₂ is the major contributor. This is a way to illustrate one simple aggregated value for the impact. The main environmental indicators are:

- Primary Energy Consumption (MJ)
- Global Warming Potential (CO₂-equivalent)
- Acidification (acidification of rain, SO₂-eq)
- Ozone formation at low altitude (summer smog, C₂H₄-eq)
- Eutrophication (PO₄-eq)
- Water (kg of water used).

Environmental profile of steel sheet piles

The functional unit selected is a 100 m retaining wall structure. Results are aggregated as the sum of the impacts of the production and end of life stage. During the use phase, impacts are negligible. Certified data used for the environmental profile calculations of the steel structure comes from the "World Steel Association" and it represents European average values for "sections" and World average values for "rebars". They are dated from 2010. According to the LCA approach, all elements such as transportation, as well as installation and extraction of the sheet piles are taken into account. Usually wall and wailing parts are recovered and therefore recycled. The distribution of impacts is equivalent for all indicators: **steel production is the main contributor** (between 93% to 98% of the impacts).



Environmental burdens of steel products used for sheet piling structures

The official World Steel Association formula used to calculate the environmental burden E is:

$$E = E' - (RR - RC) \cdot LCI_{\text{scrap}} \quad \text{and} \quad LCI_{\text{scrap}} = y \cdot (X_{\text{pr}} - X_{\text{re}})$$

With:

- E' "cradle to gate" environmental burden due to the production phase
- RR Recycling Rate at the end of life
- RC Recycled Content = amount of scrap used to produce steel
- LCI_{scrap} represents the environmental value of scrap (**environmental burden avoided by using scrap** as raw material)
- y efficiency of the electrical arc furnace in converting scrap into steel
- X_{pr} LCI for primary steel production (BOF: 100% iron ore)
- X_{re} LCI for secondary steel production (EAF: 100% scrap)

This **formula allows taking into account the benefit of the end of life recycling**, penalizing steel if the recycling rate is lower than the recycled content. Two LCI among the 16 life cycle inventories (LCI) of steel products provided by World Steel Association were used for this LCA.

¹ Hettinger, A.L.; Bourdouxhe, M.P.; Schmitt, A. "Comparative Environmental evaluation of retaining structures made of steel sheet piling or reinforced concrete". ArcelorMittal, 2010.

Delivery conditions

Tolerances on shape and dimensions of hot rolled steel sheet piles according to EN 10248 (reduced tolerances on request)

Tolerances	AU™, PU®, GU®	AZ®	AS 500®	HZ®-M
Mass ¹⁾	± 5%	± 5%	± 5%	± 5%
Length (L)	± 200 mm	± 200 mm	± 200 mm	± 200 mm
Height (h) ²⁾	h ≤ 200 mm: ± 4 mm h > 200 mm: ± 5 mm	h ≥ 300 mm: ± 7 mm	-	h ≥ 500 mm: ± 7 mm
Thicknesses (t,s)	t, s ≤ 8.5 mm: ± 0.5 mm t, s > 8.5 mm: ± 6%	t, s ≤ 8.5 mm: ± 0.5 mm t, s > 8.5 mm: ± 6%	t > 8.5 mm: ± 6%	t, s ≤ 12.5 mm: -1.0 mm / +2.0 mm t, s > 12.5 mm: -1.5 mm / +2.5 mm
Width single pile (b)	± 2% b	± 2% b	± 2% b	± 2% b
Width double pile (2b)	± 3% (2b)	± 3% (2b)	± 3% (2b)	± 3% (2b)
Straightness (q)	≤ 0.2% L	≤ 0.2% L	≤ 0.2% L	≤ 0.2% L
Ends out of square	± 2% b	± 2% b	± 2% b	± 2% b

¹⁾ From the mass of the total delivery.

²⁾ Of single pile.

Maximum rolling lengths (longer sections available on request)

Section	AZ	AU, PU	GU ¹⁾	AS 500	HZ-M	RH / RZ	OMEGA 18	C9 / C14	DELTA 13
Length [m]	31	31	28	31	33	24	16	18	17

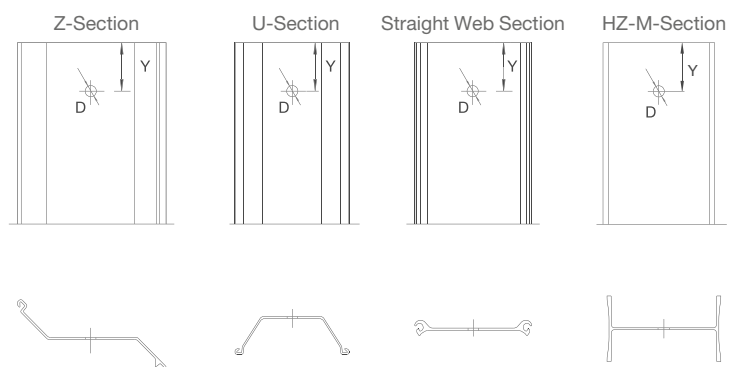
¹⁾ 2014

Handling holes

Sheet pile sections are normally supplied without handling holes. If requested, they can be provided with handling holes in the centerline of the section. The standard handling hole dimensions are as follows:

Diameter D [mm]	40	40	50	50	63.5	40
Distance Y [mm]	75	300	200	250	230	150

Diameter D [in]	2.5
Distance Y [in]	9



Markings

The following markings can be supplied on request:

- Colour marks defining section, length and steel grade.
- Adhesive stickers showing the customer's name, destination, order number, type and length of profile and steel grade.

	AZ 26 – 700	28000	mm
	S430GP		
	1400004321	002907	CIVIL & COASTAL CONSTRUCTION CAPE TOWN

Steel grades of sheet pile sections

Steel grade EN 10248	Min. yield strength R_{eH} MPa	Min. tensile strength R_m MPa	Min. elongation $L_0=5.65\sqrt{S_0}$ %	Chemical composition (% max)					
				C	Mn	Si	P	S	N
S 240 GP	240	340	26	0.25	–	–	0.055	0.055	0.011
S 270 GP	270	410	24	0.27	–	–	0.055	0.055	0.011
S 320 GP	320	440	23	0.27	1.70	0.60	0.055	0.055	0.011
S 355 GP	355	480	22	0.27	1.70	0.60	0.055	0.055	0.011
S 390 GP	390	490	20	0.27	1.70	0.60	0.050	0.050	0.011
S 430 GP	430	510	19	0.27	1.70	0.60	0.050	0.050	0.011

ArcelorMittal mill specification

S 460 AP	460	550	17	0.27	1.70	0.60	0.050	0.050	0.011
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AMLoCor®	Min. yield strength R_{eH} MPa	Min. tensile strength R_m MPa	Min. elongation $L_0=5.65\sqrt{S_0}$ %	Chemical composition (% max)							
				C	Mn	Si	P	S	N	Cr	Al
Blue 320	320	440	23	0.27	1.70	0.60	0.05	0.05	0.011	1.50	0.65
Blue 355	355	480	22	0.27	1.70	0.60	0.05	0.05	0.011	1.50	0.65
Blue 390	390	490	20	0.27	1.70	0.60	0.05	0.05	0.011	1.50	0.65

All the sections can be delivered in steel grades according to EN 10248-1, but not all sections are available in all steel grades. Below table summarizes the current possibilities. Special steel grades like **S 460 AP**, American **ASTM A 572** steel grades, steels with improved corrosion resistance like **AMLoCor** and **ASTM A 690**, or steels with copper addition in accordance with EN 10248 Part 1 Chapter 10.4 can be supplied on request. A modified steel grade A 690 with higher yield strength is also available upon request.

Please contact us for updated information.

Galvanisation has an influence on the chemical composition of the steel and must therefore be specified in the purchase orders.

We strongly recommend informing us of all surface treatment to be applied to the product when placing orders.

ArcelorMittal can also provide steel grades complying with other standards (see table below).

Europe	EN 10248	S 270 GP	S 320 GP	S 355 GP	S 390 GP	S 430 GP	S 460 AP ¹⁾
USA	ASTM	A 328	–	A 572 Gr. 50; A 690	A 572 Gr. 55	A 572 Gr. 60	A 572 Gr. 65
Canada	CSA	Gr. 260 W	Gr. 300 W	Gr. 350 W	Gr. 400 W	–	–
Japan	JIS	SY 295	–	–	SY 390	–	–

¹⁾ ArcelorMittal mill specification.

Section \ Steel Grade	EN 10248							ASTM		AMLoCor®		
	S 240 GP	S 270 GP	S 320 GP	S 355 GP	S 390 GP	S 430 GP	S 460 AP*	A 572	A 690	Blue 320	Blue 355	Blue 390
AZ-770/700	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AZ	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AU	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PU	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GU-N/S	✓	✓	✓	✓	✓	✓	✓	✖	✖	✓	✓	✓
GU-400	✓	✓	✓	✓	✓	✖	✖	✖	✖	✓	✓	✓
HZ-M	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
RH / RZD / RZU	✖	✖	✖	✖	✖	✓	✓	✖	✓	✖	✖	✖
C 9	✖	✖	✖	✓	✖	✖	✖	✓	✖	✓	✖	✖
C 14	✖	✖	✖	✓	✖	✖	✖	✖	✖	✓	✖	✖
Delta 13	✖	✖	✖	✓	✖	✖	✖	✖	✖	✓	✖	✖
Omega 18	✖	✖	✖	✖	✖	✓	✓	✖	✖	✓	✓	✓

✓ available

✖ please contact us

✖ currently unavailable

(*) ArcelorMittal mill specification

Geometric tolerances of tubular piles

Tolerance on pile length: +/- 200 mm

Standard	Outside diameter D		Wall thickness t	Straightness	Out-of-roundness		Mass	Maximum weld bead height ¹⁾
EN 10219-2	+/- 1% +/- 10.0		+/- 10% +/- 2.0	0.20% of total length	+/- 2%		+/- 6%	t ≤ 14.2: 3.5 t > 14.2: 4.8
API 5L	≤ 1422	+/- 0.5% ≤ 4.0	< 15.0: +/- 10% ≥ 15.0: +/- 1.5	0.20% of total length	D/t ≤ 75 D < 1422	+/- 1.5% ≤ 15.0	+ 10% - 3.5%	t ≤ 13.0: 3.5 t > 13.0: 4.5
ISO 3183	> 1422	as agreed			Else	as agreed		

¹⁾ Tolerance on height of external weld bead for submerged arc-welded hollow sections.
Note: values in "mm" except where specified

Steel grades of tubular pile

Steel grade EN 10219-1	Min. yield strength R _{eH} (t ≤ 16 mm) MPa	Min. yield strength R _{eH} (16 < t ≤ 40 mm) MPa	Min. tensile strength R _m (3 ≤ t ≤ 40 mm) MPa	Min. elongation L ₀ (t ≤ 40 mm) %	Chemical composition (% max)						
					C	Mn	P	S	Si	N	CEV (t ≤ 20 mm)
S 235 JRH	235	225	340-470	24	0.17	1.40	0.040	0.040	-	0.009	0.35
S 275 JOH	275	265	410-560	20	0.20	1.50	0.035	0.035	-	0.009	0.40
S 355 JOH	355	345	490-630	20	0.22	1.60	0.035	0.035	0.55	0.009	0.45
S 420 MH	420	400	500-660	19	0.16	1.70	0.035	0.030	0.50	0.020	0.43
S 460 MH	460	440	530-720	17	0.16	1.70	0.035	0.030	0.60	0.025	-

Steel grade API 5L ¹⁾ ISO 3183	Min. yield strength R _{eH} MPa	Min. tensile strength R _m MPa	Min. elongation ²⁾ %	Chemical composition for PSL 1 pipe with t ≤ 25.0 mm ⁴⁾ (% max)			
				C ³⁾	Mn ³⁾	P	S
L 245 or B	245	415	23	0.26	1.20	0.030	0.030
L 290 or X 42	290	415	23	0.26	1.30	0.030	0.030
L 320 or X 46	320	435	22	0.26	1.40	0.030	0.030
L 360 or X 52	360	460	21	0.26	1.40	0.030	0.030
L 390 or X 56	390	490	19	0.26	1.40	0.030	0.030
L 415 or X 60	415	520	18	0.26 ⁵⁾	1.40 ⁵⁾	0.030	0.030
L 450 or X 65	450	535	18	0.26 ⁵⁾	1.45 ⁵⁾	0.030	0.030
L 485 or X 70	485	570	17	0.26 ⁵⁾	1.65 ⁵⁾	0.030	0.030

¹⁾ API 5L (2007): American Petroleum Institute / ISO 3183 (2007). PSL: Product Specification Level.

²⁾ Minimum elongation: depends on tensile test piece cross-sectional area.

³⁾ For each reduction of 0.01% below the specified max C concentration, an increase of 0.05% above the specified max Mn concentration is permissible, up to a max of 1.65% for grades L245/B to L360/X52, 1.75% for L390/X56 to L450/X65 and 2.00% for L485/X70.

⁴⁾ 0.50% max for Cu, 0.50% max for Cr, 0.15% max for Mb.

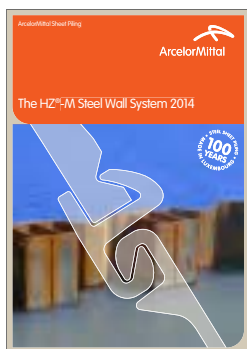
⁵⁾ Unless otherwise agreed.



Tubular pile mill, Dintelmond, Netherlands

Documentation

Please refer to our website to download all our documentation: sheetpiling.arcelormittal.com
or contact us via E-mail: sheetpiling@arcelormittal.com



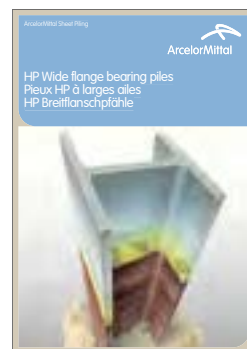
The HZM Steel Wall System
GB (2014), DE, FR, US, IT, SP, PT
(2011)



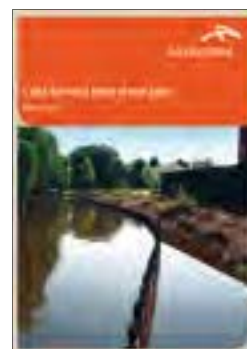
AS 500 Straight web steel sheet
piles. Design and Execution.
GB



Spirally welded steel pipes
GB



HP bearing piles
GB, DE, FR, SP



Cold formed steel piles
GB, DE, FR, NL



Harbour construction
GB



Underground car parks
GB, PT



Underground car parks – fire resistance
GB



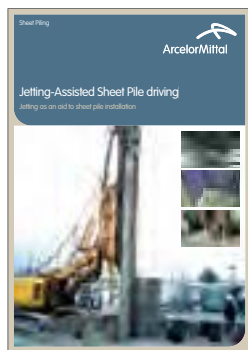
High speed line south – NL
GB, FR, NL



Environmental
Product Declaration
GB



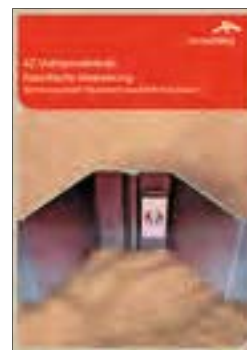
Installation of sheet piles
GB, DE, FR



Jetting-Assisted Sheet pile driving
GB, DE, FR



Anchoring of sheet piles
GB, DE



Off-centre anchoring
GB, DE, FR



Impervious steel sheet pile walls
GB, DE, FR



Piling handbook
GB
(Electronic file only)



Declutching detector
GB, DE, FR



AMLoCor Steel Grade
AMLoCor 1A
GB, DE, RU



AZ sheet piles in combined walls
GB, DE, FR



Waste disposal
GB, DE, FR



Trademarks

ArcelorMittal is the owner of following trademark applications or registered trademarks:

"AS 500", "AU", "AZ", "GU", "HZ", "PU", "AMLoCor", "AKILA", "Beltan", "ROXAN", "Arcoseal".

In communications and documents the symbol TM or [®] must follow the trademark on its first or most prominent instance, for example:

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AZ 26-700N is a steel sheet pile manufactured by ArcelorMittal group

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www.fsc.org

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New app for iPad™
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