ArcelorMittal | skylinesteel

Pipe-Z Combined Walls

About Skyline Steel

A premier steel foundation supplier serving the US, Canada, Mexico, Central America, Caribbean and South American markets, Skyline Steel is a wholly-owned subsidiary of ArcelorMittal, the world's largest and most respected steel company. ArcelorMittal's backing complements and synergizes Skyline Steel's internal strengths and empowers it to service its customers and the industry.

We have over thirty sales offices across two continents and a robust infrastructure comprised of manufacturing, coating, and fabrication facilities; dozens of stocking locations; an efficiently-coordinated supply chain; and exclusive engineering support. Collectively, these functions support a dynamic sales team that supplies hundreds of thousands of tons of steel foundation products to the industry every year.

Our flagship products include H-piles, pipe piles, hot rolled and cold formed steel sheet piles, threaded bar, micropiles, accessories, structural shapes and connectors. This product portfolio supports a variety of applications, including bridges, buildings, levees, locks and dams, ports, retaining walls, underground parking garages, environmental barrier walls, and wind towers. Of the products we manufacture and supply, 80% are made from recycled steel and are 100% recyclable.

Customer focus, our core philosophy

A strong customer focus has always been a legacy at Skyline Steel. In fact, with us, customer service goes beyond the salesperson-contractor relationship and steel delivery—it continues beyond project completion. Our well-connected network of stockyards throughout North and South America allows our sales team to supply customers with the materials needed to continue working and contractors can feel assured that steel will be available as needed, and on schedule.

Skyline Steel, your true project partner

Skyline Steel's knowledgeable engineering team works with owners, engineers, and contractors long before projects are advertised. To ensure seamless project coordination and completion, engineers propose solutions through all aspects of design, material selection, installation, and construction sequencing. Engineering support is extended even further to include provision of onsite assistance to ensure effective resolution after a project has started. Our relationship with the industry extends beyond sales—we are your *true project partner*.

Skyline Steel's manufacturing capabilities include spiralweld pipe, rolled and welded pipe, cold form sheet piling, and threaded bar in Pennsylvania, Mississippi, Kentucky, Ohio, Illinois, and Washington. To customize and protect these products, we own and operate fabrication and coating facilities in Ohio, Pennsylvania, and Arkansas. Skyline Steel also represents ArcelorMittal and external mills worldwide.

Our parent company: ArcelorMittal

With an annual steel production of over 100 million tons and operations in 60 countries, ArcelorMittal is indisputably the world's largest steel producer. A true leader, ArcelorMittal has led the consolidation of the world steel industry and ranks, today, as the only true *global* steelmaker. The company is an unchallenged leader in all major global markets, including automotive, construction, household appliances, and packaging. ArcelorMittal is also the pioneer in R&D and technology and owns sizeable captive supplies of raw materials in addition to operating extensive distribution networks. Its industrial presence in Europe, Asia, Africa, and the Americas gives ArcelorMittal access to all key steel markets—emerging to mature.

Pipe-Z Steel Wall System

Pipe-Z Wall Systems primarily serve as a key component in the construction of large bulkheads, such as: container ports, marinas, wharfs and other waterfront structures.

In addition, Pipe-Z Wall Systems provide an ideal solution for other applications, including: large capacity retaining walls with deep excavations, breakwaters, deep cofferdams, and other structures that require retaining walls to resist large loads.

What is the Pipe-Z Steel Wall System?

The Pipe-Z Steel Wall System is a combined wall system that incorporates:

- **Pipe Piles**: Main structural support of the system
- **Sheet Pile Pair**: Intermediate element
- **Connectors**: Welded to the pipes; provides a link between the pipes and sheet piles

Pipe-Z Steel Wall Systems Provide Custom Solutions

Pipe-Z Steel Wall Systems are extremely customizable through variations in pipe diameter sizes, pipe wall thickness and a wide assortment of intermediary sheet piles. They work in a variety of configurations, providing solutions for many different project needs.

Pipe-Z Steel Wall System Components

Pipe Piles

Pipe piles fulfill two primary roles:

1. Resist horizontal loads caused by soil pressure, hydrostatic pressure and surcharge loads
2. Resist vertical loads when used as bearing piles

Specifications vary depending on your unique configuration. In some cases, pipe piles resist only horizontal loads. In other configurations, pipe piles resist a combination of horizontal and vertical loads.

Intermediate Sheet Piles

In the Pipe-Z Steel Wall System, intermediate sheet piles act as the earth-retaining element, transferring loads to the king piles. One of the most extraordinary features of the Pipe-Z Steel Wall System is that it supports an extensive range of possible combinations. The Pipe-Z Steel Wall System can be configured with a wide range of pipe sizes, diameters and thicknesses, as well as a complete range of Z sheet piles, to provide solutions for your individual project needs.

The maximum capacity of the system varies depending on the configuration and steel grade. Some Pipe-Z Steel Wall System configurations can safely resist bending moment capacities in excess of 2000 kip-ft/ft.

Connectors

Pipe-Z Steel Wall System connectors are extremely versatile, and can be configured in a variety of ways to suit a broad range of projects. The connectors are welded to the pipes, and provide a link between the pipes and infill sheets. Connectors, rolled and extruded, are welded directly to the pipe, providing a unique range of customizable options based on project needs.


85

Pipe-Z King Piles

Pipe-Z King Piles come in an extensive variety and range of steel grades and sizes.*

Diameters

- Spiralweld: Ranging from 8.625" to 120"
- Rolled and Welded: From 24" up to 192"

Wall Thicknesses

- Spiralweld: Ranging from 0.179" up to 1.00"
- Rolled and Welded: From 0.250" up to 3.00"

* Additional sizes and thicknesses are available upon request.

Spiralweld Pipe

Outside Diameter in (mm)	WALL THICKNESS in (mm)										
	0.179 4.55	0.188 4.78	0.203 5.16	0.219 5.56	0.250 6.35	0.312 7.92	0.375 9.53	0.500 12.70	0.625 15.88	0.750 19.05	1.000 25.40
8.625 219.1	16.16 24.05	16.96 25.23	18.28 27.20	19.68 29.29	22.38 33.31						
10 254.0	18.79 27.97	19.72 29.35	21.26 31.64	22.90 34.08	26.06 38.78						
10.75 273.1	20.23 30.10	21.23 31.59	22.89 34.06	24.65 36.69	28.06 41.76	34.81 51.81	40.52 (0.365) 60.30				
12 304.8	22.62 33.66	23.74 35.33	25.60 38.10	27.58 41.04	31.40 46.73	38.98 58.01	46.60 69.35				
12.75 323.9	24.05 35.80	25.25 37.57	27.23 40.52	29.34 43.66	33.41 49.71	41.48 61.74	49.61 73.83				
14 355.6	26.45 39.36	27.76 41.31	29.94 44.56	32.26 48.01	36.75 54.69	45.65 67.94	54.62 81.28	72.16 107.38			
16 406.4	30.27 45.05	31.78 47.29	34.28 51.02	36.95 54.98	42.09 62.64	52.32 77.87	62.64 93.21	82.85 123.29			
18 457.2	34.10 50.75	35.80 53.27	38.62 57.47	41.63 61.95	47.44 70.59	58.99 87.79	70.65 105.15	93.54 139.20			
20 508.0	37.93 56.44	39.82 59.25	42.96 63.93	46.31 68.92	52.78 78.55	65.66 97.72	78.67 117.08	104.23 155.11	129.45 192.64		
24 609.6	45.58 67.83	47.86 71.22	51.64 76.85	55.67 82.85	63.47 94.46	79.01 117.57	94.71 140.94	125.61 186.92	156.17 232.41	186.41 277.40	
30 762.0					79.51 118.32	99.02 147.36	118.76 176.73	157.68 234.65	196.26 292.07	234.51 348.99	310.01 461.35
36 914.4					95.54 142.18	119.03 177.14	142.81 212.53	189.75 282.38	236.35 351.73	282.62 420.58	374.15 556.80
42 1067					111.58 116.05	139.04 206.92	166.86 248.32	221.82 330.10	276.44 411.38	330.72 492.17	438.29 652.25
48 1219					127.61 189.91	159.05 236.70	190.92 284.12	253.89 377.83	316.52 471.04	378.83 563.76	502.43 747.70
54 1372	**Please inquire about other diameters and thicknesses.**						214.97 319.91	285.96 425.55	356.61 530.70	426.93 635.35	566.57 843.15
60 1524							239.02 355.70	318.03 473.28	396.70 590.35	475.04 706.93	630.71 938.60
72 1829	**APPROXIMATE VALUES** Pipe Weight (lbs/ft) = 10.69*t*(d-t) d (in) - outside diameter t (in) - thickness of pipe						287.13 427.29	382.17 568.73	476.87 709.67	571.25 850.11	758.99 1129.50
84 2134							335.23 498.88	446.31 664.18	557.05 828.98	667.46 993.29	887.27 1320.41
96 2438								510.45 759.63	637.22 948.30	763.67 1136.46	1015.55 1511.31
108 2743	Pipe Weight (kg/m) = 0.0247*t*(d-t) d (mm) - outside diameter t (mm) - thickness of pipe							574.59 855.08	717.40 1067.61	859.88 1279.64	1143.83 1702.21
120 3048								638.73 950.53	797.57 1186.92	958.09 1422.82	1272.11 1893.11

Pipe Weight (lbs/ft) = 10.69*t*(D_o-t)
D_o (in) - outside diameter
t (in) - thickness of pipe

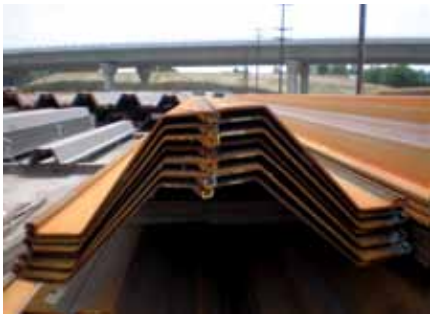
Pipe Weight (kg/m) = 0.0247*t*(D_o-t)
D_o (mm) - outside diameter
t (mm) - thickness of pipe

Rolled and Welded Pipe

Outside Diameter (D_o) in (mm)	Wall Thickness in (mm)													
	0.250 6.35	0.312 7.92	0.375 9.52	0.438 11.13	0.500 12.70	0.562 14.27	0.625 15.87	0.688 17.48	0.750 19.05	0.875 22.22	1.000 25.40	1.250 31.75	1.375 34.92	1.50 - 2.25 38.10 - 57.15
24 609.6	63.47 94.45	79.01 117.58	94.71 140.94	110.32 164.17	125.61 186.93	141.05 209.91	156.17 232.41	171.45 255.15	186.41 277.41					
30 762.0	79.51 118.32	99.02 147.36	118.76 176.73	138.42 205.99	157.68 234.65	176.86 263.20	196.26 292.07	215.58 320.82	234.51 348.99	272.43 405.42	310.01 461.35	384.17 571.71		
36 914.4	95.54 142.18	119.03 177.14	142.81 212.53	166.51 247.79	189.75 282.38	212.90 316.83	236.35 351.73	259.71 386.49	282.62 420.59	328.55 488.94	374.15 556.80	464.35 691.03	508.94 757.39	
42 1067	111.58 166.05	139.04 206.91	166.86 248.32	194.60 289.60	221.82 330.11	248.95 370.48	276.44 411.39	303.84 452.16	330.72 492.17	384.67 572.45	438.29 652.25	544.52 810.34	597.14 888.64	Max. wall thickness of 1.50" (38.1mm). Please call for weight.
48 1219	127.61 189.90	159.05 236.69	190.92 284.12	222.70 331.41	253.89 377.83	285.00 424.13	316.52 471.03	347.97 517.84	378.83 563.76	440.80 655.98	502.43 747.70	624.70 929.66	685.33 1019.89	
54 1372	143.65 213.78	179.06 266.47	214.97 319.91	250.79 373.22	285.96 425.56	321.04 477.76	356.61 530.70	392.09 583.50	426.93 635.34	496.92 739.50	566.57 843.15	704.87 1048.96	773.52 1151.13	
60 1524	159.68 237.63	199.08 296.26	239.02 355.70	278.88 415.02	318.03 473.28	357.09 531.41	396.70 590.36	436.22 649.17	475.04 706.94	553.04 823.02	630.71 938.60	785.05 1168.29	861.71 1282.37	Max. wall thickness of 1.625" (41.3mm). Please call for weight.
66 1676	175.72 261.50	219.09 326.04	263.07 391.49	306.98 456.84	350.10 521.01	393.14 585.06	436.79 650.02	480.35 714.84	523.14 778.52	609.16 906.53	694.85 1034.05	865.22 1287.59	949.91 1413.62	
72 1829	191.75 285.36	239.10 355.82	287.13 427.30	335.07 498.64	382.17 568.73	429.18 638.69	476.87 709.66	524.48 780.51	571.25 850.12	665.29 990.06	758.99 1129.50	945.40 1406.91	1038.10 1544.87	Max. wall thickness of 1.75" (44.4mm). Please call for weight.
78 1981	207.79 309.23	259.11 385.60	311.18 463.09	363.16 540.44	414.24 616.46	465.23 692.34	516.96 769.32	568.61 846.19	619.35 921.70	721.41 1073.58	823.13 1224.95	1025.57 1526.22	1126.29 1676.11	
84 2134	223.82 333.08	279.12 415.38	335.23 498.88	391.26 582.26	446.31 664.18	501.28 745.99	557.05 828.98	612.74 911.86	667.46 993.29	777.53 1157.09	887.27 1320.41	1105.75 1645.54	1214.48 1807.35	
90 2286	239.86 356.95	299.13 445.16	359.28 534.67	419.35 624.06	478.38 711.91	537.32 799.62	597.14 888.64	656.86 977.52	715.56 1064.87	833.65 1240.61	951.41 1415.86	1185.92 1764.85	1302.68 1938.61	
96 2438	255.89 380.81	319.15 474.95	383.34 570.47	447.44 665.87	510.45 759.63	573.37 853.27	637.22 948.29	700.99 1043.19	763.67 1136.47	889.78 1324.14	1015.55 1511.31	1266.10 1884.17	1390.87 2069.85	Max. wall thickness of 2.00" (50.8mm). Please call for weight.
102 2591	271.93 404.68	339.16 504.73	407.39 606.26	475.54 707.68	542.52 807.36	609.42 906.92	677.31 1007.95	745.12 1108.86	811.77 1208.05	945.90 1407.66	1079.69 1606.76	1346.27 2003.47	1479.06 2201.09	
108 2743	287.96 428.53	359.17 534.50	431.44 642.05	503.63 749.49	574.59 855.09	645.46 960.55	717.40 1067.61	789.25 1174.54	859.88 1279.65	1002.02 1491.17	1143.83 1702.21	1426.45 2122.80	1567.25 2332.33	
114 2896	304.00 452.40	379.18 564.28	455.49 677.85	531.72 791.29	606.66 902.81	681.51 1014.20	757.49 1127.27	833.38 1240.21	907.98 1351.23	1210.48 1801.40	1207.97 1797.66	1506.62 2242.10	1655.45 2463.59	
120 3048	320.03 476.26	399.19 594.06	479.55 713.65	559.82 833.11	638.73 950.54	717.56 1067.85	797.57 1186.92	877.51 1305.88	956.09 1422.82	1274.62 1896.85	1272.11 1893.11	1586.80 2361.42	1743.64 2594.83	Max. wall thickness of 2.25" (57.1mm). Please call for weight.
126 3200		419.20 623.84	503.60 749.44	587.91 874.91	670.80 998.26	753.60 1121.48	837.66 1246.58	921.63 1371.54	1004.19 1494.40	1338.76 1992.30	1336.25 1988.56	1666.97 2480.73	1831.83 2726.07	
132 3353		439.22 653.63	527.65 785.23	616.00 916.71	702.87 1045.99	789.65 1175.13	877.75 1306.24	965.76 1437.21	1052.30 1566.00	1402.90 2087.75	1400.39 2084.01	1747.15 2600.05	1920.02 2857.31	
138 3505			551.70 821.02	644.10 958.53	734.94 1093.71	825.70 1228.78	917.84 1365.90	1009.89 1502.88	1100.40 1637.58	1467.07 2183.25	1464.53 2179.47	1827.32 2719.36	2008.22 2988.57	
144 3657.6			575.76 856.83	672.19 1000.33	767.01 1141.44	861.74 1282.41	957.92 1425.54	1054.02 1568.56	1148.51 1709.17	1531.18 2278.65	1528.67 2274.92	1907.50 2838.68	2096.41 3119.81	
150 3810			599.81 892.62	700.28 1042.13	799.08 1189.16	897.79 1336.06	998.01 1485.21	1098.15 1634.23	1196.61 1780.76	1595.32 2374.10	1592.81 2370.37	1987.67 2957.98	2184.60 3251.05	
156 3962			623.86 928.41	728.38 1083.95	831.15 1236.89	933.84 1389.71	1038.10 1544.87	1142.28 1699.90	1244.72 1852.35	1659.46 2469.55	1656.95 2465.82	2067.85 3077.31	2272.79 3382.29	
162 4115				756.47 1125.75	863.22 1284.62	969.88 1443.34	1078.19 1604.53	1186.40 1765.56	1292.82 1923.93	1723.82 2565.33	1721.09 2561.27	2148.02 3196.61	2360.99 3513.55	
168 4267				784.56 1167.56	895.29 1332.34	1005.93 1496.99	1118.27 1664.17	1230.53 1831.23	1340.93 1995.53	1787.74 2660.46	1785.23 2656.72	2228.20 3315.93	2449.18 3644.79	
169-204 4293 - 5182	Please call for weight.													

Z-Pile Options

Sheet piles come in a variety of thicknesses, widths and steel grades.



Range of Sheets

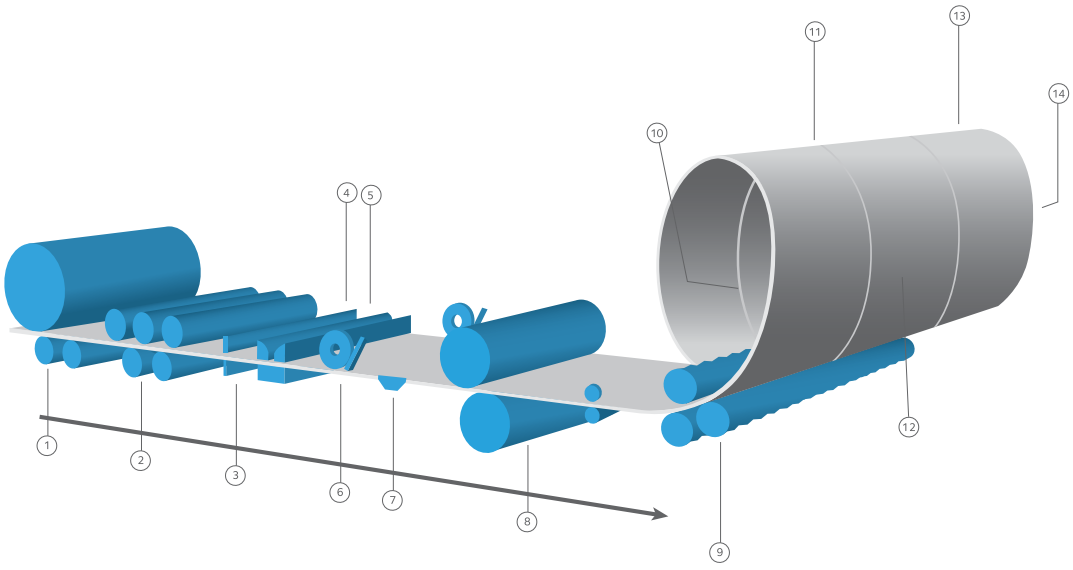
- Hot Rolled
  - AZ 12 up to AZ 50
  - PZ 22 up to PZ 40
- Cold Formed
  - SKZ 20 up to SKZ 38
  - SCZ 14 up to SCZ 30

Range of Thicknesses

- AZ 12: From 0.335" to AZ 50 thickness 0.787"
- PZ 22: From 0.375" up to PZ 40 thickness 0.600"
- SKZ & SCZ: From 0.250" up to 0.55"

Spiralweld Pipe Process

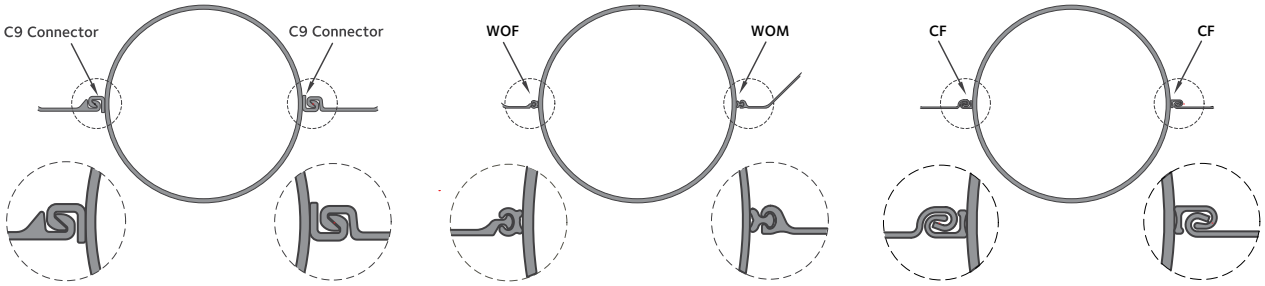
1. De-coiling
2. Leveling and centring
3. Cutting
4. Transversal beveling and transversal welding
5. Centring
6. Edge cutting
7. Beveling
8. Main drive
9. Three roll forming
10. Inside welding
11. Outside welding
12. Pipe body testing
13. US testing weld seam
14. Plasma cutting



Connectors

Rolled and extruded connectors, as shown below, are welded to the pipe. This creates a continuous interlocking system between pipe piles and sheet piles.

- C9 connectors are used with the AZ range of sheet piles
- SKPF & SKPM connectors are used with the PZ range of sheet piles
- SKCW connectors are used with the SKZ range of sheet piles

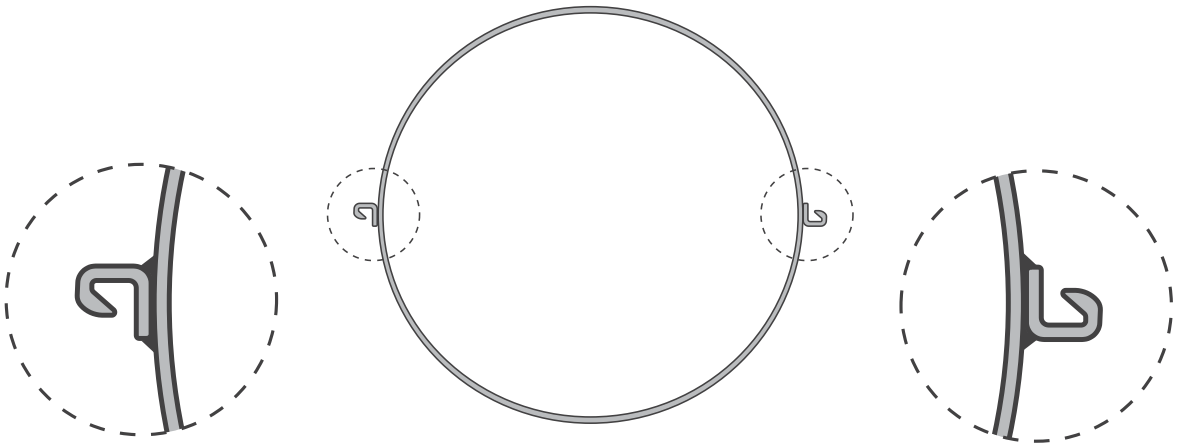


Different connections are also available; please contact us for options.

Welding Configuration

Weld Sizes and Details

- Generally 3/16" fillet weld or greater
- Depends on the pipe thickness



Steel Grades & Delivery Conditions

ASTM	Standard Specification	Application
A 36	Carbon Structural Steel	Structural Steel
A 134	Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and Over)	Casing or Liquid Conveyance
A 139	Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)	Casing or Liquid Conveyance
A 252	Welded and Seamless Steel Pipe Piles	Structural Applications
A 328	Steel Sheet Piling - Carbon steel sheet piling of structural quality for use in the construction of dock walls, sea walls, cofferdams, excavations, and similar applications	Structural Steel - Old Sheet Pile Specification
A 572	High-Strength Low-Alloy Columbium-Vanadium Structural Steel	Structural Steel - New High Strength Sheet Pile Specification
A 588	High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance	Atmospheric Corrosion Resistance
A 690	High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments	Atmospheric Corrosion Resistance for Use in Marine Environments
A 709	Structural Steel for Bridges	Structural Steel for Bridges
A 1011	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength	Coil Specification
A 1018	Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength	Coil Specification
AWWA C200	Standard - Steel Water Pipe 6 In. -150mm- and Larger	Water Transmission

Available Steel Grades

SPIRALWELD PIPE					
ASTM	YIELD STRENGTH		ASTM	YIELD STRENGTH	
	(ksi)	(MPa)		(ksi)	(MPa)
A 252 Grade 1	30	205	A 690	50	345
A 252 Grade 2	35	240	A 572	50	345
A 252 Grade 3	45	310	A 709	50	345
A 252 Grade 3 (Mod)*	50-80	345-555	A 1011/1018	50	345
A 588	50	345	Abrasion Resistant	Brinell Hardness - 190	

*Availability is dependent on pipe diameter and thickness.

C9 CONNECTORS		
ASTM	YIELD STRENGTH	
	(ksi)	(MPa)
S 355 GP	51	355
A 690	50	345

ROLLED & WELDED PIPE								
ASTM	YIELD STRENGTH		ASTM	YIELD STRENGTH		ASTM	YIELD STRENGTH	
	(ksi)	(MPa)		(ksi)	(MPa)		(ksi)	(MPa)
A 36	36	250	A 516 Grade 55	30	205	A 572 Grade 50	50	345
A 252 Grade 1	30	205	A 516 Grade 60	32	220	A 572 Grade 55	55	380
A 252 Grade 2	35	240	A 516 Grade 65	35	240	A 572 Grade 60	60	415
A 252 Grade 3	45	310	A 516 Grade 70	38	260	A 572 Grade 65	65	450
A 252 Grade 3 (Mod)	50	345	A 572 Grade 42	42	290	A 588	50	345

Additional grades available upon request.

Available Steel Grades

AZ SHEET PILES		
ASTM	YIELD STRENGTH	
	(ksi)	(MPa)
A 328	39	270
A 572 Grade 42	42	290
A 572 Grade 50	50	345
A 572 Grade 55	55	380
A 572 Grade 60	60	415
A 572 Grade 65	65	450
A 690	50	345
A 690*	57	390

PZ SHEET PILES		
ASTM	YIELD STRENGTH	
	(ksi)	(MPa)
A 328	39	270
A 572 Grade 50	50	345
A 572 Grade 60	60	415
A 572 Grade 65	65	450
A 588	50	345
A 690	50	345

SKZ SHEET PILES		
ASTM	YIELD STRENGTH	
	(ksi)	(MPa)
A 572 Grade 50	50	345
A 572 Grade 55	55	380
A 572 Grade 60	60	415
A 572 Grade 65**	65	450
A 572 Grade 65 (Mod)†	80	555
A 690	50	345
A 690	50	345

*Not available for 37-700 and larger. ** Not available for thickness ≥ 0.375" (9.525mm). †Not available for thicknesses > 0.276" (7.0mm).

Delivery Conditions & Tolerances

SPIRALWELD	ASTM		EN 10248	
Pipe Piles	± 1%			
Outside Diameter	- 5%			
Weight/Thickness	± 1 in.			

ROLLED & WELDED	ASTM		EN 10248	
Outside Diameter	± 1%			
Weight/Thickness	Per Specification			
Length	± 1 in.			

AZ SHEET PILES	ASTM		EN 10248	
Mass	± 2.5%		± 5%	
Length	+ 5 in.	– 0 in.	± 200 mm	
Height			± 7 mm	
Thickness			≤ 8.5 mm > 8.5 mm	± 0.5 mm ± 6%
Width			± 2%	
Double Pile Width			± 3%	
Straightness			0.2% of the length	
Ends out of Square			2% of the width	

PZ SHEET PILES	ASTM A 6			
Mass	± 2.5%			
Length	+ 5 in.	-0 in.		

SKZ SHEET PILES	ASTM			
Mass	± 2.5%			
Length	+ 5 in.	– 0 in.		
Interlock Opening	± 0.08 in.			
Straightness	0.2% of the length			
Twisting	0.4% of the width			

C9 CONNECTORS	ASTM		EN 10248	
Mass	± 2.5%		± 5%	
Length	+ 5 in.	– 0 in.	± 200 mm	
Height			± 7 mm	
Thickness			≤ 8.5 mm > 8.5 mm	± 0.5 mm ± 6%
Width			± 2%	
Double Pile Width			± 3%	
Straightness			0.2% of the length	
Ends out of Square			2% of the width	

Maximum Rolled Lengths*

Spiralweld	130 feet	39.6 m
Rolled & Welded	120 feet	36.6 m
C9	59 feet	18.0 m
SKPF/SKPM	Upon request	
SKCW	Upon request	
AZ	102 feet	31.0 m
PZ	85 feet for singles 70 feet for pairs	25.9 m for singles 21.3 m for pairs
SKZ	70 feet	21.3 m

* All sections are readily spliced for longer lengths.

Pipe AZ Combinations

Pipe AZ System Combination Sample*	Sheet Pile Section	PROPERTIES OF PIPE PILE			PROPERTIES OF COMBINED WALL							COATING
		Outside Diameter in mm	Wall Thickness in mm	Pipe Weight lb/ft kg/m	System Width in mm	System Inertia in⁴/ft cm⁴/m	Section Modulus in³/ft cm³/m	WEIGHT (Sheet Pile Length/Pipe Length) 100% lb/ft² kg/m²	 80% lb/ft² kg/m²	 60% lb/ft² kg/m²	Cross Sectional Area in²/ft cm²/m	Both Sides of Wall ft²/ft m²/m
PAZ24/AZ14-770	AZ14-770	24 609.6	0.250 6.4	63.47 94.5	87.13 2213.10	363 49530	23.5 1263.4	25.2 122.9	21.9 106.9	18.6 90.8	6.89 145.9	18.5 5.6
PAZ24/AZ19-700	AZ19-700	24 609.6	0.375 9.5	94.71 140.9	81.62 2073.10	608 82959	38.7 2080.6	31.6 154.1	28.0 136.9	24.5 119.7	8.74 185.0	18.5 5.6
PAZ24/AZ26-700	AZ26-700	24 609.6	0.500 12.7	125.61 186.9	81.62 2073.10	868 118464	54.0 2903.2	40.6 198.4	36.2 176.8	31.8 155.1	11.40 241.3	18.9 5.8
PAZ24/AZ 38-700N	AZ 38-700N	24 609.6	0.625 15.9	156.17 232.4	81.62 2073.15	1212 165536	73.5 3951.6	49.8 243.0	44.4 216.8	39.0 190.7	14.09 298.2	19.8 6.0
PAZ30/AZ14-770	AZ14-770	30 762.0	0.312 7.9	99.02 147.4	93.13 2365.50	597 81457	33.3 1790.3	28.1 137.4	25.1 122.4	22.0 107.3	7.79 165.0	20.1 6.1
PAZ30/AZ19-700	AZ19-700	30 762.0	0.375 9.5	118.76 176.7	87.62 2225.50	836 114217	45.6 2451.6	32.7 159.7	29.4 143.6	26.1 127.6	9.11 192.8	20.1 6.1
PAZ30/AZ26-700	AZ26-700	30 762.0	0.500 12.7	157.68 234.7	87.62 2225.50	1169 159596	62.7 3370.9	42.2 206.3	38.1 186.1	34.0 165.9	11.91 252.1	20.5 6.3
PAZ30/AZ 38-700N	AZ 38-700N	30 762.0	0.625 15.9	196.26 292.1	87.62 2225.55	1581 215898	89.3 4801.0	51.9 253.2	46.9 228.8	41.9 204.4	14.74 311.9	21.4 6.5
PAZ36/AZ14-770	AZ14-770	36 914.4	0.375 9.5	142.81 212.5	99.13 2517.90	989 135070	48.5 2607.5	31.7 154.9	28.8 140.8	26.0 126.7	8.88 188.0	21.6 6.6
PAZ36/AZ19-700	AZ19-700	36 914.4	0.438 11.1	166.32 247.5	93.62 2377.90	1299 177403	62.5 3360.2	36.7 179.2	33.6 164.2	30.5 149.2	10.32 218.4	21.6 6.6
PAZ36/AZ26-700	AZ26-700	36 914.4	0.500 12.7	189.75 282.4	93.62 2377.90	1588 216868	74.5 4005.4	43.7 213.1	39.8 194.2	35.9 175.4	12.35 261.5	22.1 6.7
PAZ36/AZ 38-700N	AZ 38-700N	36 914.4	0.750 19.1	282.62 420.6	93.62 2377.95	2379 324804	111.9 6016.1	59.6 291.0	54.9 268.2	50.3 245.3	17.05 360.8	22.9 7.0
PAZ42/AZ14-770	AZ14-770	42 1066.8	0.438 11.1	194.38 289.3	105.13 2670.30	1589 217005	69.1 3715.0	35.8 174.8	33.1 161.5	30.4 148.2	10.10 213.9	23.2 7.1
PAZ42/AZ19-700	AZ19-700	42 1066.8	0.500 12.7	221.82 330.1	99.62 2530.30	1993 272215	85.4 4593.0	41.2 201.0	38.3 186.9	35.4 172.8	11.66 246.8	23.2 7.1
PAZ42/AZ26-700	AZ26-700	42 1066.8	0.625 15.9	276.44 411.4	99.62 2530.30	2555 348961	108.1 5811.8	51.5 251.3	47.8 233.5	44.2 215.8	14.68 310.7	23.7 7.2
PAZ42/AZ 38-700N	AZ 38-700N	42 1066.8	0.750 19.1	330.72 492.2	99.62 2530.35	3188 435375	133.1 7155.9	61.8 301.8	57.4 280.3	53.0 258.9	17.72 375.1	24.5 7.5
PAZ48/AZ19-700	AZ19-700	48 1219.2	0.500 12.7	253.89 377.8	105.62 2682.70	2682 366235	102.6 5516.1	42.5 207.4	39.8 194.1	37.0 180.8	12.07 255.4	24.8 7.6
PAZ48/AZ26-700	AZ26-700	48 1219.2	0.625 15.9	316.52 471.0	105.62 2682.70	3409 465486	129.1 6940.8	53.1 259.2	49.7 242.5	46.2 225.8	15.18 321.4	25.2 7.7
PAZ48/AZ 38-700N	AZ 38-700N	48 1219.2	0.750 19.1	378.83 563.8	105.62 2682.75	4201 573708	157.3 8456.9	63.8 311.3	59.6 291.1	55.5 270.8	18.32 387.8	26.1 8.0
PAZ54/AZ19-700	AZ19-700	54 1371.6	0.563 14.3	321.33 478.2	111.62 2835.10	3908 533601	135.6 7290.3	47.4 231.7	44.9 219.1	42.3 206.5	13.55 286.8	26.3 8.0
PAZ54/AZ26-700	AZ26-700	54 1371.6	0.625 15.9	356.61 530.7	111.62 2835.10	4439 606154	152.0 8172.0	54.6 266.3	51.3 250.5	48.1 234.7	15.63 330.9	26.8 8.2
PAZ54/AZ 38-700N	AZ 38-700N	54 1371.6	0.750 19.1	426.93 635.3	111.62 2835.15	5426 741019	184.0 9892.4	65.5 319.8	61.6 300.7	57.7 281.5	18.86 399.1	27.7 8.4

* Additional combinations are available upon request.

Pipe AZ System Combination Sample*	Sheet Pile Section	PROPERTIES OF PIPE PILE			PROPERTIES OF COMBINED WALL							COATING
		Outside Diameter in mm	Wall Thickness in mm	Pipe Weight lb/ft kg/m	System Width in mm	System Inertia in^4/ft cm^4/m	Section Modulus in^3/ft cm^2/m	WEIGHT (Sheet Pile Length/Pipe Length) 100% lb/ft^2 kg/m^2	 80% lb/ft^2 kg/m^2	 60% lb/ft^2 kg/m^2	Cross Sectional Area in^2/ft cm^2/m	Both Sides of Wall ft^2/ft m^2/m
PAZ60/AZ19-700	AZ19-700	60 1524.0	0.625 15.9	396.70 590.4	117.62 2987.50	5517 753432	171.9 9241.9	52.7 257.4	50.3 245.4	47.8 233.5	15.12 320.0	27.9 8.5
PAZ60/AZ26-700	AZ26-700	60 1524.0	0.750 19.1	475.04 706.9	117.62 2987.50	6670 910802	236.5 12715.0	63.9 311.7	60.8 296.7	57.7 281.7	18.39 389.2	28.4 8.6
PAZ60/AZ 38-700N	AZ 38-700N	60 1524.0	0.813 20.6	514.08 765.0	117.62 2987.55	7377 1007349	229.2 12322.5	71.1 346.9	67.3 328.8	63.6 310.6	20.51 434.1	29.2 8.9
PAZ66/AZ19-700	AZ19-700	66 1676.4	0.688 17.5	480.01 714.3	123.62 3139.90	7569 1033622	220.5 11854.8	58.2 284.4	55.9 273.0	53.6 261.6	16.76 354.8	29.5 9.0
PAZ66/AZ26-700	AZ26-700	66 1676.4	0.750 19.1	523.14 778.5	123.62 3139.90	8346 1139687	240.7 12940.8	65.4 319.4	62.5 305.1	59.6 290.8	18.87 399.4	29.9 9.1
PAZ66/AZ 38-700N	AZ 38-700N	66 1676.4	0.813 20.6	566.19 842.6	123.62 3139.95	9183 1254014	262.2 14096.7	72.7 354.8	69.1 337.5	65.6 320.2	21.00 444.5	30.8 9.4
PAZ72/AZ19-700	AZ19-700	72 1828.8	0.750 19.1	571.25 850.1	129.62 3292.30	10122 1382242	272.4 14645.1	64.0 312.5	61.8 301.6	59.6 290.8	18.47 390.9	31.1 9.5
PAZ72/AZ26-700	AZ26-700	72 1828.8	0.813 20.6	618.31 920.1	129.62 3292.30	11048 1508654	294.9 15854.8	71.2 347.6	68.4 334.0	65.6 320.4	20.58 435.7	31.5 9.6
PAZ72/AZ 38-700N	AZ 38-700N	72 1828.8	1.000 25.4	758.99 1129.5	129.62 3292.35	13606 1858024	361.8 19451.5	87.2 425.5	83.8 409.0	80.4 392.5	25.27 534.9	32.4 9.9
PAZ78/AZ26-700	AZ26-700	78 1981.2	0.875 22.2	721.41 1073.6	135.62 3444.70	17089 2333697	395.5 21263.3	77.2 376.8	74.5 363.8	71.8 350.7	22.35 473.2	33.1 10.1
PAZ78/AZ 38-700N	AZ 38-700N	78 1981.2	1.000 25.4	823.13 1225.0	135.62 3444.75	19578 2673522	451.0 24247.2	89.0 434.4	85.7 418.6	82.5 402.9	25.82 546.6	33.9 10.3
PAZ84/AZ26-700	AZ26-700	84 2133.6	0.875 22.2	777.53 1157.1	141.62 3597.10	23445 3201620	477.7 25682.7	78.7 384.1	76.1 371.6	73.6 359.1	22.80 482.7	34.7 10.6
PAZ84/AZ 38-700N	AZ 38-700N	84 2133.6	1.000 25.4	887.27 1320.4	141.62 3597.15	26815 3661766	544.3 29263.3	90.6 442.5	87.5 427.4	84.5 412.3	26.33 557.2	35.5 10.8

* Additional combinations are available upon request.

Pipe PZ Combinations

Pipe PZ System Combination Sample†	Sheet Pile Section	PROPERTIES OF PIPE PILE			PROPERTIES OF COMBINED WALL							COATING
		Outside Diameter in mm	Wall Thickness in mm	Pipe Weight lb/ft kg/m	System Width in mm	System Inertia in⁴/ft cm⁴/m	Section Modulus in³/ft cm³/m	WEIGHT (Sheet Pile Length/Pipe Length) 100% lb/ft² kg/m²	 80% lb/ft² kg/m²	 60% lb/ft² kg/m²	Cross Sectional Area in²/ft cm²/m	Both Sides of Wall ft²/ft m²/m
PPZ24/PZ22	PZ22	24 609.6	0.250 6.4	63.47 94.5	70.36 1787.14	277 37840	23.1 1241.5	26.5 129.2	23.3 113.9	20.2 98.7	7.23 153.0	15.2 4.6
PPZ24/PZ27	PZ27	24 609.6	0.500 12.7	125.61 186.9	62.36 1583.94	597 81513	49.7 2674.3	41.9 204.5	38.3 187.2	34.8 169.9	11.69 247.4	15.2 4.6
PPZ24/PZ35	PZ35	24 609.6	0.625 15.9	156.17 232.4	71.64 1819.54	754 102935	62.8 3377.1	50.1 244.8	45.3 221.3	40.5 197.9	14.19 300.4	17.0 5.2
PPZ24/PZ40	PZ40	24 609.6	0.750 19.1	186.41 277.4	65.73 1669.54	970 132528	80.9 4348.0	60.0 293.1	54.8 267.7	49.6 242.3	17.05 360.9	17.0 5.2
PPZ30/PZ22	PZ22	30 762.0	0.375 9.5	118.76 176.7	76.36 1939.54	650 88820	43.4 2331.2	33.1 161.5	30.2 147.4	27.3 133.3	9.21 195.0	16.8 5.1
PPZ30/PZ27	PZ27	30 762.0	0.500 12.7	157.68 234.7	68.36 1736.34	982 134116	65.5 3520.1	43.8 214.1	40.6 198.3	37.4 182.5	12.32 260.7	16.8 5.1
PPZ30/PZ35	PZ35	30 762.0	0.625 15.9	196.26 292.1	77.64 1971.94	1173 160140	78.2 4203.2	52.5 256.1	48.0 234.5	43.6 212.9	14.92 315.7	18.6 5.7
PPZ30/PZ40	PZ40	30 762.0	0.750 19.1	234.51 349.0	71.73 1821.94	1503 205283	100.2 5388.0	63.1 307.8	58.3 284.6	53.5 261.3	17.99 380.8	18.6 5.7
PPZ36/PZ22	PZ22	36 914.4	0.375 9.5	142.81 212.5	82.36 2091.94	1015 138647	56.4 3032.5	34.2 166.8	31.5 153.8	28.8 140.7	9.57 202.6	18.4 5.6
PPZ36/PZ27	PZ27	36 914.4	0.500 12.7	189.75 282.4	74.36 1888.74	1507 205802	83.7 4501.4	45.5 222.1	42.5 207.5	39.5 193.0	12.84 271.8	18.4 5.6
PPZ36/PZ35	PZ35	36 914.4	0.625 15.9	236.35 351.7	83.64 2124.34	1755 239651	97.5 5241.7	54.4 265.8	50.3 245.8	46.2 225.7	15.54 328.9	20.2 6.1
PPZ36/PZ40	PZ40	36 914.4	0.750 19.1	282.62 420.6	77.73 1974.34	2241 306035	124.5 6693.7	65.6 320.3	61.2 298.9	56.8 277.4	18.78 397.6	20.2 6.1
PPZ42/PZ22	PZ22	42 1066.8	0.375 9.5	166.86 248.3	88.36 2244.34	1485 202723	70.7 3800.6	35.1 171.4	32.6 159.3	30.1 147.1	9.88 209.2	20.0 6.1
PPZ42/PZ27	PZ27	42 1066.8	0.500 12.7	221.82 330.1	80.36 2041.14	2178 297486	103.7 5577.2	46.9 228.9	44.1 215.4	41.4 202.0	13.29 281.3	20.0 6.1
PPZ42/PZ35	PZ35	42 1066.8	0.625 15.9	276.44 411.4	89.64 2276.74	2510 342802	119.5 6426.7	56.2 274.2	52.3 255.5	48.5 236.8	16.07 340.2	21.7 6.6
PPZ42/PZ40	PZ40	42 1066.8	0.750 19.1	330.72 492.2	83.73 2126.74	3195 436237	152.1 8178.4	67.8 331.0	63.7 311.1	59.6 291.2	19.46 412.0	21.7 6.6
PPZ48/PZ22	PZ22	48 1219.2	0.500 12.7	253.89 377.8	94.36 2396.74	2716 370858	113.2 6083.6	43.9 214.6	41.6 203.2	39.3 191.8	12.51 264.7	21.5 6.6
PPZ48/PZ27	PZ27	48 1219.2	0.563 14.3	285.25 424.5	86.36 2193.54	3354 457988	139.7 7512.9	52.4 256.0	49.9 243.5	47.3 231.0	14.96 316.6	21.5 6.6
PPZ48/PZ35	PZ35	48 1219.2	0.625 15.9	316.52 471.0	95.64 2429.14	3446 470594	143.6 7719.7	57.7 281.6	54.1 264.0	50.5 246.5	16.54 350.2	23.3 7.1
PPZ48/PZ40	PZ40	48 1219.2	0.750 19.1	378.83 563.8	89.73 2279.14	4371 596950	182.1 9792.5	69.7 340.3	65.9 321.7	62.1 303.1	20.05 424.5	23.3 7.1

† Additional combinations are available upon request.
* Covered by one or more patents owned by PilePro, LLC (www.pilepro.com)

Pipe PZ System Combination Sample†	Sheet Pile Section	PROPERTIES OF PIPE PILE			PROPERTIES OF COMBINED WALL							COATING
		Outside Diameter in mm	Wall Thickness in mm	Pipe Weight lb/ft kg/m	System Width in mm	System Inertia in⁴/ft cm⁴/m	Section Modulus in³/ft cm³/m	WEIGHT (Sheet Pile Length/Pipe Length) 100% lb/ft² kg/m²	 80% lb/ft² kg/m²	 60% lb/ft² kg/m²	Cross Sectional Area in²/ft cm²/m	Both Sides of Wall ft²/ft m²/m
PPZ54/PZ22	PZ22	54 1371.6	0.563 14.3	321.33 478.2	100.36 2549.14	4068 555488	150.7 8099.9	49.4 241.1	47.2 230.4	45.0 219.7	14.13 299.0	23.1 7.0
PPZ54/PZ27	PZ27	54 1371.6	0.625 15.9	356.61 530.7	92.36 2345.94	4921 672064	182.3 9799.7	58.3 284.6	55.9 272.9	53.5 261.3	16.71 353.7	23.1 7.0
PPZ54/PZ35	PZ35	54 1371.6	0.750 19.1	426.93 635.3	101.64 2581.54	5413 739139	200.5 10777.8	67.3 328.6	63.9 312.1	60.5 295.6	19.40 410.6	24.9 7.6
PPZ54/PZ40	PZ40	54 1371.6	0.875 22.2	496.92 739.5	95.73 2431.54	6662 909698	246.7 13264.8	80.1 391.3	76.6 373.8	73.0 356.4	23.15 489.9	24.9 7.6
PPZ60/PZ27	PZ27	60 1524.0	0.625 15.9	396.70 590.4	98.36 2498.34	6336 865217	211.2 11354.6	59.6 291.1	57.4 280.2	55.1 269.2	17.13 362.6	24.7 7.5
PPZ60/PZ35	PZ35	60 1524.0	0.750 19.1	475.04 706.9	107.64 2733.94	6983 953571	232.8 12514.1	68.9 336.5	65.7 320.9	62.5 305.3	19.89 421.1	26.4 8.1
PPZ60/PZ40	PZ40	60 1524.0	1.000 25.4	630.71 938.6	101.73 2583.94	9706 1325482	323.5 17394.8	91.2 445.2	87.8 428.8	84.5 412.4	26.42 559.2	26.4 8.1
PPZ66/PZ27	PZ27	66 1676.4	0.688 17.5	480.01 714.3	104.36 2650.74	8714 1189907	264.0 14196.0	65.8 321.2	63.7 310.8	61.5 300.5	18.96 401.3	26.2 8.0
PPZ66/PZ35	PZ35	66 1676.4	0.875 22.2	609.16 906.5	113.64 2886.34	10168 1388561	308.1 16566.0	79.4 387.8	76.4 373.1	73.4 358.3	23.00 486.9	28.0 8.5
PPZ66/PZ40	PZ40	66 1676.4	1.000 25.4	694.85 1034.1	107.73 2736.34	12195 1665330	369.5 19868.0	93.3 455.3	90.1 439.8	86.9 424.4	27.05 572.5	28.0 8.5
PPZ72/PZ27	PZ27	72 1828.8	0.750 19.1	571.25 850.1	110.36 2803.14	11645 1590222	323.5 17390.9	72.1 352.2	70.1 342.4	68.1 332.6	20.84 441.2	27.8 8.5
PPZ72/PZ35	PZ35	72 1828.8	0.875 22.2	665.29 990.1	119.64 3038.74	12540 1712378	348.3 18726.8	81.1 395.9	78.2 381.9	75.3 367.9	23.51 497.5	29.6 9.0
PPZ72/PZ40	PZ40	72 1828.8	1.000 25.4	758.99 1129.5	113.73 2888.74	15003 2048761	416.7 22405.6	95.1 464.4	92.1 449.7	89.1 435.0	27.61 584.4	29.6 9.0
PPZ78/PZ35	PZ35	78 1981.2	0.813 20.6	670.42 997.7	125.64 3191.14	14147 1931849	362.7 19501.8	77.7 379.4	75.0 366.0	72.2 352.7	22.53 476.8	31.2 9.5
PPZ78/PZ40	PZ40	78 1981.2	1.000 25.4	823.13 1225.0	119.73 3041.14	18133 2476190	464.9 24996.9	96.8 472.5	93.9 458.5	91.1 444.6	28.12 595.1	31.2 9.5
PPZ84/PZ35	PZ35	84 2133.6	0.875 22.2	777.53 1157.1	131.64 3343.54	18118 2474144	431.4 23192.2	83.9 409.8	81.3 397.0	78.7 384.3	24.37 515.8	32.7 10.0
PPZ84/PZ40	PZ40	84 2133.6	1.000 25.4	887.27 1320.4	125.73 3193.54	21588 2947950	514.0 27633.6	98.3 479.8	95.6 466.5	92.8 453.3	28.57 604.8	32.7 10.0

† Additional combinations are available upon request.
* Covered by one or more patents owned by PilePro, LLC (www.pilepro.com)

Pipe PZ-XL Combinations

Pipe PZ-XL System Combination Sample†	Sheet Pile Section	PROPERTIES OF PIPE PILE			PROPERTIES OF COMBINED WALL							COATING
		Outside Diameter in mm	Wall Thickness in mm	Pipe Weight lb/ft kg/m	System Width in mm	System Inertia in⁴/ft cm⁴/m	Section Modulus in³/ft cm³/m	WEIGHT (Sheet Pile Length/Pipe Length) 100% lb/ft² kg/m²	 80% lb/ft² kg/m²	 60% lb/ft² kg/m²	Cross Sectional Area in²/ft cm²/m	Both Sides of Wall ft²/ft m²/m
PPZ24/PZ22	PZ22	24 609.6	0.250 6.4	63.47 94.5	75.10 1907.54	260 35452	21.6 1163.1	24.8 121.0	21.9 106.7	18.9 92.4	6.77 143.3	15.2 4.6
PPZ24/PZ27	PZ27	24 609.6	0.500 12.7	125.61 186.9	67.10 1704.34	555 75755	46.2 2485.4	38.9 190.1	35.6 174.0	32.3 157.9	10.86 229.9	15.2 4.6
PPZ24/PZ35	PZ35	24 609.6	0.625 15.9	156.17 232.4	76.38 1939.94	707 96547	58.9 3167.6	47.0 229.6	42.5 207.6	38.0 185.7	13.31 281.8	17.0 5.2
PPZ24/PZ40	PZ40	24 609.6	0.750 19.1	186.41 277.4	70.47 1789.94	905 123614	75.4 4055.6	56.0 273.4	51.1 249.7	46.3 226.0	15.90 336.6	17.0 5.2
PPZ30/PZ22	PZ22	30 762.0	0.375 9.5	118.76 176.7	81.10 2059.94	612 83629	40.8 2195.0	31.1 152.0	28.4 138.8	25.7 125.5	8.67 183.6	16.8 5.1
PPZ30/PZ27	PZ27	30 762.0	0.500 12.7	157.68 234.7	73.10 1856.74	918 125420	61.2 3291.9	41.0 200.2	38.0 185.4	35.0 170.7	11.52 243.8	16.8 5.1
PPZ30/PZ35	PZ35	30 762.0	0.625 15.9	196.26 292.1	82.38 2092.34	1105 150926	73.7 3961.3	49.4 241.4	45.3 221.0	41.1 200.6	14.06 297.6	18.6 5.7
PPZ30/PZ40	PZ40	30 762.0	0.750 19.1	234.51 349.0	76.47 1942.34	1410 192559	94.0 5054.0	59.1 288.8	54.7 266.9	50.2 245.1	16.87 357.2	18.6 5.7
PPZ36/PZ22	PZ22	36 914.4	0.375 9.5	142.81 212.5	87.10 2212.34	960 131102	53.3 2867.5	32.3 157.7	29.8 145.4	27.3 133.1	9.05 191.6	18.4 5.6
PPZ36/PZ27	PZ27	36 914.4	0.500 12.7	189.75 282.4	79.10 2009.14	1417 193470	78.7 4231.6	42.8 208.7	40.0 195.1	37.2 181.5	12.07 255.6	18.4 5.6
PPZ36/PZ35	PZ35	36 914.4	0.625 15.9	236.35 351.7	88.38 2244.74	1661 226797	92.3 4960.6	51.5 251.5	47.6 232.6	43.7 213.6	14.70 311.2	20.2 6.1
PPZ36/PZ40	PZ40	36 914.4	0.750 19.1	282.62 420.6	82.47 2094.74	2112 288446	117.3 6309.0	61.8 301.9	57.7 281.7	53.6 261.5	17.70 374.7	20.2 6.1
PPZ42/PZ22	PZ22	42 1066.8	0.375 9.5	166.86 248.3	93.10 2364.74	1409 192401	67.1 3607.1	33.3 162.7	31.0 151.2	28.6 139.6	9.38 198.5	20.0 6.1
PPZ42/PZ27	PZ27	42 1066.8	0.500 12.7	221.82 330.1	85.10 2161.54	2057 280916	98.0 5266.5	44.3 216.1	41.7 203.4	39.1 190.8	12.55 265.7	20.0 6.1
PPZ42/PZ35	PZ35	42 1066.8	0.625 15.9	276.44 411.4	94.38 2397.14	2384 325585	113.5 6104.0	53.3 260.4	49.7 242.7	46.1 224.9	15.27 323.1	21.7 6.6
PPZ42/PZ40	PZ40	42 1066.8	0.750 19.1	330.72 492.2	88.47 2247.14	3023 412864	144.0 7740.3	64.2 313.3	60.3 294.5	56.4 275.6	18.42 389.9	21.7 6.6
PPZ48/PZ22	PZ22	48 1219.2	0.500 12.7	253.89 377.8	99.10 2517.14	2586 353120	107.7 5792.7	41.8 204.3	39.6 193.5	37.4 182.6	11.91 252.0	21.5 6.6
PPZ48/PZ27	PZ27	48 1219.2	0.563 14.3	285.25 424.5	91.10 2313.94	3179 434158	132.5 7122.0	49.7 242.7	47.3 230.8	44.9 219.0	14.18 300.1	21.5 6.6
PPZ48/PZ35	PZ35	48 1219.2	0.625 15.9	316.52 471.0	100.38 2549.54	3283 448372	136.8 7355.2	54.9 268.3	51.5 251.6	48.1 234.9	15.76 333.6	23.3 7.1
PPZ48/PZ40	PZ40	48 1219.2	0.750 19.1	378.83 563.8	94.47 2399.54	4152 566999	173.0 9301.2	66.2 323.2	62.6 305.6	59.0 287.9	19.05 403.2	23.3 7.1

† Additional combinations are available upon request.
* Covered by one or more patents owned by PilePro, LLC (www.pilepro.com)

Pipe PZ-XL System Combination Sample†	Sheet Pile Section	PROPERTIES OF PIPE PILE			PROPERTIES OF COMBINED WALL							COATING
		Outside Diameter in mm	Wall Thickness in mm	Pipe Weight lb/ft kg/m	System Width in mm	System Inertia in⁴/ft cm⁴/m	Section Modulus in³/ft cm³/m	WEIGHT (Sheet Pile Length/Pipe Length) 100% lb/ft² kg/m²	80% lb/ft² kg/m²	60% lb/ft² kg/m²	Cross Sectional Area in²/ft cm²/m	Both Sides of Wall ft²/ft m²/m
PPZ54/PZ22	PZ22	54 1371.6	0.563 14.3	321.33 478.2	105.10 2669.54	3884 530436	143.9 7734.6	47.2 230.2	45.1 220.0	43.0 209.8	13.49 285.6	23.1 7.0
PPZ54/PZ27	PZ27	54 1371.6	0.625 15.9	356.61 530.7	97.10 2466.34	4681 639257	173.4 9321.3	55.5 270.7	53.2 259.6	50.9 248.5	15.90 336.5	23.1 7.0
PPZ54/PZ35	PZ35	54 1371.6	0.750 19.1	426.93 635.3	106.38 2701.94	5171 706204	191.5 10297.5	64.3 314.0	61.1 298.2	57.8 282.4	18.53 392.3	24.9 7.6
PPZ54/PZ40	PZ40	54 1371.6	0.875 22.2	496.92 739.5	100.47 2551.94	6347 866780	235.1 12639.0	76.4 372.8	73.0 356.2	69.6 339.6	22.05 466.8	24.9 7.6
PPZ60/PZ27	PZ27	60 1524.0	0.625 15.9	396.70 590.4	103.10 2618.74	6045 825439	201.5 10832.6	56.9 277.8	54.7 267.3	52.6 256.8	16.34 345.9	24.7 7.5
PPZ60/PZ35	PZ35	60 1524.0	0.750 19.1	475.04 706.9	112.38 2854.34	6688 913349	222.9 11986.2	66.0 322.3	62.9 307.3	59.9 292.4	19.05 403.3	26.4 8.1
PPZ60/PZ40	PZ40	60 1524.0	1.000 25.4	630.71 938.6	106.47 2704.34	9274 1266472	309.1 16620.4	87.1 425.4	83.9 409.8	80.7 394.1	25.24 534.3	26.4 8.1
PPZ66/PZ27	PZ27	66 1676.4	0.688 17.5	480.01 714.3	109.10 2771.14	8335 1138210	252.6 13579.2	62.9 307.2	60.9 297.3	58.9 287.4	18.14 383.9	26.2 8.0
PPZ66/PZ35	PZ35	66 1676.4	0.875 22.2	609.16 906.5	118.38 3006.74	9761 1332960	295.8 15902.7	76.3 372.3	73.4 358.2	70.5 344.0	22.08 467.4	28.0 8.5
PPZ66/PZ40	PZ40	66 1676.4	1.000 25.4	694.85 1034.1	112.47 2856.74	11681 1595145	354.0 19030.6	89.3 436.1	86.3 421.3	83.3 406.5	25.91 548.4	28.0 8.5
PPZ72/PZ27	PZ27	72 1828.8	0.750 19.1	571.25 850.1	115.10 2923.54	11165 1524734	310.2 16674.7	69.2 337.7	67.2 328.3	65.3 318.9	19.99 423.0	27.8 8.5
PPZ72/PZ35	PZ35	72 1828.8	0.875 22.2	665.29 990.1	124.38 3159.14	12062 1647118	335.0 18013.1	78.0 380.8	75.2 367.3	72.5 353.8	22.61 478.6	29.6 9.0
PPZ72/PZ40	PZ40	72 1828.8	1.000 25.4	758.99 1129.5	118.47 3009.14	14403 1966790	400.1 21509.1	91.3 445.8	88.4 431.7	85.5 417.6	26.50 561.0	29.6 9.0
PPZ78/PZ35	PZ35	78 1981.2	0.813 20.6	670.42 997.7	130.38 3311.54	13632 1861614	349.5 18792.8	74.9 365.6	72.2 352.7	69.6 339.9	21.71 459.5	31.2 9.5
PPZ78/PZ40	PZ40	78 1981.2	1.000 25.4	823.13 1225.0	124.47 3161.54	17442 2381893	447.2 24045.0	93.1 454.5	90.3 441.1	87.6 427.7	27.04 572.4	31.2 9.5
PPZ84/PZ35	PZ35	84 2133.6	0.875 22.2	777.53 1157.1	136.38 3463.94	17488 2388150	416.4 22386.1	81.0 395.5	78.5 383.2	76.0 370.9	23.52 497.9	32.7 10.0
PPZ84/PZ40	PZ40	84 2133.6	1.000 25.4	887.27 1320.4	130.47 3313.94	20803 2840850	495.3 26629.7	94.7 462.4	92.1 449.6	89.5 436.8	27.53 582.8	32.7 10.0

† Additional combinations are available upon request.
* Covered by one or more patents owned by PilePro, LLC (www.pilepro.com)

Pipe SKZ Combinations

Pipe SKZ System Combination Sample†	Sheet Pile Section	PROPERTIES OF PIPE PILE			PROPERTIES OF COMBINED WALL							COATING
		Outside Diameter in mm	Wall Thickness in mm	Pipe Weight lb/ft kg/m	System Width in mm	System Inertia in⁴/ft cm⁴/m	Section Modulus in³/ft cm³/m	WEIGHT (Sheet Pile Length/Pipe Length) 100% lb/ft² kg/m²	 80% lb/ft² kg/m²	 60% lb/ft² kg/m²	Cross Sectional Area in²/ft cm²/m	Both Sides of Wall ft²/ft m²/m
PSKZ24/SKZ20	SKZ20	24 609.6	0.250 6.4	63.47 94.5	86.86 2206.24	348 47533	29.0 1559.5	24.1 117.8	21.1 102.8	18.0 87.8	6.51 137.9	21.5 6.5
PSKZ24/SKZ22	SKZ22	24 609.6	0.375 9.5	94.71 140.9	86.86 2206.24	444 60606	37.0 1988.4	29.3 143.0	26.0 127.2	22.8 111.3	7.98 168.9	21.5 6.5
PSKZ24/SKZ24	SKZ24	24 609.6	0.438 11.1	110.20 164.0	86.86 2206.24	509 69461	42.4 2278.9	33.1 161.7	29.5 144.2	26.0 126.8	9.13 193.3	21.5 6.5
PSKZ24/SKZ25	SKZ25	24 609.6	0.500 12.7	125.61 186.9	86.86 2206.24	563 76873	46.9 2522.1	36.3 177.0	32.5 158.6	28.7 140.1	10.09 213.5	21.5 6.5
PSKZ30/SKZ20	SKZ20	30 762.0	0.375 9.5	118.76 176.7	92.86 2358.64	650 88828	43.4 2331.5	29.7 145.1	26.8 131.0	24.0 117.0	8.19 173.4	23.1 7.0
PSKZ30/SKZ22	SKZ22	30 762.0	0.438 11.1	138.26 205.8	92.86 2358.64	738 100762	49.2 2644.7	33.0 161.2	30.0 146.4	27.0 131.6	9.12 193.0	23.1 7.0
PSKZ30/SKZ24	SKZ24	30 762.0	0.500 12.7	157.68 234.7	92.86 2358.64	837 114278	55.8 2999.4	37.1 181.2	33.8 164.9	30.4 148.5	10.35 219.0	23.1 7.0
PSKZ30/SKZ25	SKZ25	30 762.0	0.625 15.9	196.26 292.1	92.86 2358.64	1001 136752	66.8 3589.3	43.0 210.2	39.5 192.9	36.0 175.6	12.12 256.5	23.1 7.0
PSKZ36/SKZ20	SKZ20	36 914.4	0.375 9.5	142.81 212.5	98.86 2511.04	954 130338	53.0 2850.8	30.8 150.5	28.1 137.3	25.4 124.2	8.55 181.1	24.6 7.5
PSKZ36/SKZ22	SKZ22	36 914.4	0.438 11.1	166.32 247.5	98.86 2511.04	1092 149157	60.7 3262.4	34.4 168.1	31.6 154.2	28.7 140.3	9.57 202.5	24.6 7.5
PSKZ36/SKZ24	SKZ24	36 914.4	0.500 12.7	189.75 282.4	98.86 2511.04	1241 169402	68.9 3705.2	38.8 189.2	35.6 173.9	32.5 158.5	10.86 229.9	24.6 7.5
PSKZ36/SKZ25	SKZ25	36 914.4	0.625 15.9	236.35 351.7	98.86 2511.04	1504 205437	83.6 4493.4	45.3 221.2	42.0 205.0	38.7 188.7	12.81 271.2	24.6 7.5
PSKZ42/SKZ20	SKZ20	42 1066.8	0.438 11.1	194.38 289.3	104.86 2663.44	1550 211606	73.8 3967.1	35.0 170.7	32.4 158.3	29.9 145.9	9.80 207.4	26.2 8.0
PSKZ42/SKZ22	SKZ22	42 1066.8	0.500 12.7	221.82 330.1	104.86 2663.44	1752 239194	83.4 4484.3	38.8 189.5	36.1 176.4	33.4 163.2	10.88 230.4	26.2 8.0
PSKZ42/SKZ24	SKZ24	42 1066.8	0.625 15.9	276.44 411.4	104.86 2663.44	2154 294136	102.6 5514.4	46.5 226.8	43.5 212.4	40.5 197.9	13.16 278.5	26.2 8.0
PSKZ42/SKZ25	SKZ25	42 1066.8	0.750 19.1	330.72 492.2	104.86 2663.44	2541 347003	121.0 6505.5	53.5 261.3	50.4 246.0	47.2 230.7	15.25 322.9	26.2 8.0
PSKZ48/SKZ20	SKZ20	48 1219.2	0.500 12.7	253.89 377.8	110.86 2815.84	2408 328887	100.4 5395.1	39.5 192.9	37.1 181.2	34.7 169.4	11.16 236.2	27.8 8.5
PSKZ48/SKZ22	SKZ22	48 1219.2	0.625 15.9	316.52 471.0	110.86 2815.84	2963 404597	123.5 6637.1	47.0 229.3	44.4 216.9	41.9 204.5	13.31 281.7	27.8 8.5
PSKZ48/SKZ24	SKZ24	48 1219.2	0.750 19.1	378.83 563.8	110.86 2815.84	3519 480558	146.6 7883.2	55.0 268.7	52.2 255.0	49.4 241.3	15.70 332.3	27.8 8.5
PSKZ48/SKZ25	SKZ25	48 1219.2	0.875 22.2	440.80 656.0	110.86 2815.84	4059 554282	169.1 9092.6	62.5 305.3	59.6 290.8	56.6 276.4	17.93 379.5	27.8 8.5

† Additional combinations are available upon request.
* Covered by one or more patents owned by PilePro, LLC (www.pilepro.com)

Pipe SKZ System Combination Sample†	Sheet Pile Section	PROPERTIES OF PIPE PILE			PROPERTIES OF COMBINED WALL							COATING
		Outside Diameter in mm	Wall Thickness in mm	Pipe Weight lb/ft kg/m	System Width in mm	System Inertia in^4/ft cm^4/m	Section Modulus in^3/ft cm^3/m	WEIGHT (Sheet Pile Length/Pipe Length) 100% lb/ft^2 kg/m^2	80% lb/ft^2 kg/m^2	60% lb/ft^2 kg/m^2	Cross Sectional Area in^2/ft cm^2/m	Both Sides of Wall ft^2/ft m^2/m
PSKZ54/SKZ20	SKZ20	54 1371.6	0.563 14.3	321.33 478.2	116.86 2968.24	3585 489604	132.8 7139.2	44.4 216.8	42.1 205.7	39.8 194.5	12.62 267.2	29.3 8.9
PSKZ54/SKZ22	SKZ22	54 1371.6	0.625 15.9	356.61 530.7	116.86 2968.24	3963 541226	146.8 7891.9	48.7 237.6	46.3 225.8	43.8 214.1	13.83 292.8	29.3 8.9
PSKZ54/SKZ24	SKZ24	54 1371.6	0.750 19.1	426.93 635.3	116.86 2968.24	4715 643836	174.6 9388.1	57.1 279.0	54.5 266.0	51.8 253.0	16.35 346.0	29.3 8.9
PSKZ54/SKZ25	SKZ25	54 1371.6	0.875 22.2	496.92 739.5	116.86 2968.24	5448 744018	201.8 10848.9	65.1 317.8	62.3 304.0	59.5 290.3	18.70 395.9	29.3 8.9
PSKZ60/SKZ20	SKZ20	60 1524.0	0.625 15.9	396.70 590.4	122.86 3120.64	5136 701371	171.2 9204.4	49.6 242.2	47.4 231.6	45.3 221.0	14.17 299.9	30.9 9.4
PSKZ60/SKZ22	SKZ22	60 1524.0	0.750 19.1	475.04 706.9	122.86 3120.64	6109 834171	203.6 10947.1	57.9 282.5	55.6 271.3	53.3 260.1	16.56 350.5	30.9 9.4
PSKZ60/SKZ24	SKZ24	60 1524.0	0.875 22.2	553.04 823.0	122.86 3120.64	7078 966589	235.9 12684.9	66.7 325.5	64.1 313.1	61.6 300.8	19.17 405.7	30.9 9.4
PSKZ60/SKZ25	SKZ25	60 1524.0	1.000 25.4	630.71 938.6	122.86 3120.64	8029 1096386	267.6 14388.3	75.0 366.0	72.3 353.0	69.6 339.9	21.63 457.8	30.9 9.4

† Additional combinations are available upon request.

* Covered by one or more patents owned by PilePro, LLC (www.pilepro.com)

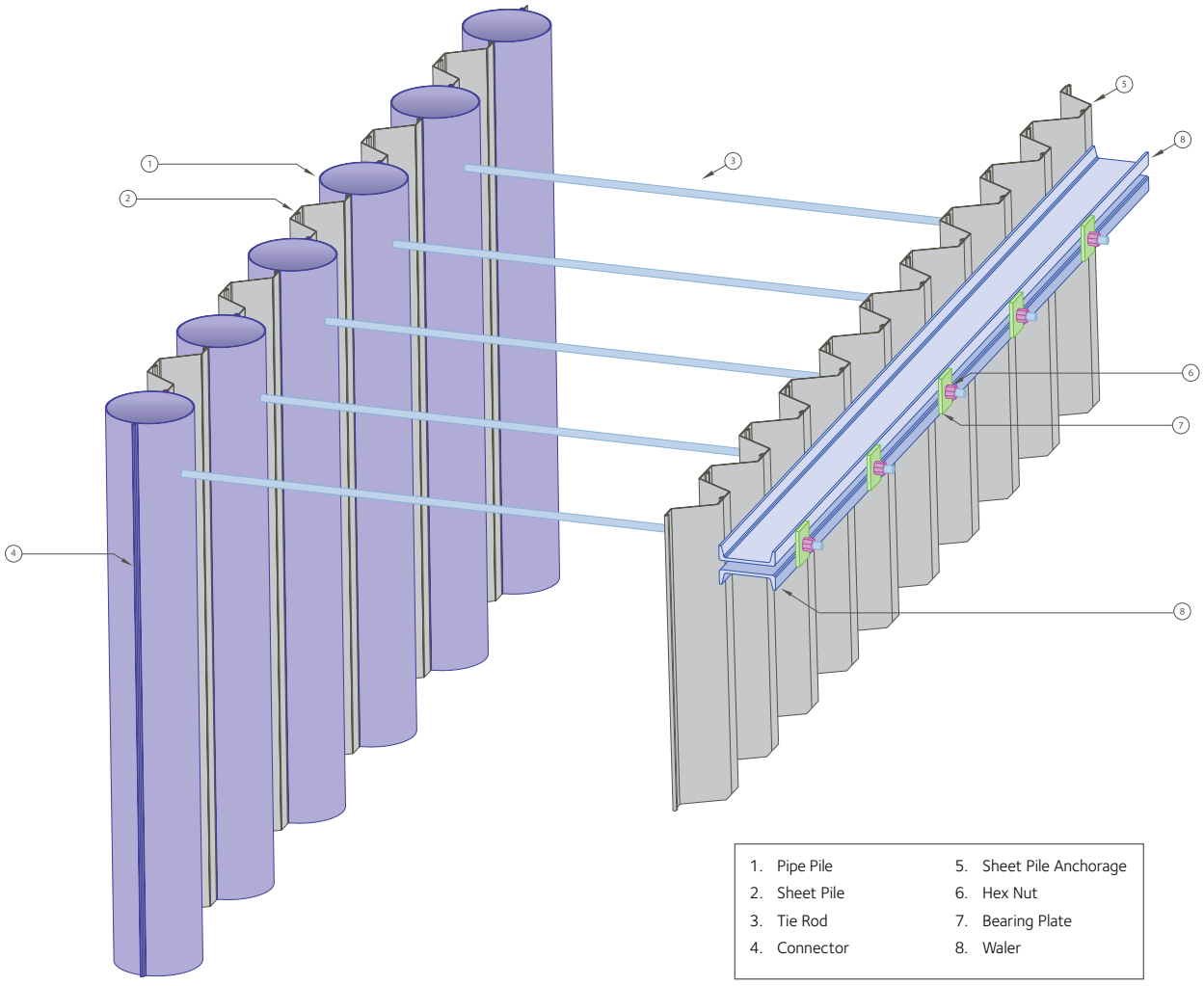
Anchorage Details for Pipe-Z Wall

The Pipe-Z Wall Tie-Back System

Pipe-Z Walls are anchored simply and effectively. A tie rod links each Pipe-Z king pile to a steel sheet pile anchor wall, or to isolated sheet pile panels, which provides a particularly economic solution.

Because each king pile is anchored, Pipe-Z Systems do not require a complicated waler system. Instead, the tie rod is linked directly to the pipe pile. There are various ways to make this connection.

The Pipe-Z Wall System also supports projects that require conventional anchoring using a traditional waler system. Pipe-Z Walls can be anchored by batter piles, or by grouted anchors.

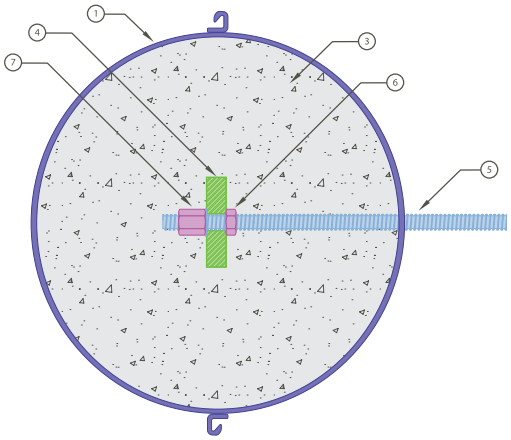


1. Pipe Pile
2. Sheet Pile
3. Tie Rod
4. Connector
5. Sheet Pile Anchorage
6. Hex Nut
7. Bearing Plate
8. Waler

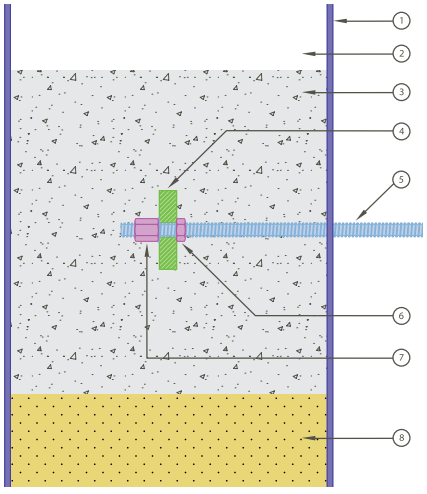
Anchorage Detail

Below you'll find two examples of connections between tie rods and pipe piles.
A whaler system is not needed.

Option 1



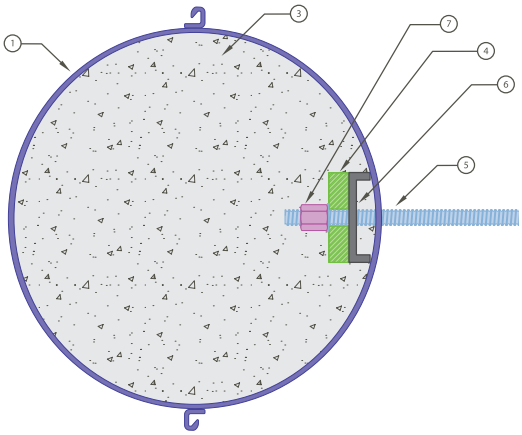
Overhead



Side view

1. Pipe Pile
2. Fill, Air, or Concrete
3. Concrete
4. Bearing Plate
5. Tie Rod
6. Hex Nut
7. Hex Nut
8. Fill

Option 2



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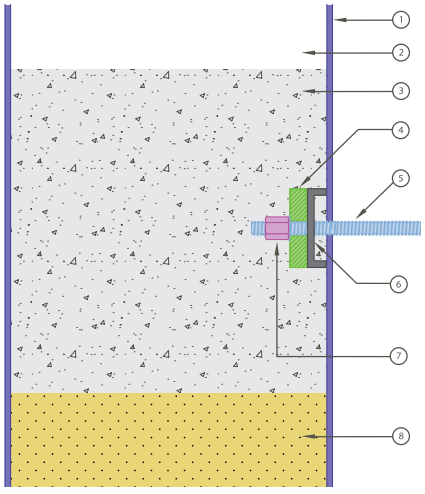


Side view

1. Pipe Pile
2. Fill, Air, or Concrete
3. Concrete
4. Bearing Plate
5. Tie Rod
6. Channel Section
7. Hex Nut
8. Fill

Design Process of Pipe-Z Wall Systems

The Pipe-Z Wall System design is similar to the design of a regular steel sheet pile wall. However, calculating the section of combined Pipe-Z walls differs from conventional sheet piling. Combined walls provide savings in terms of steel grade and pile length for intermediate sheet piles.

The Pipe-Z System Provides Potential Cost Savings
In the stress analysis, the intermediate sheet pile resists a small portion of the bending moment, proportional to its own contribution to the combined moment of inertia. Stresses in the sheet pile are inherently lower than stresses in the Pipe-Z king pile sections. As a result, a low-yield point steel grade works in normal configurations for the Z sheet pile sections.

Moment of inertia of one Pipe-Z system:

$$I_{system} = I_{Pipe} + I_{SSP} \qquad (in^4)(cm^4)$$

Moment of inertia of the system per ft (m) of wall:

$$I_{system/m} = \frac{I_{Pipe} + I_{SSP}}{b_{system}} \qquad (in^4/ft)(cm^4/m)$$

With b_{system} = width of one system (Pipe-Z combination)

I_{system} = moment of inertia of one system (Pipe-Z combination)

$I_{system/ft}$ = moment of inertia of the wall per ft (m) of wall

I_{Pipe} = moment of inertia of one pipe pile

I_{SSP} = moment of inertia of one pair of steel sheet piles

It is assumed that the bending moments are distributed proportionally to the stiffness of the different elements.

Bending moment transmitted to the Pipe-Z king pile:

$$M_{system} = \frac{I_{Pipe}}{I_{system}} M_{max} * b_{system} = \frac{I_{Pipe}}{I_{system}} M_{max} * b_{system}$$

with M_{max} = maximum bending moment per ft (m) of wall (kips*ft/ft) (kNm/m)

σ_{system} = steel stresses in the Pipe-Z beam:

$$\sigma_{system} = \frac{M_{system}}{W_{system}} = \frac{\frac{I_{Pipe}}{I_{system}} M_{max} * b_{system}}{\frac{I_{system}}{R_{pipe}}} = \frac{R_{pipe} * b_{system}}{I_{system}} M_{max}$$

$$\sigma_{Pipe} = \frac{1}{W_{system}} M_{max}$$

Where $W_{system} = \frac{I_{system}}{b_{system} * R_{pipe}}$ in^3/ft (cm^3/m)

With W_{system} = "equivalent" section modulus to determine the stresses in the Pipe-Z section

R = Radius of Pipe outside diameter (OD)

Note: "W_{system}" is labeled in the tables simply as "elastic section modulus".

Example Calculation

[48" OD x 0.500/AZ19-700]

(1) Combined Moment of Inertia:

$I_{system} = I_{Pipe} + I_{SSP}$ *units (in^4)*

$I_{Pipe} = 21045.5\ in^4$

$I_{SSP} = 288.4\ in^4/ft \times 4.6\ ft = 1326.6\ in^4$

$I_{system} = 21045.5\ in^4 + 1326.6\ in^4 = 22372.1\ in^4$ (1)

Per Foot of Wall *units (in^4/ft)*

$$I_{system} = \frac{22372.1\ in^4}{105.6\ in\ /\ (12\ in/ft)} = 2542.3\ in^4/ft$$

(2) Combined Section Modulus:

$$S = \frac{I_{system}}{0.5\ (OD)} \quad units\ (in^3) \quad (2)$$

$$= \frac{22372.1}{0.5\ (48)} = 932.2\ in^3$$

Per Foot of Wall *units (in^3/ft)*

$$S = \frac{932.2\ in^3}{105.6\ in\ /\ (12\ in/ft)} = 105.9\ in^3/ft$$

Notes: (1) Ignore contribution of connectors. (2) For simplification $\bar{Y}$ = 1/2 Pipe outside diameter (OD)

Bending moment transmitted to the intermediate Z sheet pile:

$$M_{SSP} = \frac{I_{SSP}}{I_{system}} M_{max} * b_{system} = \frac{I_{SSP}}{I_{system}} M_{max} * b_{system}$$

$$\sigma_{SSP} = \frac{M_{SSP}}{W_{SSP}} = \frac{\frac{I_{SSP}}{I_{system}} M_{max} * b_{system}}{W_{SSP}}$$

Where M_{max} = maximum bending moment per ft (m) of wall (kips*ft/ft) (kNm/m)

W_{SSP} = section modulus of the intermediate steel sheet pile (in^3) (cm^3)

The stress in the intermediate sheet piles is usually lower than the stress in the pipe piles for two reasons. The pipe piles are much stiffer than the sheet piles and therefore tend to take more load. The distance from the neutral axis of the system to the edge of the pipe piles is much larger than the distance from the neutral axis to the edge of the sheet pile so the stress in the pipe is much higher. This allows the designer to use higher strength steel for the pipe piles than for the sheet piles and maintain the same bending moment capacity.

Pipe-Z Wall System Spacing and Functionality Considerations

The required length of the intermediate Z piles is almost always less than the length of the pipe pile. The toe of the sheet pile needs to be at the point where the total pressure diagram goes from the active side to the passive side, but should be extended below this point for increased safety(Figure a).

In most cases, the arching properties of the soils are good enough that the stability of the wall is not compromised.

If the soils are particularly soft or the water pressure is high, the intermediate piles may have to be as long as the pipe piles. In soft soils with poor arching capacity, the sheet piles need to extend to the toe of the pipe pile to develop the full passive resistance of the soil. High water pressure can cause boiling of the soil inside an excavation if the sheet piles are shortened too much. This can significantly reduce the passive pressure in front of the wall and cause stability problems.

For applications that require a stronger king pile, the section modulus of the Pipe-Z king piles may be modified to meet the bending moment requirements. Stiffening bands welded to the king piles can increase the strength of the section where it is required, and allow the use of a lighter less expensive section in the portions of the pile where the bending moments are lower.(Figure b & c).

Pipe-Z king piles can carry very heavy vertical loads, which can reduce or eliminate the need for other bearing piles or foundation elements. The combined stress and increased deflections must be taken into account when the system is carrying lateral and vertical loads.

The full range of sheet piles (AZ, SKZ, and PZ) used in the Pipe-Z combined wall system offer significant design flexibility. Although the Z sections do not have a large affect on the bending strength or stiffness of the wall, they can be adjusted to increase the design life, handle difficult driving conditions, or alter the spacing of the pipe piles.

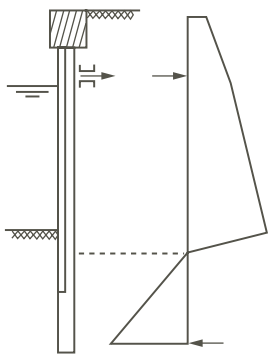


Figure a

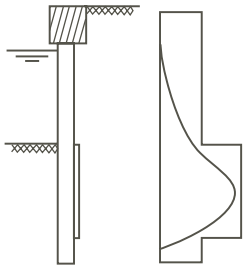


Figure b

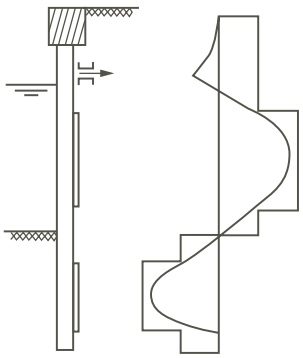


Figure c

Installing Combined Pipe-Z Walls

Procedure

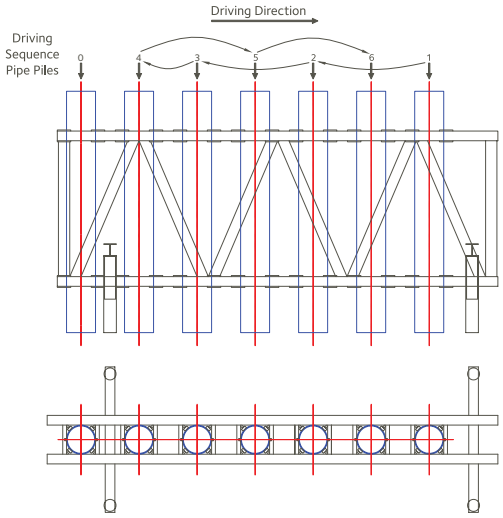
Pipe-Z combination walls can be installed in many different types of soils (from land or from water). As with all sheet pile walls, the installation team needs to make sure that the wall is properly aligned and that the piles are vertical. The two major differences between driving combination walls and sheet pile walls are the template and the order in which the piles are driven.

The pipe piles should always be driven before the intermediate sheet piles, in order to ensure that the pipes are driven in the correct location and are plumb. If the sheet piles are driven before the pipes, the relatively flexible sheet piles could deviate underground and force the pipe piles to follow the same incorrect path, resulting in a misaligned wall. The pipes are stiff enough that they can be driven straight with a very low chance of being pushed out of plumb by an obstruction.

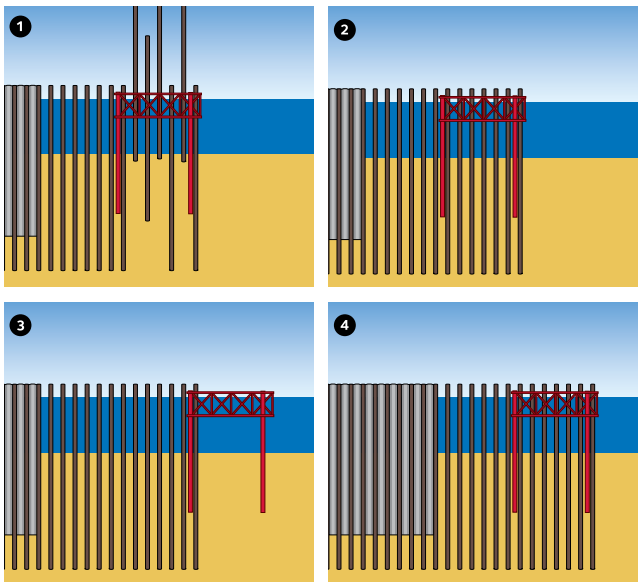
To further decrease the likelihood of a misaligned wall, the pipe piles should never be driven sequentially – a pipe is either driven with no piles on either side of it or with a pile on each side. This is done because pile driving can cause compaction in the soil, and during pile driving it is better to have the same consistency of soil on both sides of the piles, rather than have one side of the piles going through soft soil on one side, and hard compacted soil on the other side. By following the driving sequence in the step driving diagram the differences in soil compaction can be avoided.

The template for a combined wall is essential to the overall quality of the installation. As seen in the diagram below, the pipe piles are driven before the sheet piles and there are large gaps between the piles. The installation team needs to control the sizes of those gaps to make sure that all of the other pipe piles and sheet piles will fit.

The template should have two levels and be double sided. Each pipe pile should have its own bay with rollers or low friction pads guiding the pipe pile as it is being driven. The pipe pile should also be prevented from rotating so that the connectors welded to the sides of the pipe will be well aligned with the sheet piles. After all of the pipe piles in a template have been driven, the template is moved to the next system. Once the template has been moved, the sheet piles can be installed and the pipe piles can be driven to the finished elevation.



Step Driving



Driving Sequence

The template should also be well secured to the ground. If the wall is being driven from land, the template can be hung from a previously installed wall or supported by small piles driven into the ground.

If the wall is being driven from a barge, the template should be supported by piles or attached to the barge itself. If the template is supported by the barge, the barge itself must be immobilized.

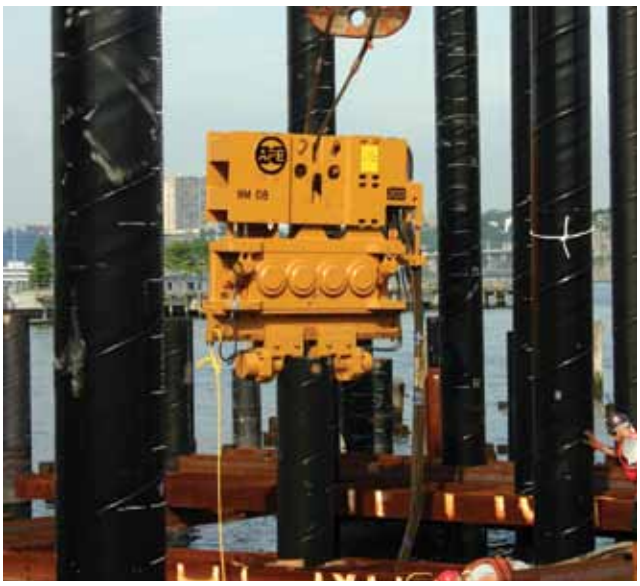
Driving Equipment

Pipe-Z walls, like most other sheet pile walls, are usually driven with vibratory hammers and/or impact hammers. Vibratory hammers are the most common method of installation because of their speed and ease of use, but they have limited ability to handle obstructions, or hard or highly cohesive soils. Impact hammers are slower and louder than vibratory hammers, but have the advantage of being able to handle almost any driving condition.

Vibratory hammers work best in wet granular soils, where the individual soil particles are free to move in relation to one another. In these conditions, the piles advance very quickly and installation can be done without damaging the piles. In very dense sands and stiff clays, the soil particles do not move easily and the pile tends to sit at the same elevation. If the pile does not advance, most of the energy of the hammer goes into the pile instead of the soil, which can cause failure of the flange or web at the location of the clamps, or it can heat the interlocks to the point where they melt and fuse together.

When the soils are too hard for the vibratory hammer to continue to drive the piles, it is best to switch to an impact hammer. Impact hammers work well in all types of soil, but they are not as fast as vibratory hammers.

The hammer needs to have enough energy to move the piles and the weight of the ram of the hammer should be at least 50% (preferably 100%) of the weight of the pile plus the cap. A hammer with a light ram and a long stroke may have enough energy, but if the ram is too light it will not advance the pile deep enough into the ground. These hammer requirements may make it necessary to use two separate hammers: one for the pipe pile and one for the intermediary sheet piles.



Vibratory Hammer

Impact Hammer

Installing Combined Pipe-Z Walls

Driving Aids

Sometimes the ground is too hard to install the piles without assistance. There are various ways to help drive the piles down and/or reduce the probability of damage.

Water jetting, either low or high pressure, can be used in granular and lightly cohesive soils. The jets of water coming out of tubes at the toe of the piles help to reduce toe resistance and skin friction near the bottom of the pile.

Augers can be used to break up hard layers of soil and make the pile easier to drive. If the piles need to be toed into rock it might be necessary to remove rock, install the pile and then replace the voids around the toe of the pile with fill or concrete.

If the bedrock is too high to ensure stability of the wall, the pipe piles and/or sheet piles can be pinned to the rock. The pipe piles can be anchored to the rock by drilling out the inside of the pipe, while the sheet piles would need additional tubes. Geotechnical and structural engineers must evaluate the wall requirements and the strength of the bedrock before attempting to anchor any piles to it.

Blasting can also be used to fracture rock when pre-drilling is not sufficient, but this method requires certain precautions. It is critical to make sure that there is enough soil above the explosion to contain all of the energy from the blast. Also, keep in mind that explosives create powerful vibrations in the soil which could affect surrounding structures. Consult an explosives expert before blasting to be sure that the grade, direction and magnitude of the explosion is properly designed.

In cohesive soils, the skin friction between the pile and the soil can make installation more difficult. Adding cutting shoes, driving points or plates to the toe of the pile will help to temporarily reduce the skin friction on the rest of the pile. The additional steel will also reduce the likelihood of damage to the toe of the pile. Under hard driving conditions, steel plates can be added to strengthen the top of the pile. These plates will reinforce the pile around the clamps of the vibratory hammer or the top of the pile, just below the driving cap.

Table of Combinations

Combination	Outside Diameter in mm	Wall Thickness in mm	Pipe Weight lb/ft kg/m	System Width in mm	Moment of Inertia in⁴/ft cm⁴/m	Section Modulus in³/ft cm³/m	Weight (Sheet Pile Length/Pipe Length) 100% lb/ft² kg/m²
P-CF48/SZK22	48 1219.2	0.500 12.7	253.89 377.8	108.00 1285.90	2480 338598	103.3 5554.4	41.2 201.3
P-PZ42PZ27	42 1066.8	0.500 12.7	221.82 330.1	80.50 1133.28	2175 296969	103.6 5567.5	46.8 228.5
P-AZ48/AZ19-700	48 1219.2	0.500 12.7	253.89 377.8	105.62 1285.36	2542 347078	105.9 5693.6	42.5 207.4
P-PZ48/PZ22	48 1219.2	0.500 12.7	253.89 377.8	94.50 1285.14	2712 370309	113.0 6074.6	43.9 214.2
P-CF54/SZK22	54 1371.6	0.500 12.7	285.96 425.6	114.00 1438.30	3299 450496	122.2 6568.9	42.4 207.2
P-AZ54/AZ19-700	54 1371.6	0.500 12.7	285.96 425.6	111.62 1437.76	3375 460909	125.0 6720.8	43.6 213.1
P-PZ54/PZ22	54 1371.6	0.500 12.7	285.96 425.6	100.50 1437.54	3627 495345	134.3 7222.9	45.1 220.2
P-CF60/SZK22	60 1524.0	0.500 12.7	318.03 473.3	120.00 1590.70	4263 582190	142.1 7640.3	43.5 212.5
P-AZ60/AZ19-700	60 1524.0	0.500 12.7	318.03 473.3	117.62 1590.16	4355 594738	145.2 7805.0	44.7 218.2
P-PZ60/PZ22	60 1524.0	0.500 12.7	318.03 473.3	106.50 1589.94	4695 641205	156.5 8414.8	46.2 225.4
P-AZ66/AZ19-700	66 1676.4	0.500 12.7	350.10 521.0	123.62 1742.56	5485 749028	166.2 8936.2	45.6 222.8
P-PZ66/PZ22	66 1676.4	0.500 12.7	350.10 521.0	112.50 1742.34	5919 808265	179.4 9642.9	47.1 230.1
P-AZ72/AZ19-700	72 1828.8	0.500 12.7	382.17 568.7	129.62 1894.96	6767 924154	188.0 10106.7	46.5 227.0
P-PZ72/PZ22	72 1828.8	0.500 12.7	382.17 568.7	118.50 1894.74	7300 996823	202.8 10901.4	48.0 234.3
P-AZ78/AZ19-700	78 1981.2	0.500 12.7	414.24 616.5	135.62 2047.36	8205 1120425	210.4 11310.6	47.3 230.8
P-PZ78/PZ22	78 1981.2	0.500 12.7	414.24 616.5	124.50 2047.14	8840 1207119	226.7 12185.8	48.8 238.1
P-AZ84/AZ19-700	84 2133.6	0.500 12.7	446.31 664.2	141.62 2199.76	9799 1338099	233.3 12543.1	48.0 234.3
P-PZ84/PZ22	84 2133.6	0.500 12.7	446.31 664.2	130.50 2199.54	10540 1439352	251.0 13492.3	49.5 241.5
P-AZ78/AZ26-700	78 1981.2	0.625 15.9	516.96 769.3	135.62 2047.52	10239 1398160	262.5 14114.3	59.1 288.5
P-PZ72/PZ27	72 1828.8	0.625 15.9	476.87 709.7	110.50 1895.28	9752 1331769	270.9 14564.4	61.8 301.7
P-AZ84/AZ26-700	84 2133.6	0.625 15.9	557.05 829.0	141.62 2199.92	12224 1669327	291.1 15648.0	60.0 292.8
P-PZ78/PZ27	78 1981.2	0.625 15.9	516.96 769.3	116.50 2047.68	11769 1607122	301.8 16223.7	62.7 306.3

Combination	Outside Diameter in mm	Wall Thickness in mm	Pipe Weight lb/ft kg/m	System Width in mm	Moment of Inertia in^4/ft cm^4/m	Section Modulus in^3/ft cm^3/m	Weight (Sheet Pile Length/Pipe Length) 100% lb/ft^2 kg/m^2
P-PZ84/PZ27	84 2133.6	0.625 15.9	557.05 829.0	122.50 2200.08	13989 1910374	333.1 17907.5	63.6 310.5
P-PZ78/PZ35	78 1981.2	0.750 19.1	619.35 921.7	125.78 2047.54	13085 1786888	335.5 18038.5	72.7 355.2
P-AZ72/AZ37-700	72 1828.8	1.000 25.4	758.99 1129.5	129.62 1895.22	13303 1816566	369.5 19866.2	86.9 424.2
P-PZ84/PZ35	84 2133.6	0.750 19.1	667.46 993.3	131.78 2199.94	15600 2130306	371.4 19969.2	73.8 360.4
P-AZ78/AZ37-700	78 1981.2	1.000 25.4	823.13 1225.0	135.62 2047.62	16141 2204193	413.9 22251.1	88.7 433.1
P-PZ72/PZ40	72 1828.8	1.000 25.4	758.99 1129.5	113.87 1895.58	14984 2046243	416.2 22378.0	95.0 463.8
P-AZ84/AZ37-700	84 2133.6	1.000 25.4	887.27 1320.4	141.62 2200.02	19293 2634550	459.3 24695.9	90.4 441.3
P-PZ84/PZ40	84 2133.6	1.000 25.4	887.27 1320.4	125.87 2200.38	21563 2944671	513.4 27602.9	98.2 479.3

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