STEEL PILES

STEEL PILES
SHEET

Larssen and Frodingham profiles of sheet piling are well known to civil engineers throughout the world.

Their usefulness and reliability in all types of earth and water retaining structures has been proven on countless occasions over many years. However, with the benefit of experience and research, the range and efficiency of the sections has continually been improved.

The following information contains full details of a major development - the new range of Larssen profiles recently developed.

The new range provides sections which are markedly superior to those previously available in terms of strength to weight ratios, but which have also been carefully proportioned to retain the traditionally highly valued driving characteristics.

More comprehensive information on the design and installation of all sections is available in the Piling Handbook, available from the publisher of this handbook - CHYE HIN HARDWARE PTE LTD.

STEEL QUALITIES

	Ultimate stress		**Minimum yield stress**				**Minimum elongation on 200 mm**	
			Up to and including 16 mm thick		Over 16 mm up to and including 40 mm thick		Up to and including 9 mm thick	Over 9mm thick
	kg/mm²	N/mm²	kg/mm²	N/mm²	kg/mm²	N/mm²	%	%
BS.4360: 1986 (mild steel) Grade FE 430A	43.8/59.0	430/580	28.0	275	27.0	265	16	20
BS.4360: 1986 (High yield steel) Grade FE 510A	49.9/65.2	490/640	36.2	355	35.2	345	15	18
Similar to ASTM-A328	49.2 min.	482.6 min.	27.0	265	27.0	265	--	17

Notes:
COPPER BEARING STEEL - all the grades of steel are available with 0.20% up to 0.35% or over 0.35% up to 0.50% Copper content.
1N/mm² = 0.101972 kg/mm²

RECOMMENDED WORKING STRESSES FOR STEEL SHEET PILING

Class of work	**BS.4360 Grade 43A ASTM A328 and CSA G40.7 (mild steel)**		**BS.4360 Grade 50A (high yield steel)**	
	kg/mm²	N/mm²	kg/mm²	N/mm²
Permanent	14.2	140	18.3	180
Temporary	17.8	175	22.9	225

Note:
Stresses in temporary conditions occuring during construction may be varied at the discretion of the client's engineer.

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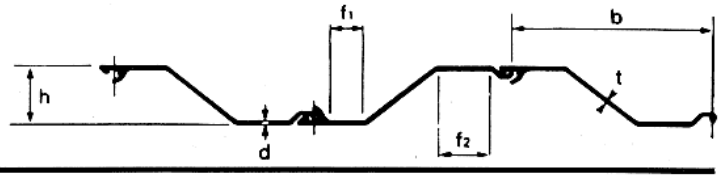

Frodingham Steel Sheet Piling - Dimensions and Properties

Section	b mm (nom.)	h mm (nom.)	d mm	t mm (nom.)	f_1 mm (nom.)	f_2 mm (nom.)	Section area sq. cm per metre of wall	Unit weight kg per linear metre	Unit weight kg per sq. metre of wall	Moment of inertia cm^4 per metre	Modulus of section cm^3 per metre
1BXN	476	143	12.7	12.7	78	123	166.5	62.1	130.4	4,919	688
1N	483	170	9.0	9.0	105	137	126.0	47.8	99.1	6,048	713
2N	483	235	9.7	8.4	97	149	143.0	54.2	112.3	13,513	1,150
3N	483	283	11.7	8.9	89	145	175.0	66.2	137.1	23,885	1,688
3NA	483	305	9.7	9.5	96	146	165.0	62.6	129.8	25,687	1,690
4N	483	330	14.0	10.4	77	127	218.0	82.4	170.8	39,831	2,414
5	425	311	17.0	11.9	89	118	302.0	100.8	236.9	49,262	3,168

Rolling margin is within 4 per cent over and 2.5 per cent under theoretical mass; 75 mm over and 50 mm under on length.
*Please check on availability before specifying.

Special Sections
Sections may be "rolled up" (thickened) or "rolled down" (thinned) by special arrangement to increase or decrease the thickness of both webs and flanges by a maximum of 0.8 mm.

INTERLOCKING SECTIONS

Section (Tongue)	Interlocks with (Groove)	Section (Groove)	Interlocks with (Tongue)
1N	2N, 3NA	**1N**	NONE
1BXN	3N, 4N	**1BXN**	2N, 3NA
2N	1BXN, 3N, 3NA	**2N**	1N, 3NA
3N	4N	**3N**	1BXN, 2N, 3NA
3NA	3N, 1BXN, 2N	**3NA**	1N, 2N
4N	5	**4N**	1BXN, 3N
5	NONE	**5**	4N

RECOMMENDED MAXIMUM LENGTHS FOR DRIVING

The maximum length for each piling section depends upon the type of strata encountered, penetration required, and the type of construction for which the piling is designed. The following table is provided as a guide only.

In hard driving conditions it may be necessary to move up a section size to achieve the required penetration. Alternatively Grade 50A may be used.

Section	Approx. max. length (metres)	Section	Approx. max. length (metres)	Section	Approx. max. length (metres)
6W	9	**32W**	26	**2N**	14
9W	14	**3**	18	**3N**	18
12W	17	**4A**	23	**3NA**	18
16W	20	**6**	30	**4N**	23
20W	23	**1N**	11	**5**	24
25W	23	**1BXN**	14		

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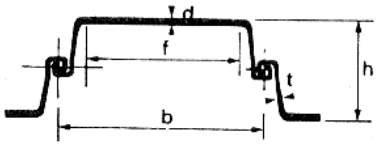
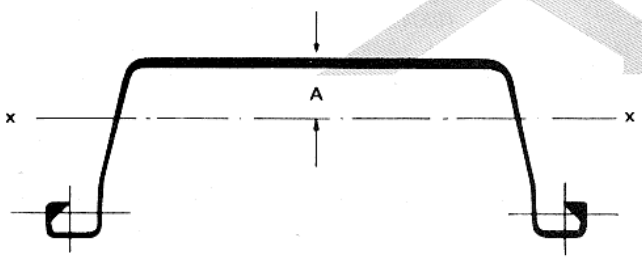


LARSSEN STEEL SHEET PILING - Dimensions and Properties

Section	b mm (nom.)	h mm (nom.)	d mm	t mm (nom.)	f Flat of pan mm	Section area sq. cm per metre of wall	Unit weight kg per linear metre	Unit weight kg per sq. metre of wall	Combined moment of inertia cm^4 per metre	Modulus of section cm^3 per metre
6W	525	212	7.8	6.4	331	108	44.7	85.1	6,371	601
9W	525	260	8.9	6.4	343	124	51.0	97.1	11,726	902
12W	525	306	9.0	8.5	343	147	60.4	115.1	18,345	1,199
16W	525	348	10.5	8.9	341	166	68.3	130.1	27,857	1,601
20W	525	400	11.3	9.4	333	188	77.3	147.2	40,180	2,009
25W	525	454	12.1	10.5	317	213	87.9	167.4	56,727	2,499
32W	525	454	17.0	10.5	317	252	103.6	197.4	73,003	3,216
3	400	250	14.1	8.5	248	198	62.2	155.5	16,980	1,360
4A	400	381	15.7	9.6	219	236	74.0	185.1	44,916	2,360
6	420	440	22.0	14.0	248	370	122.0	290.5	92,452	4,200
6	420	440	25.4	14.0	251	397	131.0	311.8	102,861	4,675
6	420	440	28.6	14.0	251	421	138.7	330.2	111,450	5,066
GSP3	400	250	13.0	8.6	271	191	60.0	150.0	16,800	1,340

Rolling margin is within 4 per cent over and 2.5 per cent under theoretical mass; 75 mm over and 50 mm under on length.



Section	Area cm^2	Dimension A mm	Moment of inertia about axis XX cm^4	Section modulus about axis XX cm^3
6W	57	45	1,247	155
9W	65	50	2,031	204
12W	77	62	3,240	288
16W	87	66	4,495	347
20W	98	79	6,737	467
25W	112	93	9,605	607
32W	132	82	10,580	626
3	79	49	2,227	227
4A	94	76	5,650	412
6 (22.0)	155	90	12,437	770
6 (25.4)	167	85	12,882	777
6 (28.6)	177	82	13,185	780
GSP3	76.4	--	2,220	223

INTERLOCKING SECTIONS

Section	Interlocks with	Section	Interlocks with
6W	9W, 12W, 16W, 4A	**25W**	12W, 16W, 20W, 32W, 3, 4A, 6
9W	6W, 12W, 16W, 4A	**32W**	12W, 16W, 20W, 25W, 3, 4A, 6
12W	6W, 9W, 16W, 20W, 25W, 32W, 4A	**3**	20W, 25W, 32W, 4A
16W	6W, 9W, 12W, 20W, 25W, 32W, 4A	**4A**	6W, 9W, 12W, 16W, 20W, 25W, 32W, 3
20W	12W, 16W, 25W, 32W, 3, 4A, 6	**6**	20W, 25W, 32W

Sheet

GENERAL INFORMATION

Steel sheet piling is used in all types of temporary works and permanent structures including cofferdams, retaining walls, river frontages, quays, wharves, dock and harbour works, permanent foundations, land reclamation and sea defence works.

The sections are designed to provide the maximum strength and durability at the lowest possible weight consistent with good driving qualities. The design of the section interlocks facilitates pitching and driving and results in a series of closely fitting joints, forming a continuous wall.

A comprehensive range of sections in widely differing sizes and weights is obtainable in various grades of steel which enables the most economical choice to be made to suit the nature and requirements of any given contract. This range can be extended if the tonnage required is economic.

Certain sections intended for use in permanent structures where stresses are not severe, such as cut-off-walls, are of uniform thickness throughout in order to provide the maximum effective useful life.

Where piles form temporary works, they can be extracted easily and without distortion for re-use.

Corner, junction and closure piles are available to cover all requirements.

Should any doubts or problems arise advice is available on application to the publisher of this handbook - CHYE HIN HARDWARE PTE LTD.

SPLICES

Steel sheet piling is generally available in lengths up to 30m. Where it is necessary to increase the pile length during driving, fishplated or site-welded joints can be used. Particulars of standard fish-plated joints or weld preparations are available on application.

Because of normal rolling tolerances there may be variations in the pile profile. Every effort should be made to match pile ends before welding.

CIRCULAR CONSTRUCTION

Steel sheet piling can be driven to form a complete circle without the water tightness of the locks being impaired.

The maximum angle of deviation in the locks is 9° for Larssen piles, and 3° for Frodingham piles. Deviation in the locks of Larssen Box Piles is limited to 3°.

The following table gives the approximate minimum diameters of circles which can be constructed using various sheet pile sections.

The diameters are only intended for guidance, as the possible deviation will vary according to length of piles, penetration required and section used.

Smaller diameters can be obtained if individual bent corners are introduced.

Sheet

Type	Section	Minimum number of piles used	Approx. minimum diameter at internal face of wall (metres)	Approx. maximum driving length at minimum diameter (metres)
Larssen	6W	40	6.47	6
Larssen	9W	40	6.42	9
Larssen	12W	40	6.38	9
Larssen	16W	40	6.34	15
Larssen	20W	40	6.28	15
Larssen	25W	40	6.23	15
Larssen	32W	40	6.23	15
Larssen	3	40	4.85	9
Larssen	4A	40	4.71	15
Larssen	6	40	4.91	15
Frodingham	1N	120	18.36	6
Frodingham	1BXN	120	18.10	6
Frodingham	2N	120	18.32	9
Frodingham	3N, 3NA	120	18.30	15
Frodingham	4N	120	18.28	15
Frodingham	5	120	16.07	15

EFFECTIVE LIFE

The effective life of unpainted or otherwise unprotected steel piling to BS 4360 Grades 43A and 50A depends upon the combined effects of imposed stresses and corrosion.

Performance is clearly optimised with combinations of high stress and low corrosion rate. Although other stress and corrosion combinations are less favourable, good design can ensure acceptable lives. The use of grade 50A steel at grade 43A stresses can also increase effective life. Copper-bearing steels are marginally advantageous but only in atmospheric exposures.

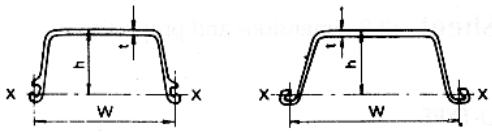
The table below indicates the minimum effective life for various environments assuming that maximum permissible design stress occurs in the zone under consideration. For regions of lower stress, the permissible loss in thickness may be increased and appropriate effective lives calculated from the corrosion data for each service environment.

Minimum Effective Life for Maximum Stress in Various Service Environments

Section type			Environments			
Frodingham	Larssen	Permissible loss in thickness (mm) at position of max stress in pile	Atmospheric corrosion	Splash and low water zones	Sea water immersion and tidal zone	Underground
			Corrosion rates, mm/year			
			0.05 (mean)	0.09 (mean)	0.05 (mean)	0.03 (max)
			Effective life in years			
	6W, 9W	3.5	70	*	*	117
	12W, 16W	4.5	90	50	90	120 +
	20W, 3, 4A	5.0	100	55	100	120 +
1N		5.2	104	58	104	120 +
2N		5.4	108	60	108	120 +
3NA		5.5	110	60	110	120 +
3N		5.9	118	65	118	120 +
	25W, 32W	6.0	120	67	120	120 +
	All No. 6	7.0	120 +	78	120 +	120 +
1BXN		7.2	120 +	80	120 +	120 +
4N		7.4	120 +	82	120 +	120 +
5		8.9	120 +	99	120 +	120 +

* Not suitable for Marine Environment.

Sheet Section properties



U-TYPE

Section	Dimensions			Section area	Unit weight		Moment of inertia		Modulus of section	
	w	h	t	Per pile	Per pile	Per wall width	Per pile	Per wall width	Per pile	Per wall width
	mm in	mm in	mm in	cm^2 in^2	kg/m lb/ft	kg/m^2 lb/ft^2	cm^4 in^4	cm^4/m in^4/ft	cm^3 in^3	cm^3/m in^3/ft
YSP I	400	75	8.0	46.49	36.5	91.2	429	3,820	66.4	509
	15.7	2.95	0.315	7.206	24.5	18.7	10.3	28.0	4.05	9.47
YSP U-5	400	80	7.6	45.21	35.5	88.8	454	4,220	64.7	527
	15.7	3.15	0.299	7.008	23.9	18.2	10.9	30.9	3.95	9.80
FSP IA	400	85	8.0	45.21	35.5	88.8	598	4,500	88.0	529
	15.7	3.35	0.315	7.008	23.9	18.2	14.4	33.0	5.37	9.84
YSP II	400	100	10.5	61.18	48.0	120	986	8,690	121	869
	15.7	3.94	0.413	9.483	32.3	24.6	23.7	63.6	7.38	16.2
FSP II	400	100	10.5	61.18	48.0	120	1,240	8,740	152	874
	15.7	3.94	0.413	9.483	32.3	24.6	29.8	64.0	9.28	16.3
YSP U-9	400	110	9.3	55.01	43.2	108	1,070	9,680	120	880
	15.7	4.33	0.366	8.527	29.0	22.1	25.7	70.9	7.32	16.4
FSP IIA	400	120	9.2	55.01	43.2	108	1,460	10,600	160	880
	15.7	4.72	0.362	8.527	29.0	22.1	35.1	77.6	9.76	16.4
YSP III	400	125	13.0	76.42	60.0	150	1,920	16,400	196	1,310
	15.7	4.92	0.512	11.85	40.3	30.7	46.1	120	12.0	24.4
FSP III	400	125	13.0	76.42	60.0	150	2,220	16,800	223	1,340
	15.7	4.92	0.512	11.85	40.3	30.7	53.3	123	13.6	24.9
YSP U-15	400	150	12.2	74.40	58.4	146	2,700	22,800	238	1,520
	15.7	5.91	0.48	11.53	39.2	29.9	64.9	167	14.5	28.3
FSP IIIA	400	150	13.1	74.40	58.4	146	2,790	22,800	250	1,520
	15.7	5.91	0.516	11.53	39.2	29.9	67.0	167	15.3	28.3
YSP IV	400	155	15.5	96.99	76.1	190	3,690	31,900	311	2,060
	15.7	6.10	0.61	15.03	51.1	38.9	88.7	234	19.0	38.3
FSP IV	400	170	15.5	96.99	76.1	190	4,670	38,600	362	2,270
	15.7	6.69	0.61	15.03	51.1	38.9	112	283	22.1	42.2
YSP U-23	400	175	14.7	94.21	74.0	185	4,380	39,400	330	2,250
	15.7	6.89	0.579	14.60	49.7	37.9	105	289	20.1	41.9
FSP IVA	400	185	16.1	94.21	74.0	185	5,300	41,600	400	2,250
	15.7	7.28	0.634	14.60	49.7	37.9	127	305	24.4	41.9
YSP V	420	175	22.0	134.0	105.0	250	5,950	55,200	433	3,150
	16.5	6.89	0.866	20.77	70.6	51.2	143	404	26.4	58.6
FSP VL	500	200	24.3	133.8	105.0	210	7,960	63,000	520	3,150
	19.7	7.87	0.957	20.74	70.6	43.0	191	461	31.7	58.6
FSP VIL	500	225	27.6	153.0	120.0	240	11,400	86,000	680	3,820
	19.7	8.86	1.09	23.72	80.6	49.2	274	630	41.5	71.1

Note:
Weight per linear meter (foot) of wall is rounded off using the JIS Z 8401-specified formula: Weight per section x $\frac{1{,}000}{\text{W (effective width)}}$

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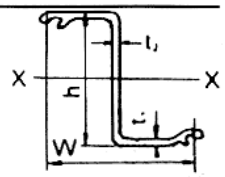
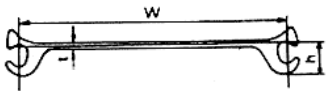


Z-TYPE

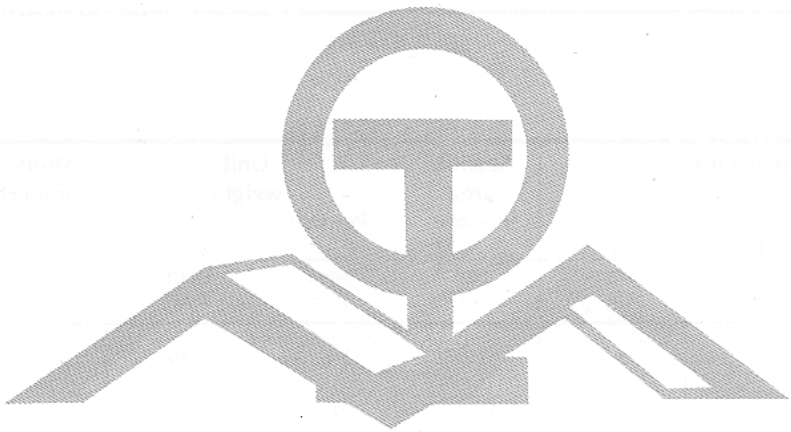
Section	Dimensions				Section area Per pile	Unit weight Per pile	Unit weight Per wall width	Moment of inertia Per pile	Moment of inertia Per wall width	Modulus of section Per pile	Modulus of section Per wall width
	w	h	t_1	t_2							
	mm in	mm in	mm in	mm in	cm^2 in^2	kg/m lb/ft	kg/m^2 lb/ft^2	cm^4 in^4	cm^4/m in^4/ft	cm^3 in^3	cm^3/m in^3/ft
FSP Z-25	400	305	13.0	9.6	94.32	74.0	185	15,300	38,300	1,000	2,510
	15.7	12.0	0.512	0.378	14.62	49.7	37.9	368	280	61.0	46.7
FSP Z-32	400	344	14.2	10.4	107.7	84.5	211	22,000	55,000	1,280	3,200
	15.7	13.5	0.559	0.409	16.69	56.8	43.2	529	403	78.1	59.5
FSP Z-38	400	364	17.2	11.4	122.3	96.0	240	27,700	69,200	1,520	3,800
	15.7	14.3	0.677	0.449	18.96	64.5	49.2	665	507	92.8	70.7
FSP Z-45	400	367	21.9	13.2	148.2	116	290	33,400	83,500	1,820	4,550
	15.7	14.4	0.862	0.52	22.97	77.9	59.4	802	611	111	84.6



STRAIGHT WEB-TYPE

Section	Dimensions			Section area Per pile	Unit weight Per pile	Unit weight Per wall width	Moment of inertia Per pile	Modulus of section Per pile	Interlock strength min.
	w	h	t						
	mm in	mm in	mm in	cm^2 in^2	kg/m lb/ft	kg/m^2 lb/ft^2	cm^4 in^4	cm^3 in^3	t/m lb/ft
YSP F	400	44.5	9.5	69.07	54.2	136	190	47.8	400
	15.7	1.75	0.374	10.71	36.4	27.9	4.56	2.92	268 780
YSP FA	400	44.5	12.7	77.50	60.8	152	196	48.3	400
	15.7	1.75	0.5	12.01	40.9	31.1	4.71	2.95	268 780
YSP FX	400	47.0	12.7	85.66	67.2	168	224	56.1	600
	15.7	1.85	0.5	13.28	45.2	34.4	5.38	3.42	403 170

Note:
1. YSP FA with minimum interlock strength of 500 t/m is subject to negotiation.
2. Normal interlock swing of YSP and YSP FA is at least 10° and that of YSP FX at least 8°.



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