

(A0006865)

Richard's Design 3/7/88

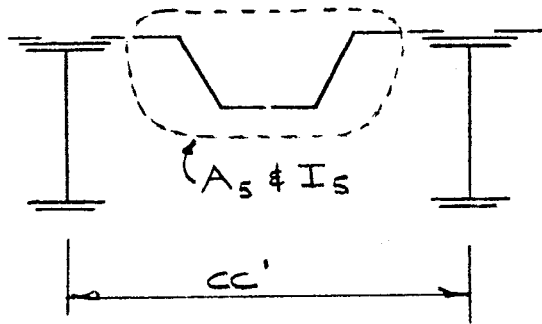
SSW DATE 9/81

SUBJECT HP-97 PROGRAM SECTION MODULUS CALC.

SHEET NO. 1 OF JOE NO.

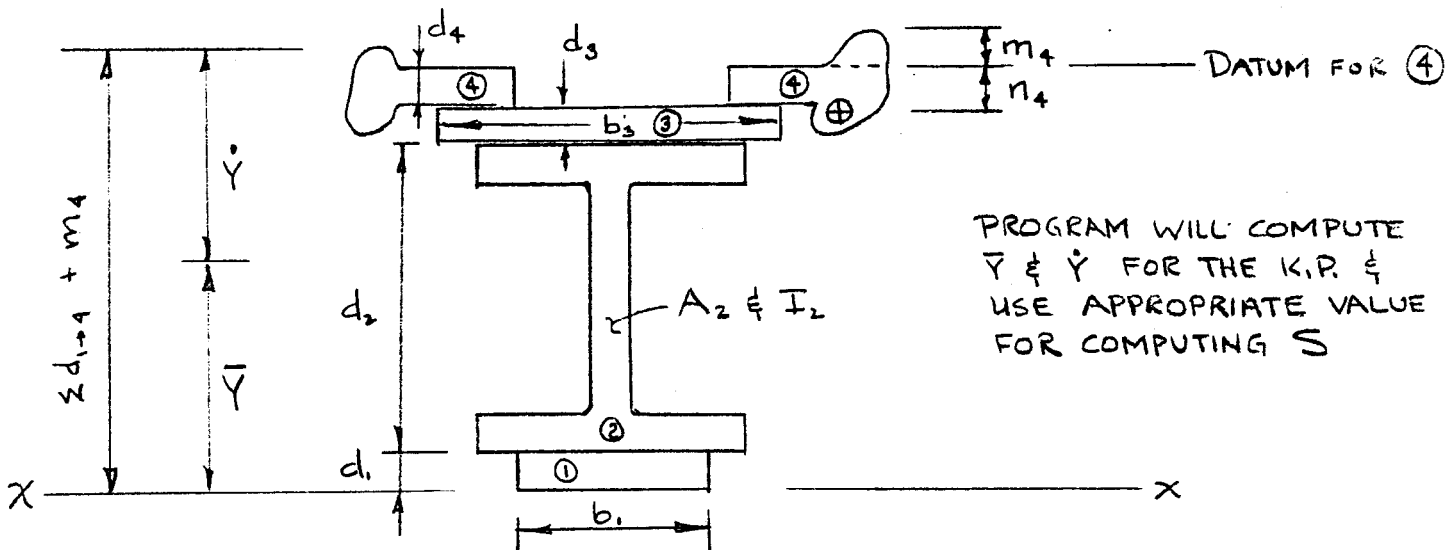
360W132 w/ P240

SYSTEM 1 - KING PILE (K.P.)



STATION	DEPTH	OUTPUT
30.31	0	
30.99	0707	
3700.00	0702	859.57 ***
0.00	0708	48.10 ***
	0701	19.00 ***
.60	0702	2.71 ***
0.00	0703	10.00 ***
0.00	0704	902.21 ***
	0705	107.11 ***
.45	0706	124.75 ***
38.69	0707	32.59 ***
1470.90	0708	

(1937 in⁴)



PROGRAM WILL COMPUTE Y-bar & Y-dot FOR THE K.P. & USE APPROPRIATE VALUE FOR COMPUTING S

INPUT (INCHES EXCEPT CC. SPAC.)

- A - d₁ } P (IF USED)
- B - b₁ }
- C - d₂ } BEAM
- D - A₂ }
- E - I₂ }
- O - d₃ } P (IF USED)
- 1 - b₃ }
- 2 - d₄ } SHEET PILE
- 3 - A₄ }
- 4 - I₄ }
- 5 - m₄ }
- 6 - n₄ }
- 7 - A₅ } INTERMEDIATE SHEETING
- 8 - I₅ }
- 9 - CC. - BEAM SPACING (FT)

OUTPUT

- 1 - TOTAL DEPTH OF K.P.
- 2 - ΣA_iȳ_i OF K.P.
- 3 - A OF K.P.
- 4 - ȳ OF K.P.
- 5 - TOTAL I OF SYSTEM OVER CC' (IN⁴)
- 6 - ȳ OF K.P.
- 7 - S OF SYSTEM OVER CC' (IN³)
- 8 - S PER FT OF WALL (IN³/FT)
- 9 - TOTAL WT. OF SYSTEM IN CC'
- 10 - WT. OF SYSTEM - #/FT²

AREA & WTS. EXCLUDE WELDS
ASSUMPTION IS SYSTEM HAS SAME CROSS SECTION FULL LENGTH (TOP TO BOTTOM)

$\bar{I}_{REQ'D} = 1850 \text{ IN}^4/\text{FT}$

SBW 3/2/88

KING PILE

	P235			P240				
	SPACING	$\frac{I}{\text{IN}^4/\text{FT}}$	$\frac{S}{\text{IN}^3/\text{FT}}$	$\frac{WT}{\#/\text{FT}^2}$	SPACING	$\frac{I}{\text{IN}^4/\text{FT}}$	$\frac{S}{\text{IN}^3/\text{FT}}$	$\frac{WT}{\#/\text{FT}^2}$
24WF162	5'-4 1/2"	1445	99.3	60.6	4'-9 1/2"	1672	115	67.8
27WF146					4'-11"	1767	109.6	62.7
161					✓ 4'-11"	1909	118.9	65.8
178	5'-5"	1827	114.1	63.0	✓ 4'-11"	2063	128.9	69.2
36WF135	✓ 5'-3"	2201	104.3	56.8	✓ 4'-9 1/2"	2464	116.3	62.1

36WF135

27WF161

Desai 504-862-2657

36WF135

35.55 STD
 39.70 STD
 7800.00 STD
 0.00 STD
 STD
 .60 STD
 9.20 STD
 0.00 STD
 0.00 STD
 .45 STD
 39.31 STD
 1367.20 STD
 5.25 STD
 08
 39.15 *
 1034.00 *
 48.90 *
 21.15 *
 11560.10 *
 15.00
 546.70
 104.12
 200.05

* WITH 1" x 9" ON BACK FLANGE OF WF

→ KING PILES 5'-3" <<

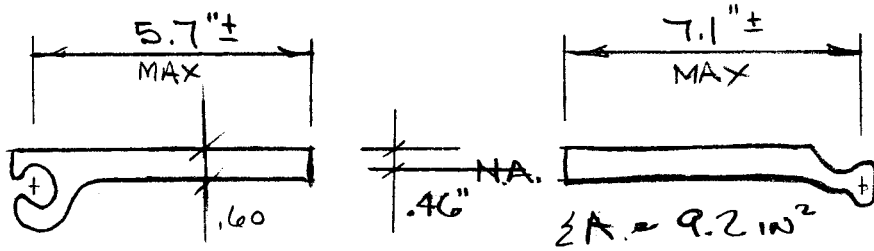
→ $I = 11560 / 5.25 = 2202 \text{ IN}^4/\text{FT}$ (2880 IN^4/FT)*

→ $S = 104.1 \text{ IN}^3/\text{FT}$ (153.4 IN^3/FT)*

→ $WT = 56.8 \text{ \#/FT}^2$ (62.6 \#/FT^2)*

SAMPLE CALC. -

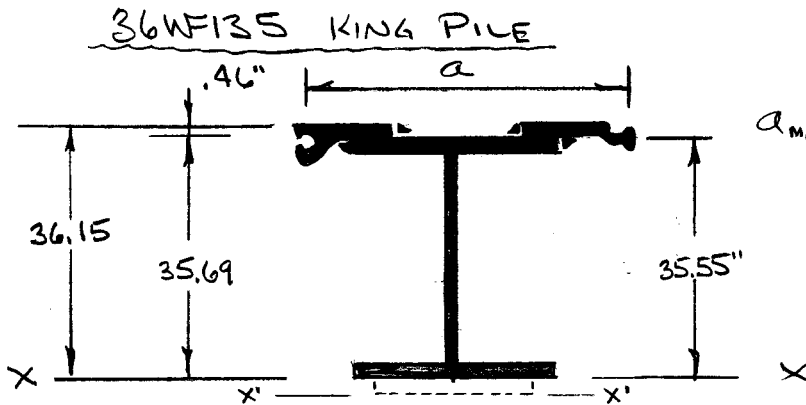
35W 3/2/88



PZ35/40

MIN LAP FOR WELDING = $5 \times .6 = 3"$ (AISC)

FOR NOMINAL WIDTH OF KING PILE ADD
 $(12.8 - 2 \times 3) = 6.8"$ MAX TO WF FLANGE
 WIDTH



$a_{max} = 11.95 + 6.8 = 18.75"$

w/ PZ35 $L = 2 \times 22.64 + 18.75 = 64"$
 Let $L = 5'-3"$

$A = 39.7$
 $I = 7800$

LOCATE \bar{Y} OF KING PILE

$$\frac{39.7 (35.55/2)}{9.2 (35.69)} = \frac{\Sigma a \bar{y}}{\Sigma a}$$

$$\Sigma a = 48.9 \text{ IN}^2 \quad \Sigma a \bar{y} = 1034. \text{ IN}^3$$

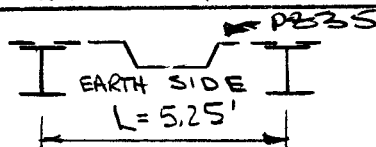
$\bar{Y} = 1034 / 48.9 = 21.15"$
 $\dot{Y} = 36.15 - 21.15 = 15.00"$

$\bar{I} = \Sigma (I + ad^2)$

$$\bar{I} = 7800 + 39.7 (21.15 - 35.55/2)^2 + 9.2 (35.69 - 21.15)^2$$

$$= 7800 + 452 + 1945 = 10,194 \text{ IN}^4$$

FIND I OF TYPICAL UNIT



$$I_{avg} = \frac{10,194 + 2 \times 681.5}{5.25} = 2201. \text{ IN}^4 / \text{FT}$$

BETHLEHEM KING PILE SYSTEM (w/o R's)

SECTION	PZ22			PZ27		
	SPACING(FT)*	S (IN ³ /FT)	WT (#/FT ²)	SPACING(FT)*	S (IN ³ /FT)	WT (#/FT ²)
W12x100	5.25'	—	—	4.5'	—	—
x120	↓	—	—	↓	—	—
x136	↓	—	—	↓	—	—
x152	↓	—	—	↓	64.6	56.7
x170	↓	—	—	↓	70.5	60.7
x190	↓	—	—	↓	76.7	65.1
HPI4x102	5.25	—	—	4.75	—	—
x117	↓	—	—	↓	—	—
W14 x 90	5.25	—	—	4.75	—	—
x 99	↓	—	—	↓	—	—
x109	↓	—	—	↓	—	—
x120	↓	—	—	↓	—	—
x132	↓	—	—	↓	—	—
W14 x145	5.25	—	—	4.75	64.6	52.3
x159	↓	—	—	↓	69.3	55.2
x176	↓	62.6	53.2	↓	75.2	58.8
x193	↓	68.2	56.4	↓	81.3	62.4
W21 x101	5.25	—	—	4.50	63.1	45.5
x111	↓	—	—	↓	63.7	47.7
x122	↓	—	—	↓	73.8	50.1
x132	↓	63.9	44.7	↓	78.9	52.3
x147	↓	70.6	47.6	↓	86.7	55.6
W24 x104	5.25	—	—	4.50	69.5	46.1
x117	↓	63.0	41.9	↓	77.3	49.0
x131	↓	70.1	44.6	↓	85.6	52.1
x146	↓	78.2	47.5	↓	95.1	55.5
x162	↓	86.6	50.5	↓	104.9	59.0
W27x146	5.25	85.9	47.4	4.75	98.3	52.5
x161	↓	94.5	50.3	↓	107.8	55.7
x178	↓	103.7	53.5	↓	118.0	59.2
W30x173	5.5	105.5	50.1	4.75	125.2	58.1
x191	↓	116.4	53.4	↓	137.8	61.9
x211	↓	128.9	57.1	↓	152.3	66.1
W33x201	5.5	132.2	55.3	4.75	155.9	64.1
x221	↓	145.4	58.9	↓	171.1	68.3
x241	↓	159.4	62.6	↓	187.3	72.5
W36x135	5.25	92.7	45.3	4.5	110.8	53.0
x150	↓	105.1	48.2	↓	125.3	56.4
x160	↓	112.3	50.1	↓	133.7	58.5
x170	↓	119.8	52.0	↓	142.4	60.7
x182	↓	127.9	54.3	↓	151.9	63.5
x194	↓	135.8	56.5	↓	161.2	66.0
x210	↓	146.8	59.6	↓	173.9	69.7
W36 x230	5.5	160.3	60.5	4.75	188.2	70.1
x245	↓	170.7	63.3	↓	200.3	73.4
x260	↓	182.0	66.0	↓	213.4	76.5
x280	↓	196.8	69.7	↓	230.5	80.7
x300	↓	209.7	73.3	↓	245.5	85.0

* ROUNDED DOWN TO 3" INCREMENTS

SSW
10/4/84

BETHLEHEM KING PILE SYSTEM (w/ P's)

SECTION	P	P222			P227		
		SPACING*	S (IN ³ /FT)	WT (#/FT)	SPACING*	S (IN ³ /FT)	WT (#/FT)
W12x106	11x.625	5.25	-	-	4.5	65.9	51.7
x120	↓	↓	-	-	↓	69.6	54.8
x136	↓	↓	-	-	↓	74.2	58.3
x152	↓	↓	61.6	53.0	↓	79.2	61.9
x170	↓	↓	66.6	56.5	↓	84.8	65.9
x190	↓	↓	71.7	60.2	↓	90.7	70.3
HP14x102	12x.5625	↓	-	-	4.75	64.0	48.1
x117	↓	↓	-	-	↓	68.3	51.2
W14x90	12x.5625	↓	-	-	4.75	62.6	45.6
x99	↓	↓	-	-	↓	65.5	47.4
x109	↓	↓	-	-	↓	68.3	49.5
x120	↓	↓	-	-	↓	72.2	51.9
x132	↓	↓	62.7	49.1	↓	75.8	54.4
x145	12x.5625	↓	66.8	51.6	4.75	80.3	57.2
x159	↓	↓	71.0	54.2	↓	84.8	60.0
x176	↓	↓	76.1	57.5	↓	90.4	63.7
x193	↓	↓	81.5	60.8	↓	96.3	67.2
W21x101	11x.625	5.25	73.1	43.4	4.5	90.1	50.7
x111	↓	↓	77.2	45.3	↓	94.9	52.9
x122	↓	↓	82.0	47.3	↓	100.4	55.3
x132	↓	↓	86.1	49.2	↓	105.2	57.5
x147	↓	↓	92.5	52.1	↓	112.6	60.8
W24x104	11x.625	5.25	81.8	43.9	4.5	99.7	51.3
x117	↓	↓	88.3	46.4	↓	107.3	54.2
x131	↓	↓	95.4	49.0	↓	115.5	57.2
x146	↓	↓	103.3	51.9	↓	124.7	60.6
x162	↓	↓	111.5	55.0	↓	134.2	64.2
W27x146	12x.5625	5.25	113.9	51.8	4.75	129.5	57.3
x161	↓	↓	122.2	54.7	↓	138.7	60.5
x178	↓	↓	131.2	57.9	↓	148.5	64.0
W30x173	14x.50	5.5	135.0	54.5	4.75	159.6	63.1
x191	↓	↓	145.8	57.7	↓	172.0	66.9
x211	↓	↓	158.2	61.4	↓	186.4	71.1
W33x201	14x.50	5.5	164.5	59.6	4.75	193.4	69.1
x221	↓	↓	177.5	63.2	↓	208.5	73.3
x241	↓	↓	191.4	66.9	↓	224.6	77.5
W36x135	11x.625	5.25	129.1	49.8	4.5	153.6	58.2
x150	↓	↓	141.7	52.7	↓	168.3	61.6
x160	↓	↓	148.8	54.5	↓	176.6	63.7
x170	↓	↓	156.3	56.5	↓	185.3	65.9
x182	↓	↓	164.3	58.8	↓	194.6	68.7
x194	↓	↓	172.1	61.0	↓	203.6	71.2
x210	↓	↓	182.7	64.1	↓	216.0	74.9
W36x230	14x.50	5.5	194.3	64.8	4.75	227.8	75.2
x245	↓	↓	204.7	67.6	↓	239.8	78.4
x260	↓	↓	215.9	70.3	↓	252.7	81.5
x280	↓	↓	230.6	74.0	↓	269.8	85.7
x300	↓	↓	243.4	77.6	↓	284.5	90.0

*Rounded down to 3" INCREMENTS.

SSW 10/14/84

High Section Modulus Requirements

There may be occasions when even PZ40 in high-strength grades of steel is not sufficiently strong to satisfy the calculated design moments. When this is the case, the designer has several available options to consider:

Cellular design

This design can be very efficient and an option that should be explored for facilities such as deep draft bulkheads and large graving docks. Cellular construction provides a solid-faced wharf in deep water without the need for elaborate anchorage systems. The feasibility of a cellular design is somewhat dependent on site and soil conditions. Refer to page 22 for additional information on cellular design.

Cover plated Z-piling

This approach extends the range of Z-piling by increasing the moment carrying capacity in the area where the design moment exceeds the capacity of the plain Z-pile.

PZ35 and PZ40 with Welded Cover Plates

Plate Size (in.)	PZ35		PZ40	
	Section Modulus in. ³ /ft of wall	Weight lb./ft ² of wall	Section Modulus in. ³ /ft of wall	Weight lb./ft ² of wall
None	48.5	35.0	60.7	40.0
4-1/2 x .25	—	—	70.2	44.7
4-1/2 x .375	—	—	74.9	47.0
4-1/2 x .50	63.2	43.1	79.5	49.3
4-1/2 x .625	67.0	45.1	84.2	51.7
4-1/2 x .75	70.8	47.2	89.0	54.0
4-1/2 x .875	74.6	49.2	93.8	56.3
4-1/2 x 1.00	78.4	51.2	98.6	58.7
4-1/2 x 1.125	82.3	53.2	103.4	61.0
4-1/2 x 1.25	86.2	55.3	108.3	63.3

Note:

- Filet weld should be sized to adequately resist design loads and be continuous and all around.
- Cover plate length depends upon moment curve.



FROM ROUGH DRAFT
OF CATALOG

Master Pile System

This system combines moment resisting and cellular design. The PSA or PS sheet piling sections transmit the soil pressures on the arcs by interlock tension to the moment-resisting master piles.

A master pile design is ideally suited to sites where very hard driving is anticipated or rock is at a high elevation and insufficient penetration is available for adequate toe resistance. In such cases, the master pile can be installed in a pre-drilled hole and grouted in place.

Depending on the number of intermediate sheets, section moduli in excess of 200 in./ft of wall can be obtained utilizing this design concept.

The following table, using selected wide-flange sections (unreinforced and reinforced), shows design properties obtainable using this approach. This table should be used by the designer as a guide. Actual master pile size and system geometry (master pile spacing, arc radius, etc.) must be determined by the engineer based on site conditions.

Master Pile	Intermediate Piles					
	3 Sections PSA23			5 Sections PS27.5 (or PS31)		
	Spacing L	Section Modulus in. ³ /ft of wall	Weight lb/ft ² of wall	Spacing L	Section Modulus in. ³ /ft of wall	Weight lb/ft ² of wall
W14 × 132	6'-0"	36.6 (51.4)	42.4	9'-8"	23.8 (35.0)	41.7
W14 × 257	6'-3"	69.2 (81.5)	60.7	9'-8"	46.4 (54.8)	54.6
W14 × 342	6'-3"	92.9 (104.1)	74.5	9'-8"	62.1 (68.9)	63.5
W24 × 162	6'-0"	72.7 (99.9)	47.4	9'-8"	46.8 (68.8)	44.8
W27 × 178	6'-0"	88.1 (118.4)	50.0	9'-8"	56.5 (81.2)	46.4
W33 × 152	5'-9"	90.7 (130.7)	47.7	9'-8"	56.0 (88.5)	43.7
W36 × 135	5'-9"	83.0 (126.2)	44.7	9'-8"	51.5 (87.1)	42.0
W36 × 170	5'-9"	107.8 (150.6)	50.8	9'-8"	66.5 (101.2)	45.6
W36 × 210	5'-9"	132.6 (174.3)	57.8	9'-8"	81.5 (114.9)	49.7
W36 × 260	6'-3"	158.7 (195.3)	61.2	10'-6"	96.8 (125.3)	50.6
W36 × 300	6'-3"	183.2 (219.0)	67.6	10'-6"	111.6 (138.9)	54.4

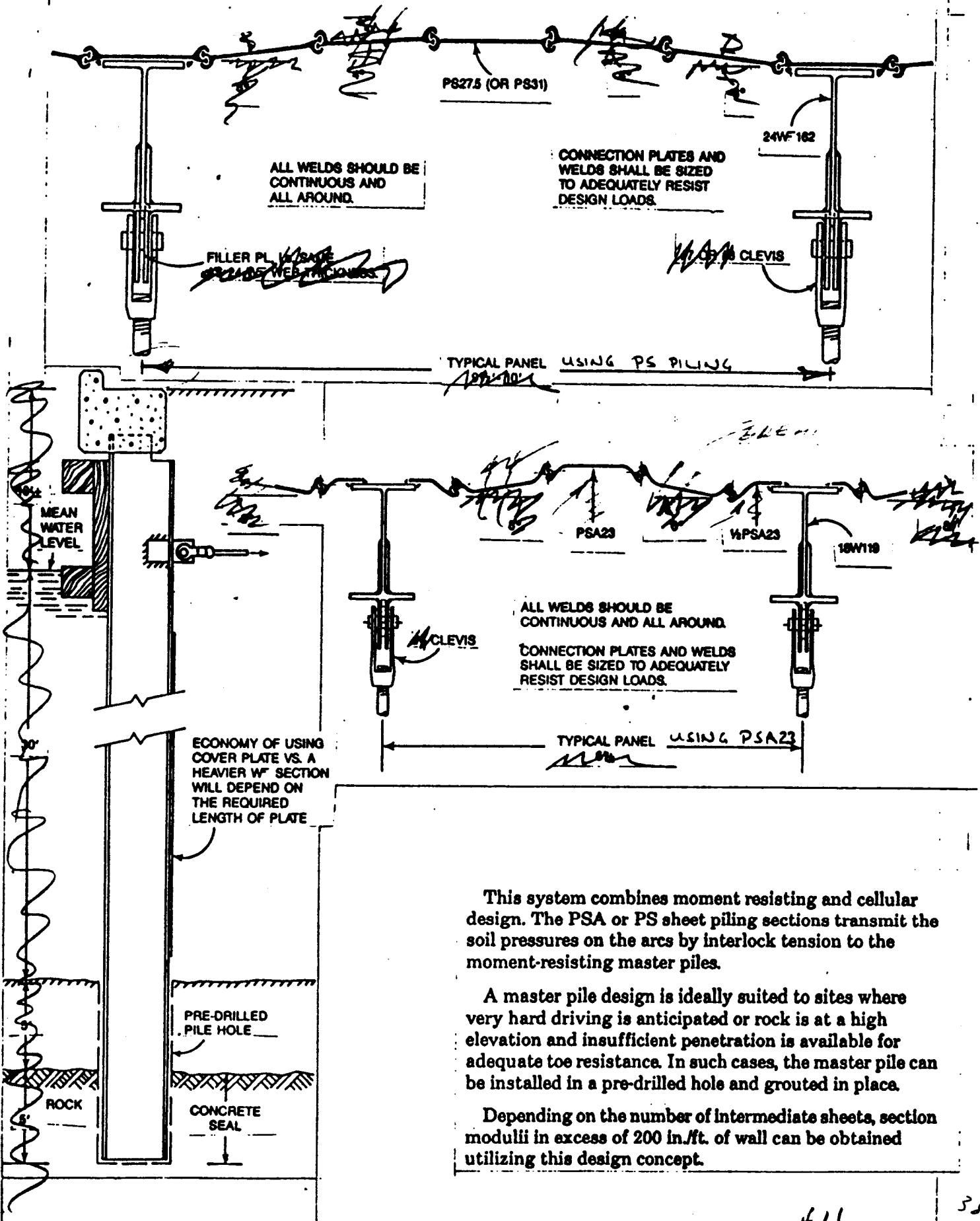
*PS pile is attached in 2 pieces.

Note:

□ Numbers in parentheses represent section modulus with a cover plate on the back of the master pile.

□ The plate (measuring 9 in. × 1 in. for a PSA23 layout and 10 1/4 in. × 1 1/4 in. for a PS27.5 layout) is welded continuously all around. The weld must be sized to resist the design loads.

Master Pile System



King Pile System

This system combines Z-piling and structural sections. Large section moduli can be developed using this approach. The flexibility of the ball-and-socket interlock design allows this heavy wall system to be more readily installed than similar systems.

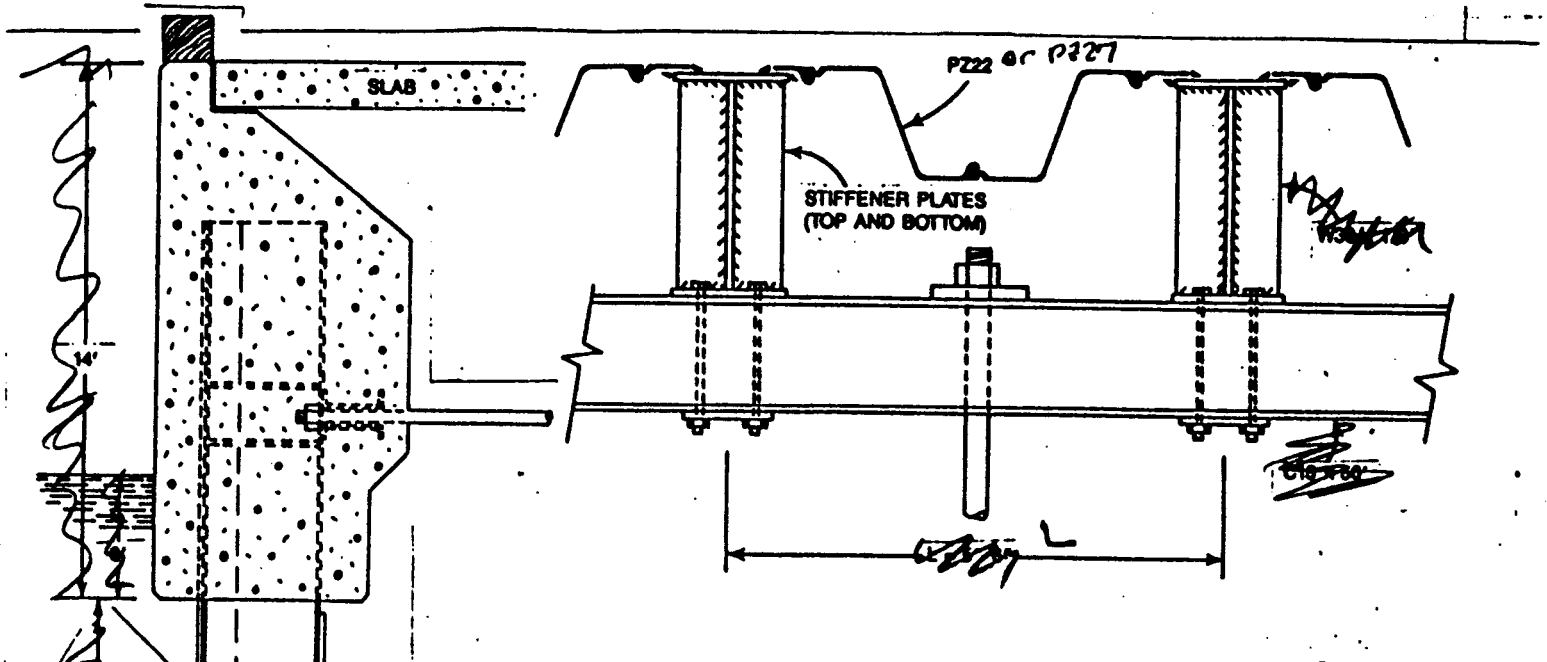
The following table, using selected wide-flange sections (unreinforced or reinforced), shows design properties obtainable using this approach.

King Pile	Intermediate Piles					
	PZ22			PZ27		
	Spacing L	Section Modulus in. ³ /ft of wall	Weight lb/ft ² of wall	Spacing L	Section Modulus in. ³ /ft of wall	Weight lb/ft ² of wall
W24 × 117	5'-3"	63.3 (88.3)	41.9	4'-6"	77.3 (107.5)	49.0
W30 × 173	5'-6"	105.8 (135.2)	50.1	4'-9"	125.2 (159.5)	58.1
W33 × 201	5'-6"	132.5 (164.5)	55.3	4'-9"	155.9 (193.1)	64.1
W33 × 221	5'-6"	145.7 (177.3)	58.9	4'-9"	171.2 (208.0)	68.3
W36 × 135	5'-3"	92.9 (129.6)	45.3	4'-6"	110.8 (153.8)	53.0
W36 × 170	5'-3"	120.0 (156.7)	52.0	4'-6"	142.5 (185.5)	60.8
W36 × 230	5'-6"	160.5 (194.1)	60.5	4'-9"	188.2 (227.2)	70.2
W36 × 260	5'-6"	182.3 (215.4)	66.0	4'-9"	213.4 (251.9)	76.5
W36 × 300	5'-6"	210.0 (242.5)	73.3	4'-9"	245.5 (283.3)	85.0

Note:

- Numbers in parentheses represent section modulus with a cover plate on the back of the king pile.
- The plate, measuring 11 in. × 5/8 in. is welded continuously all around. The weld must be sized to resist the design loads.

King Pile System



This system combines Z-piling and structural sections. Large section moduli can be developed using this approach. The flexibility of the ball-and-socket interlock design allows this heavy wall system to be more readily installed than similar systems.

The following table, using selected wide-flange sections (unreinforced or reinforced), shows design properties obtainable using this approach.

ECONOMY OF USING COVER PLATE VS. A HEAVIER W SECTION WILL DEPEND UPON THE REQUIRED LENGTH OF PLATE

King Pile	Intermediate Piles					
	PZ22			PZ27		
	Spacing L (ft.-in.)	Section Modulus in. ³ /ft. of wall	Weight lb./ft. ² of wall	Spacing L (ft.-in.)	Section Modulus in. ³ /ft. of wall	Weight lb./ft. ² of wall
W24 X 117	5'-3"	63.3 (88.3)	41.9	4'-6"	77.3 (107.5)	49.0
W30 X 173	5'-6"	105.8 (135.2)	50.1	4'-9"	125.2 (159.5)	58.1
W33 X 201	5'-6"	132.5 (164.5)	55.3	4'-9"	155.9 (193.1)	64.1
X221		145.7 (177.3)	58.9		171.2 (208.0)	68.3
W36 X 135	5'-3"	92.9 (129.6)	45.3	4'-6"	110.8 (153.8)	53.0
X170		120.0 (156.7)	52.0		142.5 (185.5)	60.8
W36 X 230	5'-6"	160.5 (194.1)	60.5	4'-9"	188.2 (227.2)	70.2
X260		182.3 (215.4)	66.0		213.4 (251.9)	76.5
X300		210.0 (242.5)	73.3		245.5 (283.3)	85.0

Note: Numbers in parentheses represent section modulus with a cover plate on the back of the king pile. The plate, measuring 11" X 5/8" is welded continuously all around.