



TRENCH SHIELD TABULATED DATA

A COPY OF THIS SHEET MUST ACCOMPANY EACH CORRESPONDING TRENCH SHIELD AT EVERY JOB SITE

MODEL NUMBER: TSR PRO-6 820 KE

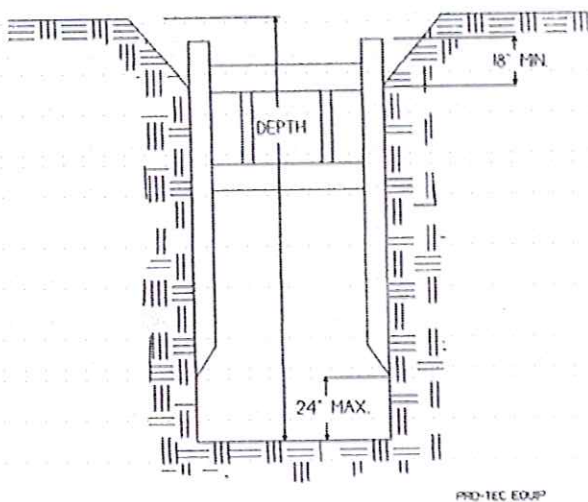
SERIAL NUMBER: 30960

SOIL	MAX DEPTH	PSF
TYPE A	57 - FT	*1560
TYPE B	33 - FT	
TYPE C60	26 - FT	
TYPE C80	21 - FT	

DATE MANUFACTURED: 03/27/15
 SHIELD WEIGHT: 10,800 - LB
 SHIELD SIZE: 8 - FT X 20 - FT
 SPREADER SIZE: 8 IN SCH 80
 MAX SPREADER LENGTH: 20 - FT

*Shield Capacity based on C60 soil at bottom of the excavation.

LIMITATIONS:



1. Soil above shield must be sloped according to OSHA Subpart P. Slope must begin no less than 18" below the top of shield. Shield may be suspended no more than 2 feet above bottom of the trench and only if there is no possible loss of soil from behind or below bottom of shield.
2. A minimum of 2 spreader pipes are required on each end with manufacturer approved 2-in diameter pins and keepers.
3. Repairs and modifications shall be approved in writing by the manufacturer and a registered professional engineer.
4. Shields may be stacked as long as each is rated to the depth it is used and manufacturer approved stack connections are utilized.
5. Surcharge loads have not been included in the above depth ratings. The allowable working depth of the shield must be reduced to account for all surcharge loading which occurs adjacent to the trench. (Adjacent is defined as within a distance equal to the depth of the trench.)
6. The Soil Types A, B, and C - 80 are as defined in the OSHA Standard. Soil Type C - 60 is a moist, cohesive soil or a moist dense granular soil, which is not flowing or submerged and has an Equivalent Fluid Pressure (EFP) of 60 PSF per foot of depth. The competent person must monitor the excavation for signs of deterioration that may alter soil pressures and produce the Soil Type C - 80 condition. Such signs are indicated by, but not limited to, freely seeping water or flowing soil entering the excavation around or below the shield.
7. PRO-TEC trench shields have been designed by a registered professional engineer as required to comply with Occupational Safety and Health Administration (OSHA) standard 29 CFR Part 1926, Subpart P.
8. Maximum depths are based on shields being in structurally sound condition. Trench Shields should be inspected prior to each use for any damage or deterioration. If a shield has sustained major structural damage or permanent deformation of a structural member or connection, the Tabulated Data is void until repairs are made as specified by a registered professional engineer.



TRINITY SHORING PRODUCTS, INC.
 A TRINITY MINING & CONSTRUCTION EQUIPMENT, INC. COMPANY

JN 17929

Usage of trench shields other than specified could cause failure or cave-ins resulting in serious injury or death.

Phone (517) 827-3250 • 1-800-292-1225 • Fax (517) 827-3263

Pro-Tec Equipment • 4837 West Grand River Ave. • Lansing, MI 48906



Trench Shield Calculation Work Sheet

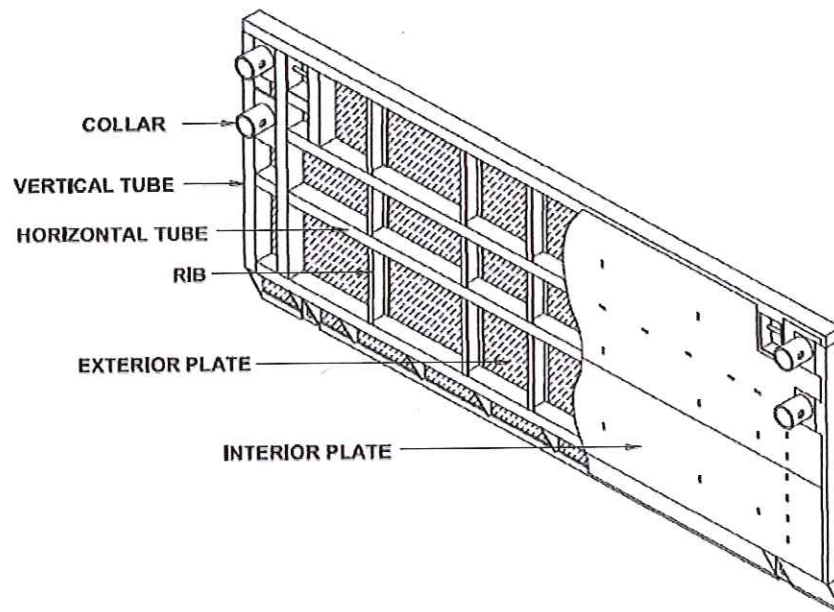
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Job Number: 17929

Date: 3/27/2015

Trench Shields are designed in accordance with the *AISC Manual of Steel Construction - 13th edition* utilizing Allowable Stress Design and the following modifications:

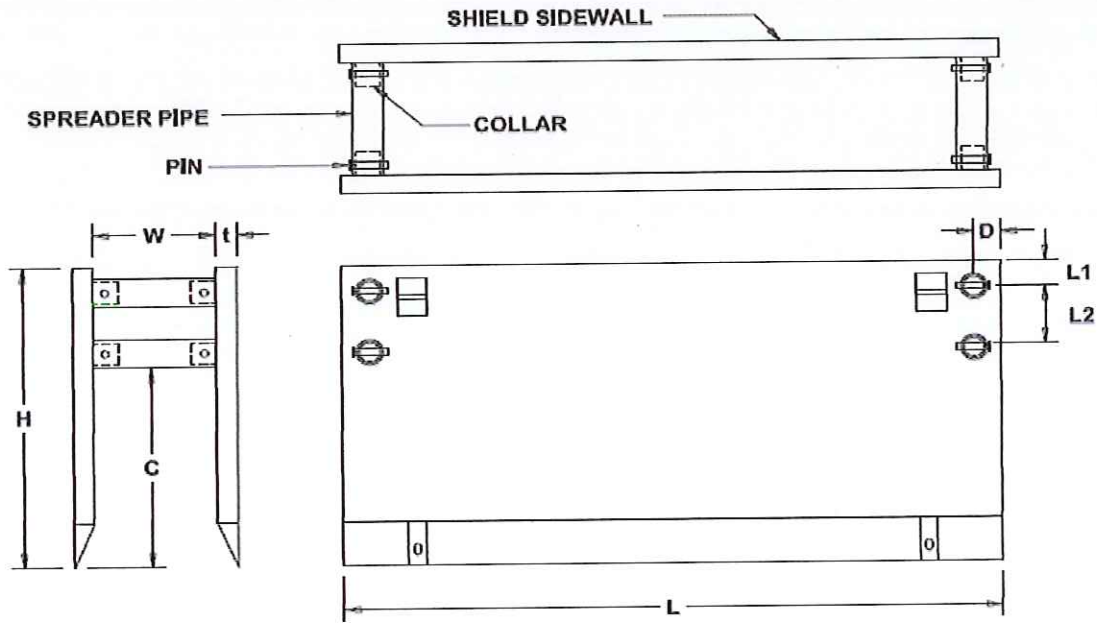
Subject	Description	Reference
Allowable Stresses	1.33 increase for wall elements for Trench Shields	NBS / NIOSH 82 - 06 - M ASCE Geotechnical Special Publication No. 74
Moment Reduction	Reduce bending moments derived by soil pressure by 0.80	NBS / NIOSH 82 - 06 - M ASCE Geotechnical Special Publication No. 74
Effective Flange Width (be) for Horizontal and Vertical sections.	Maximum width to thickness ratios for compression in wall elements: $b / t < 150$	Manufacturer's testing data



Typical Trench Shield Structural Elements



Trench Shield Calculation Work Sheet



Trench Shield Dimensions

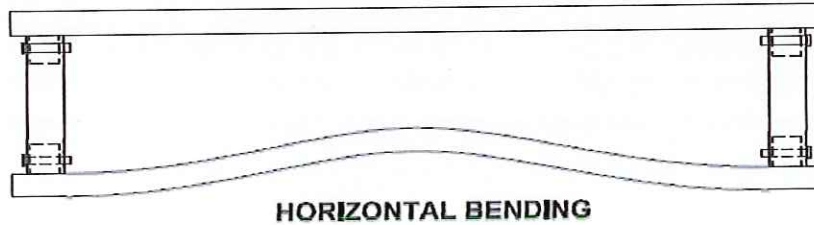
Trench Shield Geometry:

Height of Shield:	$H = 8$ ft	Pin Diameter:	$d = 2$ in
Length of Shield:	$L = 20$ ft	Spreader Size:	8 SCHD 80
Spreader Width:	$W = 20$ ft	Dimension D:	$D = 8$ in
Wall Thickness:	$t = 6$ in	Dimension L1:	$L1 = 8.5$ in
Pipe Clearance:	$C = 65$ in	Dimension L2:	$L2 = 18.5$ in

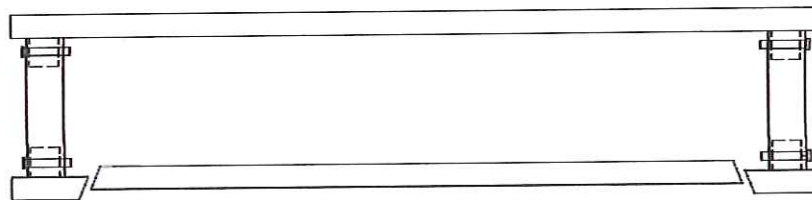
Trench Shield Ratings:

Shield Capacity (psf)	Depth Ratings			
	A25 (ft)	B45 (ft)	C60 (ft)	C80 (ft)
1,320	57	33	26	21

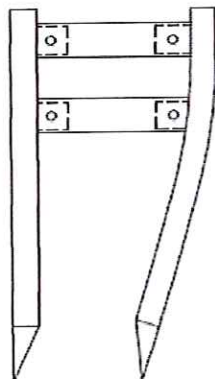
Estimated Trench Weight: 9,314 lb



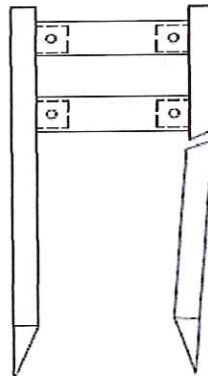
HORIZONTAL BENDING



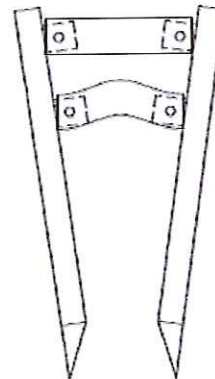
HORIZONTAL SHEAR



VERTICAL BENDING



VERTICAL SHEAR

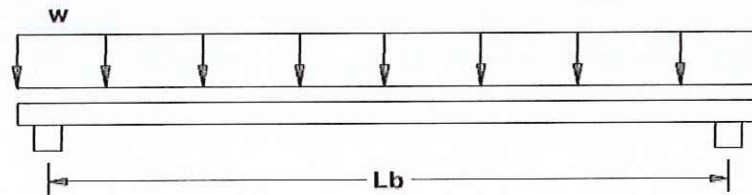


SPREADER COMPRESSION

Trench Shield Failure Modes



Trench Shield Calculation Work Sheet



Check Horizontal Bending:

Material and Geometric Properties:

$$F_y = 50. \text{ ksi}$$

$$S = 114.43 \text{ in}^3 \text{ -----} \rightarrow \text{(See Section Properties Calculations)}$$

Required Flexural Strength:

$$M_r = (0.80)(w)(L_b)^2 / 8$$

$$w = (\text{CAPACITY} / 1000)(H)$$

$$w = (1,320 / 1000)(8) = 10.56 \text{ kips / ft}$$

$$L_b = L - 2(D) / 12 = 20 - 2(8) / 12 = 18.67 \text{ ft}$$

$$M_r = (0.80)(10.56)(18.67)^2 / 8 = 367.96 \text{ kip-ft}$$

Available Flexural Strength:

$$M_n = (F_y)(S)(1/12) = 476.78 \text{ kip-ft}$$

(Eqn. F12-1)

$$\Omega = 1.67 \text{ -----} \rightarrow \text{(Factor of Safety for Flexure)}$$

$$M_a = (1.33)(M_n / \Omega) = 379.71 \text{ kip-ft} > M_r$$

(o.k.)

Check Horizontal Shear:

Material and Geometric Properties:

$$F_y = 50. \text{ ksi}$$

$$A_w = 18.75 \text{ in}^2 \text{ -----} \rightarrow \text{(See Section Properties Calculations)}$$

Required Shear Strength:

$$V_r = (w)(L) / 2$$

$$w = (\text{CAPACITY} / 1000)(H)$$

$$w = (1,320 / 1000)(8) = 10.56 \text{ kips / ft}$$

$$V_r = (10.56)(20.) / 2 = 105.6 \text{ kips}$$

Available Shear Strength:

$$V_n = (0.60)(F_y)(A_w) = 562.5 \text{ kips}$$

(Eqn. G3-1)

$$\Omega = 1.67 \text{ -----} \rightarrow \text{(Factor of Safety for Shear)}$$

$$V_a = (1.33)(V_n / \Omega) = 447.98 \text{ kips} > V_r$$

(o.k.)



Trench Shield Calculation Work Sheet

Check Vertical Bending:

Material and Geometric Properties:

$$F_y = 50. \text{ ksi}$$

$$S = 57.44 \text{ in}^3 \text{ -----} \rightarrow \text{(See Section Properties Calculations)}$$

Required Flexural Strength:

$$M_r = (0.80)(w)(C / 12)^2 / 2$$

$$w = (\text{CAPACITY} / 1000)(L / 2)$$

$$w = (1320 / 1000)(20 / 2) = 13.2 \text{ kips / ft}$$

$$C = 65 \text{ in}$$

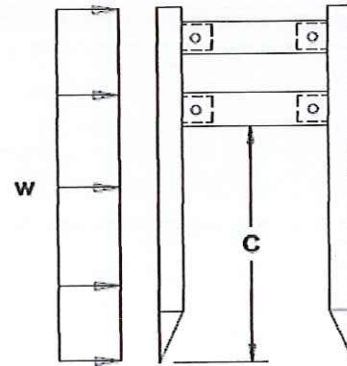
$$M_r = (0.80)(13.2)(65. / 12)^2 / 2 = 154.92 \text{ kip-ft}$$

Available Flexural Strength:

$$M_n = (F_y)(S) = 239.35 \text{ kip-ft}$$

$$\Omega = 1.67 \text{ -----} \rightarrow \text{(Factor of Safety for Flexure)}$$

$$M_a = (1.33)(M_n / \Omega) = 190.62 \text{ kip-ft} > M_r$$



(Eqn. F12-1)

(o.k.)

Check Vertical Shear:

Material and Geometric Properties:

$$F_y = 50. \text{ ksi}$$

$$A_w = 6.01 \text{ in}^2 \text{ -----} \rightarrow \text{(See Section Properties Calculations)}$$

Required Shear Strength:

$$V_r = (w)(C) / 2$$

$$w = (\text{CAPACITY} / 1000)(H)$$

$$w = (1,320 / 1000)(8) = 13.2 \text{ kips / ft}$$

$$V_r = (13.2)(20.) / 2 = 71.5 \text{ kips}$$

Available Shear Strength:

$$V_n = (0.60)(F_y)(A_w) = 180.18 \text{ kips}$$

$$\Omega = 1.67 \text{ -----} \rightarrow \text{(Factor of Safety for Shear)}$$

$$V_a = (1.33)(V_n / \Omega) = 143.5 \text{ kips} > V_r$$

(Eqn. G3-1)

(o.k.)

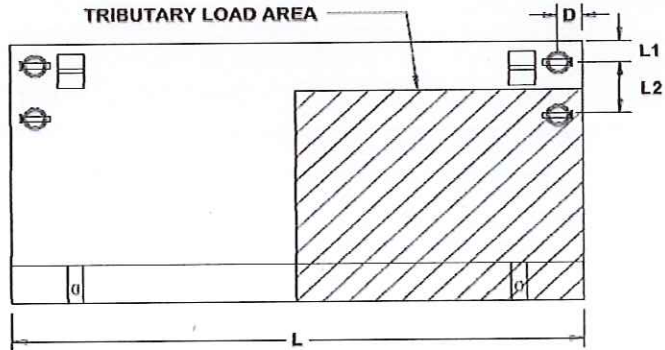


Trench Shield Calculation Work Sheet

Check Spreader Pipe for Combined Forces:

Material and Geometric Properties:

8 SCHED 80
 $F_y = 35$ ksi
 $E = 29,000$ ksi
 Weight = 43.4 lb / ft
 $A_g = 11.9$ in²
 $Z = 31$ in³
 $I = 99.39$ in⁴
 $r = 2.89$ in
 $L = W = 20$ ft
 $K = 1$



Required Compressive Strength:

$$Pr = (\text{CAPACITY} / 1000)((H)(12) - L1 - L2 / 2) / 12)(L / 2)$$

$$Pr = (1,320 / 1000)((8)(12) - 8.5 - 18.5 / 2) / 12)(20) / 2 = 86.08 \text{ kips}$$

Required Flexural Strength:

$$Mr = (\text{Weight} / 1000)(L)^2 / 8$$

$$Mr = (43.4 / 1000)(20)^2 / 8 = 2.17 \text{ kip - ft}$$

Determine Moment Magnification:

$$B1 = C_m / (1 - (\alpha)(Pr / Pe1))$$

$$C_m = 1 \text{ and } \alpha = 1.6$$

$$Pe1 = \pi^2(E)I / (KL)^2 = 493.88 \text{ ksi}$$

$$B1 = 2.11$$

(Section C2.1b)
 (Eqn. C2-2)

(Eqn. C2-5)

Magnified Required Flexural Strength:

$$Mrt = (B1)(Mr) = 4.57 \text{ kip - ft}$$

(Eqn. C2-1a)

Available Compressive Strength:

$$(K)(L) / r = (1.0)(20)(12) / 2.89 = 83.04$$

$$F_e = \pi^2(E) / ((K)(L) / r)^2 = 41.5 \text{ ksi}$$

$$(K)(L) / r < 4.71(E / F_y)^{0.5} = 135.58$$

$$F_{cr} = (0.658)^{(F_y / F_e)}(F_y) = 24.59 \text{ ksi}$$

$$P_n = (F_{cr})(A_g) = 292.63 \text{ kips}$$

$$\Omega = 1.67 \text{ -----} > \text{ (Factor of Safety for Compression)}$$

$$P_a = P_n / \Omega = 175.23 \text{ kips}$$

(Eqn. E3-4)
 (Use Eqn. E3-2)
 (Eqn. E3-2)
 (Eqn. E3-1)

Check Spreader Pipe for Combined Forces cont.:

Available Flexural Strength:

$$M_n = (F_y)(Z)(1/12) = 90.42 \text{ kip-ft}$$

(Eqn. F2-1)

$$\Omega = 1.67 \text{ -----> (Factor of Safety for Flexure)}$$

$$M_a = M_n / \Omega = 54.14 \text{ kip-ft}$$

Unity Check:

$$P_r / P_a = .49 > 0.20$$

(Use Eqn. H1-1a)

$$P_r / P_a + 8 / 9(M_a / M_{rt}) = .57 < 1.0$$

(o.k.)

Check Spreader Connection:

Design connection for an axial tensile force of 50% of the required compressive strength of the spreader pipe.

(Section J1.4b)

Required Tensile Strength of the connection:

$$R_r = (0.5)(P_r) = 43.04 \text{ kips}$$

Material and Geometric Properties of Pin:

$$F_u = 60. \text{ ksi}$$

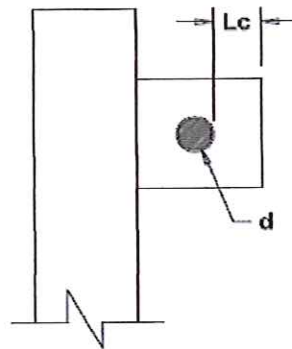
$$d = 2. \text{ in}$$

$$A_p = 3.14 \text{ in}^2$$

Material and Geometric Properties of Collar:

$$F_u = 58. \text{ ksi}$$

$$t = .5 \text{ in}$$



Available Pin Shear Strength:

$$F_v = 0.50(F_u) = 30. \text{ ksi}$$

(Table J3.2)

$$m = 2 \text{ -----> (Number of Shear planes)}$$

$$R_{np} = (m)(A_p)(F_v) = 188.5 \text{ kips}$$

$$\Omega = 2. \text{ -----> (Factor of Safety for Connections)}$$

$$R_{ap} = R_{np} / \Omega = 94.25 \text{ kips} > R_r$$

(o.k.)



Trench Shield Calculation Work Sheet

Check Spreader Connection Cont.:

Determine Required Clear Distance based on Bearing Strength:

(Eqn. J3-6b)

$$R_n = (m)(1.5)(L_c)(t)(F_u)$$

$$m = 2 \text{ -----} \rightarrow \text{(Number of Shear planes)}$$

$$\Omega = 2. \text{ -----} \rightarrow \text{(Factor of Safety for Connections)}$$

$$R_n = (\Omega)(R_r)$$

Solve for Minimum Clear Distance (L_c):

$$L_c = (\Omega)(R_r) / (m)(1.5)(t)(F_u)$$

$$L_c = .99 \text{ in}$$

Determine Required Clear Distance based on Shear Rupture:

(Eqn. J4-4)

$$R_n = (m)(0.6)(F_u)(A_{sf})$$

$$A_{sf} = (2)(t)(a + d / 2)$$

$$m = 2 \text{ -----} \rightarrow \text{(Number of Shear planes)}$$

$$\Omega = 2. \text{ -----} \rightarrow \text{(Factor of Safety for Connections)}$$

$$R_n = (\Omega)(R_r)$$

Solve for Minimum Edge Distance (a):

$$L_c = (\Omega)(R_r) / ((2)(t)(m)(0.6)(F_u)) - d / 2$$

$$L_c = .24 \text{ in}$$

Determine Shield Deflection:

Material and Geometric Properties:

$$E = 29,000 \text{ ksi}$$

$$I = 374.36 \text{ in}^4 \text{ (Horizontal)} \text{ -----} \rightarrow \text{(See Section Properties Calculations)}$$

$$I = 183.1 \text{ in}^4 \text{ (Vertical)} \text{ -----} \rightarrow \text{(See Section Properties Calculations)}$$

Calculate Horizontal Deflection:

$$w = (\text{CAPACITY} / 1000)(H) / 12 = (1,320 / 1000)(8) / 12 = .88 \text{ Kips / in}$$

$$L_b = L - 2(D) / 12 = 20 - 2(8) / 12 = 18.67 \text{ ft}$$

$$\Delta h = 5w((L_b)(12))^4 / 384(E)(I) = 5(.88)((18.67)(12))^4 / 384(29,000.)(374.36) = 2.66 \text{ in}$$

Calculate Vertical Deflection:

$$w = (\text{CAPACITY} / 1000)(L / 2) = 1320 / 1000(20 / 2) = 1.1 \text{ kips / in}$$

$$C = 65 \text{ in}$$

$$\Delta v = w(C)^4 / 8(E)(I) = (1.1)((65.)^4 / 8(29,000.)(183.1) = .46 \text{ in}$$

Total Deflection:

$$\Delta = \Delta h + \Delta v = 3.12 \text{ in}$$

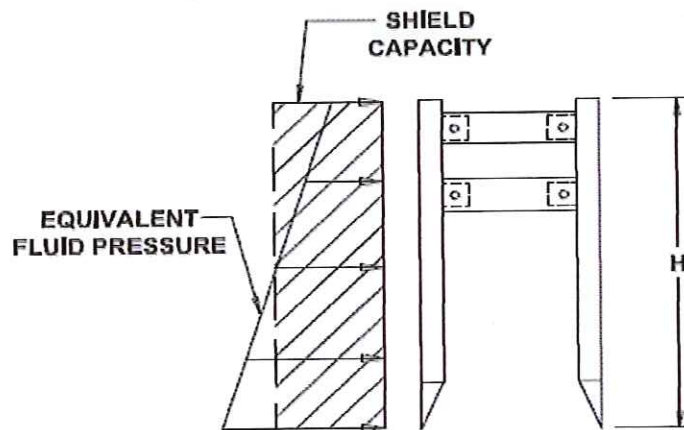


Trench Shield Calculation Work Sheet

Determine Depth Ratings:

Calculate shield depth ratings based on soils with the following equivalent fluid pressures:

Soil Type	EFP (psf / ft of depth)
A	25
B	45
C60	60
C80	80



$$\text{DEPTH RATING} = \frac{\text{SHIELD CAPACITY}}{\text{EQUIVALENT FLUID PRESSURE}} + \frac{H}{2}$$

A25 Soil: Depth Rating = CAPACITY / EFP + H / 2 = 1,320 / 25 + 8. / 2 = 57 ft

B45 Soil: Depth Rating = CAPACITY / EFP + H / 2 = 1,320 / 45 + 8. / 2 = 33 ft

C60 Soil: Depth Rating = CAPACITY / EFP + H / 2 = 1,320 / 60 + 8. / 2 = 26 ft

C80 Soil: Depth Rating = CAPACITY / EFP + H / 2 = 1,320 / 80 + 8. / 2 = 21 ft

Comments:

Capacity at bottom of shield in C60 soil:

$$\text{CAPACITY(C60)} = 26(60) = 1560 \text{ psf}$$



CALCULATION OF SECTION PROPERTIES

3/27/2015

JN 17929 TSR PRO-6 8 KE SECTION PROPERTIES

HORIZONTAL SECTION

ELEMENT	DESCRIPTION	A	x	Ax	ly	dx	Adx^2
1	(2)TS 4 X 3 X 1/4	5.820	3.188	18.551	20.920	-0.084	0.041
2	TS 6 X 2 X 3/16	2.770	3.188	8.829	11.100	-0.084	0.020
3	TS 6 X 2 X 3/16	2.770	3.188	8.829	11.100	-0.084	0.020
4	TS 6 X 4 X 3/16	3.520	3.188	11.220	17.400	-0.084	0.025
5	0.1875 Plate x 89.5	16.781	0.094	1.573	0.049	3.010	152.010
6	0.1875 Plate x 82.25	15.422	6.281	96.869	0.045	-3.178	155.736
7	Triangle 10.25 x 6.1875	31.711	2.250	71.350	67.448	0.853	23.098
8	Triangle 9.939394 x 6	-29.818	2.188	-65.227	-59.636	0.916	-25.016
		48.976		151.994	68.426		305.932

SECTION PROPERTIES	
Depth (in)	6.375
Area (in^2)	48.976
x1 (in)	3.103
x2 (in)	3.272
ly Total (in^4)	374.358
Sy1 (in^3)	120.626
Sy2 (in^3)	114.428
Aw (in^2)	18.750

VERTICAL SECTION

ELEMENT	DESCRIPTION	A	x	Ax	ly	dx	Adx^2
1	TS 6 X 4 X 5/16	5.260	3.188	16.766	24.800	0.000	0.000
2	TS 6 X 2 X 3/16	2.770	3.188	8.829	11.100	0.000	0.000
3	0.1875 Plate x 41	7.688	0.094	0.721	0.023	3.094	73.579
4	0.1875 Plate x 41	7.688	6.281	48.287	0.023	-3.094	73.579
		23.405		74.603	35.945		147.159

SECTION PROPERTIES	
Depth (in)	6.375
Area (in^2)	23.405
x1 (in)	3.188
x2 (in)	3.187
ly Total (in^4)	183.104
Sy1 (in^3)	57.444
Sy2 (in^3)	57.444
Aw (in^2)	6.006