ELEVATING SLEEVE PILE REPAIR SYSTEM

Calculations and Drawings

For Information: John Anders (504) 324-2395 or john@levare.us

Disclaimer:

The following calculations and drawings (Pages 1 thru 12) have been stamped based on the design parameters included and for the jurisdiction as noted upon the seal.

NUCOR®

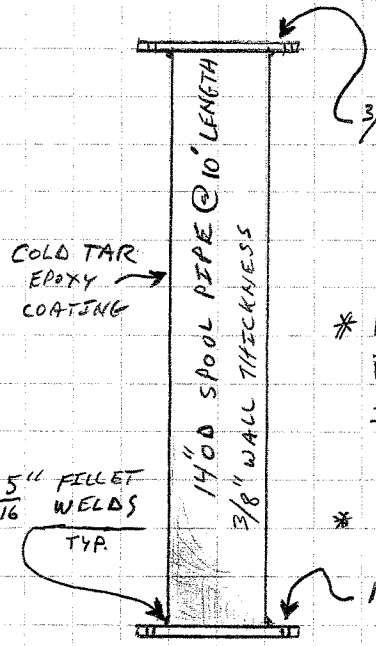
SKYLINE

Pipe

PIPE

Diameter in mm	Wall in mm	Weight lb/ft kg/m	Inside Diameter in mm	Cross Sectional Area in² cm²	Total Area of Pile in² cm²	Internal Area in² cm²	Internal Volume ft³/ft m³/m	External Coating Area ft²/ft m²/m	Moment of Inertia in⁴ cm⁴	Section Modulus in³ cm³	Radius of Gyration in cm	Maximum Available Yield Strength of A252 ksi (MPa)		
												ERW	SW	R&W
12 ¾ **324**	0.250 6.350	33.41 49.71	12.25 311.2	9.82 63.34	127.7 823.7	117.9 760.4	0.819 0.076	3.34 1.02	191.8 7,984	30.09 493.1	4.42 11.23	70 483	Not Available	Not Available
	0.312 7.925	41.48 61.73	12.13 308.0	12.19 78.65	127.7 823.7	115.5 745.1	0.802 0.075	3.34 1.02	235.9 9,819	37.00 606.4	4.40 11.17	70 483		
	0.375 9.525	49.61 73.82	12.00 304.8	14.58 94.06	127.7 823.7	113.1 729.7	0.785 0.073	3.34 1.02	279.3 11,630	43.82 718.0	4.38 11.12	70 483		
	0.394 10.008	52.04 77.44	11.96 303.8	15.29 98.67	127.7 823.7	112.4 725.0	0.780 0.073	3.34 1.02	292.2 12,161	45.83 751.0	4.37 11.10	70 483		
	0.406 10.312	53.58 79.73	11.94 303.2	15.74 101.6	127.7 823.7	111.9 722.1	0.777 0.072	3.34 1.02	300.2 12,500	47.09 771.7	4.37 11.09	70 483		
	0.500 12.700	65.48 97.44	11.75 298.5	19.24 124.1	127.7 823.7	108.4 699.6	0.753 0.070	3.34 1.02	361.5 15,050	56.7 929.4	4.34 11.01	70 483		
	0.525 13.335	68.61 102.1	11.70 297.2	20.16 130.1	127.7 823.7	107.5 693.6	0.747 0.069	3.34 1.02	377.4 15,710	59.20 970.0	4.33 10.99	70 483		
	0.687 17.450	88.59 131.8	11.38 289.0	26.04 168.0	127.7 823.7	101.6 655.7	0.706 0.066	3.34 1.02	475.1 19,780	74.53 1,221	4.27 10.85	70 483		
14 **356**	0.219 5.563	32.26 48.01	13.56 344.5	9.48 61.17	153.9 993.1	144.5 932.0	1.003 0.093	3.67 1.12	225.1 9,371	32.16 527.1	4.87 12.38	70 483	Not Available	Not Available
	0.250 6.350	36.75 54.68	13.50 342.9	10.80 69.67	153.9 993.1	143.1 923.5	0.994 0.092	3.67 1.12	255.3 10,630	36.47 597.7	4.86 12.35	70 483		
	0.312 7.925	45.65 67.94	13.38 339.8	13.42 86.56	153.9 993.1	140.5 906.6	0.976 0.091	3.67 1.12	314.4 13,090	44.91 736.0	4.84 12.30	70 483		
	0.375 9.525	54.62 81.28	13.25 336.6	16.05 103.6	153.9 993.1	137.9 889.6	0.958 0.089	3.67 1.12	372.8 15,520	53.25 872.6	4.82 12.24	70 483		
	0.438 11.125	63.50 94.50	13.12 333.3	18.66 120.4	153.9 993.1	135.3 872.7	0.939 0.087	3.67 1.12	429.5 17,880	61.36 1,005	4.80 12.19	70 483		
	0.500 12.700	72.16 107.4	13.00 330.2	21.21 136.8	153.9 993.1	132.7 856.3	0.922 0.086	3.67 1.12	483.8 20,140	69.11 1,132	4.78 12.13	70 483		
	0.625 15.875	89.36 133.0	12.75 323.9	26.26 169.4	153.9 993.1	127.7 823.7	0.887 0.082	3.67 1.12	588.5 24,500	84.08 1,377	4.73 12.02	70 483		
16 **406**	0.250 6.350	42.09 62.64	15.50 393.7	12.37 79.81	201.1 1,297	188.7 1,217	1.310 0.122	4.19 1.28	383.7 15,970	47.96 785.9	5.57 14.15	70 483	60 414	Not Available
	0.312 7.925	52.32 77.86	15.38 390.6	15.38 99.21	201.1 1,297	185.7 1,198	1.289 0.120	4.19 1.28	473.2 19,700	59.16 969.4	5.55 14.09	70 483	60 414	
	0.375 9.525	62.64 93.21	15.25 387.4	18.41 118.8	201.1 1,297	182.7 1,178	1.268 0.118	4.19 1.28	562.1 23,400	70.26 1,151	5.53 14.04	70 483	60 414	
	0.406 10.312	67.68 100.7	15.19 385.8	19.89 128.3	201.1 1,297	181.2 1,169	1.258 0.117	4.19 1.28	605.0 25,180	75.62 1,239	5.52 14.01	70 483	60 414	
	0.500 12.700	82.85 123.3	15.00 381.0	24.35 157.1	201.1 1,297	176.7 1,140	1.227 0.114	4.19 1.28	731.9 30,470	91.49 1,499	5.48 13.93	70 483	60 414	
	0.625 15.875	102.7 152.9	14.75 374.7	30.19 194.8	201.1 1,297	170.9 1,102	1.187 0.110	4.19 1.28	893.5 37,190	111.7 1,830	5.44 13.82	70 483	60 414	
18 **457**	0.250 6.350	47.44 70.59	17.50 444.5	13.94 89.94	254.5 1,642	240.5 1,552	1.670 0.155	4.71 1.44	549.1 22,860	61.02 999.9	6.28 15.94	60 414	60 414	Not Available
	0.312 7.925	59.00 87.79	17.38 441.4	17.34 111.9	254.5 1,642	237.1 1,530	1.647 0.153	4.71 1.44	678.2 28,230	75.36 1,235	6.25 15.89	60 414	60 414	
	0.375 9.525	70.66 105.1	17.25 438.2	20.76 134.0	254.5 1,642	233.71 1,508	1.623 0.151	4.71 1.44	806.6 33,570	89.63 1,469	6.23 15.83	60 414	60 414	
	0.500 12.700	93.54 139.2	17.00 431.8	27.49 177.3	254.5 1,642	227.0 1,464	1.576 0.146	4.71 1.44	1,053 43,840	117.0 1,918	6.19 15.72	60 414	60 414	
	0.625 15.875	116.1 172.8	16.75 425.5	34.12 220.1	254.5 1,642	220.4 1,422	1.530 0.142	4.71 1.44	1,289 53,660	143.2 2,347	6.15 15.61	Not Available	60 414	

ELEVATING SLEEVE PILE REPAIR SYSTEM

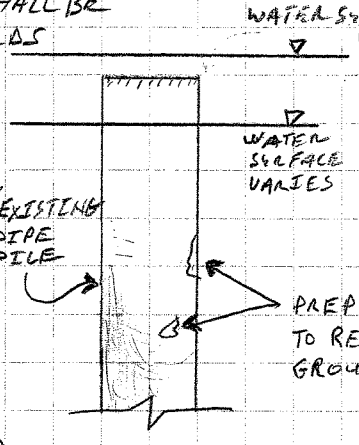


* ALL FLANGE TO PIPE WELD CONNECTIONS SHALL BE 5/16" FILLET WELDS

* PIPE SPOOL INSERT WATERTIGHT FOR INCREASED BUOYANCY

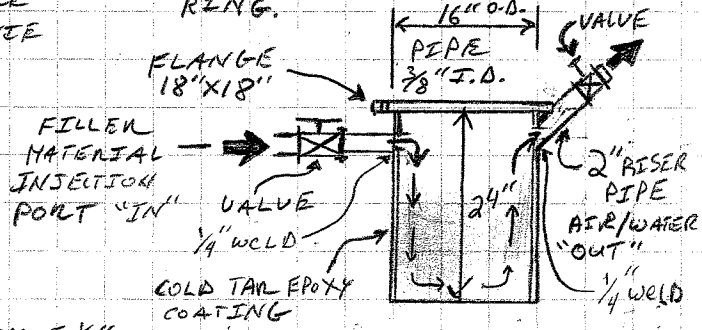
* BOLTS @ FLANGE PLATES 1" Ø DIA - 2½" LENGTH (A325)

* ALL 1" BOLTS SHALL USE LOCK WASHERS AND SHALL BE HOT DIPPED GALVANIZED TYPICAL.

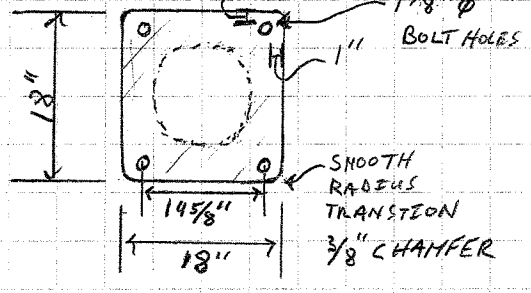


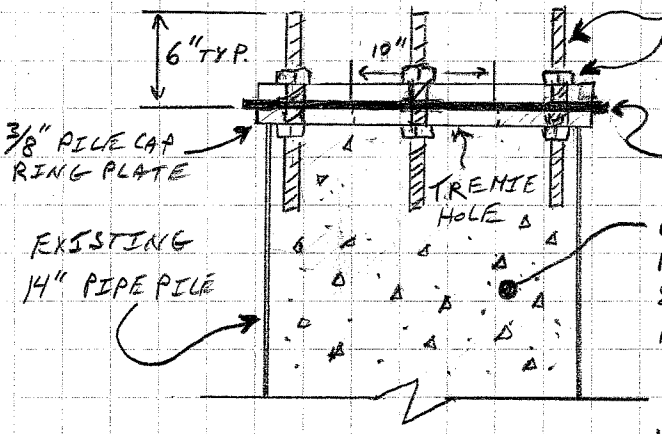
EXISTING PIPE PILE
N.T.S.

* EXISTING PIPE PILE TO RECEIVE PILECAP RING PRIOR TO GROUT FILL TO ENSURE ALL THREAD ROD EMBEDMENT 6" min TOP AND BOTTOM OF PILE CAP RING.

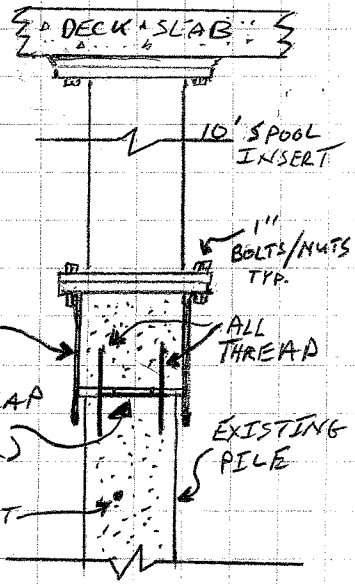


PIPE SPOOL INSERT
N.T.S.



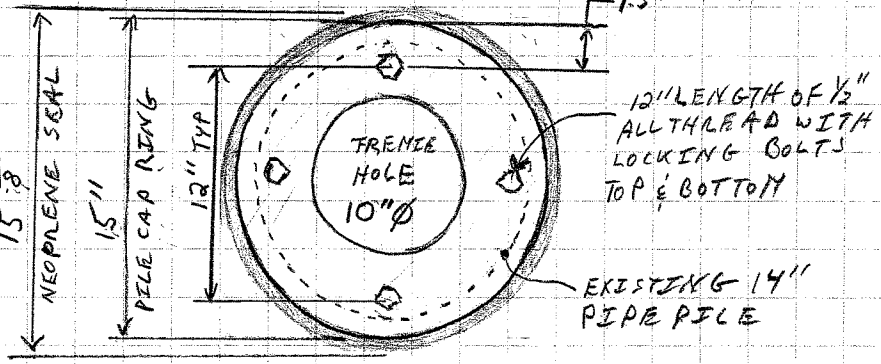


PROPOSED PILE CAP RING (PCR)
N.T.S.



ELEVATING SLEEVE
N.T.S.

PIPE SPOOL INSERT FLANGE
N.T.S.

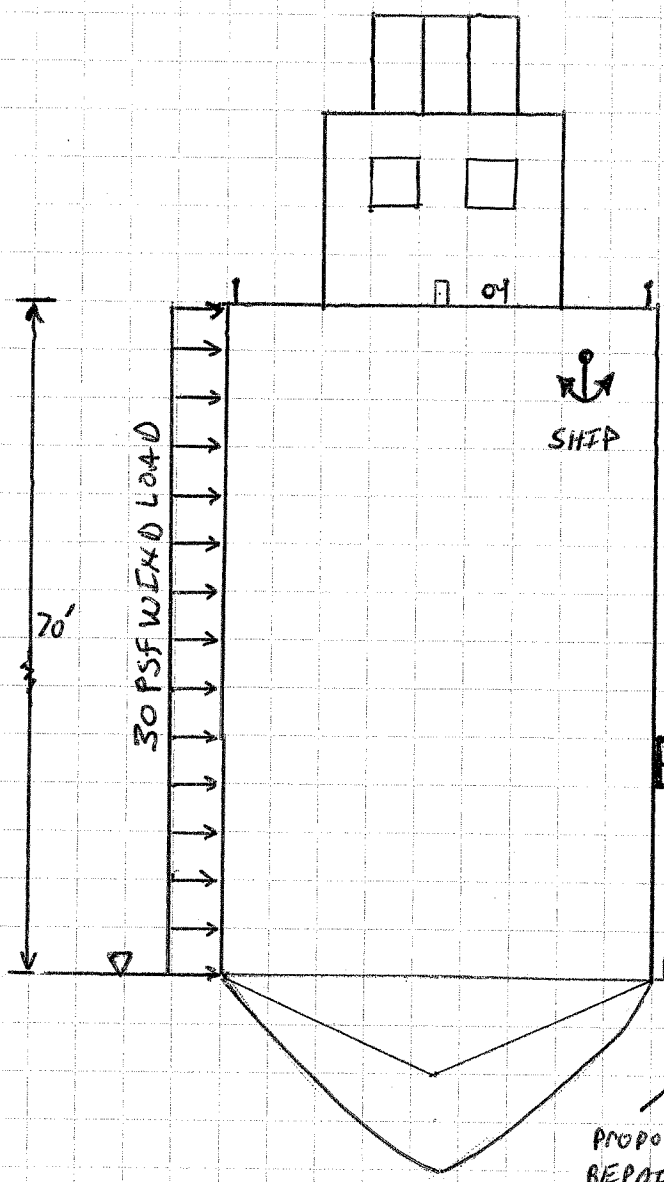


DATE: 3/16/2023

DRAWN BY: SET

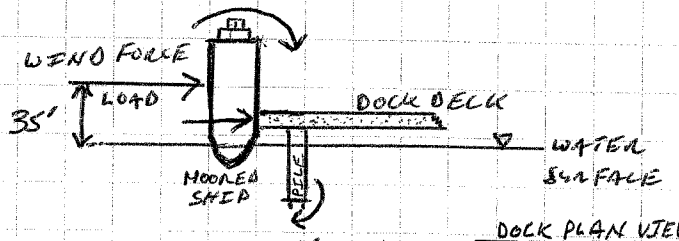
PROPOSED PILE REPLACEMENT SYSTEM N.T.S.

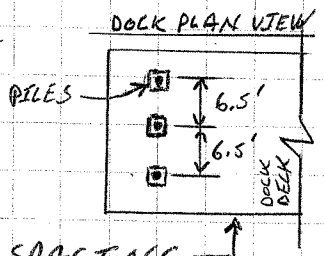
PROPOSED PILE REPLACEMENT SYSTEM CONNECTION SINGLE BOLT TENSION LOAD CALCULATION (WIND BASED)

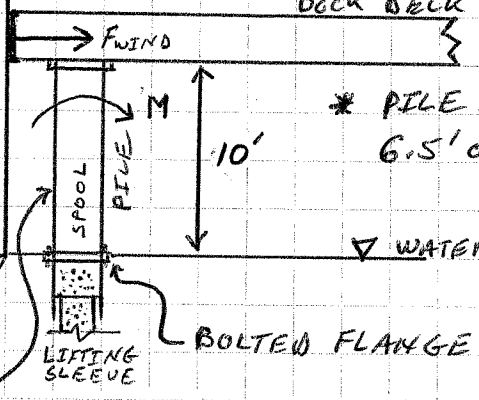


MOORED SHIP
N.T.S.

FREE DIAGRAM



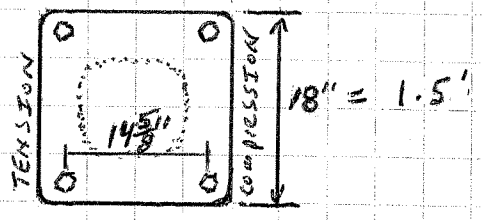




* PILE SPACING 6.5' on centers

BOLTED FLANGE CONNECTION (SPOOL TO LIFTING SLEEVE)

PROPOSED REPAIR PILE SPOOL SECTION



CALCULATE WORST CASE SCENARIO ON ONE BOLT LOADING FOR THE BOLTED CONNECTION

DISTRIBUTED LOAD AREA

$A = (70')(6.5') = \boxed{455\ ft^2}$

CALCULATE WIND FORCE

$F_{WIND} = P(A)$

$F_{WIND} = (30\ lb/ft^2)(455\ ft^2)$

$F_{WIND} = \boxed{13,650\ lbs}$

WIND LOAD MOMENT $\circlearrowright +$

$M_{\circlearrowright +} = 0 = F_{WIND}$ (OFST TO center)

$M_{\circlearrowright +} = (13,650\ lbs)(10\ ft)$

$M_{\circlearrowright +} = \boxed{136,500\ lb\text{-}ft}$

SINGLE BOLT TENSION LOAD

$T = \frac{136,500\ lb\text{-}ft}{2\ BOLTS} \div 1.5' = 91,000 \times F.O.S\ 2.5$

$= 227.5\ Kips$

$T_{ONE\ BOLT} = 227.5 \div 2 = 114\ Kips$

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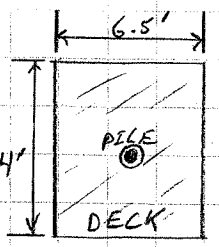
LIVE DECK LOAD $850\ lb/ft^2$



WEIGHT LIVE LOAD

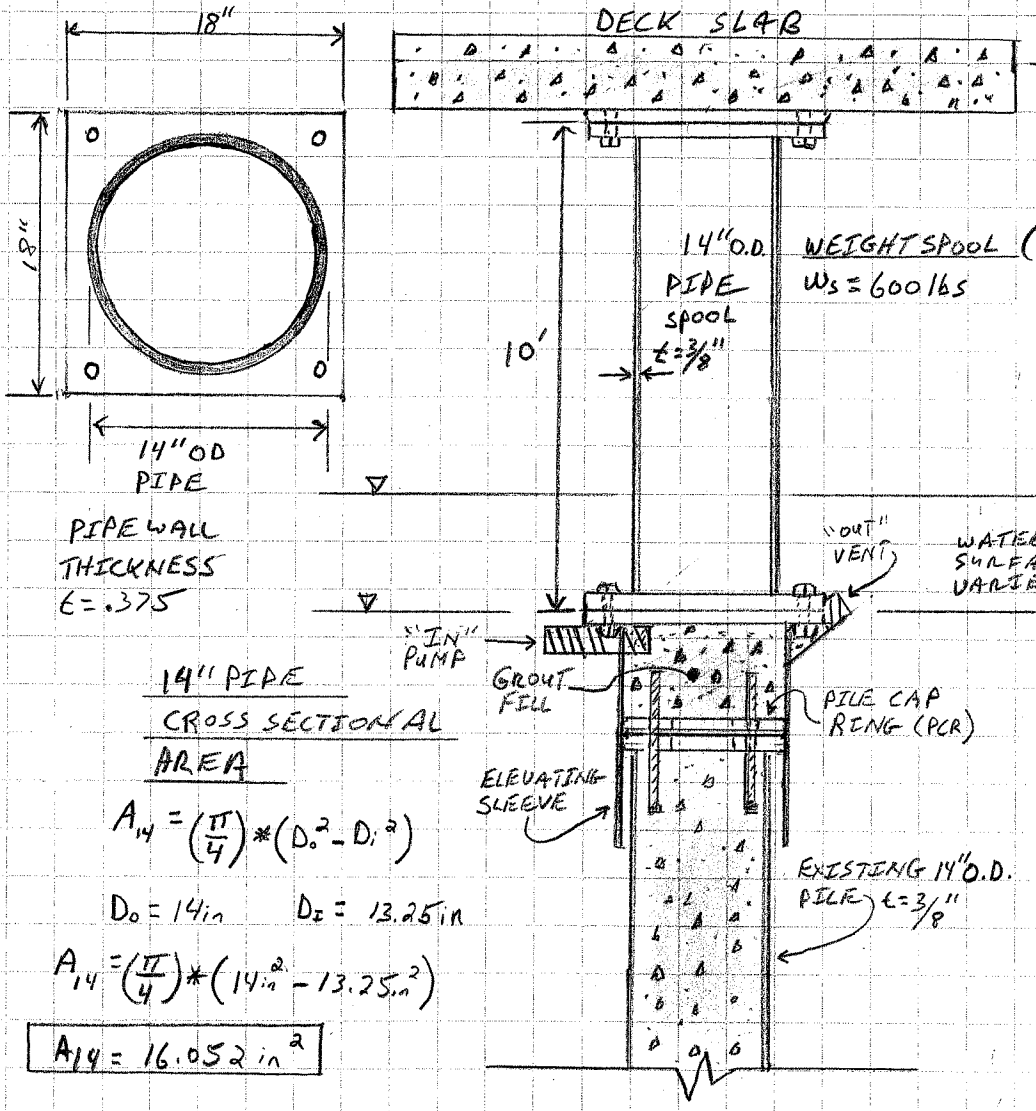
$W_L = (850\ lb/ft^2)(9\ ft^2)$

$W_L = 77,350\ lbs$

TRIBUTARY LOAD AREA

$A_D = 14' \times 6.5'$

$A_D = 91\ ft^2$



WEIGHT CONCRETE DECK (DEAD LOAD)

$W_c = (150\ lb/ft^3)(1ft)(9ft^2)$

$W_c = 13,650\ lbs$

14" O.D. PIPE SPOOL t=3/8"

WEIGHT SPOOL (DEAD LOAD)

$W_s = 600\ lbs$

PIPE WALL THICKNESS

$t = .375$

PARAMETERS

GROSS AREA (A_g) = $16.05\ in^2$

MOMENT OF INERTIA (I) = $372.8\ in^2$

SECTION MODULUS (S) = $53.25\ in^3$

RADIUS OF GYRATION (r) = $4.82\ in$

MODULUS OF ELASTICITY (E)

$E = 2.9 \times 10^7\ PSI$

$F_y = 42,000\ PSI$

USE AISC CHAPTER E "DESIGN OF MEMBERS FOR COMPRESSION"

* FIND DESIGN COMPRESSIVE STRENGTH $\phi_c P_n$ (LRFD)

$\phi_c = 0.9$

14" PIPE CROSS SECTIONAL AREA

$$A_{14} = \left(\frac{\pi}{4}\right) * \left(D_o^2 - D_i^2\right)$$

$D_o = 14in \qquad D_I = 13.25in$

$$A_{14} = \left(\frac{\pi}{4}\right) * \left(14in^2 - 13.25in^2\right)$$

$$\boxed{A_{14} = 16.052\ in^2}$$

* USE TABLE USER NOTE E1.1 - SELECTION TABLE FOR THE APPLICATION OF CHAPTER E SECTIONS. DETERMINE LIMITING STATES FOR AXIALLY LOADED PIPE.

* FOR PIPE SECTION, THE LIMITING STATE IS NOTED AS FLEXURAL BUCKLING (FB) FOR MEMBERS "WITHOUT" SLENDER ELEMENTS & FLEXURAL BUCKLING (FB) OR LOCAL BUCKLING (LB) FOR A MEMBER "WITH" SLENDER ELEMENTS

* DETERMINE IF THE MEMBER HAS SLENDER ELEMENTS
  REFER TO AISC TABLE B4.1a - "WIDTH TO THICKNESS RATIOS: COMPRESSION ELEMENTS, MEMBERS SUBJECT TO AXIAL COMPRESSION."
* THE WIDTH TO THICKNESS RATIO = $\frac{d}{t}$, UTILIZING SUB-PARAGRAPH 2 "DESIGN WALL THICKNESS FOR HOLLOW STRUCTURAL SECTIONS (HSS) CONSTRUCTED AS ELECTRIC-RESISTANCE-WELDED (ERW) PIPE. THE DESIGN WALL THICKNESS "t" SHALL BE TAKEN EQUAL TO 0.93 TIMES THE NOMINAL WALL THICKNESS.

DIAMETER OF PIPE = 14"
WALL THICKNESS PIPE = 0.375"

$$\text{WIDTH TO RATIO THICKNESS} = \frac{d}{0.93(t)} = \frac{14"}{(0.93)(0.375")} = 40.14$$

* THE LIMITING WIDTH TO THICKNESS RATIO IS GIVEN BY ROW 9 OF THE TABLE AS:

$$(B4.1a) \quad \lambda_r = 0.11\frac{E}{F_y} = (0.11)\left(\frac{2.9\times10^7 \text{ PSI}}{42{,}000 \text{ PSI}}\right) = 75.95$$

* COMPARING $\frac{d}{t} = 40.14 < \lambda_r = 75.95$ THE SPOOL MEMBER IS "NON-SLENDER"

* THE MEMBER LIMITING STATE IS FLEXURAL BUCKLING (FB) THEREFORE CHAPTER E.3 APPLIES.

* CHAPTER E.3 "FLEXURAL BUCKLING OF MEMBERS WITHOUT SLENDER ELEMENTS"

NOMINAL COMPRESSIVE STRENGTH (P_n) IS DETERMINED BY $P_n = F_{cr} A_g$

* FIND THE CRITICAL STRESS F_{cr}

E.3-DETERMINE IF THE EFFECTIVE LENGTH IS LESS THAN OR EQUAL TO:

$$4.71\sqrt{\frac{E}{F_y}}$$

$$\text{EFFECTIVE LENGTH} = \frac{KL}{r}$$

L = UNBRACED LENGTH
K = EFFECTIVE LENGTH FACTOR
r = RADIUS OF GYRATION

K - COMES FROM APPEN 7 FOR MEMBER END CONDITIONS. MEMBER FIXED AT BOTH ENDS.

$K = 0.65$

$$\text{EFFECTIVE LENGTH} = \frac{(0.65)(10\,ft)(12\,\frac{in}{ft})}{4.82\,in} = 16.18$$

NOW COMPARE:

$$4.71\sqrt{\frac{2.9\times10^{7}\,PSI}{42{,}000\,PSI}} = 123.76$$

$16.18 \leq 123.76$ CRITICAL STRESS IS AS FOLLOWS:

$$F_{cr} = \left(0.685^{\frac{F_y}{F_e}}\right)F_y$$

F_e = ELASTIC BUCKLING STRESS GIVEN BY:

$$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2} = \frac{\pi^2(2.9\times10^{7}\,PSI)}{(16.18)^2\left(\frac{1000\,lb}{1\,KIP}\right)} = 1093\,KSI$$

$$F_{cr} = \left(0.685^{\frac{42\,ksi}{1093\,KSI}}\right)42\,KSI = 41.39\,KSI$$

* NOMINAL COMPRESSIVE STRENGTH P_n

$$P_n = F_{cr}A_g = (41.39\,KSI)(16.05\,in^2)$$

$$P_n = 664\,KIPS \text{ UNFACTORED}$$

FACTORED USING LRFD $\phi_c = 0.9$

$$\text{FACTORED } P_n = (0.9)(664\,KIPS)$$

$$\underline{\phi_c P_n = 598\,KIPS}$$

* DETERMINE ACTUAL LOAD P_A

*SEE PAGE 1 FIGURE DETAIL

TRIBUTARY AREA = 91 S.F.

DEAD LOAD

WEIGHT SPOOL PIPE = 600 lbs
WIIGHT CONCRATE = 13,650 lbs

LIVLOAD

WRIGHT LIVE LOAD = 77,350 lbs

$$P_A = 1.2\ D_L + 1.6 L_L = 1.2\ (600\text{lbs} + 13{,}650\text{lbs}) + 1.6\ (77{,}350\text{lbs})$$

$$\boxed{P_A = 140{,}860\ \text{lbs} = 140.9\ \text{KIPS}}$$

* DETERMINE FACTOR OF SAFETY F.O.S.

$$F.O.S. = \frac{\phi P_n}{P_A} = \frac{598\ \text{KIPS}}{140.9\ \text{KIPS}} = 4.24$$

$$\boxed{F.O.S = 4.24}$$

∴ IN CONCLUSION - A 14" DIAMETER X 10FT LONG, 3/8" WALL PIPE IS SUFFICIENT FOR THE SPOOL PIECE APPLICATION