Above Ground Pipe Considerations

- **Thermal Expansion and Contraction**

Thermal expansion and contraction *must be considered in the design of a piping system.*

In above ground piping the four most common methods in order of preference for accommodating thermal changes are:

1. Restrained Systems using anchors and guides to prevent pipe movement.

2. Pipe Loops to absorb expansion and contraction.

3. Changes in direction to absorb expansion and contraction.

4. Expansion joints to mechanically absorb expansion and contraction.

1. Restrained Systems

An efficient method of accommodating thermal expansion is to fully anchor and guide the piping system. Restraining the growth of the pipe creates thermal end loads on the anchors which must be considered by the design engineer. Anchors must be properly located and of sufficient strength to resist these end loads created by temperature and pressure changes in the piping.

1A. Calculating Thermal End Loads

Equation:

$$T_L = \alpha E A \Delta T$$

Where:

T_L = thermal end load, lb

α = coefficient of axial thermal expansion, in./in.°F

E = modulus of elasticity, psi

A = cross-sectional area, $in^2 = \pi/4 (OD^2 - ID^2)$ of the pipe where OD is the outside diameter and ID is the inside diameter

ΔT = temperature change, °F (maximum operating temperature minus installation temperature for expansion, and installation temperature minus minimum operating temperature for contraction)

Example:

Calculate the thrust or end load on a Conley 2" Sch 40 piping system with an OD of 2.38 in. and an ID of 1.88 in.

- Axial modulus = 1.75×10^6 psi
- Installation temperature = 75°F
- Maximum operating temperature = 250°F
- Minimum operating temperature = 34°F
- Conley coefficient of thermal expansion = 9.5×10^{-6}

ΔT for expansion = 175°F

ΔT for contraction = 41°F

Cross sectional area of pipe, $in.^2$

$$A = \pi/4\,(2.38^2 - 1.88^2) = 3.14 / 4\,(5.66 - 3.53) = 0.785\,(2.13) = 1.672\ in.^2$$

Expansion

$$T_L = \alpha E A \Delta T = (9.5 \times 10^{-6})(1.75 \times 10^6)(1.672)(175) = 4{,}864 \text{ lb for expansion}$$

Contraction

$$T_L = \alpha E A \Delta T = (9.5 \times 10^{-6})(1.75 \times 10^6)(1.672)(41) = 1{,}140 \text{ lb for contraction}$$

Tables
The following tables provide thermal end loads with values for expansion and contraction.

Table 1

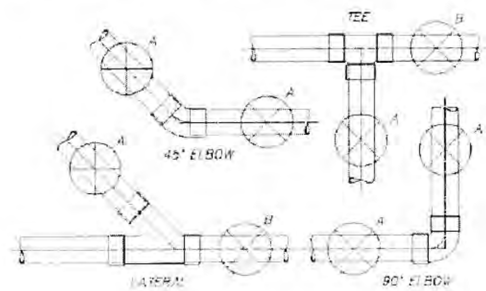
ANCHOR LOADS DUE TO RESTRAINED THERMAL EXPANSION/CONTRACTION				
NOMINAL SIZE	PIPE SCHEDULE LB/ΔT			
	SCH 25	SCH 30	SCH 40	SCH 50
1			13	14
1 1/2			21	22
2		15	28	28
2 1/2			34	34
3		28	40	40
4	24	37	53	52
6	42	61	94	94
8	55	81	130	130
10	98	131	184	184
12	120	160	247	261
14	139	201	286	286
16	159	229	326	326
18	178	291	365	365
20	197	322	382	382
24	236	456	554	508
30	296	662	752	752

Table 2

ANCHOR LOADS DUE TO RESTRAINED THERMAL EXPANSION/CONTRACTION			
NOMINAL SIZE	PIPE SCHEDULE LB/ΔT		
	90-150	90-225	90-250
1	13	13	13
1 1/2	21	21	21
2	15	15	15
2 1/2			
3	28	28	28
4	53	53	53
6	94	94	94
8	130	130	130
10	184	184	214
12	247	247	285
14	286	330	373
16	375	424	474
18	475	530	586
20	525	648	710

1B. Positioning of Anchors

Generally, anchors are used at all transition points in the lines such as changes in direction, elevation, pipe size, pipe material and connections to equipment. The positioning of the anchor is from five to ten pipe diameters in length from the anchor to the next transition point. Anchors as a general rule should also be used approximately every 300 feet on straight runs of pipe.



Example of anchoring (restraining) a fiberglass piping system against thermal and/or pressure induced thrust. Pipe anchors (A and B) at elbows and branches should be located a distance of five to ten times the nominal pipe diameter from the intersection. Other anchor locations may require a flexibility analysis.

Pipe anchors (A) such as shown above, are used in restrained systems at each end of a run and just before a change in direction, and must resist the thrust due to changes in temperature and/or pressure.

Pipe anchors (B) such as shown above, can be light-duty in-line anchors usually located between two pipe anchors (A) or midway between loops or turns in systems not restrained.

Figure 1

1C. Use of Guides

Guides may be used between anchors to constrain lateral movement of the pipe. When temperature changes are of sufficient magnitude to cause high compressible stresses, guides must be used to prevent excessive deflection and buckling of the pipeline.

The following tables present minimum guide spacing for changes in temperature, ΔT.

Table 3

SCH 30
Nominal Pipe Size (in)
Operating Temperatures(°F)*
Guide Spacing (ft)

Ø	125	150	175	200	225	250
2	10.3	8.4	7.3	6.5	5.9	5.5
3	16.1	13.2	11.4	10.2	9.3	8.6
4	21.2	17.3	15.0	13.4	12.2	11.3
6	31.4	25.7	22.2	19.9	18.1	16.8
8	41.6	34.0	29.4	26.3	24.0	22.2
10	52.0	42.5	36.8	32.9	30.0	27.8
12	63.4	51.8	44.9	40.1	36.6	33.9
14	73.7	60.2	52.1	46.6	42.5	39.4
16	83.8	68.5	59.3	53.0	48.4	44.8
18	94.2	76.9	66.6	59.6	54.4	50.3
20	104.3	85.2	73.8	66.0	60.2	55.8
24	124.9	102.0	88.3	79.0	72.1	66.8
30	156.9	128.1	111.0	99.2	90.6	83.9

*Table is based on installation temperature of 75°F

Table 4

SCH 40
Nominal Pipe Size (in)
Operating Temperatures(°F)*
Guide Spacing (ft)

Ø	125	150	175	200	225	250
1	5.7	4.6	4.0	3.6	3.3	3.0
1 1/2	8.4	6.8	5.9	5.3	4.8	4.5
2	10.9	8.9	7.7	6.9	6.3	5.8
2 1/2	13.4	10.9	9.5	8.5	7.7	7.2
3	16.5	13.4	11.6	10.4	9.5	8.8
4	21.5	17.6	15.2	13.6	12.4	11.5
6	31.9	26.1	22.6	20.2	18.4	17.1
8	42.2	34.4	29.8	26.7	24.3	22.5
10	52.4	42.8	37.1	33.1	30.3	28.0
12	64.1	52.3	45.3	40.5	37.0	34.3
14	74.3	60.6	52.5	47.0	42.9	39.7
16	84.4	68.9	59.7	53.4	48.7	45.1
18	94.6	77.2	66.9	59.8	54.6	50.5
20	104.6	85.4	74.0	66.2	60.4	55.9
24	125.3	102.3	88.6	79.2	72.3	67.0
30	157.2	128.4	111.2	99.4	90.8	84.0

*Table is based on installation temperature of 75°F

Table 5

SCH 50
Nominal Pipe Size (in)
Operating Temperatures(°F)*
Guide Spacing (ft)

Ø	125	150	175	200	225	250
1	5.7	4.6	4.0	3.6	3.3	3.0
1 1/2	8.4	6.9	6.0	5.3	4.9	4.5
2	10.9	8.9	7.7	6.9	6.3	5.8
2 1/2	13.4	10.9	9.5	8.5	7.7	7.2
3	16.5	13.4	11.6	10.4	9.5	8.8
4	21.5	17.6	15.2	13.6	12.4	11.5
6	31.9	26.1	22.6	20.2	18.4	17.1
8	42.2	34.4	29.8	26.7	24.3	22.5
10	52.5	42.9	37.1	33.2	30.3	28.1
12	64.2	52.4	45.4	40.6	37.1	34.3
14	74.3	60.6	52.5	47.0	42.9	39.7
16	84.4	68.9	59.7	53.4	48.7	45.1
18	94.6	77.2	66.9	59.8	54.6	50.5
20	104.6	85.4	74.0	66.2	60.4	55.9
24	125.1	102.2	88.5	79.1	72.2	66.9
30	157.2	128.4	111.2	99.4	90.8	84.0

*Table is based on installation temperature of 75°F

Table 6

SCH 90-150
Nominal Pipe Size (in)
Operating Temperatures(°F)*
Guide Spacing (ft)

Ø	125	150	175	200	225	250
1	5.7	4.6	4.0	3.6	3.3	3.0
1 1/2	8.4	6.8	5.9	5.3	4.8	4.5
2	10.3	8.4	7.3	6.5	5.9	5.5
3	16.1	13.2	11.4	10.2	9.3	8.6
4	21.5	17.6	15.2	13.6	12.4	11.5
6	31.9	26.1	22.6	20.2	18.4	17.1
8	42.2	34.4	29.8	26.7	24.3	22.5
10	52.5	42.9	37.1	33.2	30.3	28.1
12	64.1	52.3	45.3	40.5	37.0	34.3
14	74.3	60.6	52.5	47.0	42.9	39.7
16	84.7	69.2	59.9	53.6	48.9	45.3
18	95.1	77.7	67.3	60.2	54.9	50.9
20	105.3	86.0	74.4	66.6	60.8	56.3
24	125.9	102.8	89.0	79.6	72.7	67.3
30	157.8	128.8	111.6	99.8	91.1	84.3

*Table is based on installation temperature of 75°F

Table 7 SCH 90-225 Nominal Pipe Size (in) Operating Temperatures(°F)* Guide Spacing (ft)						
Ø	**125**	**150**	**175**	**200**	**225**	**250**
1	5.7	4.6	4.0	3.6	3.3	3.0
1 1/2	8.4	6.8	5.9	5.3	4.8	4.5
2	10.3	8.4	7.3	6.5	5.9	5.5
3	16.1	13.2	11.4	10.2	9.3	8.6
4	21.5	17.6	15.2	13.6	12.4	11.5
6	31.9	26.1	22.6	20.2	18.4	17.1
8	42.2	34.4	29.8	26.7	24.3	22.5
10	52.5	42.9	37.1	33.2	30.3	28.1
12	64.1	52.3	45.3	40.5	37.0	34.3
14	74.5	60.9	52.7	47.1	43.0	39.8
16	85.0	69.4	60.1	53.7	49.1	45.4
18	95.4	77.9	67.5	60.3	55.1	51.0
20	105.9	86.4	74.8	66.9	61.1	56.6

*Table is based on installation temperature of 75°F

Table 8 SCH 90-250 Nominal Pipe Size (in) Operating Temperatures(°F)* Guide Spacing (ft)						
Ø	**125**	**150**	**175**	**200**	**225**	**250**
1	5.7	4.6	4.0	3.6	3.3	3.0
1 1/2	8.4	6.8	5.9	5.3	4.8	4.5
2	10.3	8.4	7.3	6.5	5.9	5.5
3	16.1	13.2	11.4	10.2	9.3	8.6
4	21.5	17.6	15.2	13.6	12.4	11.5
6	31.9	26.1	22.6	20.2	18.4	17.1
8	42.2	34.4	29.8	26.7	24.3	22.5
10	52.8	43.1	37.3	33.4	30.5	28.2
12	64.4	52.6	45.5	40.7	37.2	34.4
14	74.8	61.1	52.9	47.3	43.2	40.0
16	85.3	69.6	60.3	53.9	49.2	45.6
18	95.7	78.1	67.7	60.5	55.3	51.2
20	106.1	86.7	75.1	67.1	61.3	56.7

*Table is based on installation temperature of 75°F

When designing for restrained or anchored systems using guides, anchors, and supports the three primary considerations are:

1. To calculate the amount of growth in the system if unrestrained due to temperature changes.
2. To determine the thermal end loads when the growth is restrained.
3. To determine the proper guide spacing as well as the support spacing.

Compare the guide spacing intervals with the support spacing. For example, one might adjust the spacing so a guide replaces every second or third support. Guides are essentially modified supports. A brief review of common guides, anchors and supports may be found in **Appendix A, Anchors, Guides and Supports**.

2. Expansion Loops

Changes in pipe length due to thermal expansion may be accommodated by the use of expansion loops that flex. The flexibility of the loop leg that is parallel to the line is not considered in this design. Instead, the allowable bending moments are given in Table 9. Dimension 'B' is usually one half of dimension 'A'.

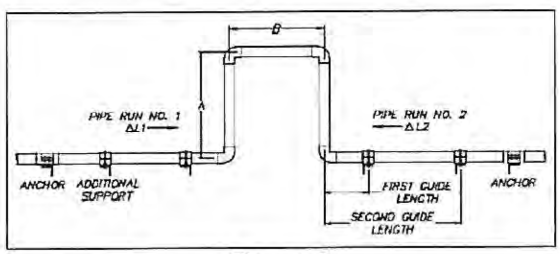


Figure 2

Each side of the expansion loop is guided with the guide spaced approximately four pipe diameters from the elbow (4D). The second guide is spaced approximately fourteen pipe diameters from the elbow (14D). Subsequent guides must not exceed the guide spacing intervals in Tables 13-18.

The pipe runs ΔL1 and 2 refer to the change in length and direction of force on the expansion loop.

Table 9 Recommended Allowable Bending Moments for 90° Elbows			
NOM SIZE	ALLOWABLE MOMENT LB-FT	ALLOWABLE MOMENT LB-IN	ALLOWABLE MOMENT N-m
1"	50	600	68
1.5"	150	1,800	203
2"	250	3,000	339
2.5"	350	4,200	475
3"	500	6,000	678
4"	700	8,400	949
6"	1,700	20,400	2,305
8"	2,900	34,800	3,932
10"	4,500	54,000	6,102
12"	7,500	90,000	10,170
14"	10,000	120,000	13,560
16"	12,000	144,000	16,272
18"	14,000	168,000	18,984
20"	16,000	192,000	21,696
24"	18,000	216,000	24,408
30"	20,000	240,000	27,120

FACTOR OF SAFETY = 4:1

Use the following equation to design an expansion loop:

$$L_A = ((12)(L_c)(E_b)(I)/(144)(M))^{1/2}$$

Where:

L_A = length of the "A" leg, ft
E_b = axial bending modulus, psi
M = allowable bending moment, lb-in.
L_c = length change, in

To determine the minimum loop leg length, first determine the amount of thermal expansion in the longest pipe run on either side of the loop. The distance from the farthest anchor to the loop will be used to calculate the change in length for various changes in temperature.

Thermal Expansion

Table 10	Operating Temperatures °F*				
	125	150	175	200	225
in/100ft	0.57	0.86	1.14	1.43	1.71

*Table is based on installation temperature of 75°F

The thermal expansion values listed above are based on the equation

$$Lc = (12)(Ct)(L)(Tc)$$

Where:

Lc = length change, in
Ct = coefficient of axial thermal expansion in./in/.°F
L = length between anchors, ft
Tc = Temperature change, °F (Maximum operating temperature minus installation temperature for expansion)

Table 11 Length of the "A" (ft)				
NOMINAL Ø	L_c (in) 1	2	3	4
1	4.0	5.7	7.0	8.1
1 1/2	4.6	6.6	8.1	9.3
2	5.3	7.6	9.3	10.7
2 1/2	6.2	8.7	10.7	12.4
3	6.7	9.4	11.6	13.3
4	9.3	13.1	16.0	18.5
6	12.1	17.1	20.9	24.1
8	14.5	20.5	25.1	29.0
10	16.1	22.7	27.8	32.1
12	18.8	26.6	32.6	37.6
14	20.3	28.7		
16	22.5	31.8		
18	24.7	34.9		
20	26.9	38.0		
24	36.3	51.4		
30	52.3	74.0		

Example: Find the length of the loop needed In a 2" line for a change in length of 3"

Assume the following values

L_c = 3 in
E_b = 1.75E+06

I = reinf. moment of inertia, in.^{4}
= $\pi(OD_r^4 - ID_r^4)/64$
M = 3000 lb-in,
OD = 2.30 in. (reinforcement)
ID = 2.00 in. (reinforcement)

$L_A = ((12)(L_c)(E_b)(I)/(144)(M))^{1/2}$
$= ((12)(3)(1.75E+06)(0.588)/(144)(3000))^{1/2}$
= 9.3 ft

3. Directional Changes

In some Conley fiberglass installations changes in direction may be used to absorb expansion. In this way they function similarly to expansion loops. (*Note: laterals and saddles should not be used to absorb the expansion. The bending stress created in these fittings could lead to fitting failure)

3.1 Determine the change in the length of the pipe line before the change of direction (L_c). Refer to Table 12 to determine the distance to the first guide after the change in direction (L_{sh}).

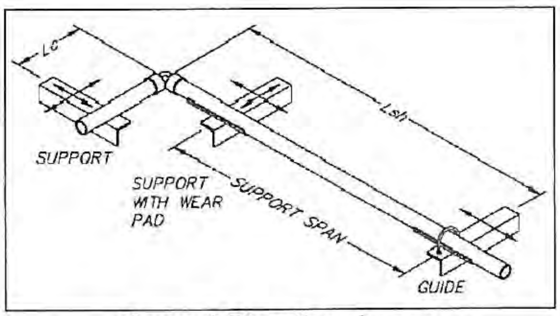


Figure 3 Direction change

Table 12
Length from directional change L_{sh} (FT)

NOMINAL Ø	L_c (in) 1	2	3	4
1	4.9	7.0	8.5	9.9
1 1/2	5.9	8.3	10.2	11.8
2	6.6	9.4	11.5	13.2
2 1/2	7.3	10.3	12.6	14.6
3	8.0	11.3	13.9	16.0
4	9.1	12.9	15.7	18.2
6	11.0	15.6	19.1	22.0
8	12.6	17.8	21.8	25.2
10	14.0	19.8	24.3	28.0
12	15.5	21.9	26.8	31.0
14	16.6	23.5	28.8	33.3
16	17.7	25.0	30.7	35.4
18	18.7	26.5	32.4	37.4
20	19.7	27.8	34.0	39.3
24	21.5	30.4	37.3	43.0
30	24.1	34.0	41.7	48.1

When guides may not be used or when large changes in length are expected before a direction change, a short length of flexible hose may be installed at the change in direction to accommodate the movement. Refer to the specifications of the hose manufacturer.

4. Expansion Joints

Expansion joints can help relieve long straight pipe runs. Various types of expansion joints are available and suitable for use with fiberglass piping systems. Since the forces developed during a temperature change are relatively low compared with steel piping systems, it is essential to specify an expansion joint design which activates with low force. Remember that fiberglass pipe runs expand more than most steel piping systems. The required movement per fiberglass joint, and the number of expansion joints may be greater for fiberglass piping systems.

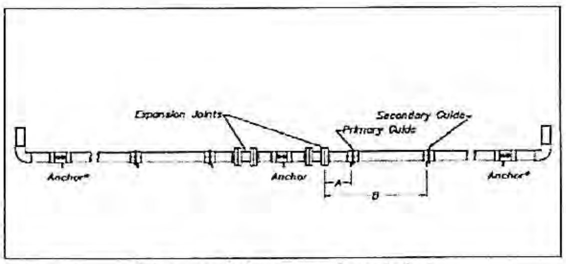


Figure 4 Expansion joint

To use a mechanical expansion joint the total amount of thermal movement expected in the system must be determined. The expansion joint must be able to absorb the full range of movement in the pipe line with a margin of safety.

In all applications, the activation force of the expansion joint must not exceed the thermal end loads developed by the pipe. The expansion joint should have an anchor on one side for proper operation.

Guide spacing is normally four (4) diameters of the nominal pipe size for the first guide from the expansion joint and fourteen (14) for the second guide. The spacing of the remaining supports and guides should remain within the maximum interval.

Helpful Links

www.awwa.org
www.asme.org
www.astm.org

Appendix A
Anchors, Guides and Supports

Anchors:

Pipe anchors secure the pipe against applied forces, both lateral and axial and effectively divide the pipeline into individual sections. Anchors are located near changes in direction, changes in size, branch connections, equipment and blind ends of pipe. Anchors are also located approximately every 300' along straight runs of pipe.

To minimize stresses on saddles and laterals (branches) caused by the bending of side runs, pipe must be anchored on either side of saddles, and both the straight run and side run of laterals must be anchored.

Typical Anchors:

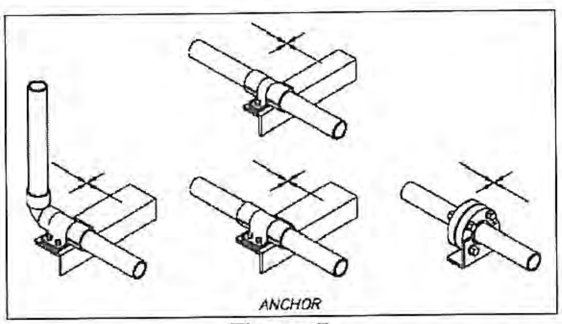


Figure 5

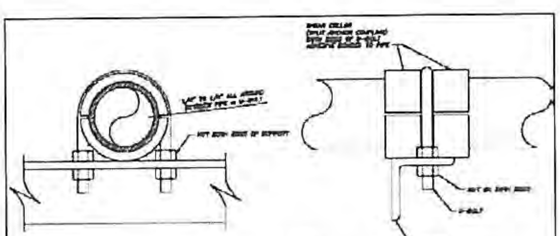


Figure 6

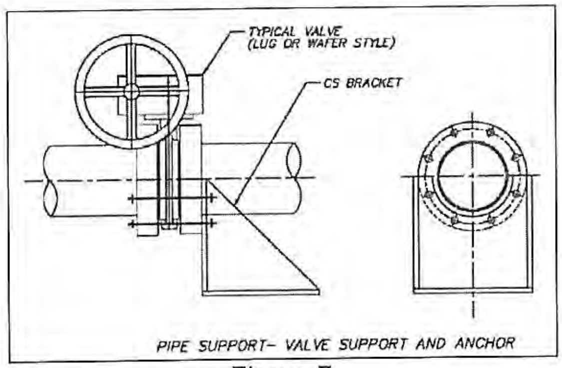


Figure 7

Important!

1) Do not anchor fiberglass by applying external pressure as point loads, such as a "U-bolt", directly against the bare pipe.
2) Clamps should fit snuggly without applying pressure to the pipe.
3) Conley shear collars or fittings must be used on both sides of a pipe clamp to anchor the pipe.
4) If using anchors at flanged connections make sure the anchor is at minimum extended to the centerline of the pipe.

Guides:

A) Use of Guides in a restrained or anchored system:

When no means for expansion is provided and the pipe is restrained, the pipe will be subjected to thermal end loads. Ref. page 2, Table 1 and 2. When the pipe is subjected to thermal loads from restrained expansion, it is necessary to guide the pipe. Guiding is necessary at specific maximum intervals or spacing to keep the pipe straight and prevent lateral movement. Guides direct the thermal load in an axial direction and prevent buckling which would otherwise occur. Maximum guide spacing for restrained thermal expansion are shown in Tables 3 to 8 pages 3 and 4 for guide spacing at different changes in temperature.

B) Use of Guides in expansion loops and with expansion joints:

The use of expansion joints and loops requires that consideration be given to guides. Guides are rigidly fixed to the supporting structure and allow the pipe to move in the axial direction only. Proper guide placement and spacing are important to ensure proper movement of the expansion joint or loop and to prevent buckling of the line. See guide spacing tables 3 to 8.

C) Typical Pipe Guide:

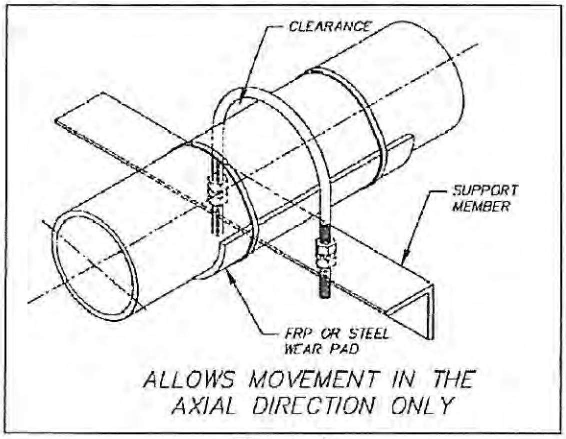


Figure 8

The guiding mechanism should be loose so it will allow free axial movement of the pipe. "U-bolts", double-nutted so they cannot be pulled down tight, are often utilized for guides. Remember that a guide also acts as a support and such as must meet the minimum support widths shown in the table.

Table 13 Minimum support width for 120° contact support

Nominal Pipe Size, in.	Minimum Support Width, in.
1	0.88
1½	0.88
2	0.88
3	1.25
4	1.25
6	1.50
8	1.75
10	1.75
12	2.00
14	2.00
16	2.50
18	3.00
20	3.50
24	4.00
30	5.00

Note: Table is based on maximum liquid specific gravity of 1.25.

Supports:

Pipe supports prevent deflection of the pipe due to the weight of the pipe and fluid. Horizontal supports should be spaced at intervals in accordance with the span tables for the specific pipe schedule being used.

Simple Horizontal Support:

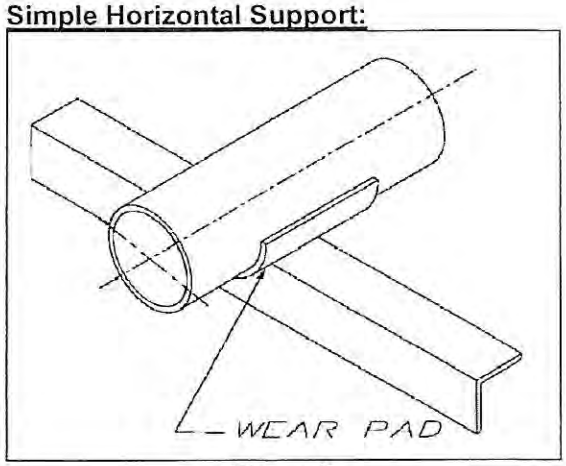


Figure 9

Important!

1) Pipe supports should contact at minimum 120° of the pipe circumference if the specific gravity of the fluid is ≤ 1.25.
2) Valves, pumps and other heavy equipment shall be supported

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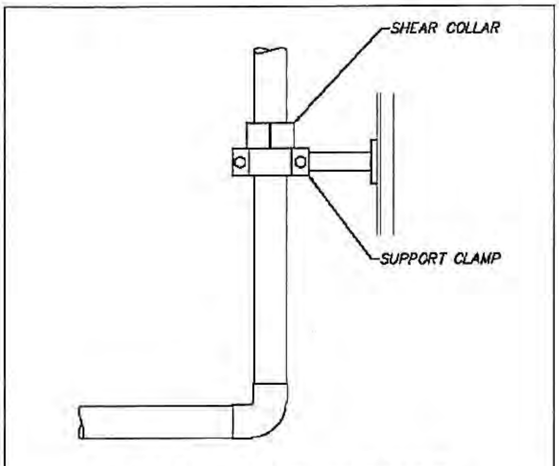
independently of the pipe.

3) Properly spaced supports do not alleviate the need for guides.
4) Use wear pads between the support and pipe to avoid point loading and abrasion.
5) Make sure supports meet minimum widths. See Table 1.

Vertical runs of pipe must also be supported adequately to avoid excessive loading of the pipe.

Vertical Support Examples:



VERTICAL RISER SUPPORT

Figure 10

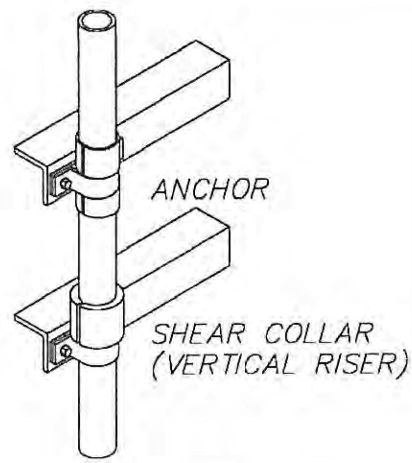


Figure 12

In both examples above, the clamps should be snug but not tight against the pipe.

Abrasion Considerations:

Wear pads placed between the pipe and supports will protect the fibreglass from abrasion anytime there is a tendency for the pipe to move or vibrate due to thermal conditions.

An additional wear pad can be placed between the pipe and guide to protect against wear from more frequent thermal cycling.

Wear pads

SIZE IN.	SCH	I.D.	O.D.	WT. LBS.
1	80	1.33	1.71	0.3
1 1/2	80	1.91	2.35	0.5
2	30	2.18	2.50	0.4
2 1/2	80	2.90	3.28	0.6
3	30	3.35	3.79	0.8
4	30	4.37	4.72	0.8
6	30	6.44	6.85	1.4
8	30	8.44	8.85	1.9
10	30	10.55	11.07	3.0
12	30	12.80	13.32	3.6
14	30	14.84	15.36	4.1
16	30	16.86	17.38	4.7
18	30	18.93	19.56	6.4
20	30	20.95	21.58	7.1
24	30	25.06	25.80	9.9
30	30	31.44	32.29	14.3

* CUSTOM LENGTHS AVAILABLE PER SPECIFIC CUSTOMER REQUIREMENTS. CONSULT FACTORY.

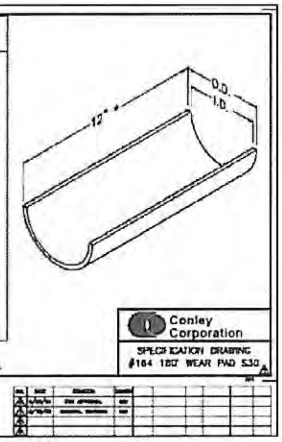


Figure 13

Six basic rules govern the design and position of anchors, guides and supports:

1) Avoid point loads:
   Use fibreglass wear pads to protect against contact with supports or U-bolts.
2) Meet minimum support dimensions:
   Supports that do not meet the minimum dimensions must be augmented with protective sleeves of metal or fibreglass.
3) Protect against abrasion:
   Use Conley wear pads to protect contact points.
4) Support heavy equipment independently both horizontally and vertically.

5) Avoid exceeding allowable load or strength.
6) Avoid exceeding allowable compression load in vertical runs.

Detailed review of thermal considerations may be found in the M45 Manual Fiberglass Pipe Design published by the American Water Works Association (AWWA)

www.awwa.org

Controlling Standards

- ASTM International Standards Worldwide
- ASME International Codes
- AWWA American Water Works Association

⚠ Fiberglass Reinforced Plastic Piping products have unique characteristics and must be installed using sound, proven procedures. To avoid serious personal injury it is imperative that all installers / fabricators familiarize themselves thoroughly with the information contained in this Fabrication Seminar & Manual material before fabricating the product. It is imperative that all installers / fabricators strictly follow the fabrication and testing procedures set forth in the manual, paying particular attention to all safety warnings, cautions and procedures. All installers / fabricators must read and thoroughly familiarize themselves and follow all instructions, cautions and warnings addressing heat tapes, adhesive kits or any Conley manufactured products, and on any other tools or products used. Improper installation may cause serious injury to person and property. Follow all general safety practices and procedures that include proper use of protective clothing, cleanliness of the work area, surfaces tools, etc., and maintain proper ventilation.

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Buried Pipe

A successful buried Conley Piping System requires proper fabrication, curing and handling. Equally important is trench design, bedding, backfill, and soil coverage of the pipe system.

Fiberglass pipe and fittings are sensitive to impact loads and must be handled accordingly. Refer to the Conley Installation and Fabrication Manual for shipping, handling, storage and inspection of Conley Fiberglass Pipe page 1. For dimensional data and tables of pipe weights refer to the Conley Products section.

Conley Piping Systems use a straight socket adhesive joining system that is totally restrained. Except in cases of very high pressure and/or temperature, thrust blocks at changes in direction are not required.

For burial applications, Conley Fiberglass pipe is considered to be a *"flexible conduit"*. Buried piping is considered to be "continuously anchored" and therefore very stable. Conley piping requires typical burial requirements for fiberglass pipe, i.e., shaped trench bottom, select granular bedding and backfill compacted to 90% Proctor Density and pavement or sleeves to provide load distribution for live loads.

In double containment piping systems, the containment pipe will remain at essentially ground temperature so thrust blocks are not normally required. Trench, bedding, and backfill materials are all specified and controlled to provide the required support for the pipe under the burial loads.

A. Trench Design and Burial Depths

One purpose of the trench is to provide working space while installing the pipe. Nominal trench widths are listed in the table below.

Table 1 Nominal Trench Widths

Pipe Size (in)	Minimum (in)	Maximum (in)
1	18	26
1 1/2	18	26
2	18	26
2 1/2	18	27
3	18	27
4	18	28
6	20	30
8	23	32
10	25	34
12	28	36
14	31	38
16	33	40
18	36	42
20	39	44
24	44	48
30	52	56

The maximum and minimum burial depths vary with diameter, soil conditions, loading conditions and pipe schedule. On the conservative side of planning and with a backfill modulus or shear strength of 1,500 lbs/ft^2, the minimum burial depth of pipe under unpaved areas is two feet.

This depth of cover assumes a tandem axle wheel load of 34,000 pounds.

For soils that do not meet the shear strength of 1,500 lbs/ft^2 or if the axial load is higher than the standard the minimum pipe burial depth will be greater than 3 feet.

The minimum burial depth may be reduced if the pipe is buried under concrete or asphalt. Maximum burial depths are usually limited to 20-ft, but may be greater if the trench and bedding are designed for greater depth.

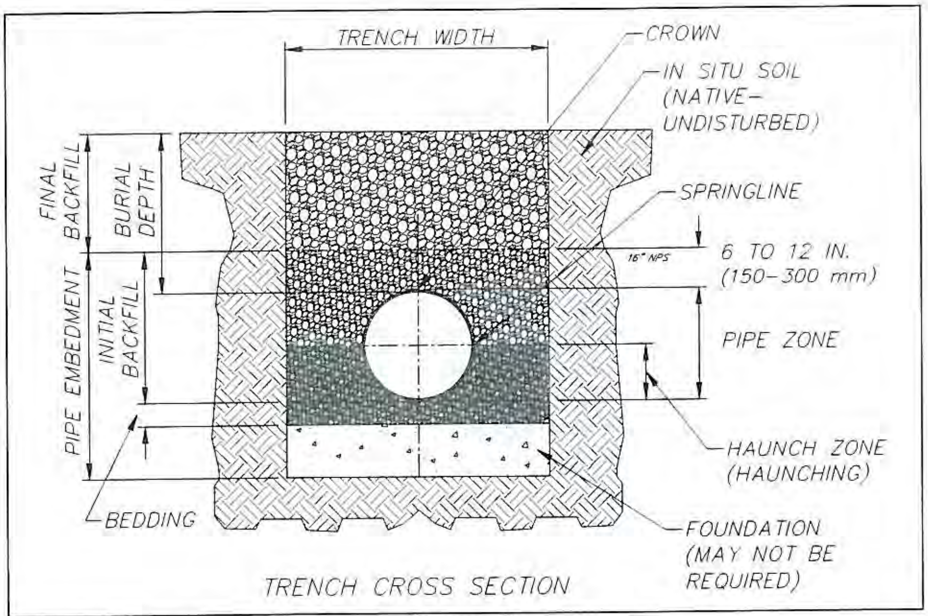


Figure 1

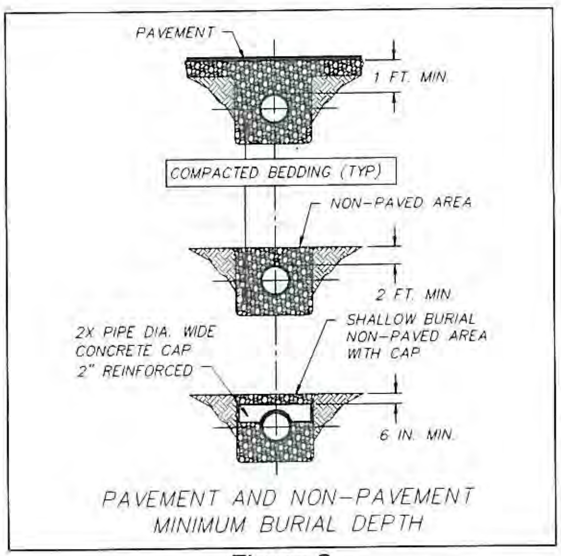


Figure 2

B. Bedding & Backfill

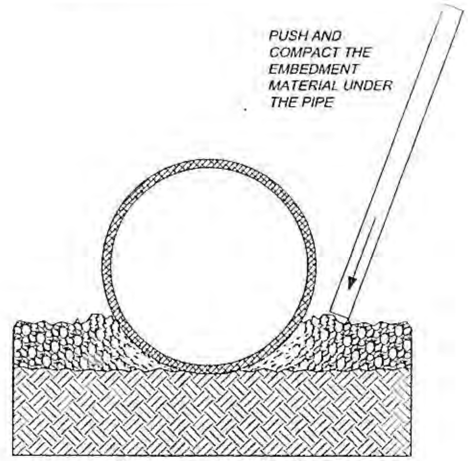
Typical burial requirements for fiberglass pipe require a fully supported and uniform trench bottom, avoiding sharp angular rocks and or voids in the bedding material. Full longitudinal support must be met.

If more than one pipe is to be laid in a trench at least six inches of properly supported backfill should separate the two pipe lines.

Table 2 Bedding and Backfill Materials Recommendation

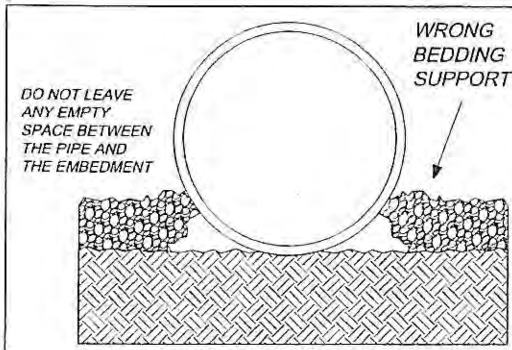
Stiffness category (Reference for AWWA M45)	Backfill Material	Compaction (%) necessary
SC1	Crushed rock 15% or less sand, maximum 25% (passing 3/8inch sieve and maximum 5%)	No compaction required
SC2	Clean coarse-grained soils (12% or less)	75-85
SC3	Coarse-grained soils (more than 12%)	85-95
SC4	Fine-grained soils (30% or less)	More than 95

Generally, the most successful bedding and pipe zone embedment material is crushed rock or pea gravel under the SC1 Stiffness Category per ASTM D2487 Standard Classification of soils for Engineering Purposes. S1 material will provide good support for the pipeline even if it is only dumped rather than compacted. Still it is better to work the bedding material into the critical zone of the trench as shown below in Figure 3.



Bedding shall be firmly supported

Figure 3



Bedding shall not be poorly supported

Figure 4

C. Pipe Under Roads

If Conley pipe is used under a roadway, a concrete or metal sleeve is generally recommended to protect the pipe from excessive loads. Pipe wear pads are usually installed to protect the pipe from abrasion.

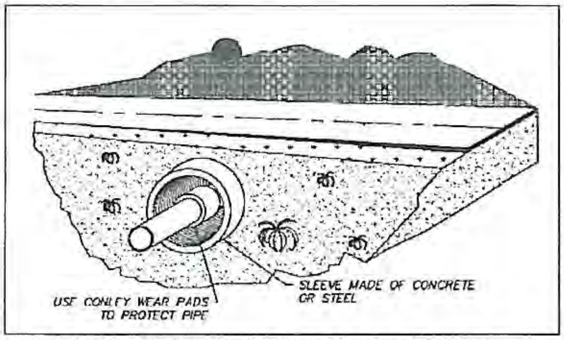


Figure 5 Typical Pipe Under Roads

D. Pipe Through Concrete Walls or Structures

Pipe passing through existing concrete structures can be sealed using a grout and should be protected with a concrete or metal sleeve.

If concrete is to be poured over Conley pipe, do not exceed the external pressure rating of the pipe. Refer to Products section for values. (One foot of concrete head is equal to approximately 1 psig of external pressure on the pipe.)

Pipe passing through buried walls or structures requires a larger steel protective sleeve filled with a flexible filler at least 2" in thickness.

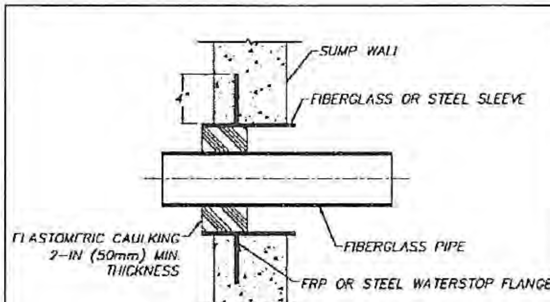


Figure 6 Piping Penetration

E. Testing

Refer to testing procedures in the Installation & Fabrication Manual.

F. Thrust Blocks

Thrust blocks- are normally used with non restrained joints or in areas with extremely soft or poor soil conditions. For more detailed information concerning burial conditions refer to ASTM D3839 and Fiberglass Pipe Design Manual of Water Supply Practices AWWA M45.

GLOSSARY

bedding – backfill material placed in the bottom of the trench on which to lay the pipe; the bedding may or may not include part of the haunch zone (see Figure 1).

crown – the top of the pipe.

haunch zone – soil directly beneath the pipe (see Figure 1).

haunching – backfill material placed on top of the bedding and under the springline of the pipe (see Figure 1).

in situ soil – native natural soil in which a trench is excavated for pipe installation.

Proctor density – the maximum dry density of soil compacted at optimum moisture content and with standard effort in accordance with ASTM D698.

stiffness category – classification of soils according to ASTM D2487 and ASTM D2488 in situ conditions.

springline – the horizontal centerline of the pipe (see Figure 1).