Technical Note PP 819-TN
Field Bending of DriscoPlex® Pipe

Polyethylene pipe's flexibility makes the pipe easy to handle and install. Not only can small diameter (6" and less) pipes be purchased in coils to reduce joining costs but the tight curvature permitted in polyethylene pipelines reduces the need for fittings. All of the major trenchless installation methods rely on the pipe's flexibility for avoiding obstacles and handling curvature in the bore path or misalignment in host pipes. Generally, its great flexibility makes polyethylene pipe the preferred pipe for installation.

Bend Radius

The measure for curvature in a pipeline is the bend radius. See Figure 1.

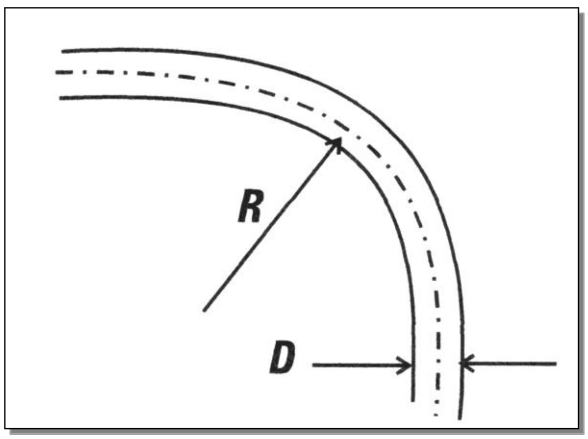

Figure 1. Bend Radius, R

Tightening the curvature of a pipeline results in a smaller (tighter) bend radius. The *minimum bend radius* is defined as the smallest radius to which the pipe may be safely curved.

The *minimum bend radius* for polyethylene pipe is given by Equation 1.

$$R = \alpha(OD) \qquad (1)$$

Where

R = *minimum bend radius* for the pipe (in)

α = *minimum bend ratio*

OD = pipe outside diameter (in)

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The longitudinal wall strain in a curved pipe is proportional to the bend ratio. Generally, the strain capacity of polyethylene is sufficiently safe for a bend ratio of 20. However, there is another limit to bending. Longitudinal bending induces ovality in the ring direction of the pipe thus reducing the resistance to kinking (local buckling). Thicker wall pipes have higher resistance to kinking and therefore can safely withstand more curvature than thinner wall pipes. Likewise, temporary curvature is less likely to cause kinking than permanent curvature because polyethylene's modulus decreases with time under load. Therefore, the *minimum bend ratio* depends on the DR and the duration of curvature. Table 1 contains *minimum long-term bend ratios* for DriscoPlex® pipe. Because fittings and flanges are rigid compared to pipe, the *minimum bend ratio* must be increased to 100 where fittings or flanges are present in the curve. The *long-term bend ratio* applies to installed pipe but it is also recommended for safely limiting curvature during handling and installation.

Table 1. Minimum Long-Term Bend Ratio for DriscoPlex® Pipe

Dimension Ratio, DR	***Minimum Bend Ratio, α***[1]
7	20
7.3	20
9	20
11	25
13.5	25
17	27
21	27
26	34
32.5	42
41	52
Fitting or flange present in bend	100

Example 1. What is the *minimum bend radius* for a 12" IPS DR17 pipe?

Solution: Find the *minimum bend ratio* in Table 1 for DR17 pipe and solve Equation 1 for the *minimum bend radius*.

$$R = \alpha(OD) = 27\,(12.75\,in) = 344.25\,in = 28.7\,ft$$

[1] See limitations for horizontal directional drilling.

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Installation of Pipe in Curves

Field bending involves excavating the trench to the desired bend radius, then sweeping or pulling the pipe string into the required bend and placing it in the trench. Temporary restraints may be required to bend the pipe, and to maintain the bend while placing the pipe in the trench and placing initial backfill. Temporary blocks or restraints must be removed before installing final backfill, and any voids must be filled with compacted initial backfill material.

Considerable force may be required to field bend the pipe, and the pipe may spring back forcibly if the restraints slip or are inadvertently released while bending. Observe appropriate safety precautions during field bending.

Special Considerations for Horizontal Directional Drilling

Directional drillers prefer polyethylene pipe over other materials as it offers them more options in determining laydown locations. They can string the pipe around roadway curves and intersections that would be impossible to do with other types of pipes. The pipe's flexibility allows installers to string pipe perpendicular to the direction of the bore and then sweep the pipe through a tight curve into the bore for pullback and it allows the driller to locate the break-over section closer to the bore. For large diameter pipe installations drillers can usually get by with a single small crane at the break-over as opposed to steel pipes which need multiply cranes. Even though stringing is a temporary condition, Table 1 is recommended for calculating the *minimum bend radius* as the pipe may remain curved for several hours or even days and be exposed to the sun.

The amount of permissible curvature in the bore itself is generally limited by the drill stem's bending capability and not the polyethylene pipe. **However, due to the increased stress in the pipe during a directional drill, the minimum bend ratio in the bore itself should not be less than two times the value shown in Table 1.** For example, a 36" IPS DR 13.5 pipe has a *minimum bend radius* of 75 feet for an open cut installation. In a bore the same pipe would have a *minimum bend radius* of two times 75 feet or 150 feet. The larger radius is rarely a limitation for the driller as the drill stem used with this size pipe (5") generally has at least a 700 foot bend radius.

Special Considerations for Plowing and Planting

Plowing and planting involve cutting a narrow trench, and feeding the pipe into the trench through a shoe or chute fitted just behind the trench cutting equipment. The shoe or chute feeds the pipe into the bottom of the cut. The *minimum bend radius* of the pipe through the shoe may be tighter than the *minimum bend radius* of the pipe used for a permanent long-term installation, but it must not be so tight that the pipe kinks. Table 2 presents the *minimum short-term bend ratio* for applications such as plowing and planting. The pipe's path through the shoe or chute should be as friction free as practicable to reduce additional outerfiber tensile stresses. Generally plowing and planting is limited to 12" and smaller pipes.

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Table 2. Minimum Short-Term Bending Radius

Pipe Dimension Ratio	***Minimum Short-Term Bend Ratio, α_{ST}***
7.3	10
9	10
11	13
13.5	13
17	17
21	17

Summary

Field bending of polyethylene pipes often eliminates the need for fittings. An example is bending the pipe to align it with the curvature in a cul-de-sac. The bending flexibility of polyethylene pipe allows for its installation by trenchless methods, such as sliplining, pipe bursting, and directional drilling and by submerging off shore. To ensure maximum performance of the pipe limit the *minimum long-term bend radius* of pipeline curves to the values given in Table 1.

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