Installation

Recommended Installation Practices For Corrugated Polyethylene Pipe and Fittings

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Your Information Resource

CORRUGATED POLYETHYLENE PIPE ASSOCIATION™

A division of the Plastics Pipe Institute, Inc.

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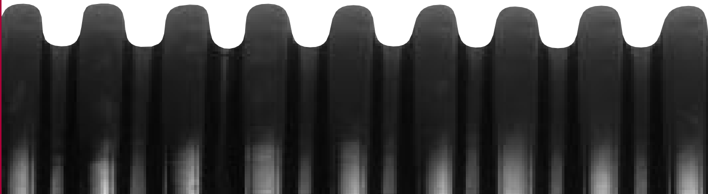

Preface

The material presented in this technical booklet has been prepared in accordance with recognized principles and practices, and is for general information only. The information should not be used without first securing competent advice with respect to its suitability for any general or specific application.

While the material is believed to be technically correct, the Corrugated Polyethylene Pipe Association makes no representation or warranty of any kind, and assumes no liability therefore. Inquiries on specific products, their attributes, and the manufacturer's warranty should be directed to member companies. An up-to-date directory of the membership of the Corrugated Polyethylene Pipe Association is available on request.

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This booklet provides information on handling and installation of corrugated polyethylene pipe and fittings in nonpressure applications including most sewers, culverts, and subdrainage systems. Some specialized nonpressure applications, such as landfill leachate systems and septic tank leach fields, require a more detailed engineering analysis and are not discussed here.

The information contained in this booklet can be applied to most corrugated polyethylene pipe. It is not intended to supersede the manufacturer's instructions, project specifications, or applicable safety laws.

OSHA safety regulations and guidelines must be observed during all phases of construction including foundation preparation, excavation, pipe handling, assembly and backfilling. These products are solely intended for the conveyance of fluids. Access into this product for maintenance, inspection, or other reason should be done in strict accordance with OSHA recommendations for confined space entry.

Delivery Inspection

Manufacturers make every effort to ensure order accuracy and quality. As a final check, the customer should conduct a personal inspection at delivery to verify that the correct product and the expected quantity is received. Pipe corrugations, gaskets, pipe ends, couplers or other joints, and any accessories should be visually inspected for damage that may have occurred during shipment.

Product Identification

Product markings on pipe, joints, and accessories may vary slightly among manufacturers. The following information is generally included on the pipe:

- Nominal pipe size
- Manufacturer's name
- Date code
- Applicable standard(s)

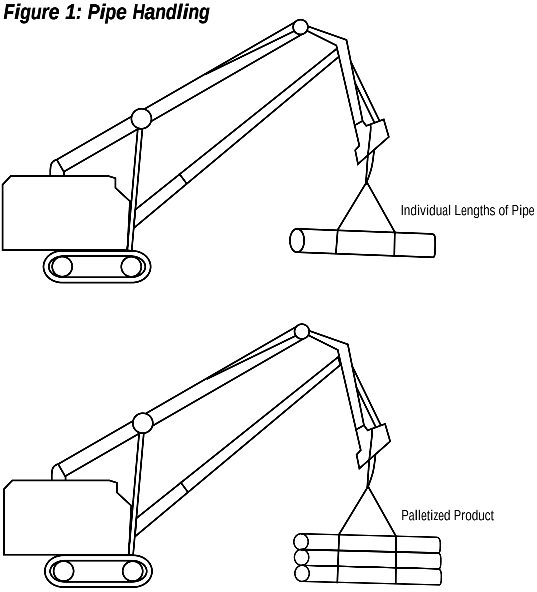
These markings help make product identification easier for jobsite delivery inspections.

Unloading

The contractor should set aside an area for products to be stored on site. This area should be flat, free of large rocks, rough surfaces, and debris. It should also be out of the way of construction traffic.

Pipe may be delivered either palletized or loose, depending on the type and quantity of product. Pallets can be unloaded with a backhoe or other piece of equipment, and a nylon sling or cushioned cable. The sling should be wrapped around the pallet at the third points as it lifts the pallet onto the ground. As an alternative to using a sling to unload full pallets, the pallet can be opened and lengths of pipe can be unloaded individually. Non-palletized pipe can be unloaded by carefully rolling single lengths of loose pipe from the delivery truck onto a front end loader, and then onto the ground. Alternatively, the pipe can also be lifted using a nylon sling or cushioned cable at the third points. Equipment such as loading booms or forklifts should not be used since they can damage the pipe. See Figure 1 (following page) for examples of proper handling during unloading.

Figure 1: Pipe Handling

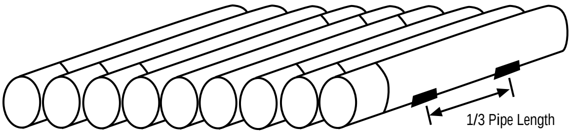


Items such as coupling bands, fittings, and accessories are packaged in different ways depending on the product, quantity, and size. They should be unloaded in a safe manner that will not cause damage.

Jobsite Storage

Palletized pipe should remain in the pallet for jobsite storage. Non-palletized pipe can be stockpiled for temporary storage in a flat debris-free area out of the way of construction traffic. Begin the stockpile with secured timbers spaced the width of the proposed stockpile, at a distance not exceeding the third points. For pipe with attached bells, a common stacking method is to alternate the direction of the pipe lengths so that the bells are not stacked on each other. As shown in Figure 2, up to three pipes can be laid before alternating direction. Subsequent layers should follow the same pattern as the first but with fewer sticks of pipe in each block. For smooth interior pipe, the storage space can sometimes be minimized by nesting smaller diameters inside larger diameters. Factory installed gaskets on the spigot can be protected by positioning them between pipe corrugations. Nesting corrugated interior pipe should only be done when the pipe can be removed easily.

Figure 2: Stockpiling for Bell-and-Spigot Pipe (First Layer)



A reasonable amount of care in handling the pipe should be taken during stockpiling. The pipe should not be dropped, dragged, or bumped against other pipe or objects, or climbed on. Stockpile heights should be limited to approximately 6' (2 m) so that the pipe can be handled easily and safely manually.

Other items, such as coupling bands, fittings, gaskets, and accessories, should be stored in a convenient area away from construction traffic, protected from damage and theft. Manufacturers may provide specific instructions for the handling of these items.

A few safety precautions should be taken during jobsite storage and stockpiling. While small diameter pipe and lightweight accessories can generally be handled manually, large diameter pipe requires equipment, such as a backhoe, with a nylon sling or cushioned cable wrapped around the third points for safe handling. Heavy fittings, as an example, should also be carefully handled with equipment. Stockpiles should not be climbed on. Depending on jobsite conditions and safety regulations, other safety precautions may also need to be followed.

Stringing the Pipe

Placing the pipe and accessories along the open trench, or "stringing," can save handling time. Each pipe length should be laid on a level surface as near as possible to the trench on the side opposite the excavated trench material; allow some space between pipe to protect pipe ends. The pipe should be out of the way of any equipment in a location that will allow excavation to proceed uninterrupted.

All types of pipe must be installed as specified to perform as expected. This section describes the installation method generally used for corrugated polyethylene pipe designed in accordance with the CPPA technical booklet *Structural Design Method for Corrugated Polyethylene Pipe.* The type of backfill material and compaction requirements must be determined during design and are not discussed in detail in this section. Other requirements may be called out in contract documents. Furthermore, additional guidelines for the installation of corrugated polyethylene pipe are located in the following standards:

- ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
- CAN/CSA B182.11 - Recommended Practice for the Installation of Thermoplastic Drain, Storm and Sewer Pipe and Fittings

Trench Excavation

According to ASTM D2321, the trench width should be no wider than what is required to safely place and compact, if necessary, the backfill material on either side of the pipe. Trench width will depend on the backfill material, compaction method, and the pipe diameter.

The width of a contractor's available excavator buckets may affect trench widths. The typical trench width for pipe 10- to 24-inches (250 to 600mm) in diameter is twice the outside diameter; for 30- and 36-inch (750 and 900mm) pipe the trench is usually the outside diameter plus two feet (0.6m). For pipe 42-inches (1050mm) and larger, a width equal to the outside diameter plus three feet (1m) is used. These widths are generally sufficient for backfill material to flow on either side of the pipe and allow for many types of compaction equipment. Typical trench widths can vary depending on the type of backfill material and the compaction method in use. This "rule of thumb" also corresponds reasonably well to trench widths suggested by ASTM D2321. ASTM D2321 establishes trench widths as the greater of the outside diameter plus 16" (0.4 m), or 1.25 times the outside diameter plus 12" (0.3 m), as shown in Table 1.

Table 1
Trench Width* Comparison

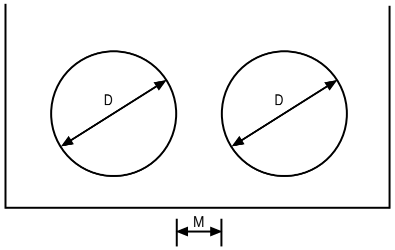
Inside Diameter in (mm)	Typical Outside Diameter in (mm)	Typical Trench Widths in (m)	ASTM D2321 Trench Widths in (m)
12 (300)	14.0 (356)	24 (0.7)	30 (0.8)
15 (375)	17.7 (450)	30 (0.9)	34 (0.9)
18 (450)	21.1 (536)	36 (1.1)	38 (1.0)
21 (525)	25.4 (622)	42 (1.2)	43 (1.1)
24 (600)	27.5 (699)	48 (1.4)	46 (1.2)
30 (750)	34.1 (866)	58 (1.5)	55 (1.4)
36 (900)	41.0 (1041)	65 (1.7)	63 (1.6)
42 (1050)	48.0 (1219)	84 (2.1)	72 (1.8)
48 (1200)	54.0 (1372)	90 (2.3)	80 (2.0)
54 (1350)	61.3 (1557)	97 (2.5)	89 (2.3)
60 (1500)	67.2 (1707)	103 (2.6)	96 (2.4)

*Wider trenches may be required if the trench width in the table is not sufficient for backfill placement.

Trench widths for smaller diameter pipe [10" (250 mm) and smaller] are often dictated by the bucket size available for the excavator, and in many cases can by necessity exceed criteria in the previous paragraphs.

For parallel pipe installations, a minimum amount of backfill is required between the pipe to provide sufficient strength to the system. Figure 3 shows minimum pipe spacing although this dimension may need to be increased depending on the type of backfill, the compaction equipment, and the joining method.

Figure 3: Minimum Pipe Spacing in Parallel Pipe Installations



For D ≤ 24-inch (600mm)
M = 1 ft (0.3m)

For D > 24-inch (600mm)
M = D/2

Where D = nominal pipe diameter

In most installations, trenches that are very wide are not only costly to excavate and re-fill with backfill, they can actually detract from the structural integrity of the pipe/backfill system. Many types of undisturbed native soils are extremely stable and add to the structural integrity of the pipe/backfill structure when trenches are relatively narrow. Overly wide trenches require more backfill material and more compaction which may not form a structure as stable as the undisturbed native material.

In very soft native soil, wider trenches may be necessary especially if the pipe will experience relatively high loads. Soft, unsupportive soils, especially in combination with narrow trenches, can detract from the pipe backfill strength. Minimum trench widths in these situations should be evaluated according to ASTM D2321 or the pipe manufacturer.

Geotextiles, or filter fabrics, may be considered in areas where the native soil is very soft, migrates easily, or has some other property not compatible with pipe installation. Geotextiles designed for strength and stability can help overcome some of the structural deficiencies in very soft native soils, and may allow the trench width to be reduced. They can also be placed along the trench bottom and sides to separate native soils and backfill material, or used to wrap the pipe to minimize the opportunity for fines to enter the pipe. Geotextiles used to separate or provide a filter are especially important in stormwater retention systems where the backfill void space must be maintained. Geotextile manufacturers can provide guidance on the most appropriate products for a particular application based on soil parameters.

Pipe of any material and size can float under the right conditions. Therefore, it is recommended that precautions be taken to prevent flotation. Contact individual pipe suppliers for conditions where flotation may be a concern.

Foundation Preparation

A sound pipe installation begins with a stable foundation. The trench bottom should be slightly overexcavated to allow for bedding material, and should be free of large stones, clumps of soil, frozen soil, or debris.

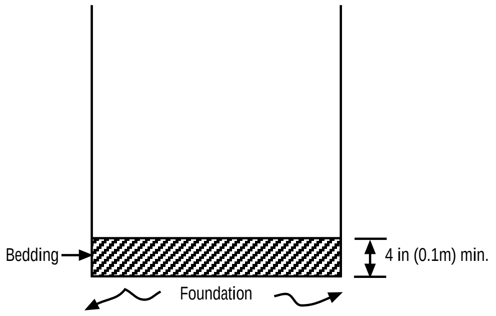
Over-excavation or sub-excavation may be required to remove rock outcroppings, muck, or other unsuitable materials since they may not provide uniform and proper support to the pipe. ASTM D2321 and individual pipe manufacturers may be able to provide additional guidance regarding foundation needs in these situations based on the severity of local conditions.

Water in the trench during pipe installation can create a safety hazard as well as make it almost impossible to install the pipe properly. Water will tend to float the pipe so that maintaining line and grade, or slope, becomes much more difficult. Dewatering is required in these situations.

Bedding

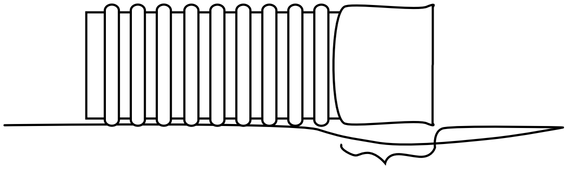
Bedding is the portion of the backfill envelope that is placed directly on the foundation; refer to Figure 4. Bedding should be sufficient to provide uniform firm support for the pipe and maintain pipe grade; commonly referenced minimum bedding depth is 4" (0.1 m).

Figure 4: Location of the Bedding Area of the Backfill Envelope



If a pipe has a bell-and-spigot joint where the bell is significantly larger than the pipe, the manufacturer may require use of "bell holes" in the installation. Bell holes are depressions in the bedding designed to accommodate the connection so that a stress point does not occur; Figure 5 shows an example. Since joint designs vary, individual manufacturers should be contacted regarding whether this is an essential construction technique for a specific product.

Figure 5: Bell Hole



Laying and Joining Pipe

Lengths of pipe should be lowered into the trench manually or with equipment depending on pipe size and trench conditions. Do not drag, drop, or roll pipe into the trench. Coupling bands, fittings, and similar products should be handled with care, using equipment and the correct straps if necessary. These products should not be thrown, or otherwise mishandled.

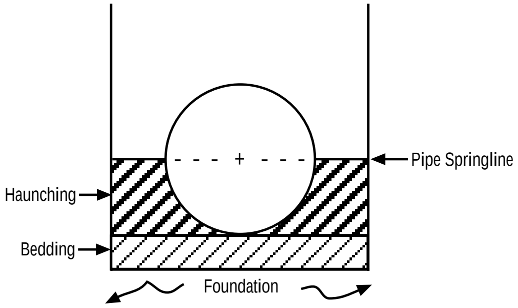
All pipe and accessories should be inspected for damage after they have been lowered into the trench but before they are connected. Pipe and fitting ends should be as clean as possible to permit proper assembly and optimum joint performance.

Several joining options are available from CPPA member companies. The application, minimum joint quality, pipe type, and diameter will determine the most appropriate joint. Individual manufacturers can provide additional information on their own designs, as well as procedures for making joints in the field.

Haunching

The haunching area of the backfill envelope provides the majority of the resistance against soil and traffic loadings. The backfill material should be installed in layers, or lifts, uniformly on each side of the pipe as specified for a particular material in the CPPA technical booklet *Structural Design Method for Corrugated Polyethylene Pipe.* Larger, more angular backfill material can usually be placed in thicker layers than can material with smaller, rounder particles. The backfill should be shoveled under the pipe, taking care to fill voids. If compaction is required, it should be conducted in such a way that the pipe alignment is not disturbed. Backfill construction should continue up to the pipe springline to complete the haunch area, as shown in Figure 6.

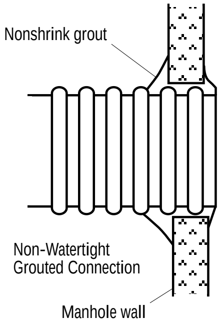
Figure 6: Location of the Haunching Area of the Backfill Envelope



Additional attention should be given to backfill placement and compaction around pipe connections at manholes, catch basins, fittings, and other structures. Since it can be difficult to work in these areas, the backfilling process is often neglected. This can lead to non-uniform settlement or product damage. As a precautionary measure in critical applications, a pipe joint can be made close to the manhole to help accommodate differential settlement, as shown in figure 6A (following page).

Figure 6A: Joint Configuration for Potential Differential Settlement Conditions

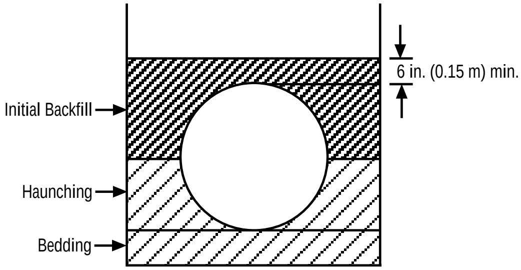
(Pipe Joint Close to Manhole)



Initial Backfill

Initial backfill distributes the loads into the haunching. This area of the backfill envelope extends from the pipe springline to a minimum of 6" (0.15 m) above the pipe crown. It should be placed and compacted in layers. If mechanical compactors will be used, it is important not to use the equipment directly on the pipe itself. Figure 7 notes the initial backfill location.

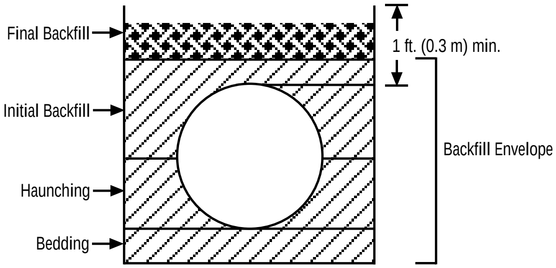
Figure 7: Location of the Initial Backfill Area of the Backfill Envelope



Final Backfill

Final backfill extends from the initial backfill to the top of the trench. In trafficked installations, the total height of the initial backfill and final backfill must be at least 1' (0.3 m); refer to Figure 8. Since this part of the installation does not directly support the pipe, the type of material and compaction level should be based on surface load conditions. For example, if roads or drives will be crossing the pipe, a relatively high strength material and compaction level will be needed to prevent settlement. On the other hand, if surface settlement is not an issue, then compaction is unnecessary. Excavated native soils are often used for final backfill in installations not experiencing vehicular loads.

Figure 8: Location of the Final Backfill Area



Additional precautions may be required on jobsites where construction traffic in excess of the design load will be present. Heavy construction vehicles can place unanticipated loads on the pipe and cause structural problems if the pipe has less than 3' (1 m) cover. The surest solution is to route the traffic around the pipe.

If heavy construction traffic cannot be rerouted, and the pipe is buried rather shallow, additional compacted soil should be mounded over the pipe to create at least 3' (1 m) of cover over the pipe crown. This mound can then be graded at the end of construction when heavy traffic is no longer present. The pipe manufacturer can provide more detailed recommendations based on specific vehicle load and load distribution information.

On the other hand, some construction vehicles, such as what might be used during paving, do not induce loads as high as the design load. In these situations, the 1' (0.3 m) minimum cover requirement may be decreased during the construction phase while paving, for example. In the finished application, however, minimum cover should always be a minimum of 1' (0.3 m). Once again, the situation should be reviewed with the individual pipe manufacturer to ensure that the loads will not create an adverse situation for the pipe system.

The degree of compaction required may vary from job to job depending on the backfill material and the installation requirements; the CPPA technical booklet *Structural Design Method for Corrugated Polyethylene Pipe* provides detail. Crushed stone and gravel are usually not mechanically compacted, but they do require care during installation to eliminate large voids in the backfill envelope. At optimum moisture levels, some materials can be compacted to minimum recommended levels simply by walking on each backfill layer. While this technique may not be acceptable for all installations, the point is that compaction need not always require a great deal of extra effort or compaction equipment.

Some situations may require mechanical compaction. The method used will depend on the type of backfill material, degree of compaction required, and moisture levels. The following information provide general guidance on typical types of compaction equipment and the soils for which they are most appropriate. In all cases, the equipment should not be used directly on the pipe, and the compaction process should not be allowed to change the pipe alignment.

Tampers

Compacting the haunching layer may require a small tamping mechanism to obtain the specified compaction in a confined area. A hand-held pole or two-by-four can be used. Tampers should be relatively lightweight, and the tamping face should be limited to an area no larger than 6" by 6" (0.15 m by 0.15 m).

Rammers

Rammers use an impact action to compact the fill. This equipment works reasonably well on soils with significant amounts of fines, Class III and Class IVA soils for example, although the water content may need close monitoring to achieve the desired densities. Rammers should not be used directly on the pipe.

Static Compactors

Static compactors use a combination of the weight and rolling motion of the equipment to consolidate soil. A sheeps-foot roller is one example of a static compactor that concentrates its weight on a series of projecting feet. Static compactors are most useful on noncohesive material away from the pipe. Other types of compaction equipment should be used near the pipe.

Vibrating Compactors

Vibrating rollers or plates “shake” the soil into a more dense arrangement and so work best on noncohesive aggregates with very little fines (Class I and Class II materials, for example). Depending on the size and weight of the machine, vibrating compactors may be used close to the pipe.

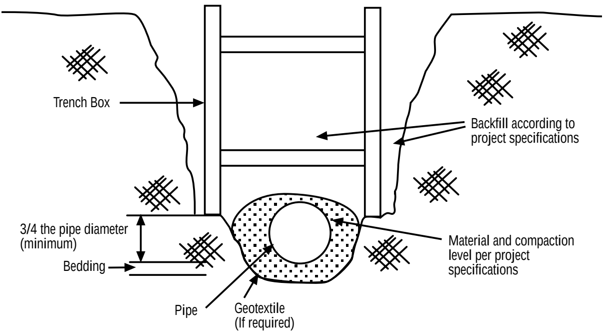
In pipe installations, one of the primary safety concerns is the trench itself. The trench wall can be sloped if there is adequate space on site. If sloping is not an option, trench boxes or some other means can be used to provide a safe work area.

Proper use of trench boxes is important to the pipe performance. When used incorrectly, they can disrupt both the backfill and the pipe joints. The following information provides recommendations on how to use trench boxes without causing pipe problems. This information is not intended to replace safety or installation requirements provided in the project specifications.

Subtrench Installations

The most effective way to maintain the integrity of the pipe and backfill is to provide a "subtrench" to place the pipe and backfill, as shown in Figure 9. The subtrench should extend at least 3/4 the diameter of the pipe above the bedding. Backfilling within the subtrench should be according to the design specifications. The trench box can be pulled along the top edge of the subtrench without affecting the pipe or the backfill.

Figure 9: Use of Trench Box in Subtrench Installation



Subtrench installations also make it easier to use a geotextile around the backfill if it is required by the project specifications. The subtrench can be lined with the geotextile, and then wrapped around the pipe and backfill so that it overlaps slightly.

Standard Trench Installations

For installations not involving a subtrench, dragging a trench box should only be done if it does not damage the pipe or joints, or disrupt the backfill; otherwise, the box should be lifted vertically into its new position. If it is necessary for a trench box to be dragged through a trench, do not lower the box below the top of the initial backfill. This allows the backfill material to flow out of the bottom of the box around the pipe so that backfill disturbance is kept to a minimum.

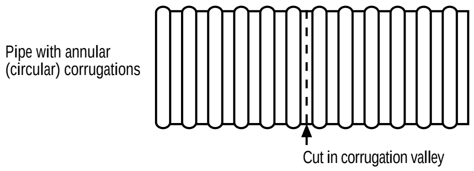
Another alternative for instances when dragging the box is necessary is to use a well-graded granular backfill material two diameters on either side of the pipe and compact it to a minimum of 90% standard Proctor density before moving the box. Immediately fill the area between the pipe/backfill structure and the trench wall with a granular material. This technique is less desirable than other options because of higher excavation and backfill costs.

If the project requires a geotextile around the backfill, use a well-graded granular backfill material and compact it to at least 90% standard Proctor density. Lift the box vertically, and then immediately fill the area between the pipe/backfill structure and the trench wall with a granular material and compact according to project requirements. The geotextile manufacturer may be able to provide additional information regarding the suitability of specific geotextiles for use with particular backfill materials or trench boxes.

Field Cutting Pipe

Pipe lengths will usually need to be modified in the field to meet site requirements. Polyethylene pipe is easy to cut with a hand saw, reciprocating saw, or similar tool. For pipe that will be connected to a manhole or catch basin, the cut should be made in the corrugation valley, as shown in Figure 10.

Figure 10: Field Cutting Pipe for Manhole and Catch Basin Connections



A variety of joint qualities and configurations are available so, if pipe is cut with the intent of joining it with another length of pipe, instructions should be obtained from the individual pipe manufacturer. This will ensure optimal joint performance.

Taps, or connections coming into the pipe perpendicular to its axis, may also be needed to connect a downspout or similar small diameter pipe to the storm sewer. For systems not required to be watertight, options include using a fitting designed for such an application. Watertight systems may require additional fittings or adapters. Not all pipe sizes or types can be connected in this manner. In order to maintain the integrity of the main sewer line, the manufacturer should always be contacted for suggestions on these types of connections.

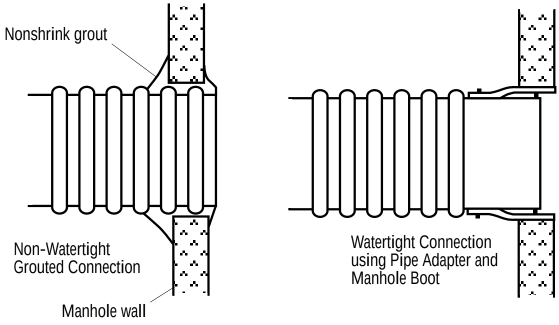
Connections to Manholes and Catch Basins

Manholes and catch basins provide points for changes in pipe grade, direction, and size; allow storm runoff to enter; and provide for system access.

The method used to join the pipe and the structure depends on the project needs, type of pipe, and the style of the structure. The most common practice for corrugated polyethylene and other pipe is to grout the pipe into the concrete manhole or basin opening. The grout mixture should be pressed between the corrugated pipe and the manhole opening. This type of connection is soil tight, as a minimum, and is acceptable for the majority of storm sewers. Because of the corrugated exterior, this connection also creates a waterstop effect. Flexible watertight connections, or manhole "boots" as they are sometimes called, are also available for projects requiring a tight system. These connections work best on pipe with a smooth outside diameter and so may require the use of pipe adapters. Figure 11 provides additional detail on manhole and catch basin connections.

Figure 11: Manhole and Catch Basin Details

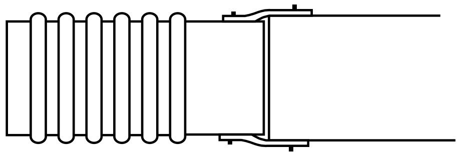
(Pipe Joint Close to Manhole)



Connecting Corrugated Polyethylene Pipe to Other Pipe Materials

It is not unusual for corrugated polyethylene pipe to be connected to other types of pipe materials. Available options depend on the joint quality required throughout the system and the particular combination of pipe materials. In most storm sewer applications, the pipe can be joined by butting the pipe ends together, wrapping them with a geotextile, and pouring a concrete collar around them. Although such a connection is dependent on contractor expertise, it will generally limit soil intrusion but not provide a watertight joint. Watertight connections between different materials will require additional fittings and adapters. If those options are not acceptable, a manhole can be used to make the transition. One example of a watertight connection commonly used is shown in Figure 12.

Figure 12: Watertight Connections Between Different Pipe Materials



Pipe manufacturers are a valuable resource during the project planning stage since they are familiar with adapters that work well with their own products.

Curved Alignments

The capability to install pipe in a slightly curved line may allow the drainage system to follow bends along roads or avoid interfering with existing utility lines without the use of fittings.

Polyethylene pipe that has a corrugated exterior and interior is flexible enough to accommodate many curved installations. Smaller diameters can be curved into a tighter radius than larger diameters. The coupling band or other connector usually allows for additional curvature.

Corrugated polyethylene pipe with a smooth interior has a significant amount of longitudinal rigidity and is not suitable for bending. Manufacturers recommend that any curvature be obtained only at the joint. Depending on the type of jointing system, up to a few degrees of angular misalignment can be obtained yet still maintain the integrity of the pipe joint. If the amount of misalignment is not sufficient for the application, the pipe can be cut into shorter sections and rejoined, or a fitting can be used. Pipe manufacturers can provide information on the amount of angular misalignment different jointing systems allow. Table 2 can then be referred to for the bending radius based on allowable joint misalignment and pipe length.

Table 2
Bending Radius

Angular Joint Misalignment	Bending Radius, ft (m)			
	20 ft (6 m) Pipe Length	13 ft (4 m) Pipe Length	10 ft (3 m) Pipe Length	5 ft (1.5 m) Pipe Length
1°	1146	745	573	286
2°	573	364	286	143
3°	382	248	191	96
4°	287	186	143	72
5°	229	149	115	57

Pipe installation, like any other engineered system, can benefit from frequent inspections to ensure that the pipe is installed according to specification. If a flexible pipe has been improperly installed, it can often be detected just from a simple visual inspection made soon after installation. The problem can be fixed at that time, before it is put into service.

Closed circuit television (CCTV) can be used to inspect pipe that cannot be visually checked because of their small diameter or safety hazards. This procedure is very common in the sanitary sewer market. The backfill integrity can be evaluated by reviewing the geometry of the pipe interior as the camera travels through. Immediate, detailed information on pipe and joint alignments is also provided. There are companies throughout the country that specialize in this inspection method.

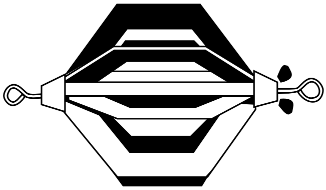
Other tests may also be required either in lieu of, or in addition to, visual inspections or CCTV. The method selected of inspection should be a function of the type of application. Testing options are discussed in more detail in the following paragraphs.

Deflection Testing

The CPPA technical booklet *Structural Design Method for Corrugated Polyethylene Pipe* limits deflection to 7.5% of the base diameter. A visual inspection or possibly a CCTV inspection is generally all that is required to confirm the installation quality.

Where the quality of the installation is in doubt, the engineer may require deflection tests. A mandrel, similar to that shown in Figure 13 (following page), is pulled from manhole to manhole. As long as the deflection does not exceed the mandrel dimensions it will go through the pipe. For this reason, mandrels are sometimes referred to as go/no go devices.

Figure 13: Example of a Mandrel Used in Deflection Testing



Information obtained from mandrel tests can easily be misinterpreted, and so a great deal of caution should be used in interpreting the findings. Mandrels may not be able to pass through pipe for a variety of reasons unrelated to deflection. For example, mandrels may not be able to pass through pipe that has been inadequately cleaned before testing. Or they may be unable to distinguish deflection from fittings that may protrude slightly into the pipe, minor joint misalignment, or grade changes.

Deflection tests are most often made on small diameter pipe that can be difficult to visually inspect after installation. It is extremely cumbersome to test pipe larger than 24" (600 mm). The mandrel must often be disassembled in order to get it into the manhole and then must be reassembled before testing. Visual inspections or CCTV provide adequate detail with much less time and effort.

If deflection testing is required, the procedure can be conducted within the first 30 days after installation. Recommended mandrel settings reflecting 7.5% of the base diameter for pipe are shown in Table 3.

Table 3
Recommended Mandrel Settings for Corrugated Polyethylene Pipe

	Pipe Meeting ASTM and AASHTO Standards		Pipe Meeting CSA Standards	
Nominal Diameter in. (mm)	**Base Diameter* in. (mm)**	**Mandrel Setting in. (mm)**	**Base Diameter (mm)**	**Mandrel Setting (mm)**
4 (100)	3.87 (98.3)	3.58 (90.9)	(96.92)	(89.7)
6 (150)	5.80 (147.3)	5.36 (136.1)	(145.42)	(134.5)
8 (200)	7.73 (196.3)	7.15 (181.6)	(193.84)	(179.3)
10 (250)	9.66 (245.4)	8.94 (227.1)	(242.34)	(224.2)
12 (300)	11.60 (294.6)	10.73 (272.5)	(290.83)	(269.0)
15 (375)	14.50 (368.3)	13.41 (340.6)	(363.65)	(336.4)
18 (450)	17.40 (442.0)	16.09 (408.7)	(436.18)	(403.5)
21 (525)	20.30 (515.6)	18.78 (477.0)	(508.86)	(470.7)
24 (600)	23.20 (589.3)	21.46 (545.1)	(581.67)	(538.0)

*Base Inside Diameter = Nominal Diameter - [(Inside Diameter Tolerance)^2 + (Out of Roundness Tolerance)^2]^$^{1/2}$

If the visual inspection or the deflection test indicates excess deflection, it is important to determine the exact situation before making any repair. Video cameras can provide a better view and help to determine what kind of repair, if any, is required.

Isolated areas of severe deflection may be the result of construction loads being on the pipe before adequate cover has been placed. These areas may be able to be re-rounded with special equipment without any excavation. Long lengths of pipe with high deflection levels may be indicative of overall installation deficiencies. Depending on the severity, the material around the pipe may have to excavated and replaced with recommended backfill. Provided the pipe has not deflected to the point of reverse curvature, it can be allowed to be returned to its round shape and reused. Individual manufacturers can provide additional assistance.

Pressure Testing

Even though a system is designed to operate in nonpressure conditions, the pipe joints may need to be watertight. Sanitary sewers, and some storm sewers in environmentally sensitive areas are examples of these applications. To validate the installed performance of the systems, they are sometimes pressure tested after installation. Air or water can be used, although air is the most common because of safety considerations. Test requirements may vary from region to region, but most require the pipe to be pressurized to at least 3.5 psi (24.1 kPa) and held for a period of time based on the length and diameter of pipe. A small drop in pressure is usually permitted. More detailed information can be found in ASTM F1417, CSA B182.11, or other locally recognized test methods.

Summary

Corrugated polyethylene pipe requires a reasonable amount of care in jobsite storage and handling. Where pipe cannot be handled easily and safely with labor alone, equipment can be used to lift the pipe with a padded strap.

Backfill material should be placed and compacted around the pipe in such a way that it does not disrupt the pipe alignment. It should be placed in layers, or lifts, uniformly on either side of the pipe and compacted as necessary. Structural backfill material should extend at least 6" (0.15 m) over the pipe crown. Total minimum cover in trafficked installation should not be less than 1' (0.3 m). If mechanical compaction equipment is used, care should be taken to avoid using it directly on the pipe.

Trench boxes improve worker safety, but can cause problems for the pipe when used incorrectly. For optimum performance, the box should be pulled along a subtrench. If this is not possible, alternative methods are presented in the text.

The pipe can be modified in the field rather easily with ordinary tools. If the length needs to be shortened for connection to a manhole or similar structure, the pipe is normally cut in the valley of the corrugation. If the pipe needs to be cut for purposes of rejoining, the manufacturer should be contacted for more specific recommendations to ensure optimum performance of the finished joint.

Inspection helps ensure that the pipe is installed according to project requirements. Projects designed and installed according to the CPPA technical booklet *Structural Design Method for Corrugated Polyethylene Pipe* will remain within acceptable performance limits. The installation integrity can usually be verified with a visual inspection, or CCTV in inaccessible situations. Deflection tests using mandrels are an alternative way to check deflection although they may produce misleading information. Watertight nonpressure systems may require pressure testing according to recognized procedures after installation to verify performance.

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