ULTRA CORR™/ ULTRA RIB™

MEETS ASTM F794 AND ASTM F949

INSTALLATION GUIDE

JM Eagle™

Building essentials for a better tomorrow™

ULRA CORR™/ULTRA RIB™

CONTENTS

THE PHYSICAL (OR CHEMICAL) PROPERTIES OF JM EAGLE™ PVC ULTRA CORR™, ULTRA RIB™ SEWER AND STORM DRAIN PIPE PRESENTED IN THIS BOOKLET, REPRESENT TYPICAL AVERAGE VALUES OBTAINED IN ACCORDANCE WITH ACCEPTED TEST METHODS AND ARE SUBJECT TO NORMAL MANUFACTURING VARIATIONS. THEY ARE SUPPLIED AS A TECHNICAL SERVICE AND ARE SUBJECT TO CHANGE WITHOUT NOTICE. CHECK WITH JM EAGLE™ PRODUCT ASSURANCE TO ENSURE CURRENT INFORMATION.

HOW THIS GUIDE CAN HELP YOU

This booklet was written especially for the installer and those who direct the actual handling and installation of JM Eagle™ PVC Ultra Corr™, Ultra Rib™ Sewer and Storm Drain Pipe. This guide should be used in conjunction with the following industry accepted installation and testing practices which are applicable. This document should not be considered a full guide or manual in lieu of:

1. ASTM D2774-04 (or later) “Underground Installation of Thermoplastic Pressure Piping.”
2. ASTM F690-86 (2003) (or later) “Underground Installation of Thermoplastic Pressure Piping Irrigation Systems.”
3. ASTM F1668-96 (2002) (or later) “Construction of Buried Plastic Pipe.”
4. ASTM F645-04 (or later) “Selection, Design, and Installation of Thermoplastic Water-Pressure Piping Systems.”
5. ASTM D2321-05 (or later) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.”
6. ASTM F1417-92 (2005) (or later) “Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.”
7. AWWA M23 “PVC Pipe – Design and Installation.”
8. Uni-Bell® PUB-09 “Installation Guide for PVC Pressure Pipe.”

9. Uni-Bell® UNI-B-6 "Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe."

10. Uni-Bell® UNI-PUB-06 "Installation Guide for PVC Solid-Wall Sewer Pipe (4-15 inch)."

11. Uni-Bell® UNI-TR-1 "Deflection: The Pipe/Soil Mechanism."

12. Uni-Bell® UNI-TR-6 "PVC Force Main Design."

13. Uni-Bell® UNI-TR-7 "Thermoplastic Pressure Pipe Design and Selection."

This guide is meant as an explanatory supplement to the materials above on how to install JM Eagle™ PVC Ultra Corr™, Ultra Rib™ Sewer and Storm Drain pipe under normal conditions so as to comply with JM Eagle™ Installation Guide. Any discrepancies between the above standards and the written information contained herein should be brought to the attention of JM Eagle™ Product Assurance immediately for resolution by JM Eagle™ prior to any actions by either contractor, engineer, or municipality.

This guide is not intended to supply design information nor to assume the responsibility of the engineer (or other customer representative) in establishing procedures best suited to individual job conditions so as to attain satisfactory performance.

Engineers, superintendents, contractors, foremen, and laying crews will find much to guide them in the following specifications. This booklet will also be of help in determining pipe needs when ordering.

WARRANTY

JM Eagle™ warrants that its standard polyvinyl chloride (PVC), polyethylene (PE), conduit/plumbing/solvent weld and Acrylonitrile-Butadiene-Styrene (ABS) pipe products ("Products") are manufactured in accordance with applicable industry specifications referenced on the Product and are free from defects in workmanship and materials. Every claim under this warranty shall be void unless in writing and received by JM Eagle™ within 30 days of the date the defect was discovered, and within one year of the date of shipment from the JM Eagle™ plant. Claims for Product appearance defects, such as sun-bleached pipe, etc., however, must be made within 30 days of the date of the shipment from the JM Eagle™ plant. This warranty specifically excludes any Products allowed to become sun-bleached after shipment from the JM Eagle™ plant. Proof of purchase with the date thereof must be presented to the satisfaction of JM Eagle™, with any claim made pursuant to this warranty. JM Eagle™ must first be given an opportunity to inspect the alleged defective Products in order to determine if it meets applicable industry standards, if the handling and installation have been satisfactorily performed in accordance with JM Eagle™ recommended practices and if operating conditions are within standards. Written permission and/or a Return Goods Authorization (RGA) must be obtained along with instructions for return shipment to JM Eagle™ of any Products claimed to be defective.

The limited and exclusive remedy for breach of this Limited Warranty shall be, at JM Eagle's sole discretion, the replacement of the same type, size and like quantity of non-defective Product, or credits, offsets or combination of thereof, for the wholesale purchase price of the defective unit.

This Limited Warranty does not apply for any Product failures caused by user's flawed designs or specifications, unsatisfactory applications, improper installations, use in conjunction with incompatible materials, contact with aggressive chemical agents, freezing or overheating of liquids in the Product, and any other misuse causes not listed here. This Limited Warranty also excludes failure or damage caused by fire stopping materials, tread sealants, plasticized vinyl products or damage caused by the fault or negligence of anyone other than JM Eagle™, or any other act or event beyond the control of JM Eagle™.

JM Eagle's liability shall not, at any time, exceed the actual wholesale purchase price of the Product. The warranties in this document are the only warranties applicable to the Product and there are no other warranties, expressed or implied. This Limited Warranty specifically excludes any liability for general damages, consequential or incidental damages, including without limitation, costs incurred from removal, reinstallation, or other expenses resulting from any defect. IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE SPECIFICALLY DISCLAIMED AND JM EAGLE™ SHALL NOT BE LIABLE IN THIS RESPECT NOTWITHSTANDING JM EAGLE'S ACTUAL KNOWLEDGE THE PRODUCT'S INTENDED USE.

JM Eagle's Products should be used in accordance with standards set forth by local plumbing and building laws, codes or regulations and the applicable standards. Failure to adhere to these standards shall void this Limited Warranty. Products sold by JM Eagle™ that are manufactured by others are warranted only to the extent and limits of the warranty of the manufacturer. No statement, conduct or description by JM Eagle™ or its representative, in addition to or beyond this Limited Warranty, shall constitute a warranty. This Limited Warranty may only be modified in writing signed by an officer of JM Eagle™.

1.0 RECEIVING AND HANDLING PIPE SHIPMENTS

Figure 1

1.1 INSPECTION

Each pipe shipment shall be inspected with care upon arrival. Each pipe shipment is carefully loaded at the factory using methods acceptable to the carrier. The carrier is then responsible for delivering the pipe as received from JM Eagle™. All shipments include an adequate amount of lubricant for the pipe and a short form installation guide. IT IS THE RESPONSIBILTY OF THE RECEIVER TO MAKE CERTAIN THERE HAS BEEN NO LOSS OR DAMAGE (including smoke) UPON ARRIVAL.

Check the materials, pipe, gaskets, and fittings received against the bill of lading (tally sheet that accompanies every shipment) in accordance with the general guidelines below, reporting any error or damage to the transportation company representative and have proper notation made on the delivery receipt and signed by the driver. Present the claim in accordance with the carrier's instructions. Do not dispose of any damaged material. The carrier will advise you of the procedure to follow in order to procure samples and report the incident.

1. MAKE OVERALL EXAMINATION OF THE LOAD. If the load is intact, ordinary inspection while unloading should be enough to make sure pipe has arrived in good condition.

2. IF LOAD HAS SHIFTED OR SHOWS ROUGH TREATMENT, THEN EACH PIECE MUST BE CAREFULLY INSPECTED FOR DAMAGE.

3. CHECK THE TOTAL QUANTITIES OF EACH ITEM AGAINST THE TALLY SHEET (pipe, fittings, lubricant, etc.)

4. ANY DAMAGED OR MISSING ITEMS MUST BE NOTED ON THE DELIVERY RECEIPT AND RETURNED TO THE TRANSPORTATION COMPANY.

5. NOTIFY CARRIER IMMEDIATELY AND MAKE CLAIM IN ACCORDANCE WITH THEIR INSTRUCTIONS.

6. DO NOT DISPOSE OF ANY DAMAGED MATERIAL. Carrier will notify you of the procedure to follow.

7. SHORTAGES AND DAMAGED MATERIALS ARE NOT AUTOMATICALLY RESHIPPED. If replacement material is needed, reorder through your distributor and make them aware of the claim.

NOTICE: Inspect the vertical ribs of the pipe during unloading and handling for damage that may occur due to over tightening of the tie-downs. A maximum of eight adjacent ribs can be missing without affecting performance. Ensure that the wall beneath the broken ribs is not cracked. Table 1 lists the maximum circumferential length of missing ribs by size that should not be exceeded.

PIPE SIZE (inches)	**MAX LENGTH** (inches)	**PIPE SIZE** (inches)	**MAX LENGTH** (inches)
18	15	27	10
21	14	30	10
24	12	36	10

Table 1

1.2 UNLOADING

Figure 2

JM Eagle™ PVC Ultra Corr™, Ultra Rib™ Sewer and Storm Drain pipe is lightweight and may be unloaded by **1)** Hand, either by passing over the side or off the truck ends. Sliding one length on another is standard practice in unloading PVC pipe, but may damage ribs of the pipe. All lengths in the load should be lifted off of the rough surface of the pipe and truck body to avoid abrasion. **2)** Compact shipping units (palletized bundles in a wood frame) are used to ship large orders of pipe. Conventional forklifts can unload these units quickly and easily. Care shall be exercised to avoid impact or contact between the forks and the pipe. The means by which JM Eagle™ PVC Ultra Corr™, Ultra Rib™ Sewer and Storm Drain pipe are unloaded in the field is the decision and responsibility of the customer. Preferred unloading is in units using mechanical equipment such as forklifts, cranes, cherry pickers or front-end loaders with adequate forks and trained, competent operators and equipment rated to safely handle the load. When unloading units, the following instructions should be carefully followed. Remove only one unit at a time.

1. Remove restraints from the top unit loads. These may be either tie down straps, ropes or chains with protection.

2. If there are boards across the top and down the sides of the load, which are not part of pipe packaging, remove them.

3. Use a forklift (or front-end loader equipped with forks) to remove each top unit one at a time from the truck. Remove back units first. Do not run the forks too far under the unit as fork ends striking adjacent units may cause damage, or push other unit off opposite side of truck. Do not let forks rub the underside of pipe to avoid abrasion.

4. If a forklift is not available, a crane or front end loader may be used to unload the pipe. We recommend employing a spreader bar with synthetic straps rated for the load. The straps should be placed approximately eight feet apart and looped under the load. Cables may be used in place of synthetic straps if they are protected by a rubber hose sleeve to prevent damage to the pipe.

5. DO NOT:
   a) Handle units with chains or single cables.
   b) Attach cables to unit frames for lifting.

6. During the removal and handling, be sure that the units do not strike anything. Severe impact could damage the pipe (particularly during cold weather).

7. Units should be stored and placed on level ground. Units should be protected by dunnage in the same way they were protected while loaded on the truck. The dunnage must support the weight of all units so that pipe lengths do not carry the weight of the unit loaded above them. Units should not be stacked more than two high.

8. To unload lower units, repeat the above unloading process (items 1 through 7).

WARNING: PVC pipe, though lighter than other material, is still heavy and may be dangerous if not handled properly. Not adhering to the above instructions may result in serious injury to pipe, property, and/or persons. Do not stand or climb on units. Stand clear of pipe during unloading.

NOTICE: PVC pipe, though lighter than other material, is still heavy and may be dangerous if not handled properly. Not adhering to the above instructions may result in serious injury to pipe, property, and/or persons. Do not stand or climb on units. Stand clear of pipe during unloading.

1.3 COLD WEATHER HANDLING

As the temperature approaches and drops below freezing, the flexibility and impact resistance of PVC pipe is reduced. Extra care should be used in handling during cold weather to avoid any type of impact to the pipe to prevent damage.

1.4 STOCKPILES

Store pipe on a flat surface so as to support the barrel evenly, with bell ends overhanging. If mechanical equipment is being used for handling, the unit bearing pieces provide an excellent base. If unloading by hand, secure two timbers for a base. Set them on a flat area spaced the same as a factory load. Nail chock blocks at each end. Build up the stockpile in the same manner, as it was stacked for shipment, transferring dunnage and chock blocks from load to stockpile. Store random lengths separately where they will be readily available. Individual lengths of pipe should be stacked in piles no higher than 5 feet.

It should be noted that when PVC pipe is stored outside and exposed to prolonged periods of sunlight, an obvious discoloration or UV degradation of pipe could occur. Based on the 24-month weathering study, the performance of PVC pipe was equally impressive. No significant changes in tensile strength at yield was observed. Reductions in impact strength were apparent after two years of exposure to weathering and ultra violet radiation. However, considering PVC pipe's high initial impact strength, the reductions were not significant enough to warrant concern. This UV degradation does not continue after the pipe is removed from UV exposure.

A method of protecting pipe during long exposures (several months) to sunlight is to cover it with canvas or other opaque material. Clear plastic sheets are not satisfactory. Allow for adequate air circulation between the cover and the pipe. This will prevent heat build-up and possible dimensional distortion.

1.5 GASKET CARE

All JM Eagle™ PVC pipe is manufactured with factory installed gaskets. Keep them clean, away from oil, grease, excessive heat and electric motors, which produce ozone. It is advisable to keep gaskets protected from direct sunlight and temperature changes to avoid cracking in prolonged exposure for optimal performance. JM Eagle™ provides a gasket that is approved for sewer service with its standard product. Special gasket types may be available for applications where oil resistance is required. Be sure the correct ring is ordered. See Section 3.4 for further information.

1.6 LOADING TRANSFER TRUCKS

Use trucks with long bodies so that pipe lengths do not over hang more than 2 feet. Make certain truck bed is smooth, without cross-strips, bolt heads, or other protrusions that could damage the pipe.

Place the first layer carefully with the bell ends overhanging. Avoid sliding the pipe and damaging it. All bell ends should overhang the layer below.

Short body trucks may be used if fitted with racks that properly support the pipe in the horizontal position. The rack shall support the pipe with supports spaced every 3 feet or less along the pipe lengths. Pad the contact areas to avoid damage to the pipe.

1.7 DISTRIBUTING ALONG THE TRENCH

In stringing out pipe, keep these points in mind:

1. Line pipe as near to the trench as possible to avoid excessive handling. (Bell direction doesn't affect flow or hydraulic coefficients.)
2. If the trench is open, it is advisable to string pipe on the side away from excavated earth wherever possible, so that the pipe can be moved easily to the edge of the trench for lowering into position.

3. If the trench is not yet open, find out which side the excavated earth will be thrown, then string out on the opposite side (leave room for the excavator).

4. Place the pipe so as to protect it from traffic and heavy equipment. Also, safeguard it from the effect of any blasting that may be done.

5. Direct sunlight may cause the exposed side of the pipe to heat up creating a bow in the pipe. Should this occur, the bow may be alleviated by rotating the cool side toward the sun or by placing the pipe in the shade. Leaving pipe in units minimizes bowing due to heat from the sun.

6. It is normal practice to string pipe with bell ends pointing upgrade.

2.0 TRENCH CONSTRUCTION

2.1 WORKING AHEAD OF THE PIPE LAYING CREW

Where soil and ground water conditions permit, long stretches of trench can be opened ahead of pipe laying, so as to take full advantage of the easy handling and speed of assembly of JM Eagle™ PVC Ultra Corr™, Ultra Rib™ Sewer and Storm Drain Pipe with elastomeric joints. However, as a general rule for most jobs, do not open the trench too far ahead of pipe laying. Avoiding these long stretches of opened trench may help with the economy of the project because:

1. It may reduce or even eliminate pumping or sheeting.
2. It minimizes the possibility of flooding the trench.
3. It reduces caving caused by ground water.
4. It helps avoid frozen trench bottom and backfill.
5. It reduces hazards to traffic and workmen.

On most jobs it will be desirable to keep excavating, pipe laying and backfilling close together.

2.2 CURVES IN THE TRENCH

The trench may be curved to change direction or avoid obstructions within the limits of the curvature of the pipe as described below. Since the moment of inertia of Ultra Corr™, Ultra Rib™ pipe is high, attempting to curve the pipe is extremely difficult. If the pipe barrel cannot be curved, the joints may be deflected to a maximum of 1½ degrees (or approximately an 4-inch offset maximum). Offset is based on a 14-foot length of pipe. To accomplish this, the pipe should be assembled in straight alignment and then, with the joint braced, the free end moved laterally using a pry bar or other suitable means. Care should be taken not to exceed the maximum deflection allowed or damage the pipe with the machinery used. The line may be assembled above ground, in a straight line, and then curved when laid in the trench, if necessary. Abrupt changes in direction may be accomplished with fittings.

NOTICE: AVOID OVER-STRESSING THE BELL (over-inserting the joints, or exceeding the maximum deflection allowed) IN ORDER TO PREVENT POSSIBLE BREAKAGE AND/OR LEAKS.

2.3 TRENCH WIDTHS

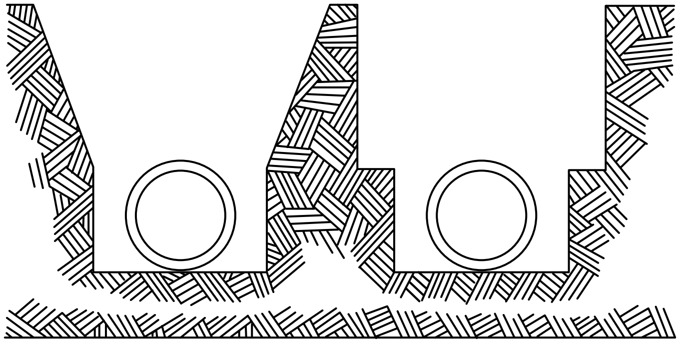


Figure 3

Since JM Eagle™ PVC Ultra Corr™, Ultra Rib™ Sewer and Storm Drain pipe can be assembled above ground and lowered into position, trench widths can be kept to a minimum. The trench width at the ground surface may vary with and depend upon depth, type of soils and position of surface structures. The minimum clear width of the trench, sheeted or unsheeted, measured at the spring-line of the pipe should be 1 foot greater than the outside diameter of the pipe. The maximum clear width of the trench at the top of the pipe should not exceed a width equal to the pipe outside diameter plus 2 feet. This spacing will allow for proper compacting of the backfill to provide necessary sidewall support. It will also allow assembly work in the trench, if desired. If the above defined trench widths must be exceeded or if the pipe is installed in a compacted embankment, pipe embedment should be compacted to a point of at least 2.5 pipe diameters from the pipe on both sides of the pipe or to the trench walls, whichever is less.

NOTICE: Since PVC is a flexible pipe, trench width and shape have little to no effect on loading experienced by the pipe, since the maximum load that may be carried by the pipe is that due to the column of soil directly above the pipe outside diameter. The reason for the trench width recommendations above are to help installers realize the economies that may result from installation of PVC pipe over other materials, while maintaining adequate control over backfilling, compaction, and placement to limit long-term deflection.

2.4 TRENCH DEPTHS

Depth is governed by surface loads, earth loads, and frost penetration govern depth. A minimum of 12 inches depth of cover is recommended where frost penetration need not be considered. Where frost is a factor, pipe should be buried 6 inches below the greatest recorded frost penetration. If the line will be drained and not used in winter, frost need not be considered.

Should unusual soil conditions and/or surface loads be anticipated and the engineer wants to calculate deflection when working with PVC pipes, “pipe stiffness” (f/Δy) for ASTM F 794/949 pipe is 46 psi, respectively. AASHTO M304 “pipe stiffness” numbers vary by size and the standard should be consulted for these values.

For more information on deflection, see Section 5.1.

2.5 PREPARATION OF TRENCH BOTTOM

The trench bottom should be smooth and free from stones greater than 1.5 inches in diameter, large dirt clods and any frozen material. Excavation at bells (bell holes) should be provided so that the pipe is uniformly supported along its length.

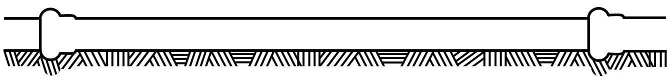


Figure 4

Generally, loose material left by the excavator on the trench bottom will be adequate for bedding the pipe barrel so that it is fully supported. Where the excavator cuts a very clean bottom, soft material can be shaved down from the sidewalls to provide needed bedding. If the trench bottom is rocky or hard, as in shale, place a 4-inch layer of selected backfill material to provide a cushion for the pipe. In rock excavation it is necessary that rock be removed and a bed of sand or selected backfill at least 4 inches deep be placed on the bottom of the trench to provide a cushion for the pipe. A pipeline of any material, which in the absence of a bedding cushion, resting directly on rock is subject to breakage under the weight of the backfill load, surface load, or earth movements.

When an unstable trench bottom is encountered and, in the opinion of the engineer, it cannot support the pipe, an additional depth should be excavated and refilled to the pipe grade with material approved by the engineer.

Trenches can be dangerous and the contractor has the responsibility of ensuring that all safety regulations and design requirements have been observed for the protection of the workers and the public.

2.6 INSTALLATION OF ULTRA RIB™ & ULTRA CORR™ PIPE THROUGH CASINGS

Casing Applications: Most casing installations are made where pipe line must pass under airport runway, highways, railroad tracks and other locations where conditions prevent the use of "open cut" excavation. Where the situations are encountered, the engineer will specify boring or tunneling. With this type of excavation, it is generally preferable to insert a casing, usually of steel piping, through the obstruction by one of several methods.

2.6.1 PLACEMENT OF CASINGS

The placement of casings requires special equipment and skills. It is a specialized field of construction, to which some construction firms devote their entire efforts.

In the smaller diameters, the steel casing is usually placed progressively, following the boring equipment as it tunnels through the obstruction. The recommended practice is to use plain steel pipe (not corrugated) for the casing to facilitate movement of the PVC pipe through the casing with a minimum of resistance. For larger diameters, most casing construction is done by jacking the pipe from excavated pits. Where long casings are involved, numerous pits for jacking operations are required along the route.

Regardless of the diameter, accuracy in alignment and grade of the casing pipe is very important in maintaining the established inverts. Proper grade of the inserted pipe is a must for satisfactory operation of a gravity flow line.

2.6.2 MINIMUM CASING SIZES REQUIRED WITH ULTRA RIB™ AND ULTRA CORR™ PIPE

PVC Gravity Sewer Pipe: The following tables give the recommended size of casing required with various sizes of Ultra Rib™ and Ultra Corr™ sewer pipe.

ULTRA RIB™ CASING SIZE			
PIPE SIZE		MINIMUM CASING SIZE	
INCHES	MM	INCHES	MM
8	200	12	400
10	250	16	450
12	300	18	500
15	375	20	600
18	450	24	650
21	525	30	750
24	600	30	850

Table 2

ULTRA CORR™ CASING SIZE			
PIPE SIZE		MINIMUM CASING SIZE	
INCHES	MM	INCHES	MM
24	600	30	889
27	675	36	975
30	750	42	1092
36	900	48	1270

Table 3

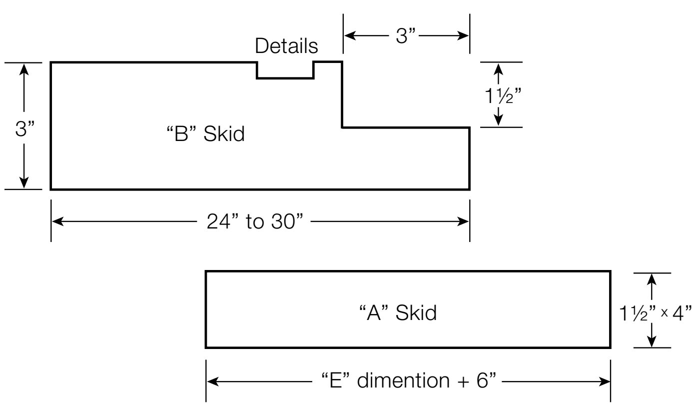


Figure 5

2.6.3 PLACING PIPE THROUGH CASINGS

The placing of PVC pipe through a steel casing entails several important considerations, often overlooked but necessary for a long-term, trouble-free installation. These are:

1. Ultra Rib™ and Ultra Corr™ PVC pipe inserted through a casing, should not rest on the bells. Therefore, the pipe lengths must be raised a sufficient distance to position the bells above the interior wall surface of the casing. Skids may be employed to properly raise, support and position the pipe lengths in the casing. Commercially available casing spacers may be employed as well.
2. The inserted pipeline should be circumferentially braced in the casing to prevent movement in any direction. For partially filled gravity lines, movement of the inserted pipe can be caused by flotation from flooding of the annular space between the casing and inserted pipe. Sealing the annular spaces at each end of the casing helps prevent flooding and the resulting flotation movement of the inserted pipeline.

2.6.4 SKIDS

Skids used on Ultra Rib™ or Ultra Corr™ PVC sewer pipe are inserted in a casing for three reasons:

1. To make the pull or push easier.
2. To prevent the pipe and bells from snagging on the inside of the casing during installation
3. To keep the installed pipeline from resting on the bells.
4. To keep pipe from over belling.

Skids should extend the full length of the pipe except the bells and spigot areas. They should also be high enough to allow for clearance between the bell and the casing bottom. Minimum skid size is 2 inches by 4 inches. On the spigot end of Ultra Rib™ the skid size should end at the pipe assembly stop mark. This will help prevent overbelling during the pushing or pulling operation.

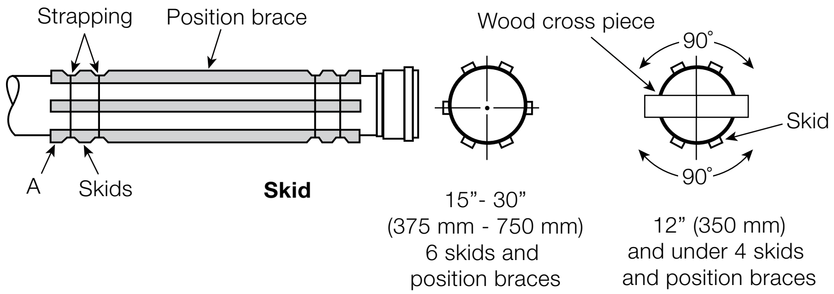


Figure 6

The leading or forward ends of the skids should be rounded as shown in “A” above. Notch the skids as shown for the strapping or wire to control the strapping operation and to prevent undue movement of the straps. Fasten skids securely to the pipe with durable strapping. The spacing arrangement of the skids should be according to the diagram shown above.

Experience has shown that six skids and positioning braces are required on 15-inch to 36-inch Ultra Rib™ or Ultra Corr™, and four skids and positioning braces on 8-inch to 12-inch Ultra Rib™, to properly support the pipe and to prevent its lateral movement within the casing. The proper casing size is also important. See “Table of Casing Sizes” in Table 2 and 3 Skids and positioning braces should be identical in size since their service function is often interchangeable. However, adequate size is required to offset the difference between the bell O.D. and the spigot O.D. For 27-inch a true 2 inches and 4 inches will be required as a minimum. When pipe is pulled into a casing with a cable, the pipe may rotate, causing the skids and positioning braces to rotate from their entry position. Consequently, if the proper number, size and circumferential spacing of skids and braces are not employed, the bells cannot be kept from contacting the casing surfaces—and particularly the bottom of the casing.

2.6.5 CASING SPACERS

Commercially available casing spacers may be substituted for skids. Like skids, they should be positioned to support and restrain Ultra Rib™ or Ultra Corr™ in the casing to prevent the pipe from resting on the bells or floating.

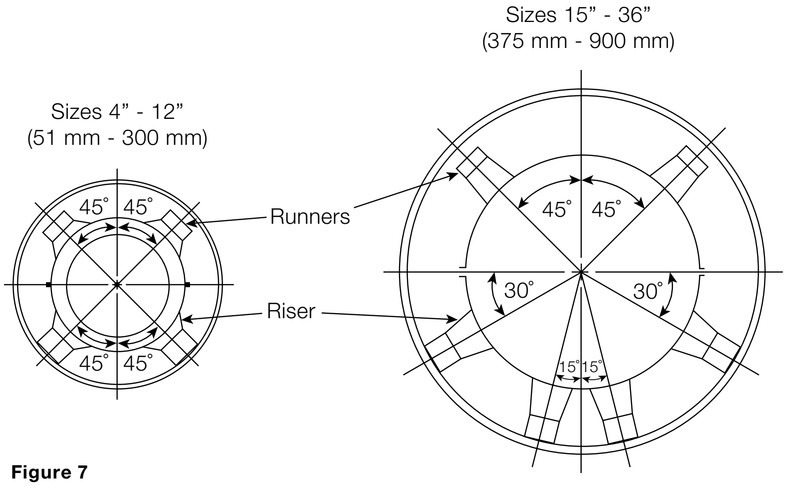


Figure 7

2.6.6 TYPICAL CASING SPACER INSTALLATION

A minimum of two spacers per 14-foot length of Ultra Rib™ or Ultra Corr™ are required. There should be spaces on either side of the bell such that the maximum clear span between spacers does not exceed 7 feet. This recommendation is based on a maximum operating temperature of 73 degrees F (23 degrees C). If higher temperatures are anticipated, more spacers per joint may be required.

Lubrication reduces friction, makes pulling and pushing operation easier.

The application of a lubricant to the inside surface of the casing and/or the skids will make the sliding easier. The casing and/or skids can be lubricated with “Drilling Mud” or “Flaxsoap.” Petroleum products, such as oil and grease, should not be used as lubricants since the prolonged exposure to these products is detrimental to the rubber rings used to seal the joints. To lubricate the casing, apply suitable lubricant at the end of the casing. Then attach rags to the cable and pull them through so that they act as swabs or spreaders. A rope attached to the cable will make it easy to retrieve the cable.

Pulling Pipe through Casing

To pull the pipe, a cable is passed through the casing and the first pipe length. The cable end is fastened to a suitable crosspiece at the bell of the pipe as shown in Figure 7 The cable is then pulled steadily (not jerked) by a truck winch, dozer or other method until about 2 feet of pipe is left projecting out of the casing. After the cable is passed through the next pipe, the two pipe sections are assembled and the pulling operation is repeated.

Angle Pull

CAUTION: If the cable is pulled at an angle, make sure that the leading pipe end is protected from damage.

Pushing Pipe through Casing

Ultra Rib™ or Ultra Corr™ pipe may also be pushed through the casing, using equipment which will exert a constant and uniform force against the pipe end. To accomplish this, the pushing equipment should be firmly anchored.

Closure at One End Required

After the pipeline is through the casing, it will be necessary to make a closure at one end to tie in to the pipeline already installed. Where the pulling method is employed to insert the pipe, a space is left between the pipe already installed and the pipe bell end protruding out of the casing. A pipe section meeting the length requirement of the space between the bell of the pipe in the casing and the spigot end of the pipe in the trench (or vise-versa), plus one repair coupling, is used to make the closure. Where the casing length is relatively short and the pushing method is used for placement of the pipe in the casing, the joing with the already-installed pipe can be easily accomplished by continuing the pushing operation, through the casing and into the prepared coupling of the installed pipe. When using this method of closure, the installed pipe should be laid to about 1 foot from the end of the casing. This way only a short section of the skids will have to be removed. In all cases, the skids and positioning braces around the pipe length should remain inside and near the end of the casing.

Backfilling Requirements

The need for backfilling the annular space in the casing under and around the pipe depends strictly on job specifications or local regulations applicable to the installation. Wooden skids in backfill should have a long life. The life of the skids will be further extended if they are treated before backfilling. If there is no backfill, it is important that the skids are treated with a wood preservative. Functionally, it is not necessary to backfill around the pipe inside the casing with sand or other material when the proper skid arrangement has been employed. However, if groundwater is anticipated, the pipe must be kept from floating off grade.

Closed Casing Ends

If the ends of the casing are to be closed, the line should be tested for leakage before closing the ends.

Method for Backfilling Casing When Required

Where backfilling the annular space under and around the encased pipe is required, three-fourths of the distance to the top of the casing should be filled with sand or other approved backfill material. This will assist in preventing movement of the encased pipe. Using a hose line, sand can be forced into the casing with water under pressure. Care must be taken to avoid forcing too much water into the casing because of the possibility of floating the pipe. Flotation could result in uneven support for the encased pipeline if the skid system fails to prevent movement in all directions.

Pressure Grouting – Alternate Method for Backfilling Casing

CAUTION: Pressure grouting when not strictly controlled can collapse PVC pipe. Pressure grouting is sometimes specified for filling in the annular space between the pipeline and the casing. If pressure grouting is to utilized, it will be necessary to arrange the skids/spacers and position braces on the pipe to accommodate a 2-inch grouting hose.

A suggested method for pressure grouting is:

1. Arrange the skids/spacers and position braces on the pipe as shown previously (Figure 7) They will accommodate the grouting house.
2. Secure the grouting hose to the leading end of the first pipe section before insertion begins.
3. Either push or pull the pipe into the casing, channeling the hose in place on the leading end of each succeeding section of pipe.
4. Cap or plug each end of the bore, leaving an air hole at the top of the low end and a hole at the top of the high end for the grouting hose to pass through.

Using a grout mixture in a ratio of four parts cement to one part sand, with sufficient water to yield a consistency of thick soup.

Start pumping very slowly. A sensitive pressure gauge should be mounted on the discharge outlet of the grouting machine. A pressure will develop equal to the pressure needed to deliver the grout through the hose. After this pressure is established, any increase in pressure by 2 or 3 psi will indicate a need to pull the grouting hose slightly until the pressure returns to the established average delivery pressure. It is essential that the pressure generated does not exceed 2 or 3 psi over the initial required delivery pressure. Continue this procedure until the bore is completely grouted.

APPROXIMATE BELL O.D OF ULTRA RIB™ PIPE			
PIPE SIZE		BELL O.D.	
INCHES	MM	INCHES	MM
8	200	9.76	247.90
10	250	12.22	310.39
12	300	14.60	370.84
15	375	17.50	444.50
18	450	21.40	543.56
21	525	25.50	647.70
24	600	28.50	723.90
27	675	32.50	825.50

Table 4

APPROXIMATE BELL OF ULTRA CORR™ PIPE	
PIPE SIZE	**APPROXIMATE BELL O.D.**
INCHES	**INCHES**
24	30.00
27	34.00
30	37.80
36	45.80

Table 5

3.0 PIPELINE CONSTRUCTION

3.1 INSPECTION

Pipe and fittings should be inspected for defects or damage prior to lowering into the trench. Any defective, damaged or unsound pipe should be repaired or replaced and all foreign matter or soil should be removed from the interior of the pipe and fittings, before lowering into the trench. If any ribs or corrugations are broken or missing from Ultra Rib™ or Ultra Corr™ pipe, See Section 1, "Receiving and Handling Pipe Shipments" for a determination of pipe serviceability.

3.2 LOWERING PIPE AND ACCESSORIES INTO TRENCH

All pipe, fittings, valves and accessories should be carefully lowered into the trench using suitable equipment in such a manner as to prevent damage to pipe and accessories. PIPE AND ACCESSORIES SHOULD NEVER BE DROPPED OR DUMPED INTO THE TRENCH.

DO NOT use chains or cables on Ultra Rib™ or Ultra Corr™ for lowering into the trench unless they are padded in some way to prevent damage to the pipe ribs. We recommend using nylon strap slings.

CAUTION: Heavy impact may cause a slight longitudinal indentation in the outside of the pipe or break ribs and create a crack on the inside. This will result in a split as soon as the pipe is placed under loading. Any pipe that has been impacted should be examined closely for this type of damage.

3.3 ASSEMBLY OF JM EAGLE™ PVC ULTRA CORR™, ULTRA RIB™ PIPE

3.3.1 ULTRA RIB™ PIPE

Make certain that both the bell and spigot are clean and have no foreign matter that could prevent an effective seal between the gasket and bell surfaces. Ultra Rib™ rings are shipped on the spigot to prevent loss of the ring. (See Figure 9.)

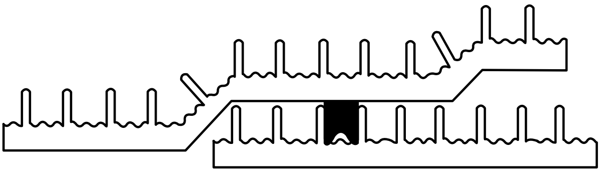


Figure 8

IMPORTANT: If for any reason the gasket must be placed on the pipe spigot in the field, the Ultra Rib™ ring should be placed between the second and third rib as shown in the Figure 9. Make sure the gasket is seated flatly in the groove so it is not twisted.

3.3.2 ULTRA CORR™ PIPE

Make sure that both bell and spigot are clean and have no foreign matter that could prevent an effective seal between the gasket and bell surfaces. Ultra Corr™ rings are shipped on the spigot to prevent loss of the ring.

IMPORTANT: If for any reason the gasket must be placed on the pipe spigot in the field, the Ultra Corr™ ring should be placed between the first and second corrugation as shown in the Figure 10. Make sure the gasket is seated in the groove so it is not twisted.

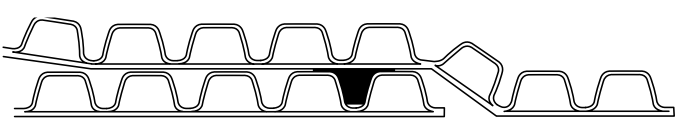


Figure 9

CAUTION: If a joint is overassembled causing the spigot to jam into the neck of the bell, flexibility of the joint is lost. Uneven settlement of the trench may cause this type of assembly to leak. Do not assemble beyond the stop mark.

Overassembly must also be avoided because it will cause the spigot to squeeze down in the neck of the bell creating a reduced internal diameter of the spigot end. If deflection testing is conducted, the pipe may appear over deflected.

1. Do not lubricate the gasket because foreign material such as stones and dirt may adhere to the lubricated surface and become lodged between the gasket and the bell sealing surface. This could cause a leak in the joint.
2. Lubricate the inside of the bell. Be sure to cover the full circumference. Lubricant coating should be as thick as a fresh coat of enamel paint.
3. Lubricant can be applied with a brush, cloth pad, sponge or gloved hand.
4. Insert the spigot end into the bell so that the rubber ring is in contact with the bell end. The pipe can be allowed to sit in this position while the puller or come-along is attached for final assembly. It can also be assembled while the pipe is suspended from a backhoe or other equipment.

CAUTION: While attempting assembly, be sure the pipe lengths are in straight alignment and not deflected vertically or horizontally. Improper alignment will cause a difficult or impossible assembly. If pipe must be deflected in line or grade, it can be done after assembly is completed. Such deflection should not exceed 1½ degrees at each joint. Also, note that deflection of an overassembled joint can cause leaks.

Small diameter Ultra Rib™ can be assembled by using the bar and block method. With the pipe properly supported, drive the steel bar into the trench bottom. Then place a wood stock at the end of the pipe and shove the pipe home. The wood block protects the pipe against damage by the bar. No matter which method of assembly is used, be sure to push the spigot into the bell until the factory-applied stop mark on the pipe barrel is flush with the end of the bell. If assembling a field cut spigot, it will be necessary to first locate a reference "stop" mark as shown below.

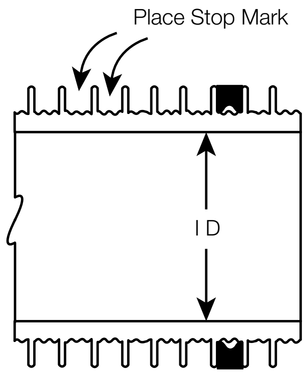


Figure 10

ULTRA RIB™ STOP MARK		
PIPE SIZE		STOP MARK RIB LOCATION
INCHES	MM	
8	200	After 5th Rib from end of Spigot
10	250	After 6th Rib from end of Spigot
12	300	After 6th Rib from end of Spigot
15	375	After 5th Rib from end of Spigot
18	450	After 6th Rib from end of Spigot
21	525	After 5th Rib from end of Spigot
24	600	After 7th Rib from end of Spigot
27	675	After 6th Rib from end of Spigot

Table 6

ULTRA CORR™ STOP MARK		
PIPE SIZE		STOP MARK LOCATION
INCHES	MM	
24	600	Middle of 5th Valley
27	675	Top of 4th Corrugation
30	750	Top of 4th Corrugation
36	900	Top of 4th Corrugation

Table 7

1. Mark the field cut section with a pencil, crayon, tape or marking pen.
2. Do not assemble pipe beyond the reference mark. By doing so, there may not be enough clearance in the bell for possible expansion of the pipe due to temperature changes.
3. If pipe is accidentally assembled beyond the stop mark, it should be pried out flush with this mark before the next pipe is installed.
4. Bear in mind that in cold weather, assembly by bar and block is more difficult since the lower temperature causes the rubber ring to become stiff. You may want to use one of the other methods of assembly when the temperature is low.
5. To assemble Ultra Rib™ or Ultra Corr™ use only the JM Eagle™ approved lubricant supplied, based on normal conditions. Extra lubricant needed for adverse conditions must be ordered separately. Lubricant is supplied for fittings based on the number of spigot ends involved.

Only lubricant approved by JM Eagle™ should be used in assembling Ultra Rib™ or Ultra Corr™ pipe.

3.3.3 LUBRICANT REQUIREMENTS

The following table gives the number of pipe joints that can be assembled using a one quart container of lubricant for Ultra Rib™ or Ultra Corr™ pipe.

PIPE SIZE		NUMBER OF JOINTS
INCHES	MM	
8	200	30
10	250	20
12	300	15
15	375	12
18	450	10
21	525	9
24	600	8
27	675	7
30	750	6
36	900	5

Table 8

3.4 FIELD CUTTING OF ULTRA RIB™ OR ULTRA CORR™

It is easier and safer to cut pipe to the exact length before it is placed in the trench. A hand saw, with "cross cut" teeth is recommended for cutting Ultra Rib™ or Ultra Corr™. Because of the unique design of Ultra Rib™ and Ultra Corr™, it is possible to get exact cuts between the ribs or corrugations. Simply measure the required length from the pipe end and cut at the mid-point between the ribs as shown below.

NOTE: If an abrasive saw is used to cut Ultra Rib™ or Ultra Corr™ pipe, safety goggles should be worn by the saw operator to protect eyes from pipe chips.

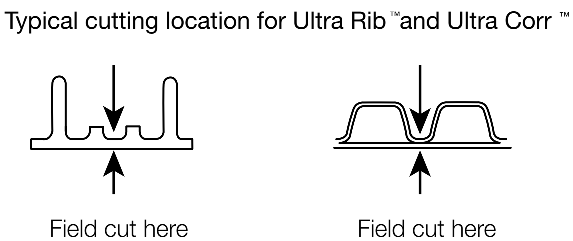


Figure 11

NOTE: It is vital to remove mold flashing from the area where new rings are to be installed on Ultra Rib™ pipe in order to assure a tight seal.

Figure 12

3.5 UNDERWATER PIPE ASSEMBLY

1. Normally, the spigot end of the pipe is inserted into the bell during assembly. The spigot should be thoroughly double lubricated above the water surface before assembly. After the initial lubrication, wait for a period of four to five minutes before the second lubrication. The pipe should be assembled immediately after the second lubrication.

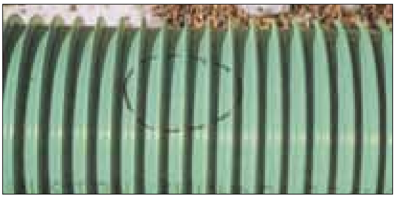
2. Cover on top of the pipe should be a minimum of three pipe diameters. Backfill material should be the same as described in Section 4.2, "Backfilling and Tamping." Care should be taken to ensure no dirt gets into the joint before or during assembly.

3.6 FIELD TAPPING

3.6.1 FIELD TAPPING FOR ULTRA RIB™

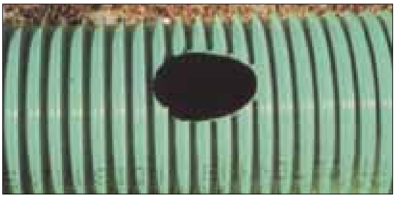
The standard smooth I.D. saddle is approved for use with Ultra Rib™ and Ultra Corr™ pipe. Equivalent saddles produced by others are acceptable. Although photos below show Ultra Rib™ pipe, similar gaskets are available for Ultra Corr™.

1. Typical equipment required to make a saddle tap Ultra Rib™.



2. Use the saddle gasket as a template to mark the location of the hole to be cut.

3. Hole can be cut using a hand saw or a sabre saw.

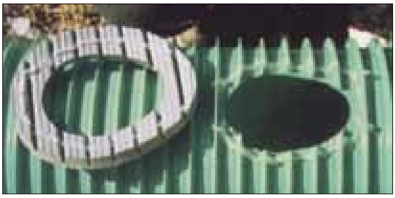


4. Properly cut hole for saddle wye. (*Note*: Hole for tee saddle will be round)

5. Saddle gasket and silicone.

6. Apply silicone liberally around the grooved side of the gasket.

7. Apply silicone to the O.D. of Ultra Rib™ around the tap hole as shown.



8. Properly applied silicone.

9. Place saddle gasket over the tap hole as shown.

10. Apply silicone in a continuous bead as shown to the smooth side of the gasket.

11. Properly align saddle with saddle gasket to prevent obstruction of incoming flow.

12. Attach two stainless steel bands as shown.

NOTE: When air testing, wait one hour between saddle assembly and testing to allow silicone to dry.

3.6.2 FIELD TAPPING FOR ULTRA CORR™

1. Typical equipment required to make a saddle tap in Ultra Corr™ .

2. Place saddle gasket over the tap hole as shown.

3. Properly align saddle with saddle gasket to prevent obstruction of incoming flow.

NOTE: When air testing, wait one hour between saddle assembly and testing to allow silicone to dry.

3.7 MANHOLES AND RIGID STRUCTURES

Sewer systems require various sizes and types of manholes for two reasons:

1. To provide access to sewer lines for inspection and maintenance.
2. To provide for changes in sewer direction and elevation.

By design practice, sewer mains are usually constructed in straight lines between manholes, which are located at points where directional changes are required. Drop manholes are used to provide for significant changes in grade or elevation due to the topography of the area. In addition, manholes are generally placed at intervals of 300 to 400 feet in sewer collecting lines. This distance varies with localities, engineers and sanitary engineering standards. The use of curved sewers, particularly in some west coast areas, has made it possible to reduce the number of manholes required on some projects.

Type of manhole construction varies by locality with brick, concrete blocks, pre-cast concrete manhole sections, and Fiberglas units being used. In more populated areas, pre-cast concrete manhole sections are now preferred because of their superior strength, water tightness and economical installation features. Concrete does not bond to PVC pipe. This means that some form of seal or water stop is required if there is to be a watertight connection between Ultra Rib™ or Ultra Corr™ and concrete structure.

3.7.1 CONNECTIONS TO MANHOLES AND OTHER RIGID STRUCTURES

There are several accepted methods of connecting Ultra Rib™ to manholes and other rigid structures depending upon the style specified. **Grouted Manhole Connections:** The gasket installed on the spigot end of Ultra Rib™ or Ultra Corr™ pipe will serve as a waterstop. The pipe may be grouted into the wall of the structure as shown in Figure 14. The ribs or corrugations serve as a structural tie-in. Another method is to use a smooth manhole adaptor with a solid exterior covered by sand. By applying PVC solvent cement primer to the smooth end the PVC is softened such that the sand will adhere to it. The grout will then bond to the sand.

Grout only Ultra Rib™ or Ultra Corr™ manhole entry

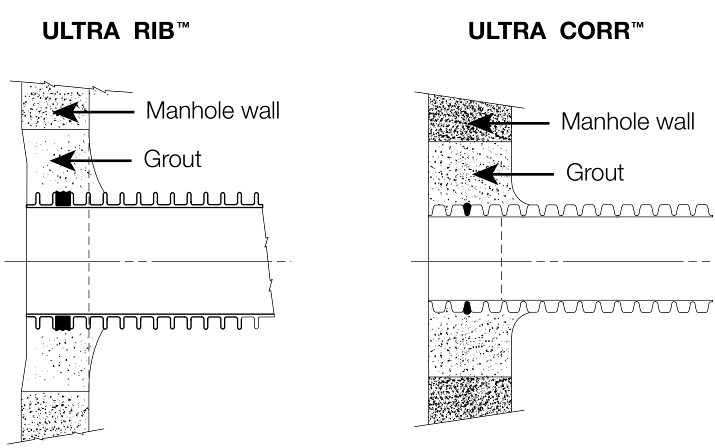


Figure 13

Booted Manhole Connections: The preferred method for making flexible boot connections with Ultra Rib™ is to utilize "Flip Top" manhole adaptor gaskets as shown below. A similar type flexible boot is available for Ultra Corr™— the "Flat Top" manhole adaptor.

ULTRA RIB™ "FLIP TOP" MANHOLE ADAPTOR

1. Remove the Ultra Rib™ gasket from the pipe.

2. Flip the manhole adaptor gasket inside out so that the flat side of the gasket is to the inside.

3. Slightly lubricate this flat side of the gasket and slide onto the pipe.

4. Continue sliding the gasket down the pipe barrel until the desired is reached.

5. At the desired location, flip the gasket so the flat surface is up.

6. Make sure the "knobs" of the bottom side of the gasket are securely in place and between the ribs on the pipe.

7. The pipe and gasket are ready for assembly into the manhole boot.

8. Position the pipe and gasket inside the manhole boot so that gasket is under the strap location.

9. Tighten strap around the manhole boot with torque wrench or screwdriver. (torque to 60 inch/pounds).

10. Completed assembly.

ULTRA CORR™ "FLAT-TOP" MANHOLE ADAPTOR

1. Follow same instructions for Ultra Corr™ as for Ultra Rib™

The approximate outside diameter of the "Flip-Top" manhole gasket after installation on the pipe is shown in the table below.

The approximate outside diameter of the "Flip-Top" manhole gasket after installation on the pipe is shown in the table on the next page.

PIPE SIZE		ULTRA RIB™ MANHOLE ADAPTOR GASKET O.D.		ULTRA CORR™ MANHOLE ADAPTOR GASKET O.D.	
INCHES	MM	INCHES	MM	INCHES	MM
8	200	9.33	236.98	—	—
10	250	11.55	292.10	—	—
12	300	13.65	346.71	—	—
15	375	16.67	423.42	—	—
18	450	20.05	509.27	—	—
21	525	23.51	597.15	—	—
24	600	26.35	669.29	25.58	649.7
27	675	29.77	756.16	28.88	733.4
30	750	—	—	32.15	816.6
36	900	—	—	38.74	984.0

Table 9

Smooth Manhole Adaptors – Ultra Rib™: Another method of making booted manhole connections to Ultra Rib™ is to use the "Smooth" manhole adaptors as shown below.

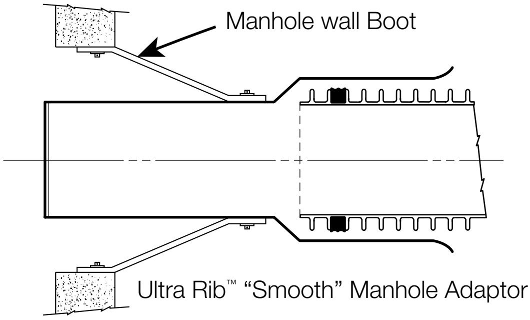


Figure 14

The "Smooth" manhole adaptor has the same spigot outside diameter dimensions as PVC sewer pipe meeting ASTM D3034 or F679 with Ultra Rib™ bells. This is true for diameters 8 inches through 27 inches. For 30 inches, the spigot O.D. is that of cast iron 32 inches or PS46 (31.496 inches).

A-LOK Manhole Connections – Ultra Rib™: Where manholes are manufactured with A-LOKS use the "Smooth" manhole adaptor shown below.

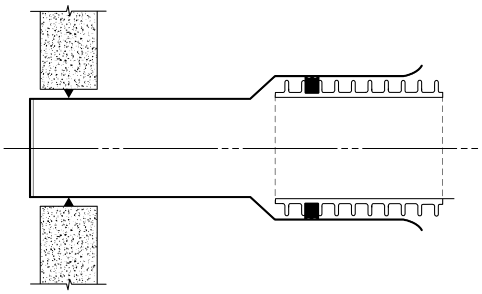


Figure 15

The A-LOK should be sized for D3034 or F679 for diameters 8 inches through 27 inches. For 30 inches it should be sized for 30 inches cast iron outside diameter 32 inches or for SDR35/PS46 31.50 inches. For 30-inch diameter, the actual dimension should be verified at the time of purchase.

Smooth Manhole Adaptors – Ultra Corr™: Where manholes are manufactured with A-LOKS use the "Smooth" manhole adaptor as shown below.

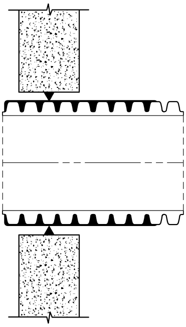


Figure 16

Where manholes are manufactured with A-LOKs, use an Ultra Corr™ A-LOK entry piece.

The A-LOK should be sized as follows:

PIPE DIAMETER	ADAPTOR
INCHES	INCHES
24	26.13
27	30.14
30	32.86
36	39.51

Table 10

3.7.2 PREPARATION OF MANHOLE FOR FUTURE CONNECTIONS

Sewer projects quite often include manholes from which sewer lines will be connected and installed at some future date. This situation frequently occurs in suburban developments where housing units are constructed in stages over a period of time. Where such future sewer extensions are planned, provisions should be made in the manholes to facilitate these connections.

3.7.3 CONNECTIONS TO DROP MANHOLES

Drop manholes are used to provide for significant changes in grade or elevation resulting from the topography of the area. These structures should be used as infrequently as possible since they are a source of high turbulence in sewage flow. The WPCF Manual of Practice, No. 9, Chapter 6, states that where hydrogen sulfide gas is present in sewage, agitation and turbulence developed by drop manholes can cause the release of this gas into the sewer atmosphere, resulting in severe odor problems or, under certain conditions, lethal, odorless concentration of the gas injurious to human health and instrumental to corrosion of the manhole structures.

Two types of drop manholes are currently being designed for use with PVC plastic pipe.

1. Inside-drop manholes
2. Outside-drop manholes

The inside-drop manhole has become the preferred method in many areas because of its economic and maintenance benefits.

The outside-drop manhole is the old standard that has been used for many years.

Please refer to the "Uni-Bell® Handbook of PVC Pipe Design and Construction" for further details.

3.7.4 SEWER CHIMNEYS OR RISERS, RIGID STRUCTURES REQUIRING SPECIAL TREATMENT

Sewer design engineers and contractors should be aware of the design and construction requirements associated with vertical sewer chimneys and deep angular risers. Considerable loads are transferred by frictional forces of the backfill Additional loads are transferred by the backfill above and surface loads to and through the chimneys or risers to the sewer pipe and fittings below. All of these loads are in turn transmitted in the form of concentrated weight to the supporting trench bedding beneath the structures. This extra, concentrated loading requires special treatment to provide adequate support for both pipe and fittings in sewer chimneys or riser installations. For further details refer to the "Uni-Bell® Handbook of PVC Pipe Design and Construction."

For angular risers and lateral house connections, care should be taken when installing lateral piping to avoid excessive settlement from poor compaction which can cause broken or leaky fittings and pipe joints. Efforts should be made to place lateral pipes on well-compacted or undisturbed soil whenever possible.

4.0 PIPE EMBEDMENT

Understanding flexible conduit terminology is essential for the installer. The soil class and density realized in the bedding, hunching, and initial backfill, as well as the manner and care with which they are placed, are important factors in achieving a satisfactory installation of a flexible conduit. Over-deflection, when it occurs, is invariably the result of improper compaction in the hunching area. Below is an illustration of a typical trench with all major regions identified, as they will be addressed in the following sections.

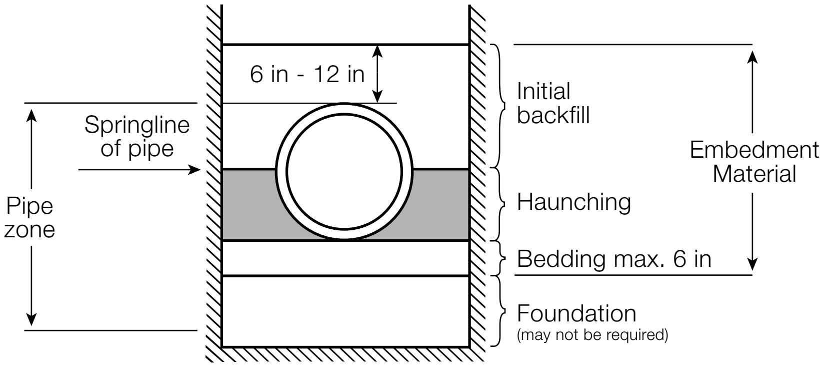


Figure 17

4.1 FOUNDATION

A foundation is required when the trench bottom is unstable. Any foundation that will support a rigid pipe without causing loss of grade or flexural breaking will be more than adequate for PVC pipes.

4.2 BEDDING

Bedding is required primarily to bring the trench bottom up to grade. Bedding materials should be placed to provide uniform longitudinal support under the pipe to prevent low spots. Blocking should not be used to bring the pipe to grade. Bell holes at every joint will allow for the joint to be assembled properly and maintain adequate support. Under normal circumstances, a bedding of 4 inches to 6 inches compacted is of sufficient thickness for the bedding. If the native trench soil is comprised of fine grain soils and migration of those soils into the bedding material is anticipated, either wide trench construction, a well-graded bedding material without voids, or a fabric barrier should be used to avoid compromising the trench backfill materials.

4.3 BACKFILLING AND TAMPING

Backfilling should follow pipe assembly as closely as possible. This protects the pipe from falling rocks, eliminates possibility of lifting the pipe from grade due to flooding of an open trench, avoids shifting pipe out of line by cave-ins, and in cold weather lessens the possibility of backfill material becoming frozen.

4.3.1 HAUNCHING AND INITIAL BACKFILL

The haunching area is the most important in terms of limiting the deflection of a flexible pipe. This is the area that should be compacted to the required or specified density.

Initial backfill begins above the springline of the pipe to a level 6 inches to 12 inches above the top of the pipe. Compacting soils to levels above the springline gives little additional side support.

There are two basic purposes of the haunching and initial backfilling of a flexible conduit such as Ultra Rib™ or Ultra Corr™ pipe:

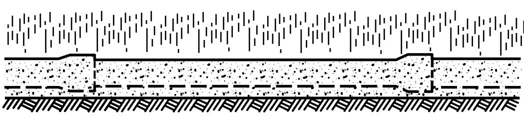
1. To provide the soil side support, which is necessary to enable the pipe and the soil to work together to meet the designed load requirements within the allowable deflection limits.
2. To provide protection for the pipe from impact damage due to large rocks, etc. contained in the final backfill.

The essentials of satisfactory haunching and initial backfilling can be summarized as follows:

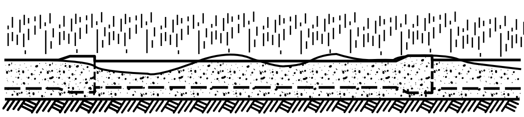
1. Provide approved materials, properly compacted continuously above the bedding and around the pipe to the spring-line, as well as between the pipe and undisturbed trench walls.
2. Provide a cushion of approved materials from 6 inches to 12 inches **over** the pipe and between the trench walls in accordance with the engineer's specifications.

After the bedding material has been placed according to Section 4.1, place the haunching and initial backfill by hand to a 1-foot minimum depth of cover above the pipe to give pipe support and cushion. In doing so, proper control should be exercised to avoid vertical and horizontal displacement of the pipe from proper alignment. This backfill should be a selected material, free from rocks greater than 1.5 inches in diameter, dirt clods or frozen material. This material is solely responsible for providing effective support of the pipe in the haunching area and limiting deflection. This is accomplished by tamping the embedment materials under the haunches and around the pipe to the spring-line of the pipe.

Side support is accomplished by tamping the soil firmly under the haunches of the pipe out to the trench walls. Tamping should be done in 4-inch layers to the height specified by the engineer, but in no case less than to the springline of the pipe. When the specified height is reached, the tamping can be stopped. If automatic tampers are used, care should be exercised to avoid damaging the pipe. For more information on tamping, see Section 4.4.1.



A. **Right**—Backfill correctly placed by hand filling all voids.



B. **Wrong**—Backfill not placed evenly.

Figure 18

The immediate placement of initial backfill will provide adequate weight of soil on the pipe so that expansion and contraction will be evenly distributed over each pipe length. This portion of the backfill begins at the spring-line of the pipe and extends to some predetermined distance above the pipe. Since little to no side support is derived from the soils placed in this area, native soils maybe used without tremendous compaction efforts, unless in the influence zone of other structures. It should be noted that at shallow depths of cover (less than 3 feet) flexible conduits may deflect and rebound under dynamic loading if the trench width is not highly compacted, resulting in damage to road surfaces. For pipes buried under flexible road surfaces at depths less than 3 feet, it is recommended that a minimum of 90 percent Proctor density be achieved from the bottom of the trench up to the road surface using Class I or Class II materials as described in Appendix 1. Minimum cover is recommended to be 1 foot from the top of rigid road surfaces or the bottom of flexible road surfaces.

4.4 COMPLETING THE BACKFILL

The trench should be carefully inspected before final backfilling to detect and remove any loose stones, which may have fallen into the trench.

The material that completes the backfilling operation need not be as carefully selected as the initial material, unless specified by the engineer. Care should be taken, however, to avoid including large stones in the backfill. They might damage the pipe when dropped or forced through the soil cushion of the initial backfill against the pipe.

The consolidation of the final backfill above the initial backfill material has no effect, except for weight, on flexible pipe performance. Therefore, its placement and compaction should be completed in consideration of other factors such as paving. However, nothing should be done above the pipe zone that will alter the previously compacted backfill in the pipe zone.

4.4.1 FINAL BACKFILL

The final backfill should be placed and spread in uniform layers in such a manner as to completely fill the trench with a uniformly dense backfill load on the pipe and avoid unfilled spaces in the backfill. Rolling equipment should not be used until a minimum of 18 inches of backfill material has been placed over the top of the pipe. If a hydro hammer is to be used to compact the backfill, a minimum of 3 feet of cover is required. Unless otherwise specified, trenches under pavements, sidewalks, or roads should be backfilled and compacted to 90 percent density, as determined by the American Association of Highway and Transportation Officials Method T99 for State

Compaction and Density of Soils. Unless specified, other trenches may be backfilled without controlled compaction in the final backfill. Additional backfill material should be supplied, if needed, to completely backfill the trenches or to fill depressions caused by subsequent settlement.

For description of backfill materials and their recommended usage, please refer to Appendix 1.

4.5 COMPACTION METHODS

The first step in providing effective support for the pipe in the haunching area is to tamp the embedment materials under the haunches and around the pipe to the spring-line of the pipe.

Tamping should be done with hand tamping bars, mechanical tampers, or by using water to consolidate the embedment materials. With hand tamping, satisfactory results can be accomplished in damp, loamy soils and sands. For more cohesive soils, the necessary compaction may require the use of mechanical tampers. Water tamping should be limited to trenches excavated in soils in which water drains through quickly and, in so doing, compacts the embedment material.

4.5.1 TAMPING BARS

Two types of tamping bars should be available for a good tamping job. The first should be a bar with a narrow head. (See A or B of Figure 20.) These are used to tamp under the pipe. The second tamping bar should have a flat head. It is used to compact the soil along the sides of the pipe to the trench walls. (See Figure 20 C.)

Tamping bars of the type shown in “A” and “B” are used for tamping under pipe and joints. The flat tamper “C” is used at the sides, between pipe and trench walls.

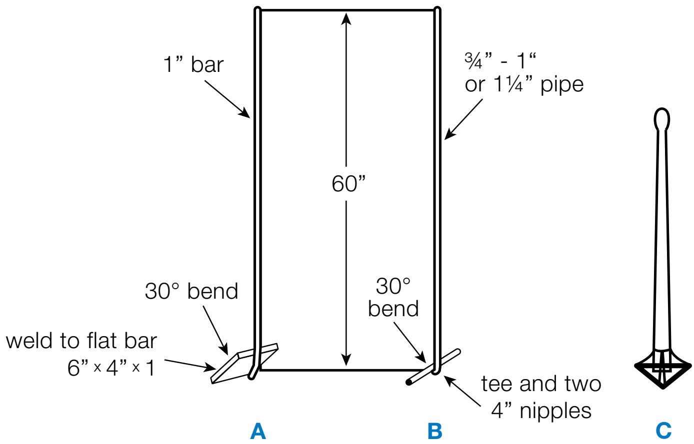


Figure 19

Do not attempt to use the flat tamper (C) in place of A or B. It will not work properly.

4.5.2 MECHANICAL TAMPERS

Care should be taken to avoid contact between the pipe and compaction equipment. Compaction of the embedment material should generally be done in such a way that the compaction equipment is not used directly above the pipe until sufficient backfill has been placed to ensure that the use of compaction equipment will not damage the pipe or cause deflection of the pipe.

When hydro-hammers are used to achieve compaction, they should not be used within 3 feet of the top of the pipe and then, only if the embedment material density has been previously compacted to a minimum 85 percent Proctor density.

4.5.3 FLOOD OR WATER TAMPING

Flooding or water tamping should be used only in trenches that are excavated in soils from which water drains quickly and, at the same time, compacts the haunching material.

If flooding is used, the approved embedment material is first hand placed, making certain all voids under, around and along both sides of the pipe and couplings are filled. Initial embedment material should be placed to a height sufficient to prevent floating of the pipe.

CAUTION: Be careful not to float the pipe.

4.5.4 WATER-JETTING

The introduction of water under pressure to the embedment material is not to be used to compact the embedment material of PVC pipe, or any other flexible conduit.

4.5.5 SHEETING AND TRENCH BOXES

When sheeting is used, it should be left in place unless it is designed to prevent disturbing the soil adjacent to the pipe when pulled and removed. If heavy wooden sheeting has to be pulled, well-graded granular material should be placed on each side of the pipe for a distance of at least two pipe diameters. The granular material should be compacted to at least 90 percent Standard Proctor Density.

Whenever possible, sheeting and bracing should be installed so that the bottom of the sheeting extends no lower than the spring-line of the pipe. When installed in this manner, pulling the sheeting will not disturb the embedment material providing sidewall support for the pipe. If a trench box is used, it should be designed so that the backend of the sides do not extend below the pipe spring-line. This will allow filling and compaction of the annular space as the trench box is moved forward.

4.6 SPECIAL CONDITIONS AND CONSIDERATIONS

4.6.1 FROZEN BACKFILL

1. Most soils have a tendency to adhere when frozen, becoming large lumps which can produce excessive impact on the pipe during the backfilling operation.

2. Frozen material has expanded and may produce excessive settlement in the trench backfill during the spring thaw.
3. Where the backfill material is extremely rocky, extra consideration should be given to the effects from frost because:
    a. freezing occurs more rapidly
    b. rocks become lodged in frozen lumps of backfill

    These lumps can penetrate the soil cushion of the initial backfill over the pipe causing damage to the pipe.

4.6.2 SURFACE LOADS

Where surface loads are anticipated over the trench, the final backfill must be compacted to a density consistent with those surface loads to be encountered. Therefore, the placement of the final backfill should be under the direction of the engineer.

4.6.3 DEEP SEWER CHIMNEY OR RISERS

These appurtenances necessitate extra care during the final backfilling to prevent damage to the piping from impact caused by the falling backfill material. Final backfilling around sewer chimneys should be under the direction of the engineer.

4.6.4 BACKFILLING AND TAMPING FOR PIPE ON SLOPES

Extra attention should be given to pipe installations on slopes to prevent the newly backfilled trench from becoming a "French drain." Before the backfill completely consolidates, there is a tendency for ground and surface waters, to follow the direction of the looser soil. This flow of water may wash out soil from under or around the pipe, reducing or eliminating the support for the pipe. This can result in pipe failures. To avoid this potential problem with pipe installed on slopes, extra care should be taken to get greater compaction of the backfill. The tamping should be done in 4-inch layers and continued in this manner all the way up to the ground or surface line of the trench. To prevent water from undercutting the underside of the pipe, concrete collars, keyed into the trench sides and foundation, are often poured around the pipe.

4.6.5 SUPPORT OF ABOVE GROUND PIPE

The installation of Ultra Rib™ pipe above ground requires continuous support except at the joints where the support should be removed to allow clearance for the pipe bells. Pipe above ground should be protected from sunlight and vandalism.

5.0 PIPE TESTING AND REPAIR

5.1 DEFLECTION

Deflection is the reduction of the vertical diameter of a flexible pipe due to an imposed load.

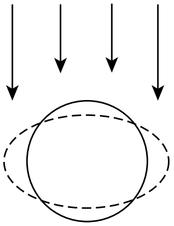


Figure 20

The amount of deflection that will occur after installation is a function of:

1. Pipe stiffness (FΔy)
2. Soil stiffness (density) in the pipe zone.
3. Load imposed on the pipe.

Of the above three factors, the most important influence on limiting deflection is soil stiffness (density) in the pipe zone, especially in the haunching area. See Section 4.0, "Pipe Embedment" for the trench cross-section terminology.

Test data plotted for deflection as a function of load and soil density clearly show that deflection is controlled primarily by soil density in the pipe zone and not by soil class. The following chart illustrates the maximum limits of deflection that can be expected in different soil classes when compacted to the densities shown. Remember, the density referred to is the "haunching" area of the pipe zone.

5.2 PIPE DEFLECTION

Deflection testing is not required when using proper construction practices and inspection during pipe installation and when using embedment material which has been properly selected, placed, and compacted. However, it may be required that random deflection tests of pipe be performed before final acceptance at construction locations between successive manholes where the construction encountered unstable trench walls or bottoms, heavy rainfall, frozen soil, high ground water levels, deep lines, or difficulty in attaining compaction. Locations with excessive deflection should be repaired by re-bedding or replacement of the pipe. Deflection testing is usually performed with properly sized "go, no-go" mandrel or sewer ball. For the purpose of deflection measurements the base inside pipe diameters without deflection are provided in Table 11. The maximum allowable deflection should be subtracted from these base inside diameters in determining the maximum diameter of the "go, no-go" test mandrel or ball. It must be emphasized that to insure accurate testing, the lines must be thoroughly cleaned.

5.2.1 DEFLECTION TESTING

It is the position of JM Eagle™ Manufacturing that deflection testing of PVC pipe is unnecessary when pipe is installed in accordance with the acceptable practices stated in this guide. Most towns and municipalities limit initial deflection to 5 percent, when in actuality ASTM D3034 recommends PVC pipe deflection at 7.5 percent of base inside diameter. Thus, exceeding these limits does not necessarily indicate any structural damage, failure or reduction in life and only add to the cost of the project. Proof of this position is that more than 750 million feet of PVC sewer pipe are performing satisfactorily in the field today. On the other hand, where improper installation practices are known or suspected, questionable bedding materials are employed, and/or installation conditions are severe, deflection testing of these sections of the installation should be considered advisable by the engineer.

BASE INSIDE DIAMETERS 7.5 % DEFLECTION MANDREL DIMENSIONS		
NOMINAL PIPE SIZE (IN)	**BASE INSIDE DIAMETER** (IN)	**O.D. OF 7.5% DEFLECTION MANDREL** (IN)
4	3.86	3.57
6	5.72	5.29
8	7.63	7.06
10	9.52	8.81
12	11.31	10.46
15	13.82	12.79
18	16.92	15.65
21	19.95	18.46
24	22.60	20.90
27	25.44	23.54
30	28.35	26.22
33	31.24	28.91
36	34.10	31.55
39	37.00	34.23
42	39.88	36.89
45	42.76	39.56
48	45.63	42.22

Table 11

5.3 MAKING LEAKAGE TESTS

After the Ultra Rib™ or Ultra Corr™ sewer pipe has been laid and backfilled, each section of the pipeline between manholes should be tested by a low-pressure air test or a water infiltration test. There are some obvious advantages to the air test method such as:

1. A test method which provides accurate results
2. Time saving, especially in large diameters
3. A clean test
4. An inexpensive test compared with water exfiltration testing. (Water can be costly, particularly on large diameter jobs.)

Table 12

PIPE STIFFNESS — F/y - 46 PSI																				
ASTM BEDDING CLASSIFICATION		DENSITY (PROCTOR) AASHTO T-99		HEIGHT OF COVER (FEET) (METERS)																
			(ft.)	3	5	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
			(m.)	.91	1.52	2.44	3.05	3.66	4.27	4.88	5.49	6.10	6.71	7.32	7.93	8.54	9.15	9.76	10.37	10.98
Gravel	Class I																			
	Class II	90%	☐ Maximum 7.5% deflection																	
		80%	■ This zone not recommended																	
Sand	Class III	90%																		
		85%																		
		75%																		
		65%																		
Clay	Class IV	85%																		
		75%																		
		65%																		
Peat	Class V	This soil class not recommended.																		

Note: Deflection values shown do not include effect of live load or longitudial bending.

Note: Ultra Rib™ has been buried up to 50' deep. For burial chart info at those depths consult your manufacturer's representative.

1. No length of pipe installed under conditions specified will deflect more than is indicated; the pipe will deflect less than the amount indicated if specified density is obtained.
2. External loading based upon soil weight at 120 lbs. per cubic foot.
3. Deflections prodicted are based upon pipe which was initially circular prior to installation. Actual deflections may differ because of initial out of roundness caused by storage and/or handling. These variations should be taken into account when measuring deflections are compared with those in the table.
4. Bedding classifications are as indicated on page 15 and correspond to ASTM D2321.
5. Deflections listed in table are maximum long-term values. The suggested maximum long-term value is 7.5 percent which is approximetaly equal to a 5 percent initial deflection.
6. Initial deflection is deflection taken within the 1st 24 hours after trench is backfilled.

When performing an air test, ASTM F1417-92 (1998) “Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air” must be adopted for safety and consistency. However, the engineer reserves the right to choose the type of test (air or water) to be conducted. A comparison of the two test methods is very complex. Results can vary greatly depending both on the type of leak involved and the type of backfill material surrounding the pipe. For example, light clay soil versus clean sand. Because of the complexity of equaling the test results, these tests cannot be claimed to be strict equivalents. Both test specifications are meaningful. All caps and end plugs should be blocked by a stake or other means prior to air testing. This will prevent dislodging of the end cap or plug and prevent failure of the air test.

5.3.1 AIR TESTING

When the air test is specified, the engineer should give explicit instructions for conducting the test in accordance with ASTM F1417 practices, including times for a 0.5 psig pressure drop. Should any test on any section of the pipeline disclose an air loss rate greater than permitted, the contractor shall, at his own expense, locate and repair the defective joints or pipe sections. After the repairs are completed, the line shall be retested until the air loss rate is within the specified allowance.

WARNING: When air is compressed in PVC pipe, it poses a severe explosion hazard and may result in pipe failure and/or injury to property and/or persons. Don’t use PVC for compressed air systems. Do not exceed 9 psig of air pressure.

5.3.2 INFILTRATION TESTING (WATER)

When high ground water tables exist and the infiltration test is required, the engineer shall give explicit instructions for conducting the test. The maximum allowable amount of infiltration rate measured by the test shall be 28 gallons per inch of pipe diameter per mile per 24 hours.

Should any test on any section of the pipeline disclose an infiltration rate greater than permitted, the contractor shall, at this own expense, locate and repair the defective joints or pipe sections. After the repairs are completed, the line shall be retested until the infiltration is within the specified allowance.

5.3.3 EXFILTRATION TESTING (WATER)

When an exfiltration test is required, the engineer should give explicit instructions to be followed in carrying out the test. The maximum allowable exfiltration rate measured by the test shall be 28 gallons per inch of diameter per mile per 24 hours. The average internal pressure of the system under test shall not be greater than 5 psi (11.6-foot head), and the maximum internal pressure in any part of the system under test shall not be greater than 10.8 psi (25-foot head).

Should any test on any section of the pipeline disclose and exfiltration rate greater than permitted, the contractor shall, at his own expense, locate and repair the defective joints or pipe sections. After the repairs are completed, the line shall be retested until the exfiltration is within the specified allowance.

Table 13

SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015													
PIPE DIAMETER		**MINIMUM TIME**	**LENGTH FOR MINIMUM TIME**		**TIME FOR LONGER LENGTH**	**SPECIFICATION TIME FOR LENGTH (L) SHOWN (MIN:SEC)**							
						100 FT	**150 FT**	**200 FT**	**250 FT**	**300 FT**	**350 FT**	**400 FT**	**450 FT**
in.	**mm.**	**min:sec**	**ft.**	**m**	**sec**	**35.48m**	**45.72m**	**121.92m**	**76.20m**	**91.44m**	**106.68m**	**121.92m**	**137.16m**
8	200	3:47	298	90.83	.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	250	4:43	239	72.85	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	300	5:40	199	60.66	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	375	7:05	159	48.46	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17.48	20:02
18	450	8:30	133	40.54	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	525	9:55	114	34.75	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	600	11:20	99	30.18	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	675	12:45	88	26.82	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	750	14:10	80	24.38	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
36	900	17:00	66	20.11	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23

Table 14

SPECIFICATION TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015													
PIPE DIAMETER		MINIMUM TIME	LENGTH FOR MINIMUM TIME		TIME FOR LONGER LENGTH	SPECIFICATION TIME FOR LENGTH (L) SHOWN (MIN:SEC)							
						100 FT	150 FT	200 FT	250 FT	300 FT	350 FT	400 FT	450 FT
in.	mm.	min:sec	ft.	m	sec	35.48m	45.72m	121.92m	76.20m	91.44m	106.68m	121.92m	137.16m
8	200	3:47	298	90.83	.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	250	4:43	239	72.85	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	300	5:40	199	60.66	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	375	7:05	159	48.46	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17.48	20:02
18	450	8:30	133	40.54	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	525	9:55	114	34.75	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	600	11:20	99	30.18	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	675	12:45	88	26.82	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	750	14:10	80	24.38	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
36	900	17:00	66	20.11	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23

5.4 MAKING REPAIRS AND TIE-INS

If Ultra Rib™ or Ultra Corr™ is damaged at the job site and it becomes necessary to replace a full length of Ultra Rib™ or Ultra Corr™, you will need the following materials:

1 – 3-foot-3-inch bell × spigot quarter length
1 – 6-foot-6-inch spigot × spigot half length
1 – 3-inch-3-inch spigot × spigot quarter length
2 – Ultra Rib™ or Ultra Corr™ repair couplings
6 – Gaskets

First, cut out and remove the damaged length of pipe, being careful not to disturb the adjacent pipe's bell or spigot. Then install the repair pieces in the following manner:

1. Install the quarter lengths and position the half length for installation after loosely placing the repair couplings on the pipe. (Figure 21)

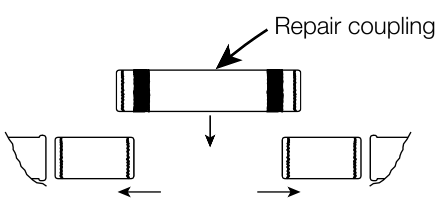


Figure 21

2. Move the half length into line and grade and position the couplings for final tightening. (Figure 22)

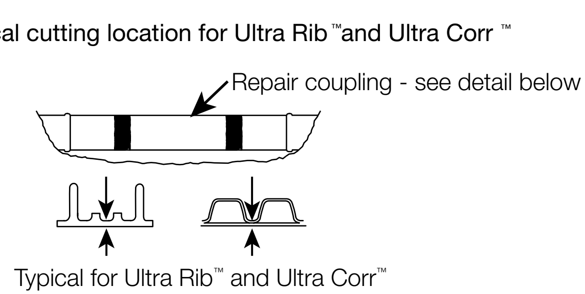


Figure 22

6.0 DIMENSIONS AND WEIGHTS

ULTRA RIB™ DIMENSIONS					
NOMINAL PIPE SIZE (IN)	**MIN. I.D.** (IN)	**APPROX. O.D.** (IN)	**APPROX. BELL O.D.** (IN)	**MIN. T.** (IN)	**APPROX. PIPE WEIGHT** (LBS/100 FT)
8	7.863	8.81	10.20	0.060	250
10	9.825	11.02	12.80	0.070	350
12	11.687	13.10	15.26	0.085	490
15	14.303	15.91	18.04	0.105	730
18	17.510	19.32	22.02	0.130	1050
21	20.656	21.73	26.17	0.160	1450
24	23.412	25.48	28.91	0.180	2120
27	26.371	28.50	32.85	0.205	2470

Table 15

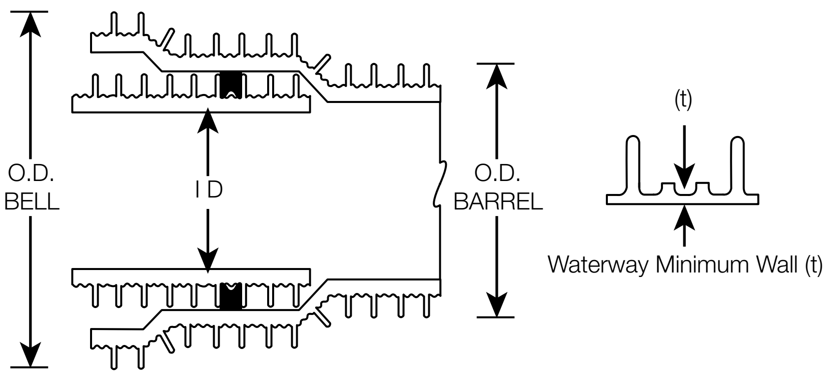


Figure 23

ULTRA CORR™ DIMENSIONS							
NOMINAL PIPE SIZE (IN)	**MIN. I.D.** (IN)	**APPROX. O.D. BARREL** (IN)	**MIN. WALL THICKNESS**			**APPROX. WEIGHT** (LBS/FT)	**APPROX. BELL O.D.** (IN)
			Inner Wall t1 (IN)	**Outer Wall t2** (IN)	**At Valley t3** (IN)		
24	23.412	25.58	0.110	0.085	0.123	18.2	28.7
27	26.371	28.86	0.120	0.091	0.137	20.2	32.5
30	29.388	32.15	0.130	0.105	0.147	26.0	35.8
36	35.370	38.74	0.150	0.125	0.171	36.1	43.4

Table 16

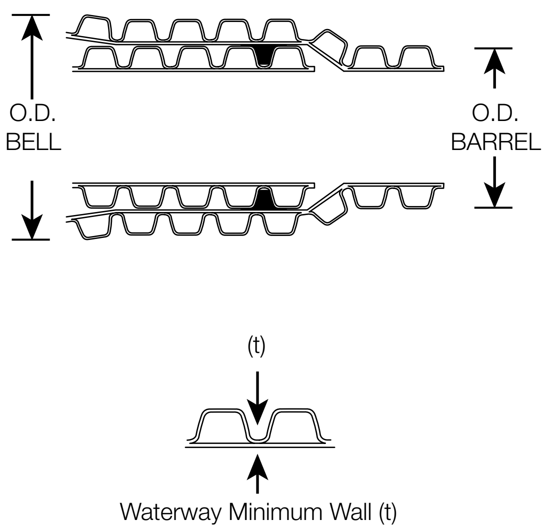


Figure 24

NOTICE TO ALL READERS OF THIS GUIDE: PVC pipe installation may be hazardous to pipe, property, and/or persons if this guide and/or the recommendations of JM Eagle™ Manufacturing are not adhered to fully. JM Eagle™ has made every effort to expose all known dangers of misusing PVC pipe in this guide; however, JM Eagle™ cannot possibly know or anticipate all situations or outcomes. JM Eagle™ maintains the position that PVC pipe is the most reliable and safest piping material available. Thus, JM Eagle™ encourages all users of our products to exercise good judgment when installing our products and to consult JM Eagle™ for additional information when questions or concepts illustrated herein are not fully answered or understood. It is recommended that all users of our products (or persons handling) attend training on pipe construction, installation, and safety prior to working with our products to ensure safety, knowledge, and understanding. Should you need further assistance, please contact JM Eagle™ Product Assurance at 1-800-621-4404.

APPENDIX 1

EMBEDMENT MATERIALS

Materials suitable for foundation and embedment are classified in the following Table A1.1. They include a number of processed materials plus soil types defined according to the Unified Soil Classification System (USCS) in ASTM D2487, "Standard Method for Classification of Soils for Engineering Purposes." Table A1.2 provides recommendations on the installation and use based on class of soil or aggregates and location within the trench. It is important to engineer all materials used in the pipe trench to work together and with the native material surrounding the trench.

Class IA Materials: Class IA materials provide the maximum stability and pipe support for a given density because of the angular interlocking of the material particles. With minimum efforts, these materials can be installed at relatively high densities over a wide range of moisture contents. These materials also have excellent drainage characteristics that may aid in the control of water. These soils are often desirable as embedment in rock cuts where water is frequently encountered. On the other hand, when ground water flow is anticipated, consideration should be given to potential migration of fines from adjacent materials into the open graded Class IA materials.

Class IB Materials: Class IB materials are produced by mixing Class IA and natural or processed sands to produce a particle-size distribution that minimizes migration from surrounding soils that may contain fines. They are more widely graded than Class IA and thus require more compaction effort to achieve the minimum density specified. When these materials are properly compacted these soils exhibit high stiffness and strength, and depending on the amount of fines, may be relatively free draining.

Class II Materials: When Class II materials are compacted, they provide a relatively high level of pipe support. In most respects, they all have the desirable characteristics of Class IB materials when widely graded. However, open-graded groups may allow for migration and the sizes should be checked for compatibility with the native trench materials. Typically, Class II materials consist of rounded particles and are less stable than the angular materials of Class IA and IB unless they are confined and compacted.

Class III Materials: These materials provide less support for a given density than Class I or Class II materials. High levels of compaction effort are required if moisture content is not controlled. These materials will provide reasonable support once proper compaction is achieved.

Class IV-A Materials: Class IV-A materials must be carefully evaluated before use. The moisture content of the materials must be near optimum to minimize compaction effort and achieve the required density. Properly placed and compacted, these soils can provide reasonable levels of pipe support. However, these materials may not be suitable under high fills, surface applied dynamic loads, or under heavy vibratory compactors and tampers. These materials should be avoided if water conditions in the trench may cause instability and result in uncontrolled water content.

Table A1.1

Description of Material Classification as Defined in ASTM D2321										
				Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
Class	Type	Soil Symbol Group	Description ASTM D2487	1.5 in (40 mm)	No.4 (4.75 mm)	No.200 (.075 mm)	LL	PL	Uniformity Cu	Curvature Cc
IA	Manufactured Aggregates: open graded, clean	None	Angular, crushed stone or rock, crushed slag, cinders or shell: large void content, contain little or no fines	100%	< or = 10%	< 5%	Non Plastic			
IB	Manufactured, Processed Aggregates: dense graded, clean	None	Angular, crushed stone (or other Class IA materials) and stone/sand mixtures with gradations selected to minimize migration of adjacent soils: contain little to no fines	100%	< or = 50%	< 5%	Non Plastic			
II	Coarse-Grained Soils: clean	GW	Well-graded gravels and gravel-sand mixtures: little to no fines	100%	< 50% of coarse fraction	< 5%	Non Plastic		> 4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures: little to no fines						< 4	< 1 or > 3
		SW	Well-graded sands and gravelly sands: little to no fines		< 50% of coarse fraction				> 6	1 to 3
		SP	Poorly-graded sands and gravelly sands: little to no fines						< 6	< 1 or > 3
	Coarse-Grained Soils: borderline clean to w/fines		Sands and gravels which are bordeline between clean and with fines	100%	varies	5% to 12%	Non Plastic			Same as for GW, GP, SW, and SP

Based on tables found in the Uni-Bell® PVC Pipe Association, “Handbook of PVC Pipe Design and Construction”.

Table A1.1 continued

				Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
Class	**Type**	**Soil Symbol Group**	**Description ASTM D2487**	**1.5 in (40 mm)**	**No.4 (4.75 mm)**	**No.200 (.075 mm)**	**LL**	**PL**	**Uniformity Cu**	**Curvature Cc**
III	Coarse-Grained Soils w/ Fines	GM	Silty gravels, gravel-sand-silt mixtures	100%	> 50% of coarse fraction	> 12% to < 50%		< 4 or < "A" Line		
		GC	Clayey gravels, gravel-sand-clay mixtures					< 7 and > "A" Line		
		SM	Silty sands, sand-silt mixtures		> 50% of coarse fraction			> 4 or < "A" Line		
		SC	Clayey sands, sand-silt mixtures					> 7 and > "A" Line		
IV-A	Fine-Grained Soils: Inorganic	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity	100%	100%	> 50%	< 50	< 4 or < "A" Line		
		CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays					> 7 and > "A" Line		

Based on tables found in the Uni-Bell® PVC Pipe Association, "Handbook of PVC Pipe Design and Construction".

Table A1.2

Recommendations for Installation and Use of Soils and Aggregates for Foundation, Embedment, and Backfill					
	Soil Class as Defined in Table A1.1				
	Class IA	**Class IB**	**Class II**	**Class III**	**Class IV-A**
General Recommendations and Restrictions	Do not use where conditions may cause migration of fines from adjacent soil and loss of pipe support. Suitable for use as a drainage blanket and underdrain in rock cuts where adjacent material is suitably graded.	Process materials as required to obtain gradation which will minimize migration of adjacent materials. Suitable for use as drainage blanket and underdrain.	Where hydraulic gradient exists check gradation to minimize migration. "Clean" groups suitable for use as drainage blanket and underdrain.	Do not use where water conditions in trench may cause instability	Obtain geotechnical evaluation of processed material. May not be suitable under high earth fills, surface applied loads and under heavy vibratory compactors and tampers. Do not use where water conditions in trench may cause instability.
Foundation	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6 inch maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom. Install and compact in 6 inch maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6 inch maximum layers.	Suitable as foundation and for replacing over-excavated trench bottom as restricted above. Do not use in thicknesses greater than 12 inches total. Install and compact in 6 inch maximum layers.	Suitable only in undisturbed condition and where trench is dry. Remove all loose material and provide firm, uniform trench bottom before bedding is placed.

Based on tables found in the Uni-Bell® PVC Pipe Association, "Handbook of PVC Pipe Design and Construction".

Table A1.2 continued

	Soil Class as Defined in Table A1.1				
	Class IA	**Class IB**	**Class II**	**Class III**	**Class IV-A**
Bedding	Suitable as restricted above. Install in 6 inch maximum layers. Level final grade by hand. Minimum depth 4 inches (6 inches in rock cuts).	Install and compact in 6 inch maximum layers. Level final grade by hand. Minimum depth 4 inches (6 inches in rock cuts).	Suitable as restricted above. Install and compact in 6 inch maximum layers. Level final grade by hand. Minimum depth 4 inches (6 inches in rock cuts).	Suitable only in dry trench conditions. Install and compact in 6 inch maximum layers. Level final grade by hand. Minimum depth 4 inches (6 inches in rock cuts).	Suitable only in dry trench conditions and when optimum placement and compaction control is maintained. Install and compact in 6 inch maximum layers. Level final grade by hand. Minimum depth 4 inches (6 inches in rock cuts).
Haunching	Suitable as restricted above. Install in 6 inch maximum layers. Work in around pipe by hand to provide uniform support.	Install and compact in 6 inch maximum layers. Work in around pipe by hand to provide uniform support.	Suitable as restricted above. Install and compact in 6 inch maximum layers. Work in around pipe by hand to provide uniform support.	Suitable as restricted above. Install and compact in 6 inch maximum layers. Work in around pipe by hand to provide uniform support.	Suitable only in dry trench conditions and when optimum placement and compaction control is maintained. Install and compact in 6 inch maximum layers. Work in around pipe by hand to provide uniform support.
Initial Backfill	Suitable as restricted above. Install to a minimum of 6 inches above pipe crown.	Install and compact to a minimum of 6 inches above pipe crown.	Suitable as restricted above. Install and compact to a minumum of 6 inches above pipe crown.	Suitable as restricted above. Install and compact to a minumum of 6 inches above pipe crown.	Suitable as restricted above. Install and compact to a minumum of 6 inches above pipe crown.
Final Backfill	Compact as required by the engineer.	Compact as required by the engineer.	Compact as required by the engineer.	Compact as required by the engineer.	Suitable as restricted above. Compact as required by the engineer.

Based on tables found in the Uni-Bell® PVC Pipe Association, “Handbook of PVC Pipe Design and Construction”.

NOTES:

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