INFRAPIPE SOLUTIONS LTD.

WEHOLITE® STRUCTURAL PROFILE WALL HDPE PIPE

INSTALLATION GUIDE

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Preface

This installation manual provides recommendations for the installation of Weholite Structural Profile Wall HDPE buried pipe used in sewers and other gravity-flow applications. It is intended as a guide and is not to supersede the project specification and requirements. The information contained in this manual is accurate and reliable to best of our knowledge. Users will find additional helpful advice about installation of thermoplastic pipe in ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe.

This manual does not address all of the safety concerns associated with pipe installation. It is the responsibility of the end user to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to installation.

Infra Pipe Solutions reserves the right to update this manual without notice.

Receiving, Unloading and Storing

When receiving thermoplastic pipe shipments at the work site, the receiver shall inspect each pipe shipment. The pipe shall have been inspected and loaded with due care at the factory using methods acceptable to the carrier. The carrier shall be responsible for delivering the shipment in good condition. The receiver shall be responsible for ensuring that there has been no loss or damage during shipment.

Any damage, missing package, etc., should be noted on the Bill of Landing and reported to the manufacturer. Products are usually identified by markings on each individual piece. These markings should be checked against the Order Acknowledgment and the Packaging List. The number of packages and their descriptions should be checked against the Bill of Landing.

General requirement for the jobsite storage is to have a relatively smooth, level surface, free of stones, debris, or other material that could damage pipe or components, or interfere with handling. Smaller diameter Weholite may be single-stacked. In no case should Weholite pipe stacks exceed 7 feet in total height.

For ease of installation, store the pipe with profile end notches the same way. Ideally, pipe should be stored with the profile end notches at the 12 o'clock position.

Always observe applicable governmental safety regulations and manufacturer's handling and unloading recommendations when transporting or handling PE piping products in the field.

PE pipe is tough, lightweight, and flexible. Installation does not usually require high capacity lifting equipment. Wide belly-band slings are recommended for handling straight lengths of pipe. Thick nylon rope slings may also be used, either in an inverted “Y” or with a spreader beam to distribute the weight more evenly between the two lifting points. Straight lengths of small diameter pipe (NPS 30 and smaller), in suitable lengths, can be safely handled using one lifting point located at mid-length Do not use chains, wire ropes, or metal cables to unload or handle pipe.

If forklifts are used the forks should be examined for ragged edges or burrs. These should be removed or the forks wrapped to prevent damage to the pipe. Spread the forks as much as possible to stabilize the pipe load. Do not lift the pipe by inserting the forks into the pipe ends unless for the temporary purpose of slightly raising the pipe for strap placement. Fork protection is required to prevent point loading damage to the ID of the pipe if lifting in this manner.

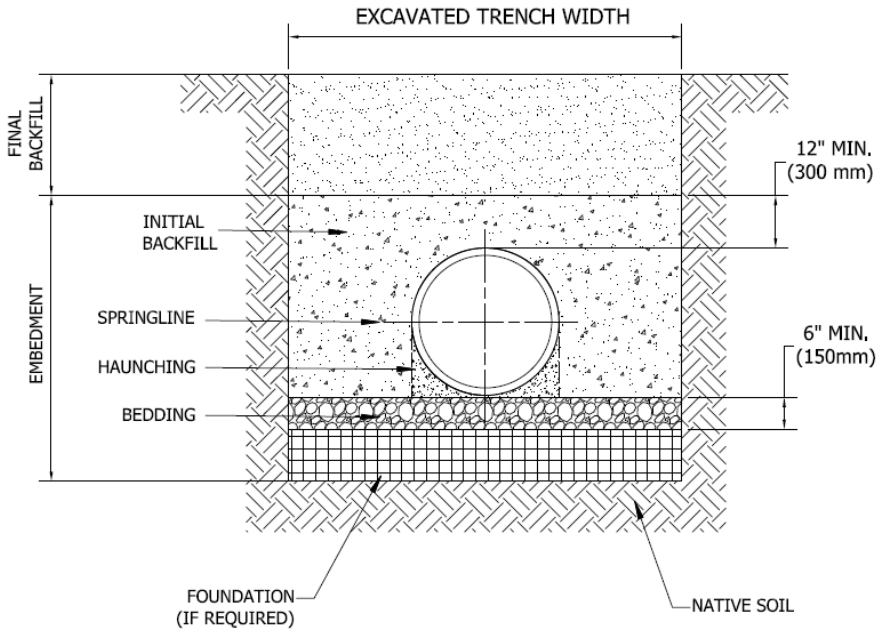
Fittings and accessories are packaged in different ways and they should be unloaded in a safe manner that will not cause the damage.

Table 1- Weholite Handling Weights (for reference purposes only)

NPS	Approx. Weight (lbs/ft)	NPS	Approx. Weight (lbs/ft)
18	18	60	100
19.5	20	66	120
21	21	72	150
24	24	78	160
27	27	84	190
30	30	90	220
33	47	96	230
36	51	102	250
40	60	108	270
42	70	120	330
48	80	132	370
54	90		

Installation and Backfilling

In any below grade piping installation, the quality of the installation is the key factor in the long-term performance of piping materials. The ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications serves as the basis for successfully installation and backfilling of Weholite.



Trench Cross Section

Trench Excavation

The trench should be excavated to the required grade and alignment as shown on the contract drawings or as directed by the supervising engineer. The depth of the trench must be adequate for the placement of bedding materials, and the bedding and foundation materials (where the existing native materials are unsuitable for bedding).

Local regulatory and safety requirements for trench side-wall bracing must be followed at all times. When using a trench box, and where soil conditions are suitable, step the trench wall at a point approximately ¾ of a pipe diameter above the initial bedding grade. The trench box should sit on the step and it should be raised as the backfill operation progresses.

Where trench walls are stable or supported, the minimum trench width shall be the larger of the pipe OD plus 16 inches or the pipe diameter times 1.25 plus 12 inches. The maximum trench width should not exceed the minimum trench width by more than 18 inches.

Table 2- Minimum Trench Widths

NPS	*Minimum Trench Width (in) ASTM D2321*	*NPS*	*Minimum Trench Width (in) ASTM D2321*
18	*37*	*60*	*96*
19.5	*40*	*66*	*104*
21	*42*	*72*	*112*
24	*46*	*78*	*120*
27	*50*	*84*	*128*
30	*54*	*90*	*136*
33	*59*	*96*	*144*
36	*63*	*102*	*152*
40	*68*	*108*	*160*
42	*71*	*120*	*176*
48	*79*	*132*	*192*
54	*87*		

In addition to safety considerations, trench width in unsupported, unstable soils will depend on the size and stiffness of the pipe, stiffness of the embedment and in-situ soil, and depth of cover. Please refer to ASTM D2321, Appendix X1 for more details.

Where water is present in the trench, excess water should be removed before laying the pipe. Maintain water level below pipe bedding and foundation to provide a stable trench bottom. Use, as appropriate, sump pumps, well points, deep wells, geofabrics, perforated underdrains, or stone blankets of sufficient thickness to remove and control water in the trench. During dewatering do not remove the fines from the foundation or bedding materials. It may be desirable to place a geotextile if the fines would otherwise be washed away during dewatering. Dewatering of excavation limits shall be maintained until backfill operations reach finish grade or as otherwise approved by the engineer of record.

If groundwater is encountered, potential flotation of the pipe following construction should be evaluated. Antiflotation restraints, such as collars or anchors, may be required in some circumstances.

Pipe Embedment Materials

The embedment is material immediately surrounding the pipe. All pipe, but especially flexible pipe, such as Weholite, are typically designed to rely on the stiffness of the soil surrounding the pipe for support. Pipe embedment materials are grouped by ASTM D2321 into five embedment classes as shown in the Table 3.

General recommendations for use of the various types of materials for foundation, bedding, haunching and backfills are given in Table 4. For more detailed information please refer to ASTM D2321.

The type of material, the degree of compaction, and the allowable maximum particle size for the embedment should be specified in the contract documents.

When coarse, open-graded material is placed adjacent to a finer material, fines may migrate into the coarser material under the action of the hydraulic gradient from groundwater flow. In general, where significant groundwater flow is anticipated, avoid placing coarse, open-graded materials adjacent to finer materials, unless methods are employed to impede migration, such as the use of an appropriate filter fabric along the boundary of the incompatible materials.

On site or native soils may be satisfactory for use in the select backfill envelope, but the properties of those soils must be evaluated by a competent geotechnical engineer and approved by the project engineer for use as the select backfill material.

Foundation

The foundation must support the bedding, pipe, embedment, backfill, and any live loads. If the foundation is unsuitable, it must be removed and replaced with suitable material. A description of what material is unsuitable for the foundation and what soil is suitable as a replacement material should be part of the contract documents. Please refer to Table 4 for guidelines on the suitable materials.

Not all foundation problems may be anticipated in the design stages. If any unusual conditions are encountered during trench excavation, site-specific modifications may be required.

A foundation is considered to be stable for laying pipe when a person can walk on the surface without sinking into the soil or can walk without feeling the soil move underfoot.

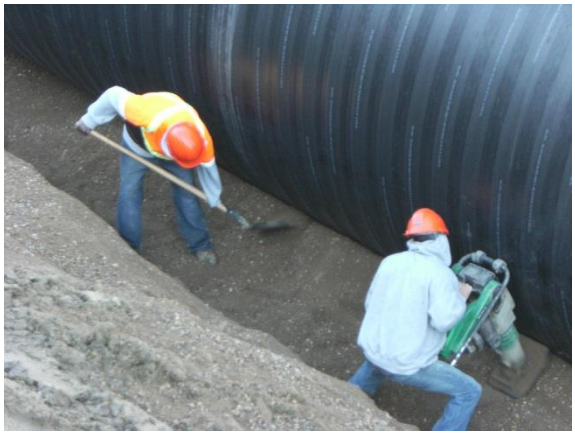
Bedding

The bedding is material placed over the foundation to provide uniform support for the pipe bottom. Bedding helps compensate for irregular trench bottoms and irregular foundation support. The bedding is constructed so that the pipe is at the proper elevation and slope when pipe is laid on the bedding. The thickness, type of soil, and degree of compaction for the bedding should be specified in the contract documents.

Typically, the minimum bedding thickness is 6 inches, the bedding material is often the same material used for the pipe embedment and it is compacted by mechanical mean to at least 90% Standard Proctor Density.

Haunch Backfill

The haunch support zone is critical to the support and performance of the pipe. Backfill in the haunch area should be angular and well graded. Class I or Class II materials as defined in ASTM D2321 are suitable. Material in Class III through Class IV may be suitable as limited by Table 4, subject to the recommendation of a soils consultant. The backfill in the haunch area should be shovel sliced and hand tamped with a haunch-tamping tool to ensure that no voids remain. When compacting material in the pipe haunch area, prevent the pipe from rising due to the compactive effort.



Initial Backfill

The initial backfill should extend to a minimum of 12 inches above the top of the pipe. Backfill should be placed evenly on both sides of the pipe in lifts of 6 to 12 inches and compacted to the required density. The same material used in the haunching shall be used for the initial backfill.

The hand-held or walk-behind compaction equipment can be used for compaction around the pipe. When compacting material over the top quarter of the pipe, place at least 12 inches of loose material over the pipe before compacting directly over the pipe with hand-held or walk-behind compaction equipment. When final backfill contains rocks, cobbles, etc., the engineer may require greater initial backfill cover levels.

Some contract documents might require the use of flowable fill (also known as controlled low strength material CLSM) as alternative to natural, manufactured and processed aggregate backfill materials. The potential for pipe flotation is high during the placement of flowable fill. The pipe will need to be weighted with sandbags, concrete blocks or held with some type of anchoring system (i.e. straps with screw anchors). The flowable fill is usually poured in lifts as recommended by the design engineer to help reduce the tendency for the pipe to float, and to prevent the pipe wall buckling.

Final Backfill

Extending from the top of the initial backfill to the ground surface, this layer doesn't directly support the pipe . Selection, placement and compaction of final backfill should be indicated in the contract documents. Requirements may vary significantly depending on terrain, surface use, etc. Backfill materials containing rocks larger than 3" should be avoided in the first 24" above the top of the pipe. Select native materials would be suitable in trenches located in open areas where minor settlement may occur in future. Granular materials may be selected if the trench is located in a roadway.

Table 3- Soil Classes, ASTM D2321[1]

	Description	***USCS Symbol***	***USCS Name***	***Sample photos (the side photos are examples of, but not limited to, the soil types as described)***
Class I	Crushed rock, angular : 100% passing 1-1/2in. sieve, </=15 % passing #4 sieve, </= 25 % passing 3/8in. sieve and </= 12 % passing #200 sieve	N/A	N/A	
Class II	Clean, coarse grained soils: SW, SP, GW, GP or any soil beginning with one of these symbols with </=12 % passing #200 sieve	GW GP SW SP	Well Graded Gravel Poorly Graded Gravel Well Graded Sand Poorly Graded Sand	
Class III	Coarse grained soils with fines : GM, GC, SM, SC, or any soil beginning with one of these symbols, containing > 12 % passing #200 sieve Sandy or gravelly fine grained soils: CL, ML, or any soil beginning with one of these symbols, with >/= 30 % retained on #200 sieve	GM GC SM SC	Silty Gravel Clayey Gravel Silty Sand Clayely Sand	

[1]Refer to ASTM D2321 for more detailed information about embedment soils and backfill materials

Table 4- General Recommendations for Installation and Use of Soils and Aggregates[1]

	Class I	***Class II***	***Class III***
General Recommendations and Restrictions	Acceptable and common where no migration is probable or when combined with a geotextile filter media.	Where hydraulic gradient exists check gradation to minimize migration. .	Do not use where water conditions in trench prevent proper placement and compaction. Not recommended for use with pipes with stiffness of 9 psi or less. Please see ASTM F894 to determine equivalent ring stiffness constant (RSC).
Foundation	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above.	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above.	Suitable for replacing over excavated trench bottom as restricted above.
Embedment	Suitable as restricted above. Work material under pipe to provide uniform haunch support.	Suitable as restricted above. Work material under pipe to provide uniform haunch support	Suitable as restricted above. Difficult to place and compact in the haunch zone.
Relative Compaction Effort	Low	Moderate	High
Compaction Methods	Vibration or impact	Vibration or impact	Impact

[1] Refer to ASTM D2321 for more detailed information on soils and aggregates.

Minimum Cover Requirements for Weholite under Construction Equipment Loads

For the light- compaction equipment (i.e. rammers, vibratory plates, walk-behind rollers etc.), provide cover (depth of backfill above top of pipe) of at least 12 in.

To preclude damage to the pipe and disturbance to pipe embedment, a minimum depth of backfill above the pipe should be maintained before allowing vehicles or heavy construction equipment to traverse the pipe trench. The minimum cover shall be determined by the design engineer through analysis based on material properties, diameter, live load, embedment material, and compaction. Infra Pipe Solutions can provide assistance with determination of minimum cover requirements.

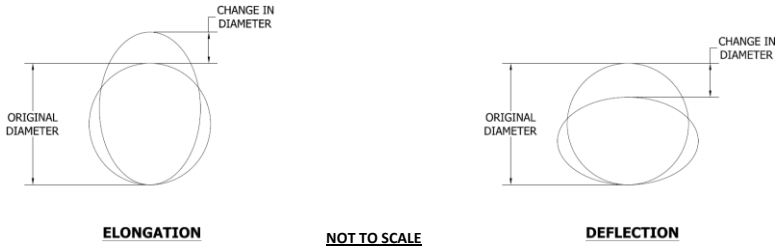
Parallel Pipe Installations

If two or more pipes are laid in the same trench, sufficient space must be provided between the pipes so that embedment material can be compacted.

The use of free flowing backfill, such as flowable fill, may facilitate the satisfactory installation and embedment of pipe in trenches narrower than specified above.

Elongation and Deflection

In general, placement and proper compaction of the initial backfill will tend to increase the vertical dimension of the pipe (a.k.a elongation). Placement of the final backfill will tend to decrease the vertical dimension of the pipe (a.k.a deflection).



At the start of the project, measurements should be taken after the initial backfill is 12 inches above the top of pipe, and again after the final backfill is complete. The difference between the two values is the initial deflection. Each project will have an anticipated by design a long-term deflection due to imposed loads. Contact the project engineer if this value has not been provided.

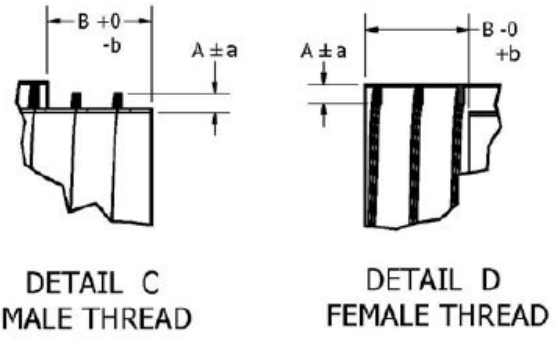
It is common practice to limit initial deflection to levels of two or three percent less than the allowable long-term value. Typically, the maximum long-term deflection is in range of 5% to 7%. If the amount of initial deflection exceeds limit set by the contract document, it indicates that side support is less than the design value due to insufficient compaction of the initial backfill. Consequently compaction should be checked, corrected, and increased as necessary for the balance of the installation.

Joints

Weholite pipe may be joined by extrusion welding, mechanical coupling and threaded joining.

Threaded Joint:

The pipe is supplied with threaded ends. It can be assembled in the field by spinning the ends together. When used with a direct burial pipe, threaded joints are suitable for drainage (no leakage limit specified) applications. The threaded joint is sand and silt tight.



Weholite Coupling Connection:

A mechanical coupling meeting the joint qualification requirements of ASTM D3212 is available and suitable for projects where the leak test requirements are as stringent as 25 USG/ inch diameter/ mile of pipe/day. This jointing system can tolerate minor pipe end misalignment. To use this mechanical coupling system the pipe must be ordered with profile cut ends.

Flanged Joints:

Flanged connections are restrained joints. Weholite is an ID controlled product with a profile wall thickness that prevents use of the same NPS bolting pattern. Flanged joints using the next larger NPS Class 150 bolting pattern have been successfully used. When the flange bolting pattern size is 24” or less it conforms to ANSI B16.5, Class 150. The 27” through 60” bolting pattern conforms to ANSI B16.47, Series A, Class 150, and larger sizes conform to AWWA C207 class B.

The metal flange acts as a backup flange and it is located behind a PE ring that is welded to the ‘face’ of the straight cut pipe. The PE ring outer diameter matches the OD of the flange.

There will be some modest mismatch in the faces when the flanges are first connected. When transitioning between Weholite and pipe of other materials at a flanged connection, leave a pipe length equal to at least 1 pipe diameter ‘free to move’, until the bolting connection has been completed. Slowly tighten the bolts in the usual arrangement and allow the pipe to strain to the required position. Do not strain more than ¼” at each bolt tightening and allow at least 1 hour between tightening sequences.

Extrusion Welding Joints:

All pipes to be welded shall be supplied with profile cut ends. When Weholite pipe is joined by extrusion welding, the surfaces to be joined must be heated at the weld bevel, and PE extrudate placed at the prepared bevel surface. Temporary reusable alignment bands are put around the exterior of the pipe at the joint, covering both pipe ends. The space between the pipe ends is heated and is filled with molten PE resin. The specialized welding equipment and a crew of field service technician(s) from Infra Pipe Solutions perform this work.

The inner wall (IW) weld is preferred whenever the physical space inside the is suitable for use. Generally the pipe diameter must be 36 inch or larger to provide sufficient room for a technician to work. The IW

weld is executed without creating a working pit under the pipe. A pit is required when manually placing an outer wall (OW) extrusion weld.

To create an OW weld, generally 2 feet of clearance is required at spring line, and a pit with a width and depth of 4 feet is required under the pipe. After welding, the pit must be backfilled and the materials compacted in accordance with the requirements of the contract documents.

The reusable alignment band is to be left in place during the welding process and then moved to the next joint once the weld has been completed. When a pipe is to be welded on both the OD and ID, the alignment bands should be removed after the ID weld has been completed.

Where required by internal operating pressure the full wall weld (FW) of a Weholite pipe can be extrusion welded using specialized equipment. This process enables the pipe to be connected at both the inner and outer pipe walls in a single operation from within the pipe. During installation of the pipe in the trench, a gap of 1 ¼" to 1 ½" is left between pipes.

Infra Pipe Solutions internal weld procedures have been developed to describe in detail how manually and semi-manually executed extrusion welds are to be made. Contact Infra Pipe Solutions for a copy of the current procedures.

Pipe may be joined at ground surface and then lowered into position, provided it is supported and handled in a manner that precludes damage. Welded joints meet the performance requirements of ASTM D3212 for gravity flow applications.

Manhole or Structure Connections

To prevent point loads from occurring where the PE pipe enters the rigid structure (concrete manhole, tank or valve chamber), it is necessary to limit the movement of the flexible Weholite PE pipe. The most effective way to limit differential movement between the Weholite PE pipe and the rigid structure is to provide an appropriately rigid soil structure around the pipe. This is easily achieved with well-graded aggregates that are compacted to 95% SPD.

Typically, the soil next to more rigid structure is over-excavated to a depth of not less than 12 inches over a distance of 2 pipe diameters along the pipe line; over the next 2 diameters away from rigid structure, the depth of over-excavation is gradually decreased until it meets the normal trench depth.

Where the native soils themselves are unstable, it may be necessary to excavate and replace the native soils with well graded and compacted granular materials. Consult the project engineers or a soils consultant to determine the extent of the replacement of native soils.

It is necessary to provide a positive mechanical connection between the Weholite pipe and a rigid structure. Since Weholite has a very smooth surface and a thermal contraction co-efficient that exceeds that of concrete, pouring a concrete sleeve around the pipe will not be effective. There are two effective methods that are commonly employed to make that positive connection. Either a PE ring can be extrusion welded to the pipe OD and the ring can be encased in concrete, or, the external wall of the pipe can be removed for a minimum distance of 2 profile turns, and the 'exposed web' section of the pipe wall can be encased in concrete.

When it is necessary to also ensure that there is no leakage occurring through this mechanical joint area it is necessary to add a hydrophilic gasket to provide a hydraulic seal. Hydrophilic gaskets swell when wet. The forces that result from the swelling of the gasket can be substantial. Contact a gasket supplier to determine the appropriate type and thickness of gasket for the concrete cover available.

Visual Inspection

The pipeline should be visually monitored during construction to check alignment, presence of debris and obstructions, excessive deflection or deformation, and connections. The inspection may be made by personal observation, photography, video, or visual lamping.

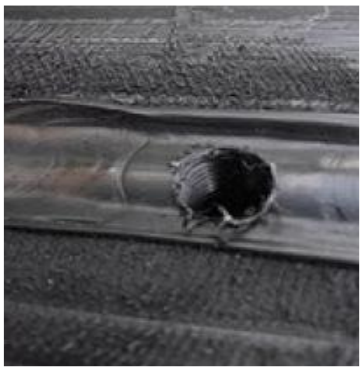
Leak Testing

After the pipe has been laid, joined, and backfilled, the pipeline shall be tested if required by the contract documents by infiltration or exfiltration of water, or pressure testing of joints with low pressure air.

An acceptable ASTM specification for testing infiltration/exfiltration is ASTM F2487. Typically, the allowable leakage rate for Weholite infiltration/exfiltration water testing is 5 USG per inch of pipe Diameter per mile of pipe per 24 hour day.

For testing conducted on the inner wall (IW) or full wall (FW) welded joint with a low pressure air, a testing apparatus with inflatable bladders is used to isolate the joint and create a circumferential cavity at the joint. The cavity is placed under low air pressure. The allowable pressure loss is a loss of 0.5 psi air, in an 8-minute duration, in a test section that has been pressurized to 4 psi.

Infra Pipe Solutions also developed the low-pressure air testing procedure for the joint formed by inner wall (IW) plus outer wall (OW) weld. Please contact Infra Pipe Solutions representative for a copy of the current procedure.



Repair Methods

This section deals primarily with repairs to Weholite due to handling, installation or to damage which has occurred after the pipe has been in service. Typically these will be repairs to punctures of the inner or outer wall surfaces caused by point loading. Pipe that is used in watertight applications must be repaired by welding. Welding repairs must be done by qualified and experienced PE extrusion welding technicians.

If the damaged area is sufficiently small, it may be possible to repair the puncture by manually extrusion welding the puncture. A small puncture is one that does not result in a gap exceeding ½" in width, and which is not more than 6" long. The puncture must not have damaged the web portion of the pipe wall (the portion separating between the inner and outer wall 'skins'). Prior to welding, the area surrounding the puncture extending approximately ½ inch (1 cm) to either side of the puncture must be scraped to remove the exposed weathered surface. Do not use chemical agents to remove this 'weathering'.

Punctures that are dimensionally larger than ½" gap by 6" long, but which have not damaged the pipe wall element separating the inner and outer skin, should be repaired by cutting out the damaged section and replacing it with a 'patch' of inner or outer wall taken from an unused portion of Weholite pipe. The patch must be carefully trimmed to match the dimensions of the hole. The patch and the pipe wall should be chamfered and scraped to remove exposed weathered surfaces, immediately prior to welding. Do not use chemical agents to remove this 'weathering'.

The weld material (extrudate) must be of the same type as the pipe to ensure that the density and melt flow index of all materials to be welded together are the same. It can be either granulate or filler rod as required by the welding equipment used.

Where a puncture has damaged the web portion of the pipe wall, it will be necessary to cut out that section of pipe and to replace it with new pipe. Joining pipe sections is described in detail in welding procedure WPS01 and WPS02 which are available from your Infra Pipe Solutions representative.

Contact your local Infra Pipe Solutions representative if you have any further questions regarding repair methods.

The Importance of Safety on the Jobsite

The subject of safe field working conditions is important to Infra Pipe Solutions personnel. Our field joining technicians are trained to use only safe working practices and the best safety equipment. Any activity that might endanger the health or safety of others will be avoided. While no summary of safe working practices can cover all aspects of safety, included here are a number of important rules:

Define the potential hazards of the operation, materials, equipment and environment and plan the work to minimize such hazards. Many hazards may not be easily identified or readily apparent.

Wear the necessary safety equipment such as hard hats, safety shoes and gloves while working on the jobsite.Around the welding machinery, watch out for pinch points, and sharp edges. Do not remove any guards on the equipment.

When handling hot extruders and hot air blowers, be aware that they are operating at temperatures greater than 400 degrees F. Some units operate at high voltages. All work practices regarding the safe use of electrical tools should be observed.

The work site should be checked for hazards created by unguarded machinery, tools chemicals, fuels, heat, excessive noise, nearby traffic, overhead equipment, power lines, buried pipes and or power cables. Steps should be taken to remove or minimize the hazards that might compromise safe working conditions.

Before work begins establish with the work crew mutually agreed upon safety procedures for working around extrusion welding equipment. This includes establishing the proper hand signals to be used when hauling, lifting, and/or moving pipe and machinery.

Before entering a confined area of trench make sure that the proper shoring and timbering is in place meeting industry standards, and that proper procedures are followed.

Establish the location of the firefighting equipment and have an adequate ABC fire extinguisher on hand. Keep flammable liquids such as gasoline in EXPLOSAFE containers and away from hot surfaces such as the air blowers and the extruders. Get immediate first aid or medical attention if required.

Be prepared in case an accident or injury should occur. Familiarize yourself with the procedures set up to deal with this emergency. (i.e. the nearest phone, phone numbers for police, fire departments, etc.)

Wear safety glasses in operating areas and additional eye protection such as chemical goggles and face shields when greater danger of eye injury exists.

Remove rings, watches, tuck in or remove ties, secure cuffs and loose clothing when near moving or operating machinery.Wear safety footwear, gloves, and hearing protection as appropriate.

Use a lock, tag, or equivalent procedure to prevent accidental starting of machinery when making changes, adjustments or repairs on powered equipment.

This section is not intended to be a comprehensive guide to Government regulations or to the practices and methods applicable to every situation. It is equally important and advisable for you to refer to the appropriate Government regulations applicable to your jurisdiction.

Infra Pipe Solutions Ltd.
6507 Mississauga Road
Mississauga, ON L5N 1A6 CANADA
Tel: 866.594.7473
Fax: 905.858.0208
Web: www.infrapipes.com