TECHNICAL NOTE

Culvert Sliplining and Lining of Casings with HP Pipe

TN 5.14
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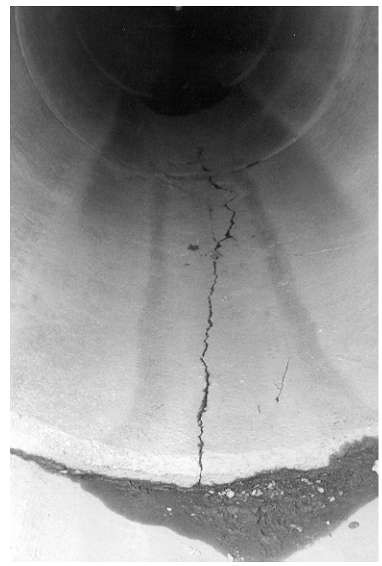
Introduction

It may be at times necessary, in an aging infrastructure, to rehabilitate drainage and sanitary lines by lining them with a new pipe. An abrasive or corrosive environment can cause premature deterioration of some types of pipe. In lieu of a total replacement, sliplining the existing pipe with a durable material may be an economical method to significantly extend the service life. N-12® HP pipe made with polypropylene (PP), is often the product of choice to slipline deteriorated pipes because of its resistance to aggressive environments.



In sanitary sewer, it is often necessary to use tunneling techniques to install a casing pipe for under high volume roads or other sensitive areas where the ground surface cannot be disturbed. SaniTite® HP pipe can be used, as appropriate, in sanitary sewer applications as the carrier pipe inside a casing pipe. The technical considerations for sliplining and lining casing pipes are similar and so the first part of this technical note describes the site and installation considerations that must be evaluated before using N-12 HP pipe in culvert sliplining; later the specific use of SaniTite HP in sanitary sewer casing applications will be addressed.

Access to the Host Pipe

The "host" pipe may be open on both ends, as in a culvert application, or it may be accessible only through a manhole opening, as in a storm or sanitary sewer applications. An HP product may only be used in applications in which the pipe is installed in such a way that the pipe is not bent during installation.

Diameter of the Host Pipe

The greater of either the outside diameter of the liner pipe or coupler should be compared to the inside diameter of the host pipe. This may be accomplished by attempting to pull a short section (~2 feet in length) through the host pipe as a trial run. The host pipe should be free from sediment and debris so as to not interfere with the installation of the liner pipe. Sliplining installations may be subject to thermal length changes and should be designed with a minimum of 10% clearance between the pipe's outside diameter and the host pipe's inside diameter. It is important to have adequate clearance between the host pipe and the carrier pipe for installation and eventual grouting measures. The maximum outside diameters of HP pipe products are shown in Table 1.

Table 1
Dimensions of HP Pipe Products

Nominal Inside Diam. in (mm)	Max Outside Diam.* in (mm)
12 (300)	14.6 (371)
15 (375)	17.8 (452)
18 (450)	21.4 (544)
24 (600)	28.2 (716)

Nominal Inside Diam. in (mm)	Max Outside Diam.* in (mm)
30 (750)	35.7 (907)
36 (900)	41.4 (1052)
48 (1200)	53.9 (1369)
60 (1500)	66.6 (1692)

* Contact ADS for additional guidance if anticipated OD values provided may not provide adequate clearance.

Length of Installation

HP pipe joints are not designed to withstand large pulling forces. It is also important not to damage pipe ends while pushing the liner pipe in through the host pipe. The method of installation will affect, in large part, the maximum length that can be slip lined without damaging the pipe. Using skids, especially in a corrugated host pipe, will help minimize resistance between the two surfaces and allow for longer installations. A push-and-pull technique keeps stress on the joints to a minimum. Maximum pushing forces listed in Table 2 shall be adhered to.

Table 2
Maximum Push Force on HP Products

Nominal Inside Diam. in (mm)	Max Force Pounds (kN)	Nominal Inside Diam. in (mm)	Max Force Pounds (kN)
12 (300)	1500 (6.7)	30 (750)	4500 (20.0)
15 (375)	2000 (8.9)	36 (900)	9000 (40.0)
18 (450)	3000 (13.3)	48 (1200)	12000 (53.4)
24 (600)	4500 (20.0)	60 (1500)	16000 (71.2)

Hydraulic Considerations

In situations where one is lining an existing pipe, careful evaluation of the current and desired hydraulics should be accomplished. Original design calculations may be referenced; however careful attention should be given to changes in land use which would change the calculated runoff tributary to the culvert. Once a discharge has been determined, the required size of the pipe may be established. If original design calculations are not available, the project engineer should complete a thorough drainage study. A culvert size can be selected based on watershed attributes, design storm, allowable headwater, culvert entrance conditions and any other related design factors.

In many cases, where culverts are too deep to make replacement practical, slightly reduced hydraulics may be an acceptable tradeoff to an expensive replacement. Typically, gravity flow systems are designed using Manning's Equation with an 'n' value of 0.012 for HP products. It should be noted that culverts in need of relining do not have Manning's 'n' values typical of original design values. Relining with smooth interior HP pipe may actually increase the capacity of the deteriorated culvert.

Structural Requirements

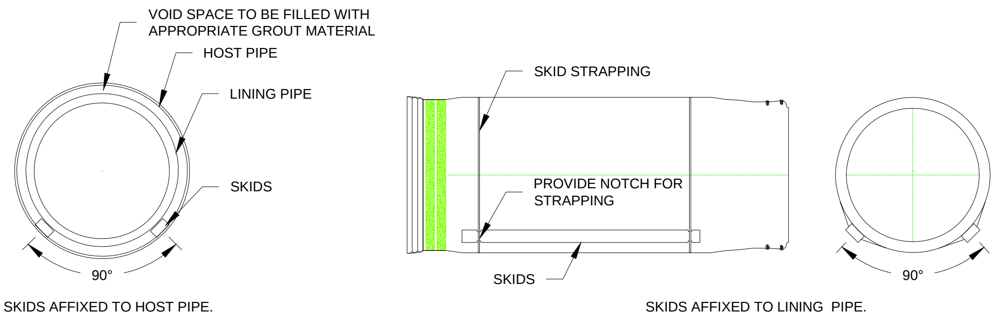
Failing culverts in need of relining may eventually deteriorate into a conduit with no structural integrity at all. For this reason, it is important to reline with a pipe product capable of handling the loads based on expected loading conditions and assuming no load reduction from the host pipe. Loading for highway and pavement tunnels shall be based upon a continuous load carrying structure for the height of cover under HS-25 loading. Voids between the surrounding soil and the host pipe shall be pressure grouted to ensure structural integrity and resistance to thermal effects. For more information for determining the structural capacity of HP pipe, refer to the *Structures* section of the *Drainage Handbook*.

Installation of N-12 HP in Host Pipe

Before the pipe is inserted into an existing culvert for relining, it is critical to inspect the existing culvert for any objects or obstructions, which may be extending into the barrel of the existing culvert to be relined. Failure to do this may result in a damaged liner pipe.

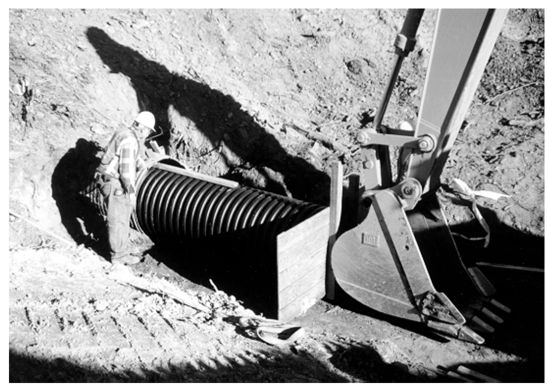
In applications where the host pipe or culvert is deteriorated, flat boards or skids shall be affixed to the culvert or the lining pipe to allow the lining pipe a suitable base to slide on. Skids can be as simple as 2x4's and it is common to place these skids in the lower haunch areas approximately 90 degrees apart, as shown in Figure 1. Typically 2 to 4 skids are used around the pipe. It is important that the skids be notched at the strap location in order to provide a smooth sliding surface.

Figure 1
Attachment of Skids to HP Pipe



Insertion Forces

Once the culvert or casing is clear, the new material may be pushed through. It is important to not exceed the maximum insertion force that can be applied to the lining or carrier pipe, as provided in Table 2. This will prevent the pipe joints from over insertion. For lengths of pipe that surpass these recommend forces, see the next section on "Sanitary Sewer Casings" or contact a local representative.



In cases where the new culvert will be two or more nominal diameters smaller than the existing culvert, it is possible to construct mechanisms to transport the new culvert along the existing culvert without sliding across the invert. Although ideal for construction, many times there is insufficient room to allow for this technique.

Grouting Procedures

When relining a culvert with HP pipe, it is recommended to fill the void space between the existing culvert and the lining pipe with grout material. The grout material is often a controlled low strength material (CLSM), also referred to as controlled density fill, CDF, or flowable fill. CLSM will help provide uniform support on the sides of the pipe, maintain a consistent soil density, provide lateral support for the pipe, and eliminate point loads. For more information on flowable fill mix, refer to Technical Note 5.02: *Flowable Fill Backfill for Thermoplastic Pipe*.

It is common for aging metal culverts to have deteriorated or completely destroyed inverts. This allows the fluid carried through the culvert to create void space under the pipe, creating an undesired condition. The grout material will help plug and fill any fractures or holes in the existing culvert along with structurally stabilizing the system from thermal effects, hydrostatic pressure, point loads, and function as a water barrier.

To ensure proper alignment and prevent joint separation, the pipe should be anchored against flotation when placing the grout material. Grouting in layers thin enough, such that they don't float the pipe, helps tremendously. Each layer should be allowed to set up between pours.

Contractors may have other techniques that will also prevent flotation such as the use of deadweight inside the pipe. Regardless of the method used, it is also important to avoid applying point loads to the pipe. For more information on flotation and anchoring methods, refer to Technical Note 5.05: *Pipe Flotation*.

When HP pipe, or any flexible pipe, is used as a liner, it is very important not to use excessive grout pressure. In most circumstances, the joint, not the wall strength, will be the limiting factor for establishing a maximum allowable grouting pressure. Including a factor of safety, the recommended maximum grouting pressure for HP pipe products is 5 psi; this value may vary based on specific site conditions and specific products used. During the grouting operation, gauges should be used to monitor the grout pressure exerted on the pipe system. For some applications, hydrostatic head pressure may increase the expected pressure on the pipe from the grouting. Additional pressure may also result from the slope and/or diameter of the pipe, elevation changes between the pipe and the gauge, and other conditions that should be considered during the design. The sum of all pressures that will be exerted on the pipe should not exceed the recommended maximum pressure for the application.

Use of SaniTite HP in Sanitary Sewer Casings

It is necessary at times to avoid open cut trenches where disruption of high volume roads, railways or other areas are not desirable. These methods are commonly referred to as trenchless pipe installation. Trenchless installations include; horizontal auger boring (HAB)),also know as jack and bore, pipe ramming, pipe jacking and micro tunneling. No matter the method of installing the casing pipe, SaniTite HP may be used to line the casing pipe in a similar way to that of drainage relining with some notable considerations.

Casing Types and Installation

The types of casings that may be used vary and may depend on the design of the overall system. Casings are most often steel pipe (non-corrugated), however Portland cement concrete pipe or fiberglass reinforced polymer mortar pipe may also be used. When concrete or fiberglass is used it is most often not lined with another carrier pipe. Typically casings are designed to carry the full overburden load, but The casing pipe may be designed to carry the whole load of the over burden fill or work in conjunction with the carrier pipe to perform structurally.

Casing Spacers and Skids

As previously noted, skids may be attached to the carrier pipe to provide a sliding surface between the casing and the carrier pipe as depicted in figure 1. It is important that the skids be notched where the straps are to provide a smooth sliding surface. Typically 2 to 4 skids are placed around the pipe. These skids run the length of the pipe, however should not be located in the spigot portion of the pipe as this may affect joint assemble.

Commercially available casing spacer may also be used to slide and guide the carry pipe into the casing. When using dual wall sanitary pipe it is important that spacers be chosen that span at least two corrugations. Small section of lumber may be used under the spacer to act as a bridge for the spacer to set on. Casing spacers are typically manufactured from polyethylene, but other non-corrodible materials are available. Casing spacers are often easier to use than wooden skids. The casing spacer manufacturer should be contact for information on location and number of spacers required; or contact your local representative. Generally a spacer shall be placed at the joint (on the bell side) and no more than 5 feet apart. Typically, casings are designed to carry the full overburden load.

Installation of Carrier Pipe in Casing

The installation of the carrier pipe through the casing pipe is much like that of culvert relining. It is important that the casing pipe be smooth and clear of any obstructions. It Skids may be placed on the casing pipe, however it is typical in these applications that skids or casings spacers are affixed to the carrier pipe. These skids or casing spacers will slide along the invert of the casing pipe. Please refer to Table 1 and 2 above when determining the diameter of the casing pipe, skids/spacer, as well as maximum insertion forces. The casing, skids or spacers may need to be lubricated to allow easier installation. .

There are two common installation techniques that may be used. The first method simply involves joining successive carrier pipe joints together outside of the casing while pushing the carrier pipe through the casing. It is recommended that a push stub be used at the joint end of the pipe to protect it construction equipment. A second method involves passing a cable through the casing and the first stick of pipe. On the opposite end of the pipe a suitable cross piece is installed as well as protection for the pipe joint (push stub). The cable is pulled through the casing by a wrench or other mechanical equipment thus bringing the carrier pipe inside the casing. Once a majority of the first pipe is inside the casing, the cross piece is disassembled and attached to the next pipe, joints are assembled and the operation begins again. See Figure 2.

If maximum insertion forces are being exceeded, it is important to adjust the construction technique so as to not damage the carrier pipe. One solution is to install a cable through the casing and a length of pipe, similar to above. Instead of joining adjacent pipes outside of the casing, in this method the pipe is brought to the opposite end of the casing and successive pipes are brought into the casing and joined inside the casing. See Figure 3. It is important to note that access to the carrier pipe during joint assemble inside the casing is imperative for proper joint alignment.

Figure 2
Installing HP Pipe in Casing

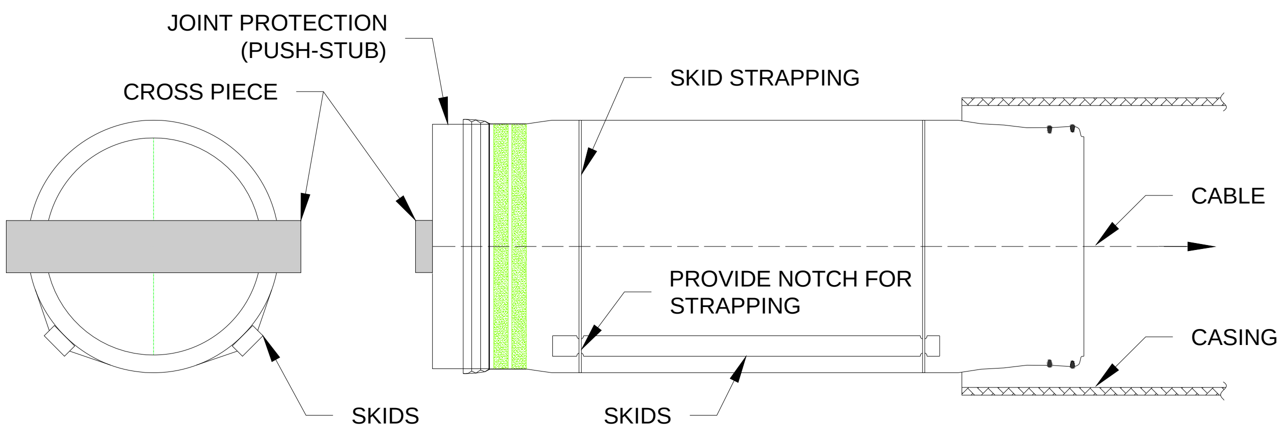
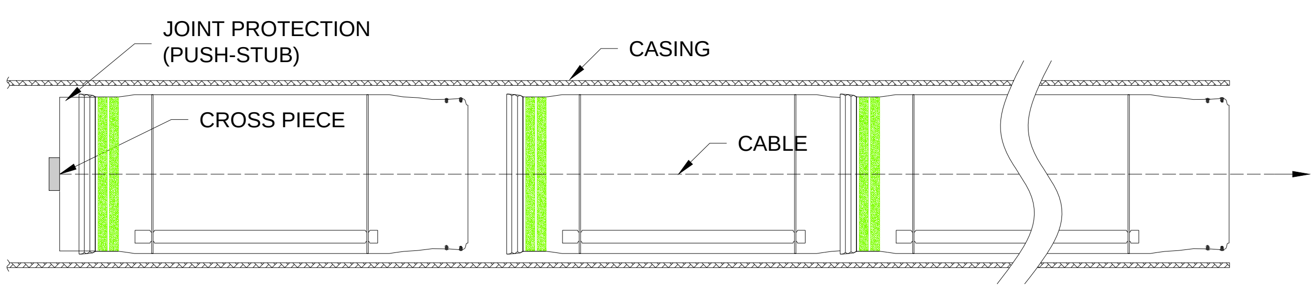


Figure 3
Alterative Installation Method
(Used when maximum insertion forces are likely to be exceeded)



Closure of Casing

All testing is to be completed prior to the casing being sealed off. Once the carrier pipe has been tested and satisfies the project specifications, the casing may be sealed with a masonry bulkhead or rubber boot as directed by the project specifications.

Grouting

When called for by the specifications the annular space between the carrier pipe and the casing may be filled with an appropriate grout material. It is important to adhere to the grouting procedures outlined above to prevent joint damage due to excessive grout pressure and flotation. If grouting is not specified, the bottom of the carrier pipe shall be continuously supported. Shims, skids, or blocking resting on the casing pipe may be used to uniformly support the bottom 1/4 of the carrier pipe. Alternatively the carrier pipe may be supported with grout material, partially filling the annular space approximately ¼ of the outside diameter of the carrier pipe.