14 Relining Existing Pipe Structures

CHAPTER FOURTEEN:
RELIGNING EXISTING PIPE STRUCTURES

A new method of reconditioning existing structures, by which an existing structure is relined with a polyethylene liner approximately the same diameter as the inside diameter of the existing pipe, is currently being used. Using this method saves costly disruption to traffic, especially in areas where a structure has a high fill over the pipe.

SLIP LINING ROADWAY CULVERTS WITH POLYETHYLENE CULVERT PIPE

High density polyethylene pipe liner is used for relining existing in-place concrete, vitrified clay, or metal culvert pipe. The annular space between the liner and the existing culvert is filled with cellular grout. The Contractor is required to furnish and install the liner and grout in accordance with Section **105.03**.

MATERIALS

The materials used to manufacture the liner are required to be high density high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34 as defined in **ASTM D 1248**. Clean rework material, generated by the manufacturer's own production, may be used if the liner produced meets all the requirements of the Specifications.

The liner material is required to be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. The liner is required to be uniform as commercially practical in color, capacity, density and other physical properties. Standard laying lengths are required to be a minimum of 19 ft, but not exceed 40 ft or as specified by the PE/PS.

The liner is required to have a maximum n-factor of .012 and be capable of maintaining a minimum flow rate equivalent to 100 percent of the original in-place culvert. The liner is also required to have a Standard Dimension Ratio (SDR) equal to 32.5, have a minimum pipe stiffness of 46 psi when tested per **ASTM D 2412**, or be Class 160 type pipe in accordance with **ASTM F 894**. SDR is defined as the ratio of the liner

outside diameter to the minimum thickness of the wall of the liner. and may be expressed mathematically as:

$$SDR = \frac{D}{T}$$

where:

D = liner outside diameter in inches
T = minimum liner wall thickness in inches

Jointing the liner is by either bell and spigot, screw type, thermal welding, or a grooved press-on joint approved by the PE/PS. The joint is required to have sufficient mechanical strength to allow the liner to be installed through the existing pipe without affecting the joint's integrity. Jointing is required to provide water tight integrity for all joints and not interrupt the flow characteristics of the pipe.

A 12 in. section of the liner is required to show no evidence of splitting, cracking, or breaking when compressed between parallel plates to 40 percent of its outside diameter within 2 to 5 minutes. The liner is required to have sufficient rigidity to withstand being placed by either pulling or pushing and exhibit a minimum amount of distortion.

The manufacturer is required to furnish certifications to the Office of Materials Management stating that the materials used in the manufacture of the liner meet the requirements of **ASTM D 1248** for the type, class, category, and grade specified. The manufacturer is required also to certify that the finished liner is in compliance with this Specification.

The materials used to manufacture the cellular grout are required to be in accordance with the following:

Fine Aggregate …….**904.01**
Fly Ash …….**901.02**
Foam Concentrate …….**ASTM C 796**
Water…….**913.01**

Admixtures, retarders, and plasticizers used are required to be in accordance with the foam concentrate Supplier's specifications. Portland cement is required to be in accordance with Section **901.01 (b)**, except Type II cement is not allowed.

The grout is made using the preformed foam process using generating equipment calibrated by the manufacturer to produce a precise and predictable volume of foam. The foam concentrate is certified by the manufacturer to have specific liquid/foam expansion ratio at a constant dilution ratio with water.

The specific job mix is submitted by the foam concentrate certified Contractor to the PE/PS for approval prior to use on the contract. The mix is required to have a minimum 28-day compressive strength of 150 psi or be approved based on prior acceptance and suitable performance on INDOT contracts.

Grout mixed off site is delivered to the job site in a truck mixer in accordance with Section **702.09,** filled to half of the mixer. The foam concentrate is then added to the cement mix in the truck and mixed to a uniform consistency.

Grout mixed on site is hatched in a deck mate or a similar device. Small batches of approximately 1 yd^3 are mixed and pumped in a continuous operation.

For each day worked or for each 100 yd^3 placed, four test cylinders measuring 3 in. by 6 in. are cast. The cylinders are prepared, cured, and transported in accordance with **ASTM C 31** and **ASTM C 192**. The cylinders are tested in accordance with **ASTM C `39**, except the test specimens are broken within the permissible tolerance prescribed as follows:

Test Age	Permissible Tolerance
24 hours	½ h
3 days	1 h
7 days	3 h
28 days	22 h

The cylinders are obtained from the point of placement.

EQUIPMENT

All equipment necessary for the satisfactory performance of this work is required to be approved by the PE/PS. The equipment includes all machinery necessary for the installation of the liner, grout, and the reworking of the temporary easements.

The equipment used to produce the grout and all equipment used in the mixing, pumping and placing is certified as to suitability by the Supplier of the foam concentrate.

The Contractor supplying and placing the grout is certified by the foam concentrate Supplier and is required to be capable of developing a mix design, batching, handling, pumping and placing grout under the contract conditions.

RIGHT OF ENTRIES

All right of entries necessary for the work are required to be acquired by the Contractor. All damage within these areas is repaired to the original condition and bare areas having sod cover are required to be repaired. The Contractor is required to install and maintain temporary fence as directed by the PE/PS.

CONSTRUCTION REQUIREMENTS

The Contractor is required to re-establish the flow line of any eroded inverts, with grout meeting the requirements as set out in the Specifications. Pre-mixed grout may be used subject to approval of the PE/PS. The Contractor is required to maintain a positive flowline in the liner. Any obvious cavities under the existing pipe are filled with grout.

After the liner has been completely inserted and has been inspected by the PE/PS, the liner is cut off flush with the ends of the existing culvert or as directed by the PE/PS and grouted in place. If the liner had been exposed to the sun before insertion is made, the liner is allowed to cool to the temperature of the existing culvert before being cut off and grouted.

Block and mortar bulkheads are placed at both ends of the culvert. A 2 in. vent hole at the crown and a 1 in. hole at the invert are placed in the downstream bulkhead. An access hole, sized to facilitate the method of grout input, and a 2 in. air vent are placed at the crown in the upstream bulkhead.

The grout is placed from the upstream end of the culvert where practical. The vent holes in the downstream bulkhead are plugged as soon as grout begins to flow out each hole. The 2 in. air vent in the upstream bulkhead is kept clear until grout begins to flow out of the vent.

The grout is placed by either gravity flow or by low pressure pumping to completely fill all voids within the annular space without causing deformation of the liner. The grout extends for the full length of the culvert.

Grout placed by gravity flow is limited to a maximum length of flow of 10 ft for each foot of available head per access hole. Additional access holes, where required, are drilled from the top and sleeved with 6 in. pvc piping.

Liner storage areas are required to be approved by the PE/PS. All drainage structures and ditches are required to remain open at all times, and traffic control is required to be in accordance with the MUTCD or as directed.

All liner sizes are required to be approved by the PE/PS prior to installation.

All incidental work, such as brush removal, flowline adjustments, etc., is done by the Contractor. Where required, and practical, a bull nose device is pulled through the existing culvert to facilitate the liner installation. The bull nose device is of appropriate diameter to permit the installation of the intended liner size. The pipe is completely cleared of all foreign material just prior to the installation of the liner.

JACKED PIPE

Jacking steel or reinforced concrete pipe consists of pushing the pipe through or under an embankment.

CONSTRUCTION REQUIREMENTS

An approach trench is dug at the forward end of the proposed pipe to a depth sufficient to form a vertical face at least 1 ft higher than the top of the pipe and large enough to provide ample working room. The size and height of this vertical face may vary; however, the roadbed and shoulders are required to always be adequately protected. After the pipe is installed, the excavated area not occupied by the pipe is backfilled with suitable material and thoroughly compacted into place.

Sheeting and bracing is provided if the nature and conditions of the soil or height of exposed face is such as to endanger either the traveling public or the integrity of the road surface.

When the use of explosives is necessary for the prosecution of the work, their use is required to be in accordance with Section **107.11**.

When ground water is known or anticipated, a dewatering system of sufficient capacity to handle the flow is maintained at the site until the dewatering system operation may be safely halted. The dewatering system is required to be equipped with screens or filter media sufficient to prevent the displacement of fines.

Jacked pipe is constructed so as to prevent leakage of any substance from the pipe throughout the length of the pipe. Installation by open-trench methods is permitted only at locations indicated and is required to be in accordance with the applicable specifications for that type of installation.

JACKING

Excavation is undertaken within a steel cutting edge or shield attached to the front section of pipe to form and to cut the required opening for the pipe. Excavation is not carried ahead of the pipe far enough to cause a loss of soil. When jacking in loose, granular, or running soils, the shield is required to have a means for inserting steel baffle plates and shelves for the purpose of preventing voids.

The thrust wall is required to be adequate for installation of the jacked pipe and be constructed normal to the proposed line of thrust.

A suitable lubricant, such as bentonite, may be applied to the outside surface of the jacked pipe to reduce frictional forces. This material is applied by the use of pressure equipment which pumps the lubricant to the outside of the shield on the lead pipe. The lubricant may be pumped outside the surfaces of the pipe through the grout holes.

The thrust load of the jacking equipment is imparted to the pipe through a suitable thrust ring which is sufficiently rigid to ensure distribution of the load without creating point loading.

When necessary to prevent loss of soil at the heading, the face of the excavation is required to have an adequate bulkhead when the work is shut down at the end of the working day.

Bracing, backdrops and jacks are required to be sufficient so that jacking may progress without stoppage, except for adding lengths of pipe, until the pipe reaches the leading edge of the pavement as shown on the plans.

BORING

Boring consists of pushing a pipe into the fill with a boring auger rotating within the pipe to remove the spoil. Advancement of the cutting head ahead of the pipe is not allowed, except for that distance to permit the cutting head teeth to cut clearance for the pipe. If granular, loose, or unstable soil is encountered during the boring operation, the cutting head is retracted into the casting a distance that assures no voiding is taking place. The excavation by the cutting head is required to not exceed the outside diameter of the pipe by more than 1/2 in. The face of the cutting head is arranged to provide reasonable obstruction to the free flow of soft or porous material.

The use of water or liquids to soften or wash the face of the cutting head is not permitted. Water may be used in sticky clays to facilitate spoil removal provided the water is introduced behind the cutting head. Lubricating agents, such as bentonite, may be used to lubricate the casing and reduce friction between the casing and embankment.

If an obstruction is encountered during installation which stops the forward progress of the pipe, operations are required to cease. The pipe is abandoned in place and filled completely with grout or other approved materials. The abandoned work is paid for in the amount of at least 75 % of the contract unit price as specified in the schedule of pay items.

Bored or jacked installations have a bored hole essentially the same as the outside diameter of the pipe. If voids should develop or if the bored hole diameter is greater than the outside diameter of the pipe by more than approximately 1 in., grouting or other approved methods are required to be used to fill such voids with no additional payment.

JACKING STEEL PIPE

For jacking steel pipe, the joints are welded in accordance with Section **711.32** and required to be water tight. The minimum wall thickness of the pipe is as follows:

Outside Diameter(in.)	**Wall Thickness (in.)**	
	Casing Contains Carrier	**Casing Used as Carrier**
18 or less	1/4	1/4
19-20	1/4	5/16
21-26	1/4	3/8
27-30	3/8	1/2
31-42	3/8	1/2
43-48	1/2	9/16

JACKING CONCRETE PIPE

Only reinforced concrete pipe of 30 in. inside diameter and larger may be jacked. The pipe is required to be class IV or stronger with tongue and groove joints. All pipes are required to have steel reinforcement concentric with the pipe wall, and, where required, additional reinforcement at the ends of the pipe. The pipe is required to be in accordance with **ASTM C 76M**.

To avoid concentrated loads at the joints from pipe to pipe, strips of plywood, asphalt roofing paper, or other similar resilient materials are inserted around the circumference in the joints as each pipe is placed ahead of the thrust ring. Resilient material is also used between the pipe end and the thrust ring.