Designation: F2985 – 14

Standard Practice for Installation of a PVC Segmental Panel Liner System in Man-Entry Size Sewers and Conduits[1]

This standard is issued under the fixed designation F2985; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The practice describes the procedures for the rehabilitation of gravity pipes, culverts, tunnels, and conduits by the installation of a field-fabricated PVC liner system. After installation of the liner system, cementitious grout is pumped into the annular space between the liner and the host structure. The rehabilitation of the host structure by this installation practice results in a rigid composite structure (PVC liner/grout/existing pipe). This type of rehabilitation process is suitable for a variety of gravity pipe applications such as storm sewers, sanitary sewers, and culverts; and with geometries including circular, egg, ovoid, elliptical, arch, and site-specific composite shapes.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)

C827/C827M Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

F2984 Specification for Segmental Panel System for the Grout-in-Place-Liner (GIPL) Rehabilitation Method of Existing Man-Entry Size Sewers, Culverts, and Conduits

3. Terminology

3.1 *Definitions:*

3.1.1 *cementitious grout, n*—the cementitious grout material is a mixture of Type B Portland cement, sand, and various admixtures designed to perform in a wet environment.

3.1.2 *panel assembly hardware, n*—the connecting long screw rods, bolts, and nuts made from carbon steel meeting SAE's classification No. 1020 with uni-chrome plating.

3.1.2.1 *Discussion*—The uni-chroming process deposits chromium onto the surface of the steel producing an anticorrosion, crack-free barrier that is compliant with the strain properties of the steel.

3.1.3 *PVC liner, n*—a tubular assembly field fabricated from injection molded PVC profile wall segments which are bolted together to form circumferential rings which are then joined together such that some portion of the entire inner circumference of the host structure is isolated from the fluid being transported.

3.1.4 *PVC segmental panels, n*—an injection molded element available in various geometries, consisting of a smooth inner surface and a ribbed outer surface (profile) with edge configurations to allow precise mechanical locking and sealing of adjacent panels.

4. Significance and Use – Summary of Practice

4.1 This practice is for use by engineers and owners involved in the rehabilitation of gravity piping, conduits, and small-scale tunnels. This practice conveys the necessary global information for the proper installation of a grout in place liner system that can lead to a full restoration of the original host soil-structure interaction system when properly designed by the local practicing engineer. In addition, this practice will also provide guidance to the design professional on how to address any modifications that must be made for any unique site-specific job conditions.

5. Materials

5.1 The injection-molded PVC panel segments and related small parts used for the field fabrication of the PVC liner shall meet the requirements in Specification F2984. The injection-molded PVC panel segments shall be sufficiently translucent so as to allow grout filling operations to be visually monitored.

[1] This practice is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

Current edition approved Dec. 1, 2014. Published January 2015. DOI: 10.1520/F2985-14

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

5.2 The adhesive/sealant used in the joining process of the panel pieces shall be polyurethane, mono-liquid, moisture setting type flexible gasket material.

5.3 The panel assembly hardware shall consist of carbon steel bolts, threaded rods, and nuts (long and standard) meeting the SAE classification 1020 that have been plated using the unichrome process or an approved equal.

5.4 The cementitious grout shall be a self-consolidating mixture of Type B Portland cement, sand, and various admixtures (shrinkage resistant and water-reducing agent, anti-foaming agent and viscosity promoter) that is displays inseparable, constant, and insoluble characteristics when in the presence of water. Grout mixtures that bleed are not acceptable. Maximum particle size of the sand used shall be 0.047 in. (1.2 mm). The cementitious grout shall exhibit no shrinkage before or after hardening when measured in accordance with Test Method C827/C827M. The compressive strength of the grout shall be a minimum of 5000 psi at 28 days or as required per the design of the composite liner system for the site-specific conditions encountered.

6. Installation

6.1 *Cleaning and Inspection:*

6.1.1 Prior to entering access areas such as manholes and performing inspection or cleaning operations, an evaluation of the atmosphere to determine the presence of toxic or flammable vapors or lack of oxygen shall be undertaken in accordance with local, state, and federal safety and confined space entry regulations.

6.1.2 *Cleaning of Pipeline*—Internal debris shall be removed from the existing pipeline. Additionally, the wall surfaces shall be water blasted using a minimum of 3000 psi at the nozzle held at a distance of 6 in. (152.4 mm) to ensure that the exposed wall is free from contamination of foreign materials and corrosion products and that the resultant surface that the grout will bond to is hard, competent material.

6.1.3 *Inspection of the Pipeline*—Inspection of the pipeline or structure shall be performed by experienced personnel trained in locating and identifying conditions that must be addressed in the design of the grout in place liner system. Specifically, the interior of the pipe or structure shall be carefully inspected to determine the location of any conditions that may prevent or adversely impact proper installation of the PVC liner such as protruding service connections, missing brick or pipe wall pieces, variations in horizontal and vertical alignment (sags, offset joints, open joints, bends, etc), major deviations to the original geometry, and groundwater infiltration (weepers, gushers, etc). Unacceptable conditions shall be noted, and as appropriate, corrected prior to installation of the PVC liner.

6.1.4 *Line Obstructions*—The existing pipeline or structure shall be clear of obstructions that will prevent the proper placement of the PVC liner. If the inspection reveals an obstruction that cannot be removed by conventional means internally, a point repair excavation shall be made to uncover and remove or resolve the obstructing condition.

6.1.5 *Bypassing*—The PVC liner process does not require a dry pipeline or structure. Installation with some flow in the existing pipe or from any lateral connections is acceptable. However, if the flow in the pipeline is deeper than 10 in. (254 mm), bypassing of the flow around the reach of the pipeline being rehabilitated is required.

6.2 *PVC Liner Installation:*

6.2.1 *Liner Installation*—The segmental panel pieces shall be ordered to cover the portion of the circumference as specified and shown on the project plans: fitting as near as is practical to the internal circumference of the structure to be lined or to produce the required annulus (space between the liner and the pipe wall). The panel segments shall be joined into rings using the fastening hardware provided by the panel system manufacturer. The panel assembly hardware shall be securely tightened to the manufacturer's stated requirements using an approved torque wrench. Prior to joining the segments together, a small bead of the sealant material will be placed in the female groove of the surfaces to be joined. The rings shall then be transported to the liner installation location. The rings shall be assembled to form a liner segment that will be shimmed in place to the specified line and grade of the finished PVC liner. Prior to joining the rings together, a small bead of sealant material will be placed in the female groove of the adjoining ring's mating surface. The joints of the segments in adjacent rings will be staggered where practical (See Fig. 1).

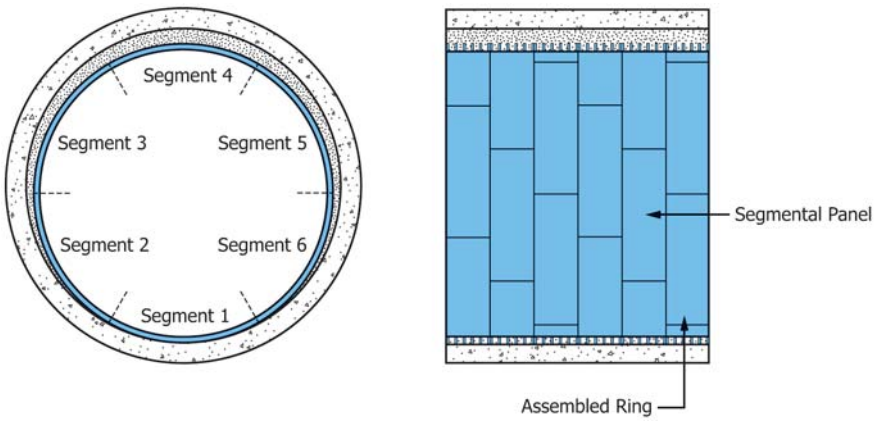

FIG. 1 PVC Liner Assembly

6.2.2 *Alignment Adjustments*—The PVC liner shall be shimmed both horizontally and vertically to follow the alignment or alignment corrections shown on the plans. The liner shall be capable of negotiating horizontal radii of curvature of 26.2 ft (8 m) or greater; and discrete deflections of up to 3-degrees shall be accommodated by manufactured bends. Vertical offsets shall be accommodated by under sizing of the ring.

6.2.3 *Grouting*—Once the PVC liner is in place, the ends of the pipe at the manhole shall be sealed by dry-packing with a rapid-setting mortar. A vent tube shall be placed in this mortar dam. Grouting inlet points shall be drilled periodically along the crown of the PVC liner to the dimensions given by the panel system manufacturer. In addition to the grouting inlets along the crown, the contractor may also choose to place additional inlets at the springline or to use the openings at the panel connection points if the segmental panel system is so equipped. The liner shall then be braced as recommended by the manufacturer, both horizontally and vertically, to ensure that the shape of the liner does not become distorted by the placement of the grout flowing into the annular space. The grouting process shall proceed (see Fig. 2) in lifts allowing sufficient time between placing of the subsequent lifts to allow the previously deposited grout to fully set (time to initial set which typically is 3-4 h). The height of each planned lift shall be a part of the grouting plan prepared by the liner material supplier for the installer. Once the grout level has passed the height of a grout injection point, a plastic plug shall be placed in the opening. There shall be no leakage of the grout at any of the joints of the liner.

6.2.4 The grout placement process shall be such that essentially 100 % of the annulus is filled. The translucent property specified for the panel system shall be used to confirm that all of the nnular space has been filled. Any visible or otherwise detected void areas shall be filled by point grouting.

6.2.5 *Service Connections*—Service connections should be cut into the PVC liner as it is being installed, leaving the lateral flow unobstructed by the lining. The connection material shall be installed in such a way as to make the penetration water tight at the new liner wall and to prevent the cementitious grout from entering the lateral during the grouting process.

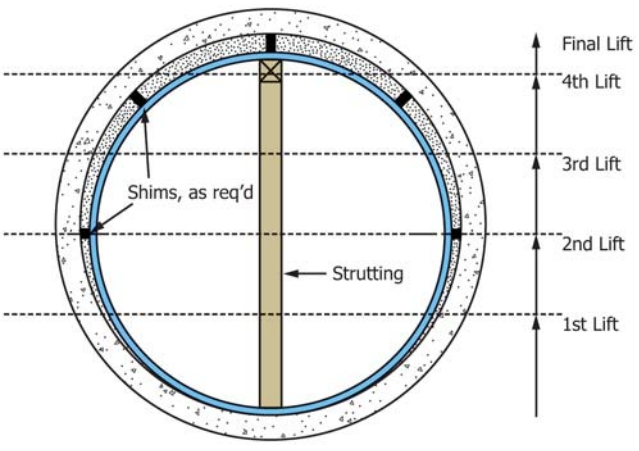

FIG. 2 Grouting Liner in Lifts

7. Inspection and Acceptance

7.1 The plastic segmental panel pieces should be inspected for damage immediately prior to their assembly. Damage that is deemed cause for rejection will consist of: *(1)* abrasions, cuts, or gouges to the wall surface extending deeper than 10 % of the wall surface thickness, *(2)* broken areas to the tongue and groove mating surfaces that will prevent the proper encapsulation of the sealant material, and *(3)* broken ribs on the back side of the wall surface that will prevent the proper installation of the panel assembly bolts.

7.2 The installation shall be inspected by CCTV or visually, if appropriate. The PVC liner shall be continuous over the entire length of the installation. Variations from true line and grade may be inherent because of the conditions of the existing pipeline; however, the installation shall follow the horizontal and vertical alignment shown on the plans as much as is practical by the variable height of the shims used to hold the liner in place for grouting. No infiltration of groundwater through the PVC liner shall be observed. All service entrances shall be accounted for and unobstructed.

7.3 *Compressive Strength Testing of the Grout*—If required by the buyer or designated in the contract documents, samples from the mixed grout being injected into the annulus shall be collected and tested for compressive strength in accordance with Test Method C109/C109M. Samples shall be taken at a sufficient frequency to verify that the delivered compressive strength values meet or exceed those stated in the project specifications for each reach of pipeline being rehabilitated.

8. Design Considerations

8.1 The design of the grouted PVC liner system is a function of the condition of the existing pipeline-soil structure interaction system. The installation's engineer of record shall make the necessary investigations to satisfy him or herself of the in situ loading requirements of the finished PVC liner/grout/host pipe/soil structure interaction system. The role of the PVC liner material is to provide a water-tight, corrosion-resistant barrier for the grout and host pipe. By virtue of the ring connecting rods being placed at approximately 6.2 in. (157.5 mm) on center around the periphery of the liner, the anchoring of the liner to the grout is assured; thus, it is the grout's strength and thickness that is designed to work in concert with the host pipe and embedment soil in taking any additional loading that comes on the new composite structure after the lining has been installed.

9. Keywords

9.1 compressive strength; grouting inlet points; grouted PVC liner system; PVC segmental panel