SUGGESTED TYPICAL SPECIFICATION FOR THE INSTALLATION OF CURED IN PLACE LATERAL LINER ACCESSED FROM THE MAIN SEWER (JUNCTION LINER)

Intent

It is the intent of this specification to provide for installation of a tubular resin impregnated sleeve affixed to the walls a lateral pipe from the the junction between the pipe and main sewer till the cleanout or given distance thereof.

General

The method involves the impregnation of an absorbent carrier material; the remote identification and location the lateral within the main; the inversion of the material into the lateral, the curing of the sleeve leaving behind a hard plastic sleeve mechanically bonded to the host pipe.

Reference specification

Tensile strength ASTM-D638

Flexural Strength ASTM D-790

Flexural Modulus ASTM D-790

Chemical Resistance ASTM D 543

Industry Specifications

ASTM F- 1216- ***Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin Impregnated Tube***

The carrier material

The carrier material shall be of fibrous absorbent composition tailored to achieve the following

1. Allow the migration of resin from its internal structure by compressing to a thickness of at least 90% of it uncompressed thickness under a pressure 1psi

2. The material must consist of non degradable fiber's such as polyester or polypropelene or Corrosion resistant fiberglass.

3. The cured material must have a smooth enough surface to allow flow through the pipe with causing blockages.

4. Where fiberglass is used a surface veil or a layer of felt must be used to act as barrier to prevent osmosis or wicking of the strands.

5. The carrier material must be resistant to the resin used and must withstand any installation forces without losing its integrity.

The resin

The resin must be a thermosetting resin cured by either heat or chemically via the use of accelerators, or any other safe energy source which does not involve the use of electric current within the main sewer, unless where evidence can supplied of the intrinsic safety.

The resin must give give sufficient working time above ground to enable impregnation of the fabric, but must cure to sufficient hardness to carry overburden loads within a maximum of 3 hours from time of insertion into the pipe.

The resin used must have resistance to most chemicals to be found within a sewer system . As a minimum it must have resistance to the following chemicals at the following temperatures

Chemical Resistance

The resin must be resistant to the chemicals likely to be within the pipe and as a minimum must be resistant to the chemicals below.

The test is done in accordance with ASTM D 543. Exposure should be for a minimum of one months at 73.4F. During this period the CIPP test specimen should lose no more than 20% of its initial flexural strength and flexural modulus when tested in accordance with Section 8 of this practice.

Chemical Solution	**Concentration**
Tap Water (ph 6-9)	100%
Nitric Acid	5%
Phosphoric Acid	10%
Sulfuric Acid	10%
Gasoline	100%

Characteristics of the Repair Sleeve

Starting Point: from	Maximum distance of 4” junction with sewer
Length in Lateral Pipe:	Up to 15 feet
Acceptable angle of lateral:	45 or 90 degrees
Time for cure at 60 degrees F	2 hours
Access requirement:	From Manhole on the main line only
Thickness:	Designed to suit. From 2mm- 6mm

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Resin Carrier Combination

The resin and the carrier fabric when cured must meet the following minimum criteria

Testing Method

ASTM- D 790

Flexural Strength	4500 psi
Flexural Modulus	250 000 psi

Testing

Visual Inspection

On completion of the work a CCTV survey should be carried out and the repairs must be verified as per below

1. There should be no evidence of water ingress from either within the lateral sleeve or the upstream termination of the sleeve.

2. The main sleeve should be watertight internally on the upstream and downstream terminations. Where bends or other defect in the existing pipe are present the maximum wrinkling allowed is 10% of the pipe diameter.

Pressure Testing

If required by the owners bid documents, testing may take place by placing a plug in the main sewer and inserting a proprietary push rod plug down the lateral. The "T" section is isolated an air is fed into the isolated section.

Test criteria and acceptable losses to be determined in advance of contract by the engineer in consultation with the contractor

Design Considerations

The design is based on the assumption of a partially deteriorated pipe. The CIPP is designed to support the hydraulic loads due to groundwater, since the soil and surcharge loads can be supported by the original pipe. The groundwater level should be determined by the purchaser and the thickness of the CIPP should be sufficient to withstand this hydrostatic pressure without collapsing. The following equation may be used to determine the thickness required:

$$P = \frac{2KE_L}{1 - v^2} \cdot \frac{1}{(SDR - 1)^3} \cdot \frac{C}{N}$$

where:

P = groundwater load, psi (MPa),
K = enhancement factor of the soil and existing pipe adjacent to the new pipe (a minimum value of 7.0 is recommended where there is full support of the existing pipe),
E_L = long-term (time corrected) modulus of elasticity for CIPP, psi (MPa)
n = Poisson's ratio (0.3 average),
SDR = standard dimension ratio of CIPP,
C = ovality reduction factor = $[1- 0.01q/ (1+ 0.01q)^2]^3$

q = percentage ovality of original pipe =

$$100 \times \frac{(\text{Mean Inside diameter - Minimum Inside Diameter})}{\text{Mean Inside Diameter}}$$

Using this formula we derive the following tables

Diameter (inches)	Thickness (mm)	Max Pressure Head ft
8	6	40
10	6	20
12	6	11
15	9	20
18	9	11
18	12	27
24	12	11

The table is based on K = 7, E = 125,000 psi (50 year strength figure), v = 0.3, C=0.64 (ie 5% ovality) and N=2

Hydraulic Design Considerations

A CIPP liner can reduce the inside pipe diameter and may affect flow in small diameter pipes, but the reduction is usually more than offset by the improved flow characteristics. These compare favorably with an existing concrete pipe's high Manning flow coefficient of about 0.015 or corrugated pipe Manning flow coefficient of 0.024. Reduced flow is insignificant in oval sewer pipes. Area reduction is only 0.6% at 5% ovalization and 2.4% at 10% ovalization

The analysis may be done using the Manning Equation

Method Statement

An assembly is made of two tubes. The clear outer tube hereinafter referred to as the Inflation tube and the inner tube made out of a 3mm thick woven absorbent fabric referred to as the Liner tube.

Resin is poured into the center of the liner tube and a roller is applied to ensure that the resin penetrates into the substrate of the tube uniformly.

A rope is attached to the back end of the inflation tube and both tubes are pulled into third tube, namely the outer Vessel tube. The rope passes through a designated hole in the back end of the vessel tube. This allows operational control of the speed of inversion/extrusion (see below).

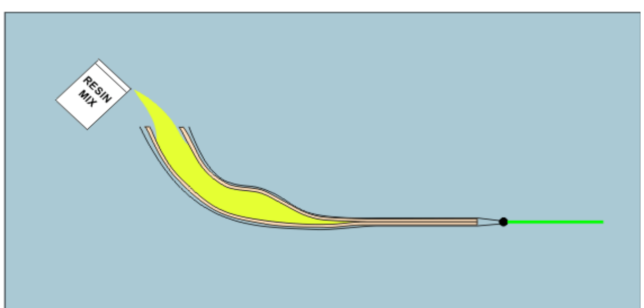
The liner and inflation tube are extended and affixed to the nose cone of the vessel tube.

Air is applied into the Vessel tube, this has the effect of forcing out the Inflation tube which in turn forces out the Liner tube.

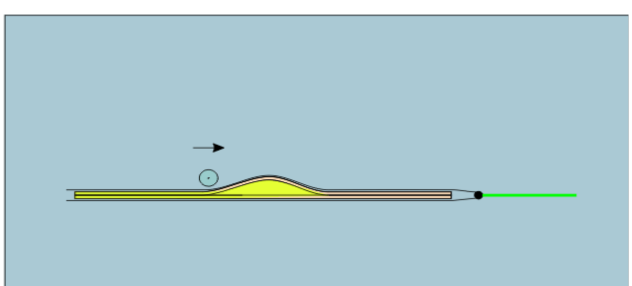
This forcing out may best be envisaged as an extrusion, whereby the combination of tubes (inflation and liner) have an inflated profile whilst at the same time moving forward like a piston.

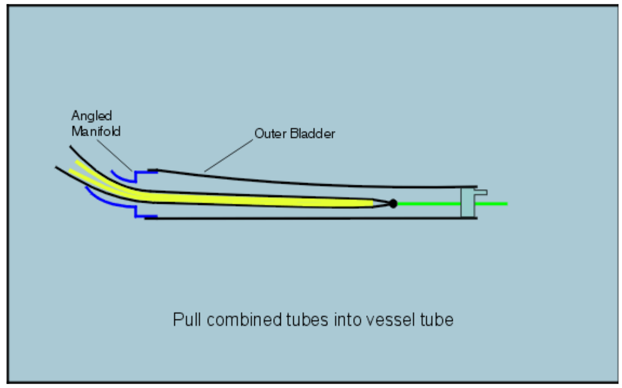
The combination of tubes are guided into the lateral run and travels till they reach the end of the length of the inflation tube.

On completion, the Inflation tube is retracted by pulling the attached rope, in effect reversing the previous

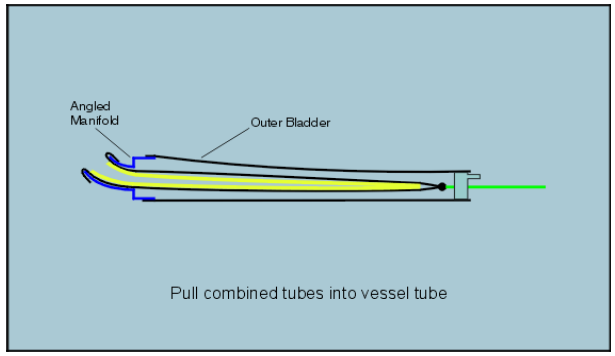


Resin mix is poured into felt liner

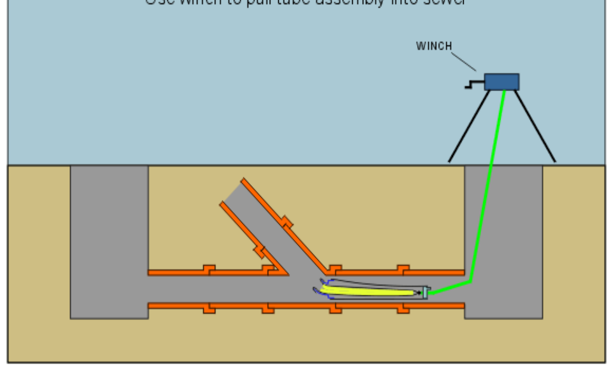

Use roller to push slug of resin up tube assembly and impregnate liner

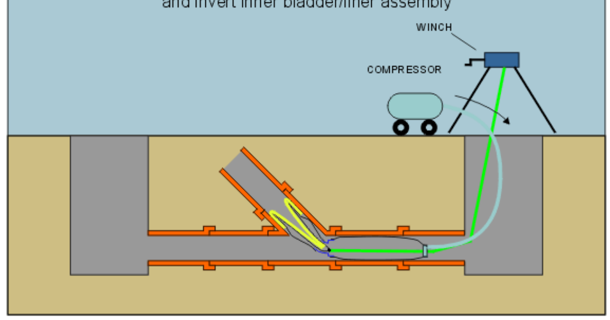


Pull combined tubes into vessel tube



Pull combined tubes into vessel tube

Use winch to pull tube assembly into sewer


Connect air supply to inflate vessel tube and invert inner bladder/liner assembly


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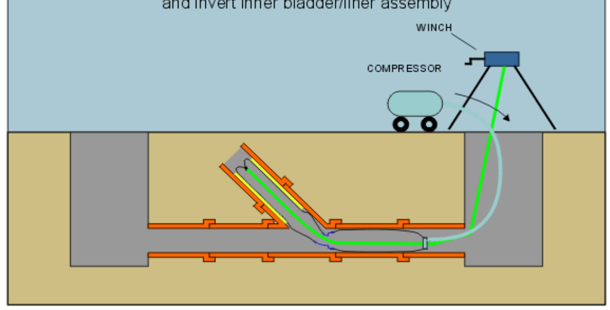

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Preparatory Procedures

Cleaning of Pipe

Cleaning of the mainline shall be performed by the contractor to ensure the passage of the Repair assembly to the lateral.

Cleaning of the Lateral Pipe

The section of lateral pipe to be relined must be free debris, obstructions, scale or any other material that reduces the effective bore of the pipe.

Prerepair survey of main pipe

A videotaped survey must be done on the main run with a pan and tilt camera to confirm the following features of the pipe run are not outside the allowable limits set by the manufacturer; The location and clock reference of the lateral junctions to be repaired, any intrusion from the lateral into the main; the angle at which the connection comes in; any changes in angle of approach of the lateral for the length of the repair; the potential flows coming throughout the lateral pipe; the potential flows gong through the main pipe; the diametric size of the connection for total chainage of the repair; the size of the main pipe at the point of the repair; the presence of active infiltration within the vicinity of the repair area; the weather; the identification of access to the head of each lateral connection .

Prerepair Survey on Lateral

A videotaped survey must be carried out on the lateral pipe after cleaning to prove the cleanliness of the pipe. This may well necessitate an excavation to gain suitable access to the pipework concerned.

The Repair Process

On completion of the the survey, a report should be submitted to the Engineer confirming the feasibility and the required program of works.

Post Repair Survey

On completion of a given run, video taped evidence must be provided by the contractor.

The repair sleeve should be monitored for excessive wrinkling, exposed unwetted fibers and pinhole leaks.

Testing

Subject to the result of the Inspection test, the Engineer reserves the right to select approximately 10% of the repairs for further testing using a proprietary Lateral Grouting Rig. The sections concerned are to be air tested. If the failure rate exceeds 10% and additional retest area of an equivalent size shall be selected for further testing.

Quality Assurance
The workmanship of the works shall be warranted for a period of 12 month following substantial completion. The material shall be warranted as per terms and condition of the manufacturer for a similar period PROVIDED the contractor applies the product in accordance with the current guidelines (Standard Operating Procedure) set out by the manufacturer.

Typical Bill Items

Description	**Measurement**	**Unit Rate**
Main Pipe Cleaning	Per Manhole Run	General Contractor
Lateral Pipe Cleaning	Per Run	General Contractor
Pre Repair CCTV survey of main	Per manhole run	General Contractor
Pre repair CCTV of lateral pipe	Per run	General Contractor
Mobilization of Repair Equipment	Lump sum	
Setting up Repair Equipment at a given manhole	Per manhole run	
Set up for Installation of repair sleeve for pipe size of 4-6” based on Design head of 10 feet	Each	
Installation of repair sleeve	ft	
Post repair survey in main with pan and tilt camera,	Per manhole run	General Contractor
or		
Post repair survey accessing lateral from clean out	Per run	$100