CHEMICAL GROUTING

Concrete Culvert Overview Flowchart
Structural Defects Flowchart (Concrete)
Bedding Deficiencies Flowchart (Concrete)
Hydraulic Capacity Flowchart (Concrete)

1 OVERVIEW

Chemical grouting can be used for sealing leaking joints or cracks in concrete pipes. Chemical grouting can be performed by applying several different techniques:

- Test-and-seal procedure - A short section of pipe is isolated and pressure-tested for leak tightness. If the test fails, the segment is sealed with self-setting chemical grout. The grout is injected under pressure to pass through the pipe wall into the surrounding soil where it mixes with the soil creating a sealing collar of material around the pipe (Figure 1).
- Expanded gasket placement (EGP) technique - A resin soaked rod (an open cell poly foam round rod) or oakum is inserted into the moistened joint (Figure 2) and firmly packed, which is followed by the grout compound expanding in contact with water and curing to form a cellular rubber gasket.
- Pressure injection - Injection holes are drilled in the concrete wall along the face of the crack at an angle to intercept the crack and injectors are staged to fill the crack with grout (Figure 3).

Figure 1. Sealing collar of material around the pipe made of chemical grout and soil (Henning, 2002)

Figure 2. Resin soaked rod being inserted into the joint as part of expanded gasket placement (EGP) technique (Henning, 2003)

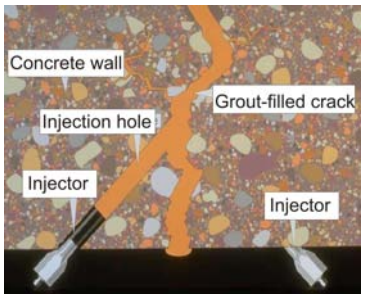

Figure 3. Pressure injection of grout through injection holes drilled in concrete (Henning, 2003)

With the exception of EGP technique, chemical grout injected under pressure typically passes through the pipe wall into the surrounding soil, where it mixes and bonds with the soil and creates a sealing collar of material around the pipe (Figure 1)

2 MATERIALS USED

Commonly used chemical grouts include acrylamides, acrylates, polyurethanes, hydrophilic expansive grouts, hydrophobic expansive grouts, ultrafine cementitious grouts, and epoxies (Magill and Berry, 2007).

3 APPLICABILITY

Chemical grouts do not provide a structural repair and the method is applicable only in structurally sound pipes.

Test-and-seal procedure can be performed in pipes ranging in circular diameter from 6 in. to 144 in. Packers are available for other pipe shapes, e.g. box culverts (Figure 4) or elliptical. For chemical grouting of large diameter pipes (24 in. and up to 96 in.), collapsible packers are used, which have a soft

natural rubber sleeve covering the two end bladders to seal against rough surfaces (Figure 5) and can be dismantled for introduction through accesses as small as 21 in. in diameter (Figure 6). Test-and-seal procedure sometimes cannot be applied (the isolated section cannot be pressurized due to too many voids in the soil envelope around the pipe).

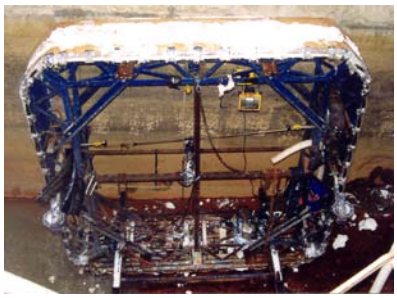

Figure 4. Custom designed packer for test-and-seal procedure in a 10 ft×10 ft box culvert (Marc Anctil, Logiball, Inc, personal communication)

Figure 5. Collapsible packer for a large diameter culvert pipe (Marc Anctil, Logiball, Inc, personal communication)

Figure 6. Collapsed packer with large wheels for easy movement (Marc Anctil, Logiball, Inc, personal communication)

4 QA/QC CONSIDERATIONS

NASTT (2006c) outlined a quality assurance plan for chemical grouting: follow good specifications (samples available from manufacturer, NASSCO publications), CCTV inspect the pipe (to verify cleanliness, condition and sealing), test all joints in a section, and verify grout consumption relative to a value obtained using a standard rule of thumb (provided by the manufacturer). Quality control measures include counting pump strokes (14 strokes = 1 gallon grout pumped), verifying levels in grout tanks (must be equal with 1:1 mix ratio for materials), limit maximum production in an 8-hour day (e.g., 125 joints in an 8 in. pipe), and take advantage of a 12-month contractor warranty (re-test prior to end of the warranty period).

5 STANDARDS AND SPECIFICATIONS

ASTM F2304 covers a procedure to inspect, test, and seal sewer pipe joints, having selected the appropriate chemical grouts, using the packer method. This practice should not be used for longitudinally cracked pipe, severely corroded pipe, structurally unsound pipe, flattened, or out-of-round pipe.

ASTM F2414 provides a guide for the installation of chemical grout in the practice of sealing sewer manholes in the case of leaks, and cracks.

6 EXAMPLE CASE HISTORIES

In Denver, CO, a precast concrete storm sewer pipe, 7 ft in diameter, was rehabilitated with chemical grouting in 1995. The pipe contained 139 bell-and-spigot joints, between 0.25 in. and 2.25 in. wide, with original gasket material missing at certain locations and presumably some voids in the soil behind them. A single component hydrophilic polyurethane was used. The joints were first treated with resin saturated oakum (EGP technique), and subsequently the urethane grout was pumped through holes drilled about 4 in. from each joint at an angle to intercept the joint behind the activated oakum (pressure injection). The water-to-resin ratio of the grout was adjusted on site from initial 5:1 to 1:1, because the volume of grout being pumped initially was up to six times the theoretical value. The change increased grout viscosity and reduced its setup time (at 60°F, it drops from 345 seconds to 90 seconds) and remedied the problem (Gumina, 1995).

In Hazelwood, MO, chemical grouting was used to seal joints in 10ft×10ft box culvert that had opened when the culvert initially settled allowing water and sand to enter the culvert, which caused further settlement. The joints on the 7 ft long sections were grouted, sealing and stabilizing over 1,700 ft of culvert. Acrylamide grout was pumped under pressure (20 psi) and some joints took as much as 200 gallons (Thomas, 1999).

7 ADVANTAGES AND LIMITATIONS

The main advantages of chemical grouting are the ability to stop infiltration/exfiltration quickly and to stabilize the soil bedding surrounding the pipe without the need for excavation or surface disruption. With test-and-seal procedure, the repair is performed only where it is needed. The method is generally less expensive than other rehabilitation methods.

The main limitation of this method is that structural repair is not provided. The longevity of repair appears to be shorter than with other trenchless rehabilitation methods: short life of installed chemical grout was reported in some case studies (e.g., between 2 and 5 years) although good performance of installed grouts was reported in other case studies (10 to 20 years after the rehabilitation).

8 REFERENCES

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Henning, S., 2003. "Tutorial: Chemical Grouting Stops Infiltration and Improves Success Rates in Lining & Coating Technologies," Underground Construction Technology UCT '03, Houston, TX, Jan 14-16, 2003, 47 slides

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Gumina, T.V., 1995. "Storm Sewer Joints Repaired After Causing Settlement Problems," *Concrete Repair Bulletin*, Nov/Dec 1995.

Magill, D. and R. Berry, 2007. "Comparison of Chemical Grout Properties," *Geo-Denver 2007*, Denver, CO, Feb 18-21, 2007.

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