PIPE SPLITTING

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

1. OVERVIEW

Pipe splitting is the method of trenchless pipe replacement where deteriorated culvert pipes are replaced with new pipes of same or slightly larger diameter. Typically, a bursting tool is passed through the pipe breaking it into fragments if the pipe is brittle or slicing through it if the pipe is ductile, and the new pipe is simultaneously pulled in (Figure 1).

Bursting of corrugated metal pipes is challenging because corrugated metal tends to bunch up during a standard bursting application. A specially designed tool (Figure 2) can be used that has a cutting sleeve designed to keep the pipe rounded: two large blades shear and separate the metal pipe and prevent ovaling. The expander at the rear of such tool separates the sheered pipe and also pulls in the new replacement pipe (HDPE) simultaneously. Another technology uses a bigger than standard blade (Figure 3) to cut through corrugations. The impact from the pneumatic tool along with such engineered blade prevents the corrugated metal pipe from compressing.

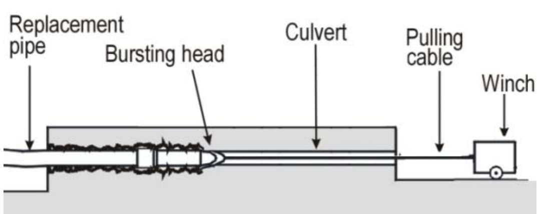

Figure 1. Pipe bursting of culverts

Figure 2. Bursting head with cutting sleeve and rear expander (TT Technologies).

Figure 3. Bursting head with bigger than standard blade, Unified Force™ blade (Tric Tools 2008)

2. MATERIALS INSTALLED

The typical replacement pipe installed by pipe bursting is an HDPE pipe since these chemically inert, they can readily flex, they maintain their circular shape, and have memory to return to its initial shape when kinked. Service life can also extend over 100 years. Other pipe types installed using pipe bursting include fusible PVC pipe, retrained joint PVC pipe, ductile iron pipe, and vitrified clay pipes.

The ASCE Manual of Practice for Pipe Bursting Projects (Najafi, 2007) reviews different types of replacement pipes providing advantages and limitations for each type of pipe.

3. APPLICABILITY

Pipe bursting can replace circular pipes up to 54 in. diameter. The length is typically limited to 750 ft (Sterling et al, 2009).

Applicability is not limited by culvert pipe type or condition. Replacement can be performed in live flow conditions.
Most favorable bursting projects involve pipes that were originally installed by trenching or open cut because the fill material surrounding them is usually conducive to pipe bursting. Upsizing depends on the soil conditions as well.

4. CONSTRUCTION ISSUES

4.1. INSTALLATION PROCEDURE

Pipe bursting of culverts is typically performed in the following steps (modified from Simicevic and Sterling, 2001):

- Excavate entrance and reception pits as needed
- Connect the replacement pipe segments into a continuous pipe, if needed
- Set up (a) winch and pulling cable, or (b) hydraulic pulling unit and pulling cable, or (3) rigid pulling rods (if static pull)
- Install air supply hose through the replacement pipe and attach to the bursting head (if pneumatic bursting)
- Install a lubrication hose, if applicable
- Attach a pulling cable (or rod) to the bursting head
- Pipe burst and simultaneously pull in the replacement pipe
- Remove the bursting head
- Remove the hoses
- Perform leakage or other testing, if required
- As necessary, complete the project by constructing or modifying head- and wing-walls on the ends of the culvert
- Site restoration

4.2. PIT EXCAVATION

Pipe bursting in general requires insertion and exit pits (Figure 1, Figure 4, and Figure 5), unless it is performed in areas where the culvert enters the side of the hill or embankment and is accessible without excavating pits.

Figure 4. Bursting ready to start (Eddie Ward, TT Technologies, personal communication).

Figure 5. The pull starts with ram, pulley wheel and resistance plate in place (Tric Tools, 2008)

4.3. LUBRICATION

Bentonite lubrication is used in various bursting situations to reduce friction. Friction also increases with the depth of the host pipe. Some soils, like beach sand, will not remain in the expanded state long enough for the installation of new product pipe. Bentonite lubrication is used in these situations to help maintain the annular space created as the tool travels through the host pipe (Orton, 2007).

5. QA/QC CONSIDERATIONS

Pipe Bursting Best Practices (NASTT, 2005) itemized QA/QC for butt fusion, a quality assurance plan for pipe bursting, quality controls during pipe bursting, and QA/QC testing and verification. Also listed were specification items that are the owner's responsibility and those that are the contractor's responsibility, as well as submittal requirements.

NASTT (2006) outlined that QA/QC may be ensured through laboratory testing of materials at the owner's or third party laboratory (materials verification). In the field, QA/QC of installation practices includes measuring heave/settlement on the surface, potential vibration from the bursting operation, monitoring strain in the new HDPE pipe, and subsurface monitoring of existing utilities. Pressure testing or CCTV are the final step of QA/QC. Knowledgeable and trained inspectors are important for QA/QC in pipe bursting projects.

6. STANDARDS AND SPECIFICATIONS

ASTM C1208 covers manufacturing, quality assurance testing, inspection, installation, field acceptance testing, and product marking of vitrified clay pipe to be used in microtunneling, pilot tube, sliplining, or pipe bursting.

ASTM D 3212 covers joints for plastic pipe systems intended for drain and gravity sewage pipe at internal or external pressure less than 25 ft head using flexible watertight elastomeric seals. Test requirements, test methods, and acceptable materials are specified.

ASTM D3350 covers the identification of polyethylene plastic pipe and fitting materials (cell classification of materials).

ASTM D 2657 describes the general procedures for making joints with polyolefin pipe and fittings by means of heat fusion joining techniques.

PPI (2006) specified the generic butt fusion joining procedure for field joining of polyethylene pipe. This standard has been adopted by most pipe manufacturers and is also referred to in ASTM D2657.

ANSI/NSF 14 covers physical and performance requirements for plastic piping components and related materials.

Additional standards related to pipe bursting are listed in Simicevic and Sterling (2001) and in Najafi (2007).

7. EXAMPLE CASE HISTORIES

8. ADVANTAGES AND LIMITATIONS

The main advantages of pipe bursting include the installation of a new pipe, ability for pipe upsizing and reduction of necessary excavation by 85% or more compared to open cut replacement. (If there is access from the end, then no excavation is needed.) The method is a proven technology with 60,000,000 ft installed worldwide (Nicholson, 2008). It is often more cost effective than open trenching in urban environments.

The main limitations of this method are inapplicability for already collapsed pipes or difficulties that arise when existing pipe composed of brittle material has had point repairs with ductile material. Pipe bursting can cause ground heave or settlement above or at some distance from the culvert, especially in dense sand, when the culvert pipe is shallow and ground displacements are primarily directed upward, and when significant diameter upsizing is performed. In addition, pipe bursting is not applicable when the host pipe experience significant sagging and deviation from the original grade.

9. REFERENCES

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