Repair or Replacement - Band-Aids vs. Surgery

"Using RCP for the Replacement of Failed or Undersized Culverts"

American
Concrete Pipe
Association

www.concrete-pipe.org

Introduction and Background

Our Nation's infrastructure owners are facing challenging times. DOT and municipal owners find themselves in an environment where money is in short supply and traditional long-term funding resources are wavering and uncommitted. As funding sources dwindle transportation system owners find themselves at a cross road. On one hand they face needs to expand and improve their existing transportation modes, and on the other hand they are challenged with how to best maintain their existing transportation system components. Proper inspection, management, and maintenance of their aging infrastructure is taking more resources, time, and money than ever before. As every day passes, existing infrastructure continues to age and fail at an alarming rate. System owners are faced with the choice of placing a BAND-AID® on some ailing infrastructure, or undertake a more expensive but long-term surgical replacement.

This document provides information to infrastructure owners about the options they have to best utilize Reinforced Concrete Pipe (RCP) and Pre-Cast Boxes to address current and pending failures, or undersized storm drains in their existing systems. The decision to replace (Surgical Correction) or repair (BAND-AID®) is certainly site-specific and can be complicated. It requires the use of sound judgment and a good measure of common sense.

Why All the Failures?

A recent paper by Al Tenbusch of Tenbusch, Inc. titled "*Failing Culverts-The Geotechnical Perspective*"[1] provides some valuable insight into the failure mechanisms of flexible pipe. The following thoughts are based that document:

> *Many of the 1950's metal culverts have reached their anticipated design life and are near failure due to deterioration. Like other highway structures, flexible culverts have a limited design life that can be decreased greatly by improper design or installation. Even newer installations of other flexible pipe products like HDPE and PVC are subject to premature failure due to poor installation, construction damage, or damage due to brush fires or fuel spill fires[2]. Initially, the service life can be extended by relatively low cost maintenance. As the culvert ages, the culvert materials start to deteriorate by corrosion or abrasion. The pipe deterioration will weaken or eliminate soil support, the key structural component in a flexible pipe. Pipe damage that has not compromised the soil support system can be cost effectively maintained and rehabilitated. Rehabilitation options include invert paving and slip lining. However, once the culvert and soil structure have both been compromised, the structure has reached the end of its service life and must be replaced.*
>
> *What many see as simply a flexible pipe failure is much more – it is the failure of the soil/pipe structure. It is expected that those who are facing the challenges of replacing or repairing the failing culverts will readily recognize the need for addressing both the pipe and the supporting soil.*

Internet reports make it easier to notice the trend of increased infrastructure failures across the country. In the reference material for this paper, a link to many cases of pipe failures has been included. Pipe failures do not get the same attention as more publicized failures of bridges, but are an issue that faces many infrastructure system owners. Two excellent resources to better understand the costs of failures are "*The Infrastructure is Collapsing*"[3] a brochure developed by the ACPA and research by Dr. Joseph Perrin, Jr. "*The Economic Cost of Culvert Failures*"[4].

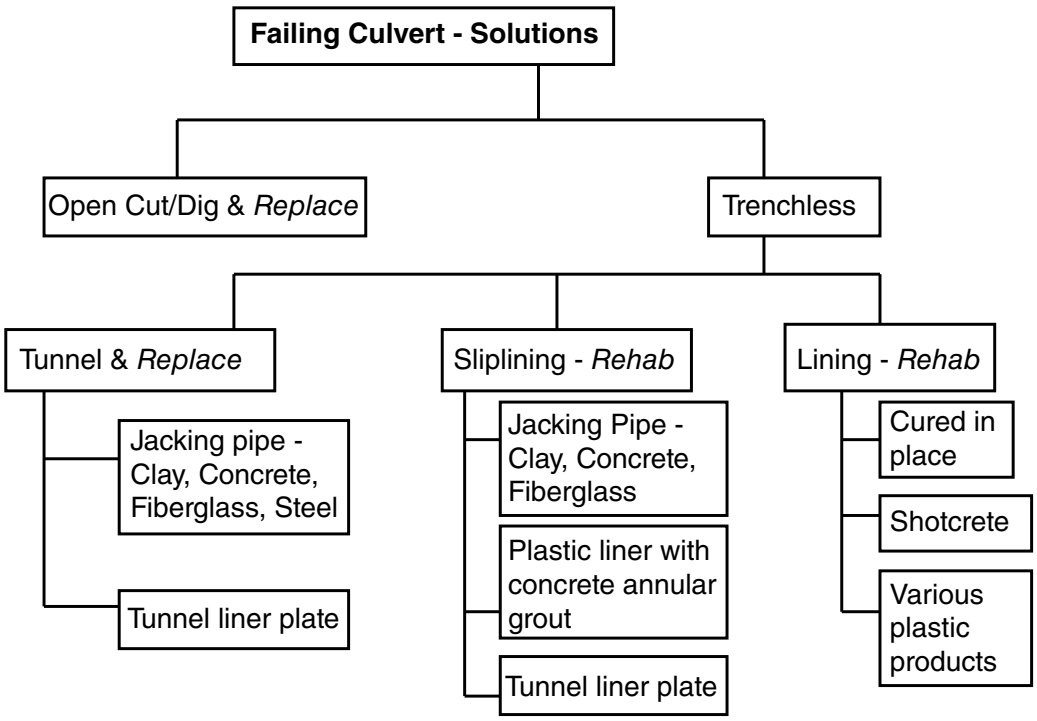
Options

As owners face the decision of how to address failing pipe system components, they realize that due to depth or traffic considerations, it is often desirable to accomplish their rehabilitation or replacement with some type of trenchless technology.

The chart below presents options for addressing failing culverts. While open cut replacement with a rigid pipe will have a longer service life than most trenchless methods, this option may not be feasible. More often, trenchless methods are employed to replace or rehabilitate a deteriorating pipeline. Trenchless options are lining, sliplining, and replacement with standard tunneling methods.

Lining: Lining is a trenchless *rehabilitation* method. The North American Society for Trenchless Technology defines lining as, "A rehabilitation process where a length of material is introduced to extend the life of the existing sewer. The lining may or may not utilize some structural strength from the existing sewer; and it may or may not function as a structural enhancement".

Sliplining: Sliplining is a trenchless *rehabilitation* method. The North American Society for Trenchless Technology defines sliplining as, "A rehabilitation technique covering the insertion of one pipe inside an existing pipe." When sliplining, the annular space between the old pipe and the new pipe will always be grouted. When a thick annular space grout is required, care must be taken to ensure that the new pipe does not float in the host pipe. Care must also be taken to ensure that 1) the new pipe does not collapse under the pressure that is developed when grouting, and 2) the heat of hydration of the grout does not cause deformation of the new sliplining pipe. As with lining, sliplining reduces the flow capacity of the culvert. The degree of under sizing depends upon the condition of the culvert. Partially collapsed culverts will have to be severely undersized to accommodate the collapse.



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Tunneling: When an existing culvert is replaced by tunneling, the existing pipe is removed along with the surrounding soil to accommodate the outside diameter of the new pipe being inserted into the tunnel. The raveling (the progressive separation of aggregate particles) of the granular fill around the existing pipe is mitigated by the shield covering the face during tunneling. In the diagram below during the process of tunneling, most of the original bedding is removed. After the new pipe is installed, the annular space is grouted. The grout will permeate, to some extent, the granular bedding material that remains. In this way the opportunity for groundwater migration along the new pipe is severely limited.

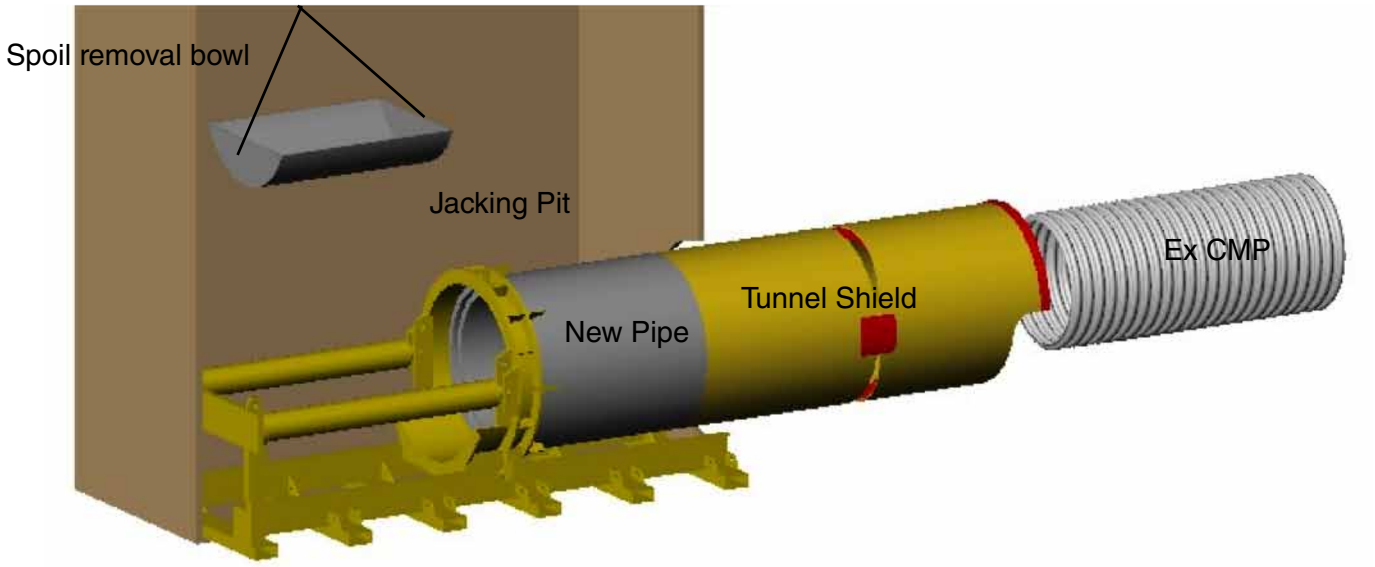

Figure 1 shows the main components of a tunneling method to install RCP to replace an existing culvert.

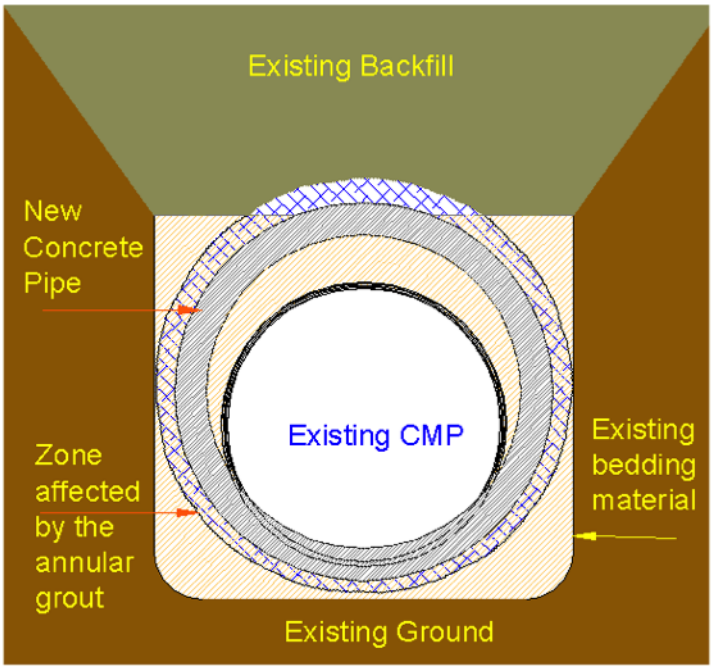

Figure 2 is a cross tunneling operation sectional view of the represented in Figure 1

The tunneling process is explained in more detail in “Failing Culverts-Solution Options”[4] found on www.tenbusch.com.

When carefully considered, owners will find that their trenchless rehabilitation options are limited when the system structure has been compromised, and hydraulic capacity is critical. The American Concrete Pipe Association believes that owners will conclude that the use of RCP and precast boxes provide the best solution in many situations. For more information about tunneling or bore and jack installations of RCP and boxes, there are several case studies provide in the references of this document.

Why Replace Failures with Tunneling and RCP?

There are many viable options for rehabilitation, however utilizing tunneling methods and replacing failed pipe with RCP provides benefits that are far superior to any of the alternative options. The benefits of tunneling and replacement with RCP include;

- Tunneling does not disrupt traffic.
- Less delay for the traveling public.
- Safety for the traveling public is much improved over open cut and detours.
- Benefit/cost ratios are excellent when traffic delays and safety is considered.
- The new RCP jacking pipe has superior structural strength.
- The new RCP will provide a service life of at least 100 years.
- The new RCP provides excellent flow capacity and can increase the flow capacity of the installation.
- The new RCP will withstand high heat scenarios developed by brush fires or Fuel spill fire events
- RCP has a low impact on the environment and is the most sustainable product and material. Less Equipment is needed, less material will be displaced, and there is only one replacement in at least 100 years.

See the links in the Reference Material Guide for case studies and more details of the benefits of tunneling/jacking RCP.

Conclusion

As each year passes, pipeline systems (the conduits for storm water and sanitary sewage, and buried bridge structures for roads and highways) continue to deteriorate and fail. Every system owner is faced with the choice to complete short-term repairs with a BAND-AID® or surgically (long-term) by replacing a system component. Traditional tunneling methods and replacement with

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RCP is an economical and effective method of removal and replacement of failing culverts and storm sewers. Utilizing tunneling methods to install RCP addresses the damaged surrounding soil and the culvert material while improving hydraulic capacity. Traffic delays are minimized, the construction is safer, and when all costs are considered, tunneling can be very economical.

Tunneling, combined with the installation of RCP creates a structure with a new long-term design life from a product characterized by an unsurpassed service life.

References and Links

1. Failing Culverts-The Geotechnical Perspective – Al Tenbusch
   http://tenbusch.com/tunnel/files/FailingCulvertsGeotechnicalPerspective.pdf

2. ePIpe: Where There's Smoke There's Fire
   http://www.concrete-pipe.org/epipe/TusconandPrescottFire_ePipe016.pdf

3. The Infrastructure is Collapsing – ACPA http://www.concrete-pipe.org/brochures/collapse.pdf

4. The Economic Cost of Culvert Failures – Joseph Perrin Jr.
   http://www.concrete-pipe.org/pdf/economiccosts.pdf

5. Failing Culverts-Solution Options – Al Tenbusch
   http://tenbusch.com/tunnel/files/FailingCulvertsAndSolutionOptions.pdf

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Case Studies

Jacked Concrete Pipe to Replace Failed CMP - http://www.concrete-pipe.org/pdfcpn/CP%20News%20Summer%202009.pdf

Micro Tunneling Story in CP-News 2001 - http://www.concrete-pipe.org/pdfcpn/CP-News-Spring-2001.pdf

Jacking Pipe ..Rt. 309 - http://www.concrete-pipe.org/pdfcpn/CP-News-Fall-2007.pdf

Jacking RCP to Replace Undersized Culverts - http://www.concrete-pipe.org/pdfcpn/CP-News-Fall-2002.pdf

Culvert Replacements Made Easy - http://www.concrete-pipe.org/pdfcpn/CP%20News%20Spring%202009.pdf

More Case Studies - http://tenbusch.com/tunnel/news.html

Related Stories and Information

Lessons Learned from the East Texas Fish Hatchery Incident - http://www.concrete-pipe.org/pdf/HDPEPipeDesignandConstructionLessonsLearnedEastTexasFishHatcheryIncident_ePipe011.pdf

Microtunneling and RCP Keep Ontario Wetlands Intact - http://www.concrete-pipe.org/pdfysk/ysk103.pdf

Pipe Jacking Keeps Major Arterial Road Open - http://www.concrete-pipe.org/pdf/news/PipeJackingKeepsMajorArterialRoadOpen.pdf

Use of RCP Jacking Pipe to Reduce Project Cost and Traffic Delays - http://www.concrete-pipe.org/pages/paw.html

Going Underground at the Pentagon with Reinforced Concrete Pipe - http://www.concrete-pipe.org/pdfcpn/CP-News-Fall-2000.pdf

Here Today, Gone Tomorrow - http://www.concrete-pipe.org/pdfcpn/2005-CP-News-Spring.pdf

Other Resources

DD 4 Jacking Concrete Pipe - http://www.concrete-pipe.org/pdfdd/DD_4.pdf

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