METAL PIPES
...what were we thinking?!

DelDOT’s failing CMP solutions...

Delaware’s Corrugated Metal Pipes

Facts by the numbers:
- There are approximately 1600 bridges in DelDOT’s inventory, 14% are CMPs.
- Any structure with an opening of 20 SF or more is considered a bridge in Delaware.
- 57 CMPs were found that meet the 20 SF opening requirements in the last 2 years.
- 160 CMPs were re-inventoried between 2007 – 2013.
- Starting in 2008, an average of 20 – 25 CMPs have been replaced each year.
- 230 CMPs still remain in DelDOT’s bridge inventory that need to be replaced.
- CMPs account for approximately 72% of all structurally deficient bridges in our inventory.

Methods of Project Contracting

Traditional Design, Bid, Build:
- Design and plans set creation takes time and coordination for each bridge.
- Environmental coordination and permitting require the same amount of time as complex bridges.
- Utility, right of way, and real estate acquisition require additional time for review and coordination.
- Project advertising, bidding, and awarding takes time.

Design-Build:
- 35 pipe replacement locations are chosen and prioritized.
- Only need to advertise and bid once for a Design-Build Contract.
- Design-Build Team is woked with utility, right of way and real estate process which saves time.
- Design and construction process is streamlined since contractor and designer work together on design.
- Department is still tasked with environmental process and real estate acquisition.

Open End:
- Can consist of up to 25 pipe replacement locations.
- Only advertise and bid once for an Open End Contract and each pipe location becomes a work order.
- Design, environmental, utility and right of way coordination still takes time.
- Essentially “fast-tracks” the design process but puts pressure on the support services.

Methods of Construction

Traditional:
- Excavate, remove existing pipe and place new pipe.
- Pro: New pipe, typical method and proven results.
- Con: Utilize lane closures or close road, utility relocation and traffic pedestrian control.
- Currently the preferred method of construction.

Pipe Lining:
- Spray high strength concrete into existing pipe.
- Pro: Little to no impact to traffic or utilities and no excavation.
- Con: Limited applications and currently not a typical replacement method.
- Design consideration must be given for bends, obstructions or obstructions in the pipe, construction feasibility and respecting the quality of the final lining.

Pipe Jacking:
- Using new pipe to place existing old pipe.
- Pro: Little to no impact to traffic or utilities, no excavation and it’s a new pipe.
- Con: Limited applications and currently not a typical replacement method.
- Design consideration must be given to ensure pipe has adequate strength for jacking forces, any bends in the pipe, construction feasibility as well as contractor’s capabilities.
ACPA and Its Engineers Help Update and Develop Pipeline Systems Standards

Some may believe that Standards are used to protect the health and safety of people. This notion is not entirely accurate. It may be argued that commerce is a stronger force underlying the development of Standards, although a product or material would be specified by engineers only if it were safe to use.

The British Standards Institute says “a Standard is an agreed way of doing something. It could be about making a product, managing a process, delivering a service or supplying materials – Standards are the distilled wisdom of people with expertise in their subject matter and who know the needs of the organizations they represent.”

The American National Standards Institute says; “Standards have become such an integral part of our existence that the average individual gives little or no thought to everyday products and services and how they work. But imagine our frustration if lightbulbs didn’t fit into lamps, or if trains couldn’t move from one state to another because the tracks were a different gauge.”

The American Concrete Pipe Association and its affiliated State concrete pipe associations and member companies, partner closely with Standards development and review agencies to ensure that the best Standards available are used for the production and installation of concrete pipe. As competitive materials continue to enter the marketplace, ACPA and its partners become more knowledgeable about conduit materials and products in addition to concrete pipe and precast.

Among other things, the purpose of the North Central Texas Council of Governments (NCTCOG) is to develop trainings and Best Management Practices for integrated stormwater management and safety evacuation. Additionally, NCTCOG developed a set of Construction Standards for the use by municipalities, school districts and other small governments.

A review of 1,000 pages of the Construction Standards (initiated in late 2011) is nearing completion. Members of Subcommittee Groups for Underground Utilities are comprised of local and regional government representatives, as well as representatives from the concrete and plastic pipe industries. NCTCOG Standards reference nationally established Standards such as ASTM and AASHTO, and proposed changes primarily reflect updates and improvements made to nationally recognized Standards.

NCTCOG has expanded installation requirements and post-installation inspection of flexible pipe products. This has a deep-seated history that directly correlates to the current Inspection Standards for potable water pipelines.
Mandrel inspection of those flexible installations is mandatory, so why not for non-pressurized drainage systems that depend upon precise installation methods? Deflection of flexible product pipelines must be within critical tolerances, or failure of the system (and most anything above it) can be expected.

In the new version of the NTCOG Construction Standard, the following requirements are included for thermoplastic installations:

- Bedding and backfill to be based on the TxDOT Special Specification, referenced in the TxDOT Memorandum of January 4, 2010 for approved Thermoplastic Pipe following the April 9, 2009 wildfires in the Wichita Falls district
- ASTM F 949 for consistent pipe strength stiffness across all diameters
- Inspection of flexible pipe products required at 30 days after installation
- Inspection by mandrel testing with an option for laser video profiling
- Minimum trench width (per ASTM D2321)
- Backfilling to 12-inches above top of pipe (TxDOT)
- Backfill materials (TxDOT):
  - Type I – Flowable Fill
  - Type II – Cement Stabilized Sand
  - Type III – Clean granular with filter fabric wrap

ACPA and the Texas Concrete Pipe Association continue to participate and partner in the Standards process and stand ready to support the process. Concrete pipe industry engineers are ready to provide information and knowledge on all pipeline products and materials based on experience working with Standards throughout the USA and sound applied science.

References

1. bsigroup.com
2. standardslearn.org/coursedetails.aspx?key=44

GET INVOLVED....BLOG YOUR THOUGHTS!

Have something to say to Matt Childs about this editorial? The blog is published under Latest News at concretepiper.com. Get involved and leave a comment.
Since the early 2000s, the Delaware Department of Transportation (DelDOT) has been focused on replacing aging and corroding corrugated metal pipe culverts throughout the state. DelDOT defines a state-length bridge as a structure with a hydraulic opening greater than 20 square feet. The federal definition of a bridge is a structure over 20 feet in length measured along the centerline of the roadway. Delaware’s bridge inventory consists of over 1,600 federal and state-length bridges. Approximately 50% are culverts.

In the late 1970s and early 1980s, several hundred short-span timber bridges were replaced with corrugated metal pipe culverts. Due to Delaware’s coastal climate, roadway salt usage, and farm runoff in the streams, metal pipe culverts corroded at a faster rate than in environments that are not as corrosive. Metal pipes make up roughly 66% of DelDOT’s structurally deficient bridges, while comprising approximately 15% of the total bridge inventory. To address apparent safety concerns, and structurally deficient culverts, DelDOT undertook a program to replace the corrugated metal culverts, using products and technology offered mainly by ACPA members.

When the focus on metal pipe culverts began in the early 2000s, DelDOT maintained over 450 metal pipe culverts. The inventory had been reduced to 240 by the end of 2015. In comparison, the inventory of concrete culverts, including pipes, boxes, and threesided frames, has grown to nearly 600, which is about two-thirds of culvert structures. Highlights from these projects include:

- First concrete pipe jacking project in Delaware
- First centrifugally cast concrete pipe liner used in Delaware
- Pre-purchase of precast boxes and frames to replace failed metal culverts in an expedited manner for emergency projects.
- Streamlined permitting for most projects by recessing concrete pipes and concrete boxes to enable aquatic organism passage.
- Four to six locations bundled under one contract for replacement using reinforced concrete pipes.
- On-call contractor to replace up to 15 metal pipe culverts with reinforced concrete pipes over a 3-year period as locations are identified.
Additional notable projects that were in design at the beginning of 2016 include:

- Design-build project to replace over 30 metal pipe culverts over the next 4 years
- Project to potentially jack a box culvert under a high volume roadway
- Continued focus in DelDOT’s Capital Transportation Program for replacing failing pipe culverts with ACPA products.

**Quick Notes**

| Who                | Delaware Department of Transportation (DelDOT)  
|                   | American Concrete Pipe Association Producer Members |
| What              | DelDOT’s Capital Transportation Program for replacing failing pipe culverts with ACPA products. |
| Why               | Several hundred short-span timber bridges were replaced in the late 1970s and 80s with corrugated metal pipe culverts that began failing in the early 2000s, due to Delaware’s coastal climate, roadway salt usage, and farm runoff in the streams. |
| When              | 2015 |
| Where             | State of Delaware |
| How               | Replace the corrugated metal culverts using products and technology offered mainly by ACPA Producer Members. |

*Jason Hastings; Jason.hastings@state.de.us*

Photos: Courtesy of DelDot.
Dry-cast Boxes a Shift in Specification for New Mexico and Bureau of Indian Affairs

Arturo Chavarria, P.E., Technical Resource Engineer, Forterra Pipe & Precast

Dry cast box sections for a precast concrete box culvert, specified for a new road to connect the Navajo town of Alamo with Interstate 40 in New Mexico, is a milestone. In a state where wet cast box sections and cast-in-place construction have been a preferred product and construction method, the use of dry cast concrete boxes on a federally-funded highway project is attracting attention. Alamo is home to about 2,000 Navajo tribal members. The new road will improve access to Alamo and bring greater prosperity to the town and other area communities.

Because of the culvert hydraulics required to carry flow under the road during periods of heavy rainfall, a four-barrel (10-foot x 10-foot) box system was specified by the Bureau of Indian Affairs (BIA) on the alignment of an arroyo. An arroyo is a dry creek, stream bed or gulch that temporarily or seasonally fills and flows after sufficient rain. The culvert has a dual purpose making it unique in the area. Not only does the culvert manage large volumes of stormwater, it also serves as a passageway for ranchers and their cattle.

Specifications of the BIA call for concrete mixes with 4% entrained air to protect concrete from freeze/thaw damage. Entrained air creates a large number of closely spaced, small air bubbles in the hardened concrete that relieve ice pressure build-up by acting as expansion chambers. Forterra tested every section of precast box for entrained air content before delivery to the job. They proved without a doubt that dry cast concrete boxes could meet the stringent specification of the BIA.

Meridian Contracting constructed the culvert on a site of variable soil conditions by first creating a bed for the boxes that could be best described as a concrete floor. Forterra provided the contractor with a jointing procedure that would meet the watertight requirement of the specification. The procedure was enhanced using pre-formed flexible plastic coils used for sealing box culverts and other precast products and systems. A field representative from Forterra was on site each day of the installation to oversee placement of the box sections and advise the contractor on technical matters. The contractor found that the precast method for constructing the culvert ensured greater control over the quality than a cast-in-place system, control over the finish of the product, and faster installation.

Forterra began shipping 44 sections of dry cast box to the site in January 2016, and by March 28 the culvert was in place on the new road alignment. Site conditions limited installation of the system to two boxes per day. The project has set a precedent for supplying dry cast boxes in specifications calling for box culverts on New Mexico’s critical infrastructure.

Arturo Chavarria, P.E.; Arturo.Chavarria@forterrabp.com

Photos: Forterra Pipe & Precast
A Forterra representative was on site each day to oversee placement of the box sections and advise the contractor.

### Quick Notes

<table>
<thead>
<tr>
<th>Who</th>
<th>New Mexico and Bureau of Indian Affairs Meridian Contracting Forterra Pipe &amp; Precast, El Mirage, AZ</th>
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</thead>
<tbody>
<tr>
<td>What</td>
<td>Four-barrel (10-foot x 10-foot) box system.</td>
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<tr>
<td>Why</td>
<td>The culvert manages large volumes of stormwater and serves as a passageway for ranchers and their cattle.</td>
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<tr>
<td>When</td>
<td>2016</td>
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<tr>
<td>Where</td>
<td>A new road to connect the Navajo town of Alamo with Interstate 40 in New Mexico.</td>
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<tr>
<td>How</td>
<td>Wet cast box sections and cast-in-place construction were a preferred product and construction method for New Mexico and Bureau of Indian Affairs, until the use of dry cast concrete boxes on a federally-funded highway.</td>
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Four-barrel (10-foot x 10-foot) dry cast concrete box culvert for stormwater management and cattle crossing.
A storm drainage project on South State Street in Dickinson, ND included 370 feet of 30-inch diameter CLASS 4 reinforced concrete pipe (RCP) jacked through a 48-inch diameter steel casing pipe under the BNSF Railroad. The project was designed by HDR Inc. to provide a grade separation between the BNSF Railroad and South State Street. Forterra Pipe & Precast supplied 8,600 feet of 15-inch to 36-inch diameter RCP from its Helena, MT facility. The casing pipe diameter was determined by the outside diameter of the bell on 30-inch pipe.

The jacking pipe included an O-Ring gasket and stainless steel casing spacers to guide the pipe through the casing, thereby reducing jacking pressures in the ungreased casing that could not exceed 60,000 psi.

Other concrete products included 150 storm and sanitary sewer structures, 3,800 feet of prestressed concrete girders and more than 36,000 sq. ft. of a mechanically stabilized earth (MSE) wall system from another precaster.

The concrete pipe jacked under the BNSF Railway had special design considerations specified by the BNSF because the line is the second busiest rail line in North Dakota, transporting North Dakota shale crude.
Quick Notes

| Who | BNSF Railway  
|     | HDR Inc.  
|     | Forterra Pipe & Precast, Helena, MT |
| What | 370 feet of 30-inch diameter CLASS 4 reinforced concrete jacking pipe with gaskets and stainless steel spacers. |
| Why | Storm drainage improvements to South State Street and a grade separation. |
| When | 2015 |
| Where | Dickinson, ND |
| How | 8,600 feet of 15-inch to 36-inch diameter RCP that included 370 feet of 30-inch diameter CLASS 4 jacking pipe. |
A Union Pacific Railroad (UPRR) specification for thermoplastic pipe, particularly HDPE, for the Port Laredo Intermodal Facility Expansion was reissued to include reinforced concrete pipe (RCP). Forterra Pipe & Precast was able to demonstrate that in many instances, a Class I or II concrete pipe would work in place of Class IV or V specified by UPRR. Forterra was contracted by Ragnar Benson Construction, LLC to supply Class III concrete pipe for culverts and storm sewers.

Ragnar Benson Construction, LLC, Construction Manager/General Contractor (CM/GC), contacted Forterra in April, 2015 to quote on the supply of RCP. Forterra Pipe & Precast, American Concrete Pipe Association, Texas Concrete Pipe Association, and its Region Engineer presented a case for the specification of concrete pipe that included the restrictive thermoplastic pipe special specification of the Texas Department of Transportation (TxDOT) and evidence that RCP gets stronger over time and not weaker like HDPE; and news that the American Railway Engineering and Maintenance-of-Way Association (AREMA) was in the process of rewriting the RCP guidelines that noted railroads no longer automatically required Class V pipe for all applications.

TxDOT revisited its specifications for culvert materials following the 2009 brushfires northwest of the greater Dallas/Fort Worth area where the entire town of Stoneburg was burned over by a 25,000 acre. The small town, with only about 100 residents, was designed with only two thoroughfares for evacuation: FM 1806 and US 81. FM 1806 collapsed when three plastic culverts, used for drainage and support for the road, ignited and melted. Consequent to the collapses, there were injuries to a truck driver and damage to a fire truck attempting to respond to the emergency. The failed culverts left only one main evacuation route out of the region.

To minimize the chance of fire-related damage on future installations, TxDOT modified the criteria for use of thermoplastic pipe on TxDOT projects. The criteria superseded criteria for use of thermoplastic pipe issued dated September 17, 2002. The special provision notes that when thermoplastic pipe is included in a contract, it should be set up as an alternate to another pipe type.

The question was presented to UPRR and the CM/GC: If TxDOT greatly limits the use of plastic pipe, why not the UPRR and its contractors and
specifiers? AREMA’s manual that covers the structural design and installation of reinforced concrete was updated in April 2016 and is now current with 21st century concrete pipe design Standards.

Between 2014 and 2040, freight moving in Texas is projected to nearly double, from 2 billion tons to more than 3.75 billion tons. A state advisory committee warned that such an extreme increase could worsen an already congested state highway system, and alternative modes -- such as rail -- will be more important than ever if the state is to remain economically competitive.

It’s a message heard loud and clear at Union Pacific. The railroad has invested more than $2.8 billion in its 6,310-mile rail network in Texas since 2009. Current UP construction projects include improvements at Houston, the Dallas/Fort Worth area, San Antonio and further south to Eagle Pass.

One of the biggest projects is the Port Laredo Intermodal Facility that services business on both sides of the U.S./Mexico border by truck and train. Intermodal facilities are large, multi-acre rail-served complexes where freight containers are loaded onto or off of trains or truck chassis.

About $280 billion in U.S. trade with Mexico annually crosses through the Laredo Customs District, making Laredo the main port of entry along the U.S.-Mexico border and the No. 2 port in the United States.

Click here for online article.

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Photos: David Tedford, Forterra

Quick Notes

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<tr>
<th>Who</th>
<th>Union Pacific Railroad (UPRR)</th>
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<tr>
<td></td>
<td>Ragnar Benson Construction, LLC</td>
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<td></td>
<td>Forterra Pipe &amp; Precast, Robstown, TX</td>
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<th>What</th>
<th>CLASS III RCP of various sizes for culverts and storm sewers at the Port Laredo Intermodal Facility Expansion.</th>
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<th>An extreme increase in freight moving in Texas could worsen an already congested state highway system.</th>
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<th>When</th>
<th>2015</th>
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<th>Where</th>
<th>Laredo, Texas</th>
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<th>How</th>
<th>Forterra Pipe &amp; Precast demonstrated that a Class I or II concrete pipe would work in place of Class IV or V specified by UPRR. Forterra was contracted to supply Class III concrete pipe for culverts and storm sewers instead of HDPE pipe that was originally specified.</th>
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RCP specified instead of HDPE in consideration of TxDOT special provision for concrete pipe, long-term performance, and resiliency to fire.
In late April, 2016, a call for emergency repair of a 42-inch diameter corrugated metal pipe (CMP) culvert was issued by the California Department of Transportation (Caltrans). A maintenance crew discovered a potential pavement failure on a section of Highway 113, seven miles North of Knights Landing, a community about 20 miles South of Yuba City. A pothole, repaired a few days earlier, had become a void in the pavement. On further investigation, it was discovered that the invert of the culvert below the pothole had corroded after 57 years of service and the culvert was in danger of collapse. Aside from obvious public safety concerns and possible road closure due to a greater pavement failure, the site was the location of a vital fiber optic cable (two feet below the invert of the existing culvert) running from Seattle to Los Angeles. Caltrans decided to replace the culvert with a 54-inch diameter reinforced concrete pipe (RCP) culvert, immediately.

The situation was ideal for replacement using the Accelerated Precast Construction (APC) method, because of the urgency for a complete replacement without damage to the cable lying below the invert elevation, no room to stockpile RCP on site, a high water table, location in an environmentally sensitive area with a regulated fishery, and disruption costs to local and regional traffic. Replacement of the culvert had to be carried out quickly with as little economic, social and environmental impact as possible. The culvert serves as a conduit between two open channels used for irrigating rice fields and the highway could not be closed.

Teichert Construction was retained for dewatering the site and construction of the culvert while Caltrans placed an emergency order with Forterra Pipe & Precast (Sacramento) for Class 3 RCP. The pipe would be installed by open trench up to the pavement and then jacked under the travelled portion of the road. The installation would follow the same grade as the CMP that was removed, as the RCP was installed. Installation was completed by May 18, just over 4 weeks from the time the pavement began to fail.
**Quick Notes**

| Who                  | California Department of Transportation  
| Teichert Construction  
| Forterra Pipe & Precast, Sacramento, CA |
| What                | Replacement of a 42-inch diameter CMP culvert with a Class 3 54-inch diameter RCP culvert using APC. |
| Why                 | The invert of the 42-inch diameter CMP culvert had corroded, and the culvert was failing as was the pavement. |
| When                | 2016 |
| Where               | On Highway 113, seven miles North of Knights Landing. |
| How                 | The RCP was installed by open trench up to the pavement and then jacked under the travelled portion of the road. |

Photos: Kevin Langley, Forterra

The culvert had to be carried out quickly with as little economic, social and environmental impact as possible.

Caltrans decides to replace 42-inch diameter CMP culvert with 54-inch diameter RCP culvert.

Maintenance crew discovered a potential pavement failure where pothole continued to grow in size and depth.
Video Features

**Caltrans News Flash #82 - I-5 Sinkhole Fix**

In this News Flash, you’re taken on location to see how a small sinkhole on the shoulder of Interstate 5 in San Joaquin County led to a shutdown of both sides of the freeway for five days. Watch how Caltrans investigated the problem and determined a true fix to ensure a safe roadway for the motoring public for years to come.

**Maintenance, Integrity and Durability**

A road collapse captured by news crews in Freeport, Maine, USA during a storm. The collapse was due to flotation of a corrugated steel semi-rigid pipe culvert. Published on YouTube on Nov. 28, 2013

**The Concrete Pipe Advantage: Long Term Structural Integrity**

There are big differences in pipe materials and how they interact with surrounding soil. Differences in rigid and flexible pipe impact the right choice of material for drainage structures.

**Supporting Members of This Issue**

Authors and suppliers of concrete pipe and precast concrete boxes

[Logo: FORTERRA PIPE & PRECAST]

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