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## On the Cover:

Specially-designed jacking pipe designed and produced by American Concrete Products Company.

American Concrete Pipe Association



# Editorial

## The Conversation Is Shifting from Sustainable to Resilient Infrastructure.

**Matt Childs, P.E., President**
**American Concrete Pipe Association**

Once the shift from the notion of sustainable to resilient infrastructure is realized and understood, it is easier for the concrete pipe industry to advance the case for building sewers and drains with concrete pipe and boxes. The sustainability of constructing infrastructure with flexible pipe products can be debated under the three pillars of Social, Economic and Environmental factors (SEE). It is more difficult, however, to debate the merits of constructing buried infrastructure with materials other than concrete, if the material is not resilient; and we know by scientific and an abundance of anecdotal evidence that flexible pipe products and materials are not resilient and arguably not sustainable. Concrete pipe has a proven track record of withstanding natural and man-made events. There is no question that it performs as designed for 100 years and more, as both a sustainable[1] and resilient engineered product.

Why is this conversation important? Since the attack of 9/11 and devastation of hurricanes Katrina and Sandy, 21st century lawmakers throughout the United States and Canada are creating rules, policy and passing legislation to reinforce the goal of resilient infrastructure. Even President Obama is engaged. He has been briefed by the National Infrastructure Advisory Council[2] on recommendations to enhance the resiliency of our nation. Let's step back for a moment and try to get a grip on the notion of resiliency.

The Merriam-Webster dictionary partially explains resiliency as the ability to become strong, healthy, or successful again after something bad happens. Wikipedia says it generally means the ability to recover from some shock or disturbance. 'Resilience theory' was coined in the early 1970s by the Canadian ecologist C S 'Buzz' Holling (*Emeritus Eminent Scholar and Professor in Ecological Sciences at the University of Florida*) who hoped to find the hidden laws that underpin disturbance – whether out of the blue, like fires or explosions, or occurring more slowly, while being similarly transformative. The use of resilience in terms of the urban environment has come to take prominence over the discussion of sustainability. This could be partly due to the sense within the word (resilience) that 'jeopardy' is increasingly more likely than not. Sustainability suggests that 'if we do this we might avoid disaster.' Resilience is more realistic and says, 'if and when disaster occurs, how well will we bounce back (Hollis)'[3].

Forces that impact the specification of concrete pipe[4] are wide and varied. Within this complex public and private sector marketplace, there is one constant, however, and that is the fact that concrete pipe used for buried infrastructure systems performs as designed for a long, long time with little unplanned maintenance.

Regulators and elected representatives will continue to make rules and regulations to address the needs of Americans in the context of extremes of nature and man. MAP-21 (Moving Ahead for Progress in the 21st Century Act)[5] is legislation intended to build resilient infrastructure. At first it contained preferential language that the plastic pipe industry had convinced Congress to include. Once the onerous wording changed, State DOTs can now specify the appropriate pipe material for highway drainage systems without appearing biased. All infrastructure owners, design engineers, specifiers and contractors have the ability to continue building resilient concrete infrastructure systems, if they choose to.

## LINKS

1. www.concrete-pipe.org/epipe/SustainablecConcretePipe-epipe004.pdf
2. www.tisp.org/index.cfm?pid=10260&cdid=11813
3. http://citiesaregoodforyou.wordpress.com/2014/02/18/what-do-we-mean-by-resilience
4. www.concrete-pipe.org/pages/why.html
5. www.concrete-pipe.org/map21.html

## Specially Designed Reinforced Concrete Jacking Pipe for Stormwater Conveyance

*By Rick Phillips, Manager of Business Development*
*American Concrete Products Company*
*RPhillips@amconco.com*

The Miller Park to Pershing Sewer Separation Project[1], designed by Carollo Engineers, Inc., included approximately 2,300 feet of 60-inch diameter sewer for stormwater conveyance in the Miller Park area of Omaha, Nebraska. A majority of the conveyance sewer (1,300 feet) was completed utilizing tunneling methods. The completion of the project resulted in removing stormwater flows from a combined sewer, thereby reducing the potential for upstream flooding, local rain-induced basement backups, and the combined sewer overflow volume at a combined sewer outfall. Given anticipated groundwater depth, the soil conditions, and the overburden, tunneling[2] with a microtunneling machine was specified. Specially designed reinforced concrete pipe was the only product considered for the tunnel that was completed in October 2013.

The jacking pipe[3] was designed according to ASTM C-76[4] (special design section 2503.2.7.) to meet design loads for earth and groundwater pressures, surcharge and jacking installation loads. ASTM C-76 – 14, *Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe*, is a manufacturing and purchase specification, that covers reinforced concrete pipe intended to be used for the conveyance of sewage, industrial wastes, and storm water, and for the construction of culverts. The pipe was produced in 8-foot sections for the construction of the 1,300-foot microtunnel.

The pipe was designed and produced by American Concrete Products Company[5] with a double O-ring gasket and a steel bell joint[6] to take advantage of as much of the wall thickness as possible for the jacking surface. This allowed jacking forces to increase while minimizing the number of intermediate jacking stations. Test ports were placed between the gaskets to facilitate the testing of the joints prior to pushing and post installation, as needed. After initial set tests were performed, the concrete mix was designed to allow stripping of the forms six hours after casting. The mix was also designed to achieve high early concrete strengths (6000 psi) within 7 days.

Pipe production started in May 2013 with double-pouring two forms to produce four sections per day. Two Dayton Superior[7] utility anchors were cast in for handling the pipe. In September, deliveries were scheduled two days prior to installation to allow for the preparation of the microtunneling process. This scheduling guaranteed no down time for the contractor due to shipping delays. Graham Construction U.S.[8] was the general contractor and NADA Pacific Corporation[9] was the microtunneling contractor.

## LINKS

1. www.omahacso.com/projects/millerparkdbss
2. www.concrete-pipe.org/brochures/repairorreplacement.pdf
3. www.concrete-pipe.org/pdfdd/DD_4.pdf
4. www.astm.org/Standards/C76.htm
5. www.enterprise-properties.com/americanconcrete/precastproducts.html
6. www.concrete-pipe.org/epipe/ConcretePipeJointsBrochureFormat-highrez-epipe07-124.pdf
7. www.daytonsuperior.com/default.aspx
8. www.graham.ca/default.aspx
9. http://nadapacific.com/contact-us.html

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- **Keyword Search on American Concrete Pipe Association Website**
  (stormwater, tunnel, microtunnel, jack)
  www.concrete-pipe.org
- **Concrete Pipe Design Manual**
  www.concrete-pipe.org/pages/design-manual.html
- **Concrete Pipe News**
  www.concrete-pipe.org/pages/cpnews.html


Concrete pipe placed in microtunneling machine prepared for push.


Pipe scheduled for installation with steel bell bands and the double gasket groove on the spigots.


Concrete thrust block.

Photos: Weston Engel P.E., Carollo Engineers.

Precast concrete boxes arrive on site with pre-lubricated rubber gaskets installed.


3,009 feet of 5-foot x 4-foot precast concrete boxes.


Gasketed precast box installed using lift inserts.

# Storm Sewer Construction Expedited With Precast Concrete Boxes

*By Bo Gossett, David Marchbanks, and Mike Wilson*
*Gossett Concrete Pipe Co., Inc.*
*david@gossettconcretepipe.com*

The City of Columbia solved flooding problems in its Harden/Read Street area caused by an outdated storm drain system. The solution was the construction of a parallel storm sewer comprised of 3,009 feet of 5-foot x 4-foot precast concrete boxes to serve as relief drain to the existing storm drain system. Fourteen special precast boxes were manufactured with catch basin access.

Box section joints were originally specified using butyl joint sealant, along with joint wrap and steel bands on the exterior of each joint. However, Gossett Concrete Pipe[1] consulted with Rusty McClam of McClam and Associates[2] to consider the option of using a pre-lubricated rubber gasket joint according to ASTM C 1677[3], *Standard Specification for Joints for Concrete Box, Using Rubber Gaskets*. The specification change was accepted by LPA & Associates/Wilbur Smith, the design engineers. The boxes were manufactured according to ASTM C1433[4], *Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers*.

By using the revised specification, each section was delivered to the job with a pre-lubricated rubber gasket attached to the spigot of each box. This allowed the contractor to maximize productivity by eliminating the field tasks of applying sealant and exterior joint wrap to each section of box. Elimination of these steps reduced the possibility of installation deficiencies. Jesse McClam, project engineer with McClam & Associates noted, "With groundwater a consistent factor for much of the box system installation, being able to eliminate the joint wrap gave us the opportunity to quickly install, support, and backfill without extra effort spent on the joints; and this made installation possible without dewatering."

The North Harden Street Phase II Streetscaping Project marked the first time that rubber gasket precast box sections were installed in South Carolina. Each gasket, supplied by Hamilton Kent[5], was glued to the spigot of each joint prior to shipment. In addition, lift inserts were cast into each box to eliminate lift holes. The use of lift pins helped speed up installation of the boxes and construction of the storm sewer by eliminating the need for lift hole repair.

Gossett Concrete Pipe and McClam had to work through tough weather conditions during the installation process that included the wettest summer on record in South Carolina. Because the joints were gasketed, the installation progressed despite the inclement weather because dewatering was not needed and workers spent less time in the trench. Unstable soil conditions and changes in stations and elevations due to existing utilities added to the degree of difficulty of the installation faced by McClam and Gossett. Ease of installation of the box sewer system contributed to the success of the project.

The North Harden Street project included roadway improvements, sidewalk construction, landscaping, street lighting, and improvements to water facilities, storm sewer, and sanitary sewer. The project was awarded in November, 2011. Gossett Concrete Pipe supplied precast boxes from January, 2013 through February, 2014.

## LINKS

1. www.gossettconcretepipe.com
2. www.mcclam.net
3. www.astm.org/Standards/C1677.htm
4. www.astm.org/Standards/C1433.htm
5. www.hamiltonkent.com

Photos: Gossett Concrete Pipe

## Learn More About Buried infrastructure

- **Keyword Search on American Concrete Pipe Association Website**
  (storm, sewer, box, precast, culvert, joint)
  www.concrete-pipe.org
- **Concrete Pipe Design Manual**
  www.concrete-pipe.org/pages/design-manual.html
- **Concrete Pipe News**
  www.concrete-pipe.org/pages/cpnews.html

## Sustainable Precast Concrete Boxes for Resilient Infrastructure

*By Michael Hook, P.E., Western Region Engineer*
*American Concrete Pipe Association*
*mhook@concrete-pipe.org*
*Eric M. Yount, P.E., Principal Hydraulic Engineer*
*Nevada Department of Transportation*

Changed weather patterns are affecting critical infrastructure systems, such as storm sewers and culverts in many areas of America. Concrete sewers and culverts are being replaced long before their design life is reached because they have become undersized to carry flows that were not considered in the original design. The minimum 100-year service life[1] of these products has not been attained, and case studies about reusing and repurposing concrete pipe and boxes are no longer unusual.

Emerging from this "new normal" is the fact that precast concrete products are a key component of sustainable and resilient infrastructure systems. "Sustainable" refers to the Brundtland Commission's definition[2] that considers the environmental, economic, and social impacts of concrete products on local, regional, and global systems. Resilient" refers to the ability of such infrastructure systems to absorb disturbance and still retain their basic function and structural capacity. Deconstruction and reconstruction of a triple-cell culvert on SR-160 in Las Vegas, Nevada is an example of reusing precast concrete boxes to reconstruct the culvert element of Nevada's highway infrastructure.

The cells (each 12-foot x 10-foot x 230-foot long) were produced by Rinker's Las Vegas facility[3] and installed in 1999. An intense storm in September, 2005 caused tremendous transport of sediment downstream with a result that the triple-cell culvert was filled with five to six feet of deposition. A survey following the flood indicated that the streambed had achieved a constant grade for a significant distance upstream and downstream. Cleaning the culvert would not solve the problem. The decision was taken to deconstruct and reconstruct the culvert at the profile of the stabilized streambed.

Constructability was the greatest concern of the Nevada Department of Transportation (NDOT)[4]. The overriding question was the degree of difficulty in separating the box sections without breaking them. Using brute force, perseverance and careful attention to separating the joints with minimum damage, deconstruction and reconstruction went according to plan. The culvert was raised 8 feet at the inlet and 5 feet at the outlet. Some superficial damage was noted on the RCBs during deconstruction, but there was no structural damage. Any damage to the tongue and grooves was patched and the box joints resealed using a bituminous joint sealer.

The boxes were originally about 22 feet deep, which was reduced to approximately 15 feet. At these depths, the loading on the box will typically be controlled by the dead loads (weight of the overburden). Since the depth of overburden and corresponding load on the boxes was reduced, but not to less than 10 feet, there were no structural concerns.

If the structure had not been reusable precast cells, concrete removal would have been at least $100,000, and delivery and installation of new RCB cells would be about $830,000. The estimated cost savings was $630,000. This is an example of sustainable and resilient critical infrastructure systems constructed with concrete. NDOT would consider reusing their precast box infrastructure, should the need arise.

Sediment-filled triple-cell box.

Deconstruction of the reinforced concrete box culvert

Reconstructed triple-cell culvert under SR-160

## LINKS

1. www.concrete-pipe.org/brochures/LCA-Brochure.pdf
2. www.unece.org/oes/nutshell/2004-2005/focus_sustainable_development.html
3. www.rinkerpipe.com/default.shtml
4. www.nevadadot.com/

### Learn More About Buried infrastructure

- **Keyword Search on American Concrete Pipe Association Website**
  (reuse, box, culvert, sustainable, resilient, durable)
  www.concrete-pipe.org
- **Concrete Pipe Design Manual**
  www.concrete-pipe.org/pages/design-manual.html
- **Concrete Pipe News**
  www.concrete-pipe.org/pages/cpnews.html

Photos: Eric M. Yount, NDOT (Hydraulic)

## Precast Post-Tensioned Overflow Structure Fabricated From 3000mm Diameter Manhole Sections

*By Theresa R. Erskine, MBA, P.Eng., Director, Marketing*
*Munro Ltd.*
*terskine@munroltd.com*

Toronto's Waterfront Revitalization[1] is the largest urban renewal project in Canada. The project required a new stormwater treatment facility and outfall for the West Don Lands precinct which will be the site of the 2015 Pan Am Games Athletes Village. The engineering challenge was managing the large quantity of storm water at its source and treating it to meet the storm water quality requirements cost-effectively. R.V. Anderson Associates[2] designed the main shaft of the outfall as a storage space for storm water to be used every time there is any appreciable rainfall. An overflow from the storage shaft was created by constructing a vertical pipe in the centre of the storage shaft with a funnel-like weir at the top of the shaft. It was this overflow pipe which required creative product engineering design and fabrication.

The 3000mm overflow pipe had to be freestanding in the centre of the 12-metre diameter shaft. The pipe was originally designed cast-in-place with a wall thickness of 400mm. Constructing this pipe would have been costly, time consuming and challenging, requiring reinforcing cages for the bottom of the shaft which was 25 metres deep. It would have been challenging to construct the reinforcement, hold it in place while pouring concrete, and keeping the wall straight. Construction would have taken several weeks.

The contractor, C&M McNally Engineering Corporation[3], and designer R.V. Anderson Associates Limited, contacted Munro Ltd.[4] to supply precast concrete products for accelerating construction. The design called for a segmental precast concrete pipe that could be post-tensioned with high strength threaded bars. The outside diameter of the overflow pipe had to remain unchanged to keep the same storage capacity. The wall thickness was reduced by 25% and the mix design modified so that concrete compressive strength could be increased to handle the reduction in the wall thickness, and the increased stresses from the post-tensioning.

The system is hydraulically connected to Lake Ontario, and contains water at all times. Additional reinforcement in the overflow pipe was necessary to resist the force exerted from the internal water pressure, as well as the vertical loads from post-tensioning. The overflow pipe acts as a column supporting the weir structure and the roof of the shaft. Joints between sections are watertight.

A frame was designed At Munro Ltd. for the rebar placement, and a jig designed to ensure rebar cages were tied accurately and consistently. Each cage had to be equally round. A mould plate and jig were designed to create the holes in the structure for the post-tensioning ducts. Munro Ltd. manufactured eight 3000mm diameter sections, each two metres in height, and one segment of partial height that was cast into the bottom of the weir structure. All were fabricated from a 3000mm diameter manhole form. The post-tensioned sections were stacked using alignment markings, and each annulus of the pipe joints was grouted.

The West Don Lands Stormwater Conveyance System also required 3m x 5m precast box sections from Munro Ltd. The project received the Ontario Concrete Award for Infrastructure in 2012.

### LINKS

1. www.waterfrontoronto.ca
2. www.rvanderson.com
3. www.mcnally.ca
4. www.munroltd.com

### Learn More About Buried Infrastructure

- **Keyword Search on American Concrete Pipe Association Website**
  (manhole, stormwater, storm, box, joint, watertight, outfall)
  www.concrete-pipe.org
- **Concrete Pipe Design Manual**
  www.concrete-pipe.org/pages/design-manual.html
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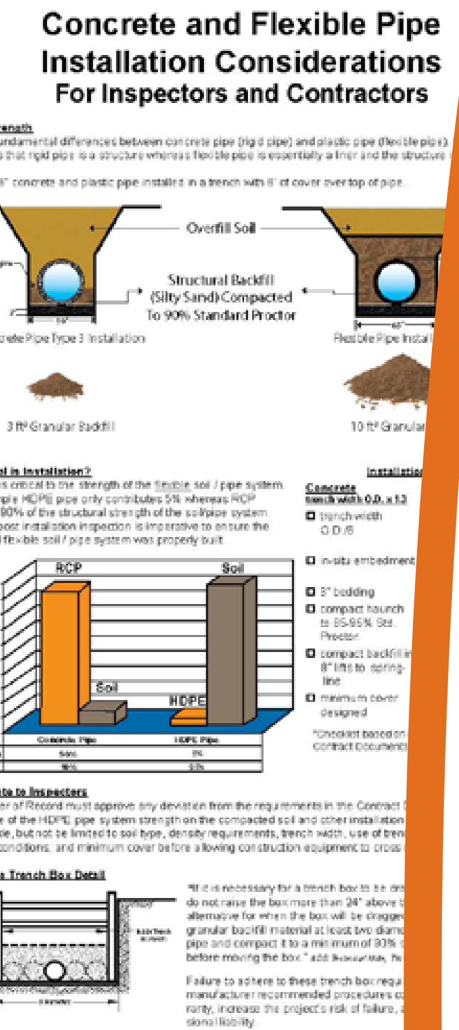
  www.concrete-pipe.org/pages/cpnews.html


Precast overflow pipe under construction.


Precast overflow pipe fabricated from manhole form.


Weir fitted onto post tensioned precast overflow pipe.

Photos: R.V. Anderson and Associates




# Direct vs Indirect Design

*Indirect Design is based on Proof-of-Manufacturing*

*By Josh Beakley and Tyson Hicks*
*American Concrete Pipe Association*
*josh@concrete-pipe.org*

Some HDPE conduit producers have been meeting with specifying agencies and making claims that concrete pipe, designed in accordance with the indirect design method provided in AASHTO, is not sufficient to withstand the loads for which it was designed. They are suggesting that specifiers and engineers specify the direct design method (also found in AASHTO) to design reinforced concrete pipe. There is no basis for these claims. Such claims are a ploy by a competing industry to obscure the long-term proven history of the indirect design method with scare tactics unsupported by any technical justification. The indirect design method is simple to use, is a proven method spanning two centuries, and is a proof-of-manufacturing method.

The Indirect Design Method[1] has existed since the 1930s, and is the method used for the design of most concrete pipe on the planet. The indirect design method uses a bedding factor to relate the governing moment on a concrete pipe in the installed condition to the moment on a concrete pipe when tested at the plant in a three-edge bearing test. The test load requirement in the plant is specified in terms of lbs-per-foot of length-per-foot of diameter, and is called the D-load. In accordance with ASTM C762 (AASHTO M170)[3], the D-load values are separated into categories and denoted as a certain Class of pipe. Standard Classes of reinforced concrete pipe are Class I through V. If you have ever specified a Class III pipe, you have utilized the indirect design method. Since the steel requirements for pipe produced per ASTM C76 are based on the proof-of-manufacturing test, and are not directly designed by the engineer, this design method is called the indirect design method.

The Direct Design Method[4] for concrete pipe has existed in its current capacity since 1921, when J.M. Paris first wrote his paper, "Stress Coefficients for Large Horizontal Pipes", Engineering News Record, Vol. 87, No. 19, November 10, 1921. Paris developed design coefficients utilizing uniform pressure distributions along the sides, top and bottom of the pipe. This is not unlike the pressure distributions that Dr. Spangler assumed when he initially developed the bedding factors for the indirect design method in his paper, "The Supporting Strength of Rigid Pipe Culverts", Bulletin 112, Iowa State College, 1933. These pressure distributions were considered a very rough approximation of the pressures induced on the pipe in the installed condition. The pressure distributions and the resulting design coefficients were used to develop equations for the moments, shears, and thrusts in the concrete pipe wall. Using these values, the engineer could then directly design the steel reinforcing required for the concrete pipe wall. Hence, the term, "Direct Design Method".

HDPE conduit[5] is extremely installation sensitive, and no such plant proof-of-performance test exists. An extensive design method must be followed to analyze the capability of a thermoplastic pipe, and this design must then be followed with a proper post installation inspection program. Certainly, there are applications for all pipe products and the design options available to use with them. However, the engineer should base their design on sound engineering principles, and not on the fear tactics of one industry attempting to increase their market share.



## LINKS

1. www.concrete-pipe.org/pdfdd/DD_9.pdf
2. www.astm.org/Standards/C76.htm
3. www.techstreet.com/products/1644706
4. www.concrete-pipe.org/pages/pipecar-info.html
5. www.concrete-pipe.org/pdf/InstallationComparisonInspectorsContractors.pdf

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8445 Freeport Parkway, Suite 350
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# Derek Light Receives Longfellow Award

The 2014 recipient of the Richard C. Longfellow Award was Derek Light, Inland Pipe (Winnipeg, Manitoba Canada). His article, "*Installed Costs a Key Consideration for Specifying RCP*"[1] was published in the Winter 2013 issue of Concrete Pipe News, Page 4. The Greens on Gardiner stormwater trunk sewer demonstrates how concrete pipe can be competitive with pipe materials with a less expensive unit price.

Each year, a Concrete Pipe News author is honored with the award for an article that most effectively demonstrates innovative and effective use of concrete pipe. The award is presented in memory of Richard Longfellow who had an outstanding career with Cretex Companies, Inc. based in Elk River, Minnesota.

**LINK TO ARTICLE**

www.concrete-pipe.org/magazine/2013wintercpnews.html

Save this link www.concrete-pipe.org/pages/cpnews.html to your favorites list to increase your knowledge about drainage applications and innovative ways to use precast reinforced concrete pipe and boxes to build structures that will last.