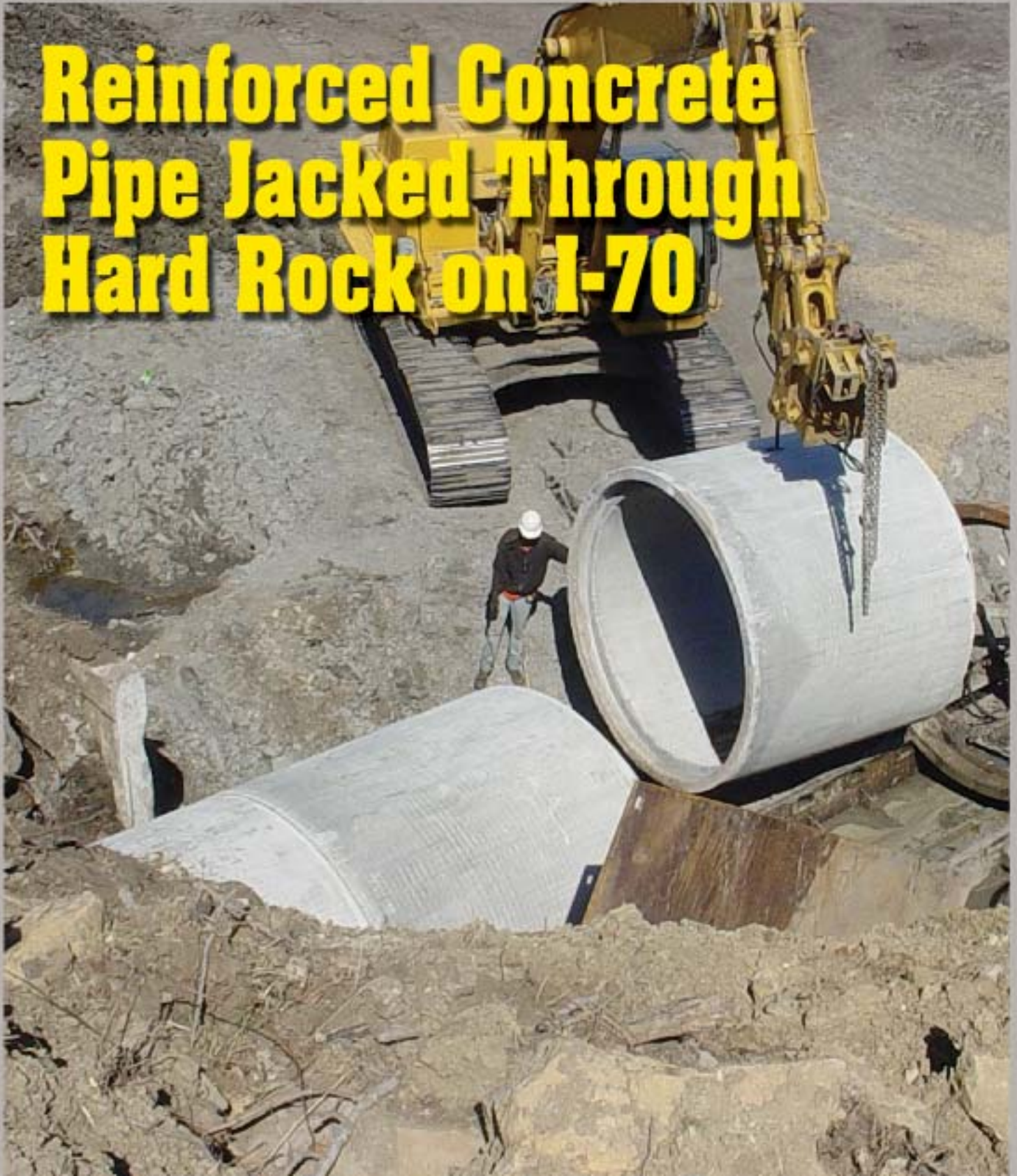


CONCRETE PIPE NEWS



The Magazine of the
American **Concrete Pipe** Association

Reinforced Concrete Pipe Jacked Through Hard Rock on I-70



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Concrete Pipe News is published four times each year by the American Concrete Pipe Association. It is designed to provide information on the use and installation of precast concrete pipe products for a wide variety of applications, including drainage and pollution control systems. Industry technology, research and trends are also important subjects of the publication. Readers include engineers, specifiers, public works officials, contractors, suppliers, vendors and members of the American Concrete Pipe Association.

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The 0.01-inch crack for installed RCP is insignificant when it is determined that the crack is the result of the concrete and reinforcing steel arriving at the modulus of rupture. Such cracks indicate that the concrete and reinforcement are working together. Because of the increasing value being placed on the Nation's buried infrastructure, taxpayers have every right to expect engineers, contractors and owners to work with trained inspectors who are familiar with the procedures involved in the inspection of RCP.

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Over 13,000 feet of reinforced concrete pipe was required for the widening of the Interstate-70 Turnpike in Kansas. All 12-inch to 96-inch diameter crossroad pipe was jacked leaving the flow of traffic on the interstate undisturbed. Some pipe was replaced with larger sizes because of changes that had occurred over the 50 years since original construction of the highway.

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In May 2005, the Kentucky Department of Transportation (KYDOT) formed a task group to evaluate current specifications and the use of HDPE pipe on future KYDOT projects. KYDOT selected seven HDPE sites and ODOT selected eleven. Pipeline and Drainage Consultants performed the field evaluations in the summer and fall of 2005.

Cover:
Concrete pipe
under extended
lanes and
overburden up
to 20 feet.



Photo: Miller the Driller

editorial

Kim Spahn, E.I.T.
Engineering Services Manager
American Concrete Pipe Association



The Insignificance of a 0.01-inch Crack

“Some engineers insist that a crack in a concrete pipe in excess of 0.01 inch represents a failure or partial failure situation. Such a conclusion is utterly ridiculous and represents a disservice, not only to the concrete pipe industry, but taxpayers as well.” This quote from Professor M.G. Spangler, a well-respected authority and early pioneer in the design of concrete pipe, should be taken into consideration when designing, installing, inspecting, or funding a project using reinforced concrete pipe (RCP). All parties involved should be aware of the **insignificance** of a 0.01-inch crack.

Reinforced concrete pipe, like other reinforced concrete structures, is designed to crack. It is well known that while concrete is very strong in compression, its tensile strength is so low that it is considered negligible in design. RCP performance is dependent upon

the high compressive strength of concrete and the high tensile strength of steel. As load on the pipe increases, and the tensile strength of the concrete is exceeded, micro-cracks will form first at the invert and occasionally at the crown as the tensile load is transferred to the steel. This moment is known as the modulus of rupture. Because of the excellent distribution of tensile stresses in RCP, cracks are very small. Typically, cracks form a V-shape with the largest part of the crack at the surface. Cracks most often terminate before reaching the reinforcement. The presence of a 0.01-inch crack does not represent failure, but rather an indication that the concrete and reinforcement are working together as intended.

The 0.01-inch crack criterion has been used as a service load design requirement for RCP for nearly 70 years. This criterion has served the industry well through the designation of a plant test that it must meet. It has also served the public well by conservatively ensuring that a strong and durable product is used in buried concrete infrastructure. Most RCP is designed to have a crack width of 0.01 inch or less, after the fully installed loading condition is experienced. While a crack width greater than 0.01 inch is an indication that the performance of the soil-pipe structure is not entirely consistent with its original design, it is not necessarily an indication that the specifier should be overly concerned with the performance of the installed pipe.

The AASHTO LRFD Bridge Construction Specification, Section C27.6.4 states, “Generally, in non-corrosive environments ($\text{pH} \geq 5.5$) cracks 0.10 inch or less in width are considered acceptable.” This allows for 10 times greater width than the design crack without repair. AASHTO LRFD Bridge Construction Specification, Section C27 goes on to say that in other environments, “Cracks having widths equal to or greater than 0.01 inch and determined to be detrimental shall be sealed by a

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Feature Story

REINFORCED CONCRETE PIPE JACKED THROUGH HARD ROCK ON I-70



Photo: Miller the Driller

By Edward A. Sexe, P.E., Market Manager
Cretex Concrete Products Midwest, Inc.
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More than 30 million vehicles each year are carried on the Kansas Turnpike from Kansas City to just north of the Oklahoma border, south of Wichita. Traffic on the turnpike was increasing at an average of three percent per year from 1995 to 2001, according to the Kansas Turnpike Authority (KTA). Between East Topeka (Toll Plaza 183) and Lecompton (Toll Plaza 197), traffic volume was increasing by five percent per year, due to commuter traffic between Lawrence and Topeka. In 2001 and 2002, studies conducted on behalf of the Kansas Department of Transportation (KDOT) and Kansas Turnpike Authority by HDR Engineering, Inc., and HNTB Corporation, provided the KTA with information to support the decision to widen this stretch of I-70 to six lanes to accommodate the volume.

With that kind of traffic volume and no

suitable alternate route, KTA had to find a way to complete the road-widening project without stopping traffic. The Kansas City based design team at HNTB Corporation (Engineers, Architects, Planners), proposed that all crossroad pipes would be jacked under I-70 leaving the flow of traffic on the interstate undisturbed. After the decision by KTA to jack the cross drains, reinforced concrete pipe (RCP) became the only feasible choice because of the inherent strength of concrete. KTA's plans for improving I-70 included widening the route to six lanes and reconstructing the highway from the ground up.

The contractor on the project was N.R. Hamm Contractor, Inc. of Perry, Kansas who focused on maintaining traffic flow throughout the bid process, and supported the jacking pipe option. Hamm chose Miller the Driller of Des Moines, Iowa to assist with the pipe jacking, and Cretex Concrete Products Midwest of Bonner Springs, Kansas to supply the

concrete pipe. Careful construction coordination was required between the concrete pipe supplier, road-building contractor and the pipe-jacking contractor. While the pipe jacking was taking place at several locations along the alignment of the road widening, Hamm Construction began placing fill over runs of concrete pipe that connected to the jacking pipe where it exited the existing road base. The new lanes were being constructed, as the jacking program was being completed.

Reinforced concrete pipe was best suited for the drainage systems at the base of the new lanes, because the installation was a positive projecting embankment with overburden up to 20 feet deep. Concrete pipe culverts could accommodate the earth loads, design life of the existing and new lanes and connection to the jacking pipe to provide a continuous concrete drainage structure.

Aside from carrying out precision jacking operations and properly embedding runs of concrete pipe under the new lanes on either side of the existing lanes, Hamm Construction was faced with widening the road in some areas where the highway passed by rock ledges. Any blasting had to occur without stopping traffic and carefully coordinated with Kansas Highway Patrol (KHP).

Whenever rock ledge blasting was required, Hamm scheduled the blasting between 10:00 a.m. and 11:00 a.m. when traffic was at a minimum. The decision to not blast at night was because of the risk of missing debris during the cleanup of the highway. The KTA, KHP and Hamm developed a procedure to accommodate the blasts. First, a turnpike maintenance truck would find a break in the traffic and merge behind the leading pack of vehicles to be sure that no one stopped on a shoulder or slowed down. Then, two highway patrol officers would enter the traffic, immediately behind the turnpike personnel,

driving side by side at about 40 miles per hour to slow the traffic creating an ever-widening gap between the leading cars, maintenance truck and the vehicles behind the highway patrol.

While traffic traveled along the highway at a controlled speed, Hamm set off their blast charges within the gap created by the control vehicles and scrambled to clear the resulting debris. All of this action took place without stopping the flow of traffic. Hamm had between two and four minutes to blast and clear the highway before the patrol cars led the traveling public onto the stretch of highway that was affected.

RCP was jacked into place at every valley along the route using diameters ranging from 12 inches to 96 inches. Some pipe was replaced with larger sizes because of changes



Large diameter RCP accommodated changes in volume of runoff over past 50 years and imperviousness of the drainage area.

to the drainage areas and imperviousness of the drainage area that had occurred over the 50 years since original construction. Many of the existing crossroad culverts were bituminous-coated galvanized steel pipe and struc-

Feature Story

tural steel plate pipes that were installed in 1956. According to the KTA the existing culvert pipes were at the end of their service life. These cross drains were blocked on the down stream side and filled upstream with cementitious flowable fill (a mixture of fly ash, borax, and water). Filling the void created by the abandoned pipe would eliminate the possibility of collapse and ultimately a pavement failure.

Jacking and boring reinforced concrete pipe is not a procedure that any utility contractor or excavation contractor can undertake. Miller the Driller has been a pioneer in the jacking and tunneling industry since it was established in 1948. One of the biggest problems encountered during pipe jacking operations was the presence of solid limestone in many locations along the length of the project. An 18-foot push through hard rock was common and considered a good day of jacking.

Unlike explosive charges used to blast through rock cuts to make room for additional lanes, the blasting device used in tunneling is about the size of a shotgun shell. It is designed to crack the rock so that it can be removed. This kind of blasting was applied in the jacking process and did not interfere with the movement of traffic.

It is common for designers and specifiers to think that jacked pipe should be of a higher class than pipe installed in an open trench. A higher-class pipe is not always the appropriate choice. Jacking puts pressure on the end of the pipe. Increasing the class of the pipe increases its ability to act like a beam. Some RCP producers supply standard inventory pipe for jacking jobs, while others make project specific pipe with a thicker wall, simply to give the jacking contractor a broader "shoulder" of pipe on which to push. For the I-70 widening, Cretex chose to use a pipe with a thicker wall than its standard pipe.

Over 13,000 feet (2.5 miles) of reinforced concrete pipe, along with 122 flared end sections were required for the project. The widening began in the spring of 2005 and is scheduled to be finished in May 2007. A total

of 9,736 feet (1.8 miles) of RCP was jacked under the highway completing a system of 86 crossroad culverts. The jacking and tunneling work took 10-1/2 months to complete. The cost of the project between East Topeka and Lecompton is \$54 million. ☺

Project: I-70 Kansas Turnpike Widening Project
East Topeka (M.P. 184) to Lecompton
(M.P. 197)

Owner: Kansas Turnpike Authority
Wichita, Kansas

Project Design: HNTB Corporation (Engineers,
Architects, Planners)
Kansas City, Missouri

Contractor: N.R. Hamm Contractor, Inc.
Perry, Kansas

Trenchless Technology

Contractor: Miller the Driller
Des Moines, Iowa

Quantities: Approximately 13,000 feet of RCP for jacking and positive embankment installation ranging in size from 12 inches to 96 inches in diameter for the section between East Topeka and Lecompton.

122 flared end sections.

Producer: Cretex Concrete Products Midwest
Bonner Springs, Kansas

Cretex Concrete Products Midwest is an affiliate company of Cretex Companies, Inc. Cretex Concrete companies continue to produce reinforced concrete pipe and other precast and prestressed concrete products to fulfill the infrastructure needs of the central United States. The Cretex Concrete Products Midwest facility was built in 1997 to improve service in the Kansas and Missouri market areas. In addition to pipe, a full range of precast box sections and the Cretex Arch Bridge System are produced at this facility. Cretex was founded in 1917 in Elk River, Minnesota, the current site of the company's corporate headquarters. See www.cretexinc.com for more information and a listing of their facilities.

Significance of Ultimate-Strength Requirements in Reinforced Concrete Pipe Design

By Balaram K. Singh, P.E.
Michigan Department of Transportation

Unlike most reinforced concrete structures, reinforced concrete sewer and culvert pipes are designed to meet a specified cracking load, rather than a specified stress level in the reinforcing steel. This is both reasonable and conservative, since reinforced concrete pipe is tested in-plant in accordance with American Society for Testing and Materials (ASTM) specifications.

Pipe Performance Test

The first visible crack observed in a three-edge bearing (TEB) test was the accepted criterion for pipe performance when the industry first began to establish performance tests for pipe. The observation of such cracks

was subject to variations depending upon the enthusiasm, diligence and eyesight quality of the observer. It became apparent that there was a need for a criterion based on the measurable crack of a specified width. Professor



Photo: ACPA photo library



Concrete sewer and culvert pipes are designed to meet a specific cracking load.

W.J. Schlick of Iowa State University established the 0.01 -inch crack width using a 0.01-inch thick leaf gauge to provide a measurable and definitive crack size for the three-edge bearing test. Eventually, the 0.01-inch (0.25 mm) crack became the accepted criterion for pipe performance.

The design crack is V-shaped in nature and

is widest at the surface penetrating usually no further than the first reinforcing cage in the pipe. Corrosion of the reinforcement is unlikely, providing the crack is not wide enough to permit circulation of moisture and replenishment of oxygen. Cracks in excess of 0.01-inch (0.25 mm) have been observed after several years with no evidence of corrosion.

Reinforced concrete pipe is designed to crack. Cracking under load indicates that the tensile stresses have been transferred to the reinforcing steel. A 0.01-inch (0.25 mm) wide crack in a concrete pipe does not indicate structural distress and such pipe will perform as intended in the installed condition. Pipe produced with greater than one inch (25 mm) cover over the reinforcing steel is an exception. In these designs, acceptable crack width should be increased in proportion to the additional concrete cover.

Load Carrying Capacity

The strength of RCP is stated as D-load, which is the load in pounds per lineal foot per foot of internal diameter. The strength test requirements under the TEB method are classified according to the D-load that produces a 0.01-inch (0.25 mm) crack and the D-load that produces the ultimate load.

When concrete pipe is subjected to external loading, resisting stresses induced in the pipe wall are flexural, axial and diagonal tension. Tensile stresses are developed in the inside wall, at the crown and invert, and on the outside at the springline. Compressive stresses are developed in the walls opposite the tensile stresses. The reinforcing of a concrete pipe consists of the placement of steel reinforcement in those zones of the pipe wall where tension stresses exist. Reinforcement in the pipe wall where compression stresses exist is not required, but is used in various methods of reinforcing for ease of placement. Stirrups placed radially within the pipe wall at

the crown and the invert zones resist the inherent diagonal shear and radial tension stresses produced by the external loading of the pipe.

Indirect Design

In the indirect method, pipe is designed for a concentrated test load that is determined by the relationship of field-calculated moment to the TEB test moment for the same load. This relationship is called bedding factor which is determined by dividing the bending moment obtained in a TEB test by the controlling bending moment in the field. Many pipes, particularly large diameter and high strength classes such as Class IV and V, have their strength governed by shear in TEB tests, while their field strength may be governed by both shear and flexure.

The indirect design method for concrete pipe is similar to the common working stress method of steel design, which employs a factor of safety between yield stress and the desired working stress. The factor of safety is defined as the relationship between the ultimate strength D-load and the 0.01-inch (0.25 mm) crack D-load. The 0.01-inch (0.25 mm) crack D-load is the maximum TEB test load supported by a concrete pipe before a crack occurs having a width of 0.01-inch (0.25 mm) measured at close intervals, throughout a length of at least one foot (300 mm). The ultimate strength D-load is the maximum TEB test load supported by a pipe.

Direct Design

Direct design is used specifically for the field condition anticipated loads and the resulting moments, thrust and shear caused by such loadings. Standard installation direct design (SIDD) emphasizes minimizing compaction immediately below the invert region to the extent feasible with uniform longitudinal support, and maximizing soil quality and

compaction level in the outer portions of the haunch zones below the pipe. A modified soils pressure configuration called the Heger distribution has been developed as a function of soil type and compaction. The configurations are referred to as Type 1, Type 2, Type 3 and Type 4, depending upon pipe bedding, soil type and compaction level. The difficulty in obtaining specified soil compaction under the haunches of the pipe has been recognized in the soil pressure distribution by conservatively assuming all installations will have voids and soft inclusion in the haunch area.

The SIDD procedure facilitates the use of a variety of design options for minimizing the amount of reinforcing steel to suit the needs of a specific installation. The outer cage reinforcement is designed to meet specific design conditions in contrast to the designs given in ASTM C76 requiring outer reinforcement to be 0.6 times of the inner reinforcement area, regardless of the governing design criteria for inner reinforcement. The design area of the inner reinforcement is sometimes increased to provide increased shear or 0.01-inch (0.25 mm) crack strength, but these criteria usually do not govern the outer reinforcing design. The outer reinforcement area, therefore, frequently can be less than 0.6 times the inner reinforcement area.

A rational method is provided for determining when shear or radial tension reinforcement is required and for designing stirrup reinforcement to meet these strength criteria. The direct design procedure permits more accurate design of reinforced concrete pipe and evaluation of pipe structure behavior using procedures that are similar to those used for other reinforced concrete structures.

Comparing Indirect and Direct Design

In comparing indirect design (D-load) with direct design, the maximum moment and

shear in the TEB test is at the same location on the pipe, which is not the case in the field. Considering the concentrated load and reaction that exists in the indirect design test, failure modes can exist that are not typical for the direct design pipe, which often require special steel reinforcing assemblies that are unnecessary in the field.

The ultimate strength of concrete pipe in the buried condition is dependent on varying soil bedding factors and installation types. The ultimate strength may amount to varying failure modes and shall not necessarily have a relationship to the ultimate strength, as determined under TEB conditions.

Pipe design methodologies allow public owners of infrastructure, pipe producers and contractors to leverage their strengths. Public owners may minimize a project's overall expense by balancing the cost of the pipe with different allowable combinations of bedding and types of installation. A producer may supply product with the appropriate reinforcing for the buried application instead of pipe produced to meet empirical testing criteria. A contractor may reduce installation costs by selecting bedding conditions, installation type or pipe strengths, which permit a fast installation with fewer installers. If an owner and contractor know the quality of the soil and installation procedures, pipe strengths can be modified accordingly when unstable soils are encountered, or high quality in-situ soil conditions exist.

Understanding the significance of ultimate-strength requirements in reinforced concrete pipe design leads to better design and long-term performance of storm and sanitary sewers. ☺

Note: A longer version of this article, authored by B.K. Singh, was first published in the summer 2006 issue of Concrete Engineering International (www.concreteengineering.com)

Concrete Box and Pipe Storm Sewers Alleviate Massive Flooding Problem

By Jarrold F. Bradley, Jr.
City of Wichita

Wichita, the largest city in Kansas with a population of over one-quarter million, experiences occasional flash flooding from the Arkansas River, which passes through the city. In addition to the flooding caused by the river, a section of Midwest Wichita has a history of flooding from a time long before paved roads were introduced in the 1950s. One of the hardest hit areas is the neighborhood east of West Street between Douglas and 2nd Streets, running west from the Arkansas River. Here, much of the flooding was attributed to undersized storm sewers that no longer had the capacity to accommodate the volume of runoff from the north and west. During heavy rainfall events, the north-south running West Street had to be closed to traffic, since a continuous half mile of the street was often underwater. The storm water drainage problem had to be solved before the City could reconstruct West Street.

In 1993, Wichita introduced the Equivalent Residential Unit (ERU), which is a monthly fee paid by the owners of all properties in the City to support the efforts of the Public Works Department. The Public Works Department is responsible for the construction, reconstruction and maintenance of the City's storm water drainage system, as well as the water quality aspects of the City's storm water pollution prevention program. The 1st and 2nd Street Drainage Improvement Project was funded from the ERU program.

Beginning at the most severe flood-prone



Photos: Jeff Bradley, Baughman Company

Flooding attributed to undersized storm sewers.

section of West Street, this project routed a precast concrete box culvert for almost two miles to a discharge point in the Arkansas River. Precast concrete box culvert construction was selected because of the consistency of the product and the speed of installation. The contract called for box sizes ranging from 8-foot x 5-foot to 10-foot x 5-foot, including over 1,500 feet of pipe and numerous inlets. A secondary 60-inch diameter precast concrete pipe trunk line was responsible for relieving the long-standing 2nd Street and Sheridan Street flooding problems. Inlets were placed at low points, and pipe stubs were incorporated in the line to accommodate future connections.

Unlike projects where there are lengths of precast pipe and related precast components and sections that are cast-in-place, this job was designed as a total precast concrete storm sewer structure. Behind the speed of the installation



were close to 200 hours of engineering from the staff at McPherson Concrete Products and its affiliate, Wichita Concrete Pipe. Both plants supplied pipe, structures, and boxes. While Wichita supplied the bulk of the standard products, McPherson supplied the majority of the specials. Project challenges related to existing utilities in the right-of-way and box geometry required the production of many special transition pieces.

At the beginning and throughout the project, the design team of Boughman Company, P.A. and Ruggles & Bohm, P.A. worked closely with City engineers and the contractor, Wildcat Construction, to size the boxes and special transition structures, set limits to the work area, establish clearances and even the production rates of the product suppliers. While construction primarily took place in the existing street right-of-way, instructions were given to the contractor regarding the amount of traffic that was allowed to be rerouted from the site at any time. Extensive sewer relocation plans were required, along with utility relocations and complete pavement replacement along the reconstruction route. The contractor accommodated the concerns of residents, especially those with special needs. Restoration work included Americans with Disabilities Act (ADA) compliant sidewalk ramps and complete street reconstruction. In most cases, restoration improvements in the eyes of residents surpassed

The contract called for precast concrete boxes ranging in size from 8-foot x 5-foot to 10-foot x 5-foot.



the streetscape conditions that predated construction.

The 1st and 2nd Street Drainage Improvement Project was completed in November 2005 almost seven months ahead of schedule and approximately \$1.4 million below the City's estimate of \$6 million. Wildcat Construction was allowed until July 2006 to complete this project, but reconstruction was completed early because of the use of precast products, comprehensive design details, and a strong cooperative attitude between all parties. Along with the speedy completion and teamwork, this project was significant because it provided the first major drainage trunk storm sewer from the Arkansas River to serve a flood prone area that has beleaguered the citizens of Wichita for over 35 years. ☺

Project:	The 1 st and 2 nd Street Drainage Improvement Project Wichita, Kansas
Owner:	City of Wichita
Project Design:	Boughman Company, P.A. Wichita, Kansas Ruggles & Bohm, P.A. Wichita, Kansas City of Wichita Public Works Department
Contractor:	Wildcat Construction Wichita, Kansas
Quantities:	Approximately 2 miles of 8-foot x 5-foot and 10-foot x 5-foot precast concrete box sections 1,500 feet of concrete pipe, including 60-inch diameter RCP. Numerous precast concrete inlets
Producers:	McPherson Concrete Products, Inc. McPherson, Kansas Wichita Concrete Pipe, Inc. Wichita, Kansas

McPherson Concrete Products, Inc. and Wichita Concrete Pipe, Inc. provide a complete range of precast concrete products for storm water and sanitary sewers including concrete pipe, box sections, manholes, catch basins and inlets. Both companies are affiliated to provide products to clients throughout the region. For information, see www.mcphersonconcrete.com.



Big projects often require special tools and strong-willed professionals to make them a reality. This is a story about how a local leader was able to secure long-term funding for the construction and maintenance of sanitary and storm sewers in a high growth county in Michigan, and the application of reinforced concrete pipe for maximum return on investment. Once funding was secured, the money was used to construct major trunk relief sewers that will return great savings to the county by adding to its assets' net worth in terms of low maintenance and performance for generations.

In the late 1990s, Genesee County (southeast Michigan) ran out of sewer capacity in its sanitary sewer interceptors. To relieve this situation, phased improvements were required to the Northeast and West Trunk Relief Sewers to handle sewage overflow. The Northeast Relief Sewer is to relieve flow from the northeast portion of Genesee County including the townships of Flushing, Mt. Morris, Genesee, Davison and the City of Burton. The West Trunk Relief Sewer is to alleviate flows from the Grand Blanc Township-City Interceptor, by diverting sewage into the Swartz Creek Interceptor located to the west. The project will free up capacity and reduce sanitary sewer overflows and back-ups.

When all construction phases are completed, Genesee County will be able to process an additional 31,600,000 gallons of sewage per day to meet sewage treatment needs for the next 30 years. The relief sewers eliminate 20 major pump stations and their maintenance costs. Since Interstate 69, Interstate 75 and Highway 23 merge in Genesee County, increased sewer

capacity will ensure that the county remains a hub of commerce by providing infrastructure capacity, protection of public health and the environment, and provision of services for economic development.

Jeff Wright, the Genesee County Drain Commissioner led the drive to find a means for long-term funding of the relief sewers and other major sewer projects. State law provides for the election of the Drain Commissioner, responsible for the administration of the Drain Code, 1956, as amended, every four years on a partisan basis. Duties include the construction and maintenance of drains, determining drainage districts, apportioning costs of drains among property owners, and overseeing local units of government that receive bids and award contracts for drain construction. The Drain Commissioner, by action of the County Board of Commissioners, serves as the County Agency that provides sanitary sewer collection and treatment for 32 local municipalities covering six counties. This responsibility covers more than 680 square miles, over 180,000 residents and thousands of businesses and their employees.

Mr. Wright was well aware of the need for relief sewers when elected in 2001, since he was born and raised in Genesee County and had worked for previous drain commissioners in various capacities from 1974 through 1997. His predecessor wanted to raise sewer rates to fund relief projects. In a move that took a ruling by the Michigan Supreme Court to prevail, Jeff Wright implemented the County Capital Improvement Fee, (CCIF) which authorized the County Drain Commissioner to charge a CCIF to all new direct and indirect connections for

\$1,000.00 per connection. This funding tool ensured that property owners of new construction would pay for increased capacity in the County's sewer system, not existing customers. By summer 2006, the CCIF had collected approximately \$13 million. This source of funds along with revenue bonds enabled the County to spend \$90 million on sewer improvements without raising sewer rates.

Over 300 property easements were needed for the sewer improvements. Historically, Genesee County paid \$1 for property easements. With revenue procured by the CCIF, the County was able to compensate property owners at fair market value, preventing the condemning of properties for the easements. Land acquisitions were less than half of one percent of the total project costs.

The Northeast Relief Sewer was designed in four phases that included approximately 32,000 feet of 48-inch to 72-inch diameter reinforced concrete pipe (RCP), 14,000 feet of 48-inch diameter RCP and 2,500 feet of 30-inch to 42-inch diameter RCP. Approximately 8,000 feet of the 48-inch diameter RCP interceptor was constructed using micro-tunneling techniques. These new sewers eliminate three major and several smaller pump stations, while redirecting several existing interceptors into the new system, thereby relieving the existing overloaded system of approximately 28 million gallons per day (peak flow).

Consoer, Townsend, Envirodyne Engineers, Inc. (CTE) was the lead engineer on the project. As one of several AECOM companies, CTE is part of a global design and management organization with 24,000 employees worldwide. In 2005, AECOM was featured prominently in the "Top 500 Design Firms" of Engineering News Record, ranking first in transportation, sewer/waste, and general building, and third overall. Hubbel, Roth and Clark assisted with pump station design while Wade Trim, Inc. and Rowe Inc. assisted with surveying and layout of the project.

Phase 1 was completed in 2005 at a cost of \$9 million. Phase 2 was awarded to Zito Construction in 2005 and work began that winter. Incorporated in 1969, Zito Construction is a

family owned company with 45 employees specializing in road building, earth moving, sewers and watermains for municipalities and Michigan developers. Burial depths of the RCP ranged from twenty to thirty feet. High water tables were encountered through 70 percent of the project, presenting additional challenges for the Zito crew. When construction is completed on Phase 2 by winter 2006, over 18,072 feet of 72-inch diameter RCP will have been installed at a cost of \$8.5 million.

Phase 3 has been awarded to D'Alessandro Contracting Group, located in Detroit. This phase will require the installation of two miles of 48-inch through 54-inch diameter RCP. Fifty-foot burial depths will require tunneling of a portion of this \$7.5 million project. Construction will begin in fall, 2006.

Phase 4 will include the installation of five miles of 48-inch through 72-inch diameter RCP.

While work has been on-going on the Northeast Extension, work is being completed on the West Trunk Interceptor. CTE was the lead engineer for Phase 1 of the West Trunk Interceptor, and Wilcox Engineering was the lead design engineer for Phases 2 through 4. When completed, the interceptor will include approximately 12 miles of new sewer. Phase 1 and 2 were completed in 2004 and 2005. Phase 3, awarded to D'Agostini & Sons, Inc began construction in mid July of 2006.

D'Agostini & Sons, Inc. is a family-owned business with 140 employees specializing in heavy construction, tunneling, sewers, watermains and emergency infrastructure repair, incorporated in 1967. When the project is completed by November 1, 2006, they will have installed over 12,408 feet of 21-inch diameter RCP. The fourth phase of the West Trunk will bid in the spring of 2007.

Superior joints, competitive

Buried depths for RCP ranged from 20 to 30 feet in open cut method.





Reinforced concrete pipe ranged in size from 12 to 92 inches in diameter.

prices, and the ability to provide on-time deliveries prompted Zito Construction, D'Alessandro Contracting Group and D'Agostini & Sons, Inc. to choose the Premarc Corporation of Durand, Michigan to supply reinforced concrete pipe for certain sections of their contracts. A major concern was the assurance of a watertight joint for all pipe units to limit migration of fine soil. Storm water inflow and groundwater infiltration had added to the sanitary flows that exceeded the capacities of these interceptors. By using diamond-tipped grinding wheels, Premarc produces exact dimensional tolerances during the manufacturing of the gasket-seating surface, ensuring dimensional control over the pipe joint. Construction crews are able to accurately install gaskets and home the pipe.

Premarc worked with engineers of the Genesee County Drain office to ensure Phase 3 concrete pipe of the West Trunk was installed according to ASTM C-1479. This involved changing the backfill specification from an open-graded aggregate material, which allowed soil migration and perhaps shifting and movement of the pipe, to a Class 2 sand backfill. This change ensured that the pipe would last well beyond the design life of the project.

To solve the problem of capacity in the existing sewers of Genesee County, it required innovative project funding and products that would meet the expectations of a life cycle cost analysis. Both the Northeast and West Trunk Relief Sewers are being constructed within the

model of long-term planning for service and maintenance. Taxpayers, both new and established will benefit from the return on investment enabled by the CCIF and reinforced concrete pipe. ☺

Project: Genesee County Northeast and West Trunk Relief Sewers

Owner: Genesee County Drain Commissioner

Designers: Consoer, Townsend, Envirodyne Engineers, Inc.
Flint, MI

Wilcox Engineering
Lansing, Michigan

Contractors: Zito Construction Co.
Grand Blanc, Michigan

D'Agostini & Sons, Inc.
Detroit, Michigan

D'Alessandro Contracting Group
Detroit, Michigan

Quantities: 13,080 feet of 72-inch diameter Class IV RCP (supplied by 4,992 feet of 72-inch diameter Class V RCP Premarc)
1,064 feet of 24-inch diameter Class III RCP
12,408 feet of 21-inch diameter Class IV RCP
376 feet of 12-inch diameter Class IV RCP
23 (48-inch diameter) manholes
10 (60-inch diameter) manholes

The Premarc Corporation is Michigan's largest precast concrete pipe manufacturer. Founded in 1927 in Durand, Michigan by the Marsh family, the company first operated in the Flint and Lansing area but now has facilities in Cadillac, Grand Rapids and Clarkston, as well as Durand. Premarc's delivery fleet supplies the entire lower peninsula of Michigan and extends into Indiana. Products include precast reinforced concrete sanitary and storm sewer pipe, manholes, catch basins, wet wells, and pump stations. Bridge products include concrete boxes, and prestressed bridge beams. For more information, see www.premarc.com.

editorial

continued from page 2 _____

method approved by the engineer.” This means that it must first be determined that the crack will have a damaging or harmful effect, and even then it only requires a repair seal, not replacement. For destructive reactions to occur within a crack located in a corrosive or highly alkaline environment, there must be a continuous replenishment of the aggressive solution and/or oxygen.

Many sources agree the 0.01-inch crack was never intended to determine the failure of installed RCP. Professor W.J. Schlick of Iowa State University established this crack width to determine the strength of RCP in a three-edge-bearing test. He used a 0.01-inch thick leaf gauge to provide a measurable and definitive crack size for the test. The three-edge-bearing test applies a bearing strip along the top of the pipe, and two closely spaced bearing strips along the bottom. This test creates a much more severe load than installed pipe conditions. Specifications for RCP require an ultimate load resistance that exceeds the required 0.01-inch crack strength, giving the designed pipe a significant factor of safety above the required service load. The 0.01-inch crack width is not related to the size of a crack that should be considered a structural failure of an installed concrete pipe. ASTM C76-06 states in section 11.3.1, “Pipe that have been tested only to the formation of a 0.01-inch crack and meet the 0.01-inch load requirement shall be accepted for use.”

A process, known as autogenous healing often occurs between two surfaces of narrow cracks in buried pipe. Autogenous healing is the ability of concrete to heal itself in the presence of moisture. This explains why the healing occurs in concrete pipe where water conditions are higher than that of other concrete structures. During this process calcium carbonate, a hard white substance, forms when moisture reacts with unhydrated cement pow-

der and regenerates the curing process. This self-healing process creates a monolithic structure just as if the crack had never occurred. In Ohio, the Department of Transportation has developed a post-construction inspection standard for installed pipe, where there is evidence of cracking that requires nothing be done to a pipe with a crack width up to 0.06 inch, due to the autogenous healing that is expected to occur.

With recent developments in video imagery technology, OSHA confined space rules, and GASB 34 asset management rules, video inspections are often employed to inventory existing systems and for the acceptance of new installations. During these inspections, cracks and the presence of autogenous healing may be evident. All too often, an untrained eye views a small crack in a post installation video inspection of a RCP and the crack is determined to be a failure. This may occur because some cameras currently available for video inspections produce distortion, and magnify hairline and shrinkage cracks. This causes cracks to appear much larger, resulting in unnecessary repairs or replacements. Recent advancements in video inspection technology have produced calibration devices that clearly indicate the actual size of the crack, resulting in an accurate inspection. Hairline cracks are expected to occur in concrete pipe, so the reinforcing steel will perform as intended.

The 0.01-inch crack in installed RCP is insignificant when determined that the crack is the result of the concrete and reinforcing steel arriving at the modulus of rupture. Such cracks indicate that the concrete and reinforcement are working together. Because of the increasing value being placed on the Nation’s buried infrastructure, taxpayers have every right to expect engineers, contractors and owners to work with trained inspectors who are familiar with the procedures involved in the inspection of RCP. ☺

Evaluation of HDPE Pipe Performance on Kentucky DOT and Ohio DOT Construction Projects

By Pipeline and Drainage Consultants (a subsidiary of Spartan Construction)
Burlington, Kentucky

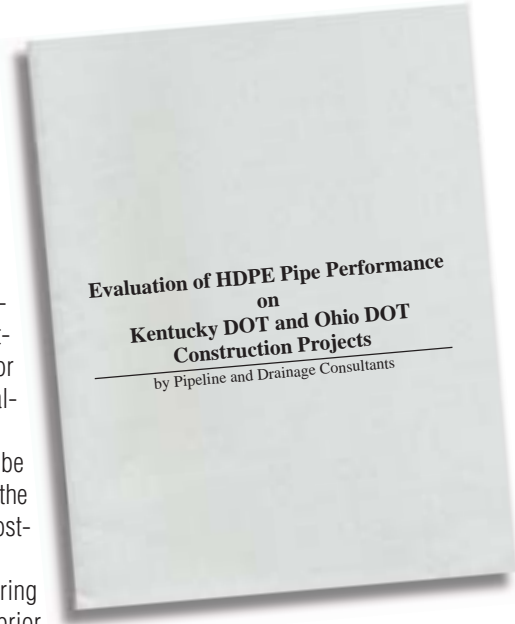
In May 2005, the Kentucky Department of Transportation (KYDOT) formed a task group to evaluate current specifications and the use of HDPE pipe on future KYDOT projects. It was decided to evaluate the long-term performance on previous HDPE pipe installations before proceeding further. The Ohio DOT (ODOT) initiated a similar performance evaluation in the fall 2005, to review previously installed HDPE pipe sites. KYDOT selected seven HDPE sites to be evaluated and ODOT selected eleven.

Pipeline and Drainage Consultants performed the field evaluations in the summer and fall, 2005. Several of these pipelines had been reviewed previously for long-term performance with results published in *Condition Investigation of HDPE pipe in service in the United States (six states), January 24 2002* by Wiss, Janney Elstner Associates, Inc. The results were compared to the field measurements taken in 2005. This gave an interesting "snapshot" of how the pipelines' condition has deteriorated over set points in time.

The following recommendations were made as a result of the evaluation.

- Further monitoring of HDPE pipe installations should be conducted.
- Post video inspection and deflection testing should be required for quality control and quality assurance.
- Deflection should be limited to 5 percent with the anticipation of some post-construction creep.
- All previous monitoring points established on prior research projects be measured and evaluated for long-term performance.
- Specifications should ensure that correct bedding and backfill requirements, proper densities and proper compaction are achieved as outlined in ASTM D 2321 and AASHTO Section 30.
- A quality control/quality assurance inspection program should be established for all drainage materials and structures.
- Video inspection and laser profiling should be evaluated for adoption into state Department of Transportation specifications for quality control and quality assurance.

The report may be viewed at www.concrete-pipe.org under Technical/Research. ☺



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