

Volume 53 No. 4 Winter 2002

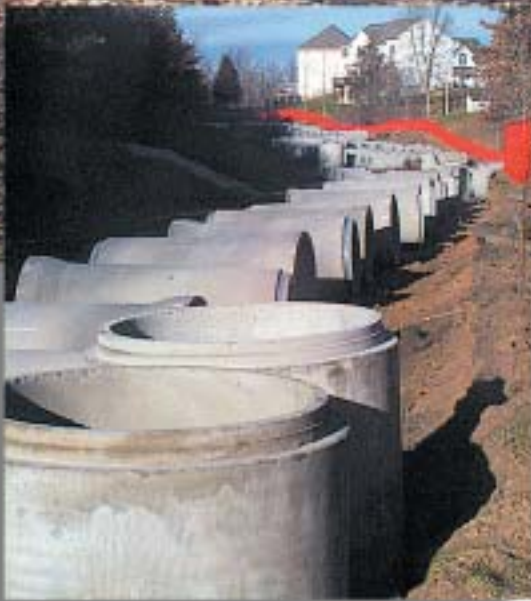
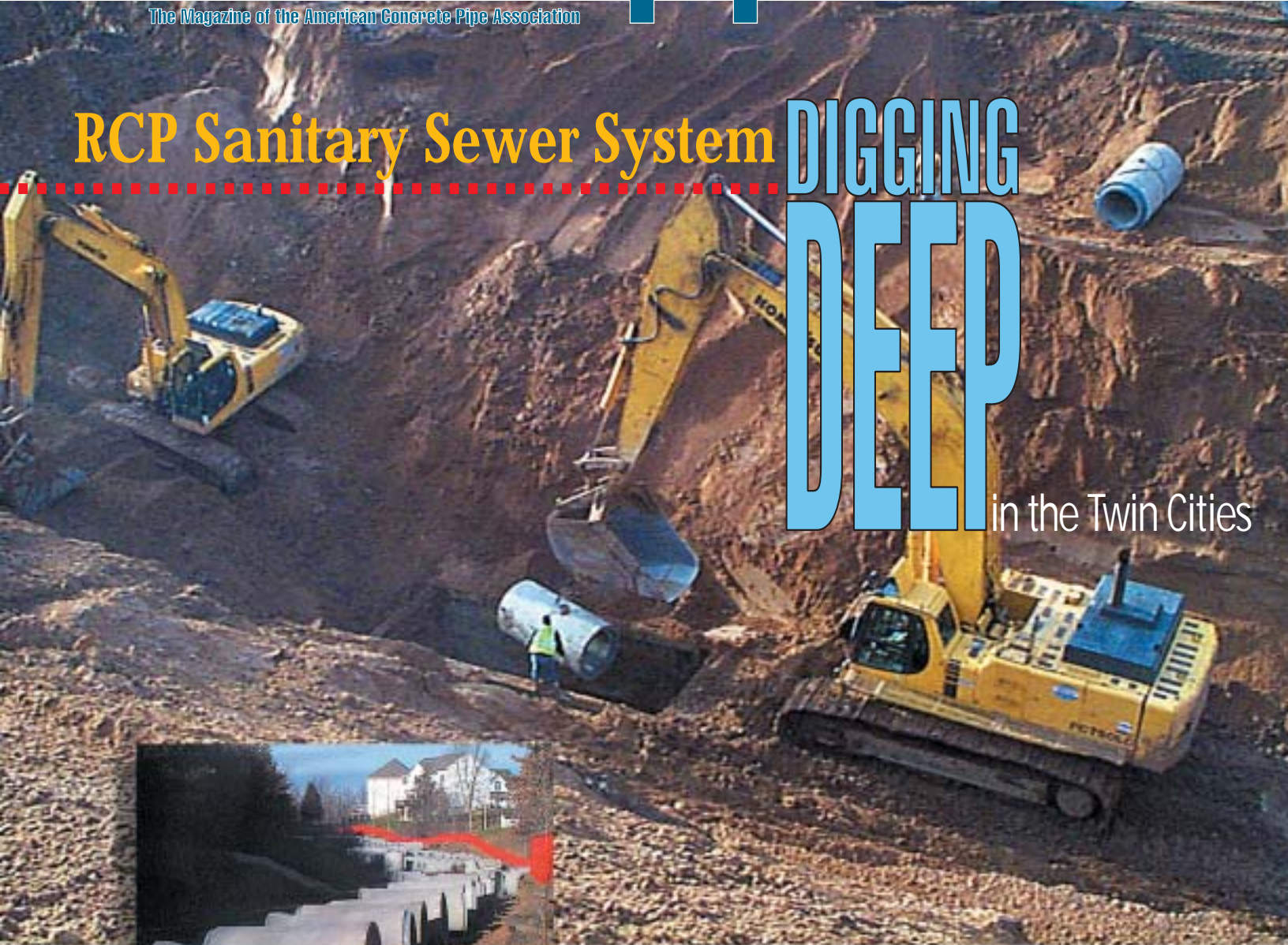
# concretepipenews

The Magazine of the American Concrete Pipe Association

RCP Sanitary Sewer System

DIGGING  
DEEP

in the Twin Cities



- **Tanner Creek Stream Diversion Uses RCP to Clean Up Portland's Willamette River**
- **Big Pipe Spurs Big Growth West of Toronto**
- **What Is The Difference Between Rigid and Flexible Pipe?**

**This issue:**

Volume 53, Number 4  
Winter 2002

*Concrete Pipe News* is designed to provide a communication forum for the concrete pipe industry to facilitate the exchange of information regarding product use and applications, industry technology and trends among members of the American Concrete Pipe Association, contractors, engineers, vendors, suppliers and other interested parties.

**American Concrete Pipe Association Staff**

John J. Duffy  
*President*

Mike Saubert  
*Director of Marketing*

Josh Beakley  
*Director of Technical Services*

Matt Childs  
*Director of Engineering Services*

Carol LeSueur  
*Director of Member Services*

Wendy Lambert  
*Controller*

**Media Task Group**

Scott Olson, Chairman  
*The Cretex Companies  
Elk River, Minnesota*

Bill Gardner  
*Madison Concrete Pipe, Inc.  
Madison, Wisconsin*

Walter Krahn  
*Inland Pipe Limited  
Calgary, Alberta*

Bill Hobson  
*N C Products  
Raleigh, North Carolina*

Merle Headington  
*Zeidlers, Inc.  
Waterloo, Iowa*

**Contract Editorial Staff**

A. Grant Lee  
*AGL Marketing Limited  
Executive Editor*

Gary Wilder  
*Wilder Studios  
Production*

**Published by:**

American Concrete Pipe Association  
222 W. Las Colinas Blvd., Suite 641  
Irving, Texas 75039-5423  
Phone: (972) 506-7216  
Fax: (972) 506-7682  
E-mail: info@concrete-pipe.org



*Opinions expressed by authors other than staff of the American Concrete Pipe Association do not necessarily reflect the official positions or policies of the Association.*

# Table of Contents

## Regular Departments

**President's Report** ..... 3

From Association President John J. Duffy

**Industry Spotlight** ..... 4

Jim Nystrom of The Cretex Companies, Inc., Elk River, Minn., shares his in-depth understanding of precast concrete box unit engineering that he has gained through applied science in the workplace and participation on industry-related committees.

## Features

**Neither Rain, nor Sleet, nor Snow Impedes the Use of Precast Concrete Pipe** ..... 5

Neither rain, nor sleet, nor snow shall impede the progress of development using reinforced concrete pipe in Minneapolis-St. Paul area and surrounding suburbs. The City of Woodbury, Minn., has started construction of a sanitary trunk system with a 36-inch diameter installation.

**Tanner Creek Stream Diversion Uses RCP to Clean Up Portland's Willamette River** ..... 7

Reinforced concrete pipe is being used on the construction of a major combined sewer overflow (CSO) reduction project in Portland, Oregon. Two phases of the Tanner Creek diversion are being built to reduce combined sewer overflows into the local Willamette River.

**Big Pipe Spurs Big Growth West of Toronto** ..... 10

A new trunk sanitary sewer servicing the Town of Milton located west of Toronto, Ontario carries effluent from new development to an expanded wastewater treatment plant on the shore of Lake Ontario. The trunk sewer and parallel water main are collectively known as "The Big Pipe".

**What is The Difference Between Rigid and Flexible Pipe?** ..... 12

Although reinforced concrete pipe is defined as rigid, this does not mean that you do not need a proper design. This technical article, from ACPA Staff, provides mathematical definitions of rigid and flexible pipe. It also points out that as new materials and composites of existing materials are developed, the definition of a rigid pipe may not be so clear in the future.

*Cover:  
A two-backhoe  
system is being  
used to place  
more than 4000  
linear feet of  
36-inch diameter  
reinforced  
concrete pipe in  
depths from 16 to  
52 feet for a  
sanitary sewer  
line in Woodbury,  
Minnesota, a  
suburb of  
Minneapolis-St.  
Paul.*







*John J. Diffy*

## *Superior Performance is Easy to See*

The American Concrete Pipe Association practices due diligence in its promotional messages and media to reassure the public, and the industry it serves, that factual information is being presented.

Advertising campaigns are often used to create an image – an imitation or impression of something real. Successful campaigns cause a reaction. This may be to make a purchase, support a cause or technology, or defeat a candidate in an election campaign. Even though the proponent of the ad may be identified with high community or industry values, a poor ad can destroy that image in a heartbeat. Viewers of an ad may see information in different ways. And occasionally, advertisers deliberately mask the facts with exciting visual effects and stirring words.

The concrete pipe industry takes great care and pride in its promotion of products and claims of performance. What you see is what you get!

This issue of *Concrete Pipe News* focuses on large diameter sewers, and high quality precast concrete pipe that is produced to last for generations.

Our cover story tells about a new 36-inch diameter RCP sanitary sewer being installed during the winter months in the Minneapolis-St. Paul area. With depths from 16 feet to 52 deep, the open-cut installation traverses a very narrow, 4,500-foot route through neighborhoods and parks. Next, you'll read an account of two phases of a stream diversion project in Portland designed to reduce combined sewer overflow into the Willamette River. By separating creeks from the combined sewers, the volume of overflow to the river will be reduced by approximately 260 million gallons per year. The next story is about 96-inch diameter RCP used for a trunk sanitary sewer in the Halton Region, west of Toronto, Ontario. The truck sewer is required to service a fast-growing community.

Our technical article looks at mathematical definitions of rigid and flexible pipe. It closes with the observation that as new and innovative materials and composites of existing materials are developed, the definition of a rigid pipe may not be so clear. The article demonstrates that the concrete pipe industry is defining a twenty-first century issue.

Jim Nystrom is the focus of our Industry Spotlight. He is an active member of the American Concrete Pipe Association's Technical Committee, and was instrumental in helping develop ASCE's Standard Installations Direct Design for precast concrete pipes as well as ACPA's BOXCAR design software for precast concrete box sections.

Over the past 30 years, the concrete pipe industry has pulled together through its national and state associations to advance the technology of precast concrete drainage products, and set in place standards of performance and quality that are recognized by governments and industry alike. Plants, processes, mixtures, testing and recommended installation procedures are all open to public scrutiny. Producers throughout North America welcome inquiries about the quality of their products and respond with enthusiasm to reinforce client expectations.

Today's precast concrete pipe industry is championing research worth millions of dollars into buried pipe technology, so that future generations are not mortgaged with sewerage systems that fail to perform as claimed. Its identity as a voice of authority in buried pipe technology is here for all to see. ☺



## Jim Nystrom, P.E.

The spotlight has never been a comfortable place for Jim Nystrom of The Cretex Companies, Inc. He is one of our industry's brightest minds who has developed an in-depth understanding of box culvert design through applied science in the workplace, and participation on committees that deal with design and application issues and industry-wide standards.

Nystrom graduated from the University of Minnesota in 1962 with a B.S.C.E. degree. After graduation, he spent several years with the City of Minneapolis as an engineer in the Water Department before moving on to Cretex to take a job designing prestressed bridge beams. Later, he broadened his responsibilities to designing and manufacturing buried concrete conduits.

Jim is an active member of the American Concrete Pipe Association's Technical Committee, and helped to develop ASCE's Standard Installations Direct Design method (SIDD). Nystrom is regarded for his knowledge in the use of large-sized box sections for culverts and short span bridge replacements. His volunteer work extended to the ASTM C-13 Committee and subcommittees dealing with gasketed joints for non-circular pipe and box culvert design with LRFD loading.

Jim has also been instrumental in helping develop new test methods for ACPA's Q-Cast plant certification program. Among the projects he has worked on, he feels that the greatest benefit to the precast concrete pipe industry came from the American Society of Civil Engineers' Committee on Buried Concrete Structures. In the last 10 years, the committee has completed five standard prac-



tices for buried concrete structures. This groundbreaking work focused on design and manufacturing methods.

In addition to his knowledge of precast concrete drainage products, Nystrom has a wide interest in science and the world around him. When asked to participate in an interview, Mr. Nystrom did not hesitate to help, although he questioned the attention given him. Here is what he had to say about a few topical issues.

**Q:** *Precast concrete box sections can be used for a wide range of applications including culverts, access chambers, and short span bridges. In your opinion, what are their greatest benefits to the general public?*

**Nystrom:** Reduced construction time and minimal interruption to travel are the greatest benefits over the alternative of cast-in-place construction. Precast concrete box structures also provide great value to owners when there is competition based on standard designs.

**Q:** *What do you believe is the most important design issue facing today's engineers when considering the use of precast box sections?*

**Nystrom:** When box culverts with up to 20-foot spans are specified, they become bridge-like structures and subsequently, the design, quality of workmanship, and manufacturing details in plants have to be more critically evaluated. Producers must use a higher level of care in manufacturing long-span structures when compared to those methods used for smaller box structures.

**Q:** *The concrete pipe industry has advanced significantly in the design of new pipe joints. How do you expect pipe joint design to evolve over the next decade?*

**Nystrom:** In the last decade, the concrete pipe industry has advanced the design of pipe joints significantly. High quality circular pipe joints have been developed during the last 40 years. Today's round pipe joints and gaskets perform very well. It is the other pipe shapes (arch, elliptical, and

*continued on page 15*

Neither Rain, nor Sleet, nor Snow...

# Impedes the Use of Precast Concrete Pipe

By Douglas J. Trangsrud,  
VP - Engineering  
Royal Concrete Pipe, Inc.  
Stacy, Minnesota  
651-462-2130

When the cold weather and snow of December arrives in Minnesota, thoughts of playing hockey on a frozen pond, skiing and sliding down hills of fluffy powder come to mind. Usually, those chilly thoughts do not include the placement of reinforced concrete pipe (RCP). Contrary to popular belief, the concrete pipe industry does business year-round – and that is true, even in the ‘frozen tundra’ of the Twin Cities.

The Twin Cities metropolitan area (Minneapolis-St. Paul and surrounding suburbs) has experienced tremendous growth in the last 20 years. To handle this expansion, the Metropolitan Council – Environmental Services (MCES) has been designing and expanding the sanitary sewer system throughout the outlying areas. Woodbury, a large southeast metro suburb, has been one of the fastest growing communities during the 1990s.

Following the vision of the MCES, the City of Woodbury has developed a plan to expand its sanitary trunk system to tie in with future expansion. The sanitary sewer system, known as the Wilmes Lake to Park Crossing project, would convey effluent to a proposed treatment facility in Cottage Grove, Minn., to the south.

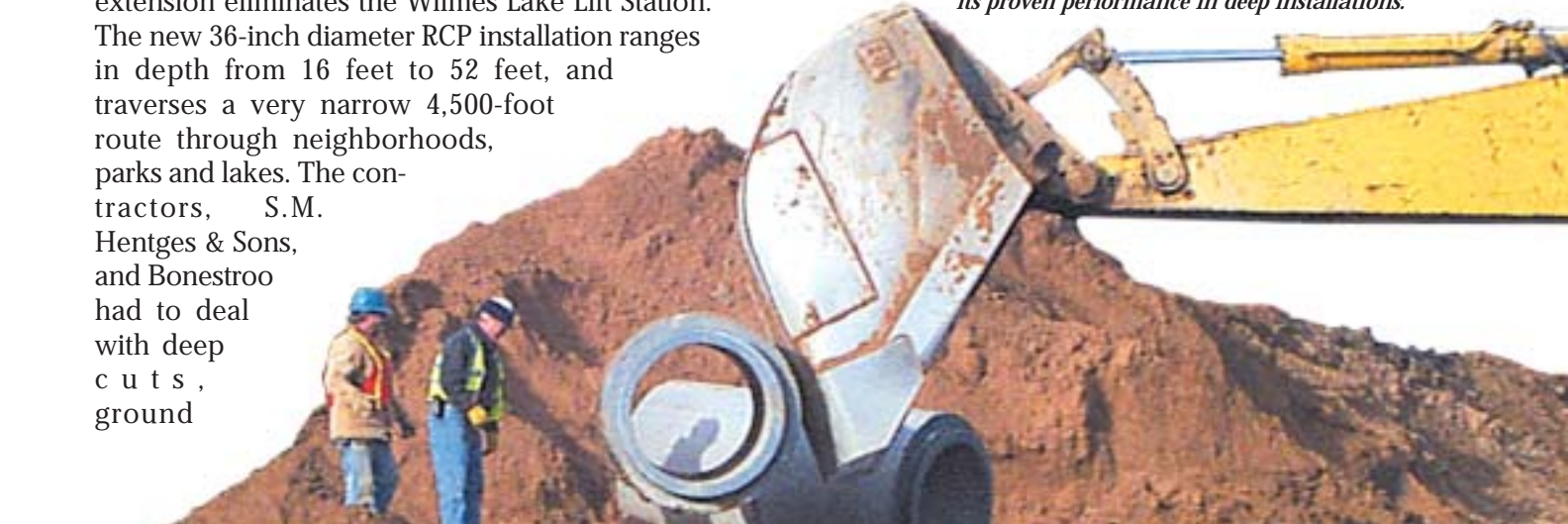
Bonestroo Rosene Anderlik & Associates (Woodbury’s consulting engineer firm) developed a tie-in for the Wilmes Lake trunk to an existing 36-inch diameter RCP sanitary stub that services the northeast sector of Woodbury. The new trunk extension eliminates the Wilmes Lake Lift Station. The new 36-inch diameter RCP installation ranges in depth from 16 feet to 52 feet, and traverses a very narrow 4,500-foot route through neighborhoods, parks and lakes. The contractors, S.M. Hentges & Sons, and Bonestroo had to deal with deep cuts, ground

water, community concerns of the work being done in an environmentally sensitive area, and cold weather – and it all had to be done in a timely manner.

The 36-inch diameter pipe designed to handle the loads caused by the deep installation of this project consisted of Class V, 4000D and 5000D RCP. As with metro sanitary projects the MCES and Bonestroo required that the pipe pass a 100-gallon/mile/in.-diameter infiltration test in the field. Reinforced concrete pipe was selected for the project because of its proven performance in deep installations and inherent strength.

Royal Concrete Pipe, Inc., Stacy, Minnesota, manufactured the reinforced concrete pipe for this project according to ASTM and MNDOT standards, as well as project specifications. It was produced in a new Shlusselbauer Exact 2500 production plant, with a Transexact robotic system. The new plant produces pipe up to 60 inches in diameter. The joint used by Royal is the offset or step joint. Royal vacuum tested and laser stenciled the pipe on the Shlusselbauer machine, and coated the bells and spigots with epoxy ester as the pipe left the production area. The epoxy ester coating on the bells and spigots of the pipe is a specification of Bonestroo and Metro Council (not a design parameter of Royal) that may provide a more uni-

*Reinforced concrete pipe was selected for the Wilmes Lake sanitary sewer project because of its proven performance in deep installations.*





form mating surface for the gaskets. To assure watertightness, the joints for pipe and manholes are gasketed with the Hamilton Kent's Tylox® SuperSeal™ gaskets. The manholes are fitted with Press Seal flexible manhole to pipe connectors.

S.M. Hentges, one of the largest dirt/utility contractors in the upper Midwest, is using a two-backhoe system to place the RCP in this deep, and narrow cut through Woodbury. S.M. Hentges is no stranger to deep sanitary lines. Two years ago they placed a reinforced concrete pipe sanitary line that was 72 feet deep. The completion date for this project is the middle of February 2002.

The Woodbury trunk extension is a small part of a larger picture in the scheme of the southeast metro sanitary sewer development. The MCES is examining the prospect of a new trunkline and associated tie-ins to a new sewage treatment facility in Cottage Grove. According to the engineers, this preliminary concept includes seven miles of new trunkline that averages 54-inch diameter pipe.

Concrete pipe is an excellent choice for communities who are upgrading or expanding their infrastructure because it has a known return on investment. The concrete pipe industry has a legacy of supplying products for a dependable infrastruc-



*Royal's new Shlusselbauer Exact 2500 production plant produced the 36-inch diameter RCP used for the Wilmes Lake Sanitary Sewer Trunk deep installation project.*

ture, and is now building the nation's future on the strength of new products and manufacturing technology. RCP is a product that can be used in any environment, including the northern regions of the United States and Canada. You might say; "Neither rain, nor sleet, nor snow shall impede the progress of development using reinforced concrete pipe." And you thought the Postal Service was the only industry that worked through harsh conditions! ☺

|                    |   |
|--------------------|---|
| <b>Project:</b>    | Wilmes Lake to Park Crossing<br>Trunk Sanitary Sewer Improvements –<br>2001   |
| <b>Owner:</b>      | City of Woodbury<br>Woodbury, Minnesota<br>David Jessup, Public Works Director  |
| <b>Designer:</b>   | Bonestroo Rosene Anderlik &<br>Associates<br>St. Paul, Minnesota<br>Thomas A. Syfko, P.E., Project Engineer   |
| <b>Contractor:</b> | S.M. Hentges & Sons<br>Jordan, Minnesota<br>Steve Hentges, Owner<br>Gary Zajac, Project Manager   |
| <b>Quantities:</b> | 764 feet – 36-inch diameter<br>Class V RCP<br>2854 feet – 36-inch diameter<br>4000D RCP<br>516 feet – 36-inch 5000D RCP                             |
| <b>Producer:</b>   | Royal Concrete Pipe, Inc.<br>Stacy, Minnesota<br>Jim Swanson, Vice President &<br>General Manager<br>Jerry Swanson, P.E.,<br>Vice President – Sales |

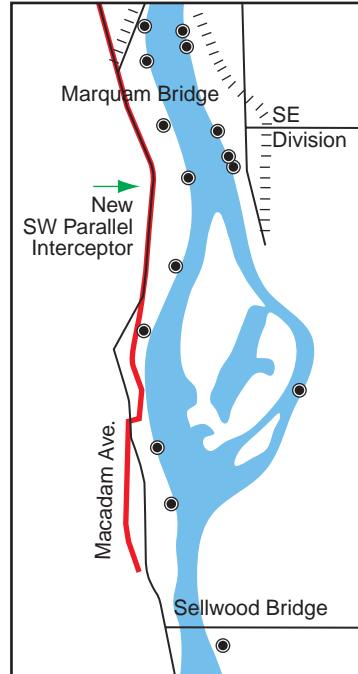
Royal Concrete Pipe, Inc., a long-time member of the American Concrete Pipe Association has been manufacturing and supplying reinforced concrete pipe, precast manholes, precast box culverts, stormwater treatment systems and other utility products for the Twin Cities metropolitan and statewide areas since 1990. The company is associated with two additional companies, Royal Environmental Systems and Royal Erosion Control Systems. Royal Environmental offers an extensive line of manhole infrastructure products, while Royal Erosion offers articulated concrete block revetment systems used to resist erosive water forces. For more information about Royal Concrete Pipe and related companies, visit [www.royalenterprises.net](http://www.royalenterprises.net).

# Tanner Creek Stream Diversion Cleans Up Portland's Willamette River

By Peter Van Tilburg  
Rinker Materials, Hydro Conduit Division  
Portland, Oregon  
503-692-3885

Reinforced concrete pipe is being used on the construction of a major combined sewer overflow (CSO) reduction project in Portland, Oregon. The city has just reached its half way mark of a 20-year program designed to reduce the amount of sewage and stormwater entering Portland's reach of the Willamette River. Among the many on-going projects is the Tanner Creek Stream Diversion that will transport storm water from the Tanner and Nicolai watersheds directly to the Willamette River. The project removes stream flows from combined sewers to help reduce combined sewer overflows.

In the 1880s, Portland built roadside ditches that carried sewage, household trash, and horse manure directly into the Willamette River. As streets were paved, the city installed sewer lines to carry sewage, stormwater, and the flow of some creeks to the river and Columbia Slough. By 1939, the river was so polluted that fish could not survive in its waters. In the early 1950s, Portland built its first sewage treatment plant and sewer pipes conveyed household wastewater, stormwater runoff, and the flow from creeks to the plant for treatment. Until the overflow reduction program was



*Over 10 miles of new pipes and tunnels are planned along the west side of the Willamette River to collect combined sewer overflows and convey effluent to treatment plants.*

The South-west Parallel Interceptor is one of several projects that will be built by 2011. Total program costs are expected to

exceed \$1 billion. Almost three miles long, the interceptor collects and stores combined sewer effluent, and directs it to the Columbia Boulevard Wastewater Treatment Plant (CBWTP) at a controlled rate for treatment, before discharge into the Willamette River. The Tanner Creek Diversion Project separates the flow of the creek from the combined sewer system.

Tanner Creek and other smaller streams once flowed freely from the west hills to the Willamette River. In the early 20<sup>th</sup> century, Portland officials diverted Tan-



*72-inch diameter RCP is being installed adjacent to the original Tanner Creek Diversion sewer in downtown Portland.*



*The original sewer included cast-in-place structures as shown in this 1917 photo.*

ner Creek and other west hills streams into underground pipes to free land for development and to control flooding. Until the diversion project was started, Tanner Creek flowed into Portland's combined sewer system and contributed to combined sewer overflows into the Willamette River.

The Tanner Creek Diversion is being built in several phases in Northwest and Southwest Portland. Contracts for Phase 2 and Phase 5 were awarded in September 2001. Rinker Materials, Hydro Conduit Division, a long-time member of the American Concrete Pipe Association, was selected to provide the precast reinforced concrete pipe and other concrete drainage structures for Phase 2 and 5 of the project. Robison Construction, Inc., commenced installation of the Hydro Conduit-supplied pipe in early December.

Phase 2 is the construction of a sanitary sewer system that will carry sewage to the CBWTP. It consists of approximately 877 feet of rubber-gasketed 72-inch diameter Class III, IV, and V RCP, 3,710 feet of 72-inch diameter Class III and V microtunneling pipe, approximately 87 feet of rubber-gasketed 60-inch diameter Class V RCP, and approximately 326 feet of rubber-gasketed 18-inch diameter Class III RCP. In addition to the pipe, Hydro Conduit supplied 16 manholes ranging in size from 48-inch to 144-inch diameter units. This phase is being constructed under the Clean Water Act as amended through the auspices of the Environmental Protection Agency.

Phase 5 is the current construction of a RCP that carries Tanner Creek water to a point where it connects with the original Tanner Creek sewer that was cast-in-place using wood forms. The original pipe, that was built nearly 100 years ago, will be relined and put back into service to carry clean Tanner Creek water directly to the Willamette River. Reinforced concrete

pipe supplied for this phase of the project includes 1500 feet of rubber-gasketed 72-inch diameter Class III and V pipe for open cut and microtunneling, and four manholes ranging in depths from 25 to 45 feet.

The City of Portland specified stringent inspection requirements for the manufacture of the 72-inch diameter microtunneling pipe. Representatives from the city were onsite at all times during production of the microtunnel pipe to ensure adherence to the multitude of project specifications and to measure manufactured tolerances. All cages were inspected prior to pouring the pieces and, once the pieces had cured, measurements were taken to ensure perpendicularity that is critical during the jacking process. Instrumental to the inspection process was Pat Corcoran, Public Works

Inspector I, City of Portland. Pat Corcoran reports to Tom Pfeiffer, P.E. who leads the Material Testing Laboratory for the City of Portland.

The beginning of the project required connection of the 72-inch diameter RCP to a

portion of existing 84-inch diameter RCP pipe by means of a concentric reducer. The plans specified that the reducer be produced of the same material as the existing pipe. To avoid producing one piece of 84-inch diameter RCP to manufacture the reducer, Hydro Conduit submitted and received approval for the use of a steel reducer, with mortar lining. Other special pieces included the manufacture of intermediate jacking station sections with modified joint designs. In particular, several pieces of pipe were manufactured to have a spigot on each end to ac-



*A 72-inch diameter intermediate jacking station section being lowered into the jacking pit.*



*Around-the-clock deliveries of microtunnel pipe were required to allow pipe to be fed continuously into the jacking pits.*



commodate the bore machine. Derek Clifford, Hydro Conduit’s draftsman, was instrumental in working out various revisions on submittal drawings to accommodate the customer’s field modifications.

Delivery of the microtunnel pipe was unique because once the contractor began to bore and jack the pipe behind the bore machine, the jacking could not stop until the contractor reached one of several receiving pits between installations. With the project located in downtown Portland and with storage space at a minimum, around-the-clock deliveries were required to allow pipe to be fed continuously into the jacking pits. At several instances during construction, work stopped and restarted which required the dispatch office to be “on-call” for pipe deliveries. During one incident, Geoff Clifford, Hydro Conduit’s dispatcher, was called in at 2:00 a.m. He had to roust Hydro employees out of bed to service the customer’s needs, due to situations that arose in the field. Wade Bruffet, Hydro Conduit’s Field Representative, was instrumental in assisting the customer with last minute needs. Additionally, Mark Hutchinson, the City of Portland Project Manager, diligently evaluated and produced numerous resolutions to issues over the course of the project.

By 2011, the City of Portland will have eliminated combined sewer overflows. Cornerstone projects will include the large sewer pipe installation to reduce direct discharge into the river and slough, sump installations to capture runoff before it reaches the sewers and the disconnection of downspouts from the sewer system. By separating creeks from combined sewers, the volume of overflow to the Willamette River will be reduced by approximately 260 million gallons per year. Construction of 10 miles of new pipes, tunnels, and two pump stations along the Westside of the Willamette River to collect and convey the combined sewer overflows to the existing Portsmouth Tunnel and onto the CBWTP for treatment will reduce overflows by 555 million gallons per year. And, construction of new CBWTP facilities (to receive and treat 2.5 billion gallons of combined sewage a year from the west and Eastside Willamette CSO facilities) will remove pollutants and disinfect the treated water before discharge into the Columbia River.

The 20-year program is expected to cost \$1 billion.

(Source: Several publications of the Bureau of Environmental Services, City of Portland. Photos courtesy of Mark Hutchinson, City of Portland.) ☺

|                    |   |
|--------------------|---|
| <b>Project:</b>    | Tanner Creek Stream Diversion Project Phases 2 and 5  |
| <b>Owner:</b>      | Environmental Services<br>City of Portland<br>Dean Marriott, Director<br>Mark Hutchinson, P.E., Project Manager   |
| <b>Designers:</b>  | Montgomery Watson,<br>Ed Barnhurst, P.E.<br>URS Greiner Woodward Clyde<br>Garry Struthers Associates, Inc.<br>David Evans and Associates<br>Kleinfelder, Inc.   |
| <b>Contractor:</b> | Robison Construction, Inc.<br>Tigard, Oregon<br>Bret Campbell, Project Engineer<br>Jan Babendererde, Project Engineer   |
| <b>Quantities:</b> | 877 feet – 72-inch diameter<br>Class III, IV and V RCP<br>3710 feet – 72-inch diameter<br>Class III and V microtunnel pipe<br>87 feet – 60-inch diameter<br>Class V RCP<br>326 feet – 18-inch diameter<br>Class III RCP |
| <b>Producer:</b>   | Rinker Materials Hydro Conduit Division<br>Portland Plant<br>Peter Hunot/ Peter Van Tilburg,<br>General Manager   |

Rinker Materials, Hydro Conduit Division-Portland, a long-time member of the American Concrete Pipe Association, has been manufacturing and supplying reinforced concrete pipe for the Portland Oregon area since 1984. The Portland plant manufactures concrete pipe and manholes up to 144-inch diameter, catch basins, box culverts, Stormceptor® structures, and CON/SPAN Bridge Systems. Additionally, it operates a video inspection crew, air-test and vacuum-testing crew, and a manhole channeling crew. Florida-based Rinker Materials is a major supplier of construction materials, aggregates, and ready-mixed concrete throughout the United States. For more information on Rinker Materials, Hydro Conduit Division, visit: [www.rinker.com](http://www.rinker.com).

## Big Infrastructure Project in Halton Region Includes Big RCP

*By Mark Bartolucci, C.E.T.  
Hanson Pipe & Products Canada,  
Whitby, Ontario  
800-265-1354*

The big infrastructure story in Halton Region, Ontario (west of Toronto) is “The Big Pipe” – a massive infrastructure improvement project to service the expansion of the Town of Milton by providing an improved sewage system for residents and a more dependable source of drinking water. For decades, growth in Milton was limited because it depended entirely on water supplied by wells. The wells and sewage treatment system were functioning at capacity.

Not only did the town require a more dependable source of potable water from Lake Ontario, it also needed a new sanitary sewer system and local treatment plant improvements. “The Big Pipe” would carry effluent from new developments to the expanded Mid-Halton Wastewater Treatment Plant in Oakville for treatment and discharge into Lake Ontario.

Construction of the project began in January 2000 to service Phase I of the “Halton Urban Structure Program (HUSP). The initial expansion would allow the construction of 6,200 new resi-

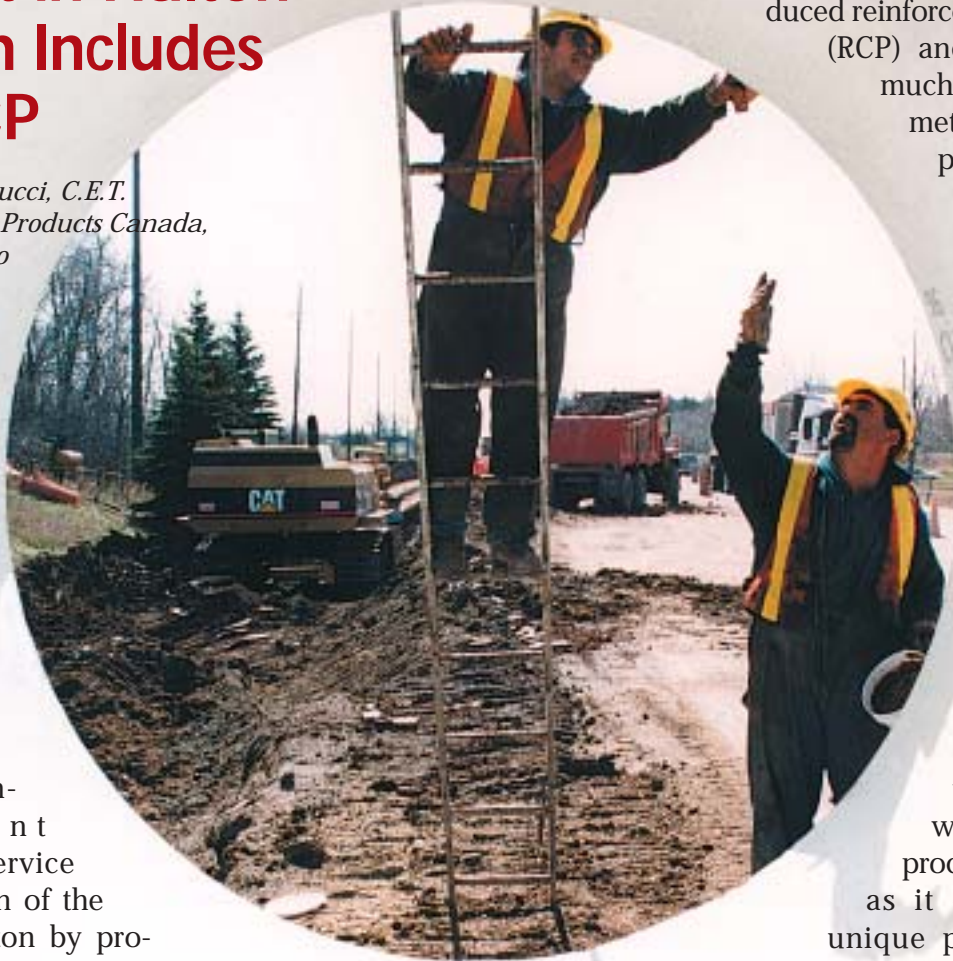
dential units and permit the use of 500 to 700 acres of business property in Halton Region.

Hanson Pipe & Products Canada produced reinforced concrete pipe (RCP) and manholes for much of the 15.5 kilometers (9 miles) of pipeline. Sizes ranged from 825-mm (33-inch) to 2400-mm (96-inch) diameter pipe.

Construction of the \$CAD 30 million trunk sanitary sewer and concrete pressure pipe water main would not have proceeded as rapidly as it did without a unique partnership between industry and government.

Halton Region had planned for the orderly development of Milton, and growth elsewhere in the Region, through the HUSP initiated in the late 1980s. The HUSP, detailed the infrastructure required for growth, and estimated costs. To bring the services to Milton, Halton Region partnered with six local developers, the Town of Milton, and a joint venture team (D’Orazio-Walter Joint Venture) to construct the pipeline. The project was entirely funded upfront by the developers.

A design/build approach to constructing the pipeline along the Highway 25 right-of-way was preferred, as it was expected that it would meet the tight schedule, and that the work would be done for a fixed price. The fast-paced construction schedule, and sequencing of work sites, was paramount since the pipeline had to be installed





in a section of the route where a portion of the western extension of the new 407 ETR (electronic toll road) was also scheduled for construction that year. The joint venture and region teams applied a value engineering assessment and found cost savings for many components of the project. The assessment also confirmed the choice of reinforced concrete pipe (RCP) for the trunk sanitary sewer.

The construction schedule included a new pumping station, the largest built to date in the Halton Region. The pumping station was required because there is a high point of land between Oakville and Milton that would have otherwise required a deep tunnel installation.

Close coordination between the contractor and pipe producer was also required. The contractor arranged for just-in-time delivery of the pipe for speedy installation and reduced impact on traffic flow. Shipping of pipe from the Hanson plant began on January 24 and ended on September 29, 2000, well within the project schedule. All of the RCP supplied to the trunk sewer and Boyne Sewage Pumping Station were standard gasketed products, and used standard design and bedding specifications.

Jim D’Orazio of D’Orazio Infrastructure Group said, “The ease of installation of our concrete wastewater main pipes helped us maintain the safest site possible. Excellent product support from Hanson was a key factor in the maintenance of our tight construction schedule.” ☺



*A fast-paced schedule and safety considerations required the use of trench boxes for much of the 15.5 kilometers of RCP installed along the Highway 25 right-of-way.*

|                     |   |
|---------------------|---|
| <b>Project:</b>     | The Big Pipe<br>Design/Build Section  |
| <b>Owner:</b>       | Regional Municipality of Halton<br>Oakville, Ontario<br>Patrick Murphy, Commissioner of<br>Planning and Public Works  |
| <b>Designer:</b>    | Greater Toronto Consulting Group<br>(Dillon Consulting Ltd., Acres and<br>Associated Ltd., R.V. Anderson<br>Associates Ltd.)  |
| <b>Contractors:</b> | D’Orazio Infrastructure Group<br>(15.5 km (10 miles) of 825-mm (33-<br>inch) to 2400-mm (96-inch) diameter<br>sanitary trunk sewer and force main.)<br>Oakville, Ontario<br>Jim D’Orazio, Chief Operating Officer<br>Walter Construction Canada Ltd.<br>(Construction of 1100 L/s sewage<br>pumping station.)<br>Toronto, Ontario<br>Frank Ross, Vice President   |
| <b>Quantities:</b>  | 2,623 meters (8,606 feet) – 825-mm<br>(33-inch) diameter RCP<br>222 meters (728 feet) – 1050-mm<br>(42-inch) diameter RCP<br>940 meters (3,084 feet) – 1200-mm<br>(48-inch) diameter RCP<br>2,777 meters (9,111 feet) – 1350-mm<br>(54-inch) diameter RCP<br>854 meters (2,802 feet) – 2400-mm<br>(96-inch) diameter RCP<br>Manholes ranged in size from 1200-mm<br>(48-inch) diameter to<br>3000-mm (120-inch) diameter sections |
| <b>Producer:</b>    | Hanson Pipe & Products Canada<br>Whitby, Ontario  |

In January 1999, Gifford-Hill became Hanson Pipe & Products, Inc. The name change was intended to strengthen the company’s identity both in the U.S and abroad, and to unify the pipe and precast operations with the rest of the Hanson organization. Hanson added LOC PIPE to its family in 1999. LOC PIPE was established in Whitby, Ontario, near Toronto, in 1974. The plant produces concrete pipe, and precast concrete products for sewers and storm drainage. The plant is ISO 9002 certified, and operates as Hanson Pipe & Products Canada, Inc., For more information visit [www.hansonpipeandproducts.com](http://www.hansonpipeandproducts.com).

# Do You Really Know the Difference Between Rigid and Flexible Pipe?

By Josh Beakley, P.E.  
 Director of Technical Services  
 American Concrete Pipe Association, Irving, Texas  
 972-506-7216

So, tell me...what's the difference between rigid and flexible pipe? I encounter this question many times, especially at industry trade shows or Concrete Pipe University seminars. When teaching classes on the basics of concrete pipe design, I have often been asked for the design criteria that differentiate a rigid and a flexible pipe. There is no easy answer to this question.

A rigid pipe is less installation sensitive than flexible pipe products. With rigid concrete pipe, a large portion of the soil-pipe structure is contained within the pipe itself, thereby relying less on the portion of the structure provided by the soil. This is not to say that you don't need to perform a proper design for whatever product you use. Concrete pipe does, however, lend itself to design of a sufficient soil-pipe structure regardless of the existing soil conditions.

There are several different pipe options, and all have their own unique design method. AASHTO splits them into three sections of its Bridge Design Code:

- Section 12.7 covers, "Metal Pipe, Pipe Arch, and Arch Structures"
- Section 12.10 covers "Reinforced Concrete Pipe", and,
- Section 12.12 covers "Thermoplastic Pipes".

The interaction between a buried pipe and the soil is extremely important. By classifying pipe materials into three distinct categories, you do not always get a good understanding of the differences between a rigid pipe and a flexible pipe, including the pipe's dependence on the soil. How would you classify a pipe as being rigid, where it works with the active pressure of the soil? And when would you classify a conduit as a flexible pipe that uses the passive pressure of soil?

In the U.S., you sometimes hear that if a pipe can deflect more than 2 percent it should be considered a flexible pipe. But outside of deflection, there is not much clarification on the issue. Other countries take a slightly different approach. In Australia and New Zealand the stiffness of the pipe is related to the stiffness of the soil surrounding it. In Europe the settlement of the top of the pipe is related to the settlement of the surrounding soil. These aspects are addressed before design of the pipe is commenced.

The US method has an advantage because the designer immediately references the chapter that deals with the chosen pipe material, rather than performing preliminary calculations. However, one disadvantage is that the designer does not fully see the roles that the soil and the pipe play in the completed structure.

In Australian/New Zealand Standard Commentary AS/NZS 2566.1, Supplement 1, to AS/NZS 2566.1, "Buried Flexible Pipelines", the engineer multiplies the soil modulus ( $E'$ ) in MPa units by 7,500 and compares it to the long-term ring bending stiffness  $S_{DL}$  of the pipe. If  $S_{DL}$  is less than  $7,500 \times E'$ , then a flexible pipe design is appropriate. If  $S_{DL}$  is greater than  $7,500E'$  then a rigid pipe design is appropriate.

For information purposes, we can compare reinforced concrete, corrugated metal, and high-density polyethylene pipes, 36 inch in diameter, using the pipe properties provided in the tables at the end of Chapter 12 of the AASHTO LRFD Bridge Design Specifications. The long-term ring bending stiffness per AS/NZS 2566.1 is:  $S_{DL} = (EI/D^3)10^6$ . Our soil assumption will be a good granular material with an  $E'$  of 2,000 psi, or 13.8 MPa. Our values are:

|                      |   |
|----------------------|---|
| 7500E' = 103,500 MPa | Reinforced Concrete Pipe $S_{DL} = 2,102,085$ MPa   |
|                      | Corrugated Metal Pipe $S_{DL} = 15,610$ MPa         |
|                      | High-Density Polyethylene Pipe $S_{DL} = 2,977$ MPa |

As anticipated, the concrete pipe value is much higher than  $7,500E'$ , and is therefore classified as a rigid pipe. The CMP and HDPE pipe values are lower than  $7,500E'$  and are therefore classified as flexible pipe. Notice just how much more "flexible" a high-density polyethylene pipe is compared to a corrugated



metal pipe.

In Europe, a somewhat similar, although more elaborate, check on the pipe's dependency of the soil is made before design of the pipe. Unlike the Australian/New Zealand Standards, which are separate for rigid and flexible pipe, the latest draft of the European Standard, JWG 1/TG 1 N 210 E, Preliminary Draft, "Piping Systems – Structural Design of Buried Pipelines", covers all buried drainage pipe under one standard. One of the first steps in the design process is to determine the "deformation ratio" of the pipe and soil. The deformation ratio, ( $\alpha$ ), is defined using the ratio between the vertical deflections of both the pipe and the soil to the side of the pipe under the same loading conditions. The deformation criterion is documented as follows:

|                       |                    |
|-----------------------|--------------------|
| $\alpha \leq 0.05$    | Rigid Pipe         |
| $0.05 < \alpha < 1.0$ | Semi-Flexible Pipe |
| $\alpha \geq 1.0$     | Flexible Pipe      |

The pipe is subsequently designed in accordance with its deformation criterion. The deformation ratio is a relatively complex calculation involving the pipe stiffness, soil stiffness, bedding angle, and lateral soil pressure ratio. If the deformation ratios were calculated using the same properties previously used for the Australian/New Zealand check, the following results would be obtained:

|   |          |
|---|----------|
| Reinforced Concrete Pipe - $\alpha = 0.042$       | $< 0.05$ |
| Corrugated Metal Pipe - $\alpha = 5.3$            | $> 1.0$  |
| High-Density Polyethylene Pipe - $\alpha = 28.96$ | $> 1.0$  |

Once again the results are as expected. Proportionally, the results are very similar to those obtained using the less elaborate Australian/New Zealand method. Concrete pipe is verified as a rigid pipe, and once again the HDPE pipe is a more flexible pipe than CMP by a factor of approximately 5. It may take more effort to perform the initial evaluation, but the information does provide insight into a pipe's soil dependency.

In the U S, the pipe designs are kept separate in AASHTO, although recent developments in the design section for thermoplastic pipe would lend itself to a similar preliminary investigation. The 2001 Interim of the AASHTO LRFD Bridge Design Specifications includes the use of a hoop stiffness factor ( $S_H$ ) in Section 12.12 for thermoplastic pipe. While this factor is used to analyze the soil load on a thermoplastic pipe, it could easily be incorporated into a rigid/flexible pipe differentiator. Similar to the rigid/flexible comparison methods used in Australia/New Zealand and Europe, the hoop stiffness factor is a function of the pipe properties and soil stiffness. The hoop stiffness is defined as follows:

$$S_H := \frac{\phi_s \cdot M_s \cdot R}{E \cdot A}$$

where:

- $S_H$  = hoop stiffness factor (dimensionless)
- $\phi_s$  = resistance factor for soil stiffness ( $\phi_s = 0.90$ )
- $M_s$  = constrained soil modulus (MPa)
- $R$  = radius to centroid of culvert wall (mm)
- $E$  = long-term modulus of elasticity (MPa)
- $A$  = wall area (mm<sup>2</sup>/mm)

The higher the hoop stiffness value, the more reliant the pipe-soil structure is on the soil. The hoop stiffness factor is subsequently used to determine the soil load on the pipe via a vertical arching factor (VAF) (factor that is multiplied by the soil prism load above the pipe). The equation for VAF being:

$$VAF := 0.76 - 0.71 \cdot \left( \frac{S_H - 1.17}{S_H - 2.92} \right)$$

If you were to graph this equation, it would look like the curve in Figure 1.

By inputting the same pipe values we used for the prior examples, we obtain hoop stiffness values of:

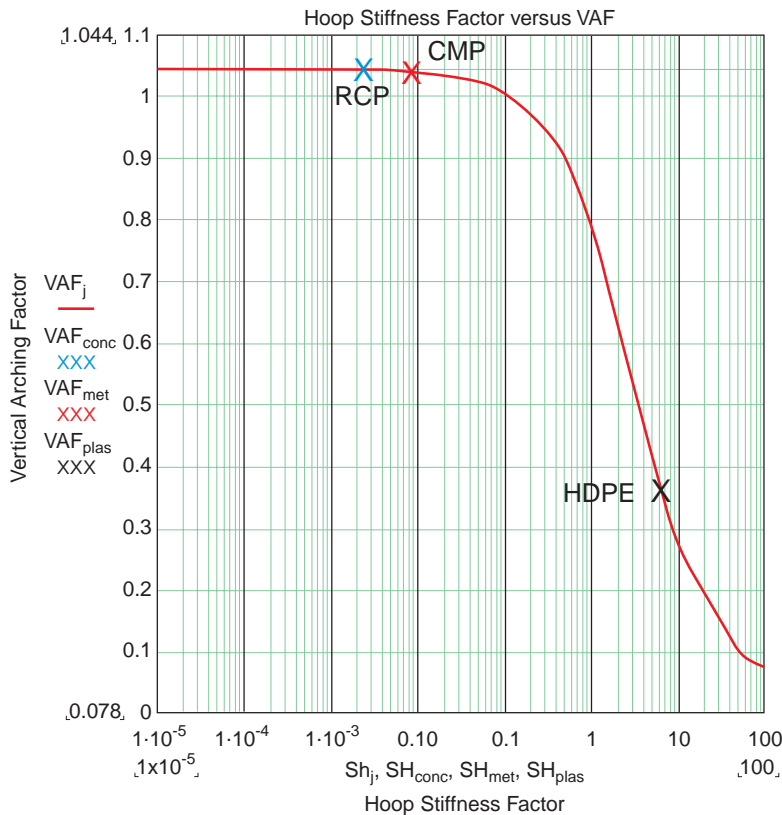
- Reinforced Concrete Pipe –  $S_H = .0023$
- Corrugated Metal Pipe –  $S_H = .0081$
- High-Density Polyethylene Pipe –  $S_H = 6.18$

These values have been plotted on Figure 1. It is easy to see that the relationships are significantly different with this method, largely as a result of the equation being dependent on pipe wall area as opposed to pipe wall moment of inertia. The RCP and CMP values are much closer when using the  $S_H$  value,

and the CMP and HDPE values are much farther apart. There is definitely an increase in the hoop stiffness value with dependence of the pipe on the soil surrounding it. The hoop stiffness factor is used for thermoplastic pipe design only. The development of the vertical arching factor based on the assumptions of a weightless, homogenous, isotropic, and linearly elastic soil medium limit its use as a final design tool. That is not to say that the hoop stiffness value may not be sufficient for use as an identifier of soil dependence.

Unfortunately, the curve for the vertical arching factor using  $S_H$  was developed for the lower modulus plastic pipe materials, and underestimates the load on a stronger pipe. Therefore, the upper range of the curve flattens out too quickly to accurately apply to concrete pipe. The curve flattens out at a VAF value of 1.044, while we know that concrete pipe VAFs are in the range of 1.35 to 1.45. We could take the existing curve, however, and decide that when a point is not “riding the curve”, but on the flat top portion of the curve, it is the rigid/flexible dividing line. The hoop stiffness value in that case would be approximately  $S_H = .0025$ .

This would be a good place for the



**Figure 1**

US to start, but a complete differentiator for rigid versus flexible pipe would have to involve pipe wall area (as applied in AASHTO’s hoop stiffness factor) as well as the pipe wall moment of inertia (as applied by our counterparts overseas). This would incorporate both hoop compression and bending deflection of the pipe in relationship with the surrounding soil.

Do we really have use for such a rigid/flexible pipe differentiator? This question will have a better answer as new and innovative materials are developed, and composites of existing materials such as concrete are developed with alternative reinforcing schemes.

As a leading voice in the applied science of buried drainage structures, the ACPA must keep abreast, and build new knowledge of the roles that the soil and pipe (of all materials) play in the soil-pipe structure. In the future, a measure of the rigidity or flexibility of a pipe may become a routine design requirement. ☺

1. Australian/New Zealand Standard, “Buried Flexible Pipelines, Part 1: Structural Design – Commentary (Supplement to AS/NZS 2566.1:1998)
2. Preliminary Draft of “Piping Systems – Structural Design of Buried Pipelines”, JWG 1/TG 1 N 210 E, November 2001
3. AASHTO LRFD Bridge Design Specifications, Second Edition, and 1999,2000, and 2001 interims



## Jim Nystrom

continued from page 4

rectangular) that present a challenge for the routine use of gasketed joints for resistance to leakage. Specifiers continue to request a high level of joint performance in pipelines. In my opinion, all precast shapes will eventually have gasketed joints that facilitate speedy assembly while keeping soil and moisture out of the pipe. In addition, the design criteria for profile gaskets will be evaluated under a new criterion. Circular gaskets will continue to be evaluated on the basis of percentage of compression, whereas the sealing capability of new profile gaskets will be evaluated on pounds per inch of force.

**Q:** *You were involved in the development of Standard Installations currently being promoted by the concrete pipe industry. What do you believe is the key message that needs to be conveyed to specifiers and users about the engineering of these bedding types?*

**Nystrom:** Most design engineers have an understanding of new standard installations, but the

message has not been passed on to the field inspectors and installers. Frequently, the installers continue to compact the foundation material under the pipe invert rather than loosening the material. This causes excessive concentration of shear and flexure forces in the invert of the pipe. Our industry must do a better job of instructing the people in the field about the correct installation methods, or change our pipe design to reflect methods actually used by the contractors.

**Q:** *How has involvement in industry associations like the ACPA, professional organizations, and standards organizations helped you as a professional engineer develop your career?*

**Nystrom:** When you first attend national meetings of any industry or professional association, you begin to understand what the issues are, and later master an understanding of problems and their solutions. Over time, confidence is gained in understanding pipeline design and manufacturing issues. You acquire a greater knowledge, and know when to share that knowledge with the next generation of people designing and building concrete pipe systems. ☺

## "Quality Cast" Certified Plants

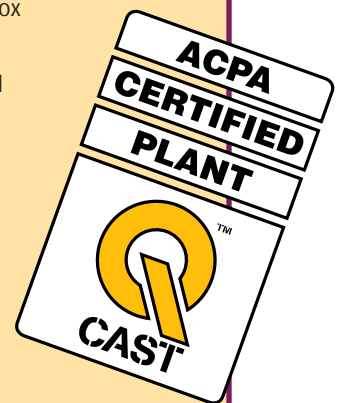
In an effort to improve the overall quality of all concrete pipe products, the American Concrete Pipe Association offers an ongoing quality assurance program to member and non-member companies. Called the "Quality Cast" Plant Certification Program, the 124-point audit-inspection program covers the inspection of materials, finished products and handling/storage procedures, as well as performance testing and quality control documentation. Plants are certified to provide storm sewer and culvert pipe or under a combined sanitary sewer, storm sewer and culvert pipe program. The following plants are currently certified under ACPA's Quality Cast Certification Program:

### Storm Sewer and Culvert Pipe

- Cayuga Concrete Pipe Company (Oldcastle, Inc.), Croydon, PA - George Stoffa
- Cayuga Concrete Pipe Company (Oldcastle, Inc.), New Britain, PA - Edward Pentecost
- Elk River Concrete Products (Cretex), Billings, MT - Milton Tollefsrud
- Kerr Concrete Pipe Company (Oldcastle, Inc.), Hammonton, NJ - Bob Berger
- South Dakota Concrete Products (Cretex), Rapid City, SD - John Link
- Riverton Concrete Products Company (Cretex), Riverton, WY - Butch Miller
- Sherman-Dixie Concrete Industries, Inc., Chattanooga, TN - Earl Knox
- Sherman-Dixie Concrete Industries, Inc., Franklin, TN - Roy Webb
- Americast-Pipe Division, Inc., Charleston, SC - Bill Gary
- Amcor-White Company (Oldcastle, Inc.), Hurricane, UT - Brent Field
- Carder Concrete Products, Littleton, CO - Bob Crusanth
- Carder Concrete Products, Colorado Springs, CO - Bob Crusanth
- Grand Junction Concrete, Grand Junction, CO

### Sanitary Sewer, Storm Sewer and Culvert Pipe

- Advanced Pipes & Cast Company, Abu Dhabi, United Arab Emirates - Poul Jacobsen
- Amcor Precast (Oldcastle, Inc.), Nampa, ID - Mike Burke
- Amcor Precast (Oldcastle, Inc.) Ogden, UT - Tim Wayment
- Atlantic Concrete Pipe, San Juan, PR - Miguel Ruiz
- Elk River Concrete Products (Cretex), Elk River, MN - Bryan Olson
- Geneva Pipe Company, Orem, UT - Fred Klug
- Kansas City Concrete Pipe Co. (Cretex), Shawnee, KS - Rich Allison
- NC Products (Oldcastle, Inc.), Fayetteville, NC - Preston McIntosh
- NC Products (Oldcastle, Inc.), Raleigh, NC - Mark Sawyer
- Ocean Construction Supplies Limited (Inland Pipe), Vancouver, BC, Canada - Rod Boyes
- Amcor-White Company (Oldcastle, Inc.), Ogden, UT - J. P. Conn
- CSR Hydro Conduit, Denver, CO - Ed Anderson
- Waukesha Concrete Products Company (Cretex), Waukesha, WI - Jay Rhyner



# PRECAST CONCRETE BOX CULVERT ANALYSIS AND REINFORCING DESIGN MADE EASY

Drainage design engineers and technicians are always looking for new and better ways to maximize their design efforts. That's what they will find with BOXCAR Software from the

American Concrete Pipe Association.

BOXCAR Software helps engineers and specifiers to significantly reduce design time and costly over-designs on projects using precast concrete box sections.

Deriving its name from "Box Culvert Analysis and Reinforcing Design", this popular interactive software program can be used to calculate reinforcing steel areas for user-specified box geometry, material properties and loading data.

BOXCAR Software (Version 2.03)

is an updated version of the software program originally developed by the Federal Highway Administration, in cooperation with the American Concrete Pipe Association. Version 2.03 incorporates AASHTO LRFD requirements and allows the use of the BOXCAR Software in a Microsoft

Windows® format.

Available on CD-ROM, BOXCAR Version 2.03 incorporates the direct design method for the structural analysis and design of precast reinforced concrete box culvert sections. It provides complete structural analysis for loads due to box weight, soil weight, internal gravity fluid weight, LRFD requirements, live loads and user-specified surcharge loads. Structural design methods conform to standards set by the American Association of State Highway Transportation Officials (AASHTO) and include ultimate flexure, shear and service load crack control.

To order BOXCAR Version 2.03, contact the ACPA Resource Center at (800) 290-2272 or via fax (972) 291-0622.

Cost: \$75.00 member, \$150.00 non-member, plus shipping and handling. Visa, MasterCard and American Express are accepted. Specify resource item #15-401 CD. For further information, contact the American Concrete Pipe Association, (972) 506-7216, fax (972) 506-7682 or email: [info@concrete-pipe.org](mailto:info@concrete-pipe.org).



American Concrete Pipe Association  
222 W. Las Colinas Blvd., Suite 641  
Irving, TX 75039-5423

[www.concrete-pipe.org](http://www.concrete-pipe.org)

PRESORTED  
STANDARD  
US POSTAGE PAID  
DALLAS, TX  
PERMIT NO 1883