

# concretepipe**news**

The Magazine of the American Concrete Pipe Association



## Utah Residents Are All Smiles With Miles of RCP Storm Drain

- Precast Concrete Stormwater Detention System Shows Great Value
- Characterization of PE Materials – Suitability for Long-Term Service, Part I
- ACPA Fall “Short Course School” Open to Designers and Contractors



**This issue:**

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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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Polyethylene (PE) is a very versatile and widely used plastic. Among other things, it is used for packaging, food containers, housewares and even pipes and fittings. The characterization of various PE materials can be accomplished by the use of short term, long-term and accelerated testing. Part I of this two-part article will examine three basic properties of PE materials that are measured by short-term testing.

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Engineers and designers of gravity pipelines will be able to attend the American Concrete Pipe Association's 2003 "Sales & Marketing" Short Course School in Las Vegas, NV, November 3-5. Here's the perfect opportunity to broaden your pipe knowledge and improve your personal skills, while earning CEU credits.

*Front Cover Inset Photo: Courtesy of Salt Lake City Convention & Visitors Bureau; Photographer: Alan Yorgason*

*Front Cover:  
An excavator lowers a  
horizontal elliptical  
reinforced concrete pipe  
(HECP) into a trench  
box in a residential area  
of Sandy, Utah. HECP was  
used to match the  
shallow cover and  
sensitive installation  
requirements in the  
neighborhood.*

*Front Cover Inset Photo:  
Precast reinforced  
concrete pipe was jacked  
under a section of the  
Utah Transit Authority  
(UTA) TRAX Light Rail  
line connecting Sandy  
City to downtown Salt  
Lake City.*





*John J. Duffy*

## Leaders Flourish In the Concrete Pipe Industry

There has never been a shortage of leaders in the concrete pipe industry. For the past 16 years we have been spotlighting our leaders in each issue of *Concrete Pipe News*. All have contributed significantly to our industry, guiding businesses and technology to heights never dreamed when precast concrete plants began to spring up at the beginning of the twentieth century. We honor our leaders in this issue of *Concrete Pipe News* with an all-to-brief retrospect of the wisdom they have shared with us. Their comments are summarized, starting on page 4 of this issue.

Leaders can be described as people who have the ability to influence others to achieve a common purpose or goal and the character to inspire confidence. The American Concrete Pipe Association is structured to draw leaders into committee work and to attract seasoned veterans to the Board of Directors to influence policy and direct the industry. The concrete pipe industry is forever vigilant, and its

leaders are prepared to act.

This year, our Chairman John Munro, Munro Concrete Products Ltd., Barrie, Ontario, is leading us into new territory for our marketing program, while leaders of major member companies continue to guide the industry through the implementation of the Strategic Promotional Plan for North America in partnership with the Portland Cement Association. We have industry leaders participating on ASTM committees and attending AASHTO meetings that develop and pass industry standards. We closely monitor federal government activities that affect the future of our industry. All research sponsored by the ACPA is managed by industry leaders. Leadership in the ACPA is strong and determined.

Through strong and determined leadership, the concrete pipe industry has become the voice of authority for all storm and sanitary sewer pipe products and culvert material. It delivers the facts and is prepared to stand and be challenged. Research and development continues to be a mainline for new information that can be tested and tried to break new ground with product improvement and product application. Competitive products must prove themselves on the same terms that RCP is scrutinized, or the concrete pipe industry will accept the challenge to take on the task of rigorous product and material evaluation.

In this issue of *Concrete Pipe News*, you will find the first of a two-part series on the basic properties of polyethylene materials. We have asked Dr. Tom Walsh to characterize various PE materials so we can more accurately assess the suitability of such materials for longer-term service life. Our purpose in conveying this information is simple and straight forward – a more informed designer is a better designer of drainage systems.

The feature article in this issue of *Concrete Pipe News* describes the award-winning 8600

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## Reflecting Upon What They Had to Say

Our industry leaders have spoken out. They have told us what has made our industry great and what we can expect to see during our lifetimes. Records show that we have published 66 interviews since 1987. These unique accounts of our past and future are rarely revisited, and we soon forget the pearls that have been passed along to us to grow a stronger industry. Let's go retro for a moment and reflect on what they had to say. Listen closely; they may speak softly, but their words are as enduring as the products they champion.

### About Communications

Several speak about the vital importance of communicating the benefits and features of concrete pipe to specifiers and regulators. Paul Heffern, P.E., former Director of Technical Services with the ACPA reminded us that the concrete pipe industry has maintained excellent communications with engineers and specifying agencies, and subsequently, the concrete pipe industry is recognized as having a great deal of technical credibility. Since alternative materials have different material and performance characteristics, engineers must have the knowledge to evaluate all of the important factors that influence the design and performance of rigid and flexible pipe. (*Summer/Fall 1997, Vol. 49 No. 2*)

Joseph (Joe) Zicaro, P.E., says that it is crucial for us to communicate to engineers the factors that do affect performance on all pipe products. He says, "The greater their understanding in general, the better their ability to ask the right questions, and require verification of the important aspects." (*Spring 1997, Vol. 49 No. 1*)

In 2000, William (Bill) Quinlen III clearly stated that the concrete pipe industry is meeting the threats of competitive products by renewing its focus on the education of those who call on specifiers and owners. He said, "The resulting high quality technical promotion is already yielding very favorable results in markets all over the United States." (*Winter 2000, Vol. 51 No. 3*)

### About Performance

Roman Selig reminded us that durability, installation and hydraulics are main aspects of pipe performance. He reminded us that these aspects are directly related to the economics of a project and concrete pipe excels in all three, especially durability. He noted that some designers and owners ignore long-term costs, and it is more difficult for an agency to obtain maintenance funds than original project funding, and that the installed cost and the superior hydraulic efficiency of concrete pipe are sometimes overlooked. (*Spring 2001, Vol. 53 No. 1*)

Life Cycle Costing and value engineering was developed and standardized to deal with performance of pipe systems. Chuck Taylor, P.E., is critical of LCCA and believes that as long as we operate on a low-bid system, the contractor's emphasis must be on the bottom line. Value engineering should deliver value first to the owner and end users, then to the contractor. He says, "Too often we see 'value engineered' changes that do nothing more than substitute material with a lower purchase price for that originally specified. While such changes might lower the constructed cost, they might not deliver value to the ultimate stakeholder – the owner or asset manager – and tax payers." (*Winter 2003, Vol. 55 No. 1*)

Government does work with industry on implementing the results of credible research, and Philip Thompson, P.E. of the FHWA noted in his interview that FHWA's HDS 5 publication has been recently updated to include the results of research on Manning's *n*. (*Spring 2003, Vol. 55 No. 2*)

As Selig noted, installation has a significant impact on performance. Many guests referenced

Standard Installations (SIDD) as one of the greatest advances in soil/pipe technology in recent time. Modern day reinforced concrete pipe is designed to perform well with SIDD beddings.

Wallace (Wally) Munden, P.E., reminded us of the evolution of Standard Installations from Soil Pipe Interaction Design Analysis (SPIDA) research that led to a fundamental change in the way we understand bedding factors and installation procedures. He says, "The biggest challenge and accomplishment has been the move from standard A,B,C and D beddings to Type 1,2,3, and 4 beddings for precast concrete pipe. This issue led to the development of PIPECAR and BOXCAR software. *(Fall 2002, Vol. 54 No. 4)*

#### About Misconceptions

The concrete pipe industry is vigilant in dispelling misconceptions about concrete pipe and alternate products as soon as they appear. More than one guest identified the belief that rigid pipe and flexible conduits perform the same way in the trench. Mel Marshall, P.Eng., says that while presenting at engineering seminars, he frequently finds that designers and specifiers aren't familiar with the technical differences between rigid and flexible materials. He says, "An explanation of all the theories and methods for determining earth loads on underground pipelines is a simple way to clarify the difference between the two." *(Summer 1999, Vol. 51 No. 1)*

Leonard Klein, P.E., believes that the most common misconception that he has encountered is that placement of steel is not important. "This is very critical and production people sometimes don't realize this, especially with elliptical pipe. If the design calls for an inch of cover, then the production people must follow the specification," says Klein. *(Summer 2000, Vol. 52 No. 2)*

#### About Automation

They saw it coming and a few experienced the first wave of automation. The late R.W. Liston firmly stated that change came in the 1950s with the R4 joint on Packerhead machines. Charles Wilson, whose family rightfully claims three generations of concrete pipe producers said there

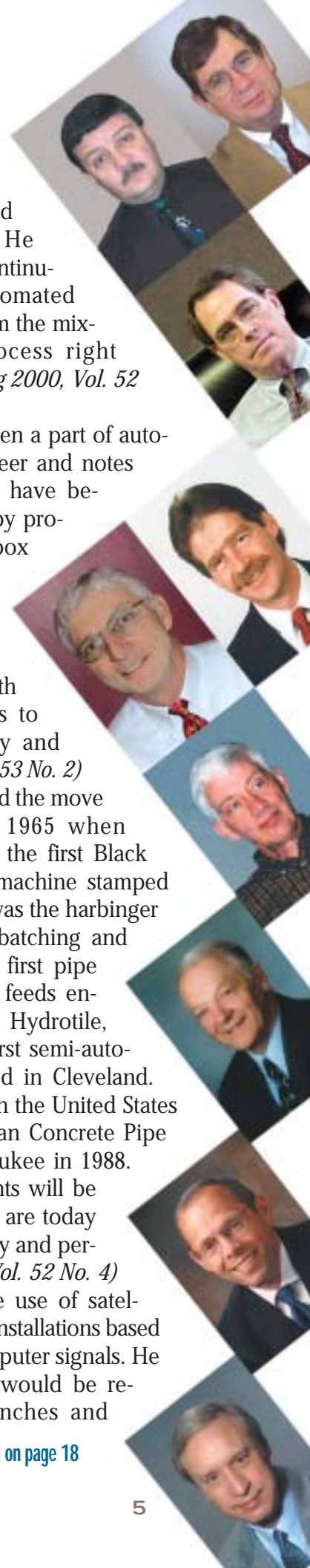
were two significant changes in his lifetime, good economical joints and production techniques. He foresees a future with continuous improvement to automated production techniques from the mixers and reinforcing process right through to the kiln. *(Spring 2000, Vol. 52 No. 1)*

Don Schmidgall has been a part of automation throughout his career and notes that manufacturing plants have become more sophisticated by producing non-round pipe, box sections, manholes and related products in addition to round pipe. He says we are seeing more sophisticated machinery with quicker changeover times to maximize plant efficiency and agility. *(Summer 2001, Vol. 53 No. 2)*

James Aumann observed the move to automated plants in 1965 when Hurlbut Company bought the first Black Clauson automated cage machine stamped with Model No. 1 on it. It was the harbinger of further automation in batching and mixing. In the 1970s, the first pipe machines with automated feeds entered the market through Hydrotile, and in the early 80s the first semi-automated pipe plant appeared in Cleveland. The first automated plant in the United States was established at American Concrete Pipe Company's plant in Milwaukee in 1988. Aumann believes that plants will be more automated than they are today to meet demands for quality and performance. *(Winter 2001, Vol. 52 No. 4)*

James Hill foresaw the use of satellites to develop automated installations based on digitized plans and computer signals. He said, "One of the results would be removing people from trenches and

continued on page 18




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# Utah Residents Are All Smiles with Miles of RCP Storm Drain

The Mountain States Concrete Pipe Association awarded its "2002 Project of the Year" Award to the 8600 South Storm Drain Project in Sandy City, Utah. This project included the construction of approximately 20,000 linear feet of storm drain trunk line that extends from 1700

East to the Jordan River and 9,000 linear feet of lateral pipeline facilities. The project made extensive use of multiple class 24-inch to 66-inch diameter reinforced concrete pipe (RCP), and other precast concrete drainage products supplied by Amcor Precast (an Oldcastle Precast, Inc. company), Ogden, Utah and Geneva Pipe Company. Orem, Utah.

Designed by Bowen, Collins & Associates as a storm drain outfall, reinforced concrete pipe's versatility of use was shown throughout the project. The project included constructing or modifying three storm drain detention facilities, constructing water quality enhancement features, jacking and boring



*An extremely tight fit required the use of a 60" elbow section in a deep trench in this section of the 8600 South Storm Drain Project in Sandy City, Utah.*

under the TRAX railroad, and crossing three canals, Interstate 15, two state roads, and two capped superfund sites. The project was completed in six months by December 2002 – one month ahead of schedule.

Precast concrete products associated with the RCP included manholes, catch basins, 45-degree bends, box sections for culverts, elliptical pipe, jacking pipe, and drop structures. There were some cast-in-place drop structures and other facilities. The jacking pipe placed under the TRAX railroad followed construction of the Utah Transit Authority (UTA) TRAX Light Rail line connecting Sandy City to downtown Salt Lake City. The TRAX Light Rail system moves nearly 22,000 passengers per day along this line and was a major transportation facility for the 2002 Winter Olympic Games.

“The project presented plenty of installation challenges,” said Craig Bagley, P.E., project manager for Bowen, Collins & Associates, “including open cut installation in sensitive areas and boring and jacking under a commuter rail line. The adaptability of precast concrete pipe and the contractors’ familiarity of the products enabled us to overcome these obstacles to provide a quality system that will benefit local residents for many, many years to come.”

During construction it was vital to the neighborhoods that all residents had appropriate access to their property. The local contractor and local pipe suppliers were determined to keep their neighbors happy by moving construction along quickly to avoid unnecessary delays. The project required close coordination with Midvale City, Salt Lake City, Utah DOT, multiple sewer districts, Salt Lake County, several state agencies, several Sandy City Departments, multiple private property owners, and many

utility companies to meet the aggressive design and construction schedule for the \$8.3 million construction project.

Divided into five bid construction contracts, the project was awarded to three local contractors, and constructed in 6 months.

Mr. Rod Sorensen, Engineering Manager for Sandy City Public Utilities was in charge of the project. Concerning the project, Rod said. “It was amazing to have a project with such an aggressive schedule come together so well. A key factor in the successful completion was that concrete pipe producers were important partners and they were right on top of the schedule.”

Mr. Bagley reinforced Sorensen’s comments, adding, “One of the things that I appreciated most was the support and cooperation we got from the local precast concrete product suppliers. While we were in the design phase we felt that simultaneously providing the required volume of precast concrete products to multiple contractors would be a challenge for the local concrete pipe suppliers. But we met with them and were assured that their production and delivery schedule would keep up with contractor demands for the product.

“The local suppliers also provided valuable support in helping us resolve a few installation problems and concerns that were experienced during construction. I believe the coordination between the suppliers, the engineer, and the contractors were a key factor in making this project so successful.”

*Drop manholes were cast into a hill to reduce velocities and pressures on the connecting 60" reinforced concrete pipe.*





*60-inch and 48-inch diameter RCP was staged for installation along Interstate 15 in Sandy City. Utah's Oquirrh Mountains provided a scenic backdrop for crews.*

To celebrate the success of the project and the involvement of two of its member firms, the Mountain States Concrete Pipe Association named the project its first "Project of the Year" and presented framed posters to the officials involved in the project. In six months, the general contractor and its sub contractors installed three miles of pipe without any major construction delays or disruption to businesses and local neighborhoods. This is indeed testimony to the ease of installation of precast reinforced concrete products and the trust that contractors and government agencies have in the performance of such products. ☺

Amcor Precast's Ogden Utah facility has been in service over 50 years. Along with a full line of concrete pipe and manhole products, Amcor also produces utility vaults, catch basin products, box sections, and a wide variety of other precast concrete products. See [www.oldcastle-precast.com](http://www.oldcastle-precast.com).

Geneva Pipe Company, located on 13 acres in Orem Utah, has been supplying RCP for 47 years. It recently upgraded its Orem Plant to improve productivity and product quality. The plant produces a wide range of sizes of reinforced concrete pipe, as well as manholes, catch basins, boxes and associated drainage products. It also supplies non reinforced concrete pipe up to 36 inches in diameter. See [www.geneva-pipe.com](http://www.geneva-pipe.com).

<b>Project:</b>	8600 South Storm Drain Project Sandy City, Utah
<b>Owner:</b>	Sandy City Department of Public Utilities Sandy City Corporation
<b>Consulting Engineer:</b>	Bowen, Collins & Associates Draper, Utah
<b>Contractors:</b>	COP Construction Co., South Jordan, Utah HK Construction, Idaho Falls, Idaho Noland & Son, West Jordan, Utah
<b>Quantities:</b>	1,105 feet of 66-inch diameter RCP 4,520 feet of 60-inch diameter RCP 1,060 feet of 54-inch diameter RCP 1,400 feet of 48-inch diameter RCP 1,200 feet of 42-inch diameter RCP 3,380 feet of 36-inch diameter RCP 2,188 feet of 30-inch diameter RCP 1,370 feet of 24-inch diameter RCP 7,000 feet of miscellaneous smaller diameter RCP 506 feet of 48-inch x 76-inch elliptical RCP 3,250 feet of 38-inch x 60-inch elliptical RCP 591 feet of 34-inch x 54-inch elliptical RCP 60 feet of 29-inch x 45-inch elliptical RCP 750 feet of 24-inch x 38-inch elliptical RCP 315 feet of 7-foot x 5-foot (span and rise) precast box sections
<b>Producers:</b>	Amcor Precast (a division of Oldcastle Precast, Inc.) Ogden, Utah Geneva Pipe Company Orem, Utah



# *Precast Concrete Stormwater Detention System Shows Great Value in “Show Me” State*

*By Tony Russo, Sales Representative  
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Underground detention systems are becoming an integral part of stormwater management programs. They offer unique benefits to the owner, and in some cases, significant challenges to the producer of the containment system. In most cases, the owners and producers of detention systems share a common goal – to obtain the best system and long-term value.

On a recent project in the Greater St. Louis-area, Independent Concrete Pipe Company worked closely with the owner and consulting engineer to point out the inherent benefits of a precast concrete detention system: greater durability, lower maintenance costs and installation cost-savings. Although the bid documents for an underground stormwater detention system were originally issued for corrugated metal products, value engineering convinced the consulting engineer that precast concrete was the best choice. Known locally as the Midland Manor Detention and Overflow Structure, it is located in the Metro Sewer District jurisdiction of St. Louis. Construction began on the

detention system in July 2002.

This project is an important achievement in the application of precast concrete products in Missouri. Until recently, almost all underground detention overflow structures were specified corrugated metal pipe because of their inherent low flow orifice and emergency standpipe. These structures can now be supplied as precast concrete products.

St. Charles Engineering and Surveying, Inc designed the detention system. The structure included 66-inch diameter RCP at one end and a manifold at the other end. The manifold end consisted of two 66-inch x 66-inch ninety-degree elbows and two 66-inch x 66-inch diameter tees. The combined



*A special 66-inch x 66-inch diameter precast concrete manifold structure with a 90° elbow was fabricated for the Midland Manor Detention and Overflow System.*

structure accommodated four 72-foot long runs of 66-inch diameter RCP. Bulkheads were used to close the system for underground storage. On the last pipe in the 72-foot runs, a 48-inch diameter manhole tee was produced for access to the 66-inch diameter pipe. Independent Concrete Pipe Company, St. Louis, Missouri supplied the standard and special precast concrete products for the structure.

A 66-inch x 66-inch cross with a 48-inch riser was designed at the manifold so an interior wall could be constructed to hold back the stored water. This weir wall has a low flow orifice and does not extend to the top of the 66-inch pipe. In the event that the low flow orifice is clogged, the weir is used for emergency overflow into a 24-inch diameter RCP. The weir and low flow orifice control the outfall so that no flooding is caused downstream.

There are numerous advantages of using precast concrete underground stormwater detention systems:

- A design life of 100 years
- No disruption to business due to failed pipe
- No special fill requirements
- Minimal risk of flotation
- Significantly reduced maintenance costs
- Easier to install
- Cost competitive
- Special designs, such as low head boxes and elliptical pipe, available.

Underground stormwater detention systems have the



*The system included 66-inch x 66-inch diameter 90° elbows and tees with four 72-foot runs of 66-inch diameter reinforced concrete pipe.*

ability to meet strict stormwater runoff regulations. With the increased design flexibility of systems, such as the Midland Manor system, owners can expect greater value. For example, the surface area above the detention system may be used for parking.



*Installation of the 72-foot runs of 66-inch diameter RCP went smoothly and provided the owners with the ability to add a parking surface above the structure.*



*48-inch manhole tees with bulkheads were installed at the end of each 72-foot run to provide access to the Midland Manor Detention and Overflow System.*

Ponds are not always the answer to stormwater management challenges, since they require a great deal of land. Some designs may include modern-day health and

safety issues considering diseases transmitted by mosquitoes and other pests, as well as new design problems associated with homeland security.

The American Concrete Pipe Association has released a new software program called DASH (Detention And Sewer Hydraulics) to facilitate the design of underground stormwater detention systems, storm sewers and sanitary sewers. The program calculates stormwater detention volumes using a variety of methods. The software helps design entire systems. It produces drawings to scale, uses

multiple sizes and types of pipes and boxes, and provides a listing of all materials required for cost estimating and quotations. Designing and constructing underground stormwater detention systems is made easy using precast reinforced concrete products.

The Midland Manor detention and overflow structure demonstrates the versatility of precast concrete pipe used for stormwater management. With the help of ACPA design software, such structures can be specified and easily constructed to last a lifetime. ☺

<b>Project:</b>	Midland Manor Detention and Overflow Structure St. Louis County, Missouri
<b>Owner:</b>	Metropolitan St. Louis Sewer District
<b>Consulting</b>	St. Charles Engineering & Surveying, Inc.
<b>Engineer:</b>	St. Charles, Missouri
<b>Contractor:</b>	Purler, Cannon & Schulte St. Charles, Missouri
<b>Quantities:</b>	72 feet (four runs) of 66-inch diameter RCP 6 (48-inch diameter) manhole tees 2 (66-inch x 66-inch ninety degree elbows) 2 (66-inch x 66-inch) diameter tees
<b>Producer:</b>	Independent Concrete Pipe Company St. Louis, Missouri

Independent Concrete Pipe Company has seven plants located in Kentucky, Indiana, Missouri and Ohio. Established in 1912, the St. Louis, Missouri Plant supplies reinforced concrete pipe and manholes, precast concrete box units and Hy-Span™ bridges to the growing metropolitan area of St. Louis. Independent Concrete Pipe Company is a long-time member of the American Concrete Pipe Association.

## Part I of a Two-Part Article

# THE CHARACTERIZATION OF POLYETHYLENE MATERIALS AND THEIR SUITABILITY FOR USE IN LONG-TERM SERVICE

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### Introduction

Polyethylene (PE) is a very versatile and widely used plastic. It is used in blow molded food bottles, blow molded household and industrial chemical bottles, automotive gas tanks, molded housewares, injection molded food containers, molded crates, cases, and pallets, as well as geomembranes, pond liners and pipe and fittings. Many of the end uses in which PE is employed are short-term packaging applications, where the service life of the product is measured in days or weeks. In contrast, geomembranes, liners, pipe, fittings or other long-term durable applications could have intended service lives of fifty years, one hundred years, or longer.

The characterization of various PE materials can be accomplished by the use of short-term testing, long-term testing, and accelerated testing. Such tests allow estimation of projected service lives of up to fifty years and beyond. It is important to understand the purpose of these tests as well as their limitations in order to accurately assess the suitability of such materials for longer-term service.

There are three basic properties of PE

materials which are measured by short-term testing that are useful to assess processing and end-use properties. These are density or crystallinity, melt index and molecular weight distribution.

### Density

The American Society for Testing and Materials (ASTM International)<sup>1</sup> has identified three major classifications based on density values for polyethylene materials. They are the following: Type I materials (0.910 to 0.925 g/cc), Type II materials (0.926 to 0.940 g/cc); Type III materials (0.941 to 0.965 g/cc). Type I materials are low-density (LDPE) and linear low-density polyethylene (LLDPE). Type II materials are medium density copolymer polyethylene (MDPE). Type III materials are high-density polyethylene (HDPE). Type III materials include both homopolymer polyethylene and copolymers of polyethylene with other alpha-olefin monomers (e.g. butene, hexene, or octene).

In homopolymer polyethylenes, the polymer chains are packed very closely together and form regular, repeating microstructures. Thus the density and degree of crystalline structure are higher. The introduction of co-monomers into the polymer chain causes the creation of short chain branches, which stick out of the polymer backbone and disrupt the regular packing of the polymer chains. This reduces the crystallinity and also the density of these materials. Homopolymer HDPE materials offer the highest mechanical strength properties because the polymer molecules are packed more regularly and more closely together.

ASTM D3350, "Standard Specification for Polyethylene Plastics Pipe and Fittings Materials," identifies four classifications of polyethylenes based on density: Cell class 1, which is densities of 0.925 and lower; Cell class 2, which includes densities

>0.925 to 0.940; Cell class 3, which includes densities of >0.940 to 0.955; and Cell class 4, which includes materials with densities >0.955.

### Melt Index

ASTM test method D1238, "Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer," provides a method for measuring the flow properties of polyethylene materials in the molten state. This test, which is more commonly referred to as melt index, measures the amount of material, in grams, which passes from an orifice of a set diameter due to the application of a set force in a set time period (ten minutes). The melt index number provides a rough estimate of the average molecular weight and processability of a particular polyethylene material. Materials having relatively short average polymer chain lengths will flow through the orifice more easily and the resulting Melt Index will have a higher value. Conversely materials with higher average polymer chain lengths (higher average molecular weights) will not flow as easily and will have lower melt index values.

### Molecular Weight Distribution

Polyethylene polymer chains are not all the same length or the same mass. A particular sample of polyethylene will have a large number of molecular chains and there will be a large variation in their lengths and thus in their masses. Molecular weight distribution is used to define the statistical groupings of these various lengths of polymer chains. When most of the polymer chains are of approximately the same length and thus similar molecular weight, the distribution is said to be narrow. When there is a large variation in the lengths of the chains, the distribution is said to be broad.

### Effects of Density, Melt Index and Molecular Weight Distribution on HDPE Properties

The effects of changes in the density, molecular weight (melt index) and molecular weight distribution (MWD) on the physical properties of polyethylene materials are shown in Table 1.

In an attempt to avoid premature cracking of the pipe, AASHTO M294 limits the material

Table 1: Effects of Changes in Density, Melt Index and Molecular Weight Distribution (MWD) on Various Properties

Property of HDPE	As Density Increases, Crystallinity Increases and The Property:	As Melt Index Increases, Average Molecular Weight Decreases and The Property:	As MWD Broadens, The Property:
Tensile strength (at yield)	Increases	Decreases	-
Stiffness	Increases	Decreases slightly	Decreases
Impact Strength	Decreases	Decreases	Decreases
Low Temperature Brittleness	Increases	Increases	Decreases
Abrasion Resistance	Increases	Decreases	-
Softening Point	Increases	-	Increases
Stress Crack Resistance	Decreases	Decreases	-
Permeability	Decreases	Increases slightly	-
Chemical Resistance	-	Decreases	-

density to .955 gm/cc and requires a melt index of 3.

## SHORT-TERM PROPERTIES

### Tensile Properties

Short-term tensile properties of polyethylene materials are commonly determined using a constant speed testing apparatus. The tensile testing results are shown in the form of force and deformation data or stress-strain curves. Test specimens are specified as to their dimensions and preparation procedures (ASTM D638 "Standard Test Method for Tensile Properties of Plastics"). These tests are normally done at room temperatures. A thermoplastic material will deform when a force is applied to it. The amount of deformation per unit length is termed the strain and the force per cross sectional area is termed the stress. At very low stress levels, strain is proportional to stress and is reversible. The material deforms but will recover its original shape if the stress is removed. The Modulus of Elasticity (or Young's Modulus) is the ratio between stress and strain in this reversible region. The strain is referred to as the elastic strain since it is reversible also. At higher stress levels, strain is no longer directly proportional to stress and it is not reversible when the stress is removed. The material begins to deform such that the original dimensions are not recoverable if the stress is removed. This strain is described as plastic strain. The point at which a stress causes a material to deform beyond its elastic region is termed the tensile strength at yield. The force required to break the test sample is called the ultimate strength or the tensile strength at break. The speed at which the test is conducted will affect the elastic modulus. At slow speeds the polymer

molecules have sufficient time to disentangle, which will lower the stress needed to deform the material and will lower the modulus. Conversely, at higher crosshead speeds on the testing equipment, the molecular entanglement requires a higher stress (force) for deformation and hence results in a higher modulus value. As this indicates, it is necessary to know the exact testing condition by which test data are developed. Slight changes in condition can drastically alter the test values. Also, test data may not correlate closely with field requirements.

### Flexural Properties

The flexural strength of a material is the maximum stress in the outer fiber of a test specimen at rupture. The test is done with a specimen supported at each end with a load applied at the center of a sample bar. The distortion of the sample is measured as the load is increased. If the specimen does not break, as is usually the case with polyethylene, then the amount of stress is reported at a specified level of strain (usually 2% or 5%). Flexural strength is related to the density and to a lesser extent to the molecular weight. As the density increases, the material becomes stiffer since the molecules do not have as much space to move around one another. The entanglement of the polymer molecules also resists these movements as the molecular weight increases and thus increases the stiffness of the material. Since most thermoplastic materials do not break under this test, the true flexural strength of these materials cannot be determined. Typically, the stress at 2% strain is used to calculate the flexural modulus. ASTM D790, "Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials" is used to determine this property. ☺

<sup>1</sup> ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959

<sup>2</sup> The Plastics Pipe Institute, 1825 Connecticut Avenue, NW Suite 680, Washington, D.C. 20009, [www.plasticpipe.org](http://www.plasticpipe.org)

<sup>3</sup> American Association of State and Highway Transportation Officials, 444 N. Capitol St., NW Washington, DC 20001

<sup>4</sup> ASTM Standardization News, October 2001

## SYNOPSIS AND COMMENTARY

**JOSH BEAKLEY, P.E.**  
**DIRECTOR OF TECHNICAL SERVICES**  
**AMERICAN CONCRETE PIPE ASSOCIATION**

Dr. Walsh is an expert in the area of plastic piping materials, and understands the resin requirements needed to achieve a particular strength and durability balance in plastic pipe. Many Civil Engineers, and those who specify drainage pipe, have had very little if any education in plastics. In this summer issue of *Concrete Pipe News* and the conclusion of his article in the Fall *Concrete Pipe News* publication Dr. Walsh provides insight into the engineering properties that often get overlooked in the flashy brochures given to specifiers.

In the first half of his article, Dr. Walsh takes us through the three basic short-term properties of PE materials; density, melt index, and weight distribution. A close look at Table 1 reveals that improvements in short-term properties are often detrimental to the pipe in the long term. An increase in material density results in a more brittle pipe that has less crack resistance. Corrugated High Density Polyethylene pipe uses its corrugations to lessen the amount of material while still maintaining a high moment of inertia in the pipe wall. While HDPE drainage pipe manufacturers find benefits in using higher density resin, such as a pipe that can use less material and still maintain its stiffness, the end user may experience problems with the product in the future. Also, because HDPE drainage pipe experiences a constant load over a long period of time and HDPE's tensile strength is tested in the lab over a short period of time, future inspection of the installed product may be warranted. If nothing else, Dr. Walsh's descriptions of the pipe material properties proves that

although HDPE pipe is highly installation sensitive, even a proper installation does not necessarily guarantee a quality product in the future if the material properties are not appropriate.

The second part of Dr. Walsh's article will focus on the long-term material properties and service issues with HDPE pipe materials. We hope that you will save this summer issue of *Concrete Pipe News* and put it together with the fall issue when it arrives so that if you ever consider specifying HDPE drainage pipe you will have the complete story on what you need to know today to have a quality installation tomorrow. ☺

*Dr. Walsh is president of Walsh Consulting Services Company, Houston, Texas. Prior to starting the firm in 1993, Dr. Walsh was executive director of the Plastic Pipe Institute. As part of the Society of the Plastic Industry, Inc., Dr. Walsh created and managed marketing programs for the development of polyethylene pipe markets in North America. During his career, he has served on numerous government agencies and regulatory bodies. Dr. Walsh is a recognized expert in the areas of plastic piping materials, testing and long-term durability. He has a Doctor of Philosophy in Chemistry from Rensselaer Polytechnic Institute and a Bachelors of Science degree from Boston College. Dr. Walsh can be reached at (281) 493-2344, email: t.s.walsh@earthlink.net.*

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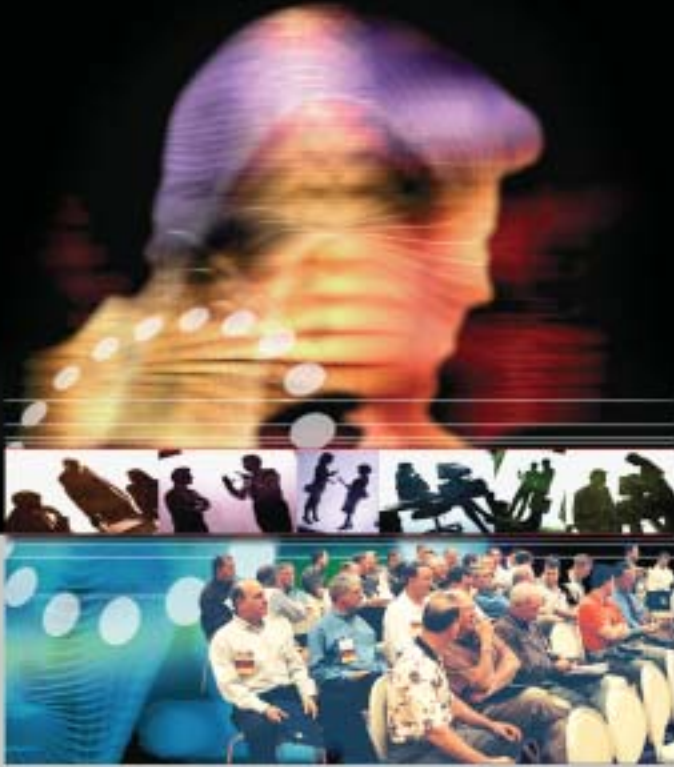
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Go online to [www.concrete-pipe.org](http://www.concrete-pipe.org) for a complete program of events and registration form. Click on the Fall SCS descriptor on the home page. Or contact ACPA at (972) 506-7216, email: [info@concrete-pipe.org](mailto:info@concrete-pipe.org). Hurry, registration closes September 30, 2003.

## President's Report

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South Storm Drain Project in Sandy City, Utah and how various governmental agencies worked together to make the project a success. Another story outlines the use of precast concrete products for an underground stormwater detention system in the St. Louis-area.

Durability was the determining factor for changing the specification from corrugated metal to precast concrete products.

The fall Sales & Marketing Short Course School is scheduled for November 3 to 5 at the Golden Nugget Hotel in Las Vegas. This year the school is open to guests of member companies, including engineers, consultants, specifiers and developers from non-pipe producing companies or organizations. This issue of *Concrete Pipe News* carries a preview of the 2003 program so that there is time to plan the trip to Vegas and register early.

As we pass mid-year with the release of the summer issue of *Concrete Pipe News*, focusing on leadership and award winning projects, it is a good time to reflect on recent months past and the rest of 2003. Markets are poised for a significant rebound. Throughout the tough economic times of the past four years, acts of terrorism and wars abroad, the concrete pipe industry has thrived. Good leaders and good products are a hard combination to beat. ☺

## Industry Spotlight

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obviously saving lives. (*Fall 1999, Vol. 51 No. 2*)

Edwin Kling, P.Eng. shares this view of safer workplaces and sees a time when laborers will no longer be in the trench as installation will be controlled from above ground. He says the net result will be more microtunneling like that in Europe. Kling is cautious about robotics and automation and recognizes shortcomings noting that the cost of automation versus the payback is an exponential curve. At the steep end of the curve, a high price is paid for very little gain in cost savings. He believes that automation will bring a younger, highly skilled workforce into the industry and a safer work environment, but at the end of the day, he says, "the concrete pipe industry must automate, innovate, or evaporate." (*Spring 2002, Vol. 54 No. 2*)

### About Change

Spotlight guests said a lot about change in their interviews. A few see a future for thin walled or non-reinforced pipe to compete with low cost alternative material. Others see new admixtures that increase the strength of concrete pipe and resist corrosive elements in the environments of certain geographic regions. Others focus on changing standards and a need for faster implementation of changes driven by technological advancements in concrete pipe technology.

Wayne MacLean, P.Eng. sees the challenges facing twenty-first century standards. He says the first challenge is to create all-inclusive performance-based standards that are clearly written, simple to apply and easy to understand. "It would be ideal to have one complete standard for each product used," says MacLean. The second challenge is the education of manufacturers/producers, consumers and general interest groups. A comprehensive standard for precast reinforced concrete sanitary sewer pipe that would include Standard Installations would assure people who purchase concrete systems that they are getting exactly what they expect to get. (*Fall 2000, vol. 52 No. 3*)

You have heard their voices through their words recorded in the Industry Spotlight interviews. These people have vision and experiences that elude many of us who soldier on, trying to build a stronger industry. For many of us, we would do well to stop and listen to what they have seen, done and anticipate in years to come. They have passed along their wisdom. We have the time and resources to act on their words. ☺

## “Quality Cast” Certified Plants

In an effort to improve the overall quality of all concrete pipe products, the American Concrete Pipe Association offers an on-going 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

- Atlantic Concrete Pipe, San Juan, PR - Miguel Ruiz
- Boughton’s Precast, Inc., Pueblo, CO - Rodney Boughton
- California Concrete Pipe (Oldcastle), Stockton, CA - Qing Lian Gao
- Carder Concrete Products, Littleton, CO - Bruce Spatz
- Carder Concrete Products, Colorado Springs, CO - Tom Walters
- Cayuga Concrete Pipe Company (Oldcastle, Inc.), Croydon, PA - Allen Reed
- Cayuga Concrete Pipe Company (Oldcastle, Inc.), New Britain, PA - Kim Venable
- Elk River Concrete Products (Cretex), Billings, MT - Bill Cooper
- Geneva Pipe Company, Hurricane, UT - Brent Field
- Grand Junction Concrete, Grand Junction, CO - Ben Burton
- Kerr Concrete Pipe Company (Oldcastle, Inc.), Hammonton, NJ - Bob Berger
- Kerr Concrete Pipe Company (Oldcastle, Inc.), Farmingdale, NJ - Scott McVicker
- NC Products (Oldcastle, Inc.), Raleigh, NC - Mark Sawyer
- Rinker Materials-Hydro Conduit Division, Denver, CO - Ed Anderson
- 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
- Sherman-Dixie Concrete Industries, Inc., - Lexington, KY - Darrel Boone
- South Dakota Concrete Products (Cretex), Rapid City, SD - Jeff Ullrich
- South Dakota Concrete Products (Cretex), Mitchell, SD - Andy Fuhrman

### Sanitary Sewer, Storm Sewer and Culvert Pipe

- Amcor Precast (Oldcastle, Inc.), Nampa, ID - Mike Burke
- Amcor Precast (Oldcastle, Inc.) Ogden, UT - Tim Wayment
- Elk River Concrete Products (Cretex), Elk River, MN - Bryan Olson
- Elk River Concrete Products (Cretex), Shakopee, MN - Steve Forslund
- Geneva Pipe Company, Orem, UT - Fred Klug
- Kansas City Concrete Pipe Co. (Cretex), Shawnee, KS - Lynn Schuler
- Langley Concrete & Tile, Limited, Langley, BC, Canada - Mark Omelianiec
- NC Products (Oldcastle, Inc.), Fayetteville, NC - Preston McIntosh
- Ocean Construction Supplies Limited (Inland Pipe), Vancouver, BC, Canada - Ron Boyes
- Amcor Precast Company (Oldcastle, Inc.), Ogden, UT - J. P. Connoley
- Waukesha Concrete Products Company (Cretex), Waukesha, WI - Jay Rhyner

### Box Culvert

- Sherman-Dixie Concrete Industries, Inc., Franklin, TN - Roy Webb
- Langley Concrete & Tile, Limited, Langley, BC, Canada - Mark Omelianiec



# New “Fill Height Tables” Brochure Available from ACPA

The American Concrete Pipe Association is pleased to announce the availability of an all-new resource item, “Fill Height Tables for Precast Concrete Pipe” (Resource Item 16-201). The new 16-page brochure includes tables for selecting the proper reinforced concrete pipe using the most beneficial Standard Installation for the conditions of the site and required depth of fill.

The brochure also includes a basic pipe and soil terminology diagram for a trench/embedment installation; SIDD soil classifications and equivalent USCS designations, plus dimensions of circular concrete pipe.

The “Fill Height Tables” brochure outlines four types of Standard Installations, each with its own soil and compaction requirement. These four choices provide flexibility and versatility for the designer and contractor, as well as performance and economy for the owners that are not available with other types of pipe.

To obtain a copy of the brochure, contact any member of the American Concrete Pipe Association. Copies may also be ordered directly from ACPA Resource Center for \$3.00 each (non-member) plus shipping and

handling. Visa, MasterCard and American Express are accepted. Contact the ACPA Resource Center at **800-290-2272**.



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