information

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No Pipe Dream: Concrete Serves Water Users Best

Whether their water is coming or going, users of water are best served by precast concrete pipe, pressure pipe, and cast-in-place concrete transmission and distribution systems.

Concrete is integral to safe processing and delivery of drinking water, and is essential for return of waste and "gray" water to treatment plants.

Concrete pipe and concrete pressure pipe are basic components of our developed infrastructure. As our built environment is improved, U.S. demand for large diameter pipe is expected to grow by 2% per year, to nearly 200 million feet in 2001, according to the Cleveland-based Freedonia Group. Of that 200 million feet, concrete pipe will garner the lion's share, almost 110 million feet. Metal and high-density polyethylene (HDPE) "plastic" pipe would compose the remainder.

Concrete is inert, safe, long-lived, and dependable. Those are exactly the kinds of qualities materials specifiers need for water systems. Recent research confirms what experts have known for decades: Concrete does not leach toxic materials, whether incorporated in the concrete, or carried through it as waste effluent.

And advanced technologies—such as high-performance concrete materials and new thin-wall designs—will continue to improve the constructibility, durability, and mechanical properties of concrete in water systems.

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Materials of choice

Precast concrete pipe and culverts for potable water supply and wastewater and stormwater return are the materials of choice for many designers, owners, and contractors. Concrete pipe is available in three basic shapes: circular, elliptical, and rectangular.

Circular concrete pipe is most commonly used, being hydraulically and structurally efficient under varied conditions. But circular pipe can cause reduction in stream width during periods of low flow.

Elliptical concrete pipe is often used instead of circular pipe when the distance from the top of the pipe to ground surface is limited, or when a wider cross-section is desirable for low-flow levels.

Rectangular cross-section box culverts fit into many site conditions, including those requiring low-profile structures.

Concrete pipe is produced in relatively shorter lengths than competing flexible products due to product mass, shipping needs, and manufacturing methods. These shorter lengths are beneficial in trench box installations, as a shorter trench box and less open excavation are required.

Another precast concrete item for water management is manholes, which are usually 4 to 10 feet in diameter.

Concrete pipe is the recognized leader in service life among buried pipe products.

In addition to water transmission and distribution, precast and cast-in-place concrete can manage the problem of nonpoint source discharge pollutants—that is, water pollution not attributable to a single location.

Some 80% of North American freshwater pollution is the result of stormwater runoff. This includes sediment carrying hydrocarbons and floating residue from paved sites into stormwater collection systems, where the pollutants are often stored in mitigated wetlands and stormwater ponds.

While such ponds and wetlands are effective treatment for these discharges, they can encumber property that could be put to more value-intensive use. Specially designed precast concrete storm systems treat stormwater by separating hydrocarbon-laced silt, other liquids, sand, and debris from location runoff. Rain event removal rates of more than 80% are typical.

And precast concrete leaching chambers constitute a superior, below-ground fluid absorption system for cleaning septic tank effluent.

Expect a century of service

Laboratory and field data have firmly established that concrete pipe is the recognized leader in service life among buried pipe products. Historical data show that specifiers and users can expect a product life of 100 years or more for concrete pipe.

Because no material is completely inert in the presence of chemical action or immune to physical deterioration, specifiers and users are best served by identifying the material that offers the greatest chance of long service life.

Exterior insult from low pH (acid) soils has never presented a problem for concrete pipe. Design options exist to combat aggressive conditions and extend the service life of concrete pipe.

Precast concrete pipe can now be produced with high-alkalinity concrete, increased concrete cover over reinforcement, a barrier coating or lining, or any combination of these, to counter the effects of acids in soil. And concrete is free from many hazards to which other materials are subject.

Unlike some competing materials, concrete pipe does not corrode by electrochemical action.

Robotics: New Twists Update Mature Product

You can teach an old dog new tricks, as the concrete pipe industry has learned as it applies advanced robotics and other technological improvements to pipemaking equipment. Lower costs, greater flexibility, and enhanced quality are among the benefits to end-users.

Labor-intensive activities lending themselves to robotics include pipe and joint ring handling, processing of finished pipe, and removal and treatment of the joint forming rings, reports the Canadian Concrete Pipe Association.

"Robotics in these areas also allow for control and consistency in the manufacturing process," CCPA says. For example, a computer-controlled robot that feeds pallets and cages to the pipe machine can shorten the machine's manufacturing cycle and increase pipe output.

In another application, a robot is integrated with the pipe machine to automatically feed and place spigot-forming headers during the manufacturing process, according to CCPA. When pipe is manufactured with spigot formers that remain in place until the product is cured, spigot dimensions are even more precise, and no personnel are required.

Automatic reinforcement cage machines manufacture dimensionally accurate reinforcement cages from coil wire with specific barrel and tongue diameters and, if required, an expanded bell end.

"New technology, contemporary standards, and quality assurance during the manufacturing process combine to produce precast concrete pipe products that are the best ever created," CCPA says. "Owners of concrete drainage systems and producers benefit most from the new technologies available today. Industry has taken the initiative to ensure quality products that will endure for generations."

Concrete pipe does not experience creep or stress relaxation as it ages, thereby minimizing deflection and increasing service life. It is not vulnerable to attack from chemicals such as strong oxidizing acids, oils, alcohols, and polar reagents such as detergents. The thickness and ruggedness of concrete pipe make surface scratches and abrasions a nonissue. Furthermore, concrete does not burn or support combustion. It does not degrade under exposure to ultraviolet light or extreme temperatures. Concrete pipe endures year after year, doing its job, unaffected by stress, strain, and environmental conditions.

One last benefit not to be overlooked is the reliability of concrete, which can reduce a specifier's liability in case of a failure in the field.

Organic or inorganic

Modern water and wastewater pipe is either organic or inorganic in composition. In North America, wooden organic materials were first used for pipe during the 1800s, according to the Ontario Concrete Pipe Association.

Today's organic pipe is made of petroleum-derived plastic, but unlike wood, plastic pipe contains preservatives, antioxidants, and stabilizers to slow down the natural, gradual loss in strength that occurs with organic materials.

In contrast, inorganic materials such as concrete have historically demonstrated good durability. Concrete is an entirely natural product with a 9,000-year track record. Samples of concrete pipe made by the Romans—along with the durability of their famous aqueducts—give credence to the claim that modern concrete pipe can last at least a century, and probably longer.

And because, theoretically, concrete never stops curing—merely slows down—tests done on old pipe discovered during reconstruction projects repeatedly confirm that concrete pipe increases in strength with time. In fact, its attribute of autogenous healing in moist environments—the ability to "self heal" small cracks—is yet another benefit of concrete pipe.

Moreover, tests universally demonstrate concrete's extremely high contaminant-fixing ability. That means whatever unavoidable, minuscule traces of leachable contaminants, such as heavy metals or polyaromatic hydrocarbons (PAHs), that may be present in any concrete mix will stay fixed in the concrete, and will not leach into the environment. This makes water transmission and distribution facilities made of portland cement concrete a great buy now and for generations to come.

Codifying confidence

In October 1997 the Kansas City (Missouri) Public Works Standards Committee (KCPWSC) selected concrete pipe over HDPE for the following reasons:

- Concrete pipe is not installation-sensitive. There is greater margin for error with concrete pipe than with other materials.
- Concrete pipe does not require contractor training for successful installation.

High Demand for Water Infrastructure Improvements

According to the Environmental Protection Agency's 1997 Infrastructure Needs Survey, the total infrastructure need for public water systems in the nation is vast, nearly $140 billion. Of that figure, some $77 billion is necessary for physical expansion, while nearly $62 billion will be required to comply with new regulations.

Significant for specifiers and users of concrete, replacement and upgrades of transmission and distribution lines make up the largest proportion of infrastructure need for all public water systems. Small systems in particular face a significant need for replacement and upgrade of such lines.

The 1997 report is based on EPA's 1996 Clean Water Needs Survey (CWNS), required by law to canvass publicly owned, municipal wastewater collection and treatment facilities; facilities for control of combined sewer overflows (CSOs); activities designed to control stormwater (SW) runoff and nonpoint source (NPS) pollution; and programs designed to protect the nation's estuaries.

The total 1996 documented and modeled needs were estimated to be $139.5 billion. This included $44.0 billion for wastewater treatment; $10.3 billion for upgrading existing wastewater collection systems; $21.6 billion for new sewer construction; and $44.7 billion for controlling CSOs.

Small communities are in especially dire straits, the survey revealed. Documented needs for communities with populations less than 10,000 total $13.8 billion, representing 11% of the total documented needs for the nation. The need for basic infrastructure is greater in small communities when compared to large.

The 1996 Clean Water Needs Survey Report was completed and transmitted to Congress on Sept. 23, 1997. The next survey was to have begun in March 1999, and the subsequent CWNS report is due Feb. 10, 2001.

- Repair and rehab funding and life cycle costs overall are modest for concrete compared to less durable alternatives.

In the late 1990s, DeKalb County, Georgia, replaced, at great expense, rusting, collapsing corrugated metal cross drains as they neared the end of their 30-year life span, according to the *Decatur-DeKalb News Era.* They replaced them with concrete pipe.

Concrete pipe is more "contractor friendly" than alternative materials because most of the bulk of the pipe-soil structure is contained in the pipe, thus minimizing the impact of less-than-optimum installations.

Competing pipe materials derive a significant percentage of their installed strength from the soil envelope. Incorrectly prepared soil envelopes will compromise the installation of these materials and the long-term performance of the pipe.

Contractors are more familiar with concrete pipe installation techniques and procedures. And because the construction industry often is the point of entry for less-educated, untrained personnel into the work force, "keeping it simple" with reliable concrete pipe can keep the installation process relatively trouble free.

Getting better all the time

Despite their great heritage, precast concrete pipe and concrete appurtenances for water and wastewater are getting better year after year.

Pipe producers are using innovative thin-walled concrete pipe and nonreinforced concrete pipe designs, while high-performance and ultra-high-performance materials—achieved through use of coal fly ash and other admixtures—improve concrete pipe's compressive strengths and functional properties.

Technology is changing the way concrete pipe is produced. "Computer control, robotics, and highly flexible manufacturing systems are being applied to all phases of production, from batching through cage fabrication, pipemaking, handling, and aftertreatment of the pipe," reports the Canadian Concrete Pipe Association. Emphasizing products of higher quality and tighter specs, the industry has also refined concrete pipemaking machines in recent years.

And the pursuit of quality doesn't appear to be letting up. The American Society for Quality Control (ASQC), through its Transformations to Quality Organizations (TQO) program, is on the home stretch of a three-year study to develop quality benchmarks for the concrete pipe industry. In this program, the University of Arkansas is partnering with industry to identify and implement quality improvements. The research will include a survey of American Concrete Pipe Association member plants, covering operations and equipment, production techniques, and customer satisfaction initiatives.

Preliminary research results indicate high levels of satisfaction. With over 770 contractors rating concrete pipe quality an average 5.82 out of a possible 7, and 590 specifiers dispensing an even more favorable rating of 5.91, the future for concrete pipe seems secure.

Advanced technologies will continue to improve the durability of concrete in water systems.

The Environmental Council of Concrete Organizations is a coalition dedicated to promoting the environmental benefits of concrete and its role in safe and sustainable construction.

ECCO members are companies, organizations, and individuals affiliated with the concrete industry. Together, they are committed to developing and disseminating information on the environmental benefits of concrete and concrete products.