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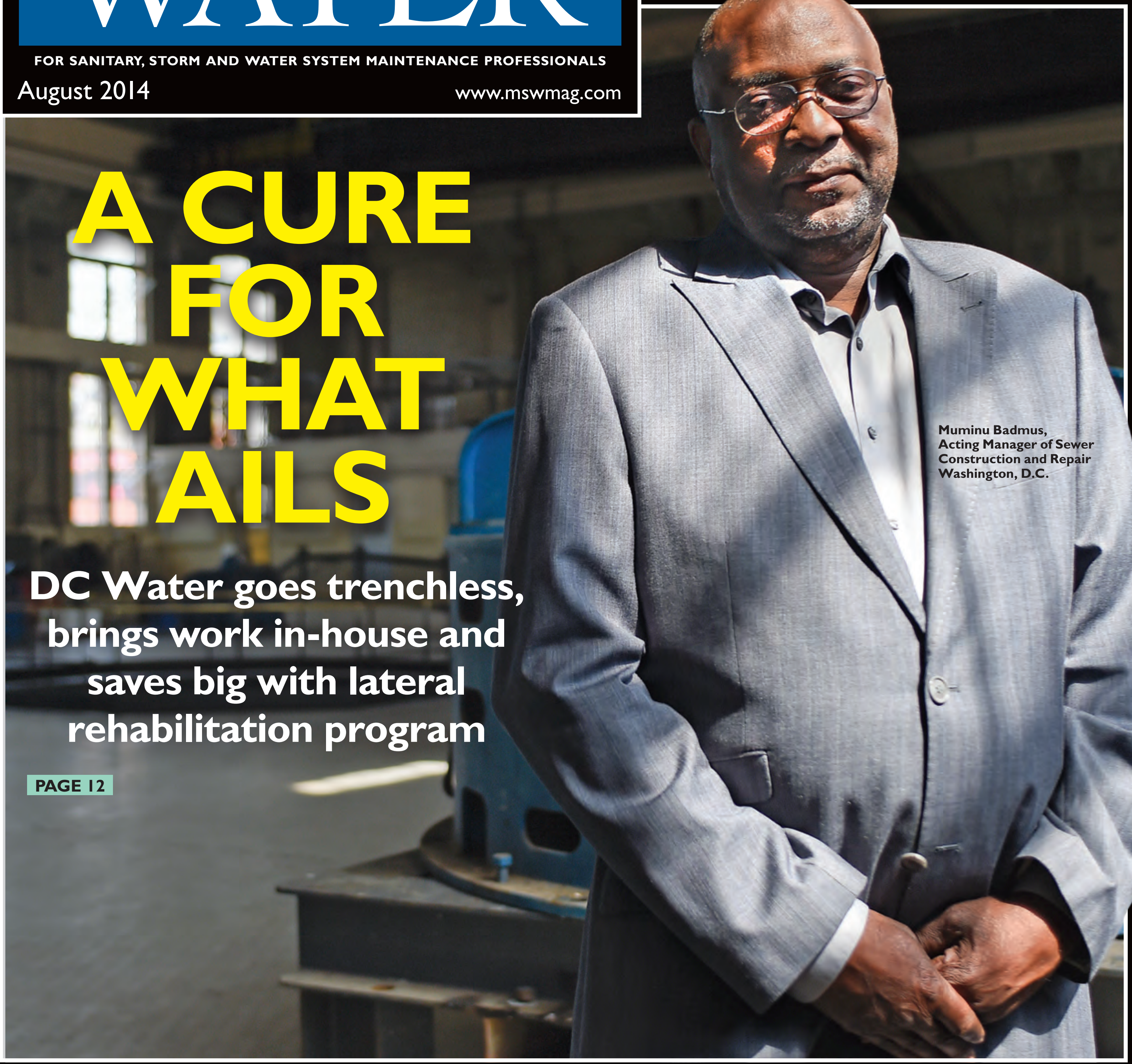

A CURE FOR WHAT AILS

DC Water goes trenchless, brings work in-house and saves big with lateral rehabilitation program

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A PIPE FOR EVERY PROJECT

Choosing the right materials requires an understanding of conditions and the strengths and weaknesses of each material

By Jennifer West

Aging infrastructure is a prime concern in the water and wastewater world. And with good reason. According to a 2007 EPA survey, the nationwide infrastructure need is estimated at $334.8 billion from January 2007 through December 2027. The largest portion of that figure – $200.8 billion – represents needs in water transmission and distribution projects.

Municipalities indeed face a gigantic task: Many pipes are nearing the end of their life spans, and the time to choose a replacement has arrived. In a long-term project like pipe replacement, where life span can exceed 100 years, proper material choice is critical. Here, we examine the most common types of municipal pipe material along with a general guide of the strengths, weaknesses and uses for each.

Ductile iron pipe

Cast iron pipe, which is the predecessor of ductile iron, is part of the infrastructural backbone of this country. Currently, more than 600 municipalities boast 100-year-old working cast iron pipe systems, and more than 20 have pipe that's reached the 150-year mark.

"It's held up very well," says Gregg Horn of the Ductile Iron Pipe Research Association. "Our argument would be if the infrastructure needs to be rehabilitated, that ductile iron would offer a similar or better service than cast iron."

Primarily used on the water side, ductile iron is a cast product manufactured almost entirely from ferric scrap. The pipe's materials are 95 percent recycled, a feature that has helped it earn a SMaRT sustainable product certification. Ductile and clay pipe are the only products in the buried infrastructure industry to claim this bragging right.

Despite its strength, ductile pipe is subject to corrosion from aggressive environments caused by acids, either in the interior of the pipe from acidic sewage materials or on the exterior from acidic soil conditions. To combat the problem in water service, the inside of the pipe is lined with a cement mortar lining, which protects the pipe and forms a barrier. Sewers can be a little more challenging for ductile iron, so a special internal pipe lining is sometimes needed.

"It also improves the hydraulics and helps water through the pipe," Horn says. "Its good flow characteristics are maintained. We're not that worried about internal corrosion from water."

The Ductile Iron Pipe Research Association has been researching external corrosion for decades, and its most recent recommendation is an enhanced polyethylene encasement. Horn references a recent case study in which workers dug up and examined ductile iron pipe that was installed in 1958 in Lafourche Parish, La.

Primarily used in gravity-flow sanitary sewer systems, vitrified clay pipe has improved greatly in recent decades. Computer-controlled kiln firing means the final product is uniform and meets quality standards. (Photo courtesy of National Clay Pipe Institute)

"When you peel the polyethylene off, the pipe looks beautiful. It looks brand-new," he says. "If you protect against external corrosion, there's really nothing that can go wrong."

Steel pipe

Steel pipe, which was first introduced in the early 1800s, has a long history of use in the United States and has been recognized for its excellent resistance to high internal pressures and pressure surges. Large-diameter steel piping is most often used in pressure pipes for water and wastewater applications. It can be made using three methods: seamless, welded and casting mold.

Like other metal pipes, steel is prone to corrosion, so it is lined with an asphalt coating when used in water mains to protect against acidic water. This also retains its good flow characteristics. The drawback to the various coatings and linings is that they can be damaged during installation.

Steel's primary benefit is brute strength. Cracking typically doesn't occur, and under abnormal loads, the material bends rather than breaks.

Vitrified clay pipe

Clay pipe has been used for millennia, with the earliest examples dating to 4000 B.C. The material was used in Mesopotamia, the Minoan civilization and the Roman Empire, and has a long pedigree of city sewer system applications. But today's clay pipe is nothing like those early examples. Nor is it anything like what was prominently used in the United States in the 1950s and '60s.

"Most people who aren't familiar with modern clay pipe associate it with something that's been in their system for more than 100 years, and they're different," says Jeff Boschert of the National Clay Pipe Institute. "Their opinion of the product is

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Concrete is one of the most common gravity-flow pipe materials. It's also one of the most versatile, as it's manufactured in several shapes, including round, elliptical, arched and box, and is used in sanitary sewers, storm drains and culverts. (Photo courtesy of American Concrete Pipe Association)

based off of something that isn't made anymore."

Primarily used in gravity-flow sanitary sewer systems, vitrified clay pipe has improved greatly in this age of technology. Computer-controlled kiln firing means the final product is uniform and meets quality standards. Gone are the laminations in the pipe body thanks to a high densification extruding process.

"Years ago, there were probably 100 different factories manufacturing a porous product that needed glazing on the interior and exterior," Boschert says. "But the modern day pipe is tight, dense and nonporous. The body of the material itself is totally different and stronger.'

The joints have also evolved. Decades ago, clay pipe did not have a factory-applied joint, which meant infiltration and exfiltration along with root intrusion and loss of pipe support. Now, joints are factory-applied using polyester with an O-ring or a polyurethane material that creates a leak-free joint. Although the pipe is rigid, the flexible compression joints provide forgiveness if the ground moves.

Clay, which has an average compressive strength of 18,000 psi, can also be used as a direct jacked pipe in trenchless applications. Vitrified clay jacking pipe was introduced to the trenchless market in 1992, and since then, it has been used in pilot-tube microtunneling, slurry microtunneling, static pipe bursting and sliplining applications.

Vitrified clay pipe really shines in highly corrosive environments, even in the presence of sewer gases and solvent-based chemicals. The only chemical known to affect clay pipe is hydrofluoric acid, which is not likely to be found in sanitary sewers.

"No pipe material can hold a candle to the corrosion-resistant properties of clay pipe," Boschert says. "Many breweries have used it because of its corrosion resistance and temperature parameters."

Clay pipe is valued for its longevity, corrosion-resistant properties and sustainability. However, it does have some limitations: It is typically limited to gravity-flow applications, and the maximum pipe length is 10 feet due to the kiln firing process.

Concrete pipe

Concrete, which is one of the world's most common building materials, is used in both gravity-flow and pressure pipe. Precast gravity-flow pipe is manufactured in several shapes, including round, elliptical, arched and box, and is used in sanitary sewers, storm drains and culverts. Concrete pressure pipe, which is a separate classification, is primarily used for potable water.

"Concrete pipe is pretty simple," says Matt Childs, president of the American Concrete Pipe Association. "You've got a big, strong, heavy pipe, and as long as you don't mess it up, it's going to be there for a really long time. We've got pipe that's been in the ground for 150 years."

This rigid pipe system is 85 percent dependent on pipe strength and only 15 percent dependent on the soil envelope for underlying support, which makes it a good candidate for low-lying or marshy environments.

"Our biggest advantage is durability, strength and longevity," Childs says. "We also have very good flow characteristics because we have a smooth surface."

Despite its durability, concrete is susceptible to H_2S attacks, and in extremely acidic soil, it can corrode. To combat these problems, concrete pipe can be coated with a plastic liner, and special measures can be used to prevent corrosion in acidic soils.

"We do like to be honest and say that you have to plan for it," Childs says.

Just like with any other pipe material, concrete pipe can fail due to improper installation. Childs reinforces a common theme in the industry: Installation is key.

"If there's a failure, typically it's the installation," he says. "We can have problems with a contractor driving over a pipe before it's installed … maybe driving heavy equipment over the top to cause heavy compacting. We have problems with installation, too. If it's not put in straight, we can run into cracks."

HDPE pipe

Borrowing technology first used by the gas and oil industry, high-density polyethylene pipe has also become a popular choice for water and wastewater applications because of its noncorrosive, highly flexible characteristics. Also, its heat-fused joints mean zero water loss, which is an important quality as worldwide water value increases.

"In other countries, water is gold. Not in the United States," says Camille Rubeiz, director of engineering at the Plastics Pipe Institute. "[Water loss] is unacceptable. Today we have new technologies, and they should be embraced."

This fusion process creates an unbreakable bond and a joint as strong as the rest of the pipe. HDPE is also highly resistant to corrosion and has a low failure rate, which further decreases life span costs. But Rubeiz states that proper planning, design, installation and inspection are essential when using HDPE.

"It's very forgiving, but that is really a weakness because it can get abused," he says, referring to installation shortcuts. "We're not buying a T-shirt that we can throw away after Christmas. This is a 100-year project. Utilities, consultants and contractors have to be given enough time and resources to do a project well."

Municipalities in earthquake-prone areas should consider HDPE because of its flexibility and ductility. According to a report by the Water Research Foundation, which studied

High-density polyethylene pipe has become a popular choice for water and wastewater applications because of its noncorrosive, highly flexible characteristics. And its heat-fused joints mean zero water loss. (Photo courtesy of Plastics Pipe Institute)

recent earthquakes and their implications on U.S. water utilities, HDPE capably withstood tremendous seismic activity. The study states that in the 2010 Chile earthquake, for instance, "while the rest of the water system suffered thousands of damaged pipes, no HDPE pipe was damaged." The report recommends HDPE for common distribution pipes and service laterals in high seismic zones.

HDPE is available in sizes from 1/2 to 65 inches, covering everything from service lines to distribution and transmission mains. Its use has expanded across Europe, and according to Rubeiz, nearly 90 percent of new pipe installations in Europe are HDPE.

"When installers and designers follow the book, there should be no issues," he says. "All conditions need to be considered at design. There shouldn't be shortcuts on something you want to last more than 100 years."

PVC pipe

Polyvinyl chloride, which scientists first stumbled upon in the 19th century, is one of the oldest synthetic materials. It wasn't until World War II, however, that demand for the material accelerated when it was used to insulate wiring on military ships. In the decades following, PVC use skyrocketed, and now it's commonly used for sanitary sewers and potable water distribution lines. PVC is a thermoplastic, meaning it can be softened and reformed, and a fusible version is now available, which competes with HDPE in trenchless construction.

This pipe is very corrosion resistant and is often used to coat other materials that are affected by acidic conditions. In a 2008 study by the Water Research Foundation titled "Impact of Hydrocarbons on PE/PVC Pipes and Pipe Gaskets," researchers concluded that PVC is also impervious to gasoline, the most common hydrocarbon contaminant.

This corrosion resistance translates to a low failure rate. A 2012 survey by Utah State University indicated that when compared to cast iron, ductile iron, concrete, steel and asbestos cement, PVC had the lowest failure rate with only 2.6 failures per 100 miles of pipe per year.

"This is space-age stuff," says Bruce Hollands, executive director of the PVC Pipe Association of North America. "It's a high-technology material that removes corrosion completely from the equation."

Cost is a large reason why municipalities are drawn to PVC. Even when including backfill and labor expenses, PVC is typically a less expensive replacement option than other materials. Hollands states that in some situations, a 70 percent savings can be realized when using the material.

That said, PVC is not without some limitations.

"There are two reasons you wouldn't use PVC," Hollands says. "You wouldn't specify it for situations with operating pressures higher than 305 psi, and you wouldn't use it in an application that requires temps above 140 degrees. These conditions, however, are extremely rare in water and sewer systems."

An American Water Works Association Research Foundation study estimates the life expectancy of PVC to be in excess of 110 years. Pipe sizes range from 4 to 60 inches for both sewer and water applications. The 54- and 60-inch-diameter water pipes are a relatively new addition to PVC and are currently not as widely available.

Making decisions

Pipe material selection can be a complex process, filled with politics, preconceived ideas and budget parameters. And to complicate the matter, municipal leaders must now navigate through marketing hype as manufacturers fight for a piece of the infrastructure pie.

What it boils down to is considering uses, soil conditions and reasons for previous failures, and then making a well-informed materials decision. After all, if all goes well, a pipe replacement decision should only come around once every 100 years. ✦