Past as Prologue

Portland Revisits Clay Pipe

By Larry G. Tolby

In Portland, Ore., the past reveals the best way forward for a 2,000-mile sewer system. By 1883, the City had installed 15 miles of terra cotta pipe ranging in diameter from 9 to 18 inches. By 1933, larger pipes made of concrete or brick extended the system to 1,100 miles of pipe that conveyed sewage directly into the Willamette River and the Columbia Slough, according to the Portland Bureau of Environmental Services.

After using a variety of other pipe materials, the City of Portland, Ore., is testing the material of choice in their system from 125 years ago – vitrified clay pipe (VCP). Inspection reports, experience and maintenance records all showed the 100-year old pipe in the system needed very little attention. In fact, in the early years of sewer system construction, pipe was buried and forgotten. Out-of-sight and out-of-mind was the basic maintenance philosophy.

It wasn't until the 1980s that regular cleaning and maintenance schedules were advocated. As is typical of older pipe installations across the country, the only repairs required are most frequently the direct result of poor installation or poor jointing. Even so, the durability and performance of the century-old pipe and the inert nature of VCP led to exploration of a new project specifying clay pipe.

Past may be prologue, but there were several challenges to be addressed before the first new project could begin:

- The city's existing suppliers didn't carry VCP simply due to a lack of demand.
- The engineering and quality control groups had heard significant mischaracterizations of the physical properties of VCP. Some of the more commonly repeated inaccuracies include concerns about the joints and the brittleness of the pipe.
- No one in the system from employees to consultants and contractors to inspectors had ever designed, tested or worked with VCP; and
- The city's current specifications included concrete, ductile iron, plastics and cast iron but lacked any reference to inspecting or testing clay pipe.

The Need

In a system of 1,446 miles of separated sewers and 878 miles of combined sewer lines, 96 pump stations and two wastewater treatment plants, processing an average of 108 million gallons per day, the maintenance department has a strong influence over the type of pipe selected. Despite the environmentally friendly nature of clay pipe, the engineers, inspectors and quality control personnel all needed a more in-depth study before being convinced.

Interest in VCP was furthered by the improved manufacturing practices of modern clay pipe.

"This isn't a change you can make lightly, so we did a lot of research and testing before we designed the first project using VCP," said Colleen Harold, senior engineering associate for the Bureau of Environmental Services for the City of Portland. Harold led the product exploration and was responsible for managing all aspects of the change, including amending the city's standard construction specifications to include the necessary VCP standards.

After many years of research, including extensive review of current product literature and the underlying data provided by the National Clay Pipe Institute (NCPI), consultation with other

agencies, critical evaluation of manufacturing techniques, testing procedures and compliance with ASTM standards and Greenbook Standard Specifications for Public Works Construction, the city's engineering department decided that a trial project was in order, so Harold needed to find or provide a solution to each of the challenges.

Identifying a Supplier

Finding a supplier was actually the easiest issue to address according to Harold, who identified two manufacturers: Gladding McBean and Mission Clay, which were already supplying pipe to other municipalities in the region on a regular basis. "They were both driving right by us to deliver pipe to Seattle and parts of British Columbia so it was easy to get the product as a stop along the way," Harold adds.

"Most areas of the United States and Southern Canada are readily serviced by an NCPI member company," said Michael Van Dine, president of NCPI. "Typically distributors are happy to provide any pipe material a municipality wants to use and getting the product to the distributors isn't an obstacle."

Correcting the Misinformation

"We ran into all kinds of misinformation," Harold commented. "But we took some pipe out to Quality Control personnel and let them stand on it, take a sledge to it and generally put it through any test they cared to. In the end we chose to install VCP."

The old pipe in the system, while called vitrified sewer pipe, wasn't actually fully vitrified. This kind of pipe is more correctly identified as terra cotta pipe. The firing techniques available before the middle of the 20th century meant that much of the older pipe was not manufactured to the strength and quality levels of today's pipe.

Inspection of cross-sections of the old pipe and a recently manufactured pipe make these differences obvious. The manufacturing processes available in the late 1800s and early 1900s meant that firing temperatures were less consistent and less precisely controllable. The limitations of the time led to laminations and voids in the pipe bodies, making them a different product than the pipe manufactured since the middle of the last century.

Today, the temperatures are precisely controlled to quickly bring the pipe from a drying room temperature up to 500 degrees F and then slowly taking it from 500 to 1,100 degrees F to burn out any impurities. Once the temperature of the pipe body reaches that level, the heating process can proceed quickly to 2,000 degrees F where the pipe is vitrified or converted to a new, stronger material. The cooling process is also controlled in steps to maintain dimensional stability. The actual timelines for this production cycle are dictated by the size of the pipe.

Clay pipe manufactured prior to 1950 was generally made in short lengths, around 3 feet. This was due to the limits of both the firing process and the effectiveness of the extrusion equipment available at the time. Today short lengths are still available and commonly used in tight urban settings, but process and equipment improvements allow for the production of pipe in up to 10-foot lengths for the larger diameters.

A design engineer, a field inspector and a quality control inspector from Portland traveled to manufacturing plants in Corona and Lincoln, Calif., to see the production processes and observe the strength and physical property testing. They were able to question each manufacturer about their compliance to all appropriate ASTM and Greenbook standards.

Although all pipe materials have their strengths and weaknesses, the amount of misinformation about VCP can be astounding, according to Harold. The old joints are the focus of a wealth of misinformation supporting the mistaken impressions of the old pipe products. A Metcalf & Eddy study published in 1935 found that 99.3 percent of municipalities with populations of 100,000 or more were using dilution as the solution to pollution. In other words, inflow was not only desirable, but intentional. Many of the older systems were designed to allow for this additional flow to keep the systems clean.

NCPI provided field training for contractors on tapping techniques for VCP.

All pipe joints prior to World War II were field manufactured. Sometimes from cement mortar, sometimes from tar, both of which were readily available on the jobsite. So the joints many municipalities see in their older terra cotta pipe were only as good as the workman in that trench on that day.

Today, compression joints are factory applied and tested to consistently deliver a leak-free joint. These joints are designed to allow for the human factor in the trench without sacrificing performance.

"We were glad to have the chance to confront the urban legends about clay pipe head-on," said Van Dine. "Some of them are quite persistent, and we rarely get the opportunity to address them so directly and so thoroughly. Today's standard very clearly states that 'joints shall not leak,' per ASTM C-425 and the factory applied joints manufactured in the last 50 to 60 years don't."

Lessons Learned

The first project designed with new VCP replaced an existing combined sewer system and realigned a gravity sewer in the public right of way. The Bybee Sewer Rehabilitation project included 6,208 feet of 12-inch mainline, included both bell and spigot VCP and VCP coupling pipe and was budgeted at $1.7 million. Dunn Construction took 257 days to deliver the project in March 2010.

Sustainability, the long service life, low maintenance and environmentally friendly nature of the pipe led Portland to a thorough exploration of the strengths and weaknesses of clay pipe. The current practices and standards led them to their first test installation.

"Using and installing clay pipe is actually similar to installing concrete," according to Harold. "If a contractor could install concrete, we allowed them to bid on the Bybee project. We will absolutely use VCP again."

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