ASTM and the National Clay Pipe Institute

100 Years of Teamwork and Achievement

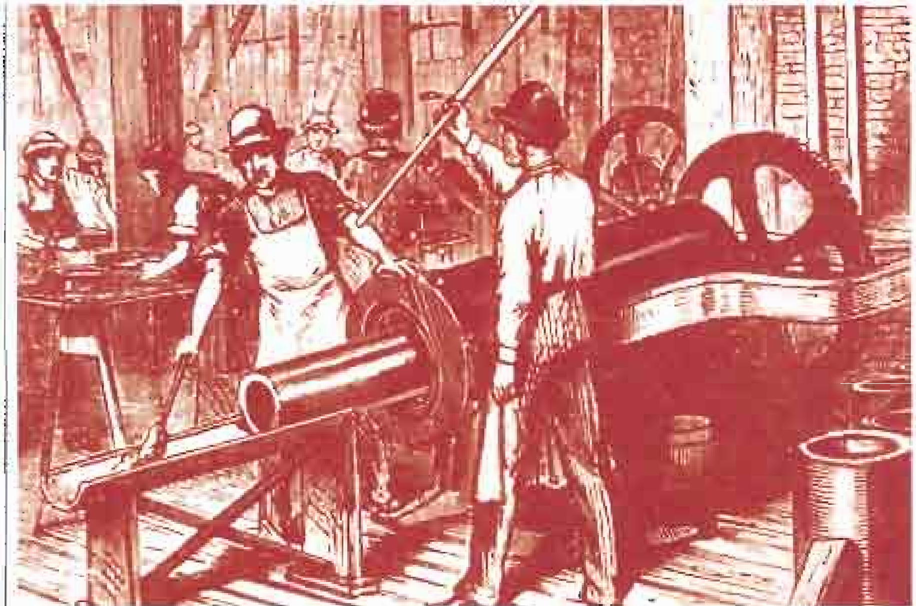
BY EDWARD J. SIKORA

ASTM Committee C04 on Vitrified Clay Pipe turned 100 years old this year. For a century, dedicated members from the public and private engineering community and clay pipe manufacturers have worked harmoniously to develop today's stringent standards for sewer pipes.

Sanitary sewers may not be the most popular topic of discussion, but let a sewer stop functioning for a few hours and you will see just how essential our sanitary sewer systems have become. This was not always the case. It was not until the mid 1800s that Louis Pasteur discovered that waterborne bacteria were responsible for the spread of disease and many deaths. It was then recognized that contaminated water must not be allowed to enter the drinking water supply. This was the main reason for the construction of sanitary sewers in Europe and later in the United States.

EARLY CLAY PIPE PRODUCTION IN THE UNITED STATES

One of the first American vitrified clay sewer pipe plants opened in 1849 in Middleburg, Ohio. Manufacturing methods were crude and it wasn't until 1865 when the first mechanical press to extrude pipe was developed. Initially, larger diameter pipes were cut into short lengths and then hand-molded onto the ends of smaller diameter pipe to form bells before firing. Shortly thereafter, the first reliable steam press came into use and the era of clay sewer pipe production began in earnest.



Early Clay Pipe Extrusion Press

THE FORMATION OF ASTM COMMITTEE C04

The design of early sewers was a major problem because there were no standard sizes, strengths, quality tests or installation methods. Recognizing the problem, Charles F. McKenna, a New York chemist, wrote to ASTM in 1903 requesting the "formation of a committee to recommend standard specifications and tests for clay and cement-concrete sewer pipe." ASTM, itself just a five-year-old fledgling organization, agreed with McKenna and, in 1904, designated Committee L to pursue this activity. Committee L was later renamed Committee C04 on Clay Pipe in 1909. Through these humble beginnings and the years that followed, the close relationship between ASTM and the clay pipe industry demonstrated that dedication and commitment to a worthy cause could achieve a high level of quality and purpose.

Standards, however, did not come quickly or easily. Under the leadership of Rudolf Hering, a consulting hydraulic and sanitary engineer from New York, N.Y., the committee devoted several years to the study of existing data and practice. In its 1911 report to the Society, the committee stated that it had divided the work among three subcommittees. By 1912, the membership included Anson Marston, an expert in the soil dynamics field. Under Marston's leadership, the first C04 document, *Memoranda of Recommendations for the Laying of Sewer Pipe*, was

Professor Anson Marston Observing Early Pipe Tests at the Engineering Experiment Station, Ames, Iowa.

appended to the committee's 1914 annual report. In 1915, ASTM accepted these recommendations as a tentative specification designated C 12, Recommended Practice for Laying Sewer Pipe.

Standard C 12 and the many technical standards that followed covered all aspects of in-plant quality control testing, installation, jointing, bearing strength, chemical resistance, and field acceptance testing. Many of these standards were industry firsts in the sewer pipe field and represented major advances in wastewater transmission over the ensuing years. The work of ASTM, through its detailed approval process, and the commitment of vitrified clay pipe manufacturers to providing a long-lasting, durable pipe proved to be just what the cities of an expanding nation needed.

EARLY SEWERS WERE AIDED BY INFILTRATION AND INFLOW

From its inception, the main purpose of a sanitary sewer was to convey sewage from populated areas to drainage ditches or natural watercourses. The practice of treating wastewater would not begin for another 50 years. Early sewers depended upon infiltration and other forms of flushing to clean the sewer and dilute sewage. Storm and sanitary sewers were combined to increase hydraulic flow since the entire system needed to be flushed periodically. Water tanks were often installed along the sewer route and routinely discharged to flush the sewer. Inflow from roof drains, sumps and building drains was permitted by most communities. The number one requirement of the sewer was conveyance. As long as a sewer drained by gravity flow and a light could be seen from one manhole to the next, it was considered acceptable.

Literally thousands of miles of clay pipe were installed by the end of the 19th century and for the next 30 years, the nation's sanitary sewer systems expanded further to include even smaller cities and towns. Dilution was the most cost-effective and practical method of sewage treatment as evidenced by the high infiltration rates that many cities adopted.

In the classic 1935 book, *American Sewerage Practice*, by Metcalf and Eddy, the authors report that "The Nuisance Removal Act of 1855" was passed in England with the following stated purpose: "to prevent rivers and other receivers of sewage from becoming offensive to the eye and nose. If neither of these conveyances could detect anything unpleasant, it was believed that there was no ground for serious complaint against the method of disposal." For many years, dilution continued to be the most economical, the most efficient, and the most commonly used method of treating sewage. As reported in Metcalf and Eddy's book, dilution was used in 99.3 percent of the U.S. cities having a population of 100,000 or more in 1930.

EARLY CLAY PIPES SUPPLIED WITHOUT JOINTS

Of further interest, as we consider the state of the art from its earliest days to about 1950, is the fact that the clay pipe supplied did not have a joint furnished by the pipe manufacturer.

Joints were simply made in the field using hot pour asphalt or cement mortar. These joints, although neither tight nor root-proof, were the standard long before the first wastewater

Early Clay Pipes Were Supplied Without Joints

Top to bottom: Early Hot-Pour Field Joints and Early Cement Mortar Field Joints

treatment plant was built.

WHEN AN ASSET BECAME A LIABILITY

Wastewater treatment changed the way infiltration was viewed. For over 50 years, infiltration and inflow provided the extra water that would help move sewage from the nation's homes and factories, which, at that time, used very small amounts of water. An occasional rain was a natural opportunity to flush the system. With the onset of wastewater treatment in the 1950s, infiltration suddenly became undesirable. The asset that had served so well for so long had become a liability.

CHANGE PRODUCES NEED

It is interesting to note that the need to limit extraneous flow set in motion a series of events that have led to the development of factory-applied compression joints, field air-acceptance testing, and improved pipe bedding systems. ASTM standards were developed for all of these disciplines.

The following needs were either direct or indirect results of limiting infiltration.

Need #1 — The clay pipe industry determined that cement mortar and asphalt-based field jointing methods were no longer appropriate and must be replaced with factory-applied flexible compression joints.

The Response — In the mid-1950s, the clay pipe industry assigned the compression joints project to the staff of the National Clay Pipe Institute. Several years of development followed until the first joints were ready for production. ASTM Committee C04 was at work during this time as well; when the joints were ready to go into production in the late 1950s, the ASTM standard was issued about the same time — C 425, Specification for Vitrified Clay Pipe Joints Using Materials Having Resilient Properties, later to be called Specification for Compression Joints for Vitrified Clay Pipe Joints and Fittings. Today, Sections 7.1.1 and 7.1.2 of this standard state "the joints shall not leak" — a complete reversal from earlier days. In fact, recent infiltration tests sponsored by the U.S. Environmental Protection Agency at the University of Houston reported zero leakage of 30-inch [76 cm] diameter clay pipe joints when tested in straight alignment, angular deflection and shear load. The factory-applied compression joint made it possible to pressure test new lines prior to acceptance, which led to the next need.

Need #2 — The next need was then to develop a line acceptance test, which would give installers and owners an opportunity to determine the tightness and structural integrity of a new line, both during construction and after the line is completely installed.

The Response — In the 1970s, the clay pipe industry sponsored a project led by California consultants Ramseier and Riek that was to become known as the Bay Area Committee on Air Testing. That study led to the first ASTM air test standard for sewer lines, C 828, Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe Sewer Lines (4 – 12 in.), published in 1975. The standard has subsequently been upgraded to include clay pipe diameters from 4 to 48 inches [10 cm to 122 cm]. With compression joints being widely used and air testing becoming common, it was now possible to check the structural integrity of new lines and to isolate and correct field problems. The led to the next need.

Need #3 — The next need was to evaluate, verify and improve bedding systems for vitrified clay pipe.

The Response — The National Clay Pipe Institute began to study problems in the field. As a result of this investigation, NCPI constructed test equipment to test a series of three full-length pipes at one time. The goals were to 1) simulate the field condition in order to duplicate the observed problems, 2) evaluate the bedding materials and bedding systems

Top to bottom: Pipe Bedding Test Equipment and Preparing Microtunneling Pipe for Insertion

that were being used to install clay pipe, and 3) develop new bedding classes with reliable bedding factors.

NCPI went beyond the laboratory to conduct numerous field investigations intended to rate and characterize bedding materials and to develop and verify bedding factors and new installation methods. The findings of this continuing NCPI research were regularly reported to Committee C04, and major improvements were incorporated into ASTM standards. Committee C04 was the first committee to approve a bedding class utilizing controlled low-strength material, sometimes referred to as "flowable fill."

Need #4 — Soon the industry realized the need to manufacture pipe that will last for 100 years or more.

The Response — Chemical and abrasion resistance have long been the attributes that have given clay pipe its long history of performance. But no industry can rest on its laurels. Improved raw material preparation, enhanced processing methods including vacuum de-airing of raw clay, and computerized drying and firing have been implemented. This advanced technology results in a consistently high-quality ceramic product that is longer, stronger, denser and more dimensionally accurate than ever before. Durability issues are addressed in C04 standard C 700, Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.

Need #5 — The last need we'll discuss is the need to make pipes that are versatile enough to meet the technological applications of a modern society.

The Response — Unlike pipeline pressure applications, sanitary sewers function by gravity flow. The pipe must be laid at a continuous downward slope to the point of treatment and ultimate discharge. Traditional installation is by means of an open trench. When new microtunneling equipment became available, the clay pipe industry recognized that the demands on microtunneling pipe could best be met by the qualities inherent in clay pipe.

Vitrified clay pipe has always had extremely high compressive strength, a feature needed to resist the high forces generated as the pipe is jacked through the ground. It must also have a new joint that would be no larger than the outside diameter of the pipe. To meet this need, the industry produced a completely new clay pipe for microtunneling applications.

As with so many other developments, ASTM approved the nation's first standard for microtunneling pipe. Later, other applications came along, such as pipe bursting and pilot tube boring. ASTM C 1208, Specification for Vitrified Clay Pipe and Joints for Use in Microtunneling, Sliplining, Pipe Bursting, and Tunnels, was the first ASTM standard explicitly approved for these applications.

100 YEARS IS ONLY THE BEGINNING

We must never forget the qualities that have been the bench marks of the efforts by the clay pipe industry working with ASTM. The durability of a ceramic material that results from its corrosion resistance and extended life will carry the industry forward as communities recognize that long-term performance is a desirable commodity in a disposable age. So whether we are looking at a product that has a demonstrated life of 100 years or a relationship with ASTM that has been mutually beneficial for 100 years, builders and users are beginning to realize that 100 years is not the whole story — it is only the beginning. //

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