

American **Concrete Pipe** Association

Transmitting Important Information
to the Engineering Community

**ABRASION A CONCERN
IN FIBER CEMENT PIPE**

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ABRASION A CONCERN IN FIBER CEMENT PIPE

Durability is the capability of pipe to continue to perform satisfactorily for an economically acceptable period of time. This is significant in the pipe's ability to perform intended structural and hydraulic functions.

Precast concrete pipe has a long history of excellent durability as a storm drainage pipe. This is due in some part to the fact that precast concrete pipe is typically buried in a non-aggressive environment where temperatures have very little variations and atmospheric exposure is either not present or greatly reduced.

Also, the concrete in precast concrete pipe is of exceptionally high quality. All raw materials and manufacturing processes undergo stringent quality control procedures. Furthermore, a low water-cement ratio is an inherent characteristic of precast concrete pipe, generally resulting in greater durability and strength than cast-in-place concrete.

Traditionally, there are several physical and chemical characteristics which can be aggressive to concrete pipe and which collectively account for practically all of the durability problems that can be encountered in traditional applications of the product. These factors include acids, sulfates, chlorides and velocity-abrasion.

Velocity, by itself does not create problems for concrete pipe within the ranges normally encountered. At velocities of 40 feet per second, or greater, cavitation effects can be serious unless the surface is smooth and internal offsets at joints are closely controlled. Within the range of velocities up to 40 feet per second, the severity of velocity-abrasion effects depends upon the characteristics of the bed load.

A bed load is the quantity of solids being moved through the pipe by the flow velocity. Bed loads may be intermittent or continuous and vary in particle size, hardness and specific gravity. This is usually more of an engineering flow problem than a question of pipe abrasion, particularly in a sanitary or storm sewer system, and can normally be controlled by proper design.

The abrasion durability of precast concrete pipe is well known when compared to that of corrugated metal pipe. In fact, an Ohio Department Of Transportation study, *The Ohio Culvert Durability Study*, analyzed in the American Concrete Pipe Association's *Buried Facts: Culvert Durability Study, Review and Implementation* has documented the performance of concrete pipe and corrugated metal pipe throughout the

state of Ohio over many years when subjected to abrasion and corrosion. Over 90 % of the concrete pipe surveyed in the *Ohio Culvert Durability Study* was rated as good or higher, including pipe manufactured before 1940. The same study rated only 71.4 % of the corrugated metal pipe as good or higher.

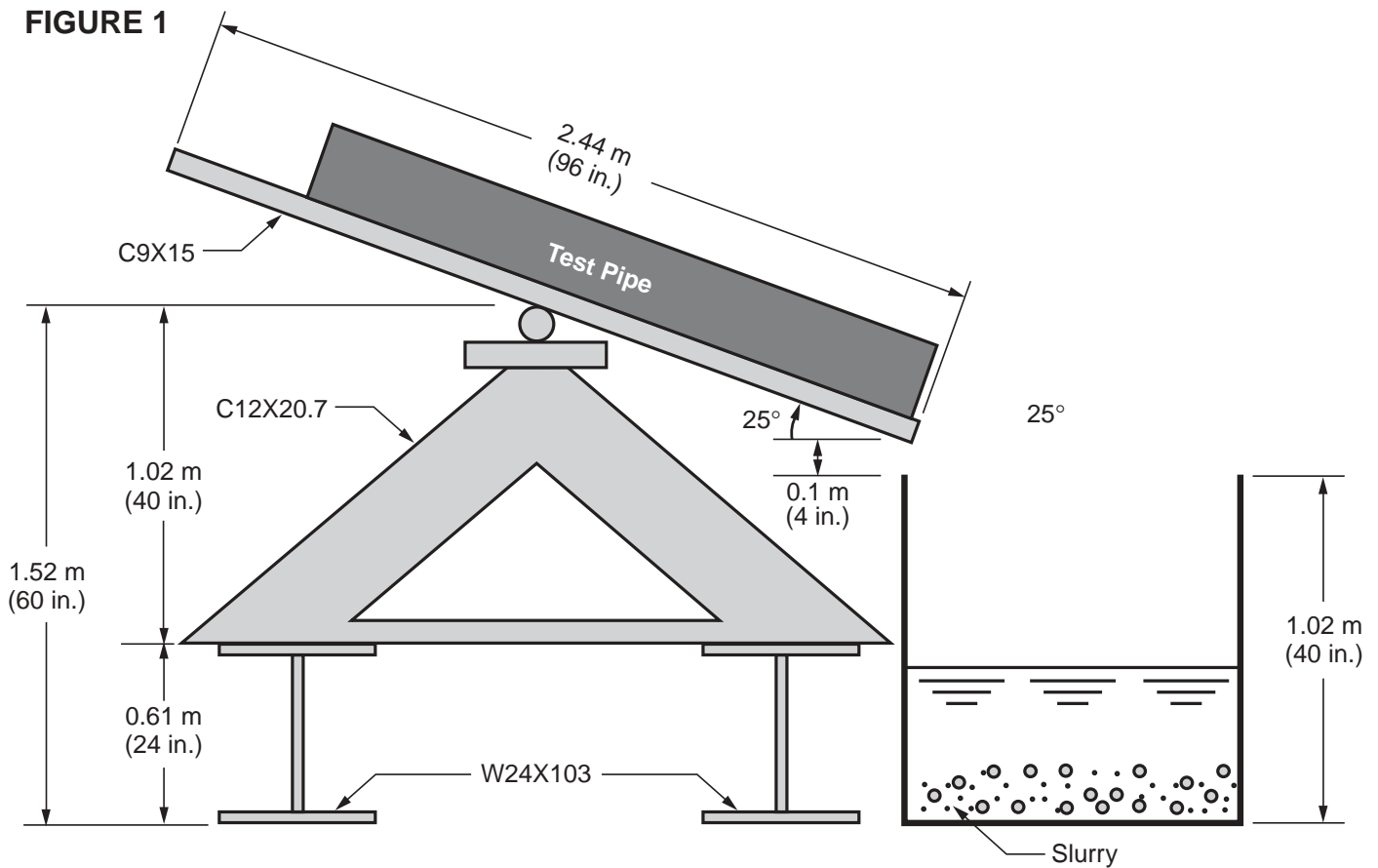
As new drainage pipe products converge on the North American drainage markets, it is important to continue to conduct research to evaluate the abrasion performance of new and existing pipe. Because of this, the American Concrete Pipe Association commissioned the University of Texas at Arlington to conduct tests of the abrasion of one new product, cellulose fiber cement pipe (cfcp) in comparison to the performance of precast steel reinforced concrete pipe (rcp). Based on the test results, the study concluded that the abrasion of cellulose fiber reinforced cement pipe is significantly higher than that of steel reinforced concrete pipe under similar circumstances.

Many researchers have investigated the abrasion characteristics of precast concrete pipe and competitive products to prove their abrasion capacities. Typically, rocking abrasion and rotating abrasion tests have been utilized to perform those tests.

A rocking motion abrasion test has been used to investigate various pipes, including asbestos cement and steel reinforced concrete pipe to determine abrasion characteristics. The rocking motion test utilizes a length of pipe rocked back and forth by a rocking apparatus. This results in a test with a high degree of accuracy and reproducibility. However, the test method does not simulate actual field conditions because water and aggregates do not move in a rocking motion in typical drainage pipe installations.

A rotating abrasion test has also been used to test the abrasion resistance of drainage pipe. This test utilizes a laboratory ball mill to rotate pipes containing slurry. The abrasive medium remains essentially at the bottom of the revolving pipe. The abrasion path was circumferential rather than longitudinal. One such study showed a loss of wall thickness of the cellulose fiber cement pipe to be 7.6 times that of precast concrete pipe.

In the research conducted by the University of Texas at Arlington, abrasion testing was performed by simulating actual service conditions of the pipe. This test method consisted of pumping a slurry composed of aggregates and water longitudinally through the pipe as shown in Figure 1.



The advantage of the slurry pumping test was that it best simulated actual service conditions of drainage pipe.

The test setup consisted of the main frame, sewage/trash pump and slurry tank shown in Figure 1. The main frame was used to support the pipes, while the sewage/trash pump was used to transport the slurry from the slurry tank through the connecting

plastic hoses.

The slurry having 10 mm (3/8 in.) crushed aggregates, fine sands and water was stored in the slurry tank. One cycle was identified by the pumping of slurry through the pipe and returning to the slurry tank.

While the aggregates in the tank were one important factor in the abrasion of the pipe, so is the velocity of the slurry pumped through pipe when conducting the test. The average velocity in the pipe was 3.68 m/sec (12.07 ft./sec) for the cellulose fiber cement pipe and 4.05 m/sec (13.28 ft./sec) for the precast concrete pipe. While these velocities are slightly greater than most service conditions of drainage pipe, they provide adequate values for comparing the two materials.

The loss of pipe wall due to abrasion was measured by drilling five holes at equal intervals along the longitudinal axis of the pipe. Reduction of wall thickness was measured by a digi-met depth gage every day over a period of thirty days. Each measurement was conducted three times at each hole to verify the repeatability of measurements. The average of the three measurements was calculated for each hole.

In the study, the cellulose-fiber cement

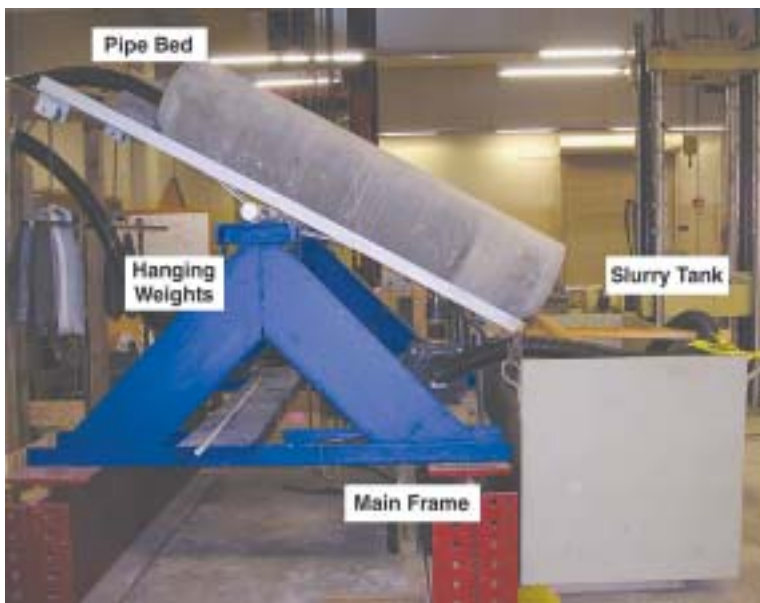
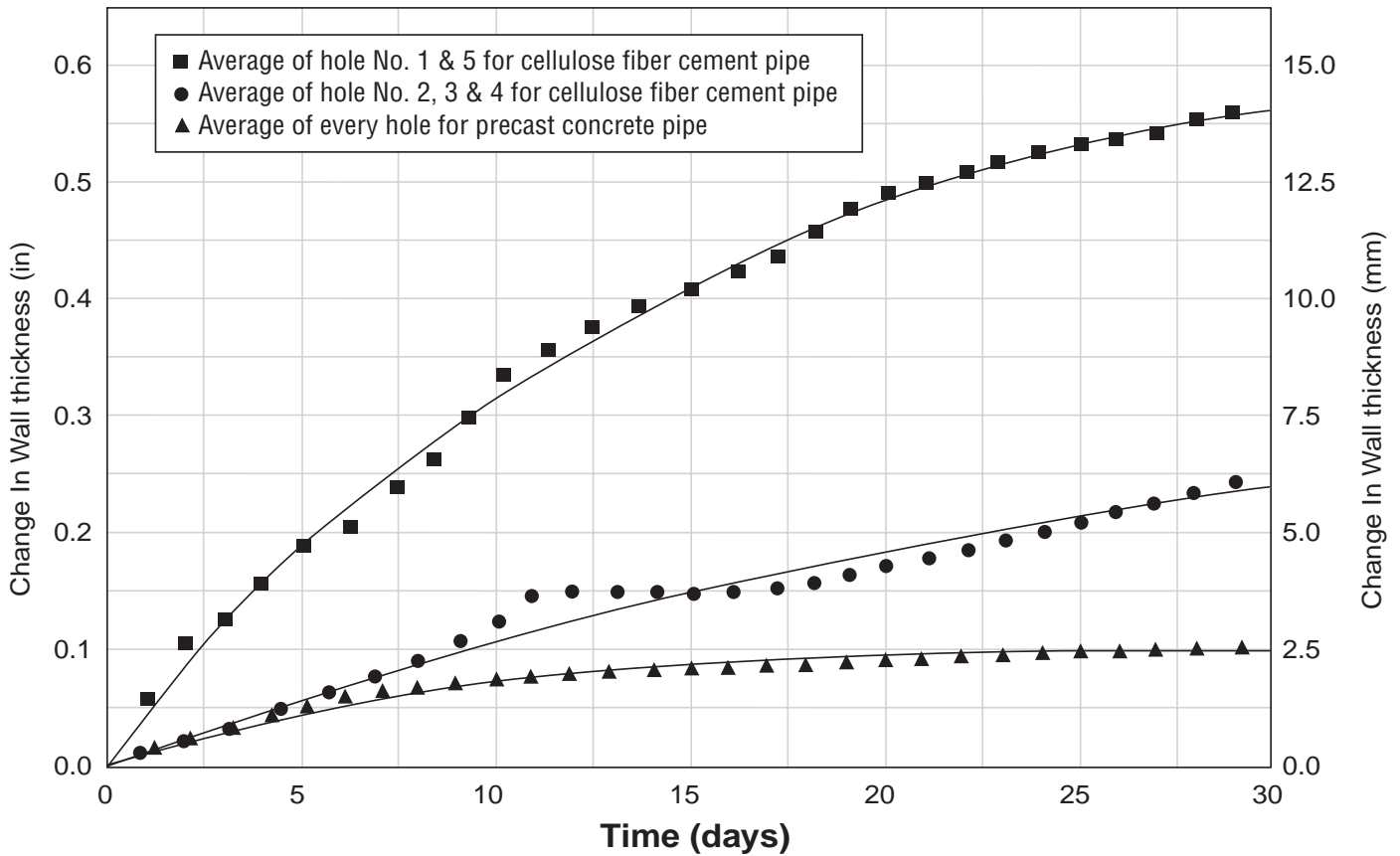


Photo of Lateral View of Abrasion Test Apparatus

pipe showed considerable reduction in wall thickness during the test period. The precast concrete pipe showed a substantially less reduction in wall thickness. For the hole at the down stream end of the pipe, **the cellulose fiber cement pipe lost 12 mm (0.47 in.) over a 30 day period, 4.8 times that of precast concrete pipe 2.5 mm (0.10 in.)**. The following graph shows comparisons of reductions in wall thicknesses for the two pipes:

created on the surface of inner wall of cellulose fiber cement pipe. These results may produce a rupture of the pipe when the pipe strength meets the maximum design loads. Consequently, the abrasion resistance of precast concrete pipe is higher than that of cellulose fiber cement pipe for drainage applications regardless of the improvement of mechanical properties for cellulose fiber cement pipe.”

Why rely on a drainage product with suspect me-



In conclusion, the University of Texas Abrasion Study states, “In this study, the wall thickness of cellulose fiber cement pipe showed a greater loss than that of precast concrete pipe for the test duration. It was also displayed that the deep abrasion path was

chanical properties and brief history of performance? When specifying your next drainage project, go with the proven performer with a service life of 100 years – **COUNT ON CONCRETE.**

For more information on the durability of precast concrete pipe or to learn more about the referenced abrasion study, contact the American Concrete Pipe Association at www.concrete-pipe.org.



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