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Evaluation of a 60-year old Iron Pipeline in a Corrosive Environment and Flow Test of a 97-year old Cement-mortar Lined Iron Pipeline

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ABSTRACT

This paper details the direct assessments of two historic iron pipelines that were the first to be supplemented to control corrosion internally (in 1922 using a cement-mortar lining) and externally (in 1958 using tightly wrapped polyethylene encasement). We will discuss the methods of control, how the two pipelines were evaluated, and how this ongoing contribution of knowledge has resulted in improvements and innovations in corrosion control for modern Ductile iron water and wastewater pipelines.

In 2019, a flow test was conducted by an independent contractor on a 97-year-old cement-mortar lined iron pipe in Charleston, SC. This pipeline is one of many that have been evaluated over the years to measure the hydraulic character and assess the longevity of the lining. The test enabled the calculation of the Hazen-Williams C value, which provides a definitive evaluation of the condition of the lining.

A second pipeline was installed in Lafourche Parish, LA in 1958. This was the first iron pipeline to be supplemented with corrosion control using a tightly wrapped encasement of polyethylene film in an uncommonly aggressive soil environment. Having been examined at different locations over the years, this describes the procedures and results of the most recent evaluations after 60 years of service.

Key words: iron pipe, ductile iron pipe, polyethylene encasement, cement-mortar lining, internal corrosion, external corrosion, water pipeline, case study

INTRODUCTION

In cast and ductile iron water and wastewater pipelines, the most often used methods of corrosion control have been polyethylene encasement in accordance with ANSI¹/AWWA² C105/A21.5³ to mitigate external corrosion and a cement-mortar lining in accordance with ANSI/AWWA C104/A21.4⁴. Both systems have long histories of performance in service but have sometimes been the subject of controversy for technical and competitive reasons. Both systems have been evaluated numerous times through field evaluations such as examination of in-service polyethylene encased iron pipelines or flow tests of in-service water pipelines throughout the United States and Canada.

Pipelines don't last forever in service, but today, the first pipeline to employ polyethylene encasement to control external corrosion and the first pipeline to install cement-mortar linings to control internal corrosion in a water main are both still available for study.

In 2018 the Ductile Iron Pipe Research Associationⁱ ("DIPRA") continued with its regular evaluations of the condition of the first polyethylene encased iron pipeline in the Lafourche Parish Water District No 1 system. Installed in 1958, this pipeline has been examined on five-year intervals dating back to the 1980s. Installed in an extremely aggressive soil, this ongoing program of evaluation is an excellent example of the efficacy of polyethylene encasement in the control of external galvanic corrosion for ductile iron pipe.

In 2019, through cooperation with the Charleston Water System, DIPRA contracted with M.E. Simpson Co. to conduct a flow test on an 8-inch cast iron pipeline installed in 1922 in Charleston, SC. This pipeline was the first iron pipeline to be provided with a cement-mortar lining that was intended to protect the pipe from internal tuberculation of the iron.

The results of these two field investigations will add to the growing knowledge base of internal and external corrosion control for ductile iron water and wastewater mains.

INVESTIGATION OF POLYETHYLENE ENCASED 4-INCH CAST IRON WATER MAIN INSTALLED IN 1958 IN LAFOURCH PARISH, LA

The evaluation of the 60-year old 4-inch iron water main was accomplished in cooperation with the Lafourche Parish Water District No. 1 (LPWD). The pipeline was originally designed to provide service to a small development along Delta Farms Road in Lafourche Parish. At the time, the water district knew of the corrosive nature of the soils and had been consulting with the iron pipe industry about corrosion control. DIPRA, then the Cast Iron Pipe Research Association (CIPRA), had been conducting research in several test sites regarding polyethylene encasement in the protection of the bolts in mechanical joints in cast iron pipelines. In that research, begun in 1952, specimens showed success in protecting the bolts, but also the pipe. In cooperation with LPWD, it was decided to encase the Delta Farms Road pipeline. Steps were taken to inspect the installation to ensure the pipeline was properly encased. Subsequently, DIPRA has been able to examine the pipeline nine times beginning in 1972 at different locations over the years to

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see if the encasement continues to protect the pipe. Beginning in 1990, DIPRA has conducted these investigations on 5-year intervals due to its historic status and the very aggressive soils into which the pipeline was installed. There have never been any failures of the pipeline, so there are no critical sections that would require examination at a specific location. The entire pipeline is in aggressive soils and installed with polyethylene encasement. Figure 1 shows an overhead view of the two locations the pipe was examined. Locations were selected by the utility, primarily for convenience of access. All of the investigations we have done over the years follow the same general procedure, as described herein.



Figure 1: Overhead view showing the two locations the pipe was examined in 2018. Locations are selected by the water district who conduct the excavation of the pipe.

In the 2018 investigation, the crews of the LPWD exposed the pipeline at two locations along Delta Farms Road. Removing the overburden involved the use of a backhoe to just above the pipeline, followed by hand digging to uncover the remainder of the main with minimal damage to the polyethylene film. Pumps were used to help keep the water table at manageable levels during the investigation.

Some five-feet of the pipeline was exposed at both locations. Prior to removal of the encasement, at each end of the exposed pipe wraps of tape were installed to facilitate the rewrapping of the pipe upon completion of the investigation. The film was then removed with photographs taken to provide visual records of the various steps in the process. The film was sent to a laboratory so that physical tests could be conducted. The soil was sampled and tested for its corrosive character. The exposed pipe was then

cleaned using a wire brush and water and then thoroughly sounded using a welder's hammer to identify any areas of the pipe surface that had experienced graphitic corrosion. Once completed, the pipe was encased using an enhanced polyethylene prior to backfilling the pipe.

OBSERVATIONS:

These results indicate an extremely aggressive soil environment and provide an excellent indication of the limits of the protection provided by polyethylene encasement. In Figure 2, the soil has been removed from around the pipe at the first excavation location. The outside of the pipe has not been cleaned at this point. Note the pump line used to keep the water in the excavation at a manageable level.



Figure 2: The exposed pipe prior to removal of the polyethylene film. Regular pumping controlled the inflow of groundwater from the surrounding soils.

The polyethylene was a clear low-density polyethylene film that was applied to the pipe as a sheet that was tightly wrapped around the pipe barrel, with another sheet used to encase the joint. The only noted damage to the film resulted from contact with the shovel used to remove the soil from directly around the pipe.

Prior to removal of the film from the pipe, the ends of the exposed pipe were provided with several wraps of tape to keep the film in place and to provide adequate overlap when the pipe is encased in new film prior to backfilling. The film was then removed from the section of the pipe to be investigated and was packaged for shipment to a laboratory where the tensile strength of the material in both the machine and transverse directions and the material thickness were measured. The exposed pipe presented evidence of oxidation of the pipe surface (Figure 3). Once the film was removed, the surface of the

exposed pipe was thoroughly cleaned using a wire brush and water. This effort resulted in removal of the oxidation, which proved to be superficial (Figure 4).



Figure 3: The film was removed from the pipe prior to shipment to laboratory for physical testing. Oxidation is visible on the surface of the pipe prior to cleaning.

After cleaning of the pipe, the surface was sounded using a welder's hammer to determine if there were any locations where graphitic corrosion had occurred. There was no pitting found on the surface of the pipe.



Figure 4: The surface of the exposed pipe has been cleaned using a wire brush and water. The oxidation was removed and found to be superficial.