Perspective on Prestressed Concrete Cylinder Pipe

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1. Introduction

Prestressed Concrete Cylinder Pipe, or PCCP, is widely used throughout the world. In the U S and Canada there is an estimated 30,000 miles of this product installed There are no known estimates for the remainder of the world, but we do know it is used in every continent. The newest plants in the world were constructed in Mainland China in the last five years.

The author's own experience with PCCP goes back twenty years. Initially I was content to see PCCP from a design manager's perspective, and noted that it competed well when it was one of several materials options in aqueduct specifications. It was a favorite among operation and maintenance personnel because it required no internal coating.

In January 1990, I began a crash course in PCCP, for it was in that month that my agency discovered severe distress (but not catastrophic rupture) in several pipelines constructed on 21-foot diameter PCCP. Those facilities had been constructed in 1977-78 with much fanfare, because they were (and still are) the world's largest PCCP. In 12 years they had deteriorated to a state of incipient rupture. In the 5 wears that followed, I participated in a very intensive and comprehensive review of the problems associated with PCCP. In the 5 years since then, I have been involved in PCCP investigations, repairs, and diagnostic testing. I am pleased to share my experiences with the audience.

2. PCCP in Review

PCCP was introduced during World War II in an effort to minimize the use of steel. By the 1960's its use was widespread. The American Water Works Association maintains the standard for PCCP in its Standard C 301 (manufacture) and Standard C304 (design). Many improvements have been incorporated into the manufacture of the product over the years.

In engineering terms, the PCCP structure is very efficient. It makes effective use of the compressive strength of concrete. PCCP incorporates the use of very high strength reinforcing steel, usually referred to as prestressing steel, and uses it very efficiently. It is manufactured in diameters from 18 inches to the 21-footer mentioned previously, however diameters above 14 feet are rare. It is used wherever people need to convey water under pressure raw water pipelines, force main sewers, industrial cooling systems, and others.

3. How does PCCP Fail?

As we will see in a moment, there are many reasons why a PCCP pipeline can fail. Usually there is a breakdown in the protection afforded by the mortar. In many cases, the inherent durability of PCCP will keep deterioration from going very far or very fast. Although corrosion or deterioration

of a strand of prestressing wire may cause that wire to break, a single broken wire is not significant. In some cases, it sets in motion a process of deterioration goes through several easily--recognized phases which usually takes years before a pipeline ruptures.

4. Why does PCCP Fail?

Some of the PCCP competitors would have us believe that a PCCP rupture is simply due to a bad product. Although there are instances where the manufacturer has been found at faults, there are myriad of reasons why PCCP fails. The fault may lie with
o the engineer - for deficiencies in the design
o the pipe manufacturer- for defects in the pipe itself
o the prime contractor, for defects in materials or workmanship
o the construction managers for failure to detect improper work on the project

or perhaps all the above depending on the results of failure investigation and on the contractual relationships for this particular pipeline. Oh yes, there is one more key player: the owners/operator. On more than one occasion a pipe owner has commissioned a comprehensive failure investigation, only to be told the problem is largely the result of actions (or inaction) by the pipeline owner.

5. The Class 4 Wire Issue

The so-called Interpace Class 4 wire issue has been a nightmare for the PCCP industry. The issue was the result of wire manufacture's efforts to get a little more efficiency from the prestressing wire in the late 1970's and early 1980's. There were some indicators that the high strengths achieved were accompanied by poor performance. It was a more common position that wire could no more be too strong than a person can be too rich. If only it could have been limited to Interpace, but unfortunately it was not. The problem has largely been eradicated at present.

6. The Future of PCCP

Recent advances in non-destructive testing of PCCP have enabled a much better maintenance program than was available previously. As was mentioned previously, the process of PCCP deterioration takes years. Fortunately this allows time for a diligent pipeline owner to find this deterioration. The successful new technologies are passive acoustic emission, and remote field eddy current. The pipeline owner is now able to make spot repairs of detected distress pipes using repair methods which did not exist ten years ago. In the next century, the life expectancy of PCCP will follow the same route that human life expectancy has in the past century: it will double.

If you have any questions, please contact **Dr. C.Vipulanandan**