TECH TIPS
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STRUCTURAL REHABILITATION OF MANHOLES

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According to published reports, it is estimated that there are over 20 million manholes in the USA and many of them have reached or exceeded their expected service life. Manholes are an important component of a sewer system and can be a significant source of infiltration and inflow (I&I). Experience to date suggests a sewer rehabilitation program excluding manholes will not adequately address I&I issues. On the other hand, ongoing deterioration of manholes can result in catastrophic failure due to loss of structural integrity and failures in deep manholes can easily reach seven figures in repair costs.

Replacement efforts after a deep, collapsed manhole.

Many utilities in North America and around the globe invest in rehabilitation of their manholes to improve overall sewer system performance by reducing extraneous flows into treatment facilities, prevent catastrophic failures, and as a good asset management practice, to increase the value of an important system asset.

As manhole rehabilitation has become more common over the years, more information is now available on design, material selection, installation, and quality assurance. NASSCO's Manhole Assessment Certification Program (MACP™) is a comprehensive, systematic approach for inspection. Following collection of field data using MACP methods, it is important to utilize them to maximum extent when taking on a manhole rehabilitation project.

First, the owner needs to set the goal of manhole rehabilitation, which can be one of the following:

1. I&I reduction only
2. Structural improvement only
3. I&I reduction and structural improvement

Although there is often a correlation between I&I and structural integrity, it is possible that a manhole can be intact and yet still be a source of significant I&I. It is also important to note that these conditions are usually related and can exacerbate each other. For instance, structural integrity of a manhole can be compromised due to I&I washing away surrounding soil, or cracks and gaps present due to structural issues, resulting in more rain and groundwater entry.

As a part of a United States Environmental Protection Agency (EPA) sponsored project (through then Water Environment Research Foundation), a diverse team led by the author investigated the structural capabilities of manhole rehabilitation methods with respect to the second and third goals listed above. The project lasted for approximately two years and included an expert workshop, a comprehensive testing protocol with various materials and methods, case study gathering, and computational modeling with the finite element method. Several publications are available that covered the details of the project including the main report (available at Water Research Foundation's website: www.waterrf.org). The USEPA/WRF study classifies manhole rehabilitation materials and methods into three categories, which is a simplified version of AWWA Classification of water main rehabilitation methods:

<u>Class A Rehabilitation Materials:</u> Manhole rehabilitation methods that provide fully structural solutions in addition to stopping I&I.

<u>Class B Rehabilitation Materials:</u> Manhole rehabilitation methods that are semi-structural. These methods can add to the residual strength of a deteriorated manhole, but they are not capable of withstanding the dead and live loads (e.g., traffic) exerted on a manhole by themselves. However, on a manhole at average depth (8-10 feet), Class B rehabilitation can withstand hydrostatic pressure from groundwater exerted directly on it through a hole in the existing manhole.

<u>Class C Rehabilitation Materials:</u> Manhole rehabilitation methods and materials that are non-structural. The purpose of using Class C rehabilitation materials is to provide preemptive protection against corrosion for manholes that are in relatively good condition and to stop leaks into the manhole.

While Class A rehabilitation is the only one that will serve as a replacement to an existing manhole, it is important to note that on average, a Class A system will cost five to six times more than Class C, and the cost of Class B rehabilitation will fall somewhere in between. As such, it is quite important to set the goal of manhole rehabilitation, and then evaluate available technologies. Some common rehabilitation methods based on their structural class are as follows:

- Class A rehab methods include prefab inserts (e.g., fiberglass, polymer concrete), steel reinforced concrete (this is essentially reconstructing a manhole inside a manhole), fiber reinforced polymers (can be carbon or glass fiber reinforced polymer applied with the wet layup method or a combination of both), spray applied or centrifugally cast special cement products and geopolymer. It is important to note that any cementitious material used should provide data on resistance against hydrogen sulfide induced corrosion or be applied with a polymeric layer on top.
- Class B rehabilitation methods include spray applied polymeric linings (epoxy, polyurethane, etc.), cured-in-place manhole liners (CIMPL), cementitious and geopolymer linings, and FRP. One can note that cementitious (or geopolymer) linings as well as FRP linings can be designed to be Class A or B. Theoretically, polymeric (spray-on) linings can be applied as Class A, but the thicknesses required for such applications can be prohibitive from the cost and applicability standpoint, in addition to lack of data on evaluating these systems as a stand-alone structure.
- Class C rehab methods include thin-applied non-reinforced polymeric as well cementitious linings, and materials and methods used to mainly stop inflow (and to some extent, infiltration) through the top part (cone, chimney, and cover) of manholes. Those products include elastomeric (rubber) joint seals, flexible and trowel applied chimney seals, and inflow "dishes" inserted below the cover.

More information about these technologies can be explored by contacting manufacturers and reading publications such as the aforementioned EPA/WERF report, NASSCO Manual of Practice, and the soon to-be-published fact sheet by the Water Environment Federation (WEF).

Reference
Najafi, M., and V. F. Sever. 2015. Structural Capabilities of No-Dig Manhole Rehabilitation. Project INFR1R12/1446. Alexandria, VA: Water Environment Research Foundation.