NATIONAL CLAY PIPE INSTITUTE
The VCP Authority Since 1917

Vitrified Clay Pipe Verses Reinforced Concrete Pipe for use in Gravity Sanitary Sewer Applications

Vitrified Clay Pipe (VCP) and Reinforced Concrete Pipe (RCP) have been utilized for storm and wastewater collection in the United States since the early 1800's. The first RCP line was installed in Mohawk, NY in 1842[1] and the first VCP sewer was installed in Washington, DC in 1815. Although RCP and VCP are both rigid conduits with inherent strength built into the pipe, there are some noticeable differences when used in a gravity sanitary sewer system.

Sanitary Sewers

Unlike storm water collection systems, the conditions in sanitary sewers frequently support the creation of hydrogen sulfide gas. Sulfides are generated in the slime layer which forms between the sewer pipe and the flowing sewage. The sulfides form hydrogen sulfide gas which first diffuses into the sewage and then, unless destroyed or neutralized, escapes into the sewer atmosphere. The sulfuric acid collects on the exposed arch of the pipe and begins a chemical attack unless the pipe material is chemically inert and invulnerable to corrosive acid action.

Material

Vitrified Clay Pipe (VCP) is made from a blend of clay and shale that has been vacuum extruded and kiln fired to temperatures approaching 2,000° F to achieve vitrification. This results in a pipe body that is chemically inert, has an average compressive strength of 18,000 psi, and is extremely abrasion resistant.

Reinforced Concrete Pipe (RCP) is made by pouring a composite cementitious material into a mold that includes steel reinforcement. RCP has an average compressive strength ranging from 4,000 to 6,000 psi.[2]

Three-edge bearing strengths for 24-inch Extra Strength (ES) VCP and Class IV RCP are 4,400 lbs./ LF and 4,000 lbs./ LF, respectively.[3,4]

Corrosion Resiliency

VCP is chemically inert and will not deteriorate from hydrogen sulfide gas, sulfuric acid, or other chemicals that may be present in a sanitary sewer. VCP is subject to corrosive attack only by hydrofluoric acid (HF) and concentrated caustics at high temperatures. Vitrified clay reliably conveys the widest range of materials the community, commercial or industrial sites can discharge into it. It will not rust, shrink, elongate, bend, deflect, corrode, oxidize, or deteriorate. VCP is used in many applications where aggressive effluent must be carried.

RCP may be subject to deterioration from various conditions, including attack from hydrogen sulfide gases present in a gravity sanitary sewer. The sulfuric acid above the flow line weakens concrete through two different mechanisms. The acid first reacts with the calcium in the concrete and allows it to be removed in the solution. Secondly, the sulfates in the sulfuric acid react with calcium hydroxide, displacing the calcium hydroxide with gypsum, which is an expansive material with virtually no strength. The structure of the concrete is deteriorated by both actions. Other threats to RCP include corrosive

soils, sulfate disruption, velocity abrasion of the concrete, and chloride corrosion of the reinforcing steel.[5]

Repair and Maintenance

Because of VCP's hardness (8-9 on the Mohs scale) and abrasion resistance qualities, it can be cleaned by all mechanical cleaning methods as well as high pressure (5,000 psi) water jetting methods. ASTM C1920 "Standard for Cleaning of Vitrified Clay Sanitary Sewer Pipelines" details the appropriate cleaning of vitrified clay pipelines. There is no similar ASTM standard for RCP.

In the unlikely event that a repair needs to be performed, VCP will accept all current repair technologies. RCP can also accept current technologies, but if a crack or defect allows chlorines or sulfides to contact the reinforcement wire or bar, the reinforcement must be treated or removed to prevent the spread of corrosion within the pipe wall.

Service life

Two research papers examined the effective service life of rigid sewer pipes. The studies analyzed pipe in both Europe and in North America using data collected from CCTV, installation methods, deterioration, soil corrosivity, live loads, etc. Both studies concluded that Vitrified Clay Pipe's service life was *non-age* dependent. RCP's service life was found to be age-dependent because of its susceptibility to corrosion attacks from soils, chlorides, and hydrogen sulfide gas.[6,7] Similarly, The Los Angeles County Sanitation Pipe Corrosion Study determined that Concrete sewer pipe loses on average 1/10 of an inch of material above the waterline annually.[8]

Conclusion

VCP and RCP are quality pipe products that can provide exceptional service life. However, the corrosion resistance of VCP makes it the preferred material for use in gravity sanitary sewers.

Sources:

1- https://www.concretepipe.org/wp-content/uploads/2015/04/techmod1-historical-overview.pdf
2- www.rinkerpipe.com
3- ASTM C700 *Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated*
4- ASTM C76 *Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe*
5- *Dude, Where's My Pipe – Accelerated Corrosion Rate Threatens Phoenix Sewers*; Ronald L. Ablin, Paul Kinshella. Proceedings of the Water Environment Federation; WEFTEC 2003
6- *Damages in vitrified clay sewers in service for 130–142 years*; Emilia Kuliczkowska, Andrzej Kuliczkowski, Anna Parka, 2022
7- *A probability model for investigating the trend of structural deterioration of wastewater pipelines;* Rizwan Younis, Mark A. Knight, 2010
8- Cement & Concrete Research; R. E. Melchers, T. Wells; Los Angeles County Sanitation District, 2014