Trenchless innovations for Cape Town

Innovative trenchless design and methodology, coupled with the ability to adapt to changing circumstances, defined the project for the rehabilitation and upgrading of the Sandrift Bulk Sewer, which won the 2018 Joop van Wamelen Award of Excellence.

Following minor collapses between 2003 and 2006, and subsequent condition assessments, it was recommended that sections of the Sandrift Bulk Sewer (SBS), located just upstream of Montague Gardens in Cape Town, be closely monitored and rehabilitated. Upon further investigation, it was found that a number of sections of the over-four-decade-old sewer were significantly degraded and in need of rehabilitation. Furthermore, the new Bridgeway Sewage Pump Station rising mains from Century City, which will discharge halfway down the existing 2 km SBS route, is expected to reach a peak discharge of 150 L/s in the next 10 to 15 years, adding to the SBS’s already large catchment area, and flow. This increase in flow would exceed the future estimated peak wet weather flow capacity of the existing SBS, necessitating an upgrade downstream of this discharge point. The upstream section has enough hydraulic capacity to allow for trenchless rehabilitation.

The rehabilitation challenge

The existing sewer consisted of reinforced concrete pipes with timberlag and sacrificial lining. However, due to variations in sewerage rising mains of neighbouring catchments discharging at a constant flow into the upstream section of the bulk of the SBS, the sewer has been subjected to severe corrosion above the water line (only) into a non-circular/near-mushroom shape. “Corrosion of the alkaline concrete sewer pipes occur when accumulated hydrogen sulfide gas in the effluent is released by turbulent flows or discharges to condensate on non-submerged sewer pipe walls to form corrosive sulfuric acid. In certain sections, the sewer had corroded right through the pipe springline to reveal external encasement concrete,” explains Ronald Roës, associate engineer, Accorn.

As the consulting engineers, Accorn concluded that the section of the sewer upstream of the Bridgeway rising mains would have just enough capacity to allow for the increased future flow estimates, and determined that the installation of a close-fit inverted or pull-in cured-in-place pipe (CIPP) rehabilitation lining in the existing SBS was the only viable trenchless solution.

However, the mushroom shape of the existing sewer presented a significant design challenge and Accorn needed to design a 3D computer-aided finite element model (FEM), modeling the expected mushroom-shaped cross-section profile and constraints of the expected liner within the rehabilitation point.

The ASTM 1216: Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Invention and Curing of a Resin-Impregnated Tube: design code only accommodates for circular linings with an allowance for ovality of up to 10%. The mushroom shape of the corroded sewer was not only expected to exceed this tolerance, but also to have a negative indentation/curvature around the corroded portion above the constant discharge flow level. This would be compounded by the high water table exerting external pressure on the liner. Moreover, the inner diameter of the existing sewer was expected to vary significantly along its length due to the severe and potentially varied corrosion conditions.

The solution

Using the 3D computer-aided FEM analysis, Accorn was able to explore resin and liner options, applying a realistic and calibrated set of ASTM 1216 design code parameters. The team found that adding an additional calibrated safety factor (increasing the liner wall thickness by an additional 20%) could be applied to accommodate for the non-circular shape of the sewer.

In order to mitigate variances in diameter along the corroded sewer length, the appointed contractor, CSV Construction, supported by Tubo SEAL and Accorn, selected an un-reinforced flat liner with a diameter slightly above the average of the actual measured diameters of the existing corroded pipes.

Due to severe corrosion, the existing sewer had become a mushroom shape, presenting significant design challenges.

To increase the incline, ribs were welded to the liner to improve it to increased cumulative eccentricities.

To fully meet the requirements of the project, it was proposed that a mudline be added to prevent the flat liner from moving and adjusting to the mushroom-shaped section.

The un-reinforced liner was able to allow a 5% to 10% stretch to ensure a close fit of the liner around the circumference of the existing pipe. Where the existing pipe was smaller than the liner circumference, longitudinal crescent cuts perpendicular to the pipe circumference could potentially form; however, it was expected that well-crafted, re-settled crescent cuts could cure into structural webs – ultimately adding to the structural stiffness of the cured liner.

Roës further explains that this was preferable to a non-close-fit lining, which could result in an uneven insert of the pipe due to sections of the liner potentially becoming buoyant from ingress ground water pressure, which would in turn negatively affect the

The robbed pipe was divided into 3 m long sections and tunneled into a bored excavation.

PROJECT TEAM

Client: City of Cape Town
Consulting engineer: Accorn
Contractor: CSV Construction
Subcontractor: Tubo SEAL

JOOP VAN WAMELSEN AWARD

Every year, the Southern African Society for Trenchless Technology (SASTT) awards the Joop van Wamelen Award of Excellence to a leading project team in recognition of exceptional contributions to the active promotion and implementation of trenchless technology in Southern Africa.

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