TRENCHLESS NEWS

SASST's Joop van Wamelen Award of Excellence was won by a team comprising consulting engineering firm AECOM and contractor CSV Construction for their precision use of micro-tunnelling technology for the construction of Phase 2 of the Cape Flats 3 Bulk Sewer

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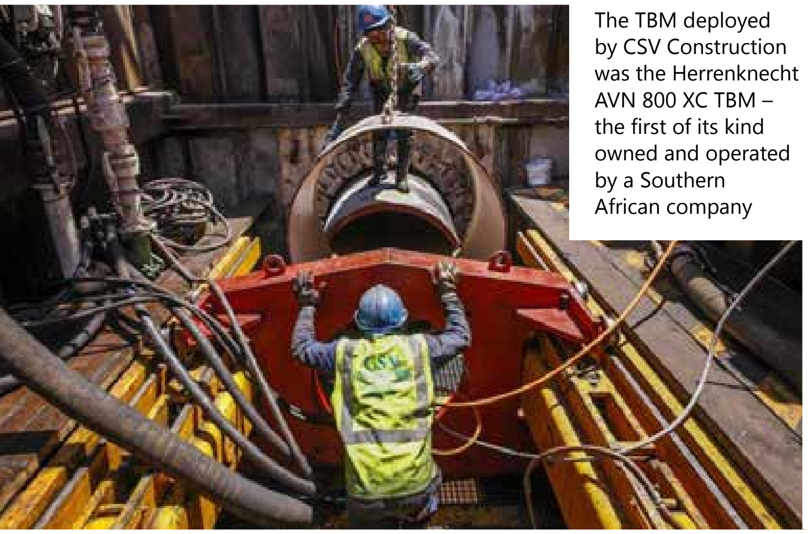
Cape Flats sewer upgrade takes top award

A TBM was used to cut and remove soil mechanically from the jacking face by means of a rotating cutting head and pumped slurry conveyance system



The TBM deployed by CSV Construction was the Herrenknecht AVN 800 XC TBM – the first of its kind owned and operated by a Southern African company

Each year, the Joop van Wamelen Award of Excellence is presented to a leading project team in recognition of exceptional contributions to the active promotion and implementation of trenchless technology in Southern Africa. This year's award recognised the team involved in the implementation of a much-needed sewer installation using micro-tunnelling. **By Danielle Petterson**

This year, the Southern African Society for Trenchless Technology (SASTT) presented the Joop van Wamelen Award of Excellence to the City of Cape Town, consulting engineering firm AECOM and contractor CSV Construction, in recognition of the successful use of micro-tunnelling technology for the construction of Phase 2 of the Cape Flats 3 Bulk Sewer (CF3-2).

Built in the 1960s, the original twin sewers (Cape Flats 1 and 2) serve an area of 8 000 ha. Silting is a significant issue for sewers in coastal areas. Not only have the original sewers silted up, dilapidation has set in to the point where the infrastructure no longer functions adequately, and therefore required urgent rehabilitation.

AECOM carried out the design work for the project, with CSV commencing with construction at the start of 2016. CF3-2 was designed as a 1 000 mm ductile iron rising main, starting at the Bridgetown Pump Station, and discharging into a gravity sewer completed as part of Phase 1. Micro-tunnelling was selected as the preferred construction method along some sections, given that the 5 km route crosses a densely-populated area, with busy roadways and many existing underground services.

Technical challenges

At first, micro-tunnelling was deemed too costly, given the tunnelling equipment that needed to be imported from Germany. However, following extensive technical and financial evaluation, it was put forward that the lower road reconstruction cost and reduced construction risk would, in fact, mean that micro-tunnelling some sections of the route would be financially feasible.

In addition, the latest ductile-iron jacking pipe technology would allow the final pressure pipeline to be installed using a micro-tunnelling tunnel-boring machine (TBM), instead of the conventional approach, whereby a pressure pipe is installed through a larger, micro-tunnelled concrete outer 'sleeve'.

Technical details

Chinese company Xinxing supplied the 4 m long ductile iron jacking pipes, with a 1 170 mm OD (outside diameter) and a 1 000 mm ID (inside diameter), an outside reinforced concrete sheath, and a polyurethane internal lining. These pipes have a jacking capacity of 5 080 kN, making them significantly stronger than conventional concrete jacking pipes, decreasing the likelihood of a pipe failure during the jacking operation, even for long distances over 200 m.

The team typically installed between three and five pipes per eight-hour work day. On its best day, the team was able to jack roughly 25 m. The most time-consuming part of the operation was to disconnect and reconnect the cables and slurry pipes in order to insert the next jacking pipe,

Receiving the Joop van Wamelen Award of Excellence: Timothy Hotchkiss and Konrad Röhrs from AECOM, and Hannes Coetzee from CSV Construction

After the TBM enters the ground from the jacking shaft, special jacking pipes are inserted behind it

FAST FACTS

Tunnel-boring machine
A Herrenknecht AVN 800 XC TBM with a 1 190 mm extension kit was deployed for the micro-tunnelling process. This is a closed, full-face excavation TBM with a hydraulic slurry circuit and a specially adapted cutter head, allowing the machine to bore through virtually any geological conditions.

A cone-shaped crusher inside the excavation chamber reduces the size of stone and debris, which is then removed through the slurry line.

Given the Cape Flats ground conditions, a soft-ground cutter head was selected as it has larger openings, allowing for faster advancement as the machines can accommodate larger volumes of material in the chamber.

Equipped with chisels, the cutter head can also handle more solid materials when required. At one point, the team unexpectedly tunnelled through some buried rubble containing reinforced concrete.

The machine cut through both the concrete and steel easily. A high-pressure jet-water system comes standard to prevent the crusher cone from clogging in sticky soils.

since all of the equipment connected to the TBM is located within the main pipeline. CSV initially decided on a maximum drive length of 150 m to circumvent the need for inter-jack stations, and the lubrication of the outside of the pipe normally required to reduce the friction on the pipe surface. The team opted not to lubricate the pipes through ports in the pipes themselves, but only from the tunnelling machine as the tunnel advanced. The machine overcut the pipe OD by 10 mm, forming an annulus around the pipe, which was filled using a computer-controlled, pressurised bentonite injection system.

At one point along the route, it was decided to increase the jacking length to over 200 m because technical challenges prevented an additional shaft from being sunk. As a result, additional slurry, hydraulic, and communication support pipes and cables were needed. The longest drive ended up being 218 m long, with jacking forces close to the 350 t jacking capacity offered by the jacking frame. An interlocking sheet pile method was used to construct 6 m by 4 m jacking shafts. In some areas, the sheet piles were driven using an excavator fitted with high-frequency vibration hammers while, in other sections, silent piling technology was used to prevent disturbances when sinking shafts close to houses.

One of the most critical areas of an operation is where the tunnelling machine exits the shaft, making it important to have the right type of exit seal. In this case, the machine was forced through a 30 mm thick neoprene exit seal to prevent sand and water from washing into the exit shaft. This is not often seen in pipe-jacking operations using open-face excavation or augers in South Africa. However, since the slurry system pushes large quantities of water through the face of the machine, it is vital to protect the exit so that the slurry does not wash back into the pit, causing possible sinkholes on the surface.

The machine was able to achieve an extremely high vertical accuracy of 13 mm, and a horizontal accuracy of 47 mm, with zero disturbances at the surface during the project. Due to the high level of control possible in monitoring groundwater pressures created and counteracted by pressures exerted by the slurry system, and the rate of advance of the TBM, depressions and heaving at ground level could be totally avoided.

Although working in an area with high groundwater levels, no dewatering was required while operating the TBM.

Successful completion

From February to November 2016, a total of 1 200 m of pipeline was installed successfully across eight sections with a high degree of precision, ahead of schedule, and within budget. The project team are confident that micro-tunnelling technology will play a crucial role in similar future projects in South Africa. 3S

Source: SASTT AGM, 2017