Steel reticulation design excels

Showcasing excellence in steel pipeline construction, the Western Aqueduct Phase 2 (Inchanga to Hillcrest) project won first place in Category 1: Engineering Excellence in Structures & Civils at the IMESA/CESA Excellence Awards 2018.

Serving the growing needs of the City of eThekwini's industrial and residential sectors is an expanding network of steel pipelines that traverse the hilly terrain common in this region. The challenging topography calls for innovative design and construction methodologies, which had a direct bearing on the pipeline reticulation system adopted.

For the Western Aqueduct Phase 2 component from Inchanga to Hillcrest, the steel pipes selected were manufactured and supplied by Hall Longmore, a market leader in South Africa and internationally since 1924. Both contracts for Phase 2 were completed in 2015.

ABOVE LEFT The historical Durban to Johannesburg railway line and the 'Inchanga Choo Choo' were used to move a large portion of the pipes during construction, saving both time and costs

ABOVE RIGHT The pipeline's external coatings and internal linings were selected to achieve the maximum possible design life from the pipeline asset

Client:
eThekwini Municipality
Consulting engineers:
Western Aqueduct Joint Venture – Knight Piésold Consulting, Royal HaskoningDHV and Naidu Consulting
Steel pipe manufacturer:
Hall Longmore

Contract WS6190 comprised some 7 km of DN 1 600 steel pipe from Inchanga Station to Alverstone Nek Reservoir, with a short section of DN 1 400 steel pipe at Alverstone Nek Reservoir. The maximum static pressure in this stage is 29 bar, requiring 13.5 mm thick X65-grade steel pipe.

Pipe laying in progress

The final section (Contract WS6191) comprised approximately 7.5 km of DN 1 400 steel pipe from Alverstone Nek Reservoir to the Ashley Drive Break Pressure Tank (BPT). The maximum static pressure in this case is 25 bar, requiring 12 mm thick X65-grade steel pipe at high-pressure sections. The Ashley Drive BPT was designed for a through-flow capacity of 400 Mℓ/day.

The Western Aqueduct was conceived as a large-diameter, thin-walled, continuously welded steel pipe. The steel pipe was selected to be both economical and functional. In low-pressure areas, this typically meant using the thinnest available X42-grade steel pipe, subject to typical slenderness limits not being exceeded. The thinnest wall was 10 mm on the DN 1 400 pipeline and 12 mm on the DN 1 600 pipeline, giving respective slenderness ratios of 140 and 133.

When pressure increases necessitated higher-strength pipe, the grade of steel pipe was changed in the first instance before increasing the wall thickness, as this was found to be a more economical solution – e.g. 10 mm wall thickness X42-grade pipe was upgraded to 10 mm thick X52-grade pipe, rather than, say, 12 mm thick X42-grade pipe. The highest grade of pipe specified was a 13.5 mm thick X65-grade steel pipe with a minimum yield strength of 448 MPa.

The pipeline was designed to be continuously welded, which resulted in the pipe wall stresses having to be calculated at every point of intersection. Because concrete thrust blocks were not a practical means of restraining longitudinal forces in such a large-diameter pressurised pipeline, these forces were taken up in the pipe itself. 3S