Construction Excellence Award 2007

Presented to Züblin

A ceremony was held in Singapore on 10 May 2007. The Construction Excellence Award 2007 was presented to Züblin as the builder of DTSS – UPPER THOMPSON LINK SEWERS.

The presentation was made by Mr. Mah Bow Tan, Minister for National Development to Mr. Hans-Jürgen Nagl, Züblin (Thailand) Co.,Ltd. - Pipe Jacking Division.

The Southeast Asia Construction Magazine published the following article.

DTSS – Upper Thomson Link Sewers

Civil Engineering Projects Category

Builder:
Ed. Züblin AG, Singapore Branch

Client:
Public Utilities Board

Principal Consultant:
KTP Consultants Pte Ltd

Quantity Surveyor:
KPK Consultancy Pte Ltd

Construction Cost:
S$41.2 Million

Construction Period:
27 months

Züblin digs deep into Singapore

The Deep Tunnel Sewerage System is a wastewater conveyance, treatment and disposal system that will eventually replace the existing system consisting of six sewage treatment works (STWs), one sludge treatment works and 139 pumping stations located all over Singapore. The concept of the DTSS is to use link sewers to intercept flows from existing sewers upstream of the existing STWs. This mega project is being developed in two phases, with Phase 1 scheduled for completion in 2008. Six design-and-build contracts were awarded between November 1999 and March 2000.

The first phase of the Deep Tunnel Sewerage System (DTSS) in Singapore encompasses in total 48 km of tunnel stretching from Kranji to Changi, 70 km of link sewers and the deep sea outfalls. The deep tunnels are circular with diameters ranging from 3.3 m to 6.0 m.

The deep tunnels constructed during the first phase of the DTSS convey wastewater by gravity to the centralised water reclamation plant (WRP) built on reclaimed land in Changi. The entire scheme is promoted by the Public Utilities Board.

The caisson sinking method was used to construct the temporary shafts.

Upper Thomson Link Sewers (UTLS)

Ed. Züblin AG was awarded the Upper Thomson Link Sewers in the North section of the DTSS Project. The scope of works involved construction of approximately 5 km of sewer tunnels ranging between 400 mm and 2,400 mm finished diameter by pipe jacking method as well as 32 numbers of shaft manholes of up to 40 m depth. The contract duration of the project works was 36 months.

The main tunnel of 2,400 mm finished diameter was constructed using the Special dual mode Pipe Jacking machine, while for the 1,200 mm, 600 mm and 400 mm finished diameter tunnels a standard AVN Pipe Jacking machine was used. Reinforced concrete pipes lined with HDPE membrane for the upper 330 deg of the tunnel circumference were used for the 2,400 mm and 1,200 mm diameter tunnels. Clay pipes were used for the 600 mm and 400 mm diameter tunnels.

Construction methods

The geological conditions varied from hard fresh Bukit Timah Granite to soft marine deposits such as Estuarine Clay. A highly permeable interface zone was encountered with ground water pressure up to 3 bars between the upper residual soils and the rock below. To counter such soil conditions, specially designed dual mode pipe jacking machines were used.

Temporary Shafts

Temporary shafts were first constructed using Züblin's caisson sinking method. The diameter of the shafts ranged from 4.4 m to 8.8 m and the depth of the shafts varied between 10 m and 40 m. The maximum height of the precast concrete segmental rings was about 2 m. The permanent manholes built inside the temporary shafts, consisted of a cast in-situ lower section and precast concrete rings at the upper section complete with HDPE lining.

The construction of the temporary shafts by caisson sinking method provided a unique and safe method of construction in difficult ground conditions. The shafts consisted of circular precast concrete rings, formed by segments which were tied together by tie rods. In the vertical position, the shaft rings were also tied by tie rods forming a rigid element capable of taking the jacking forces and transferring them into the surrounding soil. The pipe connections are designed for up to 4-bar water pressure.

Rectangular shafts of size 7.3 m x 4.2 m were also constructed in some locations due to site constraints. Swelling rubber joints ensured the water tightness of the shafts.

After fixing the rings, the excavation within the shaft commenced and the shaft rings were sunk by their own weight. More rings were added at the top as the shaft was brought down to its required depth. In order to reduce skin friction between the shaft and the surrounding soil, lubrication was carried out through the outlets in the segments. In areas where rock was encountered and further sinking of the caisson was not possible, the shafts were brought down to their final depth by shotcrete method.

Pipe Jacking

The pipe jacking operations were carried out successfully using the dual mode pipe jacking machines that can be operated in two different modes, namely Earth Pressure Balance (EPB) and Slurry. This machine, developed by Züblin and built by Herrenknecht AG, was used for the first time on this project. The main concept of this design was that the machine could be operated in EPB mode in soft ground conditions and upon encountering rock face conditions it could be switched to operate as a slurry machine.

The reason behind it was that the fissured rock may cause a lot of ground water ingress due to high pressures, resulting in settlements in the overlying soil layers, especially in peaty material. Under these conditions, the slurry removal method was the optimum solution to the potential problem.

The 12.5 m long machine with an outer diameter of 2,890 mm was equipped with a specifically designed cutting wheel with interchangeable tools to handle the different ground conditions.

In EPB-mode the excavated material was transported through a screw conveyor onto a conveyor belt and into a muck car which was then pulled out by a winch into the shaft. The muck skips were then hoisted to the surface by a gantry crane.

In the slurry mode, a stone crusher with a slurry box placed beneath the screw conveyor was brought into position and connected to a slurry pump. This was an important feature of this machine. The excavated material was then transported via the screw conveyor through the stone crusher into the slurry box and then pumped to a de-sander on the surface.

The jacking arrangement was placed in the temporary shaft (jacking shaft) and consisted of four numbers of hydraulic cylinders each with a stroke of 4,000 mm in two stages. The walls of the jacking shaft acted as the thrust block and two temporary steel structures - jacking beams - were used to transfer the jacking loads to the temporary shaft.

In those drive sections where the frictional resistance was high or in the longer drives, intermediate jacking stations were introduced into the pipeline in order to facilitate the progress of the pipe jacking operations. Upon completion of the drive, the intermediate jacks were removed and the pipeline closed up by

the main jacking station in the shaft.

The reinforced concrete jacking pipes, which are fitted with HDPE lining, were designed by Züblin and produced by a local manufacturer in Malaysia, under supervision of Züblin, Rohrwerke, Germany. The pipes had an internal and external concrete cover of 50 mm and came with stainless steel collars.

Permanent Manholes

Within the temporary shafts, permanent shaft manholes of finished diameter between 1.8 m and 3.6 m were constructed. The lower portion of the shafts was cast in-situ with an HDPE liner and the upper part was built with precast concrete rings. Cast-iron manhole covers were installed at the top of the finished manholes.

Züblin's contributions

Alternative Design

By omitting three shaft manholes, a one continuous drive of about 515 m length was achieved successfully. This was the longest drive of the project and resulted in a cost savings of about S$ 1.5 million for the Client.

Site and technical constraints

Due to the difficult and often changing soil conditions and variable size insulation in the road, Züblin's safe shaft sinking method as well as the project-designed pipe jacking machines, were successfully adopted.

Shaft locations were either moved or re-designed from circular shape to rectangular form in order to avoid the diversion of utilities and services, thereby ensuring valuable time and cost savings.

In an effort to ensure compliance with the stringent environmental requirements, de-sander equipment was used on the works. The main purpose of this equipment was to separate the sand / silt material arising from excavation works and recycle the water back into the tunnel to facilitate the pipe jacking operations.

Management skills

Detailed and systematic planning and work preparation, combined with good team management and efficient work co-ordination with the sub-contractors and suppliers ensured the timely and successful execution and completion of works.

Minimal or no diversion of services was required due to effective re-design and relocation of shafts. Where diversion was unavoidable, these were identified early and carried out successfully through smooth co-ordination with the respective authorities.

In order to reduce inconvenience to the general public and ensure minimum disruption of traffic flow, adequate signage and barricading was provided throughout the work duration, in accordance with the relevant LTA Code of Practice. Minor traffic diversions were successfully implemented in co-ordination with LTA and other relevant authorities.

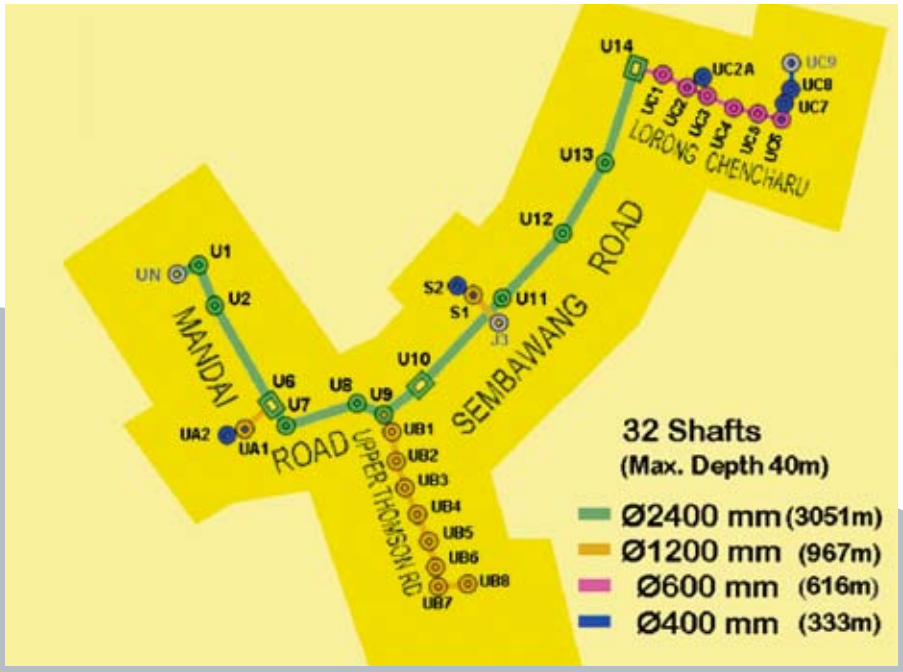
Environmental Management Programmes were drawn up and effectively implemented and monitored. Special de-sander equipment was used for the pipe jacking operations, thereby ensuring silt control and minimising the usage of water for the works. Earth control measures such as provision of silt traps and sedimentation tanks at site were carried out and maintained regularly.

Continuous noise monitoring was established and noise levels were kept to within allowable levels at all times. Pest and vector control operations were carried out effectively through a pest control specialist.

Conclusion

Project Completion was achieved nine months ahead of schedule, through detailed planning and work preparation by highly skilled and motivated site team with vast experience in shaft sinking and pipe jacking on high technical standards.

Pipe jacking from within the temporary shaft.



The layout plan of Upper Thomson Link Sewers.

Construction Excellence Awards 2007

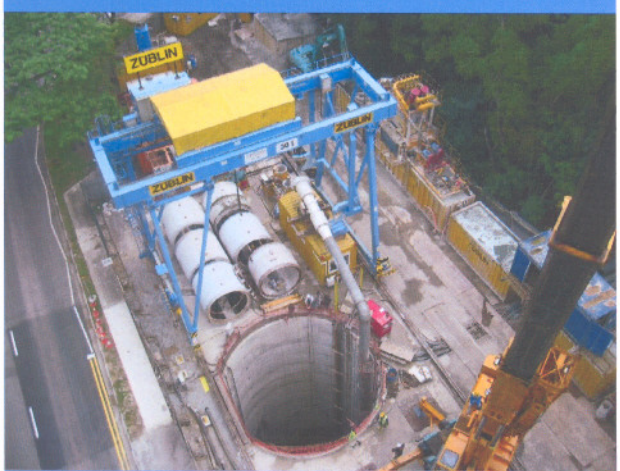
Building and Construction Authority

Presented to

ED. ZÜBLIN AG, SINGAPORE BRANCH

as the Builder of

DTSS - UPPER THOMSON LINK SEWERS



for which the

BCA Construction Excellence Award

(Civil Engineering Projects Category)
was conferred

CHAIRMAN
Building and Construction Authority

CHAIRMAN
Assessment Committee
BCA Construction Excellence Awards

Dated 10th May 2007