

Technical Visit To Pantai Trunk Sewer Tunnel

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On 14th December 2005, a technical visit to Pantai Tunnel was organised by Tunnelling and Underground Space Technical Division (TUSTD). About 60 participants attended the half-day visit. The visit was led by Engr. Neo Boon Kheng, Committee Member of TUSTD.

SECONDARY CORROSION PROTECTION LINING (CPL)

To protect the primary tunnel structure from acid attack, the project specification required a secondary corrosion protection lining to be installed, consisting of concrete lined with a thermoplastic primary CPL not less than 1.5mm thick, installed around 330 degrees. The method of construction proposed at tender was as follows:

1. Install 9m long collapsible steel formwork on five working fronts;
2. Prefabricate plastic lining to required size and install on shutter;
3. Cast 200mm thick mass concrete in annulus around 330 degrees.
4. Thermoplastic welding of joints.
5. Secondary casting of invert.

The scheduled progress of this method was 225m per month. The contractor proposed to precast the secondary lining as a pipe, push the pipe into the tunnel and grout the pipes into position. The proposal was accepted on the ground that vertical casting the lining under factory condition would ensure a quality bond between the lining and the concrete in advance of the works. The adopted method involved the following:

1. Precast pipe and deliver to work front.
2. Pipe installation working on three fronts.
3. Sealing and thermoplastic welding of joints.
4. Two-stage annulus grouting.

Table 1 contains a comparison of the scheduled progress of the In-situ CPL

method and the actual progress of the Precast CPL method.

Table 1: Scheduled progress of In-situ CPL Method vs Actual progress of Precast Method

Tunnel Section	Scheduled Progress In-situ Method (days)	Actual Progress Precast Method (days)
Shaft 1 to Shaft 2 (1134m)	128	132
Shaft 2 to Shaft 3 (789m)	97	60
Shaft 3 to Shaft 4 (990m)	119	66
Shaft 4 to Shaft 5 (1039m)	126	103
Shaft 5 to Pantai (1411m)	166	68
Total	638 days	429 days

*6-days working week.

HDPE LINING

The primary corrosion protection lining selected is HDPE cast-in concrete protection lining "Anchor Knob Sheet (AKS)" manufactured by Anchor Lining Systems in South Africa. The liner has anchors integrally formed during the plastic extrusion process. 1230 anchors per m² provide the lining with pull off resistance in excess of 70 tons per m². The material is designed to be chemically inert and able to resist chemical attack and abrasion, protecting the structural integrity of the sewer from the internal environment throughout its service life.

CPL PRECAST PIPE MANUFACTURE

Precast pipe was manufactured from the same Grade 55 concrete mix as the precast concrete segments and include 20kg/m³ silica fume. The pipe wall was 85mm with a single layer of B10 reinforcing mesh positional in the centre of the pipe wall. For the precasting process the AKS lining was secured 330 degrees around a collapsible steel inner mould. Four positioning spud inserts were placed in the invert for initial support of the pipe. A galvanised steel collar was cast in at one end to create a female support as an installation aid, while an overlap of 50-100mm of HDPE was

provided at the other end to allow an overlap extrusion weld within the

tunnel. A grouting socket was cast into the crown of every 5th pipe. Figure 1 shows the section of the completed tunnel and Figure 2 shows the precast pipe in long section.

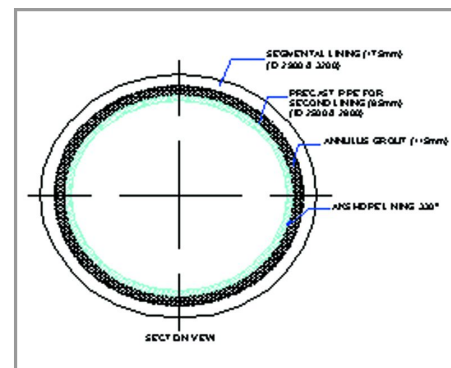


Figure 1: Section of lined tunnel

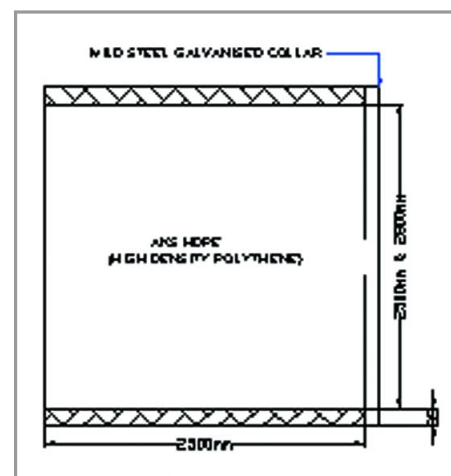


Figure 2: Precast pipe long tunnel

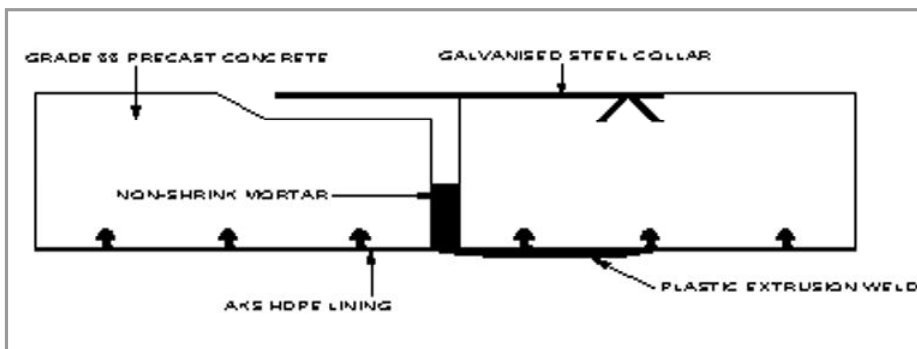


Figure 3: Precast joint prior to annulus grouting

CPL PIPE DELIVERY AND INSTALLATION

A traveler frame was designed to run on light rail pushed by a battery locomotive to deliver each pipe to the working front. The traveler was also used for positioning and setting the

pipe in position. Once set in position the joint between each pipe was sealed with non-shrink mortar and the HDPE extrusion welded prior to grouting. One cycle involved the installation and jointing of 40 pipes followed by annulus grouting. Figure

3 shows a section of the precast joint prior to annulus grouting.

HDPE LINING WELDING

In the extrusion welding process a 5mm diameter HDPE rod, manufactured from the same material as the AKS, is melted, extruded and fused with the AKS sheet to form a uniformly consistent weld. An automated orbital welding machine was employed on the 2.8m ID line to assist in maintaining consistent quality welds. The machine uses a pneumatic ram to maintain constant pressure of the extruder against the lining as the extruder is rotated at a constant rate. ■