Everdure CALITE

Hydrophobic Pore-blocking Ingredient (HPI)

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Tolo Harbour Sewage Tunnel, Hong Kong.

Tolo Harbour Effluent Export Scheme, Hong Kong (1992)

CLIENT: Hong Kong Government Drainage Services Department (DSD)
CONSULTANTS: Balfours-Haswell

Durability for Structural Concrete Exposed to Sewage Effluent and Seawater:

Tolo Harbour & Plover Cove Reservoir

The Cementaid Everdure Caltite System was specified for durability of structural concrete for a critical tunnel section of the Tolo Harbour Effluent Export Scheme, Hong Kong. Construction of the tunnel section was completed in 1992. The Everdure Caltite System was specified for this section by the project Consultant Engineers, Balfours-Haswell, a consultancy joint venture between Balfours International (Asia) Ltd. and Charles Haswell & Partners (Far East) Ltd.

This durability specification was an important consideration in the later specification of Everdure Caltite System concrete by Montgomery Watson (HK) Ltd., for the underground sewage pumping stations and manhole covers for the Hong Kong Govt.'s massive Strategic Sewage Disposal Scheme (SSDS) project (H.K. Govt. Drainage Services Dept..), for which the Tolo Harbour Effluent Export Scheme was the precursor.

The Tolo Harbour Effluent Export Scheme's central project was a sewage tunnel constructed for the H.K. Govt. Drainage Services Dept. (DSD), to deal with the expanding population around Hong Kong's Tolo Harbour area. The design called for a precast segmental tunnel, a standard design required by DSD. However, along the required route there was a critical point where the sewage tunnel had to cross over an existing potable water tunnel below, which served the Tolo Harbour area population.

For this section of the tunnel, Balfours-Haswell was required to produce a design solution that would prevent any chance of the tunnel's effluent contents leaking out and contaminating water in the potable water tunnel below, for the design life of the structure. There was to be no allowance for the possibility of carrying out maintenance procedures in the future, as there would be no access. Any instance of leakage or seepage into the potable water tunnel would be unacceptable to the client Department.

The design solution was required to provide waterproofing as well as corrosion protection from the seawater and sewage mixture of the effluent, including protection against acid attack of the concrete (due to hydrogen sulphide gas from the sewage combining with moisture in the concrete to form sulphuric acid). Epoxy coated concrete, epoxy coated reinforcing steel, membranes, coatings, cathodic protection systems, and various combinations of these with low-permeability concrete mix designs, were all considered; each had to be rejected, however, as there was no evidence of any proven, long term successful performance history for any of these measures in providing durability of structural concrete in these exposure conditions.

After examining the Everdure Caltite System's then 30-year performance history (since 1960) of durability for structural concrete in aggressive exposure conditions, the Consultant Engineers ultimately specified Everdure Caltite System alone, for a cast in-situ tunnel lining 150mm thick, to be constructed inside the precast tunnel lining and against the tunnel segments.

The construction method for the Caltite concrete in-situ lining included the use of movable, curved steel forms. A layer of plastic sheeting was used as a de-bonding layer between the outer normal concrete tunnel segments and the Caltite concrete inner tunnel, to allow for some movement in the segmental tunnel without cracking the Caltite concrete lining.

The Main Contractor for the Tolo Harbour Sewage Tunnel project was Italian construction group Viannini Construction, who also carried out the precasting works for the outer tunnel segments.

The project was completed in 1992. To date (2003), no leakage or repair or maintenance actions have been reported or required since handover.

Update Note: Further review of the current project status in 2007 has confirmed this still to be the case, with zero leakage reported and zero maintenance required.

The Tolo Harbour Sewage Tunnel specification was based on the Cementaid recommended Performance Specification, and followed a format similar to that used by Consulting Engineers Mott Connell (HK) Ltd. for the Royal Navy HMS Tamar Relocation to Stonecutters Island project in Hong Kong's Victoria Harbour -- a new two-level jetty for submarine use. The Royal Navy's Hong Kong Island base was relocated to Stonecutters Island in Victoria Harbour in 1991, ahead of the handover of Hong Kong to China in 1997.

Tolo Harbour Effluent Export Tunnel: CALTITE Concrete Invert Segment Lining.
Consultant Engineers: Balfours-Haswell, Hong Kong. Construction: 1992.

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