

HOBSON BAY SEWER TUNNEL AUCKLAND, NEW ZEALAND

TUNNELLING: PRECAST CONCRETE SEGMENTS

Product: Wirand® FF3 structural steel fibres

Problem

For over 90 years a reinforced concrete sewer pipe has graced the Hobson Bay near Auckland in New Zealand. Not only the location and the appearance of this structure, but also its deteriorating state lead to the decision to replace this pipe with a tunnel underneath the bay. The removal of the above ground sewer pipe would also open up the bay for recreational purposes and other uses.

Solution

To meet the future requirements of Auckland and to virtually eliminate overflows into the Hobson Bay, a tunnel of three kilometres in length with an internal diameter of 3.70m was proposed. The tunnel route extended across Hobson Bay from the pumping station in Orakei to Logan Terrace in Parnell. The depth of the tunnel varied from 40m underneath the Hobson Bay up to a 95m below the Orakei Ridge.

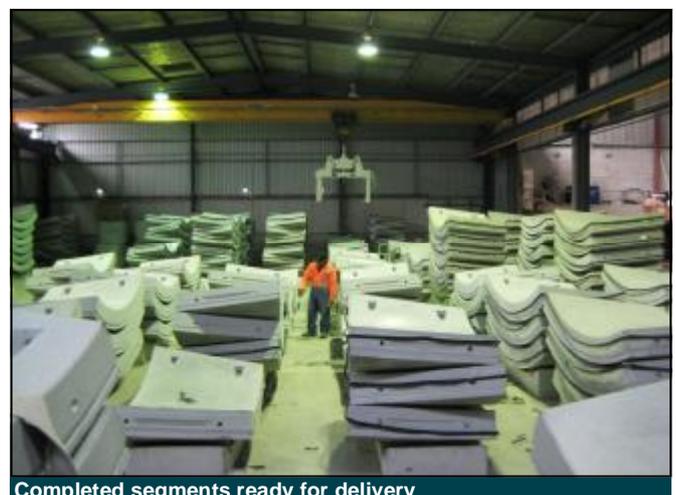
The initial design suggested a TBM (Tunnel Boring Machine) driven tunnel lined with precast concrete segments reinforced with conventional welded rebar reinforcement (120kg per segment). To improve the engineering process and reduce production costs, Wilson Tunnelling Ltd put forward the concept of using steel fibres to reinforce the segments. This approach to totally replace conventional reinforcement with steel fibres was developed further and reviewed by the segment lead design team from Babendererde Ingenieure GmbH, based in Germany. The design values for steel fibre concrete used in the structural analysis were verified from beam tests carried out at the Institute of Construction Materials Technology at Ruhr-University of Bochum in Germany. Two fibre types one being Maccaferri Wirand® FF3 were considered for the beam tests which used the exacting mix design provided by Wilson Tunnelling. Three fibre dosages of 30, 40 and 50kg/m³ were considered in the tests. The test results clearly showed that Wirand® FF3 provided the best results in terms of workability and performance when compared to the other fibre tested having the same diameter but with a longer fibre length. Wirand® FF3, with its shorter length and same wire diameter, has 20% more fibres per unit weight, which improves its effectiveness in bridging cracks, thus improving the ductility of the brittle base concrete.



Wilson Tunnelling precasting facility



Maccaferri dosing system installed at the precast facility



Completed segments ready for delivery

Client:

WATERCARE SERVICES

Main contractor:

McCONNELL DOWELL - FLETCHER JV

Concrete segment precaster:

WILSON TUNNELLING LTD.

Consultant:

BABENDERERDE INGENIEURE GmbH, GERMANY

Products used:

WIRAND FF3

Date of construction

JUNE 2008 - FEB 2009



View of the completed tunnel showing installed precast segments

The Hobson Bay Sewer Tunnel was the first earth pressure balance (EPB) TBM excavated tunnel in New Zealand. In addition, the very high productivity rate and the extremely low damage rate of the segments reinforced with Wirand® Fibres resulted in substantial cost savings. Steel fibre reinforced concrete significantly improves the impact strength of the segment due to improved ductility. This is especially essential for segment handling and installation.

Cost assessment:

- 50% time saving on segment production
- 10% cost saving on total project cost (NZ\$ 118.6 million)

Quality assessment:

- 15,000 segments produced
- 7 segments rejected as defective
- 6 damaged during installation

Project Details

Tunnel length: 3.0km
Internal diameter: 3.70m
Lining thickness: 250mm
Ring setup: 4 + 2 universal ring
Segment slenderness: 8.3
Ring length: 1.20m
Erector points: 1 central, cast-in (also serves as grout hole)
TBM type: Earth pressure balance
Concrete class @ 28d: 50MPa (cylindric)
Wirand FF3 SFRC solution: 40 kg/m³



View of the tunnel from the access shaft

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