

Project identification

Western Harbour Tunnel (Sydney)

Type of project

Design and consultancy works for immersed tunnel



Client

Bouygues Construction Australia Pty Ltd and Vinci Construction Grands Projects Australia Pty Limited

In co-operation with

Ramboll Denmark A/S

Project assignment

Design and consultancy works for the immersed tunnel and the transition structures during the tender for the delivery phase

Country

Australia

Location

Sydney

Project duration

2022

Project phase

Tender for the delivery phase

Construction cost

2.8 billion USD
(excl. VAT)

Consultancy fee

1.2 million EURO
(excl. VAT)

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Project description

The new tunnel will connect to WestConnex at the Rozelle Interchange, cross underneath Sydney Harbour between Birchgrove and Waverton, and connect with the Warringah Freeway near North Sydney via a 6.5 kilometre tunnel, with three lanes provided in each direction.

It includes an immersed tube tunnel crossing of the Sydney Harbour between Birchgrove and Balls Head, tunnelled ramps and surface connections at Rozelle, North Sydney and Cammeray, future underground connections to the Beaches Link and Gore Hill Freeway, the fit-out of and commission of ventilation outlets and motorway facilities at the Rozelle Interchange, in Cammeray and in North Sydney.

The immersed tunnel has a length of 650 m (5 tunnel elements), has 2 times 3 lanes with a central gallery widening towards the transition structures. The maximum depth at the South side amounts 30 m. 3 out of the 5 tunnel elements are fully founded in rock and 2 elements are partly founded in very soft sediments. To cope with the differential foundation conditions an additional internal immersion is pre-installed in the middle of a tunnel element which would allow for large rotations after immersion. Two other segment joints are equipped with special water stops to allow for slightly larger rotations. These, among other, design optimisation allowed for differential settlements in longitudinal direction and therewith permitted the upward shift of the vertical alignment reducing the construction costs.

The immersed tube transits at the shore to the mined road header tunnels. The special transition structure is constructed out of the mined tunnels without surface access limiting nuisance at surface level.

Scope of work

TEC (immersed tunnel) and Ramboll (transition structures) prepared the tender design for the construction Joint Venture. With a team at our offices in Copenhagen (Denmark) and Amersfoort (The Netherlands) the design was developed. A small team (4 persons) coordinated the interfaces with the contractor in Sydney and joint in meetings with the Owner.

Activities:

- Prepare Basis of Design, Basic Design and specific notes on the immersed tunnel and transition structures
- Structural, geological & geotechnical, marine works and immersion related engineering works
- Developed transition between immersed tunnel and mined tunnels. Prepared trade-off and supported the decision making with the contractor. Developed the transition structures to Basic Design level and coordinated closely with the construction methodology teams of the construction Joint Venture
- Alignment selection. Developed multiple alignments and selected a less deep and geotechnically more favourable vertical alignment. Moved the horizontal alignment to reduce torsional effects (overloading the shear keys)
- Foundation design. Compared Sand Compaction Piles, Cement Deep Mixing and a piled foundation for multiple alignments. Compared a gravel and sand flow foundation.
- Cross-sectional design development (comparison between conventional reinforced concrete, transverse post-tensioned and steel sandwich options)
- Longitudinal analyses and closure joint design. Segment and immersion joint design and two special joints allowing for larger rotations at the transition between soft (sediments) and hard (bedrock) subsoil conditions

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- Marine works design. Dredging methods, transport analyses, rock armor design and scour protection
- Miscellaneous matters like: cathodic protection, fire protection, cladding, immersion related provisions, etc.
- Coordinated with Mechanical, Electrical & Plumbing design provided by the construction Joint Venture
- Review of client specifications, EIA and other available material from previous project studies
- Assess and integration of applicable local design codes and international design guidelines
- Identify environmental conditions for permanent and temporary conditions - water levels, tide, waves, wind, and sedimentation.
- Assistance BV JV in technical meetings with the Owner
- Preparation of the tender design in 3D in Allplan