Busan – Geoje Link: Immersed Tunnel in deep water

Wim Janssen[2]
[1]Tunnel Engineering Consultants, the Netherlands:
Technical Advisor to Daewoo E&C for the Busan - Geoje Fixed Link

Abstract:
The Busan – Geoje Fixed Link will provide a road connection between the metropolis of Busan and Geoje Island. The Link triple jumps over three small islands and comprises amongst others two cables stayed bridges and an under water tunnel constructed as a concrete immersed tunnel. Travel distance to Geoje is reduced from 140 km to 60 km and contributes to reduction of environmental impact by traffic. The site conditions can be describes as challenging: (i) exposure to the East China Sea with a maximum wave height of over 9 m, currents of 0.8 m/sec result in a restricted window for marine operations (ii) structured marine clays with a thickness of 20 m with a very to extremely high plasticity and a saturated unit weight of about 14.6 kN/m³ and (iii) moderate seismic hazard. As a result the immersed tunnel has a number of special features: − its length is 3.2 km subdivided in 18 elements of 180 m consisting of 8 segments each. In order to accelerate construction the element production is semi industrial, casting the segments without intermediate construction joints using a travelling formwork.
− the water depth of over 35 m resulting in a water pressure of about 55 m under wave action, requiring special attention to prevent water ingress through the concrete, segment and immersion joints.
− an extensive soil improvement by deep cement mixing piles over the full tunnel length has been selected
to limit the settlement differences caused by the increase of effective stress following from the backfill material and rock protection. Settlement can differ considerable over the tunnel length and is difficult to predict due to (i) variation in trench excavation, (ii) variation in over consolidation rate of the original soil, (iii) variation in subsoil conditions and (iv) transition to outcrops of bedrock.
− locally the tunnel alignment is above seabed. At these locations the tunnel is placed on an under water embankment which raises about 16 m above the original seabed. Deep cement compaction piles are used to support the embankment.

The tunnel section of the Busan-Geoje Link is special for many reasons. The design embroiders on the Øresund fixed link between Denmark and Sweden but particulars go far beyond today's common practice and experience within concrete immersed tunnel technology. It is expected that completion of the Link will open new horizons for the use of immersed tunnel techniques in deep water, severe marine and difficult geological conditions.

The paper will describe the project, highlight the particular features of the design and will give the current status of construction.

Keywords: immersed tunnel, soft soil, deep cement mixing, underwater embankment.

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