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Verification of Geophysical Investigation during Subsea Tunnelling in Qatar

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Abstract : Musaimeer outfall tunnel is one of the longest storm water tunnels in the world, with a total length of 10.15 km. The tunnel will accommodate surface and rain water received from the drainage networks from 270 km of urban areas in southern Doha with a pumping capacity of 19.7m³/sec. The tunnel is excavated by Tunnel Boring Machine (TBM) through Rus Formation, Midra Shales, and Simsima Limestone. Water inflows at high pressure, complex mixed ground, and weaker ground strata prone to karstification with the presence of vertical and lateral fractures connected to the sea bed were also encountered during mining. In addition to pre-tender geotechnical investigations, the Contractor carried out a supplementary offshore geophysical investigation in order to fine-tune the existing results of geophysical and geotechnical investigations. Electric resistivity tomography (ERT) and Seismic Reflection survey was carried out. Offshore geophysical survey was performed, and interpretations of rock mass conditions were made to provide an overall picture of underground conditions along the tunnel alignment. This allowed the critical tunnelling area and cutter head intervention to be planned accordingly. Karstification was monitored with a non-intrusive radar system facility installed on the TBM. The Boring Electric Ahead Monitoring(BEAM) was installed at the cutter head and was able to predict the rock mass up to 3 tunnel diameters ahead of the cutter head. BEAM system was provided with an online system for real time monitoring of rock mass condition and then correlated with the rock mass conditions predicted during the interpretation phase of offshore geophysical surveys. The further correlation was carried by Samples of the rock mass taken from tunnel face inspections and excavated material produced by the TBM. The BEAM data was continuously monitored to check the variations in resistivity and percentage frequency effect (PFE) of the ground. This system provided information about rock mass condition, potential karst risk, and potential of water inflow. BEAM system was found to be more than 50% accurate in picking up the difficult ground conditions and faults as predicted in the geotechnical interpretative report before the start of tunnelling operations. Upon completion of the project, it was concluded that the combined use of different geophysical investigation results can make the execution stage be carried out in a more confident way with the less geotechnical risk involved. The approach used for the prediction of rock mass condition in Geotechnical Interpretative Report (GIR) and Geophysical Reflection and electric resistivity tomography survey (ERT) Geophysical Reflection surveys were concluded to be reliable as the same rock mass conditions were encountered during tunnelling operations.

Keywords : tunnel boring machine (TBM), subsea, karstification, seismic reflection survey
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