Case study of clarifying on the shallow rock mass condition and the resistivity distribution inside the tunnel under construction

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In the geological survey of tunnel, electric sounding is sometimes carried out to estimate underground condition in tunnel construction at planning stage. These method obtained useful information to predict and examine the possibility of geotechnical problems during excavation. The research results, however, are seldom verified by research results at construction stage. The author carried out electric survey at planning stage and at construction stage in tunnel in east Hokkaido, Japan, and compare them each other to verify their applicability.

Surveyed tunnel is 1.3km in length, 170m in maximum overburden, and geology of it is two layers of Neogene welded tuff. Between these layers exists a layer of sandstone/mudstone as non-marine sedimentary rock.

In this tunnel, estimated electrical resistivity along tunnel route was measured by two-dimensional electrical resistivity prospecting at planning stage. This technique was conducted at a depth of 200 m and at electrode intervals of 5m. At construction stage, electrical resistivity was obtained by vertical electric sounding on the tunnel face, and geology along tunnel formation is also obtained by the tunnel excavated data and rock tests using rock mass which was sampled in tunnel construction stage. The vertical electrical sounding at tunnel faces were conducted at 2 points based on the result of two-dimensional electrical resistivity prospecting. This technique was conducted by dipole-dipole array and Wenner array were used, and the electrode intervals were 1m at two tunnel faces. At point 1, the electrical resistivity by two-dimensional electrical resistivity prospecting is 800Ωm or higher. At point 2, the electrical resistivity is 100Ωm or lower.

Result of point 1, the electrical resistivity was 1,000Ωm or higher ahead of the tunnel face. At point 2, the electrical resistivity was 60Ωm or lower. These results of vertical electrical soundings are consistent with the results of the two-dimensional electrical resistivity prospecting that was conducted before tunnel construction for the purpose of quantifying the distribution of electrical resistivity in the ground. The geology on the tunnel face is both lapilli tuff. In addition, the rocks were hard at point 1 and soft at point 2. As a results of the rock tests by the rock mass sampled inside the pit, the P wave velocity, the uniaxial compressive strength, the effective porosity, and the electrical resistivity were 4.8km /s, 54MPa, 5.4%, 4,100Ωm at point 1 and 2.9km/s, 9MPa, 29.3%, 20Ωm at point 2. Thus, the difference in electrical resistivity was a result of the influence of the difference in such geology and physical strength characteristics.

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