Assessment of soft ground at tidal reclaimed land by integrated analysis of geoelectrical monitoring and CPTU data

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Evaluation of soft grounds is essentially required for construction of geotechnically stable structures. At construction sites, methods of obtaining data through in-situ tests such as boring investigations or identifying the physical properties of grounds through indoor tests after sampling are widely used. The on-site ground survey method provides accurate information on the position of one point but has a problem of difficulties in precisely identifying wide areas. On the other hand, geophysical explorations enable acquiring information on a relatively large area rather than in-situ tests but have a limitation of difficulties in providing quantitative information. Therefore, in this study, an integrated analysis technique that provides quantitative information for a large area was proposed by combining the advantages of the two methods, and the reliability of the analysis technique was confirmed by applying it to soft ground assessment.

To that end, a reclaimed ground where the distribution of soft grounds should be evaluated was selected as a study area. Piezocone Penetration Tests (CPTU) and boring investigations were used as geotechnical survey methods, and geoelectrical monitoring were performed as geophysical explorations. In this study, long - term data (10 months) were acquired to identify the applicability of geoelectrical monitoring. The geoelectrical monitoring data were processed using time-lapse inversion (Res2DInv, 2013), and 4D inversion (IP4DI, 2013).

To overcome the limitation of qualitative geophysical explorations, quantitative soft ground evaluation was performed through the integrated analysis with geotechnical survey data. The integrated analysis was performed using a variogram based geostatistical simulation method. The in-situ ground survey data used in the simulation are CPTU tip resistance and the geophysical exploration data used in the simulation are electrical resistivity. After analyzing the spatial correlations between individual physical properties, the Sequential Gaussian Co-Simulation (COSGSIM) was applied. Through the COSGSIM, accurate but spatially limited ground information provided by CPTU could be expressed as three-dimensional distribution data. To verify that the COSGSIM data were correctly estimated, drilling data at locations where CPTU and geophysical explorations were not performed were examined. Through the verification of simulation results using drilling data, it was identified that the depths where soil textures change and the locations judged to have soft grounds based on the N values in standard penetration tests were identical. For quantitative evaluation, simulation results were used to calculate the volume of the soft ground, which confirmed the usefulness of the geostatistical integrate technique.