Interpretation of resistivity data based on inversion with structural constraints for the detection of cavities during construction

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keywords: ground subsidence, resistivity inversion, structural constraint

Seoul, South Korea, has suffered frequent appearances of ground subsidence, which are seriously threatening public safety. More serious geotechnical hazards are caused by not only large scale land subsidence but also mine collapse or construction of tunnel, subway or large building. To reduce those serious hazards, this study focuses on applying geophysical exploration to detect underground cavities mainly at depths less than 10 m, which eventually cause ground subsidence. Among several geophysical exploration method, electrical resistivity methods can play the most powerful role because the methods have been widely used to map subsurface structures.

Inversion of resistivity data is the key in interpreting the resistivity structure, but is a non-unique problem resulting in ambiguous interpretation. To lessen the ambiguities, we describe and apply an inversion strategy with constraining structures using a priori information, which can be obtained from other geophysical or geology surveys and thus be pre-interpreted to generate a layered structure or a target area. Using the pre-interpreted structure, we construct a base-model for inversion and apply constraint with bounding ranges of the value of resistivity in each layer. The effectiveness of the structural constraints are tested for synthetic data. Comparing results from conventional and proposed inversion strategies, we can confirm that the proposed inversion with structural constraints yields more reasonable resistivity images than the conventional inversion. Further, we apply the structural constraint strategy to time-lapse inversion of resistivity monitoring data in order to detect the appearance of ground cavities during construction process. Since the process can cause geologic changes, time-lapse inversion gives more reliable results when considering interpreted structures from 3D inversion of resistivity data obtained before starting the construction process.

ACKNOWLEDGEMENTS

This work was supported by KETEP funded by the Ministry of Trade, Industry and Energy (MOTIE) of South Korea (No. 20164010201120) and by the Korea Agency for Infrastructure Technology Advancement under the Ministry of Land, Infrastructure and Transport (No. 17SCIP-B108153-03).