Three-dimensional modelling of building damage due to tunnelling

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Abstract

The tunnelling excavation in urban areas is a three-dimensional process which involves the mutual interaction between the construction activity, the ground deformation and the adjacent structures response.

2D analytical assessment methods [1] cannot take into account all the complexity of this phenomenon. Therefore, 3D finite element analyses of the coupled problem have been performed, including non-linear models for the soil behaviour and the tunnelling process, and a relatively simple representation of the affected structures [2], [3].

In this study, a 3D finite element model of a tunnel excavation in soft soil under a masonry building is analyzed. In order to take into account the effect of the stress redistribution due to the settlement induced damage of the building, a total strain rotated crack model is adopted for the masonry. Openings like windows and doors are included in the masonry facades. The soil structure interaction is modelled by a non-linear interface, and the excavation advance and the lining installation are represented using a phased analysis, in order to evaluate the three-dimensional effect of the tunnelling process on the structural response. Different locations of the building with respect to the tunnel are considered, to analyze the effect of sagging and hogging settlement troughs.

The mutual interaction between the ground deformation and the presence of the building is evaluated, comparing the longitudinal and transversal settlement troughs resulting from the analysis with the Greenfield ones. The effect of the tunnelling advance on the structural damage, which is governed by a moving longitudinal settlement profile, is studied.

Results in terms of crack pattern of the structure are presented and discussed.

References

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