Numerical analysis of building damage due to tunnelling: from 3D to 2D modelling

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ABSTRACT

Underground constructions in soft ground may lead to settlement damage to existing buildings. In The Netherlands the situation is particularly complex, because of the combination of soft soil, fragile pile foundations and brittle, un-reinforced masonry façades. The tunnelling design process in urban areas requires a reliable risk damage assessment. In the engineering practice the current preliminary damage assessment is based on the limiting tensile strain method (LTSM). Essentially this is an uncoupled soil-structure analysis, in which the building is modelled as an elastic beam subject to imposed Greenfield settlements and the induced tensile strains are compared with a limit value for the material. This approach is usually considered to be too much conservative. The main reasons for this are that the settlements are assumed to be fully transferred to the structure, and for the building the internal redistribution of stresses and stiffness due to cracking is neglected. An improvement of the existing damage classification system should include the soil-structure interaction in terms of normal and shear behaviour and a cracking model for masonry. In addition to monitoring data from damaged buildings, parametric numerical analysis can be used to develop the system. A large number of analyses are necessary to evaluate the influence of different factors as geometry, foundation type and location of the structure with respect to the tunnel. Because of computational and interpretation expenses, a 2D model would be the most suitable to perform vast series of parametric analyses. However, the simplification from 3D to 2D involves the complex issue of the assessment of an equivalent soil thickness. In this work, by means the comparison between 3D and 2D fully coupled models, the thickness of the ground necessary to represent the correct soil-structure interaction under plane strain and plane stress assumptions will be investigated.