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A simple method to evaluate the response of bridges and frame structures with separated footings to tunnelling–induced movements

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ABSTRACT

In urban areas, there is an increasing demand for underground services that often require the excavation of tunnels. Because of tunnelling-induced ground movements, there is potential for a significant loss of serviceability performance of surface structures and infrastructure (for instance buildings, bridges, roads, etc.). Previous research developed a framework based on the modification factor approach to assess the effects of tunnel-structure interaction (TSI) in the case of buildings on continuous shallow foundations. On the other hand, alternative superstructure and/or foundation configurations have received less attention in previous research.

This paper focuses on the response of bridges or buildings supported by separated footings as opposed to continuous foundations. An elastic Winkler-based two-stage analysis method is proposed, which consists of [1] the evaluation of the greenfield displacement field due to tunnelling, and [2] analysis of the structure on springs subjected to an equivalent set of forces calculated from stage [1]. Several example structures consisting of deformable members are analysed in the case of a central tunnel. In addition, both straight and curved beams are adopted to compare the TSI of arched and framed structures representative of example bridges. The variation of the response of the soil-structure system with beam shape and frame characteristics is assessed by evaluating footing displacements and rotations, reaction forces at the base of the superstructures and strain distribution within the members. Results of these simplified analyses provide valuable insights on tunnelling-induced deformation and load transfer mechanisms of surface structures with separated footings.