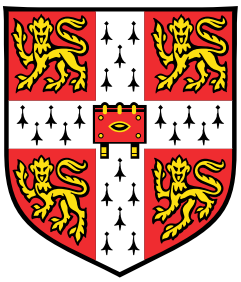
Sand Deformation Mechanisms and Earth Pressures Mobilised with Retaining Wall Movements



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Abstract

The conventional design of retaining walls is typically based on ultimate limit state calculations with arbitrary factors of safety, while the assessment of wall deformations is based on serviceability limit state calculations. Such an inconsistency has caused much uncertainty and hence inevitably excessive conservatism in retaining wall designs.

The aim of this research is consequently to propose a design method for retaining walls in sand, considering safety and serviceability simultaneously, based on the exploration of sand deformation mechanisms and earth pressure behaviours mobilised with retaining wall movements.

The first group of six centrifuge tests was conducted to investigate loose and dense Hostun sand behaviours with a complete set of rigid wall movement modes, i.e. rotation about the base, translation and rotation about the top. Sand deformations and earth pressures were measured and analysed by Particle Image Velocimetry and a Tekscan pressure mapping system, respectively. Simplified deformation mechanisms compatible with active wall movements and a simplified calculation method for the peak maximum shear strain caused by passive wall movements have been proposed based on the analysis of measured sand deformations. Observed earth pressures were quantitatively linked to sand shear strains in order to build simplified constitutive laws approximately characterising the earth pressure mobilisation with active and passive wall movements.

A novel design method has then been successfully proposed for flexible retaining walls in sand based on the simplified deformation mechanisms and constitutive laws, validated by the second group of three centrifuge tests involving a flexible retaining wall and two field measurements for the excavations supported by cantilever and propped retaining walls. Such an adaption from rigid wall results to flexible wall designs has completely applied the mobilisable strength design method to geotechnical projects in sand. This novel design method, for the first time, allows designers to rapidly assess the performance of different wall geometries and construction sequences in sand, providing extremely valuable contributions to practical engineering.