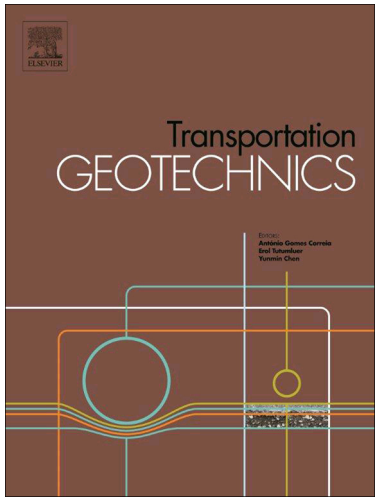

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The influence of soil nonlinear properties on the track/ground vibration induced by trains running on soft ground

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Abstract

The deflections of the track under a moving train depend on the stiffness of the underlying soil as well as the properties of the track and the train. In many situations, small-strain linear properties can be assumed for the soil. However, particularly for soft soil, as the load speed approaches the speed of Rayleigh waves in the ground, the deflections increase considerably. In such situations the use of the small-strain soil stiffness may lead to inaccuracies in the estimates of track deflections or of the critical speed. A finite element model of the track and ground has been developed to study the deflections induced by trains running on soft ground. Soil nonlinearity is introduced through a user-defined subroutine. The nonlinearity is specified in terms of the shear modulus reduction as a function of octahedral shear strain, which can be based on data obtained from laboratory tests on soil samples. The model is applied to the soft soil site at Ledsgård in Sweden, from which extensive measurements are available from the late 1990s. It is shown that the use of a linear model based on the small-strain soil parameters leads to an underestimation of the track displacements when the train speed approaches the critical speed, whereas the nonlinear model gives improved agreement with measurements. In addition, an equivalent linear model is considered, in which the equivalent soil modulus is derived from the laboratory curve of shear modulus reduction using an 'effective' shear strain. For this approach it is shown that the predictions in this specific case are improved by using a value of 20% of the maximum strain as the effective strain rather than the value of 65% commonly used in earthquake studies.