

## ABSTRACT

SETTLEMENT OF DRY COHESIONLESS SOIL DEPOSITS  
UNDER EARTHQUAKE INDUCED LOADING

The earthquake induced settlement of cohesionless sand or silty sands, has been the source of significant structural damage to bridges and buildings in past earthquakes.

The procedure for evaluating the settlement of dry sands during earthquake ground shaking developed by Tokimatsu and Seed (1987) is widely used in engineering practice. The method recognizes that seismic settlement is controlled by earthquake induced cyclic shear strain amplitudes but was developed using experimental data based on cyclic laboratory tests on only one sand. In addition, the procedure is based on simplifying assumptions approximating earthquake site response, namely the concept of an equivalent number of uniform shear strain amplitude cycles with depth varying amplitude.

This study evaluates a simplified version of a constitutive model for the settlement of sands under non-uniform time varying cyclic shear strain amplitudes (originally developed by Martin et al. (1975)) in combination with a nonlinear site response program as a means of determining the earthquake induced settlement of sands in a more rigorous manner. Compilation of existing and new cyclic simple shear laboratory tests on several different sands also shows that settlements can be significantly greater or less than the data adopted for the Tokimatsu and Seed procedure. Constitutive model parameters adopted for the settlement analyses are shown to depend on the value of  $e - e_{\min}$  (where  $e$  is the void ratio) for a given relative density.

The results of the research clearly illustrate settlement sensitivity to sand particle characteristics. A simple approach based on void ratio parameters to characterize settlement potential and the new analytical methodology adopted as a design approach, overcomes the limitations of the Tokimatsu and Seed methodology. These parameters when combined with a time history site response analysis form the basis for the proposed new design methodology. A basic understanding of volume change behavior under cyclic loading as described above is also fundamental to the understanding of liquefaction behavior of saturated sands under undrained conditions as reported by Martin et. al, 1975. The research also illustrates and reinforces this basic understanding.