ABSTRACT

Impedance functions for a rigid massless circular foundation resting on different types of layered soil and subjected to harmonic excitations are computed using cone model for different modes of vibration. Here, the principle of one dimensional wave propagation in beams (cones) with varying cross sections is applied taking into consideration the reflection and refraction at material (layer) interface and the free surface. Close form solutions are obtained for the resulting displacement in two-layered soil. But the same is not possible in case of multi-layered soil as infinite sum of infinite sum arise. However, the resulting displacement is obtained by tracking sequentially the superimposed wave pattern up to a certain stage. Linear hysteretic material damping, independent of frequency, is introduced using "correspondence principle". The frequency-amplitude response of a massive foundation is computed using the impedance functions for uncoupled vertical as well as torsional modes.

The different layered soil systems investigated are: (i) a homogeneous layer underlain by rigid base, (ii) a homogeneous layer underlain by flexible half-space, (iii) two homogeneous layers underlain by a rigid base and (iv) Two homogeneous layers underlain by flexible half-space.

To verify the solutions of cone model for their adoption and reliable application in practice, the computed response is thoroughly compared with reported results. The static and dynamic impedance are compared with the reported analytical results and found a good agreement. Frequency-amplitude response and, in particular, resonant frequencies and peak amplitudes are compared quantitatively with reported experimental results with a wide variation in influencing parameters. The comparison shows a good engineering accuracy in most of the cases. But the model predicts a little higher damping for a homogeneous half-space and when relatively stiff layer is at the top, in layered soil.

A detailed parametric investigation is carried out to study the static stiffness, dynamic impedance of massless foundation resting on two-layered soil deposit using the cone model. The parameters varied are the depth of top layer, ratio of shear modulus, ratio of shear wave velocity, material damping ratio, Poisson's ratio, and the mode of vibration. The frequency-amplitude response is also studied for vertical and torsional modes varying widely the influencing parameters. The results are presented in the form of simple and versatile dimensionless graphs, which may prove to be useful in understanding the harmonic response of foundations resting on layered soil. A number of conclusions are also derived based on the parametric investigation, which may be helpful in designing machine foundations on layered soil.

Key words: Cone model, foundation vibration, impedance functions, layered soil, machine foundations, resonant amplitude, resonant frequency and wave propagation.