Effect of material damping on dynamic response of foundation on layered soil

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Introduction

Machine Foundations and foundations near different industries are generally subjected to machine-induced vibrations. A key method to analyse the response of these foundation is to determine the spring coefficient and the damping coefficient.

The soil below the foundation may be homogeneous or it can be layered. The spring and damping coefficients of foundation on homogeneous soil have been reported by researchers like Gazetas (1983), Meek and Wolf (1992), Meek and Wolf (1994). The response of Foundation on layered soil was reported by Baidya et al. (2006), Pradhan et al. (2008). Most of the existing solutions are elastic solutions without considering different material damping models. Hence in this paper an approach has been made to study the effect of soil material damping using three different models, i.e. Hysteretic model, Voigt model and Kelvin model. A comparative analysis is presented among the model for a foundation resting on layered soil under translational motion. The outcomes will be helpful in designing machine foundations.

Method

The impedance function, in general form can be expressed as Eq (1).

$$S(a_0) = K[(k(a_0) + ia_0c(a_0)] \tag{1}$$

Where, K = static stiffness coefficient, $k\ (a_0)$ = spring coefficient and $c\ (a_0)$ = damping coefficient

The details of the calculation of impedance function using Eq (1) can be found in Pradhan et al. (2008). The material damping is introduced using Eq (2). The modified spring and damping coefficient can be expressed ad Eq (3) and Eq (4) respectively. The material damping is incorporated using the “Correspondence principle”

$$S_\xi(a_0) = K\ [(k(a_0) + ia_0c(a_0)](\eta) \tag{2}$$

$$k(a_0) = real\left(S_\xi(a_0)\right) \tag{3}$$

$$c(a_0) = \left({}^1/_{a_0}\right) imaginary\left(S_\xi(a_0)\right) \tag{4}$$

Results and Concluding Remarks

The variation of spring and damping coefficients after inclusion of material damping is shown in Figure 1. It is observed that the Voigt model produces less spring coefficient and more damping coefficient among different models considered. The hysteretic and Kelvin model produce nearly similar results. It can also be noted that the effect of inclusion of material damping is more prominent for higher values of dimensional frequency.

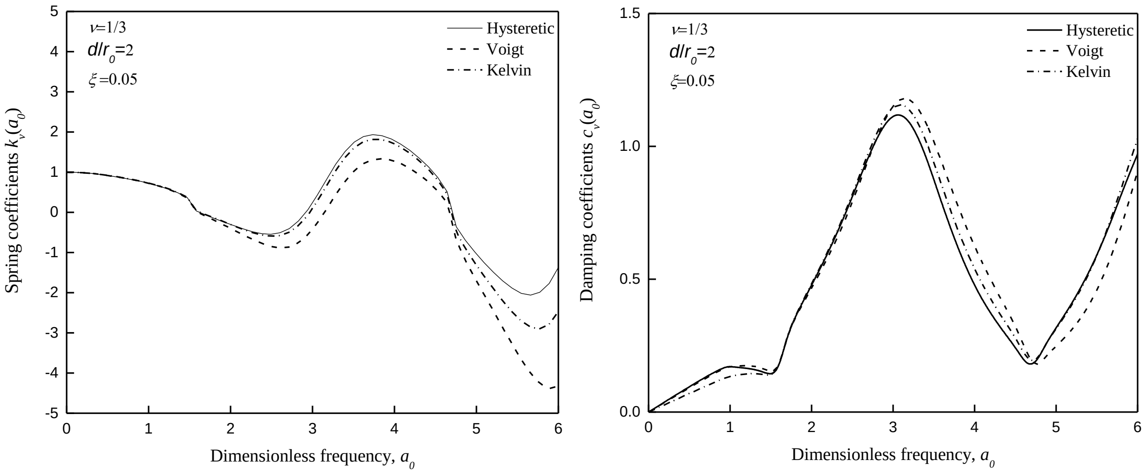

Figure 1. Effect of material damping on dynamic stiffness coefficients of foundation under vertical motion for Poison's ratio=1/3 and damping ratio= 0.05.

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