DISCUSSION

Dynamic behaviour of pile foundations in layered soil medium using cone frustums

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The authors have presented an attractive analytical method to evaluate the dynamic response of piles in layered soils. The method is based on the concept of the cone frustum and backbone cone, originally proposed by Wolf & Meek (1994) in order to determine the dynamic stiffness matrix of the free field for embedded foundations. In particular, the authors have extended the original model by introducing the coefficient ($-\alpha$) to account for the wave reflection effects at a given layer interface, and by considering the presence of rigid discs at both the interfaces of a layer. As shown by the authors, these new assumptions improve the accuracy of the solution. Nevertheless, the proposed method does not overcome a drawback of the backbone cone approach: the stiffness matrices are not symmetric (Wolf, 1994). In the discusser's opinion this aspect should be pointed out, because it could lead to significant discrepancies in the solution.

In order to illustrate this problem, a soil layer of thickness d resting on a homogeneous halfspace is considered as an example. The shear wave velocity c_{s2} of the halfspace is assumed to be two or four times that of the soil layer, c_{s1}. For simplicity, only two rigid discs, under horizontal motion, are considered. They have radius r_0 and are located at the upper and lower interfaces of the layer. The other data are: $d/r_0 = 1$, Poisson's ratio $\nu = 0{\cdot}25$ and damping ratio $\xi_g = 0{\cdot}05$. Soil density is assumed to be constant. For this simple soil system the dynamic stiffness matrix of the free field has been calculated by the discusser using the solution proposed by the authors. This matrix takes the following form

$$\left[S^{f}(\omega)\right] = \begin{bmatrix} S_{11} S_{12} \\ S_{21} S_{22} \end{bmatrix} \tag{34}$$

in which the four terms S_{11}, S_{12}, S_{21} and S_{22} are complex and depend on the circular frequency ω. Fig. 15 shows the ratio of the real parts (Fig. 15(a)) and the ratio of the imaginary parts (Fig. 15(b)) of the off-diagonal elements plotted against the dimensionless frequency $a_0 = \omega r_0/c_{s1}$. The matrix $[S^f(\omega)]$ is symmetric when both these ratios are equal to 1. As can be seen, in the simple case examined the ratio in terms of the imaginary parts presents some deviations from unity that may be accepted. By contrast, the real part of $[S^f(\omega)]$ is significantly non-symmetric, especially at high frequencies. Moreover, the higher c_{s2}/c_{s1} becomes, the higher are the deviations from unity. These remarks are valid even if the number of discs is increased.

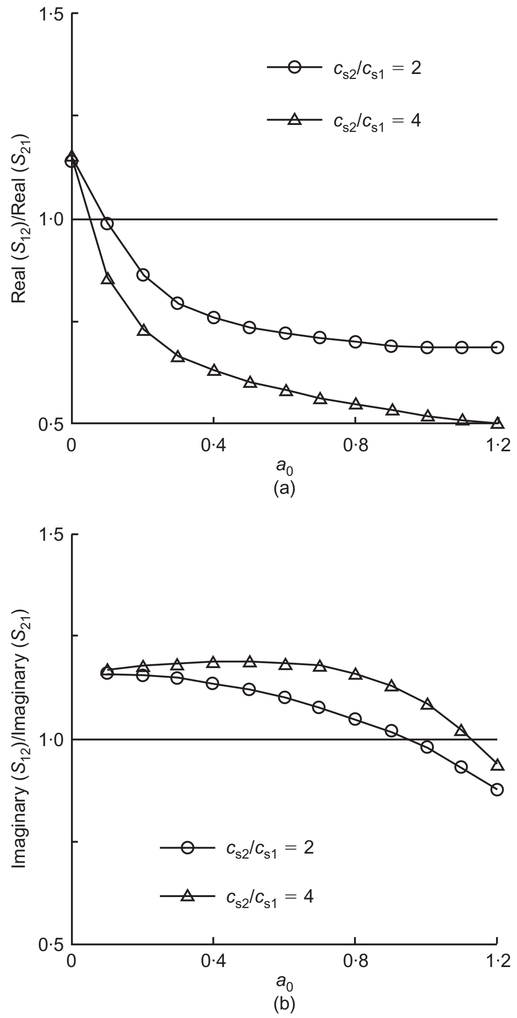

Fig. 15. Dynamic stiffness matrix: (a) ratio of real parts and (b) ratio of imaginary parts against dimensionless frequency