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Numerical Assessment on Shear Wave Propagation through Narrowly Gap-graded Packing

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The role of the finer particles on the mechanical response of gap-graded materials depends on both the size ratio between coarse and finer particles, and volumetric fines content (FC). Kenney & Lau (1986), amongst others, discussed the internal stability of cohesionless soils subject to seepage flow. Granular materials act as a low-pass frequency filter to sounds or elastic waves depending on the particle size, the void ratio and the confining stress (Otsubo et al. 2017), using discrete element method (DEM). The filtering effects through gap-graded materials have not been assessed in detail.

This contribution assesses the shear wave propagation characteristics and the small-strain shear modulus, and the low-pass frequency filtering effects of narrowly gap-graded materials using the LAMMPS molecular dynamic DEM code. Two distinct ranges of spherical particle diameters (0.45-0.6 mm and 1.2-2.2 mm) were considered to generate the binary mixtures. The volumetric fines content (FC) and the inter-particle friction coefficients were varied systematically under an isotropic stress state of 100 kPa. The propagation of shear waves was analysed using both time and frequency domain approaches.

We found that the mechanical void ratio, that treats the volume of rattler particles (coordination number = 0 or 1) as voids, is better related with the variation in the shear wave velocity for all the FC cases. The low-pass frequency limit increases with increasing FC, and there is a sudden increment between FC = 20 and 30%. This threshold FC value is in good agreement with the variation of a state parameter that quantifies the stress-contribution carried by fine particles as considered in Shire et al. (2016).

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