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基于离散单元法的颗粒阻尼耗能减振特性研究

Study on energy dissipation and vibration reduction characteristics of particle damping based on DEM

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中文摘要:

采用离散单元法并从能量耗散的角度研究颗粒阻尼对系统减振特性的影响。建立了颗粒介质细观下的法向、切向和滚动方向的粘弹性接触模型和能量耗散模型,通过冲击激励和简谐激励下系统振动响应的多参数能量耗散分析来研究颗粒阻尼的耗能机理和减振特性。数值试验表明,颗粒介质可以在一个较宽的振动幅值范围内有效的发挥其阻尼效应,其耗能具有阶梯状周期性的特点。填充率是影响颗粒阻尼耗能减振效果的主要工程可控参数并对系统共振频率产生重大影响,当填充率接近极值时,系统出现无阻尼共振及共振频率超出无颗粒系统固有频率的现象。系统在最优填充率下共振时,颗粒与箱体保持恒定相位差的超振幅稳态运动。较小粒径的颗粒可以提高能量耗散率并使振动系统更快趋向静平衡状态,而恢复系数和摩擦系数则对法向和切向耗能的比值有较大影响。

英文摘要:

The discrete element method (DEM) is adopted to explore the effect of particle damping on vibration reduction characteristics of the system in terms of energy dissipation.In the mesoscale,models of viscoelastic contact and energy dissipation in the normal,tangent and rolling directions between grains are established.Multi-parameter analysis on energy dissipation of the response of a system under an impulse or a harmonic excitation is carried out to study energy dissipation mechanism and oscillation suppression properties of the vibrating granular medium.The results show that granules exhibit good damping capacities over a wide range of amplitudes and expend energy in the way of ladder-like periodicity.Fill rate is a primary controllable parameter concerning the damping effectiveness of granular medium and has a great effect on resonance frequency of the system.When fill rate is close to an extremum,the system produces resonance in the absence of damping or the resonance frequency of the system exceeds that of the system without particles.Granules vibrate in step with the tank and have larger amplitudes than the tank as the system resonates in optimal fill rate,keeping a constant phase difference between them.Smaller particles are in favor of enhancement of energy dissipation rate and tend toward the state of equilibrium more quickly.Coefficients of restitution and friction have great influence on the energy consumption ratio of normal to tangent.