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Acceleration Techniques of DEM Simulation for Dynamics of Particle Damping

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Abstract : Presented herein is a novel algorithms for calculating the damping performance of particle dampers. The particle damper is a passive vibration control technique and has many practical applications due to simple design. It consists of granular materials constrained to move between two ends in the cavity of a primary vibrating system. The damping effect results from the exchange of momentum during the impact of granular materials against the wall of the cavity. This damping has the advantage of being independent of the environment. Therefore, particle damping can be applied in extreme temperature environments, where most conventional dampers would fail. It was shown experimentally in many papers that the efficiency of the particle dampers is high in the case of resonant vibration. In order to use the particle dampers effectively, it is necessary to solve the equations of motion for each particle, considering the granularity. The discrete element method (DEM) has been found to be effective for revealing the dynamics of particle damping. In this method, individual particles are assumed as rigid body and interparticle collisions are modeled by mechanical elements as springs and dashpots. However, the computational cost is significant since the equation of motion for each particle must be solved at each time step. In order to improve the computational efficiency of the DEM, the new algorithms are needed. In this study, new algorithms are proposed for implementing the high performance DEM. On the assumption that behaviors of the granular particles in the each divided area of the damper container are the same, the contact force of the primary system with all particles can be considered to be equal to the product of the divided number of the damper area and the contact force of the primary system with granular materials per divided area. This convenience makes it possible to considerably reduce the calculation time. The validity of this calculation method was investigated and the calculated results were compared with the experimental ones. This paper also presents the results of experimental studies of the performance of particle dampers. It is shown that the particle radius affect the noise level. It is also shown that the particle size and the particle material influence the damper performance.

Keywords : particle damping, discrete element method (DEM), granular materials, numerical analysis, equivalent noise level
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