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Energy dissipation in fragmented geomaterials associated with impacting oscillators

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In wave propagation through fragmented geomaterials forced by periodic loadings, the elements (fragments) strike against each other when passing through the neutral position (position with zero mutual rotation), quickly damping the oscillations. Essentially the impacts act as shock absorbers albeit localised at the neutral points.
In order to analyse the vibrations of and wave propagation in such structures, a differential equation of a forced harmonic oscillator was investigated, where the each time the system passes through the neutral point the velocity gets reduced by multiplying it with the restitution coefficient which characterise the impact of the fragments. In forced vibrations the impact times depend on both the forced oscillations and the restitution coefficient and form an irregular sequence. Numerical solution of the differential equation was performed using Mathematica software. Along with vibration diagrams, the dependence of the energy dissipation on the ratio of the forcing frequency to the natural frequency was obtained. For small positive values of the restitution coefficient (less than 0.5), the asymmetric oscillations were found, and the phase of the forced vibrations determined the direction of the asymmetry. Also, at some values of the forcing frequencies and the restitution coefficient chaotic behaviour was found.