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Long Wavelength Coherent Pulse of Sound Propagating in Granular Media

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Abstract : A mechanical wave or vibration propagating through granular media exhibits a specific signature in time. A coherent pulse or wavefront arrives first with multiply scattered waves (coda) arriving later. The coherent pulse is micro-structure independent i.e. it depends only on the bulk properties of the disordered granular sample, the sound wave velocity of the granular sample and hence bulk and shear moduli. The coherent wavefront attenuates (decreases in amplitude) and broadens with distance from its source. The pulse attenuation and broadening effects are affected by disorder (polydispersity; contrast in size of the granules) and have often been attributed to dispersion and scattering. To study the effect of disorder and initial amplitude (non-linearity) of the pulse imparted to the system on the coherent wavefront, numerical simulations have been carried out on one-dimensional sets of particles (granular chains). The interaction force between the particles is given by a Hertzian contact model. The sizes of particles have been selected randomly from a Gaussian distribution, where the standard deviation of this distribution is the relevant parameter that quantifies the effect of disorder on the coherent wavefront. Since, the coherent wavefront is system configuration independent, ensemble averaging has been used for improving the signal quality of the coherent pulse and removing the multiply scattered waves. The results concerning the width of the coherent wavefront have been formulated in terms of scaling laws. An experimental set-up of photoelastic particles constituting a granular chain is proposed to validate the numerical results.
Keywords : discrete elements, Hertzian contact, polydispersity, weakly nonlinear, wave propagation
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