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Waves in fragmented geomaterials with impact attenuation

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Attenuation of waves in geomaterials, such as seismic waves is usually attributed to energy dissipation due to the presence of viscous fluid and/or viscous cement between the constituents. In fragmented geomaterials such as blocky rock mass there is another possible source of energy dissipation – impacting between the fragments. This can be characterised by the coefficient of restitution, which is the ratio between the rotational velocities after and before the impact. In particular, this manifests itself in the process of mutual rotations of the fragments/blocks, whereby in the process of oscillation different ends of the contacting faces of the fragments are impacting. During the rotational oscillations the energy dissipation is concentrated in the neutral position that is the one in which the relative rotation between two fragments is zero. We show that in a simple system of two fragments this dissipation is equivalent, in a long run, to the presence of viscous damper between the fragments (the Voigt model of visco-elasticity). Generalisation of this concept to the material consisting of many fragments leads to a Voigt model of wave propagation where the attenuation coefficient is proportional to the logarithm of restitution coefficient. The waves in such a medium show slight dispersion caused by damping and strong dependence of the attenuation on the wave frequency.