Motion of masses with asymmetric and symmetric friction. Application to fault sliding

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This study analyses a situation when a geological fault contains a section of anisotropic gouge with inclined symmetry axes (e.g. inclined layering), Bafekrpour et al. [1]. Such gouge in a constrained environment induces, under compression, asymmetric friction (different friction forces resisting sliding in the opposite directions). The rest of the gouge produces conventional symmetric friction. A mass-spring model of the gouge with asymmetric and symmetric friction sections is proposed consisting of a mass with asymmetric friction connected through a spring to another mass with symmetric friction. These masses are set on a base subjected to vibration. A parametric analysis is performed on this system. Two distinct characteristic regimes were observed: recurrent movement resembling stick-slip motion similar to predicted by [2] and sub-frictional movement. Recurrent movement arises when the inertial force is sufficient to overcome frictional force of a block with symmetric friction. Sub-frictional movement occurs when the inertial force is not sufficient to overcome frictional force of an equivalent system with only symmetric friction. The sub-frictional movement is produced by the force in the connecting spring increased due to the movement of the asymmetric friction block in the direction characterised by low friction. We formulate the criterion at which sub-frictional movement occurs. The occurrence of sub-frictional depends upon the relative mass of the symmetric and asymmetric friction sections, as well as the amplitude and driving frequency of the excitation. Power spectra of the produced vibrations are determined for both regimes. The results can shed light on mechanisms of sliding over pre-existing discontinuities and their effect on seismic event generation and propagation of hydraulic fractures in the presence of discontinuities.


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