Geophysical Research Abstracts
Vol. 21, EGU2019-10636, 2019
EGU General Assembly 2019

Mechanics of Pendulum-type waves

Chengzhi Qi (3), Arcady Dyskin (1,3), and Elena Pasternak (2)

(1) University of Western Australia, Department of Civil, Environmental and Mining Engineering, Crawley, Australia (arcady.dyskin@uwa.edu.au), (2) University of Western Australia, Department of Mechanical Engineering, Crawley, Australia, (3) Beijing Research Center for Engineering Structures and New Materials,, Beijing University of Civil Engineering and Architecture (BUCEA), China

Pendulum-type waves are the waves propagating in blocky/fragmented rock or rock mass. They are characterised by low velocities and by the presence of multiple peaks in the spectrum. The pendulum-type waves were suggested by Kurlenya, et al. (1996a). Assuming hierarchical structure of rock mass the peak frequencies they suggested to be multiples of square root of 2 (so-called canonical frequencies). Pendulum-type waves were detected in laboratory experiments (e.g., Kurlenya, et al., 1996b; Alexandrova, 2003.) and in the walls of mining excavations (Kurlenya, et al., 1996c). Models of the Pendulum-type waves are usually based on dynamics of discrete systems with independent displacements of rigid blocks (e.g., Alexandrova & Sher, 2003).
In this presentation we analyse the effect of independent block rotation. To this end we consider a finite (1D) chain of identical rigid blocks each having two degrees of freedom capable of independent oscillations in the longitudinal axis and rotational oscillations in a common plane passing through that axis. Each pair of blocks is connected by two springs that model interblock connection providing resistance to both relative displacement and rotation.
The model shows that such a system supports two types of waves, longitudinal and rotational and these waves are independent. The wave velocities are controlled by spring stiffnesses, block dimensions and density and can be quite low. Furthermore the chain consisting of n blocks with the first block fixed posses 2(n-1) degrees of freedom and hence 2(n-1) modes (resonant frequencies) leading to the appearance of multiple peaks in the spectrum. It is the large number of peaks that makes the frequencies being close to some multiples of square root of 2.
The proposed model can provide the means of identification of the properties of blocky/fragmented rock based on the observed velocity of the waves and their spectrum.

Alexandrova, N.I. 2003. Elastic wave propagation in block medium under impulse loading. J. Mining Science, 39. 556-564.
Alexandrova, N.I. & E.N. Sher, 2004. Modelling of wave propagation in block media. J. Mining Science, 40, 579-587.
Kurlenya, M.V., V.N. Oparin & V.I. Vostrikov, 1996a. Pendulum-type waves. Part I: State of the problem and measuring instrument and computer complexes. J. Mining Science, 32, 159-163.
Kurlenya, M.V., V.N. Oparin & V.I. Vostrikov, 1996b. Pendulum-type waves. Part II: State of the problem and measuring instrument and computer complexes. J. Mining Science, 32, 245-273.
Kurlenya, M.V., V.N. Oparin & V.I. Vostrikov, 1996c. Pendulum-type waves. Part III: State of the problem and measuring instrument and computer complexes. J. Mining Science, 32, No. 3, 1996, 159-163.