Deformation wave in rock mass around deep level tunnels

Qi C.

Beijing University of Civil Engineering and Architecture, Beijing, China

e-mail: qichengzhi65@163.com

Rock possesses rheological property. A good example is the evolution of deformation and fracture in the form of deformation wave in rock near tunnels at Artem Mine in the Fareast of Russia[1].

Slow deformation wave was also observed in Jinchuan nickel mine and Zhangjiawa iron mine, China [2]. Laboratory experiments on samples made from alkali halide crystallines (NaCl, KCl, LiF), marble, sandstone and sylvinite showed the existence of slow deformation wave [3].

Note also that propagation of slow deformation waves is a common phenomenon in nature, for example, the wave of tectonic stresses [4], the migration of crustal deformation [5], pendulum-type waves [6], the soliton deformation wave in faults [7] ,slow strain wave in rock mass [8] and the slow rotation wave in the geo-medium composed of rotating blocks [9]. Deformation waves may trigger earthquakes[10].

Post-critical deformation of rock may be considered as continuous phase transition. In this presentation, we consider the propagation of deformation waves near deep tunnels based on the continuous phase transition model[11] in the framework of Lagrangian formalism[12]. Relative shear strain is taken as an order parameter. The potential energy is obtained by analogy with the Ginzburg-Landau's expansion of free energy. Hamilton's variational principle is used to obtain the motion equation by which several types of deformation waves can be modeled. In this way, we succeed in modelling different deformation waves.

References

1. Guzev M. A., Makarov V. V. Deformation and failure of the high stressed rocks around openings, Dalnauka, Vladivostok, 2007. 232 p.

2. Fang Zulie. The maintenance of soft rock tunnels and their control measurements, in: The supporting theory and practice for soft rock tunnels in coal mines in China, China University Mining & Technology, Xuzhou, China, 1996, 64 - 69.

3. Zuev L. B. et al. Laboratory observation of slow movements in rocks, J. Appl. Mech. Tech. Phys., 2012, 53(3): 467 - 470.

4. Nikolaevsky V. N. Geomechanics and fluidodynamics, Kluwer Academic Publishers, London, 1996.

5. Kasahara K. Migration of crustal deformation, Tectonophysics, 1979, 52(1 - 4): 329 - 341.

6. Kurlenya M. V., et al. Pendulum-type waves. Part I: State of the problem and measuring instrument and computer complexes, J. Mining Sci., 1996, 32(3): 159 - 163.

7. Bykov V. G. A model of unsteady-state slip motion on a fault in a rock sample, Phys. Solid. Earth., 2001, 37(6): 484 - 488.

8. Gershenzon N. I., Bykov V. G., Bambakidis G. Strain waves, earthquakes, slow earthquakes, and afterslip in the framework of Frenkel-Kontorova model, Phys. Rev. E., 2009, 79. 056601.

9. Vikulin A. V. Geodynamics as wave dynamics of the medium composed of rotating blocks, Geodyn. Tectonophys, 2015, 6(3): 345 - 364.

10.Sherman S.I. Deformation waves as a trigger mechanism of seismic activity in seismic zones of the continental lithosphere. Geodyn. Tectonophys, 2013, 4(2): 83 -117.

11. Landau L. D. On the theory of phase transition, J. Exp. Theor. Phy., 1937, V.7. 627 - 632.

12. Landau L. D., Lifshitz E. M. Mechanics, Pergamon, Press, London, 1969.