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Electric circuit modeling of rock specimens that suffer compressional stress and bending

P. Kyriazis (1,3), C. Anastasiadis (1), D. Triantis (1) and F. Vallianatos (2)

(1) Technological Educational Institution of Athens, Athens, Greece, (2) Technological Educational Institute of Crete, Chania, Greece, (3) Brunel University, School of Engineering and Design, Uxbridge, UK (cimon@ee.teiath.gr / Fax: +30 210-5316525)

Experiments on rock geomaterials have shown that deformation caused both by uniaxial compressional stress or bending, results in weak electric current emissions. In this work marble and amphibolite samples that are subjected to consecutive abrupt stress steps of the same level are considered as systems and are modeled by equivalent electric circuits. The input to these systems is a Heaviside step function and the output is the recorded electric current. The circuit analysis of the system in each loading step yields a set of values for the components of a 2nd order electric circuit.

The loading step can be modeled by a Heaviside step function provided that its duration is much greater than the rise time of the step, or from the experimental point of view that the current will have relaxed to a background value before unloading. A key point assumption for this modeling is that the sample parameters do not change during each step or that the system is not evolving from loading to unloading.

This deterministic model of a rather chaotic phenomenon as fracture is, can be used for a classification of the macroscopic results according to known electric circuit parameters as resistance and capacitance. It can be also helpful towards the differentiation between deformation stages of the same material, as well as the differentiation between materials that have suffered the same stress or bending.

This attempt to convert a mechanical – electrical problem into a purely electrical one and model the system status by using transfer functions allows the quantitative identification of the evolution of the material deformation and crack formation and can be

used as a tool for the systematic study of the recorded electric signals.