New application of piezoelectric sensors in health monitoring of rocks

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ABSTRACT

The inspection and maintenance of underground structures built in rocks poses difficulties to the concerned engineers due to the complex behaviour of rocks. Some of the underground regions are inaccessible for the inspection team or might warrant special clearing arrangement, leaving the structure out of service. The complexity of their design, construction and the conditions encountered during service life necessitate the deployment of a dedicated structural health monitoring (SHM) system. It is very crucial to identify the damage in the surrounding rocks in its incipient stage to prevent its further propagation and safeguard the structure built over it. The damage detection in rocks require an efficient SHM system which can monitor them on a regular basis. In the present study, lead zirconium titanate (PZT) patches are used to monitor the condition of rocks under various forms of loadings using electro-mechanical impedance (EMI) technique together with Acoustic Emission (AE) technique. In EMI technique, the vibrations generated by the actuation of PZT patch are sensed by the same PZT patch and is recorded in the form of conductance and susceptance signatures. These signatures can be quantified using root mean square deviation (RMSD) method. The same smart sensors were checked for their potential to be used for AE monitoring of rocks. The study presents a simple and cost-effective low-frequency AE technique for monitoring damages in the rocks. The AE technique is demonstrated for monitoring acoustic events happening within the rock specimens under uniaxial compressive loading. The study clearly establishes the potential of the EMI and AE technique in detecting and quantifying load induced damages in rocks surrounding the underground structures, opening avenues for its applications in real-life situations.

Keywords: Electro-Mechanical Impedance Technique, Rocks, Structural Health Monitoring, Acoustic Emission

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