Implementation of Piezoelectric Coupled Electro-mechanical Behavior for Damage Detection in Engineering Structures

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ABSTRACT

Assessment of the structural condition plays an important role in determining structural reliability. Development of systems which can monitor structural condition should lead to improved structural safety and reliability. Damage detection is a crucial issue in structural health monitoring and represents therefore an important focus of the research interest over the past years. In this work we present the methodology based on implementation of active piezoelectric materials embedded in or attached to engineering structures, which can owing to their coupled electro-mechanical behavior successfully be implemented for detection of possible damages. Such a methodology represents a non-destructive approach, which along with active structural health monitoring methods determines the future trends in the condition monitoring of engineering structures. Multifunctional properties of piezoelectric materials enable their use as active materials for such purposes.

Here particularly we are focused on coupling the electromechanical behavior of piezoelectric materials with mechanical properties of reinforced concrete structures for modeling of the piezoelectrically induced wave propagation through such structures, with the aim of damage detection. The piezoelectric material is embedded in the form of a smart aggregate into a reinforced concrete structure and as such serves for inducing and sensing the guided waves. The application of non-destructive methods based on wave propagation has been researched over a few decades, whereas the use of piezoelectric smart aggregates coupled with concrete structures is still under development.

In this paper we propose a numerical modeling of the coupled electro-mechanical piezoelectric behavior of smart piezoelectric aggregates embedded in concrete structures and develop a method for the damage detection based on damage indices which reflect the energy variations of the output piezoelectric sensor signals. The modeling procedure involves modeling of piezoelectric smart aggregates – developed using implicit finite element method and modeling of the wave propagation – developed using explicit finite element method. The method is implemented for different damage detection problems and a detailed parametric analysis of the damage index variation is performed depending on the size, position or orientation of the cracks, anomalies or damages.

REFERENCES

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