Damage prediction using response surface metamodels and electromechanical admittance signatures

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ABSTRACT

In the present work, a health-monitoring technique based on the electromechanical admittance approach is numerically presented and applied to civil engineering structures using statistical metamodeling methods. A procedure is developed for damage detection and identification as applied to a concrete sample. The detection and identification of damage is accomplished by using statistics surfaces to build the metamodels.

Piezoceramic transducers (PZTs) are extensively used in vibration and noise control, and damage detection of various engineering structures. The last decade has been applications of PZT-host structure interaction models in electromechanical impedance (EMI) techniques. In the EMI techniques, the PZT is either surface bonded or embedded inside the host structure. The governing principle in these techniques is that the PZT actuates harmonically in the presence of the electric field to produce a structural response which is known as "admittance signature". The changes in the admittance signature, which is the inverse measure of the mechanical impedance of the structure, are indicative of the presence of structural damage.

Metamodels have been used with success in many areas of engineering for decades but there is a limited amount of work in the field of damage detection. In this case, a metamodel is a reduced order model constructed by fitting a model to a set of points in the design space using a statistically design of experiments approach. Then a polynomial-type model is fit to the points using a multiple regression fitting technique. This fit allows models to be constructed that relate damage parameters of interest (such as damage severity and its location) to measurable output features (e.g. electromechanical admittance signatures).

In the present paper, the proposed damage prediction and identification methodology has been demonstrated and its success quantified for the case of a 3-D numerical specimen of a concrete cantilever plate.