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J Steel Struct Constr 2018, Volume 4
DOI: 10.4172/2472-0437-C2-012

Delamination damage detection of composite beam using Response Surface Method (RSM)

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Composite materials have gained wide importance in various industrial, civil, mechanical, aerospace, naval and military applications. Higher stiffness along with light weight gives composite materials an edge over other traditional materials for such applications. However, composites are very sensitive to defects, induced during manufacturing or service period. Delamination is one of the major defects commonly encountered in composite materials. Once induced in the structure, it can propagate very fast leading the structure to a cataclysmic failure in later period. So, this kind of damages needs to be detected in an early stage to avoid such occurrences. Throughout the years many researchers have tried to detect delamination damages by solving the vibrational response based inverse problem. Here, the authors have formulated the composite beam structure using 8-noded isoparametric elements based on layer-wise theory. Heaviside step function has been used to model the delaminated part. Combined natural frequencies and mode shapes are used as damage indicator. Instead of using finite model updating based inverse technique, Response Surface Method (RSM) is used. First the frequency and mode shapes based objective function is calculated for varying size and location of delaminations using the finite element method. The interface of damage is kept constant. Then, Minitab software is used to fit a surface of the response (objective function) as a function of location and size of the delamination. Lastly, Unified Particle Swarm Optimization (UPSO) is used to minimize the fitted surface to locate the location and size of the delamination. Present method is capable of reducing the computational effort significantly by eliminating the use of rigorous finite element model updating in every iteration during the optimization stage. Although at present this method is capable of handling only single delamination, it has greater potential in the field of damage detection in composite structure.

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