World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:12, No:05, 2018

Structural Damage Detection Using Modal Data Employing Teaching Learning Based Optimization

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Abstract : Structural damage detection is a challenging work in the field of structural health monitoring (SHM). The damage detection methods mainly focused on the determination of the location and severity of the damage. Model updating is a well known method to locate and quantify the damage. In this method, an error function is defined in terms of difference between the signal measured from 'experiment' and signal obtained from undamaged finite element model. This error function is minimised with a proper algorithm, and the finite element model is updated accordingly to match the measured response. Thus, the damage location and severity can be identified from the updated model. In this paper, an error function is defined in terms of modal data viz. frequencies and modal assurance criteria (MAC). MAC is derived from Eigen vectors. This error function is minimized by teaching-learning-based optimization (TLBO) algorithm, and the finite element model is updated accordingly to locate and quantify the damage. Damage is introduced in the model by reduction of stiffness of the structural member. The 'experimental' data is simulated by the finite element modelling. The error due to experimental measurement is introduced in the synthetic 'experimental' data by adding random noise, which follows Gaussian distribution. The efficiency and robustness of this method are explained through three examples e.g., one truss, one beam and one frame problem. The result shows that TLBO algorithm is efficient to detect the damage location as well as the severity of damage using modal data.

Keywords : damage detection, finite element model updating, modal assurance criteria, structural health monitoring, teaching learning based optimization
Conference Title : ICCEA 2018 : International Conference on Civil Engineering and Architecture
Conference Location : Berlin, Germany
Conference Dates : May 21-22, 2018