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Spectral Element Method for Damage Localization in Non-Uniform Structures With Parametric Uncertainty

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Abstract **-** Spectral element method, which works in the frequency domain, is usually used for modelling structures. It is a wave-based numerical approach. The advantage of using this method is that it reduces the number of degrees-of-freedom by representing the whole structure using a single element. The present study deals with finding damage in non-uniform structures using the spectral element method. Since the uncertainty is part and parcel of every real structure, it needs to be introduced into every methodology meant for damage detection. Therefore, this method is also used here for the stochastic system to introduce uncertainty in the model. Damage at any location is introduced as a single edge notch crack. The crack introduced is a non-propagating crack. The damage quantity introduced is expressed in terms of crack flexibility-based on the concept of fracture mechanics. At the damage location, the compatibility conditions are to be satisfied. With the help of the boundary as well as compatibility conditions being satisfied, the displacement equation for damaged case in the frequency domain is developed. In order to introduce parametric uncertainty, expressions of spectral stiffness and mass matrices are established using Karhunen-Loéve expansion. The mass and stiffness matrices for the stochastic case are expressed as random field and are discretized in terms of the random variables. Eigenvalue analysis is performed to obtain mode shapes for both damaged and undamaged cases. Difference between the mode shapes is considered to obtain the damage location. The methodology is found to be effective in localizing damage in non-uniform structures in the presence of parametric uncertainty.

Keywords**:** Spectral element method, Karhunen-Loéve (KL) expansion, Damage localization, ´ Non-uniform structure, Parametric uncertainty, Random field