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Effect of uncertainty in dynamic response of multi-cracked beams

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Abstract: This study deals with beams under dynamic loads, in presence of multiple cracks with uncertain parameters. The crack is modelled as a linearly-elastic rotational spring and, following a non-probabilistic approach, both stiffness and position of the spring are taken as uncertain-but-bounded parameters. The key idea is a preliminary monotonicity test, which evaluates sensitivity functions of the beam response to the separate variation of every uncertain parameter (i.e. stiffness and position of each crack) within the pertinent interval. Then, two alternative procedures calculate lower and upper bounds of the response. If the response is monotonic w.r.t. all the uncertain parameters, the bounds of the response are calculated selecting, for every parameter, either the lower bound or the upper bound depending on the sign of the sensitivity function associated with the parameter. In contrast, if the response is non-monotonic w.r.t. even one parameter only, the bounds of the response are evaluated via optimization and anti-optimization procedures. The method applies for every response variable (deflection, rotation, stress resultants) and the implementation takes advantage of analytical forms obtained, in this study, for all response variables and related sensitivity functions. Numerical results are presented for a multi-cracked beam equipped with tuned mass dampers to assess the effect of the uncertainty on the frequency response.

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