

An XFEM based multiscale method for flaws detection in structures

H. Waisman^{*}, H. Sun and R. Betti

Columbia University, New York, NY, USA
waisman@civil.columbia.edu

Abstract:

We present a novel multiscale algorithm for nondestructive detection of multiple flaws in structures, within an inverse problem type setting. The key idea is to apply a two-step optimization scheme, where first rough flaw locations are quickly determined and then fine tuning is applied in these localized subdomains to obtain global convergence to the true flaws. The two step framework combines the strengths of heuristic and gradient based optimization methods.

The extended finite element method (XFEM) with both circular and elliptical void enrichment functions, is used to solve the forward problem and alleviate the costly re-meshing of every candidate flaw, in both optimization steps.

The multiscale algorithm is tested on several benchmark examples to identify various numbers and types of flaws with arbitrary shapes and sizes (e.g., cracks, voids, and their combination), without knowing the number of flaws beforehand. The results are compared with the previous work that employed a single continuous optimization scheme (XFEM-GA and XFEM-ABC methods). We illustrate that the proposed methodology is robust, yields accurate flaw detection results and in particular leads to significant improvements in convergence rates compared with the previous work.

References:

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