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CRACK DETECTION BASED ON GENETIC ALGORITHMS AND STRUCTURED XFEM

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ABSTRACT

In this work a crack detection scheme is presented based on genetic algorithms and a structured extended finite element method [1]. The method is employed in order to detect cracks in structures with non-standard geometries.

Existing crack detection schemes [2,3] employ genetic algorithms in order to minimize some norm of the difference between measured response of a structure, typically strains in some specific points along the boundary, and the response predicted numerically by XFEM. During the optimization process the parameters of the crack (e.g. size and location) are treated as design variables. Moreover, since during the optimization process cracks are generated randomly, invalid cracks (e.g. cracks that lie far beyond the boundaries of the structure) have to be excluded. Towards this aim and as part of defining the crack within the existing geometry, each element of the mesh has to be individually scanned in order to determine whether it contains the crack tips.

In order to overcome this problem, the proposed method is based on a structured finite element method according to which a structured mesh is used and the boundaries of the structure are implicitly defined by radial basis functions. During the optimization process those functions serve also as a means of automatically locating the crack with respect to the structure in a much simpler way than the one used in existing methods. By exploiting the above feature, a series of numerical examples will be solved, involving the location of cracks in structures of varying geometrical complexity.

REFERENCES

[1] T. Belytschko, C. Parimi, N. Moës, N. Sukumar, S. Usui. Structured extended finite element methods for solids defined by implicit surfaces. *Int. J. Numer. Meth. Engng.*, Vol. **56**, 609–635, 2003.

[2] D. Rabinovich, D. Givoli, S. Vigdergauz. XFEM-based crack detection scheme using a genetic algorithm. *Int. J. Numer. Meth. Engng.*, Vol. **71**, 1051–1080, 2007.

[3] H. Waisman, E. N. Chatzi, A. W. Smyth. Detection and quantification of flaws in structures by the extended finite element method and genetic algorithms. *Int. J. Numer. Meth. Engng.*, Vol. **82**, 303–328, 2010.