Application of X-FEM in Isoline/Isosurface Based Topology Optimization

In this paper, application of eXtended Finite Element Method (X-FEM) is considered for structural optimization of continuum structures using an isoline/isosurface topology optimization algorithm. First, the methodology is explained for 2D design domains in which the design boundary is represented by isolines of strain energy density (SED) in a fixed-grid design space. The optimization algorithm operates by gradually removing inefficient material from low SED regions of the design domain which is separated from the solid sub-domain using isoline of a minimum SED level in each iteration. The X-FEM is used to improve the accuracy of FE solutions on the boundary of the design. In order to represent topology optimization of real-life structures, the proposed method is then extended to 3D by using isosurface boundary representation and a 3D X-FEM scheme. The proposed method is effectively used for topology optimization of several 2D and 3D benchmark problems. Efficiency and accuracy of this method is shown by comparing the converged solutions with standard BESO solutions. The results suggest that the proposed method can benefit from using a coarse mesh to generate topologies with smooth and clearly defined boundaries and also avoid time consuming remeshing approaches. This is an important advantage when the method is used for optimization of 3D structures in which the computational time matters.