

ISOGEOMETRIC TOPOLOGY OPTIMIZATION OF PLANE FIBER-REINFORCED STRUCTURES USING BOUNDARY TECHNIQUES

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Abstract

The volumetric reduction characteristic of distinct Topology Optimization (TO) techniques is attractive to both academia and industry applications. This interest stems from financial reasons associated with the reduction in material consumption and environmental aspect, which involves the reduction of natural resources and pollutant emissions. Furthermore, reinforcement provides an economically viable alternative to improve the mechanical properties of parts, inducing greater performance in engineering designs. This study presents a topology optimization formulation for reinforced structural elements based on the Level Set Method (LSM). The coupling between the Isogeometric Boundary Element Method (IGABEM) and a one-dimensional Boundary Element Method (1DBEM) for truss elements evaluates the mechanical quantities required to construct the LSM velocity field. The IGABEM represents the mechanical behavior of the solid matrix at each optimization iteration, while a 1DBEM simulates the mechanical behavior of the reinforcements. The same isogeometric mesh defines the contour of the level set function and also serves as the IGABEM mechanical mesh. Thus, the formulation avoids approximations between the geometric and mechanical descriptions of the problem. The augmented Lagrangian method defines the optimization problem of compliance minimization and assists in constructing the normal boundary velocity field through shape sensitivity. This approach enables the coupling between the mechanical analysis and the LSM. Moreover, a heuristic topology modification criterion overcomes the LSM deficiency regarding cavities generation. Finally, numerical examples demonstrate the formulation robustness and compare the resulting final geometries with those obtained by TO without reinforcement.