

ON PRESSURE-LOADED MULTI-MATERIAL STRUCTURES USING TOPOLOGY OPTIMIZATION

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Abstract

Multi-material designs subjected to design-dependent pressure loads have various engineering applications. This paper presents a topology optimization (TO) method to design such multimaterial structures subjected to fluidic pressure load. The multimaterial framework and the handling of pressure loads in a TO pose several distinct challenges. As the former increases computational challenges while making the TO problem highly nonlinear, the latter changes their magnitudes, directions, and/or locations as the design evolves. We employ a novel generalized shape function approach to address the challenges posed by a multimaterial framework, extending the linear, bilinear, and trilinear shape functions. The design-dependent nature of the fluidic pressure is tackled using the Darcy law with an additional drainage term. The flow coefficient is determined in association with the generalized shape function approach using a modified smooth Heaviside function. To demonstrate the method's efficacy, a few compliance minimization problems with many materials are solved. This approach uses fewer design variables per element than the number of materials. The proposed method is suitable for a higher number of materials while involving design-dependent pressure loads.