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Topology Optimization considering design-dependent Stokes flow loads

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Abstract

This article presents an evolutionary topology optimization method for mean compliance minimization of structures under design-dependent viscous fluid flow loads. The structural domain is governed by the elasticity equation and the fluid by the incompressible Stokes flow equations. When the modelling of a system consists in the interaction of multiple domains, the classic density-based topology optimization methods become arduous within the framework of dealing with the moving multi-physics loads and interfaces, due to the considerable volume of intermediate density elements. Herein it is suggested an alternative methodology to handle this type of loading problems. With an extended Bi-directional Evolutionary Structural Optimization (BESO) method, design-dependent Stokes flow loads are modelled straightforward during the optimization procedure. The discrete nature of the method allows both fluid and structural domains to be modelled separately in each step of the optimization. In order to validate the methodology, only small structural displacements and a simple staggered fluid-structure interaction algorithm are considered in this paper. Primary results are shown for a 2D flexible structure immersed in an incompressible viscous flow channel.

Keywords: topology optimization; BESO method; design-dependent loads; fluid-structure interaction; stokes flow.