基于SIMP和SSV的结构与支撑拓扑优化设计

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关键词： 结构 支撑 拓扑优化 SIMP SSV约束

摘 要： 针对SIMP方法中，存在中间支撑密度单元，且对拓扑分布有一定影响的情况，引入SSV约束，提出了一种基于SIMP方法和SSV约束的方法即SIMP-SSV方法，其思路是用SIMP的优化结果初始化SSV方法中的设计变量，再用SSV方法得到最终的优化目标。用SIMP-SSV方法同时进行了具有最小柔度的结构与支撑的拓扑优化设计。算例表明，SIMP-SSV方法不仅使拓扑分布更加清晰，有效消除了中间支撑变量对结构与支撑拓扑分布的影响，而且可使最小柔度比SIMP的更小。 In the results of topology optimization with SIMP (solid isotropic material with penalization model), there are always some grey areas with intermediate densities. The intermediate densities of supports will have an effect on the topologies of structure and support. In order to drive the solution to a 0/1 layout a new constraint, labeled the sum of squares of the variables (SSV) was introduced for the first time. The constraint stipulated that the SSV must be larger or equal to its value at a discrete design for a specified amount of material. Based on the SIMP approach and the SSV constraint, a two-pass method has been proposed, where SIMP was employed to generate an intermediate solution to initialize the design variables and SSV was then adopted to produce the final design. In SSV stage, the design variables were still the densities of the finite elements but Young's modulus was a linear function of these densities (in some sense, a SIMP material without penalty). The potential of the present method has been demonstrated by simultaneous topological design of structure and support for minimum compliance. The examples showed that the hybrid technique could effectively remove all intermediate densities of support, whose effects were eliminated accordingly, and generate stiffer optimal designs characterized with a sharper boundary in contrast to SIMP.

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