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Multi-objective Free-form Optimization for Shape and Thickness of Shell Structures with Composite Materials

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Abstract

In this paper, we present a two-phase optimization method for designing the shape and thickness of a shell structure consisting of an orthotropic material. Compliance vector for multiple loadings is used as the objective functional. The objective functional is quantified by the weighted sum method and minimized under the volume and the state equation constraints. In 1st phase, the shape is optimized, in which it is assumed that a shell is varied in the out-of-plane direction to the surface to create the optimal free-form. In 2nd phase, thickness optimization is implemented following the shape optimization to decrease the compliance further. A parameter-free shape and thickness optimization problem is formulated in a distributed-parameter system based on the variational method. The shape and thickness sensitivities are theoretically derived and applied to the H1 gradient method for shape and size optimization. The optimal multi-objective free-form of a shell structure with an orthotropic material can be determined using the proposal method, and the influence of orthotropic materials to the optimum shape and thickness distribution is fully investigated.

Keywords: Shell, Free-form, Shape optimization, Thickness optimization, Composite material.