APCOM & ISCM
11-14th December, 2013, Singapore

Parameter-free Shape Optimization Method for Natural Vibration Problem of Stiffeners on Thin-walled Structures

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In this paper, we present a parameter-free shape optimization method for designing stiffeners on thin-walled structures subject to natural vibration. The design problems deal with natural frequency maximization problem and volume minimization problem, which are subject to a volume constraint and an eigenvalue constraint respectively. The boundary shapes of stiffeners are determined under the condition where the boundary is movable in the in-plane direction to the surface. The both optimization problems are formulated as distributed-parameter shape optimization problems, and the shape gradient functions are derived using the material derivative method and the adjoint variable method. The optimal free-boundary shapes of stiffeners are obtained by applying the derived shape gradient functions to the H^1 gradient method for shells, which is a parameter-free shape optimization method proposed by one of the authors. Several design examples are presented to validate the proposed method and demonstrate its practical utility of the proposed method.

Keywords: Shape optimization, Parameter-free, Stiffener, Thin-walled structure, Shell, FEM