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On the optimal design of curved folded plates with multiple loading

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Abstract

The minimum weight design as an objective was a rather popular topic during the "golden ages" of optimization. The classical solutions of the different type of plate or shell problems can be followed by the works of Mroz [1], Prager & Shield [2], Shield [3,4] and Rossow and Taylor[5]. The design was elaborated in elastic or plastic ways. This presentation will overview these almost forgotten results, more specially the analytical solutions and the non-uniqueness of the optimal solutions.

The plated structures are one of the most frequently used engineering structures. The object of this research work is the optimal design of curved folded plates. This work is an ongoing investigation. There are various solution methods to analyse this type of structures, here the finite strip method is applied. At first, a single load case is considered, but later multiple load cases are used for the design. The base formulation is a minimum volume design with displacement constraint what is represented by the strain energy. For the multiple loading cases three topology optimization algorithms are elaborated: minimization of the maximum strain energy with respect to a given volume, minimization of the weighted sum of the compliance of the connected load cases with respect to a given volume and finally the minimization of the volume of the structure subjected to displacement constraints. The numerical procedures are based on iterative formula, which are formed by the use of the first order optimality condition of the Lagrangian-functions. A comparative study is presented where the first two multiple loading models introduced above (minimization of the maximum strain energy, minimization of the weighted sum of the compliance of the load cases) are investigated. The application is illustrated by numerical examples. According to our preliminary results in the multiple load cases the optimal layouts are coincident by the analytical achievements of Nagtegaal and Prager.

References

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