EngOpt2018 - 6th International Conference on Engineering Optimization
Instituto Superior Técnico, Lisbon Portugal • 17-19 September, 2018
Editors: H.C. Rodrigues, J. Herskovits, C.M. Mota Soares, et al.

Abstract ID 1267

DESIGN OF LOW-DENSITY RANK STRUCTURES

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Keywords: Rank structure; Add up model; Maximum stiffness; Multiple loading

Abstract: Rank structures with closed walls can attain maximum stiffness in theory. This study focuses on finding stiffest rank structures with any number of rank planes for any prescribed multi-loading. The performance of the rank structures are quantified by their limiting stiffness at low densities, and therefore they can include rank features at a single scale level. Moreover, regarding the negligible bending stiffness of the thin-sized planes, a so-called add-up model is used to calculate the effective properties of the rank structures by directly adding up the properties of each individual feature. The optimization can then be established to optimize the plane orientations and thicknesses for minimizing the complementary energies by the given stresses. When applying random stresses, the optimized rank structures would exhibit anisotropic behavior, but by giving the right loading conditions, they can be isotropic. Effectiveness and accuracy of the add-up model will be tested by comparing to the analytic results from rank structure, as well as the finite element analysis, and the optimizations are solved for various numbers of rank planes and for both anisotropic and isotropic rank structures.