11th World Congress on Structural and Multidisciplinary Optimisation
07th -12th, June 2015, Sydney Australia

An alternative approach for satisfying stress constraints in continuum topology optimization using nonlinear material modelling

Oded Amir[1]

[1] Israel Institute of Technology, Israel

Abstract

Various difficulties arise when considering stress constraints in computational continuum topology optimization procedures. Possibly the most challenging obstacle is the local nature of stress constraints: The corresponding optimization problem involves a large number of design variables as well as a large number of constraints. In this paper, a novel computational approach is suggested in which the nonlinear, inelastic material behavior is considered. The central idea is to drive the design towards a linear-elastic response by minimizing certain measures related to the inelastic part of the response. Then stress limits are implicitly satisfied, without imposing a large number of local constraints.

The objective in the proposed formulation is to minimize the sum of equivalent plastic strains over the whole design domain. The equivalent plastic strains are state variables determined from the elasto-plastic response governed by J2-flow theory. Global constraints are imposed on volume of material and on compliance, for a given prescribed displacement. Preliminary numerical experiments present promising results. For the classical case of an L-bracket, results obtained by minimizing plastic strains resemble those obtained by other investigators who applied linear-elastic topology optimization procedures with either local or aggregated stress constraints (e.g. [1] and various references therein).

Compared to existing approaches based on linear elasticity with local stress constraints, the suggested procedure is more demanding in the analysis phase. The added complexity is counterbalanced by the reduced complexity of the optimization problem, which involves only a few global constraints. In comparison with constraint aggregation approaches, in the current approach all stress violations are captured accurately and can be reduced simultaneously due to the inclusion of plastic strains in the objective. The potential of the proposed approach for large-scale scenarios, as well as the difficulties encountered, will be thoroughly discussed in the full paper.