Element connectivity parameterization method for the stress based topology optimization for geometrically nonlinear structure

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ABSTRACT

This research develops a novel computational approach for the stress-based topology optimization method (STOM) minimizing volume subject to locally defined stress constraints of geometrically nonlinear structure in the framework of the element connectivity parameterization (ECP) method. It is a classical but difficult engineering problem to constraint the local stress constraints in topology optimization. In the density based topology optimization method, recently some successful optimization methods have been developed for linear elastic structure. Nevertheless being no research to consider static failure constraint in topology optimization for geometrically nonlinear structure, this research develops a novel computational approach for the STOM for geometrically nonlinear structure. In addition to the stress singularity issue, the many constraint issue and the highly nonlinear behavior issue of the local stress constraints, the so called unstable element issue should be properly addressed for geometrically nonlinear structure. To resolve this issue effectively, this research adopts the ECP method which does interpolate and optimize the connectivities among solid finite elements. It is also found that in addition to the unstable element, the stress singularity issue different to that of the density based TO arises in the ECP method. By investigating the singularity behavior in detail, a new *qp*-relaxation method suitable for the ECP method can be developed. To show the validity of the present ECP method with the modified *qp*-relaxation, some two dimensional TO problems are solved.

Key words: stress-based topology optimization; geometrically nonlinear structure; element connectivity parameterization method

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