Multiobjective topology optimization of structures using particle swarm optimization algorithm

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Abstract

In this paper a Metaheuristic approach based on stochastic population and Finite element analysis is used to Multiobjective topology optimization of 2D continuum structures. The goal is a topology with minimum material and maximum stiffness resulting in minimum deflection. To aim this goal, objective functions are minimizing strain energy and maximum stress in whole design domain simultaneously with equilibrium constraint. Multiobjective Particle Swarm Optimization algorithm (MOPSO) is used to handle the problem. This approach is based on creating an initial population and update that population combined with an analyzing program , where finite element analysis is used here, can yield an optimized topology design with moving and subtracting materials from design domain. MOPSO algorithm can be considered as a suitable tool for solving general Multiobjective optimization problems and especially for Multiobjective topology optimizations. In this way, analogy with behavior of particles in a community using best personal and global positions to achieve a specific goal, the decision will be made to retention or removal of an element in design domain.

Keywords: Topology optimization, particle swarm optimization, Multiobjective optimization.

1. Introduction

Structural optimization is one of most developing objects in the field of optimization. Structural optimization consists of minimizing required materials to build a structure to resist applied loads and based on supporting conditions.

Structural optimization is divided into 3 major fields: size optimization, shape optimization and topology optimization.

Size optimization is optimizing diameter or cross section of members in a structure while topology and shape of that structure is predefined.

Shape optimization is a kind of optimization that our goal is to optimize shape of a structure while the topology is predefined.

In topology optimization, our aim is to evaluate optimized material distribution in the design domain to build a structure and eliminate them if needed. Topology optimization can be represented in continuous or discrete form. We can see discrete one in truss or frame systems. In continuous form, the design domain divides to finite and rectangular elements that each element in the design domain can be full or empty of material. In that case, our goal is to find optimized distribution of full and empty elements to find structure's optimal topology that this work is one of most challenging fields in structural optimization.

Topology optimization has attracted much attention because of its wide applications in industry.

For this, in the past decades numerous approaches have presented for structural topology optimization [1-2]. One of these approaches is Sensitivity analysis that presented by Kibsgaard [3]. This method is based on gradient calculation of objective functions according to design domain and consists of consecutive derivation in the design domain.