8th National Congress on Civil Engineering, 7-8 May 2014
Babol Noshirvani University of Technology, Babol, Iran

Discrete Size Optimization of Truss Structures Using Modified Honey Bee Mating Optimization Algorithm

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Abstract

Most structural engineering optimization problems that are used in practice require considering the design variables as discrete quantities. This paper presents a modified honey bee mating optimization (MHBMO) algorithm for optimizing the truss structures with discrete design variables, which are subjected to stress, displacement and buckling constraint. In order to demonstrate the effectiveness of the mentioned algorithm, some numerical examples from the literature were tested using this method and their results were compared with those obtained using other well-known meta-heuristic search techniques. The results express that the MHBMO algorithm is very effective and robust for the discrete optimization designs of truss structural problems.

Keywords: Truss structure, Optimization algorithm, Discrete variable, MHBMO, Honey Bee.

1. INTRODUCTION

Structural optimization strategies have been created to minimize the cost of structures, while satisfying the performance and construction criteria required by the design codes and specifications. Designers are able to produce better designs while saving time and money through the process of optimization. To achieve this goal, over the last five decades many elegant and sophisticated optimization-based techniques have been successfully applied to a wide range of structural optimization problems. Recently, direct search techniques based on the models of social biologically inspired algorithms have attracted the attention of researchers. Algorithms belonging to this field imitate the collective behavior of a group of social insects (for example: bees, termites, ants and wasps) to solve complex optimization problems [1]. Ant colony optimization and particle swarm optimization which they are well known swarm-based algorithms are employed to solve structural optimization problems [2, 3]. Lamberti and Pappalettere [4] and also Saka and Dogan [5] achieved a comprehensive review of the meta-heuristics and their applications in the field of structural optimization. Recently, Honey-bee mating has been considered as a typical swarm-based approach to optimization problems, in which the search algorithm is inspired by the process of mating in real honey-bees [6]. This is a direct-search method that the objective function utilizes and constraint values are used to guide the search strategy. The behavior of honey-bees is the interaction of their genetic potentiality, ecological and physiological environments and the social conditions of the colony. Each bee undertakes sequences of actions, which unfold according to genetic, ecological and social conditions of the colony [7].

In the practical structural optimization problems, the industrial cross sections are used, which have discrete values. Therefore, for this type of optimization problem, a discrete solution is preferred over a continuous one. In an optimization problem, when the design variables are selected from a set of a series of specific values, this problem becomes considered to be a discrete one. In size optimization problems, it is easy to change the answers of a continuous optimization problem to the nearest acceptable cross section value, but in this research, by allowing the agents to select only the discrete values from a list of some permissible cross sections, the optimal industrial cross sections are found directly. In discrete size optimization algorithms, if any of the agents rely upon the selection of another value for a design variable, the algorithm changes its magnitude to the value of the nearest bigger discrete cross section [8].