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Optimum design of steel frames using Modified Honey Bee Mating Optimization algorithm

Seied Hosein Afzali[1], Abbas Darabi[2]
1-Assistant professor of Civil Engineering,
Dept. of Civil Eng., School of Engineering, Shiraz University (Corresponding author).

2- MSc. student of Civil Engineering,
Dept. of Civil Eng., School of Engineering, Shiraz University.

afzali@shirazu.ac.ir

Abstract

Over the last decade, some evolutionary and meta-heuristic algorithm has been used as optimization tools in various Engineering problems. In this way, the Modified Honey Bee Mating Optimization may also be considered as a typical swarm-based approach for optimizing some practical problems in Civil Engineering. In this paper, a design procedure based on the MHBMO technique is developed for discrete optimization of the W-shaped steel frames. The objective function in this research is to obtain minimum weight frames subject to strength and displacement requirements imposed by the American Institute for Steel Construction (AISC) Load and Resistance Factor Design (LRFD). Two frame examples from the literature are examined to verify the suitability of the design procedure and to robustness of the MHBMO algorithm for frame structures. The comparison between the results shows that the introduced algorithm is a powerful search and applicable optimization method for design of the W-shaped steel frames.

Keywords: MHBMO, Steel frame, Optimization, Algorithm.

1. INTRODUCTION

Optimization is defined as finding solution of problems where it is necessary to maximize or minimize a function within a domain which contains several variables while some restrictions are to be satisfied [1]. There are the large amounts of set of variables in the domain that maximizes or minimizes the real function while satisfying the described restrictions. The solution which is the best among them that satisfy constrains is the optimum solution of the problem. In the optimum structural design methods, the main goal isto reduce the total cost of the structure by reducing the material necessary for construction. This goal can be outcome by minimizing the size of the structural elements considering their load carrying capacity. In this way, the methods taking discrete design variables and seeking for the global optimum under the constraints have drawn a lot of attention among the researchers and the engineers in practice. Among the various optimization methods developed and used in the structural optimization, the recent innovative stochastic search techniques emerged use nature as a source of inspiration to establish a numerical search algorithm for solving complex engineering problems and they do not suffer the discrepancies of mathematical programming based optimum design methods [2]. In these techniques,the natural phenomena such as survival of the fittest, the social interaction of ant colonies, swarm intelligence, the process of food foraging of honey bees, etc.would be simulated by a numerical algorithm [3,4]. These methods are very suitable and effective in finding the solution of discrete structural optimization problems [5,6].

Recently, Abbass [7,8] developed an optimization algorithm based on the honey-bee marriage processand showed that this algorithm has a great potential and good perspective for the solution of various optimization problems. The Honey Bee Mating Optimization(HBMO) algorithm has also remarkable accuracy and calculation speed to deal with the optimization problem.Honey-bee mating may be considered as a typical swarm-based approach to optimization, in which the search algorithm is inspired by the process of marriage in real honey-bee.Advantages of the HBMO algorithm are presented in Refs. [1,9]. In this paper a design procedure employing the Modified Honey Bee Mating Optimization (MHBMO) technique has been introduced for discrete optimization of weight of planar steel frames. The total weight of the frame structures subjected to the constraints in the form of strength and displacement requirements imposed by the American Institute for Steel Construction (AISC) and Resistance Factor Design (LRFD) [10] is considered as the objective function. Two frame examples from the literature are examined to verify the suitability of the mentioned design procedure and to demonstrate the effectiveness and robustness of the MHBMO algorithm as an optimal design method for frame structures.