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A COMPRATIVE STUDY OF THREE METAHEURISTICS FOR OPTIMUM DESIGN OF ENGINEERING STRUCTURES

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Since real-life optimization problems are often complex and difficult to solve, developing new solution strategies is always being a challenging topic in engineering. The metaheuristic algorithms are recent additions to get rid of this discordance. These algorithms are inspired by the governing laws of nature. Over the last two decades, various metaheuristics have been developed for structural optimization including Evolutionary Algorithms, Ant Colony Optimization, Particle Swarm Optimizer, Harmony Search Algorithm, Big Bang-Big Crunch Optimization and Charged System Search Algorithm and others. Structural optimization is one of the most active fields in structural mechanics. Size optimization of structures seeks for optimum values of member cross-sectional areas that minimize the structural weight. This optimal solution should also satisfy the inequality constraints that limit design variable sizes (member cross-sectional areas) and structural responses (member stresses and nodal displacements).

One of the recently developed metaheuristic technique is Firefly Algorithm (FA). This method is based on the idealized behavior of flashing characteristics of fireflies. Fireflies communicate, search for pray and breed using various flashing pattern. Firefly Algorithm idealizes and mimics some these flashing patterns in a numerical algorithm. Moreover, Artificial Bee Colony (ABC) is an innovative computational metaheuristic method to solve optimization problems which simulates the foraging of the honey bees. At its core, this optimization technique takes advantage of a relatively simple concept. Another efficient solution tool is Cuckoo Search (CS). Cuckoo birds lay their eggs in the nests of other host birds sometimes removing the host's eggs to provide more possibility of hatching their own eggs. Based on this natural phenomenon Cuckoo Search Algorithm is also one of the very recent metaheuristics which turns the breeding behavior of certain cuckoo species into an engineering optimization technique.

In this study, Firefly Algorithm, Artificial Bee Colony, and Cuckoo Search based optimum design algorithms are used to determine the solutions of structural engineering optimization problems. In the problems, the design constraints include the displacement limitations, inter-story drift restrictions, strength requirements for beams and beam-columns which are formulated according to provisions of LRFD-AISC (Load and Resistance Factor Design of American Institute of Steel Institution). Furthermore, additional constraints are considered to satisfy practical requirements. These include three types of inequalities such as beam to beam, beam to column, and column to column compatibilities. Number of structural engineering problems is considered as design examples to demonstrate the comparative performance of the three metaheuristic optimization algorithms.

Keywords: Optimization of Engineering Structures; Load and Resistance Factor Design; Combinatorial Optimization; Metaheuristic Search Techniques