Guest Editorial
Structural Design Optimization

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Structural design optimization has achieved significant progresses in recent years. Modern structural optimization techniques combine the finite element analysis with mathematical programming or optimality criteria methods into a single scheme to automatically generate optimal designs. With advances in computer technology, there is no doubt that structural optimization techniques will become essential design tools in design offices. This special issue reflects recent advances in structural design optimization.

The first three papers deal with the design optimization of skeletal structures. The paper by Saka presents the optimum geometry design of geodesic domes using the harmony search algorithm. The optimization method treats the height of the crown and the cross-sectional designations of members as design variables. The author demonstrates that the harmony search algorithm is an effective technique for determining the optimal geometry of geodesic domes. In the paper by Terlaje and Truman, structural optimization technique is employed to identify stiffness parameters in frames and trusses and to detect damages in structures. The optimality criteria method is used to solve the optimization problem. Examples are presented to illustrate the effectiveness of the structural identification and damage detection methods. The paper by Gong deals with the design optimization of long-span king-post trusses. Through two practical examples, the author provides design guidelines for the cost-effective design of long-span king-post trusses.

Sensitivity analysis forms an essential part of structural optimization methods. The paper by Petchsasithon and Gosling presents a method for the shape and thickness sensitivity analysis of linear shell structures. The method employs an 18-node hexahedral solid shell finite element to alleviate locking phenomena and the design element concept to avoid re-meshing in the optimization process. The paper by Wang et al. describes the analysis and design optimization of axially moving structures with stability constraints under wind excitations.

The rest papers in this special issue deal with the design optimization of continuum structures. The paper by Bruggi and Cinquini presents a topology optimization method for continuum structures under multiple loading conditions using mixed finite elements and nodal densities as design variables. The method of moving asymptotes is used in the optimization algorithm to achieve optimal designs. Rong et al. reports on the evolutionary structural optimization (ESO) of mixed structures with continuum and discrete finite elements. The method presented is shown to be useful for the optimal design of bracing systems for frame structures. In the paper by Guan and Doh, the ESO method is employed to develop strut-and-tie models in deep beams with web openings. A worked design example is provided to show the practical application of the ESO method. Leu and Lee presents the development of an optimal design system using finite element packages as analysis engines. The optimal design system can be used to obtain optimal solutions for complex design problems including linear and nonlinear plate and shell structures. Huang et al. describes the advantages of bi-directional evolutionary structural optimization over evolutionary structural optimization in terms of computational efficiency and robustness. The authors tested both techniques with interesting 2D and 3D examples. The last paper by Liang presents a state-of-the-art review on performance-based optimization (PBO) techniques. The author demonstrates the effectiveness and validity of automated PBO techniques as advanced design tools with practical design examples.

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