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Scott A. Burns (ed.): Recent Advances in Optimal Structural Design. American Society of Civil Engineers, Reston, Virginia, 2002. p. 385 (ISBN 0-7844-0636-7)

During the past two decades, many new developments in computational techniques and applications of structural optimization have taken place. This book documents most of these developments. The book was produced by the Technical Committee on Optimal Structural Design of the American Society of Civil Engineers. It comprises eleven chapters, each contributed by a member or members of the Committee.

In the first Chapter, Arora reviews optimization methods that can treat discrete design variables. A general mixed continuous-discrete variable optimization problem is first defined. Then, six categories of this problem are presented. Procedures and some recent applications of various methods for solving the different categories of the problem are reviewed. These include: integer programming, sequential linearization, simulated annealing, genetic algorithms, among others.

In Chapter 2, Balling surveys decomposition methods in structural optimization. These methods have been developed for decomposing large problems into smaller ones that can be solved by different groups of engineers working in parallel. Methods of decomposition are divided into three classes based on the degree of disciplinary autonomy that they provide the different groups of engineers working on a design problem. The writer focuses on two of the three classes of decomposition methods that have demonstrated impressive efficiency, namely those methods that provide analysis autonomy, and those that provide both analysis and design autonomy.

Pezeshk and Camp, in Chapter 3, present an overview of the use of genetic algorithms in the design of steel structures. The writers provide an introduction to genetic algorithms. The Chapter concludes with a chronological survey of research work related to genetic algorithms in structural steel design.

Next, Grierson and Khajehpour discuss in the fourth Chapter a particular view of the conceptual design problem for engineering structures. Specifically, the design exercise is treated as a multi-criteria optimization problem. Pareto optimization is discussed to illustrate its capability to simultaneously consider multiple conceptual designs. The use of genetic algorithms to solve the multi-criteria optimization problem is explained. Then, a literature review concerning the development of computer-based conceptual design procedures is presented.

Chapter 5, by Ohsaki and Swan, presents a review of discrete and continuum structural shape and topology optimization methods. A number of examples that have been solved in the literature with continuum structural topology optimization techniques are included. The Chapter concludes by discussing several difficulties that need to be overcome to establish efficient methods for topology optimization.

In the sixth Chapter, Xie et al. present a simple approach to optimal design that is based on the concept of slowly removing inefficient materials from a structure so that the residual structure evolves towards the optimum. They name this approach evolutionary structural optimization (ESO). To increase the reliability and efficiency of the ESO algorithm when used to optimize large structural systems, the writers introduce a technique called bi-directional ESO that allows for material addition as well as removal.

In Chapter 7, Xu presents a comparison of different design specifications of semi-rigid steel-framed structures, together with a review of research on connection behavior and semi-rigid frame analysis and design. Then, research on the design optimization of semi-rigid frames is reviewed. The writer concludes the Chapter by emphasizing that "economy means striking an optimum balance between steel weight and connection cost", and not just concentrating on steel weight reduction.

Foley, in Chapter 8, reviews the current state of structural analysis and design procedures in an attempt to foster ideas regarding the development of algorithms for optimized performance-based design (PBD) for buildings. Current PBD procedures used in seismic design are reviewed. Then, they are extended to wind and gravity load hazards. The writer subsequently reviews acceptance criteria and quantification of the loads needed for PBD optimization. A format for PBD optimization problems is suggested, and several possible solution methods are discussed.

In the following Chapter, Cheng discusses multi-objective optimum design of seismic-resistant structures. The concepts of genetic algorithms, game theory, Pareto optimal set, and life-cycle cost are first discussed. Then, the writer introduces fuzzy logic and multi-level optimization concepts for constrained Pareto genetic algorithms and life-cycle cost. Based on these concepts, new algorithms for multi-objective optimization are developed and applied. It is concluded that multi-objective and multi-level optimization, along with a life-cycle cost model, are essential for determining target reliability and seismic building code performance.

In Chapter 10, Frangopol et al. present a summary of recent developments in reliability- and cost-oriented optimal bridge maintenance planning. Three probabilistic maintenance models are reviewed; these are the corrective maintenance model, the used-based maintenance model, and the condition-based maintenance model. Based on a simplified form of the condition-based maintenance philosophy, a methodology is presented for optimizing the life-cycle inspection and repair of any deteriorating bridge.

The last Chapter includes a substantial collection of 2383 structural optimization-related journal publications compiled by Burns, covering the period from 1985 up to 1999, along with an index grouping them according to topic. No claim is made in the book that the reference list is complete. However, while the list includes many papers published in *Nippon Kikai Gakkai Ronbunshu, C Hen/Transactions of the Japan Society of Mechanical Engineers, Part C*, which is hardly accessible to researchers in North America and Europe, it does not include any papers from an easily accessible publication like the *PCI Journal*. Recently, several structural optimization-related papers have been published in the *PCI Journal*. This, however, cannot detract from the usefulness of the reference list.

Although the lengths of the different chapters in this book are not consistent, with some being noticeably shorter than others, each chapter adequately covers a particular state-of-the-art aspect of the

field. The book is a valuable reference on many new developments in computational techniques and applications of structural optimization. It is the only document of its kind that is currently up to date and includes a substantial recent bibliography. This book is of considerable value to researchers and students working in this area, and to practicing engineers interested in understanding how structural designs will be optimized in the 21st century.

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