

Cross-Sectional Area Constraint:  $(w_1 + w_2)(H_1 + H_2 + 1)/2 = 150$  or

$$h_1 = (w_1 + w_2)(H_1 + H_2 + 1)/2 - 150 = 0;$$

Excavated Material Constraint:  $(w_1 + w)(H_1/2) = (2)(w_2 + 2)(H_2 + 1)/2$  or

$$h_2 = (w_1 + w)(H_1/2) - (w_2 + 2)(H_2 + 1) = 0$$

The design variables are not independent; they are related as follows:

$$\tan \theta = \frac{H_1}{(w - w_1)/2} = \frac{H_2 + 1}{(w_2 - 2)/2} = \frac{H_1 + H_2 + 1}{(w_2 - w_1)/2}$$

So we get two more constraints from these relationships, as

$$h_3 = \frac{H_1}{w - w_1} - \frac{H_2 + 1}{w_2 - 2} = 0;$$

$$h_4 = \frac{H_1}{w - w_1} - \frac{H_1 + H_2 + 1}{w_2 - w_1} = 0$$

All the design variables must also be nonnegative:

$$-w \leq 0; \quad -w_1 \leq 0; \quad -w_2 \leq 0; \quad -w_3 \leq 0; \quad -H_1 \leq 0; \quad -H_2 \leq 0$$

### **Formulation 2:**

#### **Step 1: Problem Statement**

Shown above

#### **Step 2: Data and Information Collection**

Shown above

#### **Step 3: Definition of Design Variables**

$w_1$ ,  $H_1$ ,  $H_2$  (m), and  $s$  (unitless) are chosen as design variables which are defined below in relation to Figure E2.22:

$$s = \tan \theta$$

$$w = w_1 + \frac{2H_1}{s}$$

$$w_2 = w_1 + \frac{2(H_1 + H_2 + 1)}{s}$$

$$w_2 = 2 + \frac{2(H_2 + 1)}{s}$$

#### **Step 4: Optimization Criterion**

Optimization criterion is to minimize the volume of excavation, and the cost function is defined as:

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**Siddappa N.Byrareddy**



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Optimal Design and Control Jeff Borggaard, John Burkhardt, Max Gunzburger, Janet Peterson, 2012-12-06 This volume is the proceedings of the Workshop on Optimal Design and Control that was held in Blacksburg Virginia April 8 9 1994 The workshop was sponsored by the Air Force Office of Scientific Research through the Air Force Center for Optimal Design and Control CODAC at Virginia Tech The workshop was a gathering of engineers and mathematicians actively involved in innovative research in control and optimization with emphasis placed on problems governed by partial differential equations The interdisciplinary nature of the workshop and the wide range of subdisciplines represented by the participants enabled an exchange of valuable information and also led to significant discussions about multidisciplinary optimization issues One of the goals of the workshop was to include laboratory industrial and academic researchers so that analyses algorithms implementations and applications could all be well represented in the talks this interdisciplinary nature is reflected in these proceedings An overriding impression that can be gleaned from the papers in this volume is the complexity of problems addressed by not only those authors engaged in applications but also by those engaged in algorithmic development and even mathematical analyses Thus in many instances systematic approaches using fully nonlinear constraint equations are routinely used to solve control and optimization problems in some cases replacing ad hoc or empirically based procedures

**Case Studies in Optimal Design and Maintenance Planning of Civil Infrastructure Systems** Dan M. Frangopol, 1999-01-01 Sponsored by the Structural Engineering Institute of ASCE This collection contains 19 papers on the optimal design and maintenance planning of civil infrastructure systems such as bridges buildings transmission line structures and nuclear power plants The authors coming from Austria Canada Denmark England Germany Israel Japan Malaysia Mexico Switzerland and the United States offer case studies that are detailed and research findings that describe applications of life cycle reliability and optimization theories to civil infrastructure systems Topics include prioritization of bridge maintenance needs life cycle optimization of structures cost effectiveness optimization for aseismic design criteria of buildings condition assessment and maintenance of aging structures in critical facilities condition assessment of bridges optimization of quality assurance of welded structures optimal reliability based bridge maintenance planning effective reanalysis for damaged structures optimal design of transmission line structures optimization and reliability lifetime oriented design and optimum policy for civil infrastructure improvement decision making This book serves as a valuable reference to engineers and managers concerned with design and maintenance planning of civil infrastructure systems

**Introduction to Optimum Design** Jasbir Singh Arora, 2011-08-12 Introduction to Optimum Design Third Edition describes an organized approach to engineering design optimization in a rigorous yet simplified manner It illustrates various concepts and procedures with simple examples and demonstrates their applicability to engineering design problems Formulation of a design problem as an optimization problem is emphasized and illustrated throughout the text Excel and MATLAB are

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*Frontier Technologies for Infrastructures Engineering* Alfredo H.S. Ang, Shi-Shuenn Chen, 2009-04-21 An exclusive collection of papers introducing current and frontier technologies of special significance to the planning design construction and maintenance of civil infrastructures This volume is intended for professional and practicing engineers involved with infrastructure systems such as roadways bridges buildings power generating and dis

*Structural Sensitivity Analysis and Optimization 2* K. K. Choi, Nam-Ho Kim, 2006-12-22 Extensive numerical methods for computing design sensitivity are included in the text for practical application and software development The numerical method allows integration of CAD FEA DSA software tools so that design optimization can be carried out using CAD geometric models instead of FEA models This capability allows integration of CAD CAE CAM so that optimized designs can be manufactured effectively

**Advances in Metaheuristic Algorithms for Optimal Design of Structures** A. Kaveh, 2016-11-09 This book presents efficient metaheuristic algorithms for optimal design of structures Many of these algorithms are developed by the author and his colleagues consisting of Democratic Particle Swarm Optimization Charged System Search Magnetic Charged System Search Field of Forces Optimization Dolphin Echolocation Optimization Colliding Bodies Optimization Ray Optimization These are presented together with algorithms which were developed by other authors and have been successfully applied to various optimization problems These consist of Particle Swarm Optimization Big Bang Big Crunch Algorithm Cuckoo Search Optimization Imperialist Competitive Algorithm and Chaos Embedded Metaheuristic Algorithms Finally a multi objective optimization method is presented to solve large scale structural problems based on the Charged System Search algorithm The concepts and algorithms presented in this book are not only applicable to optimization of skeletal structures and finite element models but can equally be utilized for optimal design of other systems such as hydraulic and electrical networks In the second edition seven new chapters are added consisting of the new developments in the field of optimization These chapters consist of the Enhanced Colliding Bodies Optimization Global Sensitivity Analysis Tug of War Optimization Water Evaporation Optimization Vibrating Particle System Optimization and Cyclical Parthenogenesis Optimization algorithms A chapter is also devoted to optimal design of large scale structures

Reliability and Optimization of Structural Systems Rudiger Rackwitz, Guiliano Augusti, Antonio Borri, 2013-06-05 The 6th meeting sponsored by IFIP Working Group 7.5 on reliability and optimization of structural systems took place in September 1994 in

Assisi Italy This book contains the papers presented at the working conference including topics such as reliability of special structures fatigue failure modes and time variant systems reliability Introduction to Optimum Design Jasbir Singh Arora,2016-04-05 Introduction to Optimum Design Fourth Edition carries on the tradition of the most widely used textbook in engineering optimization and optimum design courses It is intended for use in a first course on engineering design and optimization at the undergraduate or graduate level in engineering departments of all disciplines with a primary focus on mechanical aerospace and civil engineering courses Through a basic and organized approach the text describes engineering design optimization in a rigorous yet simplified manner illustrates various concepts and procedures with simple examples and demonstrates their applicability to engineering design problems Formulation of a design problem as an optimization problem is emphasized and illustrated throughout the text using Excel and MATLAB as learning and teaching aids This fourth edition has been reorganized rewritten in parts and enhanced with new material making the book even more appealing to instructors regardless of course level Includes basic concepts of optimality conditions and numerical methods that are described with simple and practical examples making the material highly teachable and learnable Presents applications of optimization methods for structural mechanical aerospace and industrial engineering problems Provides practical design examples that introduce students to the use of optimization methods early in the book Contains chapter on several advanced optimum design topics that serve the needs of instructors who teach more advanced courses Thirty-sixth AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference and AIAA/ASME Adaptive Structures Forum ,1995 **AIAA Journal** American Institute of Aeronautics and Astronautics,2005 **Structural Optimization** Manohar P. Kamat,1993 This book is the ultimate single reference source on the subject of structural optimization Chapters written by 35 field experts document the state of the art in structural optimization with a view to establishing some of the most promising directions for future research in the field A major emphasis is placed on engineering applications **Engineering Journal** ,1996 **International Journal of Vehicle Design** ,2001 **ESCHENAUER\*OPTIMIZATION METH., IN STRUCTURAL DESIGN** ESCHENAUER,Niels Olhoff,1983 **Applied Mechanics Reviews** ,1997 **International Journal of Modelling & Simulation** ,1994 *Books in Series, 1876-1949* R.R. Bowker Company,1982 Subject Guide to Books in Print ,1971 *Advances in Design Automation, 1989: Mechanical systems analysis, design, and simulation* Bahram Ravani,1989 **Advances in Design Automation, 1987: Design methods, computer graphics, and expert systems** S. S. Rao,1987

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