Elements Of Structural Optimization

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Topology Design of Structures - Martin P Bendse 1993
The efficient use of materials is of great importance, and the choice of the basic topology for the design of structures and mechanical elements is crucial for the performance of sizing of shape optimization. This volume provides a comprehensive review of the state of the art in topology design, spanning fundamental mathematical, mechanical and implementation issues. Topology design of discrete structures involves large scale computational problems and the need to select structural elements from a discrete set of possibilities. The formulation and solution of discrete design problems are described, including new applications of genetic algorithms and dual methods. For continuum problems the emphasis is on the `homogenization method', which employs composite materials as the basis for defining shape in terms of material density, unifying macroscopic structural design optimization and micromechanics. All aspects of this field are covered, including computational aspects and the use of the homogenization method in a computer-aided design environment.
Structural Optimization with Approximate Sensitivities - Surya N. Patnaik 1994
Applied mechanics reviews - 1948

Discretization Methods and Structural Optimization — Procedures and Applications - Hans A. Eschenauer 2012-12-06
In recent years, the Finite Element Methods FEM were more and more employed in development and design departments as very fast working tools in order to determine stresses, deformations, eigenfrequencies etc. for all kinds of constructions under complex loading conditions. Meanwhile. very effective software systems have been developed by various research teams although some mathematical problems (e. g. convergence) have not been solved satisfac torily yet. In order to make further advances and to find a common language between mathe maticians and mechanicians the "Society for Applied Mathematics and Mechanics" (GAMM) agreed on the foundation of a special Committee: "Discretization Methods in Solid Mechanics" focussing on the following problems: - Structuring of various methods (displacement functions, hybrid and mixed approaches, etc. >, - Survey of approach functions (Lagrange-/Hermite-polynominals, Spline-functions), - Description of singularities, - Convergence and stability, - Practical and theoretical optimality to all mentioned issues (single and interacting). One of the basic aims of the GAMM-Committee is the interdisciplinary cooperation between mechanicians, mathematicians, and users which shall be intensified. Thus, on September 22, 1985 the committee decided to hold a seminar on "Structural Optimization" in order to allow an exchange of experiences and thoughts between the experts of finite element methods and those of structural optimization. A GAMM-seminar entitled "Discretization Methods and Structural Optimization - Procedures and Applications" was hold on October 5-7, 1988 at the Unversity of Siegen.
Recent Advances in Optimal Structural Design - Scott A. Burns 2002-01-01
Sponsored by the Technical Committee on Structural Design of the Technical Administrative Committee on Analysis and Computation of the Technical Activities Division of the Structural Engineering Institute of ASCE. This report documents the dramatic new developments in the field of structural optimization over the last two decades. Changes in both computational techniques and applications can be seen by developments in computational methods and solution algorithms, the role of optimization during the various stages of structural design, and the stochastic nature of design in relation to structural optimization. Topics include: Ømethods for discrete variable structural optimization; Ødecomposition methods in structural optimization; Østate of the art on the use of genetic algorithms in design of steel structures; Øconceptual design optimization of engineering structures; Øtopology and geometry optimization of trusses and frames; Øevolutionary structural optimization; Ødesign and optimization of semi-rigid framed structures; Øoptimized performance-based design for buildings; Ømulti-objective optimum design of seismic-resistant structures; and Øreliability- and cost-oriented optimal bridge maintenance planning. The book concludes with an extensive bibliography of journal papers on structural optimization published between 1987 and 1999.
Computational Mechanics for Heritage Structures - B. Leftheris 2006
Reflecting the authors' extensive experience, and describing the results of projects they have worked on, this book deals with applications of advanced computational mechanics techniques in structural analysis, strength rehabilitation and aseismic design of monuments, historical buildings and related structures. The results are given with clear explanations so that civil and structural engineers, architects and archaeologists, and students of these disciplines can understand how to evaluate the structural worthiness of heritage buildings without the use of difficult mathematics.
Advances in Structural Optimization - José Herskovits 1995
This text presents the techniques for a wide set of applications, ranging from the problems of size and shape optimization (historically the first to be studied) to topology and material optimization. Structural models are considered that use both discrete and finite elements. Structural materials can be classical or new. Emerging methods are also addressed, such as automatic differentiation, intelligent structures optimization, integration of structural optimization in concurrent engineering environments, and multidisciplinary optimization.
Structural Optimization - Kevin Z. Truman 2019-12-12
Today's biggest structural engineering challenge is to design better structures, and a key issue is the need to take an integrated approach which balances control of costs with the requirement for handling earthquakes and other dynamic forces. Structural optimization is based on rigorous mathematical formulation and requires computation algorithms for sizing structural elements and synthesizing systems. Now that the right software and enough computing power are readily available, professionals can now develop a suite of alternative designs and a select suitable one. A thoroughly-written and practical book on structural optimization is long overdue. This solid book comprehensively presents current optimization strategies, illustrated with sufficient examples of the design of elements and systems and presenting descriptions of the process and results. Emphasis is given to dynamic loading, in particular to seismic forces. Researchers and practising engineers will find this book an excellent reference, and advanced undergraduates or graduate students can use it as a resource for structural optimization design.
Structural Optimization, - A. Borkowski 1990-01-31

Structural Optimization - Franklin Y. Cheng 2017-12-21
Today’s biggest structural engineering challenge is to design better structures, and a key issue is the need to take an integrated approach which balances control of costs with the requirement for handling earthquakes and other dynamic forces. Structural optimization is based on rigorous mathematical formulation and requires computation algorithms for sizing structural elements and synthesizing systems. Now that the right software and enough computing power are readily available, professionals can now develop a suite of alternative designs and a select suitable one. A thoroughly-written and practical book on structural optimization is long overdue. This solid book comprehensively presents current optimization strategies, illustrated with sufficient examples of the design of elements and systems and presenting descriptions of the process and results. Emphasis is given to dynamic loading, in particular to seismic forces. Researchers and practising engineers will find this book an excellent reference, and advanced undergraduates or graduate students can use it as a resource for structural optimization design.
Topological Optimization of Buckling - Bingchuan Bian 2018-09-24
This book discusses the application of independent continuous mapping method in predicting and the optimization of the mechanical performance of buckling with displacement, stress and static constrains. Each model is explained by mathematical theories and followed by simulation with frequently-used softwares. With abundant project data, the book is an essential reference for mechanical engineers, structural engineers and industrial designers.
Elements of Structural Optimization - Raphael T. Haftka 2012-12-06
The field of structural optimization is still a relatively new field undergoing rapid changes in methods and focus. Until recently there was a severe imbalance between the enormous amount of literature on the subject, and the paucity of applications to practical design problems. This imbalance is being gradually redressed. There is still no shortage of new publications, but there are also exciting applications of the methods of structural optimizations in the automotive, aerospace, civil engineering, machine design and other engineering fields. As a result of the growing pace of applications, research into structural optimization methods is increasingly driven by real-life problems. t-.Jost engineers who design structures employ complex general-purpose software packages for structural analysis. Often they do not have any access to the source program, and even more frequently they have only scant knowledge of the details of the structural analysis algorithms used in this software packages. Therefore the major challenge faced by researchers in structural optimization is to develop methods that are suitable for use with such software packages. Another major challenge is the high computational cost associated with the analysis of many complex real-life problems. In many cases the engineer who has the task of designing a structure cannot afford to analyze it more than a handful of times.
Structural Optimization Under Stability and Vibration Constraints - M. Zyczkowski 1989-12-27
Optimal design of structures leads, as a rule, to slender and thin-walled shapes of the elements, and such elements are subject to the loss of stability. Hence the constraints of structural optimization usually include stability constraints, expressed by some eigenvalues. Optimal design under vibration constraints belongs also to optimization with respect to eigenvalues. The present volume gives a short introduction to structural optimization and then pays particular attention to multimodal optimization under stability and vibration constraints, both in elastic and inelastic range. One part is devoted to thin-walled bars optimized for interactive buckling with imperfections taken into account. The volume is of interest both to researchers and design engineers: it covers the most recent results of multimodal and interactive optimization, allowing for inelastic behaviour of structures, and the constraints discussed appear in almost all problems of engineering design.
Discrete Structural Optimization - W. Gutkowski 1997-03-07
The engineering design of structures and machines consists often in finding the best solution among a finite number of feasible decisions. This volume comprises problems and solution methods for discrete structural optimization. Exact, approximate and heuristic methods are presented applying deterministic and stochastic approaches.
Evolutionary Structural Optimization - Y.M. Xie 2012-12-06
Evolutionary Structural Optimization (ESO) is a design method based on the simple concept of gradually removing inefficient material from a structure as it is being designed. Through this method, the resulting structure will evolve towards its optimum shape. The latest techniques and results of ESO are presented here, illustrated by numerous clear and detailed examples. Sections cover the fundamental aspects of the method, the application to multiple load cases and multiple support environments, frequency optimization, stiffness and displacement constraints, buckling, jointed frame structures, shape optimization, and stress reduction. This is followed by a section describing Evolve97, a software package which will allow readers to try the ideas of ESO themselves and to solve their optimization problems. This software is provided on a computer diskette which accompanies the book.
The Finite Element Method for Engineers - Kenneth H. Huebner 2001-09-07
A useful balance of theory, applications, and real-world examples The Finite Element Method for Engineers, Fourth Edition presents a clear, easy-to-understand explanation of finite element fundamentals and enables readers to use the method in research and in solving practical, real-life problems. It develops the basic finite element method mathematical formulation, beginning with physical considerations, proceeding to the well-established variation approach, and placing a strong emphasis on the versatile method of weighted residuals, which has shown itself to be important in nonstructural applications. The authors demonstrate the tremendous power of the finite element method to solve problems that classical methods cannot handle, including elasticity problems, general field problems, heat transfer problems, and fluid mechanics problems. They supply practical information on boundary conditions and mesh generation, and they offer a fresh perspective on finite element analysis with an overview of the current state of finite element optimal design. Supplemented with numerous real-world problems and examples taken directly from the authors' experience in industry and research, The Finite Element Method for Engineers, Fourth Edition gives readers the real insight needed to apply the method to challenging problems and to reason out solutions that cannot be found in any textbook.
Topology Design Methods for Structural Optimization - Osvaldo M. Querin 2017-06-09
Topology Design Methods for Structural Optimization provides engineers with a basic set of design tools for the development of 2D and 3D structures subjected to single and multi-load cases and experiencing linear elastic conditions. Written by an expert team who has collaborated over the past decade to develop the methods presented, the book discusses essential theories with clear guidelines on how to use them. Case studies and worked industry examples are included throughout to illustrate practical applications of topology design tools to achieve innovative structural solutions. The text is intended for professionals who are interested in using the tools provided, but does not require in-depth theoretical knowledge. It is ideal for researchers who want to expand the methods presented to new applications, and includes a companion website with related tools to assist in further study. Provides design tools and methods for innovative structural design, focusing on the essential theory Includes case studies and real-life examples to illustrate practical application, challenges, and solutions Features accompanying software on a companion website to allow users to get up and running fast with the methods introduced Includes input from an expert team who has collaborated over the past decade to develop the methods presented
Structural Optimization by Generalized, Multilevel Decomposition - 1985

Structural Optimization - Franklin Y. Cheng 2017-12-21
Today’s biggest structural engineering challenge is to design better structures, and a key issue is the need to take an integrated approach which balances control of costs with the requirement for handling earthquakes and other dynamic forces. Structural optimization is based on rigorous mathematical formulation and requires computation algorithms for sizing structural elements and synthesizing systems. Now that the right software and enough computing power are readily available, professionals can now develop a suite of alternative designs and a select suitable one. A thoroughly-written and practical book on structural optimization is long overdue. This solid book comprehensively presents current optimization strategies, illustrated with sufficient examples of the design of elements and systems and presenting descriptions of the process and results. Emphasis is given to dynamic loading, in particular to seismic forces. Researchers and practising engineers will find this book an excellent reference, and advanced undergraduates or graduate students can use it as a resource for structural optimization design.

Computational Design of Lightweight Structures - Benoit Descamps 2014-03-10
The author of this book presents a general, robust, and easy-to-use method that can handle many design parameters efficiently. Following an introduction, Chapter 1 presents the general concepts of truss layout optimization, starting from topology optimization where structural component sizes and system connectivity are simultaneously optimized. To fully realize the potential of truss layout optimization for the design of lightweight structures, the consideration of geometrical variables is then introduced. Chapter 2 addresses truss geometry and topology optimization by combining mathematical programming and structural mechanics: the structural properties of the optimal solution are used for devising the novel formulation. To avoid singularities arising in optimal configurations, this approach disaggregates the equilibrium equations and fully integrates their basic elements within the optimization formulation. The resulting tool incorporates elastic and plastic design, stress and displacement constraints, as well as self-weight and multiple loading. The inherent slenderness of lightweight structures requires the study of stability issues. As a remedy, Chapter 3 proposes a conceptually simple but efficient method to include local and nodal stability constraints in the formulation. Several numerical examples illustrate the impact of stability considerations on the optimal design. Finally, the investigation on realistic design problems in Chapter 4 confirms the practical applicability of the proposed method. It is shown how we can generate a range of optimal designs by varying design settings.
Optimierung - Kurt Littger 2013-03-09
Optimierung ist eine Aufgabe von besonderer Bedeutung für Unternehmen und Organisationen. Durch wachsenden Wettbewerb wird dieses Thema immer wichtiger. Hier wird es in einer Darstellungsform behandelt, die den Praktiker ohne große mathematische Vorkenntnisse in dieses komplexe Sachgebiet einführt. Hierbei werden theoretische (algorithmische) Aspekte konzeptionell behandelt und in Beziehung zu Aspekten der Datenverarbeitung (Software) sowie zu den Anwendungsgebieten gestellt, wie z.B. Standort-, Personal-, Produktions- und Vertriebsplanung von Unternehmen. Das Buch führt den Leser von den klassischen Methoden und Anwendungen bis zu den neuesten Verfahren und Problemstellungen betriebswirtschaftlicher und technischer Art. Es trägt dazu bei, dem großen Interessentenkreis aus den verschiedensten Branchen den Blick für die Möglichkeiten des rechnergestützten Optimierens zu öffnen. Von besonderem Wert für den Leser ist der einführende Charakter der Darstellung und das reichhaltige, strukturierte Literaturverzeichnis.
Elements of Structural Optimization - Raphael T. Haftka 1991-11-30
The field of structural optimization is still a relatively new field undergoing rapid changes in methods and focus. Until recently there was a severe imbalance between the enormous amount of literature on the subject, and the paucity of applications to practical design problems. This imbalance is being gradually redressed. There is still no shortage of new publications, but there are also exciting applications of the methods of structural optimizations in the automotive, aerospace, civil engineering, machine design and other engineering fields. As a result of the growing pace of applications, research into structural optimization methods is increasingly driven by real-life problems. t-.Jost engineers who design structures employ complex general-purpose software packages for structural analysis. Often they do not have any access to the source program, and even more frequently they have only scant knowledge of the details of the structural analysis algorithms used in this software packages. Therefore the major challenge faced by researchers in structural optimization is to develop methods that are suitable for use with such software packages. Another major challenge is the high computational cost associated with the analysis of many complex real-life problems. In many cases the engineer who has the task of designing a structure cannot afford to analyze it more than a handful of times.
Computers in Engineering, 1982: Mesh generation. Finite elements. Computers in structural optimization. Computers in engineering workplace. Computers in energy systems. Personal computing - 1982

Mathematical Applications in Continuum and Structural Mechanics - Francesco Marmo 2021-11-30
This book presents a range of research projects focusing on innovative numerical and modeling strategies for the nonlinear analysis of structures and metamaterials. The topics covered concern various analysis approaches based on classical finite element solutions, structural optimization, and analytical solutions in order to present a comprehensive overview of the latest scientific advances. Although based on pioneering research, the contributions are focused on immediate and direct application in practice, providing valuable tools for researchers and practicing professionals alike.
Biomechanics - Ghias Kharmanda 2017-02-13
In this book, the authors present in detail several recent methodologies and algorithms that they developed during the last fifteen years. The deterministic methods account for uncertainties through empirical safety factors, which implies that the actual uncertainties in materials, geometry and loading are not truly considered. This problem becomes much more complicated when considering biomechanical applications where a number of uncertainties are encountered in the design of prosthesis systems. This book implements improved numerical strategies and algorithms that can be applied to biomechanical studies.
Elements of Structural Optimization - Raphael T. Haftka 1985

Optimization of Large Structural Systems - G. I. N. Rozvany 1993
Structural optimization deals with the optimal design of all systems that consist, at least partially, of solids that are subject to stresses and/or deformations. Because of the increasing need to optimize discretized systems with many elements, the optimization of large structural systems is becoming an important disciplines in all branches of technology, including aerospace, structural, mechanical, civil and naval engineering, building science, energy technology and biomechanics. Applications range from space vehicles, long-span bridges and motor cars to artificial organs and sporting equipment, and more.
Evolutionary Topology Optimization of Continuum Structures - Xiaodong Huang 2010-03-11
Evolutionary Topology Optimization of Continuum Structures treads new ground with a comprehensive study on the techniques and applications of evolutionary structural optimization (ESO) and its later version bi-directional ESO (BESO) methods. Since the ESO method was first introduced by Xie and Steven in 1992 and the publication of their well-known book Evolutionary Structural Optimization in 1997, there have been significant improvements in the techniques as well as important practical applications. The authors present these developments, illustrated by numerous interesting and detailed examples. They clearly demonstrate that the evolutionary structural optimization method is an effective approach capable of solving a wide range of topology optimization problems, including structures with geometrical and material nonlinearities, energy absorbing devices, periodical structures, bridges and buildings. Presents latest developments and applications in this increasingly popular & maturing optimization approach for engineers and architects; Authored by leading researchers in the field who have been working in the area of ESO and BESO developments since their conception; Includes a number of test problems for students as well as a chapter of case studies that includes several recent practical projects in which the authors have been involved; Accompanied by a website housing ESO/BESO computer programs at http://www.wiley.com/go/huang and test examples, as well as a chapter within the book giving a description and step-by-step instruction on how to use the software package BESO2D. Evolutionary Topology Optimization of Continuum Structures will appeal to researchers and graduate students working in structural design and optimization, and will also be of interest to civil and structural engineers, architects and mechanical engineers involved in creating innovative and efficient structures.
Reliability and Optimization of Structural Systems ’90 - A. Der Kiureghian 2012-12-06
This proceedings volume contains papers presented at the Third Scientific Meeting of the IFIP Working Group on "Reliabilty and Optimization of Structural Systems". The contributions reflect recent developments in the field of modern structural systems optimization and reliability theory and point out directions for further research. Also perspectives for the education in this field were discussed.
Object Oriented Finite Element Analysis for Structural Optimization Using P-Elements - Matthias Baitsch 2004

Finite Elements Analysis: Procedures in Engineering - H. Lakshmininarayana 2004-10
This textbook has emerged from three decades of experience gained by the author in education, research and practice. The basic concepts, mathematical models and computational algorithms supporting the Finite Element Method (FEM) are clearly and concisely developed.

Structural Optimization - Uri Kirsch 1993
"This book introduces the fundamental concepts and practical applications of modern structural optimization. It presents, in a unified approach, recent developments in the area. The text addresses both the student and the practising structural engineer. The book discusses in detail alternative problem formulations, the relative merits of different optimization methods and various considerations related to structural design. The emphasis throughout is on approximation concepts, which are essential for the solution of many practical design problems. It demonstrates how various formulations, methods and approximations are integrated to achieve effective design procedures. The advantages as well as the limitations of the different approaches are discussed and illustrated by numerous examples."--Back cover.
Optimization in Industry - Ian Parmee 2012-12-06
Optimization in Industry comprises a collection of papers presented at the third US United Engineering Foundation's 'Optimization in Industry' Conference. The main thrust of this, the third conference of the series is related to engineering optimization including both manufacture and parametric design. The papers included explore the relationships between well-established deterministic optimization methods and the emerging stochastic and mainly population-based search and optimization algorithms. A mix of approaches across a wide range of engineering disciplines is included. It illustrates the manner in which various techniques can be utilised either in a stand-alone manner or within hybrid systems to give best performance in terms of optimal design and computational efficiency. The papers span scientific, application, awareness/information dissemination and industrial requirements areas. They provide information on available search and optimization techniques and their application to specific design problems and across the field of manufacturing generally. Papers identifying and dealing with problems of incorporating novel optimization techniques within day-to-day design practice and industrial software requirements are also included. The book will thus be of interest to both the industrial and academic communities.
Structural Optimization of Components and Joints in Assemblies Considering Fail-safety - Olaf Ambrozkiewicz 2022
Structural optimization has become an increasingly important part of product development, especially in the aerospace industry, where weight savings due to lightweight design have a particularly strong impact on efficiency and thus economy and environmental compatibility. One area of structural optimization is topology optimization, which offers maximum design freedom and thus enables the greatest improvements. However, load-adapted designs obtained by topology optimization are usually highly sensitive to an unpredictable local loss of stiffness, like e.g. for the case of randomly inflicted damage to individual load paths of the structure. Therefore, these designs are not considered fail-safe. This thesis presents a two-stage procedure for density-based optimization towards a fail-safe design. Existing approaches are either computationally extremely expensive or do not explicitly consider fail-safe requirements in the optimization. The presented method trades off both aspects by employing a two-stage optimization approach to provide redundant designs that offer robustness to the failure of single load paths. In the first stage, a topology optimization with local volume constraints is performed. The second stage is referred to as "density-based shape optimization" since it only alters the outline of the structure while still acting on a fixed voxel-type finite element mesh with pseudo-densities assigned to each element. The performance gain and computational efficiency of the proposed method are demonstrated by application to various 2D and 3D examples. The results show, that the presented method can be carried out with reasonable computational effort, in contrast to existing approaches with explicit consideration of fail-safety in topology optimization. For the 2D examples considered, the number of analyses for a fail-safe optimization is reduced by three orders of magnitude compared to existing methods and is at most 5.6 times higher than for a standard topology optimization. Consequently, the proposed method is also applicable for large-scale models in an industrial context. With the possibility to compute and manufacture single optimized components, the question of how to optimize the connections between different components in an assembly arises. This thesis therefore also provides a method for the simultaneous optimization of the topology of components and their corresponding joint locations in an assembly. Therein, the joint locations are not discrete and predefined, but continuously movable. The underlying coupling equations allow for connecting dissimilar meshes and avoid the need for remeshing when joint locations change. The presented method models the force transfer at a joint location not only by using single spring elements but accounts for the size and type of the joints. When considering e.g. riveted or bolted joints, the local part geometry at the joint location consists of matching holes that are surrounded by material. For spot welds, the joint locations are filled with material and may be smaller than for bolts. The presented method incorporates these material and clearance zones into the simultaneously running topology optimization of the components. Furthermore, failure of joints may be taken into account at the optimization stage, yielding assemblies connected in a fail-safe manner. Finally, by embedding the above-mentioned efficient method for fail-safe optimization of single components in the presented assembly optimization framework, damage tolerant assemblies can be obtained that are robust to the failure of joints and single load paths of each component.
Nonlinear Analysis of Shells by Finite Elements - Franz G. Rammerstorfer 2014-05-04
State-of-the-art nonlinear computational analysis of shells, nonlinearities due to large deformations and nonlinear material behavior, alternative shell element formulations, algorithms and implementational aspects, composite and sandwich shells, local and global instabilities, optimization of shell structures and concepts of shape finding methods of free from shells. Furthermore, algorithms for the treatment of the nonlinear stability behavior of shell structures (including bifurcation and snap-through buckling) are presented in the book.
Structural Optimization - George I. N. Rozvany 2012-12-06
Proceedings of the IUTAM Symposium on Structural Optimization, Melbourne, Australia, February 9-13, 1988
Optimization of Structural Topology, Shape, and Material - Martin P. Bendsoe 1995-05-16
In the past, the possibilities of structural optimization were restricted to an optimal choice of profiles and shape. Further improvement can be obtained by selecting appropriate advanced materials and by optimizing the topology, i.e. finding the best position and arrangement of structural elements within a construction. The optimization of structural topology permits the use of optimization algorithms at a very early stage of the design process. The method presented in this book has been developed by Martin Bendsoe in cooperation with other researchers and can be considered as one of the most effective approaches to the optimization of layout and material design.
Finite Elements in Civil Engineering Applications - Max.A.N. Hendriks 2021-06-23
These proceedings present high-level research in structural engineering, concrete mechanics and quasi-brittle materials, including the prime concern of durability requirements and earthquake resistance of structures.
Structural Optimization of Thin Shells Using Finite Element Method - 1992

Structural & Construction Conf - Franco Bontempi 2003-01-01
Objective of conference is to define knowledge and technologies needed to design and develop project processes and to produce high-quality, competitive, environment- and consumer-friendly structures and constructed facilities. This goal is clearly related to the development and (re)-use of quality materials, to excellence in construction management and to reliable measurement and testing methods.