

# Engineering Rock Mass Classification Tunnelling Foundations And Landslides

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Vast knowledge has been developed in the area of tunnelling in weak rocks over the years, and this book bridges an important gap by bringing all the information together for the benefit of the tunnelling Industry. In particular, tunnelling in poor conditions is a huge challenge for engineers and designers, and this book tackles all typical problems headon. Topics covered include classification approach, design approaches for site-specific grounds, a new invention on shielded tunnel boring machine, case histories, tunnel mechanics, risk engineering and management culture. OCo Based on extensive field research experiences in Himalayan region and Alps OCo Exclusive chapters on tunnelling hazards, squeezing ground conditions (a full detailed case study), swelling ground conditions, critical state rock mechanics, etc. OCo Supported by over 180 figures and 90 tables of data, and test examples (with solutions)"

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Classification: Tunnelling, Foundations and Landslides provides construction engineers and managers with extensive practical knowledge which is time-tested in the projects in Himalaya and other parts of the world in complex

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methods including: Barton's Q and Q' systems, Bieniawski's RMR, Laubscher's MRMR and Hoek's and GSI systems. With this book in hand, engineers will be able to gather geotechnical data, either from rock cuts, drifts or core, and process the information for subsequent analysis. Rich with international case studies and worked out equations, the focus of the book is on the practical gathering information for purposes of analysis and design. Identify the most significant parameters influencing the behaviour of a rock mass. Divide a particular rock mass formulation into groups of similar behaviour, rock mass classes of varying quality. Provide a basis of understanding the characteristics of each rock mass class Relate the experience of rock conditions at one site to the conditions and experience encountered at others Derive quantitative data and guidelines for engineering design Provide common basis for communication between engineers and geologists

Rock Engineering and Rock Mechanics: Structures in and on Rock Masses covers the most important topics and state-of-the-art in the area of rock mechanics, with an emphasis on structures in and on rock masses. The 255 contributions (including 6 keynote lectures) from the 2014 ISRM European Rock Mechanics Symposium (EUROCK 2014, Vigo, Spain, 27-29 Ma

In this second, enlarged edition the author continues to emphasise aspects of rock mechanics. Firm in his belief that there is no better way to study the subject than by the detailed analysis of case histories, Dr Jaeger has incorporated a number of new ones.

Engineering Rock Mechanics Part II: Illustrative Worked

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Examples can be used as an independent book or alternatively it complements an earlier publication called Engineering Rock Mechanics: An Introduction to the Principles by the same authors. It contains illustrative worked examples of engineering rock mechanics in action as the subject applies to civil, mining, petroleum and environmental engineering. The book covers the necessary understanding and the key techniques supporting the rock engineering design of structural foundations, dams, rock slopes, wellbores, tunnels, caverns, hydroelectric schemes and mines. There is a question and worked answer presentation with the question and answer sets collated into twenty chapters which match the subject matter of the first book.

Underground Excavations in Rock deals with the geotechnical aspects of the design of underground openings for mining and civil engineering processes. During the last two decades rock mechanics in Europe has been undergoing some major transformation. The reduction of mining activities in Europe affects heavily on rock mechanics teaching and research at universities and institutes. At the same time, new emerging activities, notably, underground infrastructure construction, geothermal energy develop

Rock Mass Classifications - A Practical Approach in Civil Engineering was written in response to the many unanswered questions regarding this subject. Questions such as - Is Classification reasonably reliable? Can it be successful in crisis management

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of geohazards? Can a single Classification system be general for all rock structures? Is Classification a scientific approach? Laborious field research was undertaken in the Himalayan mountains by a team of scientists from the Central Mining Research Institute (CMRI), University of Roorkee (UOR), Central Soil and Material Research Station (CSMRS), U.P. Irrigation Research Institute (UPIRI), and Norwegian Geotechnical Institute (NGI) to answer these questions. The results obtained from the research work were systematically compiled to produce this book which bears particular relevance to civil, mining and petroleum engineers and geologists.

Endorsements "It is a Handbook of Rock Engineering" - Zhao Jian, School of Civil & Structural Engineering, Nanyang Technological University, Singapore "I came across your new book - Rock Mass Classification, absolutely fantastic" - Subodh K. Jain, U.S.A

More often than not, it is difficult or even impossible to obtain directly the specific rock parameters of interest using in situ methods. The procedures for measuring most rock properties are also time consuming and expensive. Engineering Properties of Rocks, Second Edition, explores the use of typical values and/or empirical correlations of similar rocks to determine the specific parameters needed. The book is based on the author's extensive experience and offers a single source of information for the

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evaluation of rock properties. It systematically describes the classification and characterization of intact rock, rock discontinuities, and rock masses, and presents the various indirect methods for estimating the deformability, strength, and permeability of these components as well as the in situ rock stresses. Presents a single source for the correlations on rock properties Saves time and resources invested on in situ testing procedures Fully updated with current literature Expanded coverage of rock types and geographical locations This text combines the science and engineering of hydrogeology in an accessible, innovative style. As well as providing physical descriptions and characterisations of hydrogeological processes, it also sets out the corresponding mathematical equations for groundwater flow and solute/heat transport calculations. And, within this, the methodological and conceptual aspects for flow and contaminant transport modelling are discussed in detail. This comprehensive analysis forms the ideal textbook for graduate and undergraduate students interested in groundwater resources and engineering, and indeed its analyses can apply to researchers and professionals involved in the area. This practical guide describes the stage-by-stage development of a method for predicting the penetration rate (PR) and the advance rate (AR) for tunnel boring machines based on an expanded

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version of the Q-value, QTBM. The author analyzes 145 TBM tunnels that total 1,000km in length. He then develops simple formulae to estimate PR and AR from the QTBM value and to back-calculate QTBM from performance data. The book quantitatively explains actual advance rates as high as five m/hr for one day or as low as 0.005 m/hr for several months. It also covers logging methods, empirical TBM tunnel support design, and numerical verification of support.

This Practical Guide to Rock Tunneling fills an important void in the literature for a practical guide to the design and construction of tunnels in rock.

Practical Guide to Rock Tunneling takes the reader through all the critical steps of the design and construction for rock tunnels starting from geotechnical site investigations through to construction supervision. The guide provides suggestions and recommendations for practitioners on special topics of laboratory testing, durability of rock and acceptance for unlined water conveyance tunnels, overstressing or deep and long tunnels, risk-based evaluation of excavation methods, contract strategies, and post-construction inspections. Key considerations and lessons learned from selected case projects are presented based on the author's extensive international experience of over 30 years and 1000 km of tunneling for civil, hydropower, and mining infrastructure, including some of the most

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recognized projects in the world to date. Instead of revisiting all theory and concepts that can be found in other sources, this book contains the hard learned lessons from the author's experience in the field of Rock Tunneling, gathered over 30 years of service. The safe and economical construction of tunnels, mines, and other subterranean works depends on the correct choice of support systems to ensure that the excavations are stable. These support systems should be matched to the characteristics of the rock mass and the excavation techniques adopted. Establishing the support requirements, designing support systems and installing these correctly are essential elements in safe underground construction. This is a comprehensive and practical work which also gives access to user-friendly computer programmes which enable the investigation and design of support techniques. Details on how to obtain this software are also included in the book. This practical and design-oriented book focuses on ground characterization and structural calculation, as part of the active structural design methodology. With a focus on rock tunnelling it offers a comprehensive rather than a topic-based perspective, deriving sound tunnel design criteria and methods from basic principles. Ground characterization includes excavations, site investigation, and in situ stress determination, culminating in geotechnical classifications. The book



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then deals with various construction methods and their appropriate calculations, which range from constitutive models for the stress-strain behaviour of an excavation and tunnel support elements to a full stress–strain analysis methodology. The heavily practical approach of the book draws on the authors' twenty years of tunnelling experience in Spain and South America. It will help any young or established professional who wants to develop a career in the underground field across both civil engineering and geology. As it incorporates the very fundamentals of tunneling design, it can be used as a support for tunneling courses or as a textbook for master's and PhD courses. Benjamín Celada was Chief Tunnel Engineer at Hunosa and Potasas de Navarra S.A. before founding Geocontrol S.A. He has also worked for twenty years as Professor of Underground Works at the Polytechnic Mining University in Madrid, Spain. Z. T. Bieniawski directed the Rock Mechanics Department of the Council for Scientific and Industrial Research in Pretoria, then taught at the Pennsylvania State University for twenty years.

Engineering in Rock Masses is a 26-chapter text that deals with the behavior, investigation, and construction of rock masses. The first chapters review the properties, behavior, classification, and occurrence of groundwater in rock masses. The subsequent chapters discuss the stress analysis,

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exploration, laboratory testing, geophysical methods, and instrumentation in these materials. These topics are followed by discussions of slope stability, rockfall problems, settlement and bearing capacity, subsidence, and seismic movements of rocks and rock masses. This work also evaluates the role of pumping system, ground freezing, grouting, rock anchors, drilling, blasting, and open excavation. The remaining chapters look into the rock masses' tunneling, underground chambers, shafts, socketed foundations, and retaining structures. This book will be of great value to practicing civil and mining engineers, engineering geologists, and researchers. This is the first authoritative reference on rock mass classification, consolidating into one handy source information once widely scattered throughout the literature. It includes new, previously unpublished material and case histories, presents the fundamental concepts of classification schemes, and critically appraises their practical application in industrial projects such as tunneling and mining. A practical guide to the principles of rock mechanics and their relevance and application to rock engineering in a form which is rapidly assimilable and easily accessible to civil and geotechnical engineers. No bibliography. Annotation copyrighted by Book News, Inc., Portland, OR

With the ever-increasing developmental activities as diverse as the construction of dams, roads, tunnels,

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underground powerhouses and storage facilities, petroleum exploration and nuclear repositories, a more comprehensive and updated understanding of rock mass is essential for civil engineers, engineering geologists, geophysicists, and petroleum and mining engineers. Though some contents of this vast subject are included in undergraduate curriculum, there are full-fledged courses on Rock Mechanics/Rock Engineering in postgraduate programmes in civil engineering and mining engineering. Much of the material presented in this book is also taught to geology and geophysics students. In addition, the book is suitable for short courses conducted for teachers, practising engineers and engineering geologists. This book, with contributions from a number of authors with expertise and vast experience in various areas of rock engineering, gives an in-depth analysis of the multidimensional aspects of the subject. The text covers a wide range of topics related to engineering behaviour of rocks and rock masses, their classifications, interpretation of geological mapping of joints through stereographic projection, in situ stress measurements, laboratory and field tests, stability of rock slopes, foundations of structures, including dams and support systems for underground excavations. The Third Edition of the book is further enriched with the addition of a number of case histories in which the analyses and

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designs were carried out by adopting rock mass parameters as per RMR, Q or GSI. The consequence of such an approach is critically examined. With the adoption of parameters from joint factor, excellent performance prediction has been demonstrated for anisotropic rocks and tunnel. Various expressions developed for  $K_n$  and  $K_s$  for different conditions are included for adoption in numerical analyses. When dilatancy component is separated, the scale effect on shear response is insignificant. This edition provides a comprehensive understanding of rock mass response and enables students to tackle rock engineering problems more confidently and realistically, and therefore it will be of immense benefit to students, teachers, professionals and designers alike.

This volume presents a selection of chapters covering a wide range of tunneling engineering topics. The scope was to present reviews of established methods and new approaches in construction practice and in digital technology tools like building information modeling. The book is divided in four sections dealing with geological aspects of tunneling, analysis and design, new challenges in tunnel construction, and tunneling in the digital era. Topics from site investigation and rock mass failure mechanisms, analysis and design approaches, and innovations in tunnel construction through digital tools are covered in 10 chapters. The

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References provided will be useful for further reading.

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Encompassing nearly all aspects of rock mass classifications in detail, *Civil Engineering Rock Mass Classification: Tunnelling, Foundations and Landslides* provides construction engineers and managers with extensive practical knowledge which is time-tested in the projects in Himalaya and other parts of the world in complex geological conditions. Rock mass classification is an essential element of feasibility studies for any near surface construction project prior to any excavation or disturbances made to earth. Written by an author team with over 50 years of experience in some of the most difficult mining regions of the world, *Civil Engineering Rock Mass Classification: Tunnelling, Foundations and Landslides* provides construction engineers, construction managers and mining engineers with the tools and methods to gather geotechnical data, either from rock cuts, drifts or core, and process the information for subsequent analysis. The goal is to use effective mapping techniques to obtain data can be used as input for any of the established rock classification systems. The book covers all of the

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commonly used classification methods including: Barton's Q and Q' systems, Bieniawski's RMR, Laubscher's MRMR and Hoek's and GSI systems. With this book in hand, engineers will be able to gather geotechnical data, either from rock cuts, drifts or core, and process the information for subsequent analysis. Rich with international case studies and worked out equations, the focus of the book is on the practical gathering information for purposes of analysis and design. Identify the most significant parameters influencing the behaviour of a rock mass Divide a particular rock mass formulation into groups of similar behaviour, rock mass classes of varying quality Provide a basis of understanding the characteristics of each rock mass class Relate the experience of rock conditions at one site to the conditions and experience encountered at others Derive quantitative data and guidelines for engineering design Provide common basis for communication between engineers and geologists This volume addresses the multi-disciplinary topic of engineering geology and the environment, one of the fastest growing, most relevant and applied fields of research and study within the geosciences. It covers the fundamentals of geology and engineering where the two fields overlap and, in addition, highlights specialized topics that address principles, concepts and paradigms of the discipline, including operational terms, materials, tools, techniques and

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methods as well as processes, procedures and implications. A number of well known and respected international experts contributed to this authoritative volume, thereby ensuring proper geographic representation, professional credibility and reliability. This superb volume provides a dependable and ready source of information on approximately 300 topical entries relevant to all aspects of engineering geology. Extensive illustrations, figures, images, tables and detailed bibliographic citations ensure that the comprehensively defined contributions are broadly and clearly explained. The Encyclopedia of Engineering Geology provides a ready source of reference for several fields of study and practice including civil engineers, geologists, physical geographers, architects, hazards specialists, hydrologists, geotechnicians, geophysicists, geomorphologists, planners, resource explorers, and many others. As a key library reference, this book is an essential technical source for undergraduate and graduate students in their research.

Teachers/professors can rely on it as the final authority and the first source of reference on engineering geology related studies as it provides an exceptional resource to train and educate the next generation of practitioners.

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Surface and Underground Projects is the last volume

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of the five-volume set *Rock Mechanics and Engineering* and contains twenty-one chapters from key experts in the following fields: - Slopes; - Tunnels and Caverns; - Mining; - Petroleum Engineering; - Thermo-/Hydro-Mechanics in Gas Storage, Loading and Radioactive Waste Disposal. The five-volume set “*Comprehensive Rock Engineering*”, which was published in 1993, has had an important influence on the development of rock mechanics and rock engineering. Significant and extensive advances and achievements in these fields over the last 20 years now justify the publishing of a comparable, new compilation. *Rock Mechanics and Engineering* represents a highly prestigious, multi-volume work edited by Professor Xia-Ting Feng, with the editorial advice of Professor John A. Hudson. This new compilation offers an extremely wideranging and comprehensive overview of the state-of-the-art in rock mechanics and rock engineering and is composed of peer-reviewed, dedicated contributions by all the key experts worldwide. Key features of this set are that it provides a systematic, global summary of new developments in rock mechanics and rock engineering practices as well as looking ahead to future developments in the fields. Contributors are worldrenowned experts in the fields of rock mechanics and rock engineering, though younger, talented researchers have also been included. The



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Individual volumes cover an extremely wide array of topics grouped under five overarching themes: Principles (Vol. 1), Laboratory and Field Testing (Vol. 2), Analysis, Modelling and Design (Vol. 3), Excavation, Support and Monitoring (Vol. 4) and Surface and Underground Projects (Vol. 5). This multi-volume work sets a new standard for rock mechanics and engineering compendia and will be the go-to resource for all engineering professionals and academics involved in rock mechanics and engineering for years to come.

This book offers a practical reference guide to soft rock mechanics for engineers and scientists. Written by recognized experts, it will benefit professionals, contractors, academics, researchers and students working on rock engineering projects in the fields of civil engineering, mining and construction engineering. Soft Rock Mechanics and Engineering covers a specific subject of great relevance in Rock Mechanics – and one that is directly connected to the design of geotechnical structures under difficult ground conditions. The book addresses practical issues related to the geomechanical properties of these types of rock masses and their characterization, while also discussing advances regarding in situ investigation, safety, and monitoring of geotechnical structures in soft rocks. Lastly, it presents important case histories involving tunnelling, dam foundations, coal and open pit mines

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Stability of underground excavations is of great importance to an operating mine because it ensures the safety of the working people and operating equipment, and successful ore production. Due to the complex geological conditions and mine constructions, and variability and uncertainty in estimating rock mass mechanical properties, the assessment of rock mass stability for an underground mine is extremely challenging and difficult. Tackling of this difficult problem is not covered in detail in any of the textbooks currently available in the rock mechanics literature. This monograph aims to cover this gap in the rock mechanics and rock engineering field. This monograph provides detailed procedures for the stability assessment and support design for an underground mine case study. It covers the background of the mine site including the monitored deformation data, the state-of-art methodologies for the stability analysis of rock masses around underground excavations, performed laboratory tests, estimation of the rock mass properties, a brief theory and background of the 3-D Distinct Element Code (3DEC), and numerical modeling of underground rock mass stability including investigation of the effectiveness of rock supports. The monograph is an excellent reference for the senior undergraduates, graduate students,

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researchers and practitioners who work in the Underground Rock Mechanics and Rock Engineering area in the Mining Engineering, Civil Geotechnical Engineering and DEM (Distinct Element Method) Numerical modeling. Practical Handbook of Rock Mass Classification Systems and Modes of Ground Failure is a comprehensive, yet concise, guide to 16 of the most important rock classification systems and their failure modes. The book discusses these systems in relation to the design of excavations and ground reinforcement/support under passive, active, static, and dynamic mining conditions. This includes rock testing assessment, surface and underground site investigation, and any practical activity that deals with the physical and mechanical properties of rocks. The book is an excellent professional reference for geoscientists, technicians, and geological engineers doing research and consulting in mining, geological, civil, and petroleum resource fields.

This book is the third volume of the proceedings of the 4th GeoShanghai International Conference that was held on May 27 - 30, 2018. This volume, entitled "Rock Mechanics and Rock Engineering", covers the recent advances and technologies in rock mechanics and rock engineering. These papers are grouped in three categories: (1) Theoretical and numerical study of rock behaviours, (2) Experimental study of rock behaviours, and (3) Applications of rock mechanics and case studies. This volume presents the state-of-the-art theories, methodologies and findings in the related areas.

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The book may benefit researchers and scientists from the academic fields of rock mechanics and rock engineering, geotechnical engineering, geoenvironmental engineering, transportation engineering, geology, mining and energy, as well as practical engineers from the industry. Each of the papers included in this book received at least two positive peer reviews. The editors would like to express their sincerest appreciation to all of the anonymous reviewers all over the world, for their diligent work.

The Channel Tunnel has been called the greatest engineering project of the century, overcoming a unique set of financial, political and engineering challenges. This book provides a comprehensive insight into the events which culminated in the first dry link between Britain and France. It describes the relationship between the site investigation, data interpretation and construction of the works. It examines areas such as the difficulties inherent in predicting geology from a relatively small number of boreholes and revealing how the use of modern geophysical techniques.

This book, written for the benefit of engineering students and practicing engineers alike, is the culmination of the author's four decades of experience related to the subject of electrical measurements, comprising nearly 30 years of experimental research and more than 15 years of teaching at several engineering institutions. The unique feature of this book, apart from covering the syllabi of various universities, is the style of presentation of all important aspects and features of electrical measurements, with neatly and clearly drawn figures, diagrams and colour and b/w photos that illustrate details of instruments among other things, making the text easy to follow and comprehend. Enhancing the chapters are interspersed explanatory comments and, where necessary, footnotes to help better understanding of the chapter contents. Also, each chapter begins with a "recall" to link the

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subject matter with the related science or phenomenon and fundamental background. The first few chapters of the book comprise "Units, Dimensions and Standards"; "Electricity, Magnetism and Electromagnetism" and "Network Analysis". These topics form the basics of electrical measurements and provide a better understanding of the main topics discussed in later chapters. The last two chapters represent valuable assets of the book, and relate to (a) "Magnetic Measurements", describing many unique features not easily available elsewhere, a good study of which is essential for the design and development of most electric equipment – from motors to transformers and alternators, and (b) "Measurement of Non-electrical Quantities", dealing extensively with the measuring techniques of a number of variables that constitute an important requirement of engineering measurement practices. The book is supplemented by ten appendices covering various aspects dealing with the art and science of electrical measurement and of relevance to some of the topics in main chapters. Other useful features of the book include an elaborate chapter-by-chapter list of symbols, worked examples, exercises and quiz questions at the end of each chapter, and extensive authors' and subject index. This book will be of interest to all students taking courses in electrical measurements as a part of a B.Tech. in electrical engineering. Professionals in the field of electrical engineering will also find the book of use.

This report discusses tunnel design procedures based on various rock mass classification systems. A comparison is made between the tunnel support design based on the classical Terzaghi rock load method and the support selection based on the RSR Concept, the Geomechanics Classification, and the Q-System. These classification systems are described and guidelines are given for step-by-

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step application of the three methods. Using an actual tunnel case history, an evaluation is made of the current design practice by comparing it with the design approaches involving the three rock mass classification systems. It is concluded that the current design practice may lead to overdesign of support, and recommendations are made for improved procedures that would ensure the construction of safe and more economical rock tunnels. Finally, a few areas are identified where more research would benefit the current tunnel design practice. This report was reprinted in FY 89 during which time a bibliography covering the appropriate literature through 1986 and a discussion of recent developments were added. Keywords:

Tunneling/construction; Engineering geology; Park River project; Rock classification; Rock masses; Tunnels; Rock mechanics. (edc).

It is intended that the book will serve as a useful source of reference for professionals in the field of geotechnical and geological engineering. It helps college students bridge the gap between class education and engineering practice, and helps academic researchers guarantee reliable and accurate test results.

An Ideal Source for Geologists and Others with Little Background in Engineering or Mechanics Practical Rock Mechanics provides an introduction for graduate students as well as a reference guide for practicing engineering geologists and geotechnical engineers. The book considers fundamental geological processes that give rise to the nature of rock masses and control their mechanical behavior. Stresses in the earth's crust are discussed and methods of measurement and prediction explained. Ways to investigate, describe, test, and characterize rocks in the laboratory and at project scale are reviewed. The application of rock mechanics principles to the design of engineering structures including

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tunnels, foundations, and slopes is addressed. The book is illustrated throughout with simple figures and photographs, and important concepts are illustrated by modern case examples. Mathematical equations are kept to the minimum necessary and are explained fully—the book leans towards practice rather than theory. This text: Addresses the principles of rock mechanics as it applies to both structural geology and engineering practice Demonstrates the importance of and methods of geological characterisation to rock engineering Examines the standard methods of rock mechanics testing and measurement as well as interpretation of data in practice Explains connections between main parameters both empirically as well as on the basis of scientific theory Provides examples of the practice of rock mechanics to major engineering projects Practical Rock Mechanics teaches from first principles and aids readers' understanding of the concepts of stress and stress transformation and the practical application of rock mechanics theory. This text can help ensure that ground models and designs are correct, realistic, and produced cost-effectively.

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