
This highly original and innovative book is the outcome of the work of the Commission on Rock Engineering Design Methodology of the International Society for Rock Mechanics (ISRM) in the period 2007–2011. The work of the Commission was managed by the authors, Professor John A Hudson, ISRM President for 2007–2011, and Professor Xiating Feng, ISRM President for 2011–2015, in association with the Chinese Society for Rock Mechanics and Engineering. Recently, this reviewer (2011) has argued that the work of its Commissions has been among the major achievements of the ISRM in the 50 years since its foundation in 1962. This book adds to that impressive record of achievement.

The task that the authors set the Commission and themselves was a challenging one. At the outset, in the Introduction in Chapter 1, they argue that “we are now anticipating a paradigm shift in rock engineering design because, in the future, there will be an emphasis on more sophisticated site investigation, the use and intelligent interpretation of numerical modelling, technical auditing of the use of computer programs and their inputs, calibration of the modelling through site observations, computer perception of the results, and virtual underground laboratories”. Against this background, the book is structured essentially in two parts. Chapters 1–5 set out the background to, and the foundations of, the future rock engineering design methodologies proposed by the authors, while Chapters 6–10 provide detailed and valuable illustrations of the application of these approaches to real life rock engineering design. The centrally important Chapters 2–5 are based on four joint papers by the authors published previously in the International Journal of Rock Mechanics and Mining Sciences (Feng and Hudson, 2004, 2010; Hudson and Feng, 2007; Brown, 2011).

Chapter 2 discusses the ways ahead for rock engineering design methodologies. A flowchart of rock mechanics modelling and rock engineering design approaches (Fig. 2.1, page 16, after Feng and Hudson (2004)), illustrates the overall approach proposed and identifies the eight rock mechanics modelling approaches discussed in the book. Key features of these modelling approaches are the use of computer networks and of integrated intelligent methods which build on a range of previous original contributions made by the authors, notably Professor Feng’s work on the application of neural networks in rock engineering. The integrated intelligent design methodology discussed is then applied to two practical design examples.

Chapter 3 is concerned with the development and use of flowcharts for rock engineering modelling and design. It presents and discusses briefly, a range of previously published flowcharts as background, and then introduces the authors’ updated flowchart for the rock engineering design process (Fig. 3.12, page 59, after Hudson and Feng (2007)). Figs. 2.1 and 3.12 provide the key building blocks for the remainder of the book. Once again, the procedure developed is applied to three different practical examples.

Chapter 4 specifies the information required for the proposed approaches to rock mechanics modelling and rock engineering design (Feng and Hudson, 2010), including an information theory approach. Here again, the guidance given is quite detailed being clearly set out in tables and figures and illustrated by two detailed examples, one of which uses advanced numerical models. A feature of the information required that may not be familiar to all non-Chinese readers is the use of the Chinese “Basic Quality” (BQ) system for rock mass classification introduced here and set out in detail in Appendix B.

Chapter 5 discusses the technical auditing (or reviewing) of rock mechanics modelling and rock engineering design (Hudson and Feng, 2010). Quite detailed procedures and check lists are provided for three types of technical audit, i.e. “soft”, “semi-hard” and “hard”. The “soft” audit procedure addresses 10 subject areas through a total of 26 questions. It is illustrated by application to an in-situ stress measurement programme. The “semi-hard” audit procedure for modelling addresses 11 subject areas through what is said on page 177 to be 38 questions (although the reviewer counted 39 questions in Table 5.23, on three occasions!). The “semi-hard” modelling audit is illustrated through application to the modelling for the design of the caverns for the Laxiwa Hydropower Project on the Yellow River, China. The reviewer has found these auditing procedures and the associated Protocol Sheets (see Chapter 8) to be especially informative and helpful in his own work as a technical reviewer.

Chapter 6 provides an example of the design and construction of the plunge pool rock slope at the Nuozhadu Hydropower Station on the Lancang
(Mekong) River, China. This chapter discusses in great detail the initial design and the use of monitoring measurements and feedback during construction to develop the final design. Accounts are also given of the design and use of a deformation warning system.

Chapter 7 presents another detailed practical example of the application of the methods introduced in the book, this time for the Jinping II underground hydroelectric powerhouse in a deep valley region on the Yalong River, China. The complex and challenging design was carried out in several stages involving a number of optimisation procedures and the use of monitoring data for feedback.

In Chapter 8 the authors present seven sets of Protocol Sheets for use in technical auditing. Each set deals with a different technical issue and may contain several sub-sheets, each listing a number of questions. Importantly, a number of the questions on each sheet deal with records of the completion, checking and electronic storage of the Protocol Sheets. The application of these unique Protocol Sheets to the Jinping II underground hydroelectric powerhouse design is detailed in Chapter 9.

And finally, the Concluding Remarks of Chapter 10 provide a concise and entertaining summary of the authors’ rock engineering modelling and design philosophy and approach, again with an emphasis on intelligent methods and “seeing with our memory”.

Two suggestions are offered for consideration in the further work of the ISRM Commission on Rock Engineering Design Methodology and in further editions of this book. The first is to expand the limited treatment given of the overall engineering design process at the outset to include explicit reference, if only in an overall flowchart, to practical design issues such as project definition, the development of design (e.g. layout) alternatives, design selection criteria, design optimisation (although this issue is covered extremely well in some of the illustrative examples), constructability, excavation scheduling (again, this issue is discussed in some of the examples), specifications, costing, and design documentation. As it stands, the book appears to be more about the application of modelling than about design in this broader sense. The second suggestion is to make risk assessment and management an integral part of the design process as it now compulsorily is in many countries. Risk is referred to in the Introduction while hazard assessment is discussed in some of the illustrative examples and is listed as an issue in the Protocol Sheets. However, risk is not listed as an item in the minimalist Short Index.

This superb book has many outstanding features. Its original approach and arguments are set out and developed with the greatest clarity; the writing is clear, fluent and accessible; the structure of the book is logical, guiding the reader through a series of stages required to develop a good, or even deep, understanding of the subject matter; the chapter summaries are succinct and informative, as are the summaries of some topics presented in tables and figures; and the detailed technical auditing approach developed is especially valuable. Perhaps most importantly, the several detailed practical examples given in each chapter illustrate just how the approaches developed and described have been applied in practice to the most challenging rock engineering design projects. These examples, together with a summary given in Chapter 1, provide compelling evidence of the monumental achievements of rock mechanics and rock engineering in China in recent years. Through this book and in other ways, the authors have contributed significantly to those achievements.

References


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