TRB NEW PUBLICATION

ROCKFALL
CHARACTERIZATION AND CONTROL

A. Keith Turner and Robert L. Schuster, Editors

A rockslide in October 2009 closed Interstate 40 in North Carolina for nearly six months. (Photograph: North Carolina Department of Transportation)

Rockfall is an important, ongoing socioeconomic issue at many locations worldwide. Accelerated development accompanying population growth, with the associated increased demands for energy, mining, forestry, agricultural, and recreational activities, has caused communities and civil infrastructure to expand onto marginal lands, where evaluations of potential rockfall hazards and appropriate countermeasures are often difficult. At many locations on major transportation routes, the degradation of rock exposures constructed 30 to 40 years ago has increased rockfall-induced traffic disruptions, accidents, and injuries.

Demands for improved rockfall evaluation and mitigation have encouraged adoption of new technologies to support new approaches to the evaluation and quantification of rockfall hazards and to the provision of protection from rockfalls. Information about these technologies, however, is not widely available.

The Transportation Research Board (TRB) therefore has developed and published an extensively researched book, ***Rockfall: Characterization and Control***, devoted to all aspects of rockfall characterization, analysis, and mitigation.

BOOK CONTENTS

Developed over five years by a TRB task force, the book comprises 18 chapters authored by a dozen internationally recognized rockfall experts. The book addresses the state of knowledge about rockfall, the available procedures for rockfall investigation, and the regulatory and economic climates affecting rockfall investigations and corrective actions. The book includes a DVD with video clips of rockfall field tests and several historical movies documenting rockfall field activities.

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Part 1: Recognition of Rockfall Hazard

Five chapters cover topics related to the identification and evaluation of rockfall hazards:

Chapter 1, **Introduction**, by A. K. Turner and G. P. Jayaprakash, provides an historical overview to rockfall research and examples of significant rockfall events.

Chapter 2, **Rockfall Types and Causes**, by J. D. Higgins and R. Andrew, reviews rockfall failure types and mechanisms, summarizing and referencing more extensive sources.

Chapter 3, by L. A. Pierson, introduces the principles of the **Rockfall Hazard Rating System** (RHRS), developed in Oregon and supported by the Federal Highway Administration since 1990. More than 25 transportation agencies in North America, as well as many jurisdictions throughout the world, have adopted the RHRS.

Several agencies have modified the RHRS to reflect specific topographic, climate, or geology characteristics, or to expand its evaluation of mitigation alternatives and possible economic impacts of rockfall events. Chapter 4, **Implementation of Rock Slope Management Systems**, by L. A. Pierson and A. K. Turner, provides details of eight systems that have made significant adjustments to the original RHRS.

Railroad derailment caused by a small-volume rockfall near Lytton, British Columbia, Canada, January 2007. (www.arizonarails.com/cn-derailment.html)

Large rockfall blocks severely damaged a bridge deck on Interstate 70 in Glenwood Canyon, Colorado, closing the highway for four days and leading to extended travel restrictions. (Photograph: Colorado Department of Transportation)

Chapter 5, **Rockfall Risk Assessment and Risk Management**, by A. K. Turner, describes alternative approaches to assess risks posed by rockfall hazards, including the evaluation and quantification of rockfall hazards and risks and the selection of rockfall mitigation measures.

Part 2: Fundamentals of Rockfall Analysis and Investigation

Five chapters collectively define the rockfall investigation process:

Chapter 6, **Site Characterization**, by R. Andrew and J. D. Higgins, describes the rockfall characterization process, including organization of the investigation process and the importance of obtaining appropriate descriptive data during field investigations.

Chapter 7, **Instrumentation and Monitoring Technology**, by R. Andrew, B. Arndt, and A. K. Turner, discusses the range of new technologies for measuring and monitoring rockfalls, including photogrammetric, LiDAR, radar, and GPS surveying systems.

Chapter 8, **Evaluation of Rockfall Mechanics**, by A. K. Turner and J. D. Duffy, presents the fundamentals of Newtonian mechanics and their use to describe the motions of falling, bouncing, and rolling rock blocks.

Chapter 9, **Modeling and Prediction of Rockfall**, by A. K. Turner and J. D. Duffy, discusses and compares approaches for the quantitative modeling and prediction of rockfall. These include empirical models based on field observations that are used to establish hazard zones, computer-based approaches incorporating the empirical relationships, 2-D simulation models that provide energy and bounce-height data for designing mitigation measures, and recently developed 3-D models that allow a full spatial evaluation of rockfall events.

Chapter 10, **Conducting Field Test Experiments**, by J. D. Duffy and A. K. Turner, provides a detailed description of conditions affecting rockfall field tests.

Part 3: Rockfall Mitigation

Part 3 starts with an overview of rockfall mitigation options in Chapter 11, **Mitigation Selection**, by L. A. Pierson and M. P. Vierling, including definitions of engineered versus nonengineered solutions and discussions of criteria for selecting an option. The five following chapters describe the major mitigation options:

Chapter 12, **Avoidance of Rockfall Areas**, by T. C. Badger and J. D. Duffy;
Chapter 13, **Stabilization of Rockfall**, by R. Andrew and L. A. Pierson;
Chapter 14, **Protection**, by T. C. Badger, J. D. Duffy and K. Schellenberg;
Chapter 15, **Flexible Rockfall Fences**, by J. D. Duffy and T. C. Badger; and
Chapter 16, **Drapery Systems**, by T. C. Badger and J. D. Duffy.

Part 4: Rockfall Maintenance and Management Programs

Chapter 17, **Maintenance, Monitoring, and Response**, by T. C. Badger, discusses maintenance or monitoring activities that may significantly reduce the risk associated with rockfall and improve public safety.

Chapter 18, **Rockfall Management Programs**, by S. M. Lowell and N. I. Norrish, discusses the importance of rockfall management programs, drawing on the experience of the Washington State Department of Transportation.

Walenstadt test facility, Switzerland. (Photograph: Geobrugg)

Appendices

Appendix A offers stereographic projections for structural analysis. Appendix B, by J. D. Duffy, describes the contents of the DVD included with the book. The DVD contains digital copies of all the book illustrations, including color versions of photographs and some technical drawings; 29 short video clips of rockfall field tests illustrating rockfall impact energies and some testing procedures; and four longer video presentations, including a copy of the historic movie of the 1963 rockfall testing procedures conducted in Washington State.

INTENDED AUDIENCE

Although the focus of the texts is on rockfall events along transportation facilities, most of the discussions and examples apply to any situation requiring rockfall characterization and control. The factors of geology, topography, and climate that interact to cause rockfalls are the same, the methods for evaluating rockfall hazards remain the same, and the methods for prevention or correction of rockfall hazards—within economic limits—remain largely independent of nearby land uses.

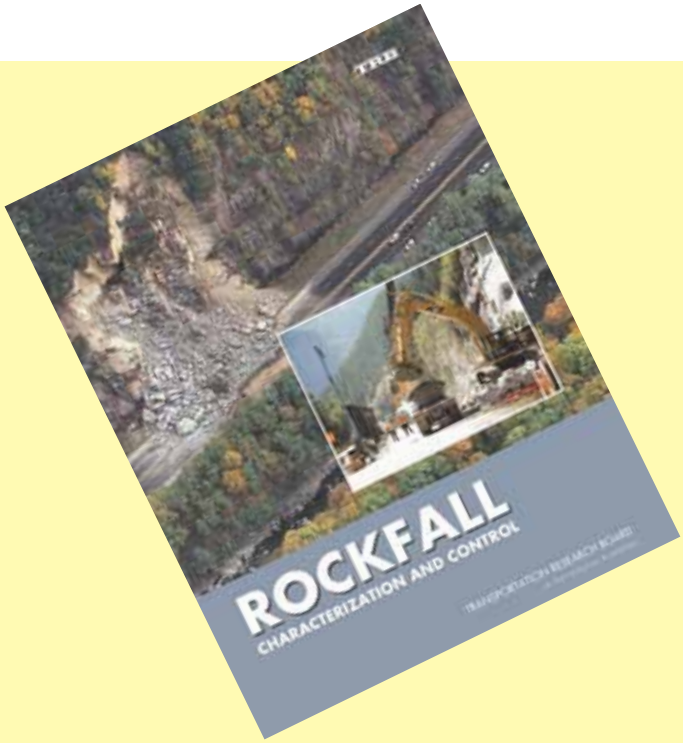
This volume will be useful therefore for anyone involved in the evaluation of rockfall hazards. The text is intended to appeal to a diverse audience, including

- Transportation engineers responsible for rockfall investigations,
- Students in geoscience and geotechnical fields with an interest in rockfall, and
- Researchers who need a definitive source for rockfall investigation and mitigation procedures.

Many students and researchers seek comprehensive references to the literature and discussions of case studies, state-of-the-art techniques, and research directions. Accordingly, considerable effort was expended in identifying suitable literature citations and in providing some discussion of recent developments.

References to specialized and hard-to-obtain sources, however, were avoided as much as possible.

Multiple rockfall protection systems installed near the Pen-Y-Clip tunnel on the A55 North Wales Expressway, United Kingdom. (Photograph: David Giles, University of Portsmouth, United Kingdom)



ORDERING INFORMATION

Rockfall Characterization and Control is 658 pages and includes a DVD with video clips of rockfalls and field tests.

Order your copy today at **www.TRB.org/Rockfall**

Hardcover, ISBN 978-0-309-22306-5, $110
Paperback, ISBN 978-0-309-22312-6, $100

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