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### A review of: “Rock blasting and explosives engineering”

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## BOOK REVIEW

*Rock Blasting and Explosives Engineering.* Per-Anders Persson, Roger Holmberg, and Jaimin Lee. 540 pp. CRC Press, Boca Raton, 1993. Price \$69.95, hardcover. ISBN 0-8493-8978-X. (Reviewed by D. Linn Coursen and William C. Davis).

This book, by three authors who have all done distinguished and innovative work in the science and technology of industrial explosives, is clearly the single current book most suitable for teaching a first course in explosives to engineering students, or for review and self-study by many already engaged in the field. The book bears the accurately descriptive subtitle "A textbook for students and a handbook for scientists and engineers covering the science and engineering of the industrial use of explosives with major emphasis on rock blasting." It gives a good sense of the present state of the art, and the large set of thoughtfully selected exercises makes it particularly suitable for students.

Rock blasting and explosives engineering, interdisciplinary in the extreme, involve thermodynamics, mechanics, chemistry, strength of materials, geology, physics, civil engineering, mining engineering, and economics. These diverse subjects are discussed at least briefly in the various chapters. A strength of the book is the breadth of its perspective, stated as "..... the entire operation of drilling, blasting, loading, transport, and crushing has to be considered as one system, to be optimized as a whole." This breadth adds to the complexity; the book is not a recipe book. The engineer must consider exactly what he or she wants to do, and what equipment and material are available, and then spend some effort to select the best system from several alternatives. This book provides the necessary background to carry out that program successfully.

In the first paragraph of the introduction, the authors state that they will "convey the message that explosives, just like all other materials, function according to the laws of physics and chemistry; that the effects of explosives can be precalculated quite accurately; and that rock blasting and explosive working of other materials are just branches of engineering, with equations and graphs, and good and bad design." Explosives engineers, like engineers in all fields, use simple models, some as simple as rules of thumb, to make their designs. A

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Published in 1994 by Dowden, Brodman & Devine, Inc.

principal strength of this book is that it attempts to connect the simple models and rules of thumb back to the underlying science and mechanics, explaining the assumptions and simplifications they involve. The thoughtful worker has a chance, then, to understand the limits of his or her design method.

The topics covered in the book can be inferred from the division into chapters:

Chapter 1, Rock strength and fracture properties, gives a good overview of this difficult field for the non-specialist, with a lucid description of measurements and models of rock and how it breaks. It is not integrated into the rest of the text; there is apparently not a single reference back to Chapter 1.

Chapter 2, Mechanical drilling and boring in rock, is a practical and detailed introduction to making holes in rock at minimum cost. Detailed calculation tables are given. Swedish practice and methods are described, but the perspective is broad and general.

Chapter 3, Explosives, is a review of available energetic materials and their properties. Much information not easily available elsewhere is presented here.

Chapter 4, Shock waves and detonation, is the theory chapter, covering everything from the Rankine-Hugoniot equations to explosive performance tests. The discussion of recent approaches to understanding the structure of the reaction zone in detonating explosives is particularly illuminating. No subject in this brief chapter is covered in depth, but references are given. A sophisticated worker will struggle to get a grasp of all topics treated here, and others will give up on some of them. Enough to be worthwhile can be picked out by all.

Chapter 5, Initiation systems, is an in-depth review of practice, a valuable guide to safe and reliable initiation systems.

Chapter 6, Principles of charge calculation for surface blasting, and

Chapter 7, Charge calculation for tunneling, are just what they say they are. They are not recipes; emphasis is on why, not just how.

Chapter 8, Stress waves in rock, rock mass damage, and fragmentation, tells what really happens to the rock in a blast, and what fragments are expected.

Chapter 9, Contour blasting, describes how to get smooth surfaces with minimum damage to the remaining rock.

Chapter 10, Computer calculations for rock blasting, gives a glimpse of a field that is developing so rapidly that a weekly journal is out of date. Simple programs are presented to illustrate the principles. No attempt is made to survey what is now available.

Chapter 11, Blast performance and control, discusses making meaningful tests of new explosives, initiation methods, mining methods, etc. Coverage of this topic is badly needed; engineers are routinely faced with evaluating systems, but the subject is seldom explicitly discussed except in specialized papers. Test design, control of all the relevant parameters, and evaluation of the accuracy of the measurements are topics that would make a book by themselves. In the present book, the subject is barely introduced, and illustrated with examples. It was an excellent idea to put this chapter in the book; it is unfortunate that it cannot be

longer and more detailed.

Chapter 12, Flyrock,

Chapter 13, Ground vibrations, and

Chapter 14, Air blast effects, discuss in detail these dangerous, damaging, and annoying side effects of blasting operations. These chapters are as much the meat of this book as the ones on charge calculation, and are well done.

Chapter 15, Toxic fumes, deals with the fumes, created by explosives, that pose a health or environmental hazard, and techniques for their measurement and control, and provides a thoughtful introduction to this vital topic. The reviewers take this opportunity to mention a hazard, not mentioned in the book, which has been encountered by one of them but never published. The reaction of hydrogen and carbon monoxide, from aqueous compositions containing a high content of aluminum, with rock containing iron sulfides can generate toxic hydrogen sulfide and iron pentacarbonyl.

Chapter 16, Metal acceleration, fragment throw, metal jets, and penetration, and

Chapter 17, Explosive art, explosive metal forming, welding, powder compaction, and reaction sintering, depart from rock blasting and treat the great range of other applications of explosives. The emphasis is on understanding rather than providing recipes. The photographs of explosive art are great.

Chapter 18, Safety precautions, rules, and regulations,

Chapter 19, Safety in production of explosives, and

Chapter 20, United Nations recommendation on the transport of dangerous goods, are important reviews of subjects that must concern everyone who uses explosives.

The last two sections of the book are "Exercises" and "Solutions to selected exercises". These are well thought out and ingenious problems that help the reader to get the most from this book. Everyone, not just regimented students, should do all the exercises.

Obviously no book of 540 pages can do more than give an introduction to such a wide range of topics. Probably no reader will agree with the authors's choice of the depth appropriate for treatment of any particular subject, especially the one that reader is most interested in. The references, and the references found in the references, will provide an entry to the extensive literature on industrial explosives and blasting for those who want to delve deeper. The book fills an important part of the void; that it does not fill it completely is not a valid criticism.

It is not unusual for first printings to contain misprints, and this one is no exception. Some of the errors are important and not obvious. The index contains many irritating errors. If you can, get a copy from a later printing, and obtain a list of errata from the publisher.