IAHR AIRH

Journal of Hydraulic Research Vol. 41, No. 3 (2003), pp. 327–328

Book review

The Hydraulics of Stepped Chutes and Spillways

By HUBERT CHANSON, *A.A. Balkema Publishers, Lisse, 384 pp, ISBN 90-5809-352-2, 2002*

Stepped hydraulic structures have a wide range of applicability, which goes from decorative architecture (stepped cascades) to spillways for large dams. Surprisingly, the advantages and disadvantages of using stepped works are discussed only in very few modern treatises on hydraulic structures. During the period 1980–2000, a vast amount of research concerning stepped spillways has been performed worldwide, with contributions from countries as distant as Australia, Brazil, Canada, Japan, and Spain. These facts reveal a clear need for books aimed at summarizing the present knowledge about stepped hydraulic structures and, at the same time, at presenting a systematic understanding of the subject. Hubert Chanson has himself contributed earlier to fulfill the above purposes with the book entitled "Hydraulic design of stepped cascades, channels, weirs and spillways", Elsevier Science, Inc., New York, N.Y., 1994, reviewed by Prof. N. Rajaratnam in the Journal of Hydraulic Engineering, ASCE, 121(12), 1995. The present book could therefore be considered as a by-product and an update, of that book.

The present contribution gives a state-of-the-art in the research and design of stepped chutes and spillways. It is a well-organized book, which provides in ten chapters clear and abundant information on the topic.

Chanson opens the book with an interesting glossary (in the same spirit as he did in his earlier book "Air bubble entrainment in free-surface turbulent shear flow", Academic Press, 1996, 348 pp.) in which he includes not only technical terms and definitions related to the subject, but also brief historical notes.

Chanson continues with a nice Introduction (Chapter 1) illustrated with several photographs of model and prototype stepped spillways. A complete table accompanies these pictures, detailing the major studies about the topic up to date.

The flow in stepped structures is usually classified in *nappe flow* and *skimming flow* regimes. Some authors refer to a *transitional flow* regime as well, non-recommendable for design conditions. Whereas in the first regime the flow coming from the upper step falls to the following resembling a "free overfall", in the last one, the flow looks like a coherent stream, in which the steps harbor recirculating vortices. These types of flow are introduced by Chanson in Chapter 1. The basic ideas and concepts are clearly explained through drawings and pictures. The chapter closes with an overview of the main mechanisms of air incorporation in stepped chutes. A table with worldwide examples of cascades and dams with stepped structures is additionally available.

In Chapter 2, Chanson reviews the use of stepped chutes since Antiquity, beginning in Greece and Assyria and including the famous dropshafts cascades in Roman aqueducts. Photographs of some of the relics of those structures, and maps with their locations, are also presented, giving abundant details to the interested reader. The review ends with a discussion of design criteria of those old hydraulic structures.

In Chapters 3–5, the three aforementioned types of flow in stepped chutes, i.e., nappe flow, transition flow and skimming flow regimes, are explained in detail. Again, this information is accompanied with valuable photographs and drawings. In the case of nappe flow regime, Chapter 3, Chanson identifies three sub-regimes, depending on whether a full or partial jump is formed, or supercritical flow takes place on the step. Convenient space is devoted to the discussion of issues such as nappe ventilation and oscillation, and to energy dissipation. Also, a prototype experience is described.

The transition flow regime (Chapter 4) is the least studied regime. Chanson provides most of the information available, stemming mainly from his own contributions. This flow type is characterized by a chaotic behavior, about which Chanson dedicates the last part of the chapter.

The skimming flow case is described in detail in Chapter 5. Chanson presents plots summarizing diverse experimental results regarding the location and depth of the inception point for air entrainment. Data from Master and Ph.D. theses (not readily available) are included in the plots. A portion of the chapter is devoted to resistance laws in this complex two-phase flow. A compilation of numerous data points of Darcy-Weisbach resistance coefficients from different studies shows discrepancies in trends between model and prototype data. The chapter finally offers a brief comparison regarding energy dissipation among the different types of flow.

Chapter 6 discusses gas transfer issues. Basic mass-transfer equations are reviewed, and aeration characteristics are discussed for the regimes of nappe flow and skimming flow.

Chapter 7 deals with design criteria for stepped spillways and decorative stepped cascades. Numerous pictures of such

structures constitute an aid to potential practitioners. Gabion stepped weirs are also discussed and space is even devoted to small works made in wood and debris.

Related to design criteria, Chanson analyzes in Chapter 8 cases of accidents and failures connected to stepped structures. The chapter finishes with a discussion about design errors often encountered in civil engineering. Chanson puts the emphasis on previous evidence omitted during design. This certainly is a matter of debate and it would deserve a discussion forum on its own.

Chapter 9 in turn is devoted to wave phenomena in stepped chute flows, including a section about flood waves and dam-break waves.

Chapter 10 summarizes the most important ideas presented throughout the book. Interestingly, a series of questions-answers beautifully gives closure to the discussion about the design of this type of structures. This part resembles the FAQ (Frequently Asked Questions) section of various websites in this computer-based age, and I have found it attractive.

The book closes with 9 appendices. I personally believe that some of them (Appendices 3, 5, 6 and 7), dedicated to the theory and modeling aspects of flow in stepped hydraulic structures, could have been included in the main text, but this is not a major drawback. In future editions, the book could be improved by including exercises at the end of the design and modeling chapters. Also, chapters devoted to the measurement and theory of two-phase flows would enrich significantly the content of the book. The typeface is nice and it helps in reading the material.

The book constitutes an excellent reference for the design engineer in search for clear guidelines; it is also extremely useful for introductory teaching purposes, by virtue of the exhaustive number of pictures, drawings and plots included. For the researcher, the book offers a list of more than 350 papers, reports, theses, and books where to look for more, specific information. The Author has done a major contribution to profession bringing together an impressive amount of information on the subject.

Overall, this is a complete, attractive, and profusely illustrated book about stepped chutes. Finally, it is my impression that this book is called to be a required reference to be read by those involved in the hydraulic design of stepped spillways and cascades.

Fabián A. Bombardelli,
Ven Te Chow Hydrosystems Laboratory,
Dept. of Civil and Environmental Engineering,
University of Illinois at Urbana-Champaign,
Urbana, Illinois, USA;
on leave from Instituto Nacional del Agua (INA), Argentina;
e-mail: bombarde@uiuc.edu