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Hydraulics of stepped chutes and spillways

by Hubert Chanson

Stepped channel designs have been used for more than 3500 years. Recent advances in technology (e.g. RCC, polymer-coated gabion wire) have triggered a regain in interest for the stepped design, although much expertise had been lost in the past 80 years.

This book presents the state of the art in stepped chute hydraulics. Results from more than forty five laboratory studies and four prototype investigations were re-analysed and compared. The book provides a new understanding of stepped channel hydraulics, and it is aimed at both the research and professional community.

In the introduction, the basic concepts of stepped channels and stepped chute flows are described. A clear distinction is being made between the main flow regimes (nappe flow, transition and skimming flow). The second chapter presents the historical progress of stepped channels and spillways from Antiquity up to today. In the next chapter, the hydraulic characteristics of stepped channel flows are reviewed. Three different flow regimes may take place depending on the flow conditions and chute geometry: nappe flow regime for small discharges, transition flow and skimming flow. The hydraulics for each flow regime are described in chapters 3, 4, and 5. The effects of flow aeration and air bubble entrainment are discussed. the gas transfer processes taking place above stepped chutes are described: aeration, reoxygenation, stripping, denitrification (chapter 6). Practical examples of hydraulic design are presented in chapter 7, such as stepped fountains, stepped weirs, gabion stepped spillway, earth dam spillways with precast concrete blocks, roller compacted concrete (RCC) weirs, and debris dams. Chapter 8 presents a critical review of accidents and failures with stepped channels, highlighting that the hydrodynamic forces on the step faces are much larger than on smooth chute invert. There is a separate chapter (9) on wave phenomena and instabilities. In the last chapter, the key issues are summarized and basic questions are answered.

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About the author

Hubert Chanson has been an active researcher, expert consultant and educator on the topic for the last ten years. His publication record includes four books and over 180 international refereed papers. The Department of Civil Engineering at the University of Queensland is actively involved in research studies of stepped chute flows. The hydraulics of stepped spillways is taught regularly to professionals (short courses) and postgraduate students. The Department has three experimental channels, two of which have near full scale dimension.

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