J. Fluid Mech. (1969), *vol.* 37, *part* 1, *pp.* 207–208
Printed in Great Britain

REVIEW

Loose Boundary Hydraulics. By A. J. RAUDKIVI. Pergamon Press, 1967. 331 pp. £2. 10*s*.

This book is concerned with the properties of the flow (generally turbulent) of water over an erodible bed (e.g. a bed of sand). Some of the central problems of this field, discussed in various chapters, are: (i) to determine the critical shear stress which will just cause particles on the surface of the bed to move; (ii) given that this critical stress is exceeded, to determine the rate of transport of sediment in terms of the given mean properties of the flow; (iii) to determine what proportion of this total transported sediment is transported in the form of suspension, and what proportion is due to creeping of the bed; (iv) to explain the formation and propagation of the various bed-waves (ripples, dunes and antidunes) that are commonly observed; (v) to determine the rate of transport of sediment that can be caused through interaction of the bed with surface water waves.

The problems (i), (ii) and (iii) are exceedingly difficult and the only approach that has as yet been attempted with any success is that based on dimensional analysis, supplemented by fairly crude assumptions concerning the nature of the forces exerted by the water on the particles of sediment and by the particles on each other (as a result of collisions). The theories that have survived have of course been those that have shown reasonable agreement with experiment over some limited range of the governing parameters. Problems (iv) and (v), by contrast, admit a fairly detailed analytical treatment, provided some semi-empirical answer to the problem (ii) is accepted as a starting point.

The character of the book is, to some extent, conveyed by the opening sentences of the preface: 'The real task in writing this book was the summarizing and correlating of all the publications scattered throughout the technical literature. A staggering number of publications was found to exist.' The references are listed at the ends of each chapter, and will undoubtedly be useful for the novice entering the field. He will have considerable difficulty, however, in understanding the filtered versions of the original papers that are given, in which the crucial equations are faithfully reproduced, but much of the explanatory and discursive material is omitted. While an original paper may have been by no means easy to understand, the skeleton version given here is inevitably even more obscure and unconvincing. The summary (in § 6.4.2) of the epic paper by Bagnold (1957, *Phil. Trans.* **249**, 235) is a case in point. To a reader who is already familiar with the paper, this section may be a useful jog to the memory; but to one who is new to the subject it may have a less beneficial effect. The formulae and curves are given amid a plethora of symbols,† but there is little attempt to make critical comments either favourable or unfavourable, and some of the underlying assumptions are

† In this 9 page section alone, the following 59 symbols occur: a, a_0, A, A', B_b, B_s, C, C_D, C_{Ds}, C'_{Ds}, C'_D, C'_{Db}, d, E, G, n, Q_b, Q_{sb}, Re, T_0, T'_0, T_R, T_c, u, u_b, u_s, $\overline{u}_b$, U, $\overline{U}_s$, v, v_s, $\overline{v}_s$, v_b, W, W_b, W_{bF}, y, y_0, α, α_0, β, η, ρ, ρ_s, θ', θ_c, θ_0, θ_*, σ, ν, ϕ_b, ϕ_s, ϕ'_b, ϕ'_s, $\phi_{s(b)}$, χ_b, χ_s.

not even stated, far less discussed. This example is by no means untypical and the resulting juxtaposition of sections reads more like a handbook of empirical formulae than a 'text, which is intended to be introductory in nature' as proclaimed in the preface.

It is perhaps unfair to apply normal standards of criticism to a treatment of a subject such as this, which combines all the complexities of turbulence, low Reynolds number flow, and 'interacting particle' phenomena, which inevitably requires constant appeal to empiricism, and for which experimental observations (natural and laboratory) involve enormous scatter (at least 50 %, for example, in figures 14.24 and 14.25). It is, however, fair to compare the book with other treatments of the same topic. The book by Henderson, *Open Channel Flow* (1966, Macmillan Co., New York), contains a chapter of 83 pages on sediment transport, which covers a large part of the material of the book under review, and, in the opinion of this reviewer, does so in a more coherent and satisfactory manner. Henderson's account is self-contained and comprehensible on a first reading, and it reads fluently and convincingly. Raudkivi casts his net somewhat wider over the published literature of the subject, but in so doing he does not do justice to the theories that he describes, and the intelligent student may be confused at the seemingly arbitrary choice of theories with which he is confronted.

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