ment, though this would be corrected by reference to the chapter on the blood.

Taking a general survey of the whole, we see that the book is far from perfect. Few books are when they first appear, and much that is faulty can be corrected in subsequent editions. We must, however, congratulate Dr. Griffiths on being the first to break new ground by producing a work on the subject, as well as on the good points that the book exhibits, and to which allusion has already been made.

W. D. H.

THE DESIGN OF RETAINING WALLS AND RESERVOIR DAMS.

A Text-Book on Retaining Walls and Masonry Dams. By Prof. Mansfield Merriman. (New York: John Wiley and Sons, 1892.)

BEFORE entering upon the investigation of retaining walls and their design, the author devotes two chapters to the consideration of earthwork slopes and the lateral pressure of earth. Owing to the changeable condition of earth under the influence of moisture, and the variable nature of any stratum, it is impossible to obtain strictly exact expressions for the forms of slopes of cuttings and embankments, or definitely accurate values for the lateral pressure of earth; but, nevertheless, the formulæ deduced by the author from general principles are useful in serving as a guide to correctness of design. It is indicated that theoretically an earthwork slope should be curved, becoming flatter towards the base; and though a straight slope is always adopted for cuttings and embankments, the curved form left by slips is somewhat in accord with this theory. The inclination of slopes must indeed depend on the nature of the soil, and must be flatter in made ground than in cuttings; whilst efficient drainage and protection of the surface of the slopes from the weather are equally important for ensuring stability.

The pressure of earth is the basis of all theoretical principles relating to retaining walls, and it has formed the subject of numerous experimental investigations in England and on the Continent which might have been advantageously referred to in this book. The author adopts the view that the pressure is normal to the back of the wall; but as this theory is not universally accepted, he has also obtained a formula for inclined pressure. A retaining wall may fail by sliding or rotation, and the masonry is assumed to be laid dry, owing to the uncertain amount of cohesion in mortar joints. In practice, however, retaining walls of any height are built with cement mortar; and sliding occurs at the base, or even sometimes on detached slippery surfaces of clay below the base; whilst rotation is due to excessive pressure on yielding foundations at the front of the wall. Stability largely depends upon the nature of the foundation and the backing behind the wall. A clay foundation is far less trustworthy than gravel, and sliding is most effectually prevented in slippery soils by carrying down the foundations well below the surface; whilst careless backing up with bad materials, not brought up in their layers, may push over the wall. Efficient drainage, moreover, at the back of the wall, and outlets for water at intervals through the wall to prevent its accumulation behind, are almost as important considerations as the design of the wall. A wall leaning over backwards is shown to be the most economical; but though this form might be adopted for building against an embankment, it would not be convenient for a wall built in a timbered trench to retain the side of a cutting. The four chapters relating to earthwork and retaining walls, which comprise the main portion of the book, will be very useful for practical engineers who desire to extend their theoretical knowledge on these subjects; but students should bear in mind that an almost exclusive treatment of the theoretical aspect of these questions must be supplemented in actual design by practical experience.

The theory of the strains on masonry dams, considered in the concluding chapter, is more precise, owing to the exactness of our knowledge of the laws of water pressure as compared with the uncertain and variable pressure of earth. The well-known condition of stability, that the lines of resultant pressures, with the reservoir empty and full, should fall within the middle third of the cross section, is explained, as well as the uncertainty which exists as to the actual distribution of the pressures throughout the dam. The lines of resultant pressures for any given section are easily obtained graphically, for the line of pressure with the reservoir empty is the locus of the centres of gravity of the sections above a series of base lines taken down the dam, and the actual pressure is the weight of these successive sections; whilst the line of pressure with the reservoir full is the modification produced in the former line by the addition of the water pressure at the successive depths. The theoretical section given on page 110 resembles the section of the Furens dam in France, the highest masonry dam hitherto erected, the form of which was determined by elaborate analytical calculations. The principles laid down concerning masonry dams require to be supplemented by two practical considerations, namely, that high masonry dams must be founded on solid rock to secure them against undermining and settlement, which would be fatal to their stability; and that their inner face should be coated with an inpervious material, to prevent the infiltration which otherwise takes place through their joints at great depths. In taking the pressure due to waves on the top three or four feet of the dam below the water as equivalent to the greatest observed pressure exerted by waves on the sea-coast, the author far exceeds the probable limit; for ocean waves, owing to the great extent of the exposure and the depth, are impelled with a much greater force than the waves of a comparatively small and sheltered reservoir. The additional strength given to a dam by arching it towards the reservoir is very properly neglected in the calculation of its stability, for besides being difficult to estimate precisely, this increase in strength is inappreciable in a long dam, and even in the short Furens dam the arched form was merely regarded as an extra safeguard.

The book is clearly and concisely written; it is illustrated by numerous diagrams in the text; and problems to be worked out are given at the end of most of the articles, each of which deals with a subject under a special heading.