In the first eight chapters and in the mathematical treatment (Chapters XI–XIV) Professor Fisher assumes that the probability of risk is zero. In Chapter XIV he remarks: "To attempt to formulate mathematically in any useful, complete manner the laws determining the rate of interest under the sway of chance would be like attempting to express completely the laws which determine the path of a projectile when affected by random gusts of wind." He does, however, give a qualitative discussion of what would happen if risk were taken into account. It would seem that by assuming a law of risk obtained from empirical data in a way similar to the way in which a mortality table is drawn up, and by writing the demand as a functional defined on a range extending from some time in the not too remote past to a time in the future as I have indicated in my paper in the Journal of Political Economy, Oct. 1927, one might formulate a mathematical theory of interest which would take risk into account. The question of whether or not such an extended theory would be worthwhile from a practical standpoint would of course remain open.

In the mathematical treatment the author assumes that all of the income for each year is concentrated at the middle of the year (p. 288). If he had not made this restrictive assumption, the problem would have become one in the maxima of functionals instead of one in the maxima of functions. One wishing to develop further the theory of interest from this point of view may find meager hints in a related theory in my papers in this Bulletin, March–April, 1928, and the American Journal of Mathematics, January, 1928.

C. F. Roos

TIMOSHENKO ON STRENGTH OF MATERIALS

Strength of Materials. By S. Timoshenko. Two volumes. New York, Van Nostrand Company, 1930. xii+368 pp; v+401–735 pp.

The recent appearance of these texts on elasticity will be welcomed by engineering colleges and technical schools for many reasons. Perhaps foremost is the fact that it is written in English and fills a large gap between the two extremes of required courses of strength of materials in our engineering colleges and the comprehensive treatise by A. E. H. Love, *The Mathematical Theory of Elasticity*, now in its fourth edition.

Today it is becoming increasingly more difficult for the designer to meet the needs of greater working stresses, as required by more rapidly moving machine elements, unless analytical methods replace "rules of thumb." To further this end the author has provided a mine of interesting methods both for the student in the classroom and the research man in the laboratory. To quote the author's preface: . . . . "At the present time a decided change is taking place in the attitude of designers towards the application of analytical methods in the solution of engineering problems . . . . . The importance of analytical methods combined with laboratory experiments in the solution of technical problems is becoming generally accepted . . . . . It is the aim of this book (vol. I) to present problems such that the student's attention will be

focussed on the practical applications of the subject . . . . . The second volume is written principally for advanced students, research engineers and designers."

The fact that industries are making it more urgent that engineering students have a thorough basic training, is finding a response by our colleges in that some of them are organizing for a larger program by creating a separate department of applied mechanics, so styled or labelled by some other suitable name. In this connection Hovgaard (Science, vol. 71, No. 1840, p. 347) writes concerning theoretical mechanics (which includes mechanics of elasticity): ". . . . On the whole it appears that in the United States this subject is too often taught in a scattered way, and as a subsidiary science, of which each department gives only what is required for its spe ific needs without much regard to unification of the science . . . . . It is time that theoretical mechanics be given its appropriate place in the curriculum of American engineering schools. As a means of training in scientific methods of thinking and as a mental discipline introductory to research work, the subject is probably unequaled." To promote these ends, it is the opinion of the reviewer that the author has made a large contribution.

The chapter headings for Part I are: Tension and Compression Within the Elastic Limit, Combined Stress, Torsion, Stresses in Beams, Deflection of Beams, Statically Indeterminate Problems of Bending, Plastic and Non-Linear Bending, Stresses Due to Direct and Bending Loads, Combined Bending and Twist, and Energy of Strain; Part II: More Complicated Problems in Bending of Beams, Curved Bars, Thin Plates, Deformations in Bodies Generated by Revolution, Buckling of Bars, Plates, and Shells, Stress Concentration, and Mechanical Properties of Materials.

Part I is based upon the material usually covered in engineering courses, although it is more comprehensive in the types of applications. No apology is made for abundant use of differential and integral methods. As early as p. 19 appears the expression

$$\left(1+\frac{x}{n}\right)^{n}_{n=\infty} = e^{x}$$

which is intended for $\lim_{n\to\infty}(1+x/n)^{n}$. This limit is used to obtain a well known specific result from a general case, a type of analysis frequently used by the author. Part I is characterized by many special features such as Mohr's circle for combined stresses, conjugate beams for obtaining deflection, principle of superposition for statically indeterminate systems, tangent property of ellipse of inertia for determining neutral axis when the plane of deflection is not the plane of the bending forces, and use of integral methods before the method of differential equations. It is reserved for the final chapter to show the great utility of energy methods, particularly the application of Castigliano's Theorem and the Theorem of Least Work to the solutions of statically indeterminate problems, also the Reciprocal Theorem of Betti for obtaining direct results, especially the so-called "line of influence."

The reviewer had the opportunity of completing a study of Part I before the second volume was off the press. In view of the increasing scope as indicated by frequent references in Part I to more extended theory in the second volume, it was somewhat disappointing not to find a chapter on general equa-

tions of equilibrium. One might have anticipated the biharmonic equation for the stress function or for deflection of plates (the second-order equation in curvature is used for the circular plate in Chapter 3). An excellent treatment of minimizing the potential energy to derive equilibrium equations is given in Chapter 2 of the *Handbuch der Physik* (1928), a monumental treatise to which no reference is made. Pursuing the author's purpose . . . . "to prepare a book which contains new developments that are of practical importance . . . . without going beyond the limit of the usual standard in engineering mathematics . . . . ," he presents practical applications of trigonometric series to problems of beams, energy methods to curved bars and stability problems, membrane and electric analogs to stress concentration at reentrant corners of rolled sections, and a description of the photoelastic method for investigating stresses near filets and holes in tension and compression members. The concluding chapter on materials and strength theories is non-mathematical.

The typography and paging is excellent. (The lapse in paging between the two parts is to allow revision without changing the folios.) Nearly five hundred well executed figures aid in the visualization so necessary to the student in this analysis. The table of notations given at the beginning of each book largely follows the German system. About four hundred examples are given of which three-fifths are accompanied by suggestions for their solution. Many of these doubtless have come from the author's wealth of experience.

The books are well indexed both as to contents and to authors, listing some three hundred writers with references to over five hundred cited papers. Only about forty per cent of the citations are in English. This seems to be adequate indication that the foreign language requirement should be stressed, particularly for graduate students. Modesty prevents the author from including his name in the index of authors, although footnotes refer to some thirty of his published articles.

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