

**FATIGUE DESIGN—2nd Edition**, C. C. Osgood  
 Pergamon Press, Elmsford, N.Y., 1982 - 606 pp. - \$22.50  
 (paperback)

**REVIEWED BY H. SAUNDERS<sup>1</sup>**

Fatigue has been a "household" word in engineering circles for over a hundred years. Large expenditures have been allocated on fatigue testing and analysis during this period. Yet, we don't understand all of its ramifications. As stated by the author, "All machines and structural designs are problems in fatigue because the forces of Nature are always at work and every object must respond in some fashion." The ever increasing demand for guaranteed performance and life intensifies the need to regard all design situations as those in which imperfect materials are subject to dynamic loadings. This book attempts to provide a better understanding of fatigue by incorporating some of the most important aspects of fracture mechanics. The book is a complete revision of the previous edition.

The book consists of four chapters and an excellent bibliography. Chapter 1 introduces the reader to fatigue and states its scope, level and limitations. Chapter 2 describes the design approach and the various important parameters associated with fatigue design. Amongst the topics are loads, stress and stability analysis, safe-life and fail-safe design, factors of safety, minimum weight design of machines as contrasted to structures, a short section on residual strength concludes the chapter.

Chapter 3 is the lengthiest and covers 364 pages. This chapter concerns itself mainly with fatigue life. This includes methods of prediction, cumulative damage (miner, random, and constant amplitude loading), rainflow method plus local strain method. With this under our belt, we proceed to nonlinear and damage boundary rules. This considers stress concentration factor ( $K_T$ ), fatigue reduction factor, fatigue quality index, structural reliability and random loading statistics. The latter is described in a very lucid manner. The next fatigue subject is fracture mechanics. This is the heart of

modern thinking in fatigue analysis. This covers transition-temperature considerations, stress intensity equations, stress corrosion cracking, toughness and the well-known crack growth equations. A number of examples are provided which help the reader cross over the hurdles. In addition, a number of special topics are discussed. These cover bolted joint design, preload torque relationships, stress concentration in bolts and nuts, lugs and devices, riveted and welded joints. The author makes no mention of Heywood equation for loading and stress concentrations. This method is used in turbine and gear design. Continuing, we next encounter temperature effects and thermal fatigue which includes choice of materials and means of analysis for thermal fatigue and thermal shock. The chapter concludes in determining the need for fatigue evaluation of pressure vessels and piping, and fatigue of machine parts. This encompasses bearings and preload, power and motion gears plus springs. A very "well put-together" chapter and full of information. However, the reviewer feels that this chapter is too lengthy and should have been divided into a number of separate chapters.

The concluding chapter, although brief in comparison to chapter 3, contains a great deal of information. Beginning with the mechanism of fatigue (work and soft hardening, monotonic and cyclic properties), it progresses into various forms of fatigue tests and methods of data reduction and presentation. This includes equations, scatter in fatigue damage and detection applied to fatigue damage. The various structural materials are considered, i.e., carbon and alloy steel, stainless steel, aluminum, magnesium and titanium alloys, nonferrous materials, cast irons and steels, plastics, laminates, and composites. The concluding section examines residual stresses and surface treatments. This is a very informative chapter.

The reviewer was impressed by the book. The practical examples were excellent and the design hints were most welcome. However, the reviewer believes that oil bearings should have been included. The discussion of low cycle fatigue is too brief and should be greatly expanded. The J-integral method in fracture mechanics is not mentioned.

In summary, this is an excellent book. It contains a great deal of information that could be of great value to the designer, analyst and test personnel. This is in response to their quest for information in understanding the ramifications of fatigue. The reviewer recommends this book to the tyro as well as experienced personnel.

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