Preface

The design and analysis of high-temperature behavior of engineering structures play an important role for aviation and transport gas turbine engines, stationary steam and gas turbine power plants, including gas-transfer stations, and also for aerospace, atomic and chemical engineering, and other branches of industry.

The pioneering work by J. Duhamel in the middle of the nineteenth century inspired investigation of temperature stresses within the framework of solid mechanics. Interest in engineering applications of this phenomenon manifested only in the early twentieth century with the advent of steam and then gas turbines (A. Stodola, R. Bailey, F. Norton, N. Lebedev, and others). Toward the second half of the last century, the theory of thermal integrity (thermal strength) was established as a branch of engineering science studying high-temperature material behavior. It became especially apparent in connection with the invention of aviation gas turbine engines.

In the West, related problems were embodied in publications by A. Freudenthal, R. Larson and J. Miller, L. Coffin, N. Hoff, W. Prager, B. Gatewood, B. Boley and J. Weiner, R. Hill, and other English-speaking authors.

In the USSR, analysis of material strength at high temperatures in application to aviation gas turbines was initiated by V. Uvarov. Beginning from the middle of the twentieth century, this topic was intensively developed at the Moscow Central Institute of Aviation Motors (CIAM) by I. Birger and S. Serensen, and also by their followers B. Shorr, R. Sizova, R. Dul'nev, I. Dem'janushko, Yu. Temis, and some others. This research was carried out in close collaboration with a number of Russian and Ukrainian colleagues, including Yu. Rabotnov, Ya. Fridman, R. Shnejderovich, N. Malinin, and G. Pisarenko. Main results on the subject were delivered at major scientific conferences and widely published.

A relatively complete exposition of the aforementioned problems until the mid-1970s has been presented in the monograph "Thermal Strength of Machine Parts" edited by I. Birger and B. Shorr. Although 12,000 copies were published, the book gained rare status soon after publication in 1975 in USSR.

However, Russian publications in the area of thermal strength remained unknown to researchers from other countries, except for a small number of contributions translated into English.

During the second half of the twentieth century, both in the West and in Russia, numerous papers and books reporting the novel theoretical and experimental results on the strength of materials and structures under elevated temperatures have been published. The range of applications of these developments has been expanded since non-uniform temperature stresses arise not only in mechanical systems, but also in civil structures, road coatings, and even in the Earth's core.

Thermal integrity is a multidisciplinary field combining joint efforts of mechanical engineers, material scientists, and applied mathematicians approaching the problem from their specific viewpoint. This monograph draws on the research of a broad scientific community including the author's contribution.

The scope of thermal strength analysis was considerably extended due to making use of modern computers along with the implementation of FEM codes. However, the author believes that there is a sort of disparity between the power of advanced software, and lack of easy-to-follow books on the theoretical and experimental aspects of thermal integrity. The author endeavors to ensure the rigor of the underlying assumptions along with sufficient simplicity of presentation making the book compelling to a wide audience.

The book is targeted at engineers, university lecturers, postgraduates, and final-year undergraduate students involved in computational modeling and experimental and theoretical analysis of high-temperature behavior of engineering structures. The book is also intended for attention of researchers developing the thermal strength theory as a branch of continuum mechanics.

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