

Preface to the English translation

Severe stress conditions of present-day structures and strict limitations on their material consumption call for continuous refining of the methods of strength analysis and optimization of the technologies employed. The progress in creating rational structures and developing new efficient manufacturing processes depends primarily on the level of our knowledge of mechanical properties of the materials used. For this reason, much attention has always been paid to the accumulation of information in this field.

Unfortunately, the handbooks published in many countries contain only standard characteristics of the mechanical properties of materials obtained mainly in uniaxial tension and uniaxial compression, though it is known that in most cases the material of the carrying structural components works under conditions of a complex stress state.

This situation has repeatedly been the subject of discussions at numerous representative scientific forums and meetings of practical orientation. Yet in view of the difficulties associated with the methods of testing under multiaxial loading, particularly under conditions of high and low temperatures, one can still feel a serious shortage of reliable data on the regularities of deformation and fracture of structural materials under a complex stress state.

It should be noted that serious investigations involving this aspect of experimental mechanics have been performed in Ukraine, Russia, and other East European countries. As far back as the 1950s, the first testing machine for combined loading was created under the supervision of A.A. Ilyushin (Moscow). It made it possible to obtain unique experimental results on physical justification of new hypotheses and postulates which formed the basis of the theory of the material ultimate state and the theory of plasticity being developed. Beginning in 1960 systematic experimental investigations in the field of theories of plasticity have been carried out at the Institute for Problems of Strength of the National Academy of Sciences of Ukraine (Kiev). Here automated systems were created which enable materials to be tested under complex stress conditions over the temperature range from 30 to 1600 K. A great scope of experimental works was performed at the Institute of Mechanics of the National Ac. Sci. of Ukraine, the Institute for Problems of Mechanics of the Russian Ac. Sci. (Moscow), National Technical University of Ukraine (Kiev), and at other institutions. Unfortunately, the results of those investigations are little known in the West European countries and in the United States and this often leads to duplicating complicated tests and obtaining the already known relationships.

To the best of our knowledge, the first handbook containing extensive information on the influence of the stress state on the material properties was compiled by the authors and published in 1983 by Naukova Dumka Publishers (Kiev, Ukraine) in 3,000 copies. The handbook was sold out quickly, and at present it is a bibliographical rarity.

Since publication of the first edition, much new information has been obtained on the mechanical properties of various structural materials under conditions of a complex stress state, including low- and high-temperature behavior. The authors were constantly concerned with the accumulation and systematization of those data, taking them from the publications in periodical literature, proceedings of scientific conferences, and meetings, and using the results of their own investigations.

The main goals and tasks of the Handbook were highlighted in the preface to the Russian edition. In the preparation of the present edition, the overall trend of the book and the order in which the material is presented are left unchanged wherever possible. The introductory part regarding general problems of the mechanics of materials and methods of their testing is presented in a rather concise form without rigorous proofs or a lengthy journey into the history

of the subject. This is reasonably compensated for by the extensive bibliography at the end of the book which allows a reader to form an objective idea about the stages in the development of one of the most important branches of the science concerned with material properties, and about the original works in this field, as well as about the pioneer investigators.

The bank of experimental data presented in the Handbook involves the results of testing only the most typical homemade materials. We consider this limitation justified because it is impossible to study all the materials known in the world due to their enormous quantity. Moreover, this would be unreasonable because the regularities of the deformation and fracture of the materials considered are the fundamental results and can be extended to any material of the corresponding class. Thus, in most cases, this rules out the necessity of organizing additional expensive tests which yield no qualitatively new results, or reduces appreciably their scope.

The authors tried to make the Handbook more complete and up-to-date by including new experimental data which reflect the latest achievements in the issues in question. Moreover, the authors took into account all the readers' remarks, acceptable in their opinion, which had been received after the publication of the first edition. In particular, in some cases, formats for presentation of the data on the effect of the stress state mode on the mechanical properties of materials were changed. This made them clearer and more convenient for use by researchers in refining the tools of the mechanics of a deformable solid, and by design engineers in selecting materials most acceptable for the structures designed, as well as in constructing the computation algorithms.

Additions were made to all sections of the Handbook. The most essential of them are the following.

1. Additional information has been introduced on the characteristics of strength and plasticity of materials of various classes under three-dimensional (triaxial) stress conditions, and three-dimensional compression in particular, which makes it possible to specify and to choose with a higher degree of justification the models of deformation and the criteria of strength of quasi-brittle materials used in practical calculations.

2. Important additions have been made to the results of studying the lifetime of structural materials under conditions of high-cycle loading and complex stress state.

3. The problems related to the influence of the stress state mode on the material crack growth resistance have been considered in more detail.

4. For the majority of homemade materials, their analogues (in chemical composition or mechanical properties) produced in the United States are presented. All the numerical results have been converted to the metric system.

The authors hope that with all these additions and amendments the Handbook will be more exhaustive in its content and will satisfy the needs of a wide circle of American and Western European specialists in the mechanics of materials concerned with various aspects of the theories of plasticity and strength, and researchers, engineers, and technicians engaged in designing machines and engineering structures.

The topicality of the material generalized in the Handbook seems to be unquestionable for scientific and technical workers. In this respect, it is pertinent to quote the following wise words belonging to Russian Academician I. Pavlov: "No matter how perfect the wing of a bird is, it would have never brought the bird high into the sky without the support of the air. Facts are the air for a scientist, without them you'll never be able to take wing. Without them your theories are vain attempts."

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The authors will be grateful for any further remarks and comments to the second edition of the Handbook.

The authors