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## STUDIES ON THE STRENGTH OF STEEL

This book represents a symposium of 12 articles edited by I. V. Kudryavtsev, Candidate of Technical Sciences, describing recent works of TsNIITMASh (Central Scientific Research Institute of Technology and Machine Building) in the field of the strength of steel. Six articles deal with the problem of surface strengthening, and the remaining six relate to the theory and design of testing machines and instruments, and other subjects. Titles and brief summaries of all articles are given below.

1. "Determination of Residual Stresses Induced by Shot Peening," by M. M. Saverin, Candidate of Technical Sciences, pp 6-32, describes a method for determining residual stresses in plates subjected to surface cold hardening in the process of shot peening which induces in surface layers a plane stressed state with a high-variation gradient of stresses in depth. The new method, using a single specimen, permits plotting the diagram of residual stresses along a cross section of the plate, interpolating the middle section of the diagram. The shape of the complete diagram permits evaluating the precision of experimental analysis. Application of the new method reveals that not only the peening process itself but also conditions of fastening the plate have a great effect on the distribution of residual stresses.

2. "The Fatigue Strength of Steel Products With Surface Defects in the Form of Thin Cracks," by I. V. Kudryavtsev, Candidate of Technical Sciences pp 33-59, develops a method of obtaining closed notches on steel specimens of high and medium hardness. This method permits studying the influence of surface defects such as seams, hair cracks, and corrosion damage, on the fatigue strength of steel parts. Closed notches cause a sharp decrease in the resistance of a steel piece to alternating load. Surface rolling considerably decreases and sometimes entirely eliminates this harmful effect on fatigue strength. This favorable effect of surface rolling can be explained by the



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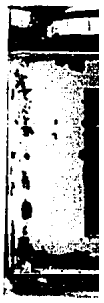

action of residual compressing stresses. Subsequent tempering of notched and rolled steel specimens plays an important role in maintaining a proper fatigue limit; high temperature of tempering decrea es the fatigue limit due to the removal of favorable residual stresses.

3. "Application of the Optical Method for Analyzing the Distribution of Residual Stresses in the Process of Surface Strengthening of Machine Parts," by M. M. Saverin, Candidate of Technicel Sciences, and V. M. Zavartseva, Engineer, pp 60-93, attempts to study the distribution of surface residual stresses directly in the zone of stress concentration by creating in optically active material residual stresses similar to those induced by surface strengthening processes such as shot peening, surface rolling, case hardening, and others. Optical analysis shows that concentration of residual compressing stresses in the zone of a notch permits relieving the most critical section of a machine part from stresses caused by exterior load. This factor explains the high effectiveness of surface strengthening of parts having various stress concentrators, as, for example, surface cuts and scratches.

4. "Effect of Surface Hardening by High-Frequency Current and Subsequent Rolling on the Fatigue Strength of Steel," by I. V. Kudryavtsev, Candidate of Technical Sciences, and L. I. Savko, Engineer, pp 94-101, corroborates results of previous studies of surface-hardened steel, showing that the fatigue limit of a specimen decreases when its chamfered portions have no hardened layer. Surface rolling of these zones improves the fatigue strength of weakened parts. Crankshaft journals, which are subject to surface hardening, usually have a hardened layer interrupted in the critical zone of transition into shoulders, the induction hardening of which is technically difficult. The authors suggest combined treatment for crankshaft journals of automobile, aircraft and diesel engines, and induction hardening of journals and surface rolling of shoulders.

5. "Strengthening Cast Steel by Surface Cold Hardening," by M. M. Kobrin, Engineer, pp 102-121, offers experimental proof of the economic and technological expediency, in many cases, of replacing forged steel by surface-hardened cast steel, which has a low sensitivity to stress concentration and develops fatigue strength considerably higher than forged steel when surface notches are present. The high effectiveness of surface cold hardening of specimens with notches is explained by the concentration of residual compression stresses around the notches, and by the stability of these stresses under cyclic load. Since machine parts, as a rule, have stress concentrators similar to notches on specimens, it may be assumed that the effectiveness of surface cold hardening will also be high under operational conditions. Methods of surface strengthening, such as surface rolling or shot blasting, are recommended for a number of cast parts such as crankshafts of internal combustion engines and forging machines, connecting rods of steam engines, cast steel rollers of rolling mills, etc. The fatigue strength of cast steel can be considerably increased by special heat treatment consisting mainly of high-temperature long-term diffusion annealing, which is especially effective for parts with a wall thickness above 25 mm.

6. "Increasing the Endurance of the Welded Rotor of the Low-Pressure Cylinder in a 35,000-Kw Turbine," by D. N. Vidman and I. V. Kudryavtsev, Candidates of Technical Sciences, pp 122-126, presents an example of practical application of the surface rolling method: increasing the endurance of a high-power turbine rotor, on the surface of which fatigue cracks appeared in the zone near a weld.

7. "Instrument for the Determination of Relative Vibration Damping," by V. I. Prosvirin, Doctor of Technical Sciences and N. N. Morgunova, Engineer, pp 127-133, describes an instrument for studying damping of torsional vibrations. An optical method used for vibration recording keeps the instrument's

own losses of energy to a minimum. The instrument, according to the authors, will facilitate further study of an essential characteristic of steel, namely, cyclic viscosity, seldom used in technical calculations due to a lack of dependable data on the cyclic viscosity of metals.

8. "Methods for Studying the Fatigue Strength of Steel Under Bending by Asymmetrical Cycles," by S. G. Kheyfets, Candidate of Technical Sciences, pp 134-146, describes a number of methods for realizing an asymmetrical cycle of reversed bending. The possibility of breaking a specimen under reversed bending at pulsating compression is experimentally established, contradicting the opinion of certain American scientists who assume that fatigue failure can be caused only by tensile stresses.

9. "The Resonance Torsional Machine for Fatigue Testing," by O. O. Kulikov, Engineer, pp 147-177, describes the K-2 machine which realizes symmetrical cycles of loading. Loading and torsiometric devices are based on a two-flywheel vibratory system. Incorporating the feature of all resonance-type machines, i.e., including high stresses with small loads, the K-2 possesses, at the same time, a quality of machines with a two-flywheel system, namely, internal balance of basic forces.

10. "Selection of Testing Machine Parameters and Permissible Beats of Specimens in Fatigue Testing," by S. G. Kheyfets, Candidate of Technical Sciences, pp 178-195, discusses the physical nature of specimen wobbling and methods for selecting testing machine parameters which keep the harmful effect of wobbling to a minimum. Suggestions given in the article are based on the author's previously published investigations.

11. "Utilization of an Optical Method for Measuring Stresses in the Solution of Problems With Elastically Plastic Contact," by M. M. Saverin, Candidate of Technical Sciences, and V. M. Zavartseva, Engineer, pp 196-222, studies the distribution of specific pressure along the arc of grabbing in the rolling process. Models of a roll were made of optically active material and a lead strip was used for experimental rolling. Modeling of the rolling process and analysis of experimental results corroborate a hypothesis, taken as a basis for the new theory of specific pressure distribution, namely, in addition to two zones of slipping, i.e., lagging and overrunning, there is another zone between them where slipping of the rolled metal is absent.

12. "Longitudinal Bend of a Beam With a Flat Lateral Support," by R. M. Brumberg, Engineer, pp 223-256, deals with the calculation of a beam for longitudinal bending when its buckling is limited by a side support. This investigation, an answer to practical demands for calculating certain details of metallurgical machines, gives the solution of the problem under various conditions of beam fixing and for various forms of bending which depend on the relationship between load value and beam dimensions.

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