DETERIORATION AND FAILURE OF STRUCTURAL MATERIALS

Chair of Strength of Materials works

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PREFACE

Safety of engineering structures is beyond any doubt a main concern of engineering design. Engineers, immersed in thinking in terms of elasticity (which goes more than three centuries back to Robert Hooke) often reduce it to limiting internal quantities like stress of strain. However these, though in everyday use of engineers, are not measurable state variables. When structures fall beyond elastic limit or when are subjected to different environmental effects, the concept of stress turns to be inefficient. A deep study of internal material structures and its evolution comes to play a leading role. It requires to study down the scale of physical phenomena, like in material science, but simultaneously must be brought back on macroscopic level to make it useful for engineers. The set of papers in this book falls into such frame of reasoning.

In Cracow University of Technology this branch of mechanics has firm roots. Perhaps one can think of M.T.Huber paper of 1903 in "Czasopismo Techniczne", the technical journal still published by CUT, in which he set general limits of elasticity and thus opened the doors to further study of plasticity. M. Życzkowski, late professor of this university became an worldwide outstanding contributor to this branch of mechanics in XX century. His doctoral student, Stefan Piechnik, now professor emeritus of CUT, made a great step into enhancing notion of material sustainability. Working on creep of materials at high temperatures in Royal Institute of Technology, Stockholm in early 60-ties he get acquainted with a new concept of damage parameter originally develop in 1958 by L.M.Kachanov in Russia (then SSSR). This idea, which soon spread over the all scientific world, was pursued at CUT by Professor Piechnik and his co-workers for next decades until today. The climax of its development on European scale was Euromech 251 conference held at CUT in 1989 preceded by an international summer school at Janowice Conference Centre of CUT in 1977. On the world-wide scale it gave rise to the forming a new branch of science named damage mechanics.

One main phenomenon connected with material deterioration, leading to catastrophic failure, is anisotropy. As often (e.g. in creep conditions) micro-voids open perpendicular to the main principal stresses the anisotropy changes in time making the analysis even more complex. Therefore, the presented monograph is composed along these different aspects of this phenomenon rather than the names of Authors. Beginning with consideration of general built-in anisotropy (P.Kordzikowski) it goes to structural anisotropy of composites (J.German and Z.Mikulski) and arrives at anisotropy induced by environmental effects: creep of materials at elevated temperatures (K.Nowak) and chemical corrosion

(A.Zaborski). The variety of numerical methods were necessary to be developed including matrix analysis, numerical methods up to a new method of cellular automata application.

The papers included here are of high scientific value. It is worthwhile, perhaps, to put an emphasis on educational aspects of the topics discussed here. All of them contribute to the broadening of thinking on safety of materials and structures. The magic sphere of elasticity and stress and strain as unique measure of safety is exceeded. However including it into engineering curriculum requires some basic knowledge so it may be interwoven into graduate studies as separate course or a part of specific courses on different engineering applications. In the era of innovation it enhances engineering thinking, in general.

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