

# Preface

The contents presented in this book are, in the opinion of the authors, an essential conceptual basis for the training of professional mechanical engineers in the field of experimental methods applied to theory of structures. Our intention is not to give an overview of all the experimental methods used in stress analysis, as we present only those that we have utilized for research purposes and scientific and technical consulting. Experimental analysis methods are based on different branches of science such as mechanics, electronics, optics, information theory, etc.: excellent specialized books are available written by specialists from different areas, which focus exclusively on methods. This book is a complementary reading to such specialized works, in that it gives an outline of some methods and shows how their applications make it possible to understand the *foundation* of a problem even before obtaining a detailed solution. For this latter task, the computing methods that cover nearly every need in solving particular cases are the best.

While historically experimental analysis was developed as a surreptitious tool due to a lack of analytical solutions to structural problems, today it is an instrument for clarifying the limitations of analytical theories, but primarily, due to the inverse nature of experimentation, for identifying unknown parameters, *integrating experimental data into analytical models*. Experimental Stress Analysis was classically regarded as a collection of experimental methods dedicated to the measurement of deformations of loaded bodies, and then to the corresponding states of stress. This has been modified into a methodology to build acceptable models for setting up phenomenological theories and supporting design practices.

It is common to speak of design for safety, reliability, or design to prevent high cycle fatigue, low cycle fatigue, crack propagation, multi-mode failures, etc. On the basis of years of teaching and consulting experience, we believe that the ultimate goal of experimental analysis is not only the knowledge of a state of stress but also the design and assessment of the integrity of structural systems.

There is another issue here that must be dealt with: Experimental Stress Analysis requires a variety of devices, testing machines, etc. that may be available on the market, often packaged in the form of black boxes. Self-made equipments give

many more opportunities for adjusting to specific problems and have an unparalleled role for training the experimentalist and also for education in structural design. The laboratory practice is highly educational for this purpose since it is conceptually similar to the practice of design. Both deal with problems in which a lot of data is unknown. This book is therefore oriented to applications, which require a self-made laboratory equipment on the assumption that it may offer a useful aid to help graduate students develop sensitivity to quickly discovering the few controlling variables and the essential tests for solving the problem.

According to its inverse methodology nature, experimental analysis has recently found new tasks in the solution of reliability problems. The estimation of reliability, and therefore also the answer to the question of a possible extension of life, requires experiments in order to identify the causes of defects and failures and to measure the failure rate. Therefore, the role of experimentation is not one of simple verification of a theoretical prediction, but is a continuous monitoring and control of processes and an invaluable tool for the estimation of the life of technical systems.

Finally, we did not use the more accredited and common label of Experimental Mechanics as the title to cover the topics of this book. Generic nominalization might lead to a confused definition of boundaries and to misunderstandings: important topics, such as Experimental Vibrations Analysis, have for many years constituted disciplines in their own right and are not covered in this book. Along the same line, there is no reason to limit Experimental Mechanics to solid bodies.

References to experimental stress analysis can be found in materials produced by scientific societies in various countries, such as SEM (American Association of Experimental Mechanics) in the USA, GESA (Gesellschaft für Experimentelle Spannung Analyse) in Germany, GAMAC (Avancement des Methodes d'Analyse des Contraintes) in France, BSSM (British Society for Strain Measurement) in the UK, AIAS (Italian Association of Stress Analysis) in Italy, EURASEM (European Association for Experimental Mechanics) for Europe, the Danubia-Adria Symposium for Central Europe, and the International Committee IMEKO TC 15 (Experimental Mechanics) with related YSESM, (Youth Symposium for Experimental Solid Mechanics) expressly devoted to young researchers.

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