Extreme Man-Made and Natural Hazards in Dynamics of Structures

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Extreme Man-Made and Natural Hazards in Dynamics of Structures

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PREFACE

There is currently ever pressing need to provide a critical assessment of the current knowledge and indicate new challenges which are brought by the present time in fighting the man-made and natural hazards in transient analysis of structures. The latter concerns both the permanently fixed structures, such as those built to protect the people and/or sensitive storage material (e.g. military installations) or the special structures found in transportation systems (e.g. bridges, tunnels), and the moving structures (such as trains, plains, ships or cars). The present threat of the terrorist attacks or accidental explosions, the climate change which brings strong stormy winds or yet the destructive earthquake motion that occurs in previously inactive regions or brings about tsunamis, are a few examples of the kind of applications we seek to address in this work.

The common ground for all the problems of this kind from the viewpoint of structural integrity, which also justifies putting them on the same basis and addressing them within the same context, is their sudden appearance, their transient nature and the need to evaluate the consequence for a high level of uncertainty in quantifying the cause. The problems of such diversity cannot be placed within a single traditional scientific discipline, but they call for the expertise in probability theory for quantifying the cause, interaction problems for better understanding the physical nature of the problems, as well as modeling and computational techniques for improving the representation of inelastic behavior mechanisms and providing the optimal design.

The present time of high uncertainty is very likely to increase (rather than decrease) the frequency or severe intensity of the high-risk situations that a very few engineering structures have been built to sustain. It is therefore important to understand any potential reserve, which might exist in engineering structures for taking on a higher level of risk. The complementary goal, also of great importance, pertains to providing the best way of reducing the negative impact of high-risk situations that cannot be avoided, by resorting to a more sound design procedure.

Never before have we had the same level of development of scientific and technological achievements, which can be brought to bear on the present problem of high complexity. First, the constant progress in computational tools ought to be exploited to construct the more refined structure models than those used previously, which can provide a more detailed information and explore all potential reserves in a more old-fashioned design. Second, one can nowadays understand much better the particular physical nature of the loading conditions, by simulating the actual physical process that is at its origin, and in that manner providing a more reliable estimate of the parameters governing the processes of this kind. The quantitative information can be bracketed between the probabilistic bounds, which can nowadays be constructed for more and more complex processes, thanks to significant advances in modern computational probability research.

The present work is the outcome of a lively exchange of ideas among the world leading scientists dealing with different facets of this class of complex problems. Among them, specialists in probability, in structural engineering, in interaction problems and in development of computer models, as well as related experimental works, have all contributed to the successful accomplishment of the hazard reduction goal set for our meeting. The lectures presented in this book are regrouped on any single topic to provide the most detailed presentations, seeking to reach eventually complementary points of view. A fair number of pages is allocated to each chapter in order to provide the complete presentation of any given facet of the problem and a sufficiently detailed exposition to any important idea to be grasped. Among several illustrative applications which are discussed herein we find: quantifying the plane-crash or explosion induced impact loading, quantifying the effects of a strong earthquake motion, quantifying the impact and long-duration effects of strong stormy winds, providing the most efficient tools to construct the probabilistic bounds and computational tools for probabilistic analysis, constructing refined models for nonlinear dynamic analysis and optimal design and presenting modern computational tools for that purpose.

All the papers collected in this book are first presented as the keynote lectures at NATO-ARW No. 981641, which was held in the city of Opatija in Croatia, from May 28 to June 1, 2006. We would like to thank all the participants for their important contributions to the successful outcome of this meeting, and in particular to the keynote lecturers, Professors K.J. Bathe, N. Bicanic, F. Dias, P. Fajfar, M. Geradin, A. Ibrahimbegovic, P. Leger, H.G. Matthies,, D.R.J Owen, M. Papadrakakis, D. Peric and E.L. Wilson, for ensuring a more lasting impact of this meeting in terms of the present book.

Last but not least, we would also like to thank NATO Science Committee for selecting our meeting, NATO-ARW No. 981641, for the financial support by NATO.

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