Preface for Previous Title: Impact and Explosion – Analysis and Design

The dynamics of impact and explosion are an important consideration in the design of conventional structures in general, and sensitive and unconventional structures in particular. Accidents causing damage and explosion are a matter of growing concern in many areas such as nuclear, chemical, civil, mechanical, electrical, offshore, gas, aeronautical and naval engineering. This book provides, in Chap. 1, a comprehensive, illustrated survey of accidents and explosions, including those caused by aircraft, missiles, bombs, detonators, sea-going vessels, cars, lorries, trains, etc. Gas and nuclear explosions are also covered.

Engineering modelling of impact and explosion requires a great deal of data as an input. This input is needed so that a comprehensive analysis can be carried out on the design of structures. Chapter 2 gives a comprehensive treatment of various types of impact and explosion. Tables and examples are given for tornado-generated, plant-generated and military missiles, and civilian and military aircraft. The impactors included may be categorized as follows:

- **Environmental**: Jet fluids, snow/ice, falling stones/boulders, trees, poles, pylons and various types of dropped weights
- **Military/Naval**: Tanks, tankers, ships, carriers, hydrofoils and hovercrafts
- **Civilian**: Cars, lorries, trains, earth movers and bulldozers

Data on explosion cover bombs, shells, grenades, explosives, gas leaks, chemical dusts and nuclear and underwater detonations. Tables and graphs are provided to act as inputs to various engineering problems. Both Chaps. 1 and 2 will familiarize the reader with the range of types of missiles/impactors and explosions and their disastrous effects in terms of human lives and structural damage.

The modelling of shock impact and explosion remains one of the most difficult tasks. It involves structural dynamics, load–time relationships, impactor–target interaction, material properties including strain-rate effects and
solution/convergence procedures. Before the reader is introduced to numerical models and design/protection techniques, it is essential to emphasize the importance of knowing basic structural dynamics, which is the theme of Chap. 3. This chapter covers all areas of basic structural dynamics, such as elastic and elasto-plastic systems, degrees of freedom, fundamental vibrations, forced vibrations and impact/impulsive loads versus vibrations, and includes tables and graphs covering numerical data with typical examples.

The reader is then in a position to study the dynamics of impact and explosion. Chap. 4 provides an extensive treatment of impact dynamics. It includes vehicle collision mechanics and impact due to dropped weights, water jets, snow/ice, ocean waves, missiles and aircraft. Empirical models are introduced for non-deformable and deformable missiles. Materials considered are steel, concrete, bovine, soil/rock and composites. A special section covers impact on water surfaces. A simplified analysis for load–time relationship is presented. Tables, graphs and line diagrams are used to evaluate parameters and coefficients in the numerical analysis.

The dynamics of explosion, as introduced in Chap. 2, is considered in depth in Chap. 5. Apart from discussing various numerical parameters and major assumptions, this chapter includes detailed analysis and numerical modelling for explosions occurring in air, underground and underwater. Prominent among them are explosions due to nuclear detonations, gas leaks, dust bombs and explosives. Blast loads and their overpressures are fully discussed.

Chapter 6 gives formulations for the dynamic finite-element analysis of shock, impact and explosion. Various boundary conditions are discussed. A step-by-step analysis suggests only the use of higher-order elements representing various materials alone or in combination. Material strain rates, dynamic material modelling simulation and solution techniques are fully discussed. On the other hand, the analysis is flexible enough to include linear, nonlinear, plasticity and cracking criteria under shock, impact and explosion conditions.

Chapter 7 covers impact and blast load design. Case studies are chosen from various engineering disciplines. Each case study is supported by a brief introduction to the background of the relevant areas. Care is taken to include those case studies that are supported by experimental test results and/or site monitoring. This then gives a degree of validation to the analytical results. The major case studies chosen are from the following disciplines: building, civil, mechanical, naval, aerospace, offshore, defence, nuclear, transportation and underwater facilities. Final design recommendations are made for each case study. The text gives a comprehensive bibliography for those who wish to carry out further research in depth.

Shock, Impact and Explosion – Analysis and Design will be of use to research and practising engineers, designers, technologists, mathematicians and specialists in computer-aided techniques of structures under transient loads in various engineering disciplines as identified earlier in this text. It will
also be of use to non-engineering specialists involved in the manufacture and application of various impactors and explosive induced structures and their protection.

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Preface for Shock, Impact and Explosion

The Preface given here can be treated as an extension to the earlier preface given in this text under ‘Impact and Explosion – Analysis and Design’. The statement given therein must therefore be valid for this new text. This book gives additional materials on the individual subjects of importance. Chap. 1 on accidental survey has been improved upon. This now gives an up-to-date data on accidents. Chap. 2 gives additional materials on impactors, aircraft and missiles. Very recent data have been incorporated on aircraft, missiles and their collisions and crashes. Many new items are included, which are based on advanced research and recent events. Chap. 3 gives an updated version of basic structural dynamics. Examples and mini-case studies are included to explain and support the understanding of basic dynamics. Chap. 4 is devoted to impact dynamics. The subject has been extended by including more advanced materials, data, charts, tables and examples. Explosion and blast effects are extremely difficult to evaluate and correlate with site monitoring data. Chap. 5 has tried to reach the audience and find some valuable answers to the complicated problems. Many advanced materials on dynamic finite element concerning shock, impact and explosion are included in Chap. 6. Criteria for solution procedures are examined. Useful problems are solved with the help of computer programs compiled under Program ISOPAR in the Appendices.

Chapter 7, as before, deals with numerous case studies. Many additional case studies are included apart from revising some existing case studies. Sections and their contents are slightly changed to bring about a uniformity concerning the subject matter. Section A covers steel and composites. A modification is proposed to A.1 on steel structures. Section B, which is devoted to concrete structures, has been modified. Topics like steel–concrete composite structures and steel fibre-reinforced concrete panels or slabs have been added with detailed results and conclusions. More sophisticated approach on masonry structures with proven results are now given in Section C. Sections D, E, F, G, H, I, J, K, and L have been revised to cater for the new advancement in research, practice and site monitoring techniques. Section I is devoted
to underground and underwater explosion and their effects. An effort has been made to correlate results with experimental and site monitoring data. Section J is entirely devoted to shock, impact and explosion on bridges. A comprehensive analytical and codified method is referred to in this section. Results and discussions are given with every section. Section K is entirely earmarked for the analysis of luggage container under explosion. The results are fully described and are meaningful. Section L is devoted to buildings under impact and explosion. Since the author has published a well-known book *Explosion-Resistant Buildings*, Springer, 2005, some latest results on the Twin Tower collapse are included. This section also covers collision and provides analysis and results between adjacent buildings. Apart from existing computer sub-routines, many more are given to cover for the analysis of all the aspects of this volume. More references are added for the readers who wish to carry out research and design of individual structures subject to shock, impact and explosion.

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