

2019 UCT Book Award

Shell Structures in Civil and Mechanical Engineering: Theory and Analysis

by **Alphose Zingoni**

Professor of Structural Engineering and Mechanics, Department of Civil Engineering, University of Cape Town

In his opening remarks in a review of this book for the Institution of Structural Engineers (London), Professor Tim Ibell (Fellow of the Royal Academy of Engineering, and Past President of the Institution of Structural Engineers) says “It has been such a pleasure to read this book. Shell structures have so much to offer our profession, and this book demonstrates their extraordinary scope of application. It leads the reader rather beautifully through the increasing complexity of applications of shell structures, providing full derivations throughout to problems of real practical importance.” Shell structures find application in many fields of engineering, notably civil, mechanical, marine and aeronautical disciplines. They are encountered in the form of iconic roofs like the Sydney Opera House in Australia, large hyperbolic cooling towers at power stations, fuel-storage steel tanks at petroleum refineries, elevated water tanks in urban areas, boilers and pressure vessels, car bodies, submarine hulls, aircraft fuselages and spacecraft shells.

Since about the beginning of the 20th century, considerable effort has been expended on the development of rigorous theories – both general and specialist – to describe the behaviour of shells as realistically as possible. In the preface of his book, Zingoni points out that the problem with such rigorous formulations is that, in almost all cases, they lead to sets of differential equations for which exact mathematical solutions cannot be found, or for which the mathematical solutions that are obtained are not very practical from an engineering point of view. On the other hand, numerical methods can provide practical approximate solutions for such situations. However, he argues, they are not necessarily the most effective for purposes of studying the effect of varying a given single parameter during the course of design. Closed-form solutions are much more suited to analytical study, provided they can be found. Unfortunately, they are not easy to find.

In writing this book, Zingoni, a world-recognised authority on the subject of shell structures, has employed a unique strategy that allows closed-form analytical solutions to be successfully obtained for a wide range of practical shell problems. These closed-form solutions are highly suitable for practical calculations; they permit the designer to rapidly evaluate stresses in a given shell structure, or to gain important design insights by simply examining the form of the mathematical expressions, or to obtain a deeper understanding of the effect of varying the design parameters of the shell. It is this powerful approach that sets the book apart from all other existing books. In the words of reviewers, “the result is an extraordinary work that stands out above other books on the subject”. Since publication, the book has garnered highly laudatory reviews from both academia and industry. It enjoys a diverse readership (postgraduate students, academics and practitioners) that is distributed across many countries around the world, including South Africa. Engineers have consulted the book in designing novel shell structures.