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Book Review

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Book review

Tension Structures: Form and Behaviour – 2nd edition

Wanda J. Lewis. ICE Publishing, London, UK, 2018,
ISBN 978-0-7277-6173-6, £60.00, 232 pp.

Although just 200 pages, this book's masterful exposition is hard to describe in this short review; no complexity is glossed over. The essential difference between what might be termed normal structures and tension structures is that the change of shape under loading is fundamental to the process of stress analysis. The copiously illustrated introductory chapter stresses this point, and clearly sets out all the ways tension structures may be encountered, together with the essential characteristics of each type.

One cannot pretend that the structural analysis of these structures is straightforward, and due to the lack of explicit solutions to the governing equations, various types of iterative numerical methods are required. An essential step for tension structures, given defined boundary conditions and an initial shape, is to find the final shape of the loaded structure; this is called form-finding. The second chapter is devoted to the various approaches to this essential step.

Over several following chapters Professor Lewis then outlines the various options for structural analysis. Mathematical basics are outlined, all clarified by diagrams. An intermediate summary chapter is called 'Cable roof structures. Case studies'. Here a number of common types of cable structures are presented, clarified by examples using computed results and clear diagrams. These are backed up with graphs showing the variation in results between experimental and computed methods. In preparation for the chapter's conclusions, a number of studies are given that examine the effect of geometric construction errors. The 'Conclusions' note that 'tension structures have a remarkable ability to accommodate loads

and relieve stresses', but that 'errors in cable lengths can lead to a large variation in the tension field'. This is followed by a number of words of practical wisdom.

One of the most fascinating chapters in the book is entitled 'Tension cables in suspension bridges'. Here the effect of departing from commonly used simplifying assumptions, such as inextensible main cables, weightless cables and hangers and a uniform deck load, is carefully explored. The mathematical derivations are accompanied by helpful diagrams. The chapter ends with words of caution about trying to make a suspension bridge follow a desired shape – a dictated form – which clearly violates engineering realities.

A 16-page centre section contains 22 colour illustrations, which show what variety constructed tension structures can take. These include well-known projects such as the Munich Olympic stadium, the O2 Arena, the Millennium Bridge, and even an 'upside-down' tension structure; the Gateway Arch in St. Louis.

Unfortunately, the initial design of tension structures is often carried out by those ignorant of the basic concepts. Unsurprisingly, this often results in less than suitable forms. It is refreshing to read Professor Lewis' pithy comments on ill-conceived tension structures that have tried to defy engineering reality.

Having battled with tension structures early in his career, this reviewer's engineering life at that time would have been a great deal easier if this book had been to hand. For any engineer who is involved, or wants to be, or thinks they will ever be involved in tension structures, the study of this book by Professor Lewis, a recognised authority on the subject, is absolutely essential.

Malcolm Millais