Book reviews

BRIDGE DECK ANALYSIS.

E. J. O'Brien and D. L. Keogh. E & FN Spon, 1999. ISBN 0 419 22500 5, £60, 278 pp.

This seven-chapter book may be considered as a very useful companion to the now classical texts of *Bridge deck analysis* by A. R. Cusens and R. P. Pama (1975) and *Bridge deck behaviour* by E. C. Hambly (1991). Chapters 1 and 2 introduce the reader to the constituent parts and appearance of bridge decks, and the various loads which they are called upon to resist. Then, with the exception of Chapter 3, the remainder of the book concentrates on how to model bridge decks for analysis purposes.

Chapter 1 sets the scene with sections on structural form, articulation, bridge accessories (as they affect analysis such as bearing and joints) and finally aesthetics.

Chapter 2 defines the various types of loading on bridges due to self-weight, traffic, temperature, prestress and two interesting, though brief, sections on impact loading and dynamic effects which are not covered in the classical texts.

Chapter 3 attempts to introduce the reader to bridge analysis by a modified form of the method of moment distribution (MD) and the concept of equivalent loads. Unfortunately, this approach did not really work for me, and I doubt if engineers new to bridge analysis would gain anything from it. MD is rarely used for initial analysis these days; rather it may be used as a tool to check the reliability of computer output. In contrast, the section explaining how to convert the effects of temperature and prestress to equivalent loads was clearly presented and of practical use. It could, however, have been further enhanced by considering the effects of shrinkage in concrete and describing the concept of self-equilibrating stresses.

Chapter 4, although extremely interesting and practical, is, I feel, misplaced, dealing as it does with the peculiar problems related to integral bridges. It would have been better placed at the end of the book. Notwithstanding this, the text is more detailed than Hambly's and readers will find the description of the problems and the associated worked examples of real practical use.

Chapter 5 moves on to the study of slab bridge decks. The way

they behave under load, and ways of modelling them are explained by recourse to the theory of thin plates and the grillage analogy. The finite-element method is briefly discussed but gives useful guidance on how to shape, arrange and size the finite elements for a particular deck. Finally, the theory and application of the Wood and Armour equations to deal with torsion in slabs is illustrated with a couple of examples.

The real meat of the book is in Chapter 6 which expands on the content of Chapter 5 and describes in great detail how to use the grillage and finite-element methods to model a bridge deck. Particular attention is given to the sizing of the grillage beams and finite elements for the purpose of determining the properties needed for a computer analysis such as the second moment of area and the torsional constant. There are nine numerical examples which guide the reader through the various stages of grillage or element orientation and size, and calculation of their section properties. The deck types examined are the uniform slab, a slab with edge beams, a voided slab, beam and slab, cellular decks and finally decks which are skewed or curved.

Chapter 7—the final chapter of the book—goes on to deal with the problems associated with the three-dimensional modelling of bridge decks. It also considers the effect of shear lag, and has a long, well-written section on the application of the upstand grillage beam and upstand finite element.

This book can rightly take its place alongside the classical texts referred to earlier. It does not pretend to be definitive but should be recognised as making a primary contribution to the subject of bridge deck analysis. It will prove to be both a useful elementary text for those bridge engineers new to the business of bridge deck analysis, and a useful reference book on some of the more advanced topics for more experienced bridge engineers.

M. J. RYALL

STRUCTURAL DESIGN FOR FIRE SAFETY.

A. H. Buchanan. John Wiley and Sons Ltd, 2001. ISBN 0 471 88993 8 (cased), 0 471 89060 X (paperback), £39.95, 421 pp.

Whilst the probability of a serious fire in a building is low, it is a destructive force that causes significant loss of life and considerable economic loss around the world. Until recently

much design for fire safety has been on the basis of prescriptive codes of practice, but over recent years there have been significant moves towards performance-based approaches. Current approaches often employ a mix of prescriptive and performance philosophies, with a prescriptive 'acceptable solution' providing one of the alternative means of achieving the requirement. An alternative is to perform a performance-based fire engineering design from first principles. To do so requires a multi-disciplinary approach that draws upon various fields of science and engineering.

This book was developed out of the lecture notes for the Master's Degree course in Fire Engineering at the University of Canterbury, New Zealand—one of the first countries to adopt a performance-based building code for fire safety in buildings.

The book brings together a wide range of information from many sources around the world. It starts with fundamentals, giving an introduction to fire and fire safety, outlining the significant contribution made by structural fire resistance to overall fire safety. Methods for calculating fire severity and achieving fire resistance are described, as is the fire performance of the principal structural materials. In the sections upon design the focus is upon performance based approaches to fire engineering to achieve rational methods of fire control by employing appropriate forms of construction. More generally the book outlines the differences between the life safety and property protection aspects of fire safety, briefly indicating how these might be delivered by drawing upon active and passive methods.

The author identifies his target audience as practising structural engineers and students of this discipline who need to consider the structural performance of steel, concrete or timber structures exposed to fire. A basic knowledge of structural mechanics and design is assumed.

The layout of the book reflects its origins as a taught course. It is divided into 12 chapters and contains four appendices and an extensive list of references. The main elements of the content are as follows.

- Chapter 2 discusses the general issues of fire safety in buildings, looking at overall strategies and the importance of preventing the spread of fire or structural collapse.
- Chapter 3 provides a review of the issues relating to combustion and the physics of heat transfer.
- Chapter 4 describes fire behaviour in rooms in order to give an understanding of the impact of an uncontrolled fire on the building structure.
- Chapter 5 gives an overview of basic methods for designing structures for fire safety. It describes methods for quantifying fire severity, making comparisons between post flashover fires with the provided resistance. It explores the concept of equivalent fire severity which is used for comparing real fires with the standard fire time-temperature curve.
- Chapter 6 examines methods of achieving fire resistance, reviewing standard test fire results and calculation methods for rating structural elements.
- Chapter 7 contrasts structural (strength) design required for fire exposure with that undertaken for normal

temperatures, with consideration being given to material properties, loads, support conditions and restraints, deformations, as well as to approaches to design for individual members and assemblies.

- Chapters 8, 9 and 10 describe simple methods for the design of steel, concrete and timber structures exposed to fire, respectively. Reference is made to the fire aspects of the structural Eurocodes that are under development and due for implementation shortly.
- Chapter 11 is concerned with light frame and sandwich panel structures using a combination of materials.
- Chapter 12 provides a summary of the recommended fire design methods for structures of different materials.

Worked examples are provided at the end of most chapters. These illustrate many of the basic points and seem sufficiently detailed to make a useful contribution to the reader's understanding.

Whilst the book provides only a basic coverage of fire science, this is probably sufficient for its target audience. As with other topics, the book makes extensive reference to other more detailed works for further reading. The book does not deal with the following in any depth

- human behaviour in fire or escape route design
- fire suppression
- procedures for reinstatement after fire.

Overall this is a useful textbook for those wishing to improve their understanding of

- the behaviour of buildings that may be exposed to a severe fire
- the basics of a rational approach to fire design.

S. MATTHEWS

STEEL BRIDGE STRENGTHENING.

I. L. Kennedy Reid, D. M. Milne and R. E. Craig. Thomas Telford, 2001. ISBN 0 7277 28814, £40, 136 pp.

This is a very interesting publication which is a 'must read' for engineers involved in bridge assessment and strengthening. The book consists of a short introduction followed by 17 case histories of various steel bridge strengthening schemes.

The introduction discusses firstly how to inspect a bridge structure and how to carry out *in situ* testing. It then considers why a bridge might need to be strengthened and, very importantly, how strengthening can be limited or avoided. The rest of the introduction looks at methods of designing strengthening, expanding on the problems of parapet upgrading, bridge buckling and fatigue. The introduction is only 14 A4 pages long so it only scratches at the surface. However, there is a list of 96 references at the end to take the reader deeper into the subject. Most of the references have been taken from the proceedings of various conferences on bridges.

The case histories follow a standard pattern. In each case the bridge is named, its weakness identified and various details of the strengthening given. In most cases there are very useful

drawings or photographs to point up the engineering involved. The case histories have been chosen to illustrate the various problems which have arisen on steel bridges, large and small. In each history there are sections entitled 'problems revealed?' and 'anything went badly?' It was surprising how few things went wrong. Was this very good engineering or a fading of bad memories?

This short book is a really useful introduction to the difficult area of bridge assessment and strengthening. For newcomers to the field it is a very useful route into the subject; for the experienced it is either a source of self-congratulation or worry.

S. MOY

ICE DESIGN AND PRACTICE GUIDES: FRP COMPOSITES—LIFE EXTENSION AND STRENGTHENING OF METALLIC STRUCTURES.

S. S. J. Moy. Thomas Telford, 2001. ISBN 0 7277 30096, £25, 64 pp.

The upgrading and rehabilitation of structures is becoming increasingly important as part of today's infrastructure management requirements. Buildings and structures are undergoing changes of use, often entailing increased loading, and structures may fail assessments based on modern criteria. These factors necessitate the strengthening of structures, many of which are metallic. They include historic structures, often under the regulation of bodies such as English Heritage and local authority trusts, which impose strict requirements on aesthetics and the preservation of the original fabric of the structures.

The use of advanced fibre-reinforced polymer (FRP) composites is gaining acceptance as an effective and simple method of strengthening. These materials are light, strong and stiff, and their mechanical properties can be tailored by appropriate choices of fibre arrangements. Also, since the materials are thin, they can be installed on the metallic frames of buildings, for example without affecting the space required to restore cladding units. They are well-suited to the strengthening of metallic structures generally. This book has been written by an experienced panel of practitioners, researchers and client users, with varied backgrounds in the use of FRP composites.

The book reviews the material types available and the various processing techniques used for installing them. These are hand lay-up, vacuum bag moulding, resin transfer moulding, prepreg laminating, pultrusion bonding and filament winding. It is suggested that prepreg laminating is not practical for construction applications, but this can be disputed. The quality control required for the application techniques is critical to the success of the strengthening method; the book gives this area due attention.

The design process for strengthening with FRPs and the fundamental variables are explained well. Consequently, the book provides an essential review for the inexperienced and forms a useful reference source for others. The basic design equations, and the principles on which they are based, have been outlined clearly. The assessment of damage to composite

components is considered, providing practical confidence in the reparability of such strengthening schemes. Brief guidance is given on testing, verification and long-term monitoring, which are areas that need to be addressed on a case-by-case basis.

This book is recommended to engineers and architects involved in the strengthening of any form of metallic structure. It is a succinct reference guide and will prove invaluable in the use of this strengthening technique.

H. N. GARDEN

THIN PLATES AND SHELLS: THEORY ANALYSIS AND APPLICATIONS.

E. Venstel and T. Krauthammer, Marcel Dekker Inc., 2001. ISBN 0 8247 0575 0, £165, 647 pp.

The book is divided into two main parts, the first dealing with the elastic theory of thin plates and the second dealing with the elastic theory of thin shells. A brief but informative discussion of physical behaviour, applications and the historical development of the basic theories, which are subsequently presented in a concise, rigorous and comprehensive manner, introduce each part. Following chapters are devoted to specific applications of the basic theories, to problems of practical significance encountered in civil, structural, mechanical, aeronautical, marine and chemical engineering.

The stated objectives of the authors were first to provide a comprehensive and mathematical presentation of the fundamentals of thin plate and shell theories, based on a strong foundation of mathematics and mechanics with emphasis on engineering aspects. Second, to acquaint readers with the most useful and contemporary analytical and numerical methods for solving linear and non-linear plate and shell problems, and finally to apply the theories and methods developed to the analysis and design of thin plate and shell structures in engineering. The book is also intended as a text for undergraduate and postgraduate students and as a reference book for practising engineers.

The first of the objectives has undoubtedly been achieved in that the theories are presented in a concise and rigorous manner. Fundamental assumptions and approximations are emphasised, in particular in relation to shell theories, and illustrated by numerous well-prepared figures. It is somewhat unusual however that none of the figures have captions.

The second of the objectives has also been substantially achieved in that series, finite difference, boundary collocation, boundary element, Galerkin, Ritz and finite element methods are clearly explained and illustrated by relevant examples. However, the overwhelming advantages of the finite element method, in dealing with complex geometrical configurations and highly non-linear geometric and material behaviour, are given little emphasis compared with the more accurate but less versatile semi-analytical procedures.

The last of the objectives has also been substantially achieved. Numerous detailed examples of applications of the theories are presented including plates and shells of various geometries

subjected to transverse and membrane loading; thermal stresses in plates and shells; orthotropic, stiffened and sandwich plates and shells; shell roofs; liquid storage and pressure vessels; and the buckling and vibration of plates and shells. A slight deficiency of the book, in relation to the practical application of plates in structures and buildings, is the somewhat brief coverage given to plate buckling and postbuckling, which occupies only approximately ten percent of the part of the book devoted to plates.

This is undoubtedly a competent and well-presented book that

contains a wealth of contemporary information concerning the theory, solution procedures and practical applications of thin plates and shells. Much of the material contained in the book is pitched at postgraduate level and as such it should appeal to a wide readership of postgraduate students, lecturers, researchers and experienced designers. It is a worthy addition to the library of anyone undertaking an in depth study of plates and shells.

T. M. ROBERTS