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Strengthening and rehabilitation of civil infrastructures using fibre-reinforced polymer (FRP) composites

Edited by L. C. Hollaway and
J. G. Teng



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Strengthening and rehabilitation of civil infrastructures
using fibre-reinforced polymer (FRP) composites

Related titles:

Durability of composites for civil structural applications
(ISBN 978-1-84569-035-9)

This comprehensive book addresses the current lack, or inaccessibility, of data related to the durability of fibre-reinforced polymer composites which is proving to be one of the major challenges to the widespread acceptance and implementation of these materials in civil infrastructure. Part I discusses general aspects of composite durability. Chapters examine mechanisms of degradation such as moisture, aqueous solutions, UV radiation, temperature, fatigue and wear. Part II then discusses ways of using fibre-reinforced polymer composites, including the strengthening and rehabilitation of existing structures. This section also covers monitoring techniques such as structural health monitoring.

Advanced civil infrastructure materials: science, mechanics and applications
(ISBN 978-1-85573-943-7)

In recent decades, material development in response to the call for more durable infrastructures has led to many exciting advancements. Fibre-reinforced composites, with very unique properties, are now being considered for use in many infrastructural applications. Even concrete and steel are being steadily improved to have better properties and durability. This book provides an up-to-date review of several emerging infrastructure materials that may have a significant impact on repair and/or new construction. Chapters include examples of real world applications using such advanced materials.

Durability of engineering structures: design, repair and maintenance
(ISBN 978-1-85573-695-5)

Structures often deteriorate because not enough attention is given to durability during the design stage. Since failure incurs high maintenance and repair costs, knowledge of the long-term behaviour of materials is the basis for avoiding these costs. *Durability of engineering structures* looks at the design of buildings for service life, and effective maintenance and repair techniques in order to reduce the likelihood of failure. It describes the *in-situ* performance of all the major man-made materials used in civil engineering construction. In addition, some relatively new high-performance materials are discussed. Deterioration mechanisms and the measures to counteract these, as well as subsequent maintenance and repair techniques are also considered.

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Over the last two decades there has been a growing awareness amongst civil/structural engineers of the importance of the unique mechanical and in-service properties of advanced fibre reinforced polymer (FRP) composites. They have emerged as an attractive competitor to the more conventional civil engineering materials for the creation of new structures and the strengthening/rehabilitation of existing ones. For new structures the material is used for reinforcing and/or prestressing concrete structures as well as constructing all FRP or hybrid FRP structures such as FRP bridge decks and concrete-filled FRP tubular columns and piles. Currently, one of the main uses of FRP composites is the strengthening/rehabilitation of structures which were erected post Second World War. From the mid-1980s and continuing to the present time a vast number of concrete, metallic and masonry structures were/are in urgent need of repair/strengthening/rehabilitation, due to either a change in use or structural degradation. Furthermore, many concrete, metallic, timber and masonry structures were built prior to the introduction of modern design codes, and hence do not meet modern design requirements.

The extraordinary properties of FRP composites of lightweight, high strength-to-weight ratio, corrosion resistance, potentially high overall durability, tailorability and high specific attributes enable them to be used in areas where the conventional construction materials might be restricted.

Over the past three decades, the fabrication technologies for the production of FRP composites have been revolutionised by sophisticated manufacturing techniques. These technologies have enabled FRP composites to be produced to high quality with minimal voids and accurate fibre alignment. In addition, a number of design guidance documents have been produced and, with rational design methods, a safe and economic utilisation of this relatively new technology can be assured.

The aim of this book is to provide under one cover a background to the physical and mechanical properties, the use and the design of FRP composites in upgrading structures in the civil infrastructure. Strengthening

techniques and design methods for rehabilitating reinforced concrete, metallic, timber and masonry structural members are presented and some case study examples are provided to illustrate the use and versatility of the material. Moreover, the book discusses the current fabrication techniques for the material. It introduces the fibres and matrices that are used in the production of FRP composites for the rehabilitation of civil structures, their mechanical and in-service properties and their long-term durability and loading characteristics; the important topic of the surface preparation of the two dissimilar adherends in the rehabilitation technique is discussed at length. A chapter is also devoted to quality assurance/quality control, maintenance and repair of concrete structures rehabilitated with FRP composites.

This book has been written mainly with practitioners (including designers, engineers and contractors) in mind. Therefore, the book attempts to present information that is of direct interest to practitioners instead of providing a comprehensive or exhaustive summary of all published research. Nevertheless, the book will also provide research engineers, academics, and research students working in the field of rehabilitation of structural members in the civil infrastructure with a useful and fundamental guide to the latest structural design techniques and the latest utilisation of advanced composite materials.

The editors would like to express their sincere thanks to the authors of the chapters in this book and to the past and present members and collaborators of their respective research groups at The University of Surrey, UK and at The Hong Kong Polytechnic University, China who have directly or indirectly helped to produce this book. The first editor acknowledges the financial support of the EPSRC, Industry and the University of Surrey which has made it possible for him to undertake research work in the area of advanced polymer composites for construction. The second editor is grateful to The Hong Kong Polytechnic University, the Research Grants Council of the Hong Kong Special Administrative Region and the Natural Science Foundation of China for supporting his FRP composites research programme. Particular thanks go to the engineers who willingly supplied details of the case studies concerned with the durability of rehabilitated structures for which they were responsible.

*L. C. Hollaway
J. G. Teng*

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