

Advanced Fibre Reinforced Polymer Frp Composites For Structural Applications Woodhead Publishing Series In Civil And Structural Engineering

Advanced composite materials for bridge structures are recognized as a promising alternative to conventional construction materials such as steel. After an introductory overview and an assessment of the characteristics of bonds between composites and quasi-brittle structures, Advanced Composites in Bridge Construction and Repair reviews the use of advanced composites in the design and construction of bridges, including damage identification and the use of large rupture strain fiber-reinforced polymer (FRP) composites. The second part of the book presents key applications of FRP composites in bridge construction and repair, including the use of all-composite superstructures for accelerated bridge construction, engineered cementitious composites for bridge decks, carbon fiber-reinforced polymer composites for cable-stayed bridges and for repair of deteriorated bridge substructures, and finally the use of FRP composites in the sustainable replacement of ageing bridge superstructures. Advanced Composites in Bridge Construction and Repair is a technical guide for engineering professionals requiring an understanding of the use of composite materials in bridge construction. Reviews key applications of fiber-reinforced polymer (FRP) composites in bridge construction and repair Summarizes key recent research in the suitability of advanced composite materials for bridge structures as an alternative to conventional construction materials

Fibre reinforced polymer (FRP) composites are used in almost every type of advanced engineering structure, with their usage ranging from aircraft, helicopters and spacecraft through to boats, ships and offshore platforms and to automobiles, sports goods, chemical processing equipment and civil infrastructure such as bridges and buildings. The usage of FRP composites continues to grow at an impressive rate as these materials are used more in their existing markets and become established in relatively new markets such as biomedical devices and civil structures. A key factor driving the increased applications of composites over the recent years is the development of new advanced forms of FRP materials. This includes developments in high performance resin systems and new styles of reinforcement, such as carbon nanotubes and nanoparticles. This book provides an up-to-date account of the fabrication, mechanical properties, delamination resistance, impact tolerance and applications of 3D FRP composites. The book focuses on 3D composites made using the textile technologies of weaving, braiding, knitting and stiching as well as by z-pinning.

The term liquid composite moulding (LCM) encompasses a family of processes in which a dry fibrous reinforcement is impregnated by a liquid resin inside a sealed cavity. As the understanding and control of these processes improve, their field of application widens. LCM processes can be used as a replacement to decrease the environmental impact and improve the quality of composite parts made via traditional open-mould processes. they can also provide a cost-cutting alternative to prepreg techniques while maintaining a high part quality. This chapter describes the variety of processes blanketed under the class liquid composite moulding and the research advances in the monitoring and simulation of these processes. the subsequent section presents the current usage of LCM techniques in the field of civil engineering, including some case studies, before outlining some future trends and offering sources for further information.

The use of fiber-reinforced polymer (FRP) composites in infrastructure systems has grown considerably in recent years because of the durability of composite materials. New constituent materials, manufacturing techniques, design approaches, and construction methods are being developed and introduced in practice by the FRP composites community to cost-effectively build FRP structural systems. FRP Composite Structures: Theory, Fundamentals, and Design brings clarity to the analysis and design of these FRP composite structural systems to advance the field implementation of structural systems with enhanced durability and reduced maintenance costs. It develops simplified mathematical models representing the behavior of beams and plates under static loads, after introducing generalized Hooke’s Law for materials with anisotropic, orthotropic, transversely isotropic, and isotropic properties. Subsequently, the simplified models coupled with design methods including FRP composite material degradation factors are introduced by solving a wide range of practical design problems. This book: Explores practical and novel infrastructure designs and implementations Uses contemporary codes recently approved Includes FRP case studies from around the world Ensures readers fully understand the basic mechanics of composite materials before involving large-scale number crunching Details several advanced topics including aging of FRPs, typical failures of structures including joints, and design simplifications without loss of accuracy and emphasis on failure modes Features end of chapter problems and solved examples throughout. This textbook is aimed at advanced undergraduate and graduate students and industry professionals focused on the analysis and design of FRP composite structural members. It features PowerPoint lecture slides and a solutions manual for adopting professors.

14. Advanced fiber-reinforced polymer (FRP) composites to strengthen structures vulnerable to seismic damage

6. Prepreg processing of advanced fibre-reinforced polymer (FRP) composites

7. Advanced fiber-reinforced polymer (FRP) composites for civil engineering applications

Developments in Fiber-Reinforced Polymer (FRP) Composites for Civil Engineering

17. Applications of advanced fibre-reinforced polymer (FRP) composites in bridge engineering: rehabilitation of metallic bridge structures, all-FRP composite bridges, and bridges built with hybrid systems

*Advanced fibre-reinforced polymer (FRP) composites for structural applications*12. *Understanding the durability of advanced fibre-reinforced polymer (FRP) composites for structural applications*Elsevier Inc. *Chapters*

Fibre-reinforced polymer (FRP) composites are increasingly being used in the field of civil engineering, either for the rehabilitation/retrofitting of existing infrastructures or for the construction of new structural elements. However, such applications are still recent and there are still unresolved questions regarding the long-term durability of FRP reinforcements or structural elements under service conditions, and their behaviour under accidental fire events as well. In this chapter, it is proposed to highlight the basic mechanisms involved in the environmental degradation of FRP composites, with a large emphasis on ageing mechanisms of the polymer matrix and their consequences on the mechanical properties. The last section is specifically devoted to the fire behaviour of polymer composites and also recalls existing fire-proofing solutions.

This chapter provides some basic knowledge about FRP manufacturing processes involving prepreg materials. It contains information regarding the manufacture of prepreg semi-finished products, processing methods for obtaining structural components, and some considerations about quality. It is intended as an overview only, addressing engineering students or practitioners who have only little knowledge about composites and prepreg processing technologies.

In this chapter, we report the findings of experimental investigations conducted on durability of glass fiber-reinforced polymer (GFRP) composites with and without the addition of montmorillonite nanoclay. First, neat and nanoclay-added epoxy systems were characterized to evaluate the extent of clay platelet exfoliation and dispersion of nanoclay. GFRP composite panels were then fabricated with neat/modified epoxy resin and exposed to six different conditions, i.e. hot-dry/wet, cold-dry/wet, ultraviolet radiation and alternate ultraviolet radiation–condensation. Room temperature condition samples were also used for baseline consideration. An improved dispersion of nanoclay and exfoliation of clay platelets were observed in 2wt% of epoxy samples. Weight change, discoloration and significant reduction in properties were observed in all conditioned GFRP samples. However, addition of nanoclay considerably improved the durability of GFRP samples as evident from the mechanical and micrographical results in comparison to neat samples subjected to similar conditions.

10. *Understanding and predicting interfacial stresses in advanced fibre-reinforced polymer (FRP) composites for structural applications*

Strengthening and Rehabilitation of Civil Infrastructures Using Fibre-Reinforced Polymer (FRP) Composites

Composites for Construction

19. *Sustainable energy production: key material requirements*

Focusing on Innovation, Technology Implementation and Sustainability

Portland cement concrete is a brittle material. The main reason for incorporating fibres into a cement matrix is to improve the cracking deformation characteristics, increasing not only the toughness, impact and tensile strength, but also eliminating temperature and shrinkage cracks. Several different types of fibres have been used to reinforce cement-based materials. This chapter briefly discusses the characteristics of fibre-reinforced concrete (FRC), reporting the effect of the fibres on the physico-chemical and mechanical properties. It also presents some of the recent research and future perspectives of FRC.

Thermosets such as phenolic thermosets are brittle at room temperature. Thus, in applications where good mechanical properties are required thermosets must be combined with reinforcements to improve these properties. Composites based on thermoset matrices can substitute for steel and concrete in some applications of civil construction structures because of their higher resistance to oxidation than steel and better freeze–thaw resistance than concrete. Furthermore, phenolic composites can be produced with complex shapes, and with careful design, materials can be obtained with high strength and stiffness and excellent impact strength, making these materials alternatives to metals. Construction materials require fire- and high-temperature-resistant components, and moldings and laminates based on phenolics can be utilized due to their resistance to burning and minimal smoke and toxic fumes production. Phenolic composites can positively impact the building and construction industry by improving safety and reducing cost.

The first textbook on the design of FRP for structural engineering applications Composites for Construction is a one-of-a-kind guide to understanding fiber-reinforced polymers (FRP) and designing and retrofitting structures with FRP. Written and organized like traditional textbooks on steel, concrete, and wood design, it demystifies FRP composites and demonstrates how both new and retrofit construction projects can especially benefit from these materials, such as offshore and waterfront structures, bridges, parking garages, cooling towers, and industrial buildings. The code-based design guidelines featured in this book allow for demonstrated applications to immediately be implemented in the real world. Covered codes and design guidelines include ACI 440, ASCE Structural Plastics Design Manual, EUROCOMP Design Code, AASHTO Specifications, and manufacturer-published design guides. Procedures are provided to the structural designer on how to use this combination of code-like documents to design with FRP profiles. In four convenient sections, Composites for Construction covers: * An introduction to FRP applications, products and properties, and to the methods of obtaining the characteristic properties of FRP materials for use in structural design * The design of concrete structural members reinforced with FRP reinforcing bars * Design of FRP strengthening systems such as strips, sheets, and fabrics for upgrading the strength and ductility of reinforced concrete structural members * The design of trusses and frames made entirely of FRP structural profiles produced by the pultrusion process

To ensure better performance for a range of existing reinforced concrete structures in seismic regions with standard structural details, seismic retrofit is an economical solution. Hence, this chapter presents some of the available results in which fiber-reinforced polymer (FRP) composites can be used for damage-controllable structures. For example, the performance of existing reinforced concrete structures whose components are vulnerable to shear failure, flexural-compression failure, joint reinforcement bond failure, or longitudinal reinforcement lap splice failure and retrofitted with FRPs is described. Novel concepts of modern constructions with controllability and recoverability using FRP composites are addressed.

Theory, Fundamentals, and Design

3. Polyester resins as a matrix material in advanced fibre-reinforced polymer (FRP) composites

2. Phenolic resins as a matrix material in advanced fiber-reinforced polymer (FRP) composites

Advanced fibre-reinforced polymer (FRP) composites for structural applications

Mechanics of Fibrous Composites

The chapter discusses the use of one type of thermoset polymer, polyester, and its use as a matrix material in fibre-reinforced polymer (FRP) composites. It begins with an overview of FRP composites, before explaining why polyester is a particularly suitable material for this application, through discussion of its key properties and structures and the manufacturing processes involved. Composites can offer improved mechanical properties compared with pure polymers at no extra cost, meaning that they are widely used in a variety of applications, including in the transport industry (manufacturing passenger cars and other vehicles), marine and shipping uses, and as structural materials. Some examples of these applications, particularly in civil engineering, are provided in this chapter, along with discussion of potential future trends in the field.

This chapter continues the discussions of the development of advanced polymer composite material applications associated with bridge engineering. It focuses on the rehabilitation of metallic bridge structures, all-FRP composite bridges and bridges built with hybrid systems. covered the materials used in FRP composites, in-service properties and applications of FRP composites in bridge enclosures, the rehabilitation of reinforced and prestressed concrete bridge beams and columns.

The strengthening of reinforced concrete (RC) structures using advanced fibre-reinforced polymer (FRP) composites, and in particular the behaviour of FRP-strengthened RC structures is a topic which has become very popular in recent years. This popularity has arisen due to the need to maintain and upgrade essential infrastructure in all parts of the world, combined with the well-known advantages of FRP composites, such as good corrosion resistance and ease for site handling due to their light weight. The continuous reduction in the material cost of FRP composites has also contributed to their popularity. While a great amount of research now exists in the published literature on this topic, it is scattered in various journals and conference proceedings. This book therefore provides the first ever comprehensive, state-of-the-art summary of the existing research on FRP strengthening of RC structures, with the emphasis being on structural behaviour and strength models. The main topics covered include: * bond behaviour * flexural and shear strengthening of beams * column strengthening * flexural strengthening of slabs. For each area, the methods of strengthening are discussed, followed by a description of behaviour and failure modes and then the presentation of rational design recommendations, for direct use in practical design of FRP strengthening measures. Researchers, practicing engineers, code writers and postgraduate students in structural engineering and construction materials, as well as consulting firms, government departments, professional bodies, contracting firms and FRP material suppliers will find this an invaluable resource.

Sustainable energy contributes to reducing the dependence on the use of fossil fuel resources, thus providing the opportunity to reduce greenhouse gases. The renewable technologies may be divided into three generations. The first commenced in the nineteenth century and was hydro- biomass- and geothermal-power. The second stage started during the 1980s and consists of wind power, tidal and wave power, and solar power.

The third stage is under development and is gasification, bio-refinery and ocean power. This chapter describes and discusses the second generation of renewable technologies and the phase to which each has currently progressed; these developments have been rapid. It also forms an introduction to which considers the significance of equipment made from advanced polymer composite materials in obtaining sustainable energy.

Fiber Reinforced Polymer (FRP) Composites for Infrastructure Applications

3. Advanced processing techniques for composite materials for structural applications

Structural Design with FRP Materials

20. Advanced fibre-reinforced polymer (FRP) composite materials for sustainable energy technologies

Advanced Composites in Bridge Construction and Repair

An overview is presented of four groups of static load tests to determine the mechanical properties of pultruded GFRP materials and structures. The first group includes standard and non-standard tests on material samples. The second group encompasses bending, buckling and collapse load tests on structural elements. The third and fourth groups include tests on bolted joints and sub-structures/full-scale structures, respectively. Throughout the overview, the difficulties of simulating practical support and loading conditions and monitoring deformations are emphasised. Future developments are mentioned briefly in the final section. It is noted that dynamic load testing and monitoring of static/dynamic deformations by means of full-field and other novel techniques are likely to receive much greater attention.

This chapter describes the elastic qualities of advanced fibre-reinforced composites, in terms of characterization, measurement and prediction from the basic constituents, i.e. the fibre and matrix. The elastic analysis comprises applying micromechanics approaches to predict the lamina elastic properties from the basic constituents, and using classical lamination theory to predict the elastic properties of composite materials composed of several laminae stacked at different orientations. Examples are given to illustrate the theoretical analysis and give a full apprehension of its prediction capability. The last section provides an overview on identification methods for elastic proprieties based on full-field measurements. It is shown that these methodologies are very convenient for elastic characterization of anisotropic and heterogeneous materials.

Rehabilitation of Concrete Structures with Fiber Reinforced Polymer is a complete guide to the use of FRP in flexural, shear and axial strengthening of concrete structures. Through worked design examples, the authors guide readers through the details of usage, including anchorage systems, different materials and methods of repairing concrete structures using these techniques. Topics include the usage of FRP in concrete structure repair, concrete structural deterioration and rehabilitation, methods of structural rehabilitation and strengthening, a review of the design basis for FRP systems, including strengthening limits, fire endurance, and environmental considerations. In addition, readers will find sections on the strengthening of members under flexural stress, including failure modes, design procedures, examples and anchorage detailing, and sections on shear and torsion stress, axial strengthening, the installation of FRP systems, and strengthening against extreme loads, such as earthquakes and fire, amongst other important topics. Presents worked design examples covering flexural, shear, and axial strengthening Includes complete coverage of FRP in Concrete Repair Explores the most recent guidelines (ACI440.2, 2017; AS5100.8, 2017 and Concrete society technical report no. 55, 2012)

This chapter briefly discusses the performance and durability of bonded composite systems used for on-site rehabilitation of timber and concrete structures. In spite of some recent developments, the exploitation of their full potential is still often restrained by the lack of structural design guidance, standards for durability assessment and on-site acceptance testing. Therefore, this chapter provides a review of current understanding on the use of hybrid bonded composite systems on the construction site in terms of structural repair, reinforcement, and seismic retrofit. It focuses on the requirements and practical difficulties in the work on-site with regards to the performance and durability of the rehabilitated structure, the characteristics and requirements that must be fulfilled by structural adhesives and advanced polymer composite materials, and the subsequent need for quality control and in-service monitoring. It also highlights the factors affecting performance and durability of bonded joints. Finally, a general overview of the research needs and a bibliography giving references to more detailed information on this topic is given.

Strengthened RC Structures

5. *Epoxy resins as a matrix material in advanced fiber-reinforced polymer (FRP) composites*

22. *Advanced fibre-reinforced polymer (FRP) composites for the rehabilitation of timber and concrete structures: assessing strength and durability*

FRP
7. *Resin infusion/liquid composite moulding (LCM) of advanced fibre-reinforced polymer (FRP)*

Fibre-reinforced plastic (FRP) composite materials are basically of two types. The first type is short fibres reinforced in a plastic matrix, and the other type continuous (long) fibres reinforced in a plastic matrix. The exact distinction between a short and a continuous fibre is discussed in Chapter 1. Continuous fibre-reinforced composite materials are referred to by FRP composites, fibrous composites, composite materials or simply composites. These terms are now generally accepted to mean the same type of material, namely, continuous fibre reinforced in plastic. In this book, the term fibrous composites is used to define a continuous fibre reinforced in plastic. Fibrous composites are presently in use for a variety of structural and non-structural applications, and are used in place of conventional metallic materials. The behaviour of fibrous composites subjected to a loading condition is very different from that of a metallic isotropic material. Therefore, 'new' analytical and testing methods are required to analyse a structural element and sections made from layered fibrous composites. There are a number of books written on the subject of comp content and achieve the authors' objectives.

This chapter will introduce advances in properties, production and manufacturing techniques of the advanced polymer/fibre composite materials that are utilised in the manufacture of machines that produce sustainable energy. discussed the various methods of transferring wind, tidal, wave and solar energies into electrical power and this chapter will show how ad machines. Furthermore, it will suggest methods for the repair, maintenance and recycling of advanced polymer composite wind turbine blades. Finally, the future trends of sustainable energy systems and the role that polymers and polymer/fibre composites will have in their manufacture/fabrication will be evaluated.

This volume highlights the latest advances, innovations, and applications in the field of FRP composites and structures, as presented by leading international researchers and engineers at the 10th International Conference on Fibre-Reinforced Polymer (FRP) Composites in Civil Engineering (CICE), held in Istanbul, Turkey on December 8-10, 2021. It covers a diverse range of topics including: Bond and interfacial stresses; Concrete-filled FRP tubular members; Concrete structures reinforced or pre-stressed with FRP; Confinement; Design issues/guidelines; Durability and long-term performance; Fire, impact and blast loading; FRP as internal reinforcement; Hybrid structures of FRP and other materials; Materials and products; Seismic retrofit of structures; Masonry and timber structures; and Testing. The contributions, which were selected by means of a rigorous international peer-review process, present a wealth of exciting ideas that will open novel research directions and foster multidisciplinary collaboration among different specialists.

This chapter deals with the uses of advanced composite materials in the construction industry. After considering the advantages of using composites and methods of fabrication, it outlines the surprisingly wide range of applications of composites. Examples are given from around the world of components and complete buildings and bridges, railway and other infrastructure, and the water sector. Finally a number of more unusual or future possibilities are presented.

Reinforced Polymer Composites

13. Testing of pultruded glass fibre-reinforced polymer (GFRP) composite materials and structures

15. High performance fibre-reinforced concrete (FRC) for civil engineering applications

Advanced Fibre-Reinforced Polymer (FRP) Composites for Structural Applications

Design, Construction and Practical Applications

Strengthening of Concrete Structures Using Fiber Reinforced Polymers (FRP): Design, Construction and Practical Applications presents a best practice guide on the structural design and strengthening of bridge structures using advanced Fiber Reinforced Polymer (FRP) composites. The book briefly covers the basic concepts of FRP materials and composite mechanics, while focusing on practical design and construction issues, including inspection and quality control, paying special attention to the differences in various design codes (US, Japan, and Europe) and recommendations. At present, several design guides from the US, Japan, and Europe are available. These guidelines are often inconsistent and do not cover all necessary design and inspection issues to the same degree of detail. This book provides a critical review and comparison of these guidelines, and then puts forward best practice recommendations, filling a significant gap in the literature, and serving as an important resource for engineers, architects, academics, and students interested in FRP materials and their structural applications. Written from a practitioner's point-of-view, it is a valuable design book for structural engineers all over the world. Includes a large quantity of design examples and structural software to facilitate learning and help readers perform routine design Provides recommendations for best practices in design and construction for the strengthening of bridge structures using advanced fiber-reinforced polymer (FRP) composites Presents comprehensive guidelines on design, inspection, and quality control, including laboratory and field testing information

This chapter discusses the epoxy resins which, thanks to their good and versatile properties, can be considered nowadays the most important class of thermosetting polymers. In particular the chapter first reviews both the epoxy resins commonly available on the market, including a new class of bio-derived epoxy resins, and the most-used curing agents. It then describes the principal characteristics of the epoxy resins and how it is possible to enhance them by adding several fillers to the epoxy system. Finally, the chapter analyzes the main engineering fields in which epoxy resins find application today and their possible future utilization.

Presents state-of-the-art processing techniques and readily applicable knowledge on processing of polymer composites The book presents the advancement in the field of reinforced polymer composites with emphasis on manufacturing techniques, including processing of different reinforced polymer composites, secondary processing of green composites, and post life cycle processing. It discusses the advantages and limitations of each processing method and the effect of processing parameters on the overall performance of the composites. Characterization and applications of reinforced polymer composites are also introduced. Reinforced Polymer Composites: Processing,

Characterization and Post Life Cycle Assessment starts off by providing readers with a comprehensive overview of the field. It then introduces them to the fabrication of both short fiber/filler reinforced polymer composites and laminated reinforced polymer composites. Next, it takes them through the processing of polymer-based nanocomposites; the many advances in curing methods of reinforced polymer composites; and post life cycle processing, re-processing, and disposal mechanisms of reinforced polymer composites. Numerous other chapters cover: synthetic versus natural fiber reinforced plastics; characterization techniques of reinforced plastics; friction and wear analysis of reinforced plastics; secondary processing of reinforced plastics; and applications of reinforced plastics. -Presents the latest development in materials, processing, and characterization techniques, as well as applications of reinforced polymer composites -Guides users in choosing the best processing methods to produce polymer composites and successfully manufacture high quality products -Assists academics in sorting out basic research questions and helps those in industry manufacture products, such as marine, automotive, aerospace, and sport goods Reinforced Polymer Composites: Processing, Characterization and Post Life Cycle Assessment is an important book for materials scientists, polymer chemists, chemical engineers, process engineers, and anyone involved in the chemical or plastics technology industry.

The repair of deteriorated, damaged and substandard civil infrastructures has become one of the most important issues for the civil engineer worldwide. This important book discusses the use of externally-bonded fibre-reinforced polymer (FRP) composites to strengthen, rehabilitate and retrofit civil engineering structures, covering such aspects as material behaviour, structural design and quality assurance. The first three chapters of the book review structurally-deficient civil engineering infrastructure, including concrete, metallic, masonry and timber structures. FRP composites used in rehabilitation and surface preparation of the component materials are also reviewed. The next four chapters deal with the design of FRP systems for the flexural and shear strengthening of reinforced concrete (RC) beams and the strengthening of RC columns. The following two chapters examine the strengthening of metallic and masonry structures with FRP composites. The last four chapters of the book are devoted to practical considerations in the flexural strengthening of beams with unstressed and prestressed FRP plates, durability of externally bonded FRP composite systems, quality assurance and control, maintenance, repair, and case studies. With its distinguished editors and international team of contributors, Strengthening and rehabilitation of civil infrastructures using fibre-reinforced polymer (FRP) composites is a valuable reference guide for engineers, scientists and technical personnel in civil and structural engineering working on the rehabilitation and strengthening of the civil infrastructure. Reviews the use of fibre-reinforced polymer (FRP) composites in structurally damaged and sub-standard civil engineering structures Examines the role and benefits of fibre-reinforced polymer (FRP) composites in different types of structures such as masonry and metallic strengthening Covers practical considerations including material behaviour, structural design and quality assurance

FRP Composite Structures

Improving the Durability of Advanced Fiber-reinforced Polymer (FRP) Composites Using Nanoclay

Strengthening of Concrete Structures Using Fiber Reinforced Polymers (FRP)

18. Advanced fiber-reinforced polymer (FRP) composites for the manufacture and rehabilitation of pipes and tanks in the oil and gas industry

Proceedings of CICE 2020/2021

Despite considerable potential and many advantages over conventional materials, composites are making limited progress in the field of infrastructure applications, where the only niche market for composites is in FRP deck construction over steel girders and externally bonded FRP repair. The reasons, of course, are to be found in their high initial cost compared with conventional materials. This can only be addressed through the use of large-volume automated processes such as pultrusion and filament winding, which have the potential to lower the cost of raw materials and technologies for all applications. This chapter summarises the current level of applications of filament winding in the infrastructure industry.

This book examines current issues of fiber reinforced polymer (FRP) composites in civil infrastructure. The contents of this book are divided into two parts. The first part engages topics related to durability and service life of FRP composites and how they contribute to sustainability. The second part highlights implementation and applications of the FRP composites with an emphasis on bridge structures. An introductory chapter provides an overview of FRP composites and its role in a sustainable built environment highlighting the issues of durability and service life followed by a current review of sustainability in infrastructure design.

There is strong evidence that the oil and gas industry has become increasingly interested in using pipes and risers made of fiber-reinforced polymer (FRP) composite materials. Moreover, oil and gas exploration nowadays has to be conducted in much deeper water depths (500-1500m and deeper), thus requiring more resilient and lighter materials. In this section various applications of FRP in relation to pipes and risers are discussed to familiarize the reader with various FRP and hybrid pipes. The issues affecting the long-term performance of these materials, as well as issues involved with joining pipes and risers are also covered. Finally, the recent trends related to the use of FRP for repair and rehabilitation of deteriorated metallic pipes are presented.

Fiber-reinforced polymer (FRP) composites have become an integral part of the construction industry because of their versatility, enhanced durability and resistance to fatigue and corrosion, high strength-to-weight ratio, accelerated construction, and lower maintenance and life-cycle costs. Advanced FRP composite materials are also emerging for a wide range of civil infrastructure applications. These include everything from bridge decks, bridge strengthening and repairs, and seismic retrofit to marine waterfront structures and sustainable, energy-efficient housing. The International Handbook of FRP Composites in Civil Engineering brings together a wealth of information on advances in materials, techniques, practices, nondestructive testing, and structural health monitoring of FRP composites, specifically for civil infrastructure. With a focus on professional applications, the handbook supplies design guidelines and standards of practice from around the world. It also includes helpful design formulas, tables, and charts to provide immediate answers to common questions. Organized into seven parts, the handbook covers: FRP fundamentals, including history, codes and standards, manufacturing, materials, mechanics, and life-cycle costs Bridge deck applications and the critical topic of connection design for FRP structural members External reinforcement for rehabilitation, including the strengthening of reinforced concrete, masonry, wood, and metallic structures FRP composites for the reinforcement of concrete structures, including material characteristics, design procedures, and quality assurance-quality control (QA/QC) issues Hybrid FRP composite systems, with an emphasis on design, construction, QA/QC, and repair Quality control, quality assurance, and evaluation using nondestructive testing, and in-service monitoring using structural health monitoring of FRP composites, including smart composites that can actively sense and respond to the environment and internal states FRP-related books, journals, conference proceedings, organizations, and research sources Comprehensive yet concise, this is an invaluable reference for practicing engineers and construction professionals, as well as researchers and students. It offers ready-to-use information on how FRP composites can be more effectively utilized in new construction, repair and reconstruction, and architectural engineering.

12. Understanding the durability of advanced fibre-reinforced polymer (FRP) composites for structural applications

Developments in fiber-reinforced polymer (FRP) composites for civil engineering

9. Pultrusion of advanced fibre-reinforced polymer (FRP) composites

3D Fibre Reinforced Polymer Composites

The International Handbook of FRP Composites in Civil Engineering

The use of fiber-reinforced polymer (FRP) composite materials has had a dramatic impact on civil engineering techniques over the past three decades. FRPs are an ideal material for structural applications where high strength-to-weight and stiffness-to-weight ratios are required. Developments in fiber-reinforced polymer (FRP) composites for civil engineering outlines the latest developments in fiber-reinforced polymer (FRP) composites and their applications in civil engineering. Part one outlines the general developments of fiber-reinforced polymer (FRP) use, reviewing recent advancements in the design and processing techniques of composite materials. Part two outlines particular types of fiber-reinforced polymers and covers their use in a wide range of civil engineering and structural applications, including their use in disaster-resistant buildings, strengthening steel structures and bridge superstructures. With its distinguished editor and international team of contributors, Developments in fiber-reinforced polymer (FRP) composites for civil engineering is an essential text for researchers and engineers in the field of civil engineering and industries such as bridge and building construction. Outlines the latest developments in fiber-reinforced polymer composites and their applications in civil engineering Reviews recent advancements in the design and processing techniques of composite materials Covers the use of particular types of fiber-reinforced polymers in a wide range of civil engineering and structural applications This chapter focuses on the properties, manufacturing processes and quality control of pultruded advanced composites used in civil engineering applications. Pultrusion technology is first briefly explained, with the main features of the raw materials used being introduced, and the philosophy underlying the development of pultruded advanced composites discussed. A detailed description of the pultrusion process then follows, covering the equipment and procedure, technical specifications and quality control. Subsequently, the types, properties, applications and sustainability of pultruded profiles, reinforcing bars and strengthening strips are described. The final part of the chapter discusses future trends for the pultrusion of the advanced composites used in civil engineering applications.

Chapters 16 and discuss the development of the advanced polymer composite material applications in bridge engineering. They demonstrate the innovative types of components and structures which have been developed from FRP composite materials and the most advantageous way to employ composites in bridge engineering. Given the importance of bridge infrastructure, the discussion of this topic has been split over two chapters. This chapter focuses on the type of FRP composite materials used in bridge engineering, their in-service properties and their applications in bridge enclosures and the rehabilitation of reinforced and prestressed concrete bridge beams and columns. covers rehabilitation of metallic bridge structures, all FRP composite bridges and bridges built with hybrid systems.

This chapter discusses the use of vinyl ester resin as a matrix in polymer composite materials to be used in civil engineering applications. The chapter begins by discussing the increasing trend of composite development and use in civil engineering along with the related reasons. It then reviews the chemistry of vinyl ester resins together with their mechanical and chemical properties as well as the applications of vinyl ester resin and composites in the construction industry. The chapter includes indications on future applications of vinyl ester-based fibre-reinforced composites along with a section devoted to sources of further and relevant information.

16. Advanced fibre-reinforced polymer (FRP) composite materials in bridge engineering: materials, properties and applications in bridge enclosures, reinforced and prestressed concrete beams and columns

4. Vinyl ester resins as a matrix material in advanced fibre-reinforced polymer (FRP) composites

Rehabilitation of Concrete Structures with Fiber-Reinforced Polymer

21. Improving the durability of advanced fiber-reinforced polymer (FRP) composites using nanoclay

Processing, Characterization and Post Life Cycle Assessment

This chapter addresses all aspects pertaining to stresses inherent within civil applications of advanced composites, particularly the critical interfacial adhesive stresses usually controlling the design strength for externally bonded FRP composites. Informed discussions and explanations are presented on influential aspects closely affecting the distribution and magnitude of interfacial stresses along the bondline. Traditional and promising experimental methods for stress estimation are addressed, together with a corresponding brief literature review highlighting their evolution and practical advantages and disadvantages. Theoretical and numerical methods for interfacial stress analyses are also reviewed for different FRP bonding applications, and their stress prediction capabilities are verified with experimental validations. Finally, key conclusions and recommendations for future trends in the stress characterizations of adhesive joints are provided.

Advanced fibre-reinforced polymer (FRP) composites have become essential materials for the building of new structures and for the repair of existing infrastructure. Advanced fibre-reinforced polymer (FRP) composites for structural applications provides an overview of different advanced FRP composites and the use of these materials in a variety of application areas. Part one introduces materials used in the creation of advanced FRP composites including polyester, vinyl ester and epoxy resins. Part two goes on to explore the processing and fabrication of advanced FRP composites and includes chapters on prepreg processing and filament winding processes. Part three highlights properties of advanced FRP composites and explores how performance can be managed and tested. Applications of advanced FRP composites, including bridge engineering, pipe rehabilitation in the oil and gas industry and sustainable energy production, are discussed in part four. With its distinguished editor and international team of expert contributors, Advanced fibre-reinforced polymer (FRP) composites for structural applications is a technical resource for researchers and engineers using advanced FRP composites, as well as professionals requiring an understanding of the production and properties of advanced FRP composites, and academics interested in this field. Provides an overview of different advanced FRP composites and the use of these materials in a variety of application areas Introduces materials used in the creation of advanced FRP composites including polyester, vinyl ester and epoxy resins Explores the processing and fabrication of advanced FRP composites and includes chapters on prepreg processing and filament winding processes

Testing of composite materials can present complex problems but is essential in order to ensure the reliable, safe and cost-effective performance of any engineering structure. This essentially practical book, compiled from the contributions of leading professionals in the field, describes a wide range of test methods which can be applied to various types of advanced fibre composites. The book focuses on high modulus, high strength fibre/plastic composites and also covers highly anisotropic materials such as carbon, aramid and glass. Engineers and designers specifying the use of materials in structures will find this book an invaluable guide to best practice throughout the range of industrial sectors where FRCs are employed.

Modern structural applications of composite materials are dictated by the processing methods available. In this chapter, we introduce recent developments related to the manufacturing of composites in civil engineering applications using vacuum assisted resin transfer molding, pultrusion, and automated fiber placement.

10th International Conference on FRP Composites in Civil Engineering

8. Filament winding processes in the manufacture of advanced fibre-reinforced polymer (FRP) composites

Mechanical Testing of Advanced Fibre Composites

11. Understanding and predicting stiffness in advanced fibre-reinforced polymer (FRP) composites for structural applications