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ADVANCED FIBER- REINFORCED POLYMER (FRP) COMPOSITES FOR STRUCTURAL APPLICATIONS

SECOND EDITION



Edited by
JIPING BAI

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

**S. Zainuddin, M.V. Hosur, S. Jeelani, A.
Kumar, J. Trovillion**



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

Advanced Fibre-Reinforced Polymer (FRP) Composites for Structural Applications Jiping Bai, 2022-12-05 Advanced Fibre reinforced Polymer FRP Composites for Structural Applications Second Edition provides updates on new research that has been carried out on the use of FRP composites for structural applications These include the further development of advanced FRP composites materials that achieve lighter and stronger FRP composites how to enhance FRP integrated behavior through matrix modification along with information on pretension treatments and intelligence technology The development of new technology such as automated manufacturing and processing of fiber reinforced polymer FRP composites have played a significant role in optimizing fabrication processing and matrix formation In this new edition all chapters have been brought fully up to date to take on the key aspects mentioned above The book s chapters cover all areas relevant to advanced FRP composites from the material itself its manufacturing properties testing and applications in structural and civil engineering Applications span from civil engineering to buildings and the energy industry Covers all areas relevant to advanced FRP composites from the material itself its manufacturing properties testing and applications in structural engineering Features new manufacturing techniques such as automated fiber placement and 3D printing of composites Includes various applications such as prestressed FRP FRP made of short fibers continuous structural health monitoring using advanced optical fiber Bragg grating FBG durability of FRP strengthened structures and the application of carbon nano tubes or platelets for enhancing durability of FRP bonded structures *Advanced fibre-reinforced polymer (FRP) composites for structural applications* L.C. Hollaway, 2013-09-30 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 **Advanced fibre-reinforced polymer (FRP) composites for structural applications** M.F.M. Fahmy, 2013-09-30 To ensure better performance for a range of existing reinforced concrete structures in seismic regions with substandard 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 *Advanced fibre-reinforced polymer (FRP) composites for structural applications* K. Benzarti, X. Colin, 2013-09-30 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.

Advanced fibre-reinforced polymer (FRP) composites for structural applications A. Al-Shawaf, 2013-09-30 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 for structural applications S. Zainuddin, M.V. Hosur, S. Jeelani, A. Kumar, J. Trovillion, 2013-09-30 In this chapter, we report the findings of experimental investigations conducted on the 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. 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.

Advanced fibre-reinforced polymer (FRP) composites for structural applications J. Custódio, S. Cabral-Fonseca, 2013-09-30 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

Advanced fibre-reinforced polymer (FRP) composites for structural applications L.C. Hollaway,2013-09-30 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

Advanced fibre-reinforced polymer (FRP) composites for structural applications L.C. Hollaway,2013-09-30 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 advanced composites are utilised in these various 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

Advanced fibre-reinforced polymer (FRP) composites for structural applications T.H. Panzera,A.L. Christoforo,P.H. Ribeiro Borges,2013-09-30 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

Advanced fibre-reinforced polymer (FRP) composites for structural applications J. Ramôa Correia,2013-09-30 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

Advanced fibre-reinforced polymer (FRP) composites for structural applications R.M. Guedes,J. Xavier,2013-09-30 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

Advanced fibre-reinforced polymer (FRP) composites for structural applications V. Fiore,A. Valenza,2013-09-30 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

Advanced fibre-reinforced polymer (FRP) composites for structural applications S. Pansart,2013-09-30 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

Advanced fibre-reinforced polymer (FRP) composites for structural applications F. Sarasini,C. Santulli,2013-09-30 This chapter discusses the use of vinylester 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 vinylester resins together with their mechanical and chemical properties as well as the applications of vinylester resin and composites in the construction industry The chapter includes indications on future applications of vinylester based fibre reinforced composites along with a section devoted to sources of further and relevant information

Advanced fibre-reinforced polymer (FRP) composites for structural applications E. Frollini,C.G. Silva,E.C. Ramires,2013-09-30 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 **Advanced fibre-reinforced polymer (FRP) composites for structural applications F.**

Taheri,2013-09-30 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 familiarise 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 *Advanced fibre-reinforced polymer (FRP) composites for structural applications*

A. Khennane,2013-09-30 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

Advanced fibre-reinforced polymer (FRP) composites for structural applications N. Miskolczi,2013-09-30 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 *Strengthening of Concrete*

Structures Using Fiber Reinforced Polymers (FRP) Hwai-Chung Wu, Christopher D Eamon, 2017-02-21 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

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