R. A. Sheno
University of Southampton,
UK

S. S. J. Moy
University of Southampton,
UK

L. C. Hollaway
University of Surrey, UK

P. A. Smith
University of Surrey, UK

Guest editorial

R. A. Sheno, S. S. J. Moy, L. C. Hollaway and P. A. Smith

Fibre reinforced polymer (FRP)-based composite materials have a number of features that make them highly suitable for modern construction projects. FRP has been used for several decades in construction applications and its use is set to increase to meet demands for improvements in construction processes. The science and technology associated with this subject are advancing at a rapid rate. It is therefore important for engineers and researchers to exchange ideas in this area in order to promote the safe and cost-effective use of FRP for structural applications in construction.

A conference on this theme was held in April 2002 in Southampton under the auspices of a network dealing with Advanced Polymer Composites for Structural Applications in Construction (or CoSACNet), supported by the Engineering and Physical Sciences Research Council of the UK. It was intended to promote knowledge and expertise underpinning the potential use of polymeric composites for structural applications in civil construction. The conference was organised by the University of Southampton, University of Surrey and the Building Research Establishment. The conference was successful in attracting technical papers covering diverse themes such as the application of FRP to concrete and metallic structures; concrete cylinders and columns; walls and pipes; analysis and design; all composite structures; and case studies.

It was evident from the wide coverage and attendance at the conference that the subject is of great interest to the scientific and industrial communities. The conference organisers therefore felt it appropriate to approach a learned body such as the ICE with a view to find a mechanism for wider dissemination of this knowledge in a deeper, more thoroughly argued form as part of the *Proceedings*, in the *Structures and Buildings* journal. The theme of this special issue therefore is to review progress towards the greater exploitation of polymer composites and FRP materials in infrastructure. The papers selected after peer review for this special issue fall broadly under five categories, namely design codes, novel structural elements, refurbishment of concrete structures, assessment of jointing assemblies and through life performance of composite structures.

Even though many large-scale demonstration projects involving polymer composite materials have been conducted around the world over the past decade, composite construction remains an

exception rather than the rule. One of the major inhibitors to progress in this regard is the lack of appropriate structural design standards and guidelines. There is ongoing work in this area in the UK, USA, Europe and the Far East. Recognising this significant barrier to the utilisation of polymer composites in civil engineering and construction, the Composites Institute of Australia initiated a major programme to develop a code of practice for the structural design of composites. The paper by Ayers and Van Erp outlines two of the initial projects undertaken as part of the development programme.

Innovation is very often derived from themes borrowed from other sectors. In the composites world, the initial applications were in the marine field followed by extensive fundamental work in the aerospace sector; therefore one avenue for exploring possible concepts for civil construction could arguably be these two areas. However not all solutions borrowed from such sources are conducive for civil engineering practice. The problems in construction are unique and the solutions require careful tailoring. Occasionally these need to be supplemented by radical re-examination of the needs of the structure and the development of a new concept. The paper by Hulatt *et al.* discusses the use of a new advanced polymer composite material formed by pre-impregnation of carbon and glass fibres in an epoxy polymer matrix and then combining with concrete to form an I-beam element. The work represents one element of a recently finished Brite-Euram project called COMPCON.

Concrete has proved a most attractive material for civil construction over many years. While its compressive properties are unquestionable, it does need to be reinforced and strengthened for tensile capability; this has been done primarily using steel-based rods, bars and grids. Steel has one major drawback, namely corrosion, and this leads to wastage and deterioration of the structural capability. The use of FRP materials as reinforcements is therefore a possible alternative option for designers and engineers. This usage can be considered either at the initial construction stage or during the service life as a retrofitting possibility; FRP can be used either as internal or external reinforcement. Failure mode assessment and practical production issues need to be considered. The papers selected for this issue cover these diverse aspects.

Four papers in this category cover generic design issues at initial stages of construction. The paper by Tann *et al.*

examines the suitability of a new design-based method for the determination of deformability as well as an energy-based process for quantifying the ductility levels in FRP-strengthened reinforced concrete (RC) members. De Lorenzis *et al.* study the stiffness and ductility features of externally bonded FRP laminates and bars for flexural strengthening of RC members. The work of Aiello *et al.* is devoted to the assessment of crack evolution in FRP reinforced concrete tension members and the resulting structural deformability features. Sekijima *et al.* report on a new shield-cutable tunnel wall system involving CFRP reinforcements with particular attention being paid to the performance of the mechanical splices. Two further papers in this category of RC construction consider retrofitting related issues. The paper by Salom *et al.* considers the use of composite laminates to increase the torsional capacity of concrete beams through experimental modelling supplemented by an analytical study. A more detailed theoretical approach for modelling the bonding of FRP members to RC members and the consequential interfacial stresses induced under arbitrary loads is explored by Yang *et al.*

This leads to perhaps a critical aspect of using FRP, namely jointing between different components or structural parts. In

most cases, structural failure is initiated and precipitated at joints. Consequently, it is important to understand and characterise the load transfer mechanisms at joint junctions. Lees and Makarov investigate the feasibility of a new type of connection technique involving mechanical pins and adhesive bonding, used principally for pipeline work, and report on the load deflection and failure modes.

Having considered design, construction and retrofitting aspects it is finally important to recognise the in-service performance. The paper by Halliwell, reporting on work sponsored by the UK's Department of Trade and Industry, examines case histories of several structures under the categories of cladding, structural applications, modular structures, roofing and bridges. She reports on the changes in the structure since erection, the need for maintenance and repair and whether performance requirements were being met.

Finally we wish to express our gratitude to the Editor and Editorial Board of *Structures and Buildings* for approving this idea and helping to fulfil the objective of publishing high quality, peer reviewed papers in the area of FRP materials for civil construction structures.