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Editorial

Editorial for the "FRP Structures" Special Issue

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Abstract: The objective of this Special Issue is to present recent advances and emerging cross-disciplinary in the field of thin-walled composite profiles made of Fiber Reinforced Polymers (FRP), as well as the use of FRP components in structural engineering in general. In this Editorial, a brief summary is provided for all the published papers, in order to emphasize the wide range of possible applications of FRP composites in buildings and structural systems.

Keywords: Fiber Reinforced Polymer (FRP) Composites, Reinforced Concrete Structural Glass, Façades and Building Skins, Masonry Vaults, Design Standardization

Introduction

The Special Issue call 'FRP structures' was first launched in April 2016 for the American Journal of Engineering and Applied Sciences (AJEAS).

The objective of this Special Issue is to present recent advances and emerging cross-disciplinary in the field of thin-walled composite profiles made of Fiber Reinforced Polymers (FRP), as well as the use of FRP components in structural engineering in general.

On one side, the use of thin-walled composite profiles made of Fiber Reinforced Polymers (FRP) has been spreading over many engineering applications, especially where characteristics of lightness and durability are of primary importance. In fact, with respect to traditional materials, FRP components may offer significant advantages in assembling, transporting and launching large parts of structures. Moreover the strong resistance to chemical attacks makes them particularly suitable for use in aggressive environments. These advantages may sometimes result in significant cost reductions in comparison with other construction materials and make all-FRP structures really sustainable.

At the same time, large applications in civil engineering buildings and infrastructures can be found in modern applications in the form of FRP retrofitting jackets or tendons for concrete, steel, timber, masonry and even glass structural members.

In response to the call for submissions, seven original research articles were finally accepted for publication, including contributors from Italy, The Netherlands and Portugal.

These papers are related to various topics, including both experimental testing and Finite Element numerical modeling. Most of the published papers are related to the use of FRP components as efficient strengthening tool for retrofitting of existing structures, as well as for the enhancement of novel structural glass assemblies.

The use of FRP jackets for reinforced concrete members and frames represent a research topic attracting the interest of several researchers since the last three decades. While it is well-known that a strength and ductility enhancement can be expected from the use of FRP strips and jackets compared to a given bare reinforced concrete frame, recent studies only focused on the optimization of the FRP jackets themselves, in the form of cost, weight and structural benefits. In the paper from Chisari and Bedon (2016), this open topic is further assessed by means of a genetic algorithm optimization problem. A key aspect, in that study, is given by the multi-objective optimization approach, as well as by the possible control-via a local reinforcement technique-of the global collapse mechanism for a given concrete structure.

Chiozzi *et al*. (2016) also focused on the use of FRP for retrofitting purposes, with specific application in masonry vaults. Their paper presents an adaptive procedure for the kinematic limit analysis of FRP reinforced masonry vaults through applications. As in the case of (Chisari and Bedon, 2016), an optimization problem is presented, but an approach that relies on a new Genetic Algorithm NURBS-based general framework-recently presented by the same authors-is taken into account. The basic idea consists into exploiting the NURBS structure of a CAD geometric 3D

model for a given reinforced masonry vault, in order to define an adaptive rigid body assembly on which an (upper bound) limit analysis can be performed. In such system, the internal dissipation is allowed along interface elements only. A number of structural examples are then provided and critically discussed, showing that the approach can represent a useful tool for the structural design and assessment of FRP reinforced masonry vaults.

Some of the published papers are then focused on the integrated use of FRP composites as load-bearing components for novel structural assemblies.

In (Bedon and Louter, 2016), the bending performance of laminated glass beams with adhesively bonded CFRP post-tensioning tendons has been assessed, based on Finite-Element numerical models validated towards recent experimental test results. The exploratory FE study emphasized the efficiency of the so assembled and post-tensioned composite assemblies, namely affected by several influencing factors, such as the typical brittleness of glass, as well as the key role of adhesive joints as well as the post-tensioning phase itself.

While FRP members or retrofitting components in general are typically associated to enhanced, one of the major limits in their mechanical performance is represented by high temperatures.

Some of the FRP properties that mainly suffer of important degradations associated to higher temperatures are the ultimate stress (both in tension and compression) and modulus of elasticity. Although glass fibers-as inorganic compounds-are very stable and mostly insensitive to temperature variations, in fact, the mechanical properties of polymeric resins rapidly decrease above a critical temperature which is typically lower than the glass-transition temperature range of the resin (≈ 60-170°C).

In order to overcome these limits, the paper from dos Santos and Bedon (2016) present a preliminary investigation on the feasibility and potential of a novel 'smart' SMA-reinforcement for FRPs. Shape-Memory Alloys (SMA) are in fact a class of metal materials that exhibit two outstanding properties, namely the Superelastic (SE) and the Shape-Memory Effects (SME). Due to their intrinsic mechanical properties, SMAs have been largely used for civil engineering buildings and infrastructures in the form of active control systems in general.

A brief review on the current use of FRP composites in facades and building skins has then been proposed by Bedon (2016). In that paper, the wide range of possible application of FRP in building envelopes is emphasized, giving evidence both to 'traditional' retrofitting examples as well as to the current trends in design and open research studies, where the use of FRP composites is optimized both from a thermal and a structural point of view.

Despite the number of open and generally well-promising research applications of FRP in structures of various typologies, however, design recommendations and provisions have a primary role for practitioners and engineers. In the paper from Minghini *et al*. (2016), in this context, current design equations for Pultruded FRP (PFRP) columns and beams are discussed and a proposal for updating the National Research Council (CNR) Italian guideline is presented. Careful consideration is paid especially for the local buckling moment of I-section beams in major-axis bending, for which a new design equation is proposed. In the same paper, the need for round robin tests on built-up members is also recalled and a new built-up cross-section allowing for easy disassembling and re-assembling is shown.

An advanced three-dimensional model, based on an innovative variant of the regularized eXtended Finite Element Method (XFEM), is finally presented by Orlando and Benvenuti (2016). An application for the simulation of the pull-out of steel bars and for the debonding of FRP plates from concrete specimens is discussed. The accuracy of the modelling approach is validated and critically discussed towards experimental test results, giving evidence of the potential of the approach.

Conclusion

In conclusion, a special thanks is forwarded to the Authors, who actively contributed to the Special Issue call. An acknowledgement is also reserved to the AJEAS Editor-in-Chief as well as to the Reviewers who carefully read the submitted articles. Their observations and comments provided strong support for the Authors – to improve their original manuscripts-as well as for the Guest Editors – to make objective decisions with regard to the quality of the submissions.

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