Development and research on the innovative FRP girder for bridge application

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Summary

The main goal of the research project, carried out by the science-business consortium, was to develop and demonstrate FRP composite members for bridges, including their concept design, material research, manufacturing technique selection and structural testing. The objective of the paper is the development and research on a new FRP bridge girder fabricated by VARTM manufacturing technique. The reduced scale prototype girder with the total length of 13,5 m was tested to evaluate its carrying capacity, modes of failure, basic dynamic parameters as well as overall behaviour under ultimate static load. The girder met the prescribed serviceability and safety criteria and is likely to be implemented on-site soon. The FEM model of the girder was validated against testing results and was further used for a prototype FRP bridge design. The output of the research project gives a very promising future for the FRP girder application in bridge engineering.

Keywords: FRP composites, material test, VARTM technique, bridge girder, failure test.

1. Introduction

FRP composites offer the designer a combination of properties not available in traditional construction materials (concrete, steel and wood) and are being commonly applied in industries like aerospace, automotive and naval. Nowadays we have also huge development of FRP composites in civil engineering, particularly in bridge construction, thanks to their advantageous material properties. FRP composites are commonly used for strengthening of existing structures made of concrete, steel and timber. Recently FRP composites have been used more and more in construction of new structural bridge components [1]. However, potential capacity of FRP materials has not yet been exploited widely because of lack of specific codes for design. This implies reluctance of the clients as a public administrations to accept this material and lack of confidence of structural designers in the use of FRP's as they are not guaranteed by a legal codes. There is a need for more practical applications and real examples of FRP structural members being used for bridge construction so the material itself is well accepted by the industry and clients.

Almost always, when an innovative solution is proposed for building real structure, it is often the case that both designers and the clients of such structure consider that full-scale testing is to be performed in order to validate the numerical models and to check design criteria, essentially the ultimate load capacity of the primary structural components. Therefore most of the recently elaborated and implemented FRP bridge girders have been comprehensively tested in full-scale. For example, Gutiérrez et al. [2] presented results from the laboratory quasi-static tests conducted on a full-scale section of a 46 m long, vehicular composite bridge, tested under different loading conditions. Capéran et al. [3] described results of an experimental campaign on a hybrid-composite, fibre-reinforced, motorway bridge beam. The 14 m long, 2,5 m wide and 1,5 m deep bridge beam was composed of a U shaped FRP shell body with diaphragms for stability and the reinforced concrete slab. Hayes et al. [4] showed results of research on the pultruded double web beam of the Strongwell company with the girder length of 12 m. Finally, Hejll et al. [5] tested large scale hybrid FRP composite girders for use in bridge structures.

https://doi.org/10.2749/222137814814069561