Structural Behaviour of Composite Sandwich Panels for Civil Engineering Applications

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Summary

This paper presents results of analytical, experimental and numerical investigations on the mechanical behaviour of sandwich panels with glass fiber reinforced polymer (GFRP) skins. The performance of two different core materials - rigid plastic polyurethane (PU) foam and polypropylene (PP) honeycomb - and the effect of using lateral GFRP ribs along the longitudinal edges of the panels were investigated. The experimental campaign first included material characterisation tests on small scale specimens. Subsequently, flexural static and dynamic tests were carried out in full-scale sandwich panels in order to evaluate their service and failure behaviour. The numerical study included the development of 3D FE models of the tested sandwich panels, which allowed simulating the mechanical behaviour of the sandwich panels with a good accuracy.

Keywords: sandwich panels, GFRP skins, polyurethane foam, polypropylene honeycomb, experimental tests, FE models.

1. Introduction

The recent need for structures with low self-weight, high strength and durability has been fostering the development of fibre reinforced polymer (FRP) materials, within which composite sandwich panels are playing an increasingly important role [1-3]. The structure of sandwich panels follows a typical basic pattern that comprises (i) relatively thin, stiff and strong skins, enclosing (ii) a relatively thick and light core [4]. Many alternative forms of sandwich construction are possible by combining different skin and core materials and geometries, therefore enabling optimum designs to be produced for particular applications. Among the main advantages of composite sandwich panels one can outline the high specific strength and stiffness, the lightness, the high thermal insulation, the possibility of producing complex geometries and the improved durability provided by the FRP skins. As drawbacks, composite sandwich panels generally present low acoustic insulation, poor performance for relatively high temperatures and lack of design codes or guidance.

Standard composite sandwich panels are often made of glass fiber reinforced polymer (GFRP) skins and rigid polyurethane (PU) foam core. Despite their very competitive costs, the stiffness and strength of these conventional sandwich panels are hardly compatible with their structural use in building floors or bridge decks, at least for standard spans and loads. The main weaknesses of these panels stem from the low stiffness and strength of the core, the top skin susceptibility to delamination and buckling, owing to the inexistence of reinforcements bridging the core and the skins.

This paper presents results of further analytical, experimental and numerical investigations on the mechanical behaviour of composite sandwich panels, taking into account their possible structural

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