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The structural behavior of tiled laminate GFRP composites, a class of robust materials for civil applications

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1 Abstract

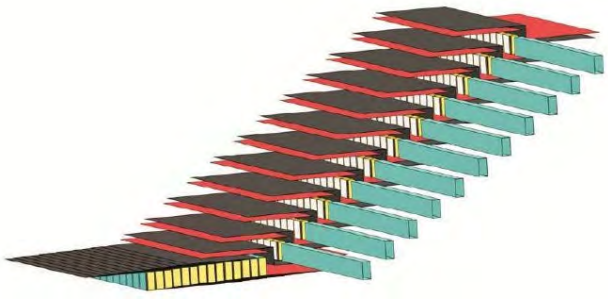
This paper focuses on the structural behavior of tiled laminate composites. Such laminates, in which the plies are not parallel to the outer surfaces are found in GFRP bridge deck panels. The technology is developed for the construction of robust GFRP panels useful in highly loaded structures such as bridges or lock gates. In civil structures, the drawback in traditional FRP sandwich structures has always been debonding of skin and core. Such a debonding problem may occur after unintentional impact, followed by fatigue loading. Through the concept of using overlapping Z-shaped and two-flanged web laminates, alternating with polyurethane foam cores, debonding is no longer possible in vacuum infused GFRP bridge deck panels. In such panels, the fibers in the upper and lower skins as well as in the vertical webs run in all directions, rendering a resin-dominated crack propagation impossible. As a result of the integration of core and skin reinforcement, a skin material is created in which the reinforcement is not parallel to the outer surfaces, but tiled. Based on experimental results and numerical simulations the relevance of tiled laminates for civil applications is demonstrated.

Keywords: tiled laminate, tiled sandwich, composite, GFRP, finite element analysis, Abaqus, failure behavior

2 Introduction

The tiled laminate panel technology is developed for the construction of a robust glass fiber reinforced polymer (GFRP) panel applicable for highly loaded structures [1-4]. The inherit drawback of traditional FRP sandwich structures in civil engineering has always been debonding of skin and core) due to impact followed by fatigue loading. Using the tiled laminate concept, such skin-core debonding is no longer possible. Figure 1 shows an exploded view of an tiled laminate sandwich panel. The panel consists of multiple foam cores over which single fiber mats and Z-shaped fiber mats are draped according to a predefined configuration. The panel's span direction corresponds to the longitudinal direction of the core elements.

Figure 1. Exploded view of an tiled laminate sandwich bridge deck panel



Each fiber layer is thus part of the top skin of the panel, the core and the bottom skin of the panel. Due to this full integration of skins and core, skin-

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