Construction process simulation of moveable hybrid GFRP/ concrete bridge deck

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Summary

Glass/carbon FRP composites have been gaining popularity and acceptance in the bridge construction industry because of their high strength-to-weight, corrosion resistance, higher energy absorption, and competitive cost. A novel cost-effective moveable hybrid GFRP/Concrete deck system was proposed, and the concrete cast on the GFRP plate was simulated by sand irrigation test. The load-displacement relationship, stiffness and stress distribution were investigated to verify the feasibility of GFRP plate serve as the framework. Base on the test results, 3-D FEM is established to analyze the mechanical properties of the GFRP plate under construction process. The FEA results showed fairly good agreement with the experimental ones in terms of strength, deformation, and stiffness. Results confirmed that the stiffness and strength of GFRP plate under construction loading meet the requirements of relative code, and the FEM can be used to provide some guidance in the design of GFRP plate.

Keywords: Bridge deck; GFRP; Concrete; Construction process; Sand irrigation test; FEA

1. Introduction

Glass Fiber Reinforced Polymer (GFRP) decks have emerged as a promising solution to the premature deterioration and structural deficiency problems associated with conventional bridge decks, owing to their several advantageous properties including high strength, lightness, free formability, ease of installation, good thermal and electromagnetic insulation properties, low maintenance requirements and resistance to corrosion and fatigue when compared to traditional materials [1]. The world's first FRP vehicular bridge, albeit with only FRP box girders, was built in China in 1982 [2], after that time, many bridges with FRP deck systems have been developed and built in the United States and worldwide[3-4]. There have been an increasing number of research efforts reported on FRP composite decks and their application in rehabilitation or replacement of deteriorated bridges and in new bridges. Experimental (both model and field test) and analytical work on FRP bridge decks with various materials, configurations, and connection detailing, mechanical characteristics including stiffness, strength, and stability, etc, have been widely reported [5-9]; However, the largest concern regarding FRP decks in the bridge industry involves the initial higher price of an FRP deck compared to that of a concrete deck presently [10]. In the long run, the higher cost of FRP may be justified by considering life-cycle costs. On the other hand, compared with concrete decks, the further significant drawback are the low stiffness in the main girder direction, the lack of material-adapted structural shapes, the brittle behavior and the susceptibility to instability phenomena [11]. To overcome such disadvantages and to make the best use of materials, combinations of FRP and conventional materials as concrete with low cost but high compressive

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