The smart FRP panel for bridge redecking – development and experimental validation of "panel – panel" and "panel – girder" connections

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Abstract

The paper presents the smart FRP deck system, called Optideck, which was developed as a sandwich panel in which the core is ribbed by a vertical laminates forming a honeycomb structure. The panel is equipped with distributed fibre optic sensors for structural health monitoring. The sensors are built into the panel during the infusion process and fully integrated with the structure. Taking into account the design and transport constraints, the final parts of the deck slab have to be connected longitudinally or transversely on site, which is quite a challenge due to the irregular form of the ribbed core. The panel has to be also efficiently attached to the main girders of the bridge. The paper presents the stages of creating the concept of panel-panel and panel-concrete and steel girder connections, their design, production of prototypes and finally their static and fatigue tests in the laboratory. The conclusions drawn from the individual stages led to the selection of the best solution and its use in the future in the final deck panels.

Keywords: FRP deck, glass fibres, distributed fibre optic sensors (DFOS), connections, FE analysis, adhesive, anchors, panel, concrete, steel.

1 Introduction

The reasons of damage to the bridge deck slabs can be divided into three groups. The first group of damage reasons includes the constant and rapid increase in the intensity, weight and speed of road traffic, including heavy vehicles. The number of oversize vehicles with a single axle load greater than the allowable one and with an increased total weight is constantly growing. The second group are the environmental pollutants causing a very rapid degradation of the deck elements include mainly chemicals used to prevent winter slippery on roads, and by other pollutants in the atmosphere, especially in the form of carbon dioxide and sulphur compounds, the content of which in the air increases with the development of industry and the automotive industry. The third group of reasons includes inadequate design and material solutions, which have been used in many existing and operated bridge structures until today.

Recently, a progressive number of implementations of high tech solutions in the bridge industry can be observed, especially for decks slabs, as they are, as shown above, the weakest part of the entire bridge [1, 2]. New ideas are usually new, better material, often inseparable from new structural solutions, as well as technological aspects (i.e. FRP) and long-time monitoring over its life cycle (i.e. DFOS). Necessity of new solutions are mainly aimed at optimizing financial savings related not only to production cost of the construction itself, but also costs during entire lifecycle of the structure [3, 4].

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