New concepts in movable lightweight bridges in fibre reinforced polymers (FRP)

Martijn Veltkamp, Arnoud Haffmans

FiberCore Europe, Rotterdam, the Netherlands

Contact: veltkamp@fibercore-europe.com

Abstract

Low maintenance and low self-weight are two of the most important advantages of using fibre reinforced polymers (FRP) as structural material for bridges in general, and movable bridges in particular. These advantages count in both new-built and refurbishment projects. In the last few years, a variety of such structures has been constructed, enabling to compare the different typologies, their experiences and an outlook on how FRP can best be used to further employ its full potential.

Keywords: Fibre reinforced polymers (FRP); movable bridges; structural topology; lightweight.

1 Introduction

Explicit consideration of life cycle costs at early project-stages has made clear the need for more durable, less maintenance-intensive structural materials. In parallel to the required design-life becoming longer, a maintenance-regime needs to be in place to realise this ambition. The FRP-material being durable and not being prone to degradation to known aggressors such as water, salts and UV-radiation, eliminates a large part of the structurally necessary maintenance-intervals needed for conventional construction materials.

In movable structures a low self-weight presents a range of indirect advantages in addition to the reduced permanent loading only. For design, it results in more slender bridge spans with less voluminous counterweights. In the construction stage it implies a shorter building time due to a lower mass of the prefabricated parts. In use, a lower mass has less inertia and requires less energy to move, lift or rotate.

Other than in new-built, FRP also enables retrofitting and upgrading of existing structures. The ageing stock of existing infrastructure includes structures that no longer meet the design loading requirements and performance criteria that have gradually been upgraded over time. While structures may have been built with some intentional redundancy in them, or with a hidden capacity that can be demonstrated through modern means of assessment, both are rarely the case for the bridge deck. The deck is often built in steel or timber and suffering most from degradation under the influence of water, de-icing salts or fatigue.

Dependent on the type of fabrication, the FRP material is resistant to both impacts and de-icing salts and replacing the bridge deck implies an upgrade in both quality and capacity. For refurbishment projects the challenge generally is to provide upgraded load-bearing capacity, possibly including a widening, within the same nett weight as the original structure in steel. This

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