Carbon Fibre Reinforced Polymers in Bridge Engineering

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Summary

From where are we coming, and to where are we going with Carbon Fibre Reinforced Polymers (CFRPs) in bridge engineering? CFRPs have been used starting 1991 in practical applications for bridge rehabilitation. Since about 2000 this class of materials is accepted for post-strengthening in most countries. Due to quick and easy application techniques and therefore less labour hours, it is in general more economic to post-strengthen a bridge with expensive CFRPs instead of steel. The R&D work for CFRP cables has been initiated in 1980. World's first CFRP stay cables were installed in 1996. From the technical point of view CFRP cables are very successful, however not from the economic side. As long as not the whole life cycle of a bridge will be considered, CFRP will not replace steel for such applications. Solutions are discussed to overcome this hurdle. If in the far future very long span bridges will be needed, CFRPs will be instrumental for such constructions.

Keywords: Carbon Fibre Reinforced Polymer (CFRP); post-strengthening; cables; post-tensioning; anchors; long span bridges.

1. Introduction

The author presented at the IABSE Symposium 1991 in Leningrad/St. Petersburg the paper "Carbon-Fibre-Reinforced Polymers: Modern Materials in Bridge Engineering". This paper, published in [1], was in the following year winning the IABSE Outstanding Paper Award. There were a lot of promises for carbon fibre reinforced polymers (CFRPs) like no corrosion, no fatigue, effective and efficient post-strengthening, a superior equivalent modulus for stay cables etc. The future potential of carbon fibres and the limiting spans for suspended bridges were also discussed. What has been reached meanwhile? What might be reached in the future?

2. From where are we coming?

2.1 Carbon fibres, carbon fibre reinforced polymers (CFRPs)

CFRPs have become due to their high strength, high elastic modulus, low density, outstanding fatigue performance and resistance against corrosion since the 1960ties the dominant advanced fibrous composite materials for high tech applications like in aerospace, selected structural elements in ground transportation, sporting goods, and highly accelerated components in machinery. As the price of carbon fibres decreased in the 1970ties and 1980ties dramatically, their applications had even broadened to construction. Based on today's carbon fibre production technologies that are consuming high amounts of energy and the expected development of costs for crude oil, the industrial feedstock for carbon fibres, we cannot expect another spectacular decrease in price.

2.2 Rehabilitation, post-strengthening

Since the 1970ties it more frequently has been necessary to post-strengthen existing bridges or parts

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