



Application of Carbon Fibre Reinforced Polymer Cable in Extradosed Bridge

Li Dong, Peng Feng

Department of Civil Engineering, Tsinghua University, Beijing, China

Yu Wang

School of Civil Engineering, Chongqing Jiaotong University, Chongqing, China

Contact: fengpeng@tsinghua.edu.cn

Abstract

The extradosed bridge is defined as the structure between the girder and cable-stayed bridges. Carbon fibre reinforced polymer (CFRP) cables are favoured over steel cables due to their lower weight, higher strength, and reduced thermal expansion ratio, rendering them suitable for shorter tower structures. A comparative design study involving the replacement of steel cables and concrete girders with CFRP cables and steel girders in a 220m span extradosed bridge reveals that the cables bear most of the vertical loads. Proper implementation of CFRP cables reduces nonlinear effects and main girder stresses, increases deflection and vibration period, and mitigates the adverse impact of temperature load. This study offers a novel application of CFRP cables in an extradosed cable-stayed bridge, providing economic and environmental benefits, expedited construction, and enhanced structural performance.

Keywords: CFRP cable; extradosed bridge; structural performance; cost; carbon emission.

1 Introduction

Due to constraints in material properties and construction ability, bridges often utilize cables to enhance their spanning capacity^{[1][2]}. Extradosed bridges, serving as a structural system intermediate to continuous girder bridges and cable-stayed bridges, are designed to provide higher levels of external prestressing than continuous girder bridges, along with pylons of lower height compared to typical cable-stayed bridges. Extradosed bridges leverage the benefits of variable-height continuous girders, and cable supports to extend concrete bridge spans to over 200 meters.

The lower height of the pylons in a structural system akin to a cable-stayed bridge leads to increased axial pressure on the main girders^[3]. This requires more material to be used in the main girders to withstand it, resulting in a further increase in deadweight. Moreover, the larger nonlinear effect of longer cables with smaller horizontal angles also reduces the efficiency of force transmission. Concrete girders are typically constructed using cantilever casting, a method that demands longer construction time and entails higher risks. The consolidation of pylons and girders commonly employed in extradosed cable-stayed bridges enhances structural stiffness and mitigates construction challenges. However, it