Experimental Study on Simply Supported Bridges of Steel-Concrete Composite Structure Strengthened with Externally Pre-Stressed CFRP Plates

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Abstract

This paper mainly studies the mechanical properties of steel-concrete composite beams reinforced with trapezoidal prestressed un-bonded retrofit (TPUR) system. The prestressing of CFRP plate through the jacking of columns can not only apply the prestressing force to the main beam, but also provide upward lifting force to the bottom of the main beam to reduce the deflection of the original structure. Moreover, the surface treatment of steel beams is not required in the TPUR system, which can improve the speed and efficiency of reinforcement construction. The effects of the amount of CFRP, the prestress level, the height of the pillars and other parameters on the stiffness and bearing capacity of the composite beam are studied through static tests on the scaled model.

Keywords: tension string reinforcement; CFRP plate; steel-concrete composite beam; active reinforcement method; flexural bearing capacity.

1 Introduction

1.1 Development background and existing problems of steel-concrete composite girder bridges

The steel-concrete composite structure can give full play to the characteristics of concrete and steel, and is a sustainable form of bridge structure[1]. Due to the advantages of small height, short construction period and high degree of industrialization[2], steel-concrete composite beams have been widely used in highway and urban bridge construction. There are some problems in the use of steel-concrete composite girder bridges built in the early days. On the one hand, with the increase of service life, various structural damages and quality problems occur in composite beams, which affect their bearing capacity; on the other hand, if there are defects in the early design, the increase of traffic loads will lead to insufficient overall bearing capacity[3].

1.2 Application of CFRP material in bridge repair

When CFRP is used for bridge structure reinforcement, there are mainly two reinforcement methods: passive reinforcement method and active reinforcement method. The disadvantage of passive reinforcement method is that it cannot reduce the deformation and cannot close the cracks of the original structure[4]. The active reinforcement method is represented by the application of prestress to CFRP materials, which generates prestress in the bridge structure and redistributes the internal force of the original structure, which can effectively overcome the defects of the passive reinforcement method[5].

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