Prestress Effect of Composite Girder Bridge with Corrugated Steel Webs

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Summary

The joints connecting corrugated steel webs and concrete slabs are significant to the structural behaviour of composite girder bridges. Flanged Connection, Embedded Connection and Wrapping Connection were compared and discussed. Both global and local prestress effects were analysed on the basis of finite element method. The numerical results indicated that composite girder bridges with corrugated steel webs could save 20% of the tendons applied in concrete girder bridges. The global prestress efficiency could hardly be affected by using different web-slab joints. To ensure the concrete slab's durability in Serviceability Limit State (SLS), precise analysis should be performed to evaluate the local stress concentration of the connections. The results indicated that the Wrapping Connection had favourable structural behaviour under prestressing, with high global prestress efficiency and low stress concentration at the web-slab joint.

Keywords: composite girder bridge; corrugated steel webs; prestress efficiency; joint; finite element analysis.

1. Introduction

Prestressed composite girder bridges with corrugated steel webs are among the most innovative composite structures in urban viaducts and highway bridges [1]. This design is characterized by corrugated steel webs with high shear buckling strength and low axial rigidity. As a result, a lighter structure can be achieved by reducing stiffeners, and prestress efficiency can be enhanced due to accordion effect [2-3].

The joints which connect corrugated steel webs and concrete slabs are critical to the structural behaviour of composite girder bridges. Full shear connection is required for composite action of steel and concrete members. Three types of joints have been developed in composite girder bridge with corrugated webs, i.e. Flanged Connection, Embedded Connection and Wrapping Connection. They mostly differ in the arrangement of shear connectors and steel flanges.

In 1986, Cognac Viaduct was built in France by CB construction and Flanged Connection was adopted for web-slab joint [4]. The steel flanges were welded upright to corrugated steel webs. The lower concrete slabs were placed under the lower steel flanges, and shear connectors were installed to connect steel and concrete members.

In 1998, Embedded Connection was applied to web-slab joint of Hontani Bridge in Japan [5]. The corrugated steel webs were directly embedded into concrete slabs, and circle holes were punched out on the webs to achieve effective shear connection.

Recently, a composite girder bridge with corrugated webs was completed in China. This bridge employed Wrapping Connection at web-slab joint. Unlike the Flanged Connection, the lower steel flange was set up below the lower concrete slab. The shear connectors were installed upward on lower steel flanges, which was beneficial to concrete pouring.

Despite different arrangements of shear connectors and steel flanges, these types of joints are all

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