Exploration of Structural Performance of Stiffened Steel-Concrete Composite Beams with Perforated Stiffening Rib Plates

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Summary

A ribbed steel plate-concrete composite section (PSRP) was proposed to prevent or limit flexural cracking in the negative moment region normally with a spiky rise and rapid reversal. The proposed section was composed of concrete and steel plate with perforated stiffening rib plate to reduce the dependency of shear transfer on interfacial bond. The objective of this study was to obtain experimental and analytical data essential to investigate, and establish, a design method for the steel plate reinforced concrete against flexural cracking under the service load condition. This paper presents the results of a total of eight scale specimens prepared for the comparison test. Six specimens were reinforced using steel plate with perforated stiffening rib plates, one specimen was reinforced using conventional reinforcing bars and one specimen was reinforced using epoxy-bonded steel plate for comparison. All beam specimens were tested to failure. The test results indicated the steel plate with rib stiffeners can offer a pronounced improvement to the cracking resistance of the concrete. The cracking load for the PSRP specimen with stiffening rib plate is three times higher than the specimen reinforced with conventional steel, and two and half times higher than specimen reinforced with epoxy-bonded steel plate. The perforated stiffening rib plate appears to have not only increased interfacial bond area and but also provide a volumetric restraint and confinement to adjoining concrete that improves its material uniformity, in comparison to the discrete and localized line bonding provided by the reinforcing bars. This improvement of the material uniformity may have led to a significant rise of tensile stress limit of the confined concrete.

Keywords: steel plate; flexural cracking control; steel stiffener plates; prestressed concrete; reinforced concrete; steel-concrete composite

1. Introduction

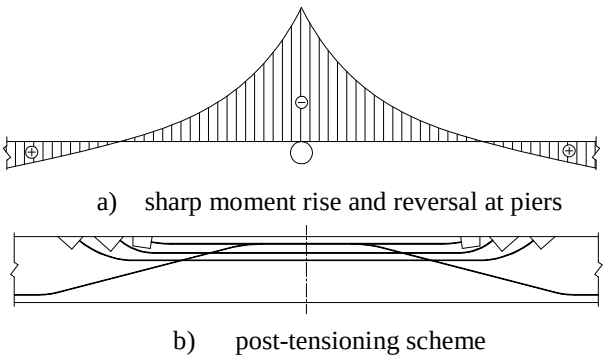

Fig. 1: Typical sharp moment rise and reversal

Simultaneous occurrence of maximum negative bending moment and shear at the support region of a continuous span concrete bridge or at the skewback of an arch bridge with fixed end (see Fig. 1) often requires significant increases of the cross-section, local reinforcement, or application of partial post-tensioning. The moment in these regions often rises sharply and reverses rapidly within a short range. Conventional design methods are often cumbersome and sometime ineffective for this region. Tapering up the cross-section would significantly increase the material cost with most of increased strength

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