Behaviour of Partially Encased Composite Girder with Corrugated Steel Web under Combined Shear and Flexural Loads

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Summary

Concrete-encased composite girder with corrugated steel web is proposed to improve the mechanical performance of continuous girder under hogging moment, avoiding the buckling of the corrugated web and compressive flange caused by large combined shear force and bending moment. The structural behavior under combined shear force and bending moment was investigated experimentally and analytically, the load-carrying capacity and failure mode of composite girders with different length of concrete encasement were investigated. Analytical results show that the failure modes of composite girders depend on the length of concrete encasement, and the ratio of shear to bending affects the shear stiffness after concrete cracking and ductility at ultimate load state. Based on experimental results, the analytical evolution of shear strength and bending strength were investigated, also interaction equation with respect to shear and bending strength was proposed to evaluate loading capacity of such composite girders.

Keywords: Composite girder; corrugated steel web; concrete encasement, combined shear and flexural loads.

1. Introduction

Steel and concrete composite bridges are very attractive solutions for short and medium span bridges due to the benefits of combining the two construction materials. As for continuous composite girder, large bending moments and shear forces exist at the intermediate supports, concrete slab is in tension which induce cracks affecting the durability and service life of bridges, while the lower flanges and lower parts of webs are in compression which is vulnerable to lateral-torsional buckling. Therefore, the girder area around the intermediate supports is the critical part of the continuous girder. The mechanical performance including crack control and internal force redistribution in this area has been the focus of recent studies [1-5].

In order to improve the structural performance of continuous composite girder bridges under hogging moment, Nakamura *et al.*[6,7] proposed two measures around support areas: concrete casting on the bottom flange for twin-girder section and on the bottom plate for box girder section to form double composite section. Therefore, flexural rigidity was enhanced so that instability problems were avoided, resulting in the lower position of neutral axis and deformation restriction by concrete encasement. Kim & Shim [8] proposed double composite section at hogging moment areas to enhance the structural performance of existing twin-girder bridges, static tests were conducted to investigate the effective width, shear connection, and ultimate strength.

PCGirders with Corrugated Steel Webs (PCBCSW) are one of the promising concrete-steel hybrid structures applied to bridge structures. According to statistical data of existing PCBCSW, continuous and rigid frame bridges with the span length from 50m to 150m account for about 80% of the total number for PCBCSW[9]. Also, there are weak points in the position around intermediate supports; concrete is poured in this area surrounded by the upper flange, lower flange and web [10-

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