Design Expressions for the Effective Width of Composite Steel-Concrete Members

Fabrizio GARA
Assistant Professor
Universita' Politecnica delle Marche
Ancona, Italy
f.gara@univpm.it

Gianluca RANZI
Associate Professor
University of Sydney
Sydney, Australia
gianluca.ranzi@sydney.edu.au

Graziano LEONI
Professor
University of Camerino
Ascoli-Piceno, Italy
graziano.leoni@unicam.it

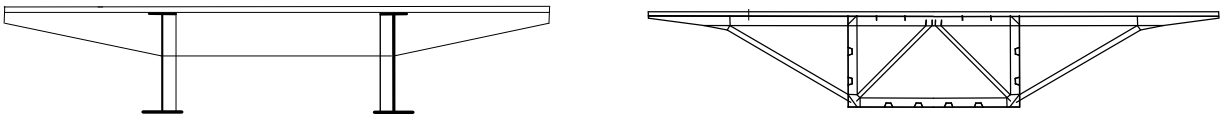
Summary

This paper presents a new approach for the evaluation of the effective width for the analysis of composite steel-concrete members. The proposed method is based on the use of simple expressions which enable the calculation of the effective width of the slab accounting for shear-lag effects. Its particularity relies on its ability to utilize the results of a global analysis carried out specifying the real width of the slab along the whole bridge length and to port-process these by means of a cross-sectional analysis using simple design equations to define the geometry of the concrete slab. The expressions for the effective widths have been derived for different loading conditions including constant uniformly distributed loads, envelopes of transverse actions due to traffic loads, support settlements, thermal effects and shrinkage. Several applications are then presented to outline the ability of the proposed method to accurately predict the stress state in the concrete slab while accounting for shear-lag effects. These results are also compared against those obtained based on available design guidelines and calculated by means of the finite element method using line and shell elements.

Keywords: composite bridge, composite beams, effective width, shear-lag

1. Introduction

Steel-concrete composite continuous decks are widely used in viaducts and bridges with medium span length (from 40 to 100 m). These usually consist of two steel beams or a single box girder, even in the case of wide concrete slabs (about 25 m), that can be transversally prestressed or sustained by cantilevered cross-beams or lateral struts (Figure 1). In steel-concrete composite continuous decks with wide slabs, the usual assumption of preservation of the plane cross-section is not realistic. In fact, due to the interaction with the steel beams, the concrete slab undergoes significant warping which induces a non-uniform stress distribution, usually referred to as shear-lag effect.



(a) Twin-girder deck with cantilevered transverse beams (b) box girder with lateral struts

Figure 1. Typical composite decks with wide concrete slab

For the design of this typology of decks (Figure 1) the main codes of practice recommend taking into account the effects of shear-lag by suitably reducing the slab width in both analysis and design to remain within the assumptions of plane cross-sections.

https://doi.org/10.2749/222137814814027701