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Analysis of a Modular Timber/Concrete Composite System for Short-Span Bridges

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1 Abstract

This article describes a modular timber/concrete composite system for short-span highway bridges. The system is assembled from modules. Each module spans from support to support and consists of two glulam girders and a deck slab constructed of ultra high-performance fiber reinforced concrete (UHPFRC). A method of analysis is proposed for the system to study both the longitudinal and transverse behavior under live loads. The method is based on a spatial grid model, which incorporates Vierendeel frames to account for partial composite action in the longitudinal direction. Preliminary results show that the proposed modular timber/concrete composite system achieves a high degree (91.4%) of longitudinal composite action and possess good transverse load sharing performance between modules.

Keywords: composite structure; modular system; timber structure; UHPFRC; Vierendeel frames; spatial grid model.

2 Introduction

This article proposes a method of analysis for a modular timber/concrete composite system for short-span highway bridges currently under development at the University of Toronto [1]. The focus is on calculating the effects of highway live load.

The modular timber/concrete composite system was intended for short-span highway bridges with spans in the 20 to 40 m range. The system can be applied to different road widths by changing the number of modules. The system is composed of inverted-U shaped modules consisting of two glulam girders and a concrete slab constructed of UHPFRC. To connect the two parts, shear connectors are designed with bent reinforcing steel bars glued into holes drilled in the wood and then cast into the concrete slab. Partial-depth timber diaphragms are provided in exterior modules to transfer lateral impact from rail posts. Full-depth diaphragms are provided in both exterior and interior modules at the supports, as well as at the quarter points of the bridge. Modules are completely prefabricated off-site and will be erected on site with adjoining girders in contact. X-shaped self-tapping screws drilled in the adjoining gliders and UHPFRC closure pours are used to connect modules transversely. The screws are provided primarily to prevent relative displacement of modules during casting and curing of closure

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