



Analysis and design of a 45 m long highway bridge constructed using glulam arches

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Summary

While upgrading Highway 27 in Sweden, a 47,4 m long arch bridge consisting of glulam was built. Due to architectural reasons, the arches were not allowed to be connected to each other above slab level. The moment transmitting joint between the vertical beam hanger and transverse girder results in U-shaped connections between the arches. A 13,9 m spacing of the arches made the design of this structural part challenging. Stability of the arches was especially considered, regarding both in and out of plane buckling due to vertical and horizontal loads. Dynamic factors for the wind load were calculated using a single mode principal. A stress-laminated timber slab made of glulam beams was used as the bridge slab. This glulam - steel hybrid structure consists of approximately 230 000 kg of untreated glulam and approximately 100 000 kg of steel.

Keywords: Glulam, arch bridge, stress-laminated-timber slab, FE analyses, wind analyses, buckling

1. Introduction

When the new stretch of Highway 27 was built, it was an action to redirect the traffic outside of the town of Gislaved in Sweden. This was the main achievement, traffic safety improvement was another. In an early stage it was decided that the largest bridge crossing should consist of a glulam arch bridge. This crossing had a clear span of 45m over Nissan River. The early architectural works concluded that the arches shall not be attached above slab level. This places high demands on the interaction between the vertical hangers and the transversal girders in a structural manner. In an architectural sense it creates an unobstructed feeling for the drivers crossing the bridge. A small arch radius is also an architectural effect, resembling an old steel arch bridge nearby.

The joint between the vertical hanger and the transversal girder has to transmit moment, which makes it a critical detail of the bridge structure.

The Swedish Transport Administration (Trafikverket) today prevents the use of some appendices of EN 1991-1-4 [1]. As a result of this, structural designers have to calculate the parameters included in the structural factor of EN 1991-1-4, by using other methods.

Each arch consists of five curved glulam beams of untreated timber. The bridge slab is a stress-laminated timber (SLT) slab, out of untreated timber. The use of untreated timber is an environmentally preferred solution which places high demands on detailing to ensure durability.

Main contractor of the highway stretch was Svevia. Subcontractor for the bridge superstructure was the timber bridge manufacturer Moelven Töreboda (Moelven). WSP Civils Sweden (WSP) was contracted by Moelven to design the bridge superstructure.