Torsion of a Norwegian bridge with partial box-action - a case study

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Abstract

Some old bridges have a truss between the bottom flanges not intended for torsional effects but for transferring horizontal forces. This paper describes the effects of the truss on torsion for a Norwegian three span bridge from 1967, without composite action. Furthermore, the effects of post-installed shear connectors are investigated.

For composite bridges without intended composite action in bending, the effects of the slab preventing the top flanges from moving laterally should not be ignored, since this is important for the deformations of the girders under eccentric loading. Furthermore, the load distribution between the girders for an eccentric load is significantly enhanced if the horizontal truss is considered. The paper also investigates and presents the effects of post-installed shear connectors, with respect to bending stresses in the bottom flanges (moderate effects) and the top flange (large effects).

Keywords: Composite bridge, strengthening, horisontal bracing, composite action, box-action.

1 Introduction

The highest loads Norwegian roads are exposed to are mainly due to industrial timber harvest and special heavy transports. To increase redundancy and relax the most utilized routes, some of the roads are analysed and sometimes upgraded to accept higher load capacities to match the demand of the industry. Bridges being part of this network are often the bottlenecks of specific routes. The Norwegian Public Road Administration (NPRA) specifies requirements for classification of bridges for the specific uses. Classes are defined for bridges that have about 50 years or less remaining of the 100-year lifetime. The heaviest class for timber lorries allows for 60-tonne total load with 10-tonne axle load, referred to as Bk10/60, whereas requirements for special heavy transport falls into class Sv12/100 that requires the bridge to tolerate a 100-tonne total load with 12-tonne axle load. Load cases are defined more in detail in Handbook V412, [1].

Old bridges of different types are continuously assessed by bridge managers and the NPRA to update their classes. In the Norwegian road network, there are over 1700 steel girder bridges with a concrete deck without an intended composite action with the steel girders. The NPRA advises conservative assumption that the steel girders resist entirely the permanent and variable loads acting on the bridge. Many of these bridges can be reinforced by establishing a shear connection between the steel girder and the concrete deck to enable composite action.