Separation of Structural and Practical Functionalities for Wearing Courses on Steel Box Girders

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Summary

Steel box girders are frequently used for road bridges. They are an economical solution and are easily built using modern construction techniques. During the day, a box section is subjected to the influence of the diurnal solar radiation cycle. This paper describes a new research project which focuses on the quantification of the thermal behaviour of these steel boxes. The objective of the research is to reach a new and fundamental insight in the problem and the behaviour of closed steel box girders, subjected to a variable thermal load, and the repercussions of such a loading combined with the live load on the stability of the box section, be it as the main arch of the bridge or as a part of the deck structure. This paper reports on the initial results of the finite element modelling of such thermal loading and its consequences for future wearing courses, which would benefit from a separation of the structural and practical functionalities.

Keywords: bridges, orthotropic plated bridge deck, thermal loading, wearing courses, box girders, solar radiation.

1. Introduction

1.1 The research project

Steel box girders, equipped with an orthotropic bridge deck and constructed using stiffened plates are one of the most frequently used concepts for road bridges and flyovers spanning between 80 and 160 m. They are a very economical solution and are easy to build thanks to the modern construction techniques. A new problem has arisen in recent international research, that was not taken into account for the design until now, which can heavily influence the behaviour of the bridge.

During a 24-hour cycle, a closed box girder is susceptible to heating, caused mainly by the radiant heat of the sun, but also by heat transfer by convection in the air inside the box girder and by the good thermal conductivity of the steel. The radiant heat of the sun, which acts primarily on the surface of the bridge, is captured by the surfacing and transmitted to the supporting steel structure. Once the steel section of the box girder heats up by thermal conduction, it will then on its turn start to heat up the air inside of the box girder, which will result in an internal heat convection system in the girder. The natural ventilation because of the manholes in these types of girders can never be influential enough to create a cooling airflow substantial enough to countermand this effect, taking in mind the typical dimensions of such a structure. As soon as the external heating source of the surfacing and the effects of the radiant heat decrease, the surface layers will start cooling. The interior of the box however, will nevertheless keep heating the surface layers for a considerable amount of time, but now from the inside working outwards, because of the thermal inertia of the

https://doi.org/10.2749/222137807796119799