IABSE Conference – *Structural Engineering: Providing Solutions to Global Challenges*
September 23-25 2015, Geneva, Switzerland

Design challenges of the runnability of long span bridges

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Abstract

Long span bridges crossed by railway traffic require proper runnability analysis, based on different modelling levels. In this paper the influence of global, medium scale and local deck deformation on the stresses induced on the bridge structure is investigated, by adopting a proper combination of models, with different dimensions and detail levels. What makes a bridge with railway traffic different from bridges crossed by road traffic only is the need to install a track system which involves local stress concentration related both to higher axle loads and specific connection devices. Special attention is given to the influence of the track system on the locally transmitted loads and consequent stresses, by making reference to the case of an embedded rail system directly installed on the top plate of a railway box girder and to the related fatigue resistance of the deck structural elements. Simulation and laboratory tests can be a synergic combination for properly guiding the bridge structural design.

Keywords: long span bridges, runnability simulation, multi-scale analysis, track systems, lab tests

1 Introduction

Bridges can represent an essential link for connecting highly density populated areas, or the key elements of long distance corridors, also helping in enhancing the local economy of far regions. Railway transport is becoming more and more competitive both for passengers (high speed trains) and for goods transportation. As a consequence, there is an increasing number of projects were long span bridges are requested to carry both road traffic and railway traffic, posing challenges related both to structural integrity of the bridge in general and of the railway deck in particular, and to the train's operating conditions, i.e. what in a single word is referred to as runnability.

The interaction between a train and a bridge occurs through the local wheel-rail contact forces, which in turn are related to the effect of both local and global bridge motion and external actions (like wind or earthquake).

When a long span bridge is designed for carrying mixed traffic, different problems arise. Some of them are related to the global deflections due to wind and road/rail traffic and their interaction with train dynamics, other items are referred to a scale corresponding to train length. Finally, at a very local scale wheel-rail contact forces play a key role in the safety issues (derailment and rollover). An example of the connection between global and local problems from the design point of view, is given by the use of a box girder instead of lattice girder, in order to reduce the drag force due to wind and therefore achieve an optimal

https://doi.org/10.2749/222137815818357692