Railway vehicle and bridge interaction: some approaches and applications

Gennady Mikheev, Ekaterina Krugovova and Roman Kovalev

Laboratory of Computational Mechanics
Bryansk State Technical University

Corresponding author: Dr. Roman Kovalev
bulv. 50-let Oktyabrya 7, 241035, Bryansk, Russia
Phone, Fax: +7 4832 568637
email: kovalev@umlab.ru

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Abstract

The present paper describes the CAE-based approach for analysis of dynamics of a coupled model of flexible railway bridge and train [3, 5, 6]. The approach is being implemented in Universal Mechanism (UM) software. The railway bridge is considered as a flexible multibody system. Dynamics of flexible bodies is simulated using data imported from finite element analysis (FEA) software. An application of the approach to the investigation of dynamics of a railway vehicle and a bridge supposes taking into account flexibility of the bridge.

Equations of motion of a flexible body are derived using floating frame of reference method [4]. Linear flexible displacements of the body are described by the component mode synthesis method [1, 2].

Rail-to-wheel contact forces are applied to a flexible structure as a running load. Both lateral and vertical force components are considered. Since FEA-approach supposes force applying to a flexible body in nodes of FE-mesh only, the simple algorithm of the decomposition of wheel-to-rail contact forces between the nearest nodes of FE-mesh was used.

The comparison of simulation results for bridge models with different number of flexible degrees of freedom are discussed. The dependence of stresses and strains in the bridge on train velocity is shown.

Railway bridges are often many kilometers in length. The question of reasonable decreasing the length of observed flexible structures with keeping appropriate accuracy of simulation results is considered. The relationship between actual length of the train and recommended length of the bridge model for simulation of bridges with regular recurrent designs is discussed.

Examples of investigated objects are shown in Figures 1, 2.

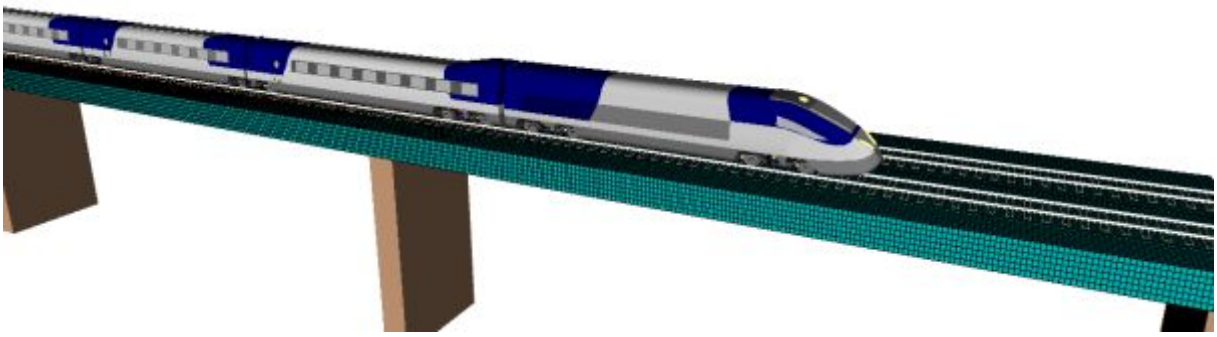

Figure 1. Simulation of a train motion on flexible two-way bridge.

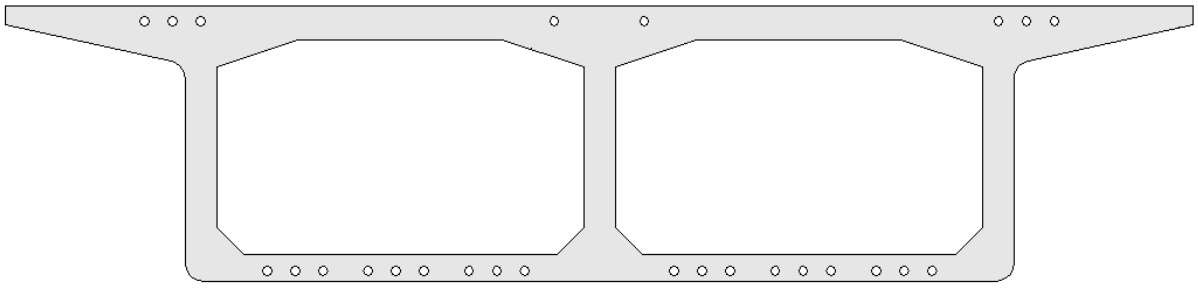

Figure 2. Cross section of a two-way bridge.

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