An Engineering Approach to Analyze Displacement Rate in Embedded Rail System Coupled with Bridge

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Abstract

Estimation of coupling parameters is the key for calculating the interaction between embedded rail system (ERS) and a bridge. It was proven recently that material parameters of polymer-based elastic poured compound (EPC) and other parts of ERS are subjected to change with temperature and displacement rate. Both effects have been discussed in the scientific literature quite thoroughly. However, very little is known to this day about how to address the displacement-rate along the bridge. Therefore, a new engineering approach for analyzing the bridge-ERS track relative displacement-rate is discussed in this contribution. What parameters are affecting the displacement-rate in the ERS? How is the displacement rate in ERS longitudinally distributed? How should be the displacement rate in ERS calculated considering longitudinal and vertical loads? These questions are answered in the paper based on the results of a vast parametric analysis.

Keywords: embedded rail system, elastic poured compound, track-bridge interaction, displacement-rate dependence, load-rate dependence, bridge, longitudinal resistance, vertical stiffness, coupling parameters

1 Introduction

Embedded rail system is a kind of fastening system providing with continuous longitudinal support for the rail. ERS is formed by fastening the rail to the steel or concrete channel by an in-situ poured elastic material. It also involves the space saving components to reduce the volume of EPC and an elastomeric strip under the rail foot. Many scholars have reported various benefits of this fastening system type. It may be used for significant reduction of noise emissivity [1] and dynamic impact caused by vertical vehicle-track interaction [2]. Due to the latter and omission of small fastening steel parts like screws and clamps, ERS exhibits higher durability. Furthermore, ERS properties can be modified for individual projects by optimal design of its cross section [1,3]. Authors see one of the greatest benefits in that ERS might be an ideal option for conversion of existing bridges with balastless tracks [3]. This is because it can significantly improve their performance while not affecting negatively the dead load, nor the bridge deck height. However, if the ERS is considered for use on a bridge, special attention needs to be paid when carrying out the bridge-ERS track longitudinal interaction analysis. The fundamental rules for bridge-ERS track assessment are set by European codes and leaflets [4,5]. These specify the general principles for numerical modelling and analysis of track-bridge interaction, the corresponding loads and basic values of linear longitudinal stiffness k_x (also referred to as the elastic bedding coefficient [6]). Pilot experiments improved knowledge of