Influence of Uniform Thermal Cycles in Reducing Rail Stresses Induced by Creep and Shrinkage Built over Time in Concrete Railway Bridges

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Abstract

In railway bridges supporting a continuously welded rail, the friction induced at the location of the fasteners generates an increment of axial stress in the rail, to be controlled to maintain its integrity. The adequacy to consider creep and shrinkage effects along with the thermal effects in rail structure interaction (RSI) studies is often debated over. A widely accepted analysis approach in the industry is to model the fastening system as reversible bi-linear elastic-plastic. The present article exposes the conclusions of a study which, instead, adopted a realistic hysteretic law for the fastening system to demonstrate, through adequate time-dependent analysis, that the cyclic nature of temperature over time tends to eliminate the gradual increase in axial stress in the rail due to creep and shrinkage, potentially rendering the consideration of concrete rheologic effects in RSI analysis unnecessary, or to be accounted for adequately in order to avoid unnecessary conservatism.

Keywords: RSI; CWR; creep; shrinkage; temperature; railway bridge; fasteners; UIC; hysteretic; longitudinal restraint.

1 Introduction

On railway bridges, the use of "Continuously Welded Rails" (referred to thereafter as "CWR") has become very common because of advantages such as, amongst others, user's comfort, ease of maintenance and installation cost. Since the tracks and the bridge structure are connected, the behaviour of one element affects the other and generates forces and displacements. The study of this interaction is often referred to as "Rail-Structure Interaction" (thereafter referred to as "RSI"). The global context of codes and norms is not very abundant and the UIC 774-3 code is often cited as reference to provide guidance on the axial stress that has to be controlled in the rail.

1.1 Principles of rail structure interaction

When the supporting structure contracts of expands, its contraction or expansion entrains the rails through the connection of the fasteners connecting the structure and the rails. The simply supported beam example shown in Figure 1 is used to illustrate the phenomenon. Under thermal effect, the structure contracts along the x-axis of the beam with a boundary condition in A where no displacement is possible: and Point (B) where the beam is free to displace. The simply supported beam contracting under the rails then tends to compress the rails in the region of Point (A) while it tends to put the rail in tension in the region of Point (B).

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