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Data-driven Structural Assessment of Railway Bridges by Empirical Green Functions and Fragility Curves

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Introduction

The **assessment of the state of railway bridges** in Europe requires large efforts in terms of both time and resources, which have increased since the creation of the **Trans-European Transport Network (TEN)**.

The aim of this study is to provide a number of complementary tools which allow a **quick analysis of the condition state** of railway bridges (including nowcasting and forecasting) where higher loads and speeds can be simulated without the need of complex simulation models. These tools aim at supporting the decision-making process of infrastructure managers. The work is divided into two main sections: **Empirical Green Functions** and **Fragility curves**.

Methodology

Empirical Green Functions

The methodology is based on the possibility of evaluating railway bridges through the measurement of vibrations (displacements, speeds or accelerations) recorded by appropriate instrumentation during the action of a train. It establishes an analogy between the recording of vibrations after specific events (train motion) and other geophysical schemes.

The objective is to simulate time records when a train passes at a certain speed from time records observed in the same railway bridge when a selected train passes at a known speed. In this **semi-empirical approach**, the convolution of a series of Dirac delta functions and an empirical Green's function (EGF) obtained from a monitoring process is performed. Therefore, the methodology enables the simulation of new load and speed scenarios in a particular bridge so as to evaluate the response of the bridge to this new loading state.

Fragility Curves

This robust methodology generates fragility curves to analyse the behaviour of bridges based on a numerical procedure that is able to adapt and integrate the condition state of the bridge.

The workflow allows the generation of **fragility curves based on records of accelerations and displacements** via the use of Montecarlo simulations and probability density functions that characterise the displacement or acceleration.

The workflow is divided into two main phases: the identification of structural parameters from vibration measures and the development of state-dependent fragility curves.

Results

Fragility curves: Generic 1-span bridge simulation considering different parameters (damping, span, speed, train and dynamic model).

Empirical Green Functions: Comparison of real and simulated events for a S112 AVE at 200 kph in a 15 meters span bridge.

Next objective: Study of both methodologies combined together.

More information

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