FEM-based research on the dynamic response of a concrete railway arch bridge

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Abstract

The dynamic response of a concrete railway arch bridge is studied through a case study of the bridge over Kalix River, situated at Långforsen on the railway line between Kalix and Morjärv in northern Sweden. A simplified beam-element model, a spatial grillage-beam model and a refined shell-element model were built to analyze the bridge structure. A methodology was applied where measured static and dynamic responses were used to update finite element models of Långforsen Bridge. A multi-response objective function was presented, and the finite element method was proved feasible by comparison of predicted and measured response. In the paper comparative analyses were made of the time history displacement of three finite element models under three measured load cases. A standard train model from EUROCODE, HSLM-A 1, was applied and the dynamic responses under different speeds were studied. The results showed that a refined shell element model could accurately analyze dynamic responses of the concrete railway arch bridge in a better way than beam element and spatial grillage models. The dynamic analysis based on this type of shell model can give an optimized suggestion for the railway operation as well as for the design of high-speed railway bridges.

Keywords: Refined shell element model; Dynamic response; Moving load; Concrete railway arch bridge.

1 Introduction

Finite element method (FEM) is an achievement through comprehensive development and integration of multiple disciplines such as mechanics, mathematical physics, computational science, and computer technology, etc. It is a numerical simulation and analysis method used for structural analysis of large-scale structural projects which has been widely implemented in computer programs based on theory of structural mechanics and elasticity, and its application ranges from linear to non-linear, from static to dynamic [1].

Nowadays, there is a need to extend the life and capacity of many existing bridges, considering maintenance, upgrading, repair, and replacement

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