Dynamic Behavior Analysis of High-Speed Railway Bridges

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Summary

The design of high-speed railway bridges focuses more on the riding stability of the train rather than on problems relative to the structure of the bridge. In order to secure the riding stability of the train, the criteria to be satisfied are the displacement, and acceleration. For trains running at high speeds, resonance may occur according to the correspondence between the frequency of the excitation produced by the continuously applied wheel loads and the natural frequency of the bridge. Since very large responses may occur in such case, the verification of the dynamic response of the bridge with respect to the running speed of the train is essential. This paper overviews dynamic behavior analysis of high-speed railway bridges. The analysis example models a PSC box girder bridge, a Steel box girder bridge, and Steel arch bridges by means of shell elements, beam elements and spring elements, and performs frequency analysis and moving load analysis. The evaluation is preformed by comparison of dynamic responses with the design criteria through numerical modelling on bridges using finite element method and dynamic analyses of bridges subjected to moving forces. It examines the maximum acceleration and displacement responses in the wings and loading point of the cross-section at mid-length of the span according to the running speed of the train. Vertical displacements, accelerations, and deck twists of the bridges are compared with design criteria.

Keywords: Dynamic behavior, High-speed railway bridge, Moving load analysis, Dynamic analysis of the bridge, Dynamic stability of the bridge

1. Introduction

Running tests of high-speed train(named KTX) have being been performed on the lane which we designed and started to construct in the early. The bridge for high-speed railway is designed considering not structural safety of it but riding stability of the train, which is different with the case of normal highway bridge. The criteria relating with riding stability of the train are regulated on the displacement, the acceleration, the end-rotation, and the torsional rotation of the deck. When the frequency of the bridge is close to the one of repeated beat caused from passing wheels, the resonance of the bridge may be apt to occur, and then the responses of resonated bridge with high-speed train can become much larger than those of un-resonated bridge. Therefore it is necessary to evaluate dynamic behaviors of the bridge due to riding trains with high speed. This study was carried out using both the theoretical analysis mentioned above and the test performed in the real bridge for KTX. At the beginning of the design stage for the phase-1 construction of the Gyeongbu high-speed railway, a large variety of concrete bridge types were examined from prestressed concrete beam bridge, T-beam bridge, preflex bridge, slab bridge, PSC box-girder bridge to rahmen bridge, together with composite bridges for special sections. However, the dynamic stability investigation of the bridges subjected to running high-speed trains made it possible to narrow design to rahmen bridges for station zones, single PSC box-girder bridges for ordinary sections and

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