Dynamic Vehicle-Bridge Coupling Analysis with a Finite Element Model Based on Abaqus

Dong Yang, J.W.Zhang, Shoutan Song and Yongming Tu

Southeast University, Nanjing, PR China

Contact: 254619604@qq.com

Abstract

This paper builds bridge models using PYTHON language based on ABAQUS, embeds the vibration equation of vehicle model into the modeling and loading procedure of the bridge, and solves the vehicle equation by taking advantage of the numerical analysis ability of PYTHON. A single finite element software is utilized in the whole solving process, which avoids interaction call between different softwares. Zhai Algorithm explicit integration method is adapted to predict the vertical dynamic response in the next step according to the dynamic response (vertical displacement, vertical velocity) function of the vehicle and bridge in current analysis step. This method is able to calculate the interaction force between the vehicle and bridge in coupled vibration, improve the computing accuracy and reduce calculation work at the same time. The proposed analysis model is verified through an example with respect to coupled vibration.

Keywords: Vehicle-Bridge Coupling, ABAQUS, PYTHON, Separate iteration method.

1 Introduction

Coupled vibration analysis of vehicle-bridge structure, as a necessary part in the research on vehicle to bridge dynamic action and the influence of bridge vibration to traffic safety, is a key part in bridge design.

In the development of vibration analysis of vehicle-bridge structure, many models (such as static method, constant moving force method, moving harmonic method, moving mass block method and moving sprung mass method) were proposed[1]. There are two main analysis methods for vehicle-bridge coupling vibration currently: (1) Deriving the vibration differential equation of the whole vehicle-bridge system, in which the motion equation matrix changes at every time step. (2) Dividing the vehicle and bridge into two independent solving system and connect them with the displacement of wheeltrack. He Xia[2] developed a program for the analysis by the first method, whose advantage is the convenience of calculating without iteration at the same time step. Qi Li and Wanming Zhai [3,4] adapted the second method for the analysis, whose advantages are the available of nonlinear wheel-track interaction model and the invariability of motion equation during solving process. With the increasing of vehicle speed and complexity of bridge structures, requirements for the analysis technique of coupled vibration also improves, which can be developed by more sophisticated vehicle-bridge models and simplified analysis procedure. As finite element technology and large-scale structure analysis softwares have spread widely, it's a tendency to analyze vehicle-bridge system by taking advantage of universal finite element softwares. Yuhong Liang, Jianrong Yang et al. [5-8] analyzed vehicle-bridge coupling vibration by utilizing the interaction of ANSYS and external softwares, and Peiwen Jiang, Binmin

https://doi.org/10.2749/stockholm.2016.2479