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3D Seismic Response Analysis of VBI System

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【Background】

Japanese high-speed railway system: Shinkansen is playing an important role in domestic transportation, and it is important to secure the safety of the Shinkansen during earthquakes. Therefore, the responses of acceleration and relative displacement of vehicle-bridge interactions under seismic activities are simulated and discussed. Previous studies mainly consider this topic with the assumption that bridge material performs within its linear range. However, in order to simulate the situation in a more realistic condition, train dynamics and material non-linearity are into consideration and conducts simulations based on a commercial software Abaqus.

【Objective】

This research is aiming at obtaining a three-dimensional computer-simulation-based seismic response of high-speed train and bridge interaction system taking both material non-linearity and train dynamics into consideration. Also, whether the current design code taking train as pure mass is reasonable or not is discussed.

【Approach】

This study is based on two algorithms in numerical integration to solve vehicle-bridge interaction: HHT-α Method and Newton-Raphson Method. From these two algorithms, the time history of acceleration and relative displacement responses of the vehicle-bridge interaction system can be obtained. Then the responses under both moderate earthquake and strong earthquake are then compared with the results obtained from the reference model in order to find out the differences between them. And based on the differences, the possible reasons for such results are investigated and discussed.

【Results】

Results from simulations show that train acted as dampers in VBI system under seismic activities. And it is reasonable and conservative for the design code to take train as pure mass. However, further investigations have to be made in order to figure out the reasons of larger responses when train is taken as a dynamic system (train standing case) under strong earthquake.