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Graduate School of Engineering/Department of Civil and Earth Resources Engineering
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Seismic Performance and Vulnerability of Transportation Networks Subjected to Strong Earthquakes Considering Traffic Loading

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Nonlinear seismic analysis for vehicle–bridge interactive system

【Background】

Earthquakes have caused damage to transportation networks. Also, the inertial effect caused by live load due to earthquakes during traffic jam could not be negligible. However, design procedures do not consider the simultaneous presence of live load and earthquakes to be considered. For this reason, in urban areas where traffic congestion is a frequent occurrence, the adequacy of bridges to sustain strong earthquakes considering traffic loading has been under investigation. Few studies consider strong earthquakes and nonlinear behavior on vehicle-bridge interaction system.

【Objective】

This research aims to clarify dynamic responses of vehicle-bridge interaction (VBI) system during strong earthquakes by means of a developed platform to simulate various situations. This study also intends to provide information concerning how the effects should be included in the seismic design of bridges

【Approach】

Recursive Substructure Method was developed to simulate the dynamic interaction between the bridge and moving vehicles, incorporating the effect of nonlinear behavior, earthquake and road surface roughness. Bridge and vehicles were modelled in different software suite. The finite element (FE) bridge model was established in ABAQUS and moving vehicle model was established in MATLAB. The above two substructures were integrated and a recursive analysis scheme were controlled by a MATLAB algorithm.

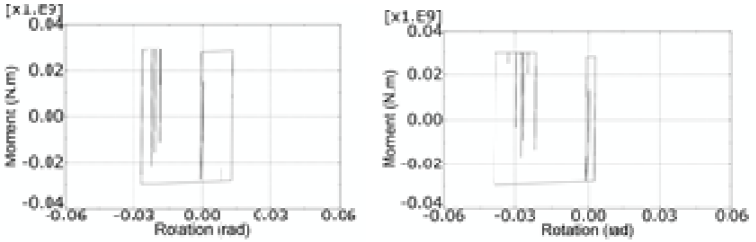
【Publication】

Sudanna Borjigin et al. Dynamic responses of an urban highway viaduct considering vehicle-bridge interaction under strong earthquakes. WCCM XII & APCOM VI, 24-29 July 2016, Seoul, Korea.

Sudanna Borjigin et al. Numerical investigations on dynamic responses of a highway bridge under moving vehicles subject to strong earthquakes. JSCE Annual Conference, 7-9 September 2016, Sendai.

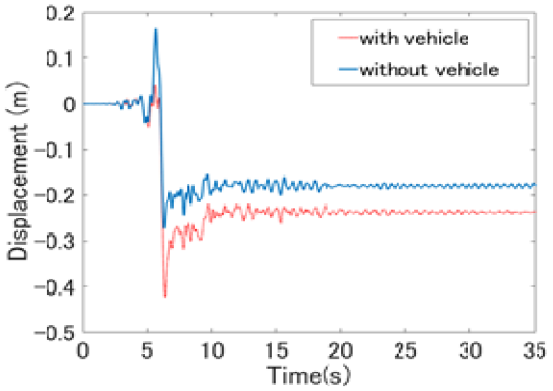
【Results】

It was observed that continuously moving vehicles might yield larger longitudinal displacement responses and plastic deformations than those of the bridge alone, implying that ignoring vehicle effects might be on the non-conservative side.



Without vehicle With vehicle

Hysteresis loop of plastic hinge



Longitudinal displacement of pier top