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VEHICLE/BRIDGE INTERACTION DYNAMICS FOR HIGH SPEED RAIL SUSPENSION BRIDGES CONSIDERING MULTIPLE SUPPORT EXCITATIONS

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ABSTRACT

A suspension bridge possesses an advantage in spanning valleys, rivers for its characteristics of long span. However, the suspension bridge may be subjected to multiple support motion in seismic zone. This issue would become an important role in affecting operation of high speed rail, especially for the running safety of a traveling train over it. As shown in Fig. 1, this study model the suspension bridge as a suspended beam and the train over it as a sequence of moving sprung masses. Then the total response of the suspended beam under ground motions can be decomposed into two parts: the *pseudo-static* response and the *inertia-dynamic* component, in which the *pseudo-static* displacement is analytically obtained by exerting the support movements on the suspended beam statically and the governing equations in terms of the *inertia-dynamic* component as well as moving oscillators are transformed into a set of nonlinearly coupled generalized equations by Galerkin's method.

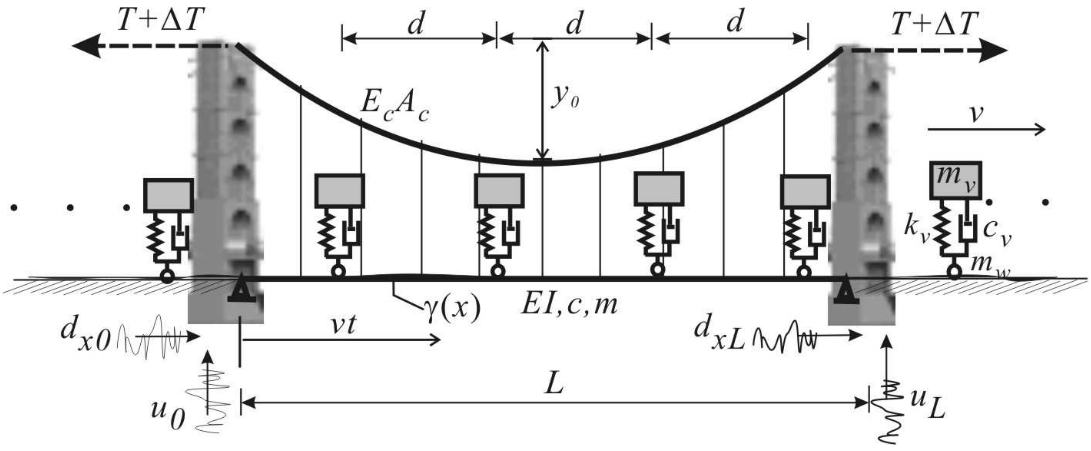
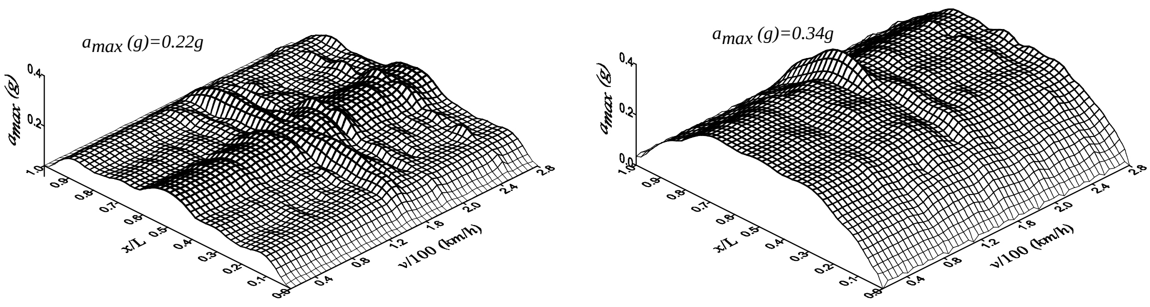


Fig. 1 Suspended beam under train loads and ground support motions

When conducting the dynamic response analysis of a suspended beam subject to moving vehicles and multiple support excitations, one needs to deal with nonlinear coupling vibration problems with time-dependent boundary conditions. Instead of solving the coupled equations for the *inertia-dynamic* generalized system containing *pseudo-static* support excitations and moving oscillators, this study treats all the nonlinear coupled terms as pseudo forces, and then solves the decoupled equations using Newmark's β method with an incremental-iterative approach that can take all the nonlinear coupling effects into account. Numerical investigations demonstrate that the present solution technique is available in conducting the dynamic interaction problem with support excitations. Moreover, the numerical demonstrations indicated that non-uniform seismic inputs may amplify the both responses of the suspended beam (see Fig.2) and moving vehicles (see Fig.3) over it significantly. Such an effect is often neglected by the assumption of uniform seismic ground motions in conventional design of bridge structures.



(a) (b)

Fig. 2 a_{max}-v-x/L plot: (a) vertical uniform support motion; (b) multiple support motions.

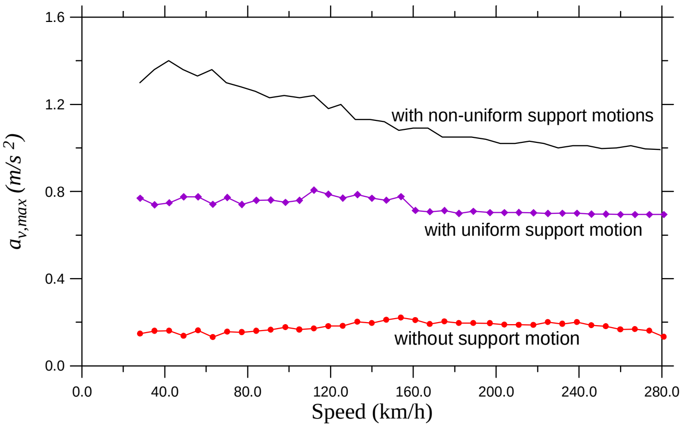


Fig. 3 Maximum acceleration of moving sprung masses.

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