Nonlinear dynamics of train-bridge interaction system under strong earthquakes

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【Background】

When a strong earthquake happens, bridge structure might suffer from severe damages and perform with nonlinear characteristics. However, seismic responses of the train-bridge interaction system in this condition ,in which the material non-linearity might occur, are not clear. In current design code, the train is simplified as additional masses. While in previous researches, several potential influential factors, the mass, springs and dashpot and running states, have been claimed that might affect seismic responses of the coupled system. However, influence from these factors have not been investigated in the nonlinear cases.

【Objective】

1. Clarify potential characteristics in seismic responses of the train-bridge interaction system under strong earthquakes considering potential material non-linearity;
2. Investigate and quantify the influence from potential factors, mass of the train, partial loading effect, springs and dashpots and the running state, on the bridge structure under strong earthquakes.

【Approach】

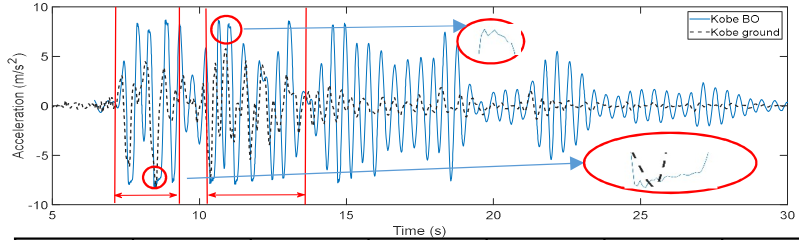
A series of finite element models were including both the bridge structure and train sub-systems as well as ground motions. Nonlinear elements were embed into the model for plastic hinge simulation. Characteristics in seismic responses and influence-evaluation were proposed through comparison between these models.

【Publication plan】

・One journal paper for the nonlinear bridge responses.

【Results】

Acceleration time history of the mid-span point of the bridge structure in a bridge-only model under the Kobe earthquake was shown in the upper figure. The lower figure shows the comparison of energy transfer comparison between the series of models.



		TR**	TS	PL	TM	BO
Total Input (× 10^6 J)	Whole	9.158	8.954	8.630	8.699	7.768
	Bridge	8.583	8.346	8.628	8.699	7.768
SE + KE* (× 10^6 J)	Whole	1.208	1.322	1.194	1.189	1.180
	Bridge	1.011	1.077	1.099	1.189	1.180
VD (× 10^6 J)	Whole	2.791	2.566	2.180	2.302	2.146
	Bridge	2.332	2.093	2.180	2.302	2.146
PD (× 10^6 J)	Bridge	6.241	6.243	6.437	6.366	5.593