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EFFECTS OF THE MULTI-SUPPORT EXCITATION ON LINEAR RESPONSE OF ONE-STORY BUILDINGS

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In dynamic analysis of buildings, a single ground motion is assumed for all structural supports. However, the shear wave velocity in soil has a limitation (175<Vs<750), which makes the abovementioned assumption doubtful.

The less shear wave velocity causes more difference between supports excitation. At large distances, in addition to the time delay, spatial variation is occurred in earthquake time history records (Zerva, 2008). Multi support excitation has been already considered for long span structures, such as bridges (Harichandran, 1999 and Ye Jihong et al., 2011), but not for regular buildings which is studied in this paper; the governing formula have been generalized to allow different prescribed motions at various supports and then effects of the multi-support excitation have been investigated on the buildings by the proposed formula. Time delay between records received by different supports is only considered and spatial variation is ignored. The shear wave velocity is considered as 200 m/s. Influence of considering multi support excitation on linear response of one-story buildings with 1- span and 3-spans are studied and it has been assumed that the supports are separated from each other and not connected by footing beam. The considered building has one storey with 3.2m height and one 5m bay. Mass of the roof is 9.93 ton, stiffness of the first and second columns are 165.5 N/m and 404.2 N/m. Stiffness of the columns are assumed different to raise the multi support excitation (MSE) effects, however, damping of the columns are assumed the same. Natural period of vibration of the system and damping ratio are 0.26sec and $\zeta = 5\%$, respectively.

Initially, the influence of MSE is studied for a synthetic record of $u_g=1-\cos(\omega.t)$; the frequency of this record is changed from 0.5 to 5 HZ. Damping ratio of the structure is also changed between 2% to 20%. Drift of each column is calculated for two cases. Case1: with MSE Case 2: without considering MSE. Ratio of the base shear of case 1 to case 2 and also ratio of the drift of each column are shown in Table1. The results show that considering MSE change the drift of the column up to 119% and also the base shear up to 39% (both for frequency of 0.5 hz). The obtained results show that influence of considering MSE is also sensitive to the structural damping ratio; for a single excitation of 1-cos (3.14t), considering MSE has increased the column drift up to 137% but decreased the base shear up to 6%. It is worth noting that column drift can be different from storey drift, regarding different excitation for each column base when considering MSE.

Effects of multi support excitation are also studied for real earthquake records. Column drifts of a single storey building is shown in Figure 1 for (Loma Prieta earthquake record (a sample of near field earthquake), compared with the case in which MSE is ignored; drift of the first column is increased 3%, but for the second column decreased 4%, when MSE is considered. The obtained results for AQABA earthquake (a sample of far field earthquake) are summarized in Figure 2; relative drift of the columns is decreased up to 6%, when MSE is considered. Therefore, ignoring MSE is conservative for this earthquake. In summary, it can be concluded that multi support excitation has a considerable influence on building response and thus cannot be ignored.

Table 1. Influence of excitation frequency and structural damping ratio on the effect of MSE

	Excitation Frequencies						Damping Ratio			
	0.5	**0.7**	**1**	**2**	**3**	**5**	**2**	**5**	**10**	**20**
Ratio* of column drift for C1	2.19	1.69	1.68	1.07	1.04	0.96	2.20	2.19	2.22	2.37
Ratio* of column drift for C2	1.07	1.15	0.92	0.94	0.93	0.94	1.18	1.07	1	1.05
Ratio* of Base Shear	1.39	0.97	1.14	0.98	0.96	0.95	0.98	0.97	0.96	0.94

*- *Ratio of Case 1 to Case 2*

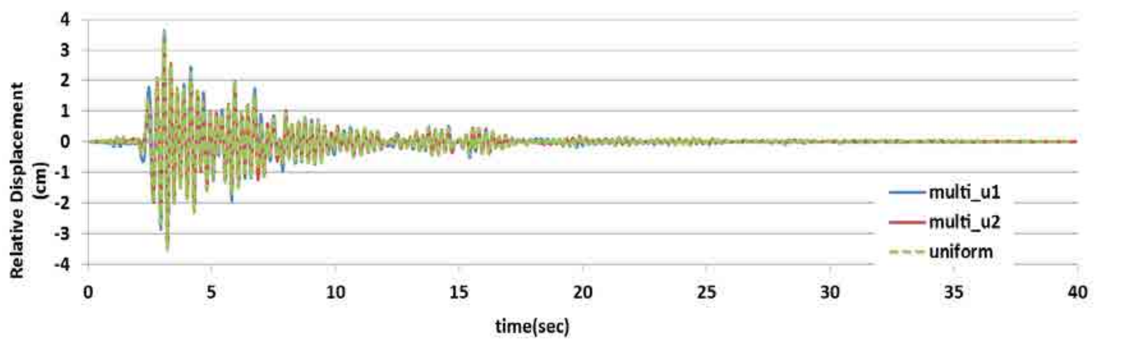

Figure 1. Influence of considering MSE for a near field earthquake (Loma Prieta-1989)

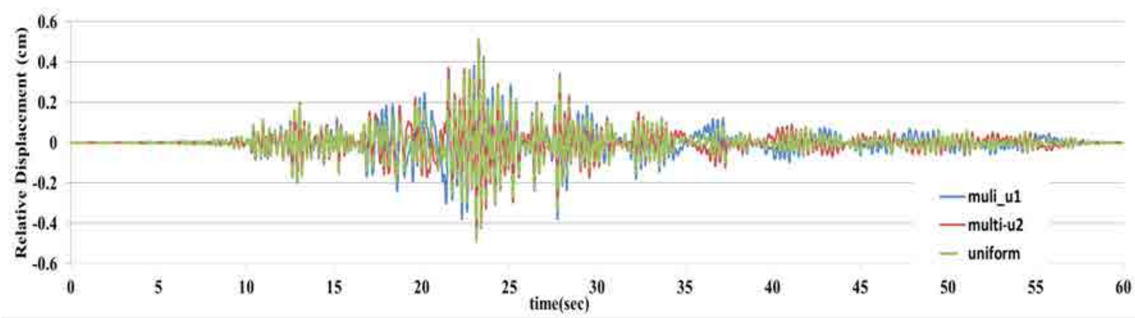

Figure 2. Influence of considering MSE for a far field earthquake (AQABA-1995)

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