EFFECT OF TIME INTERVAL BETWEEN PEAK HORIZONTAL AND VERTICAL RESPONSE OF SEISMIC COMPONENTS ON THE BEHAVIOR OF RC BUILDINGS

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Reinforced concrete buildings are generally subjected to three-dimensional earthquake ground motion. Recent studies, supported with increasing numbers of near-fault records, indicate that the ratio of peak vertical-to-horizontal ground acceleration can exceed the usual. With the considerable increase in near-fault strong ground motion records, and field evidence from earthquakes in two last decades, the considering importance of vertical ground motion has increased. Goswami and Chaudhuri (2012) and Papazoglou and Elnashai (1996) showed the significance of vertical ground motion and its destructive effects.

From past ground motion records, it has been observed that peak vertical and horizontal pulse may arrive at a coincident time of a time-history. However, the effect of such simultaneous arrival of

pulses on seismic response of RC buildings has not been investigated in detail. A few studies conducted so far have considered the arrival time of vertical and horizontal pulses and they come concluded that this coincidence influence the response of structures and cause high levels of distress in structural members. For this reason, it is important to study the relationship between the timing of peak response in the horizontal and vertical components of ground motion, i.e., the inclusion of realistic input motion in both vertical and horizontal directions is necessary. As can be seen from Figure 1, some records have significant vertical ground motion that occurs earlier than horizontal motion while the others exhibit a near coincidence.

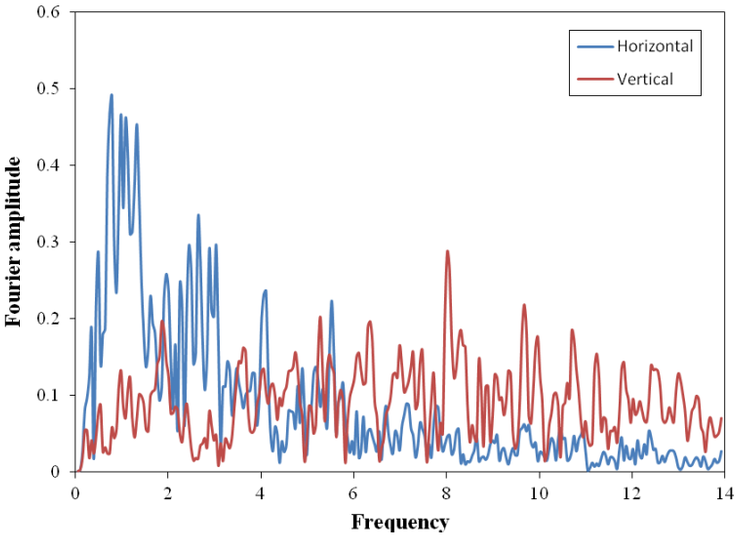

Figure 1. Comparison of Fourier spectra of vertical and horizontal ground motion

In this paper, the effect of time intervals between the arrival of vertical and horizontal peaks of given earthquake records are studied on the RC buildings.

The study by Collier and Elnashai (2001) indicates that horizontal and vertical ground motion peaks can be coincident when source distance is less than 5 km. Within 25 km from the source, the arrival time interval for most records is less than 5 sec. Thus, in this study, a total of 7 records were selected to cover a range of frequency content, duration and amplitude. These records come from earthquakes having a magnitude (MW) range of 6.2 to 7.3, and were recorded at closest fault distance of 0.0 to 7 km. Information pertinent to the ground motion data sets, including station, components of earthquake and peak ground acceleration (PGA) of vertical and horizontal components are presented in Tables 1.

Table 1. Near-fault ground motion database

	Earthquake	Year	Station	Distance (km)	M_w	PGA-H_{max} (g)	PGA-H_{min} (g)	PGA-V_{ert} (g)
1	Gazli (USSR)	1976	Karakyr	5.46	7.1	0.718	0.608	1.264
2	Imperial Valley	1979	Bonds Corner	2.68	6.4	0.755	0.588	0.425
3	Morgan Hill	1984	Coyote Lake Dam	0.30	6.2	1.298	0.711	0.388
4	Erzican (Turkey)	1992	Erzincan	4.38	6.8	0.515	0.496	0.248
5	Landers	1992	Lucerne	2.19	7.3	0.785	0.721	0.818
6	Northridge	1994	Rinaldi Rec Stn	6.50	6.7	0.838	0.472	0.852
7	Kobe (Japan)	1995	KJMA	0.96	6.9	0.821	0.599	0.343

The specified arrival time was achieved by shifting the horizontal record along the time axis and original recorded V/H ratios were maintained throughout the arrival time study.

The effect of arrival time interval on the period of vibration, ductility demand, and internal forces in structural members was studied by comparing against results from the case of the coincident vertical and horizontal peaks. The results show that the horizontal period is more elongated when the time interval is small. It can observe from results that mean ductility demand of the late arriving pulse motions is higher compared to the mean demand of the early arriving pulse motions.

The results show that the contribution of vertical ground motion to the axial force variation tends to be reduced as time interval increases. Shear capacity of critical columns tends to decrease due to vertical ground motion. Changes in arrival time interval have no clear correlation with moments of critical columns and lateral displacement. The arrival time interval has a rather important effect on the shear capacity.

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