EFFECT OF BIDIRECTIONAL NEAR FIELD GROUND MOTIONS ON INELASTIC RESPONSE OF 3D MODELED RC FRAME BUILDINGS

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Investigations confirm that near field ground motions differ from far field ground motions in amplitude as well as frequency content. Yet seismic regulations have not properly taken the effect of near fault ground motions into account. On the other hand, since many cities (specially in Iran) have been developed close to seismic sources and in high earthquake zones, building structures near seismic sources and therefore evaluating their behavior subjected to near field earthquakes is inevitable. In the vicinity of seismic sources, depending on different rupture mechanisms, fling step and forward directivity pulses are likely to appear in either the fault normal or fault parallel components of the horizontal ground motions. Various scenarios can be formed, due to different faulting mechanisms.

Throughout the years a vast number of studies in the near field area have been conducted on 2-dimensional model of structures, and hardly any studies have been conducted on 3-Dimensional nonlinear models of structures that take the near field effects into account. A 2-dimensional analysis might cause some error due to the approximation and presumptions in mass, stiffness and etc.; while a 3-D model can reduce this kind of modeling related errors and better take into account the real behavior of a building. From another point of view, a 3D model which is imposed by bidirectional nonlinear time history analysis can also verify whether the results obtained from 2-D models under one directional time history analysis can be reliable, or not.

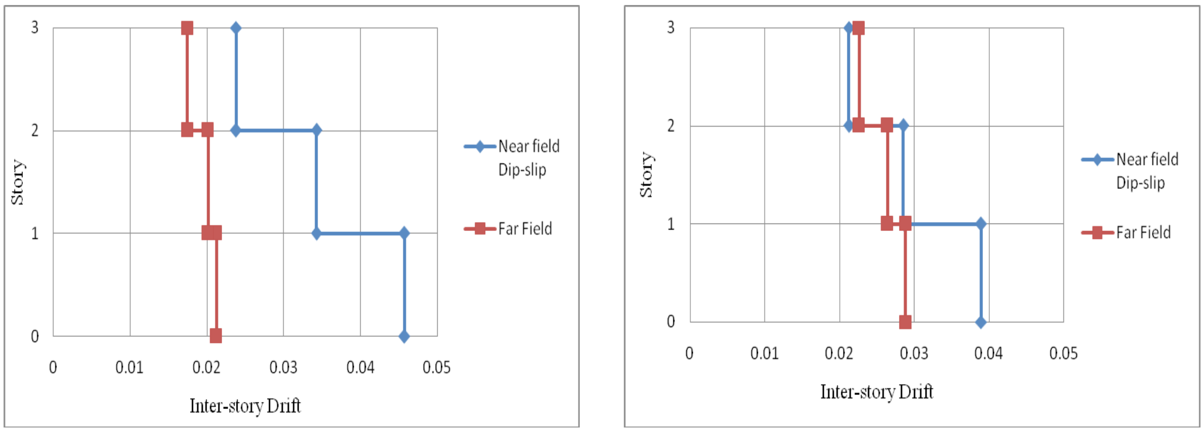
The main objective of this study is to investigate near-fault ground motion with forward directivity effects on the seismic behavior and inelastic response of 3D concrete frame buildings with various fundamental periods. The same buildings will be subjected to far field ground motions as well, and responses of the two cases will be compared to each other to form a better notion of the difference between a structure's behavior under near and far field ground motions this purpose, three typical buildings have been designed according to ACI Committee 318 (1999) and FEMA-356 (2000a) and then have been modeled in 3D in OPENSEES. The buildings have been subjected to two horizontal components and a vertical component of records of previous earthquakes and through nonlinear time history analysis, and by taking the maximum inter-story drift ratio as a measure of seismic demand; seismic behavior of the structures in near field will be evaluated and compared to that of far filed earthquakes. The buildings have a 20-m-square plan, which is consisted of 4, 5 meter bays in Y direction and 5, 4 meter bays in X direction; they are 3, 6 and 9 stories and have been chosen so as to cover a reasonable range of periods. Table (1) shows the fundamental periods of each building obtained from OPENSEES.

Table 1. Fundamental periods of modelled structures in X and Y directions

No.	Model	X-direction period	Y-direction period
1	3 Story	1.07	0.97
2	6 Story	1.54	1.44
3	9 Story	1.95	1.83

The ground motion database considered for this study includes 2 sets of near field which contain forward directivity pulse, one from dip-slip fault mechanisms and the other strike-slip, and a set of far field records, each set containing 7 ground motions. These records have all been chosen and scaled to the MCE spectrum of ASCE07-10 according to scaling regulations of ASCE07-10.

For each building, 21 nonlinear time-history (NTH) simulations have been conducted, 7 NTH analyses for each scenario and the mean of maximum inter-story drift ratio of the 7 NTH analyses is used as a measure of seismic response. As an example, results from NTH analyses conducted on the 3-story building for far-fault ground motions and near-fault ground motions from dip-slip faults are obtained and mean of maximum inter-story drift versus story level curves for the aforementioned scenarios are presented in figure 1.



(a) X-direction (b) Y-direction

Figure 1. Mean of maximum inter-story drift for 3-story building in X and Y direction

It should be noted that in near field ground motions, buildings are subjected to fault normal ground motions in X-direction and fault parallel ground motions in Y-direction. Noticeable difference is observed both in peak inter-story drift patterns, values and the story that experiences the maximum peak inter-story drift. As it is expected, the studied buildings show lesser inters-story drift capacity in comparison with those reported elsewhere from 2D analysis. The P-M2-M3 interaction effects on derived responses are more significant from 2D models. The conclusion inferred from current study emphasizes the need to use 3D models instead of 2D, where the influence of near field record is investigated.

REFERENCES

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