8th International Conference on Seismology & Earthquake Engineering
11-13 Nov. 2019, Tehran, Iran

NOTES ON PROGRESSIVE COLLAPSE ANALYSIS OF MODULAR MOMENT FRAMES UNDER DIRECTIONAL EFFECTS OF PULSE-TYPE GROUND MOTIONS

Erfan ALGHASI
M.Sc. Student, Kharazmi University, Faculty of Engineering, Tehran, Iran
erfan_alghasi@yahoo.com

Afshin MESHKAT-DINI
Assistant Professor, Kharazmi University, Tehran, Iran
meshkat@khu.ac.ir

Jafar KEYVANI GHAMSARI
Associate Professor, Kharazmi University, Tehran, Iran
jkeyvani@khu.ac.ir

Keywords: Framed structure, Progressive collapse, Incident angle, Velocity pulse, Nonlinear dynamics

In recent years, seismic design of structures has been accompanied by global changes in conceptual criteria from the resistance lemma to the performance subjects. The most notifications related to performance concepts are essentially categorized in; 1- The design and evaluation of structural seismic demands, 2- The characteristics of earthquakes and their effects on the code-design structures. The main purpose in codified structural designation is achieving to the enough strength and stiffness capacities which to keep the structure stable under the most critical loading conditions over its lifetime. Hence, the critical members whose destruction causes general or local progressive failure modes in the resistant skeleton, should be taken into consideration accuratly. In this research, the basic seismic performance parameters of a code-design steel structure with modular moment frame skeleton under the directional effects of near-field earthquakes have been studied. Moreover, the structural stability conditions exposed to seismic tremors and the viewpoints of probable progressive collapse phenomenon have been investigated. This research results were numerically obtained through conducting several nonlinear dynamic time history analyses. In this regards, four incidence angle circumstances related to the imposing azimuth of earthquake records as well as three types of member removal configurations have been supposed and applied to the 20-story studied structure. All of the aforementioned inelastic structural analyses were run using SAP2000 software. The studied structure was designed according to the Iranian Standard 2800 (4th Ed.) as well as the sixth and tenth issues of the Iranian national building regulations.

The ensemble of the selected records includes a group of strong ground motions which were registered in near-fault zones and contain strong rupture directivity effects. This ensemble includes the main ground quake related to the Bam 2003 earthquake tremor in Iran as well as two strong record SCS and SYL due to the Northridge 1994 earthquake in southern California. All of these three-component records were imposed as free-field tremors to the studied structure at incidence angles of 0°, 15°, 30° and 45° respectively. Nearfield records often contain coherent pulses in the velocity time history which can cause serious damages to structures. The existence of distinct velocity pulses in the time history of strong records is considerably justified on the basis of rupture directivity process (Najafi et al., 2013; Hayden et al., 2014). Progressive collapse process is a dynamic consecutive phenomenon that usually causes large structural deformations. The analytical implementation of progressive collapse process under seismic loading is usually accompulished based on conducting nonlinear dynamics analyses corresponding to some assumed member removal cases (Gurley et al., 2008). One of the most important viewpoints which obtained via progressive collapse analyses is that any probable final structural failure would not be proportional to the initial failure mode occurred in the resistant skeleton. For this purpose, it needs to determine the member removing function and define the member removal locations. These subjects have been considered in this research as illustrated in Figure 1.

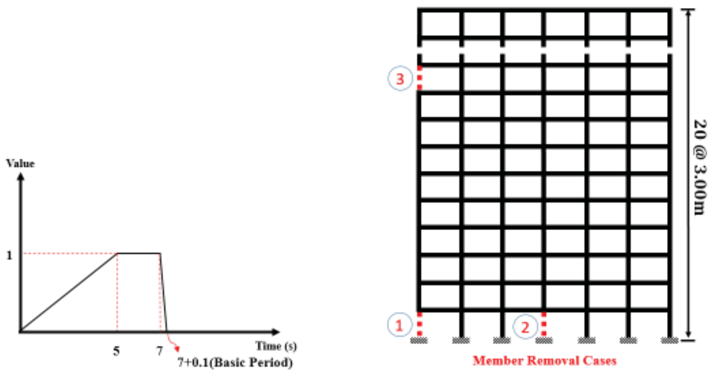

Figure 1. The member removing function and the member removal cases considered for the studied structure.

Regarding the maximum lateral drift charts subjected to the Bam 2003 record (Figure 2) it can be seen that the relatively maximum values occurred more or less near the middle height levels of the studied structure. The maximum lateral drift demands are due to the imposed earthquake record under the incidence angle of 0°. Figure 3 illustrates the height-wise variations of the maximum rotation of the corner columns. The numerical amplitude of this response parameter has almost been obtained under the load case with incidence angle of 0°. Moreover, for different states of assumed member removals the values of this response parameter have a slight difference.

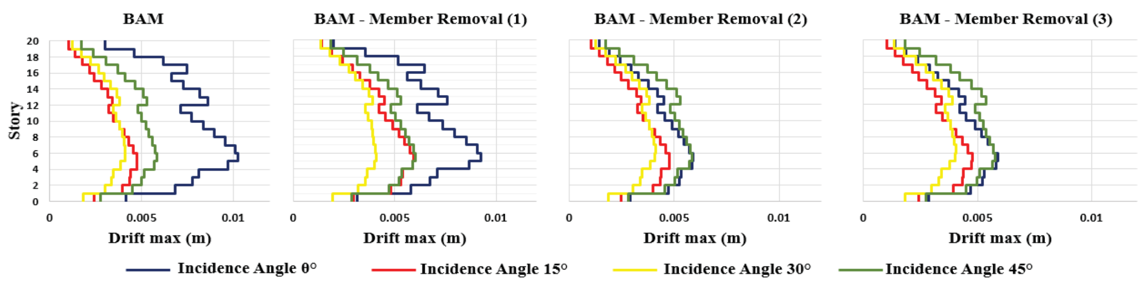

Figure 2. The maximum lateral drift demand due to different member removals and earthquake incidence angles.

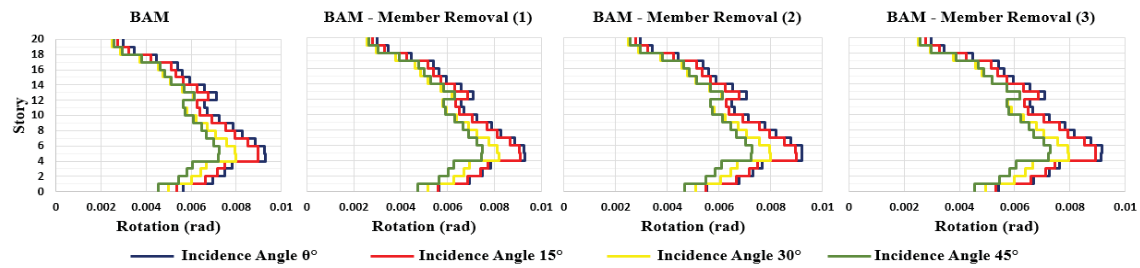

Figure 3. The maximum rotation demand due to different member removals and earthquake incidence angles.

REFERENCES

Computers and Structures (2000). SAP2000, Integrated Structural Analysis and Design Software. Berkeley, CA.

Standard No. 2800 (2014). *Iranian Code of Practice for Seismic Resistant Design of Buildings* (4th Ed.).

Iranian National Building Code (2014). *Design Loads for Buildings - Issue 6*, Tehran, Iran.

Iranian National Building Code (2014). *Steel Structures - Issue 10*, Tehran, Iran.

Najafi, L.H. and Tehranizadeh, M. (2013). Evaluation of seismic behavior for moment frames and eccentrically braced frames due to near-field ground motions. *Asian Journal of Civil Engineering (BHRC)*, *14*(6), 809-830.

Hayden, C.P., Bray, J.D., and Abrahamson, N.A. (2014). Selection of near-fault pulse motions. *Journal of Geotechnical and Geo-Environmental Engineering*, *140*(7).

Gurley, C. (2008). Progressive collapse and earthquake resistance. *Practice Periodical on Structural Design and Construction*, *13*(1), 19-23.