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EFFECT OF ROTATIONAL COMPONENTS OF STRONG GROUND MOTIONS ON NONLINEAR RESPONSE OF HIGH-RISE 60-STORY BUILDING WITH OUTRIGGER AND BELT-TRUSS SYSTEM

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As population increases and cities spread, it is necessary to use the land efficiently. High-rise buildings are an appropriate and economical solution to accommodate the population for living and work in a small space of the land. In addition to their magnificence and their contribution to the aesthetics of the city, these buildings can help urban planners as well.

Outrigger and belt-truss system is one of the accepted system for construction of high-rise buildings among many other applicable structural systems. The first building built with this system was the First Wisconsin center in Milwaukee, US, which is built in 1974 with the steel material. This building has 42 stories with 183 m height (Kheyroddin & Aramesh, 2015). High-rise buildings are required to be designed precisely and comprehensively due to their importance and strategic position. In order to design the structures properly, the loads on the structures must be fully identified and considered in the design procedure. The earthquake has six components in reality which three of them are transitional and three are rotational. During an earthquake, rotational components are usually combined with transitional components; however, these components are usually neglected. It has been years since ground motion records are identified to have six-components; nevertheless, this fact is usually neglected in the design of the structures (Suryanto, 2006). In this study, a 60-story steel structure with bracing core, outrigger and belt trust system in different heights of the structure is subjected to three-component and six-component nonlinear time history analysis from far-fault ground motions, near-fault ground motions with forward directivity and near-fault ground motions with fling step. In order to select structural properties such as specifications in the plan, height (Figure 1), and the reports of high-rise building constructions are used (ASCE, 2010; Habibullah, 2015). The elastic response of applied earthquake records to the structure is also shown in Figure 2. Moreover, Figure 3 illustrates the distribution of drift ratio index in different stories in the subjected building.

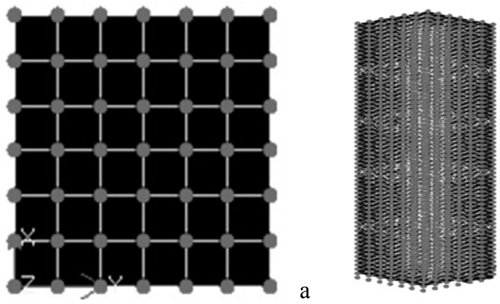

Figure 1. (a) Plan and (b) Three-dimensional view of the final 60-story building model with OpenSees Table 1 the sections used in different stories of the 60-story building.

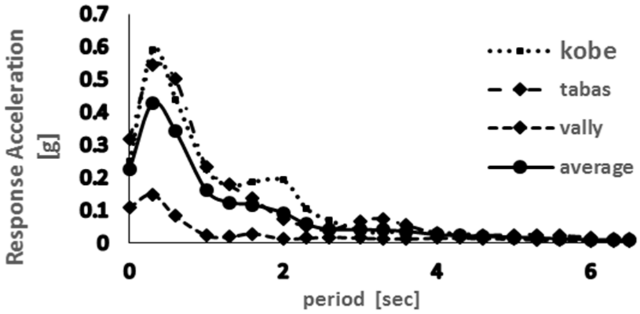

Figure 2. Elastic response spectra in far field ground motion.

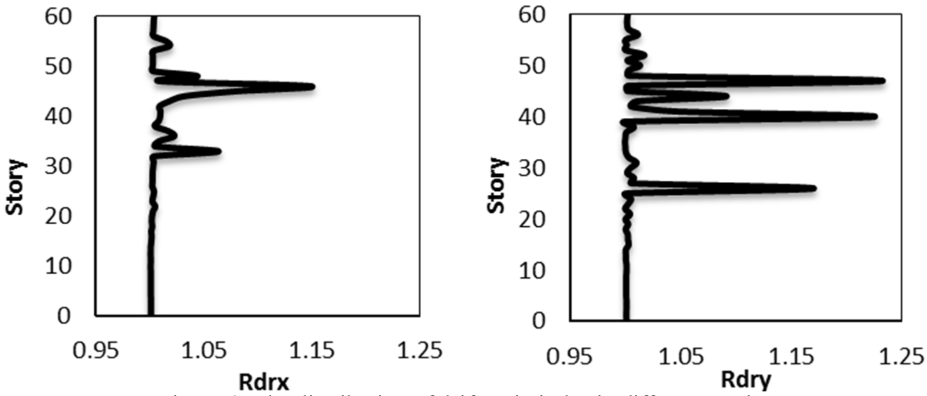

Figure 3. The distribution of drift ratio index in different stories.

It can be understood from this paper that six-component analysis can increase the responses of the structure in comparison with three-component analysis. The effect of rotational components on the responses is much more in near-fault ground motions in comparison with far-fault ground motions.

REFERENCES

Kheyroddin, A. and Aramesh, S. (2015). *Lateral Resisting systems in Tall Buildings*. Semnan University of Technology, 70-240 (in Persian).

Suryanto, W. (2006). *Rotational Motions in Seismology: Theory and Application*. Dissertation, LMU München: Faculty of Geosciences.

American Society of Civil Engineers (2010). *Minimum Design Loads for Buildings and Other Structures*.

Habibullah, A. (2015). *ETABS-Three Dimensional Analysis of Building Systems, User's Manual*. Computers and Structures Inc. Berkeley, California.