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SIESMIC PERFORMANCE OF REGULAR AND IRREGULAR BRB FRAMES UNDER SEISMIC SEQUENCE

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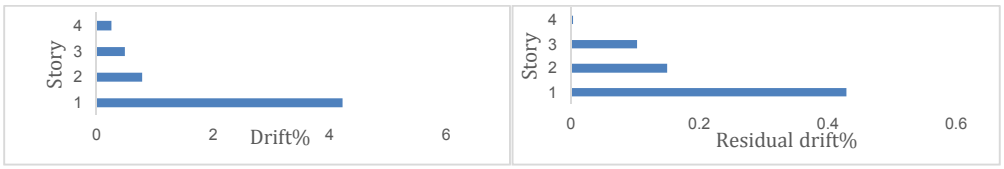
INTRODUCTION

The Buckling-restrained braces were introduced in 1989 for the first time, in which compression buckling of bracing could be avoided by its confinement (Kersting et al., 2015). Buckling-restrained braces yield in tension and compression, and show an ideal hysteretic behavior (Sabelli et al., 2003). However, these braces have a low post-yield stiffness, which can lead to large permanent deformations or occurrence of soft story during a seismic sequence. This also can be intensified by irregularity of the structure. Chen et al. (2015) showed that earthquake influence coefficients for irregular frames are larger than values of the design code. On the other hand, recently it is proved that seismic sequence is a phenomenon that can cause more extensive damages in comparison to mainshock only. The key parameter for structures to withstand against aftershocks is residual drift under mainshock (Tesfamariam & Goda, 2015). In this study, behavior of regular and irregular frames with BRB under seismic loads has been investigated. Eight 4-, and 8- story frames have been modeled. Time history and incremental dynamic analysis were analyzed for structures. Next, response of these structures under seismic sequence is investigated.

TIME HISTORY ANALYSIS OF THE MAINSHOCK

Firstly, nonlinear time history analysis has been used in order to determine the average distribution of interstory drifts in structural frames that 22 far-field earthquake records recommended by FEMA-P695 (ATC, 2009) have been used here. The results show, in four-story frames, the maximum interstory drift has occurred on the first story. Also, in irregular structures, the maximum drift and the maximum residual interstory drift of the first story is much higher than that of the higher stories.

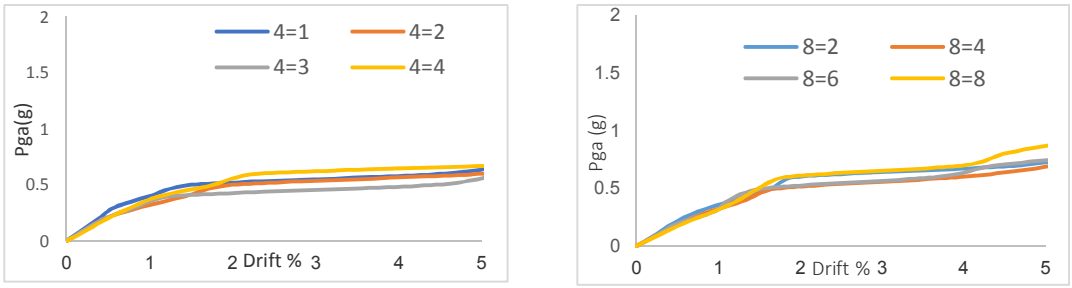


a) The maximum interstory drift b) Residual interstory drift

Figure 1. Time history curves of the frame 4-1 under mainshock.

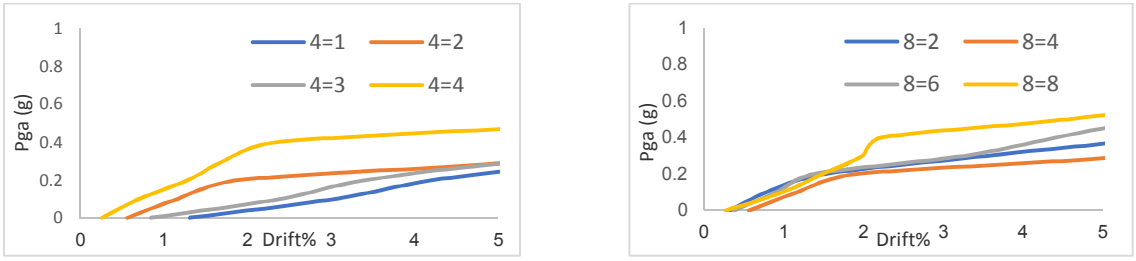
INCREMENTAL DYNAMIC ANALYSIS UNDER MAINSHOCK AND UNDER SEISMIC SEQUENCE

The main goal of this method is to obtain structural responses for different values of the seismic intensity and different aftershock intensities, and the results of this analysis are presented as IDA curves. For this purpose, 22 far-field earthquake records recommended by FEMA-P695 are used for analysis under mainshock. In general, record characteristics of mainshock and aftershocks within the same sequences are different (Ruiz-García, 2012; Goda, 2015). On this basis, many studies have used a randomized approach using the same bin of ground motions for mainshock and aftershock (Hatzigeorgiou, 2010; Hatzigeorgiou & Liolios, 2010; Ruiz-García & Aguilar, 2017). Therefore, a randomized artificial approach is used here and the records are selected randomly from those 22 records. To achieve a general state of structural behavior and to reduce information dispersion, the concept of median is used in this section. Figure 2 shows that performance of irregular four story frames is lower than that of the regular frame. In eight-story frames 8-4 and 8-6 have weakest performance. Also figure 3 shows that among the four-story irregular frames, the frame with irregularly in the middle section has a better performance than other irregular frames under MS-AS. It is also observed that the regular four-story frame performs much better than irregular frames with the same number of stories. For eight-story frames, it becomes clear that all eight-story irregular frames collapse at an almost the same PGA under MS-AS, while the regular frame can withstand twice seismicity.



a) 4-story structures b) 8-story structures

Figure 2. IDA curves of the structures under mainshock.



a) 4-story structures b) 8-story structures

Figure 3. IDA curves of the structures under seismic sequence.

CONCLUSION

In this paper, the performance of regular and irregular structures with BRB braces was investigated. First, a nonlinear dynamic analysis was conducted. Then, using the incremental dynamic analysis, the seismic performance of the structures was investigated. According to the results of the analyses it can be concluded that irregularity in height can significantly affect performance of the structure. However, taller irregular structures are more affected in seismic sequence. Results showed that 8-story regular structures can tolerate around twice interstory drift compared to irregular ones. Also it can be concluded that the residual drift from the mainshock has a great influence on the behavior of the structures under the aftershock which irregularities are exacerbated that.

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