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THE ASSESSMENT OF THE SEISMIC PERFORMANCE OF THE RC BUILDINGS HAVING ONE OR TWO SOFT-STORIES RETROFITTED WITH GAPPED INCLINED BRACING

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Aghabeigi et al. (2015) introduced a new method called gapped inclined bracing (GIB) for retrofitting the old buildings with a first soft-story issue. The basic idea behind this method lies in trying to concentrate the seismic demands at the first story where it plays the role of an isolator story and consequently the rest of the stories are displaced as a rigid mass. The GIB element as it is shown in Figure 1 is a gapped bracing connected to the two sides of the columns of the first story. While the structure is at rest, the gap is open and does not affect the overall performance of the system. However, as the lateral displacement exceeds a critical value the gap is closed and subsequently cooperates in withstanding the lateral and gravitational forces exerted by the upper stories (Beigi, 2014). Since the distance between the column bases and these elements' joint with the beams are as low as 0.5 m, this system is able to enhance the performance of the structures without wasting much of the usable space between the adjacent columns.

This method's effectiveness in the reduction of the earthquake demands on old RC buildings has been assessed on by Aghabeigi et al. (2014). Moreover, they have also performed the cost-benefit analysis to determine the applicability of this method (Beigi et al., 2016).

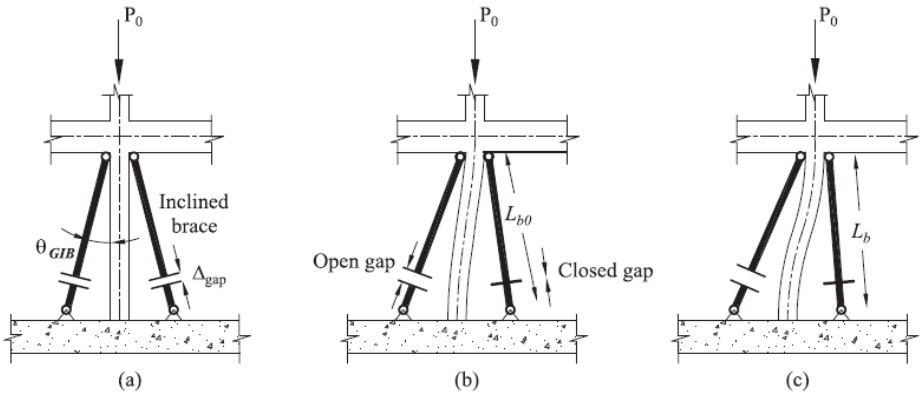

Figure 1. The Gapped Inclined Bracing (GIB) System on the existing columns a- Initial stage b- the gap closing stage c- the final stage (Beigi et al., 2014).

The main purpose of this research is to investigate the adequacy of this system for improvement of the seismic performance of RC buildings with soft stories without altering their good features. In order to accomplish this, three 2D RC intermediate moment frames with 4, 8 and 12 stories designed according to the latest Iranian seismic code No. 2800 which display soft-story mechanism are considered. The lumped plasticity model of Ibarra-Medina-Krawinkler (Haselton & Center, 2008) model in OpenSEES software (Mazzoni et al., 2006) is used to model the structures and the pushover analysis, as well as Incremental Dynamic Analysis, is performed to investigate their near-collapse behavior.

To circumvent the shortcomings of the Aghabeigi's method for design of these elements concerning ductile structures,

a new method of design is developed here and its effectiveness is verified using sensitivity analysis. Figure 2 depicts the fragility curves estimated using the PEER (Ramirez, 2009) methodology for different structures and the effect of using GIB system on the likelihood of side-way collapse. It's seen that structures having a soft story at the 1st level retrofitted by GIB exhibit a significant reduction of collapse probability even compared to the fully-infilled structure. It's seen that adding the GIB system to a structure possessing two soft-stories located at the 1st and 2nd levels has improved the original system's margin of collapse drastically.

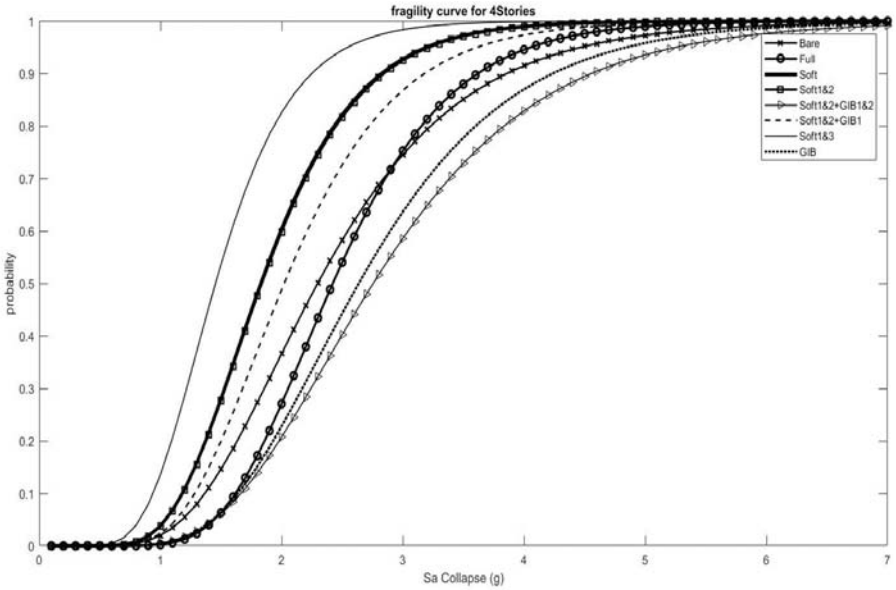

Figure 2. The Fragility curve of the 4-story structures.

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