DEVELOPMENT OF A MECHANISTIC MODEL TO EVALUATE SOFT STOREY PHENOMENON IN REINFORCED CONCRETE (RC) 2D FRAME WITH INFILL MASONRY WALLS

S. Shrestha[1], K. Timsina[2], C. K. Gadagamma[3]

[1] *Graduate Student, Department of Structural Engineering, AIT, Pathum Thani, Thailand*
Email: snehashrestha1997@gmail.com
[2] *PhD Student, Department of Civil Engineering, The University of Tokyo, Japan*
Email: ktimsina051@gmail.com
[3] *Assistant Professor, Department of Structural Engineering, AIT, Pathum Thani, Thailand*
Email : chaitugk@ait.ac.th

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1. INTRODUCTION

During earthquakes, soft storey buildings collapse on the open floor due to a sudden reduction in stiffness on that floor. Various retrofitting techniques are implied to improve the performance of these buildings however these methods are not economically feasible.[1] On the other hand, the solutions suggested by many building codes or indices do not give a satisfactory level of performance.[2] In this paper, a mechanistic model, which can identify the extent of the damage of an existing soft story building is defined as an index defined by authors as a soft story index (SSI).

2. METHODOLOGY

A mechanistic model is developed as SSI to identify the extent of Damage for a given performance in an existing soft storey frame. Equation (2.1)

$$SSI = \frac{f_s\,(\delta_{s,i}, p)}{f_B(\delta_{s,i}, p)} \qquad (2.1)$$

Where, SSI is soft storey index defining given damage state of a frame, f_S & f_B are the given Natural frequency of a given damage subject structure and baseline structure, $\delta_{s,i}$ is the inter-storey drift ratio, p is the given qualitative performances.

3. RESULTS AND DISCUSSION

The hypothesis was tested using static pushover analysis (SPO) and incremental dynamic analysis (IDA) [3] which established a relationship between qualitative performance and inter-storey drift.

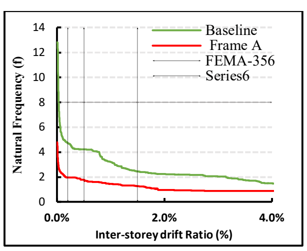

Fig 1 SPO

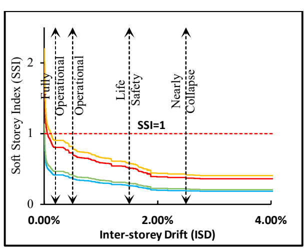

Fig 2 Normalized Performances Level

According to Fig. 1, baseline frame performs five times better than Frame A. Normalizing Frame A in comparison to baseline frame, each performance level based on FEMA-356 of the frame could be increased by the amount of improvement necessary at each performance level to achieve the necessary performance to act like baseline frame performances, as shown in Fig. 3 for life safety performances. Performances of the frame are shown in Fig. 4 at various earthquake intensities; the proposed approach is successful in enhancing the performances for soft storey structure.

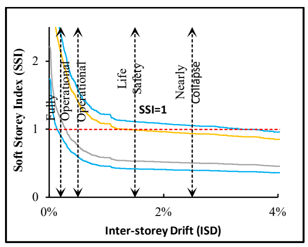

Fig 3 SSI Performances Level

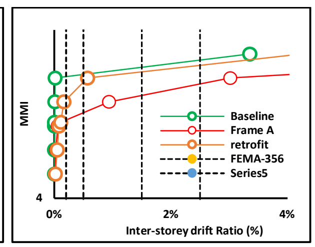

Fig 4 IDA

4. CONCLUSION

We retrofitted the frames, raised their performance level to life safety (FEMA-356) while considering SSI, and then used IDA to examine their dynamic responses. According to these results of a study, performance will improve when using the SSI, depending on the degree of soft story frame improvement needed. With the necessary level of performance attributed to the suggested SSI, retrofitting will become both economically feasible and sustainable.

REFERENCES

[1] K. Timsina, C. G. Krishna, and K. Meguro, "Sociotechnical Evaluation of the Soft Story Problem in Reinforced Concrete Frame Buildings in Nepal," *J. Perform. Constr. Facil.*, vol. 35, no. 4, p. 04021019, Aug. 2021, doi: 10.1061/(ASCE)CF.1943-5509.0001582.

[2] E. DiPasquale and A. S. Cakmak, "On the relation between local and global damage indices," p. 82.

[3] D. Vamvatsikos and C. A. Cornell, "Incremental dynamic analysis," *Earthq. Eng. Struct. Dyn.*, vol. 31, no. 3, pp. 491–514, Mar. 2002, doi: 10.1002/eqe.141.