Seismic Capacity Comparisons of Reinforced Concrete Buildings with Various Ductility by Incremental Dynamic Analysis.

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Summary

This study applied the concept of equivalent single degree of freedom (ESDOF) for evaluating the seismic performance of the studied building by the mean of incremental dynamic analysis (IDA). The results found that this ESDOF method can reduce about 93% of the computational time. This study also found that the lateral load capacity of gravity load designed (GLD), intermediate ductile frames (IDF), and special ductile frames (SDF) building was 16.64, 23.63, and 23.56%W, respectively. The average response spectrum at the collapse state for GLD, IDF, and SDF are 0.53 g, 0.77 g, and 0.80 g, respectively.

Keywords: Seismic capacity; incremental dynamic analysis; reinforced-concrete buildings, SAP2000.

1. Introduction

Many researches were studied on non-linear analysis of reinforced concrete framed structures subjected to earthquake excitations. As a consequence, several researchers and designers are interested in nonlinear static (pushover) analysis more than nonlinear dynamic (time history) analysis (NTHA) of multi-degree of freedom structure (MDOF), because the later procedure required a lot of resources and time-consuming. To reduce analysis times of NTHA of the MDOF, a non-linear static (pushover) combined with NTHA of equivalent single degree of freedom (ESDOF) is applied. FEMA-P440A (2009) investigates the effect of stiffness and strength degradation on the seismic response of the structures by using concept of ESDOF.

The new standard for the building design under seismic loading in Thailand DPT 1302-52 (2009) define three types of moment frames systems, namely, ordinary moment frames, intermediate ductile frames and special ductile frames (OMF, IDF and SDF, respectively). This study aimed to evaluate and compare the performance of moment resisting frames with various detailing. Three 5 storey dormitory buildings, namely, SDF, IDF and GLD are designed according to DPT 1302-52 and detailing by the provisions of UBC 1997 and DPT 1301-50 (2007).

2. Analysis method

A computer-intensive procedure that offers demand and capacity prediction capability by using a series of nonlinear dynamic analyses of ESDOF under suitably 20 multiplied scaled ground motion. Analytical models of buildings are developed using nonlinear finite element program SAP 2000. This study involves seismic performance and evaluations of 5-storey dormitory buildings which

have different structural detailing, i.e., SDF, IDF and GLD with and without infill wall (Figs. 1 and 2). The analytical models used in this study emphasize on the plastic hinges (PHs) in beams and columns. Three types of PHs were studied include shear failure, flexure to shear failure, and flexure failure. The initial stiffness of PHs in beam-column joints was considered as a part of the column.

3. Results and conclusions

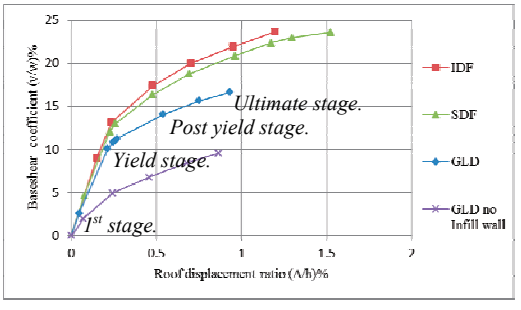
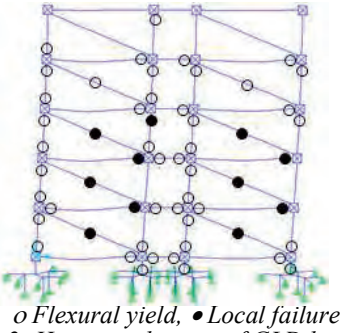


Fig. 1: Capacity curve of 5-storey buildings with various ductility.



o Flexural yield, • Local failure
Fig. 2: Hinge mechanism of GLD building at ultimate stage

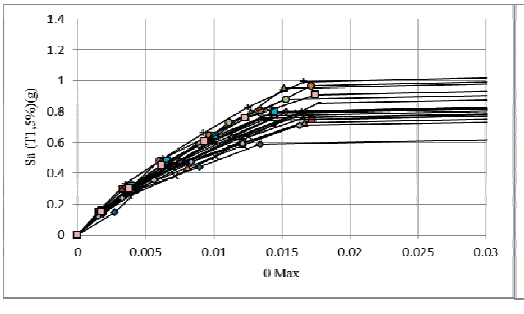


Fig. 3: All twenty IDA curves for IDF buildings.

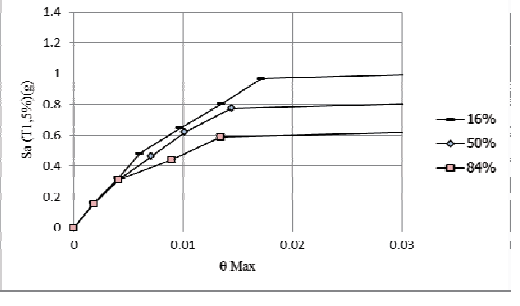


Fig. 4: 16%, 50% and 84% fractile curves for IDF buildings.

Based on this study, seismic performance for all buildings can be explained as follow:

(1) From pushover curve, GLD building with infill wall can increase the maximum capacity reach to 73.8%, compared with GLD building without infill wall (Fig. 1).

(2) Using the concept of ESDOF for evaluating the seismic performance of the studied building by the mean of IDA can reduce the computational time from 90 minutes per load case for multi degree of freedom (MDOF) to 6 minutes per load case for ESDOF. It reduced about 93% of computational time.

(3) The seismic performance evaluation found that the lateral load capacity of GLD, IDF, and SDF building was 16.64, 23.63, and 23.56%W, respectively (Figs. 1 and 2). The average response spectrum at the collapse state for GLD, IDF, and SDF are 0.53 g, 0.77 g (Figs. 3 and 4), and 0.80 g, respectively. All of frames are able to resistant a design earthquake. SDF is more ductile than IDF, and the initial strength of SDF is close to IDF.

4. Acknowledgements

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