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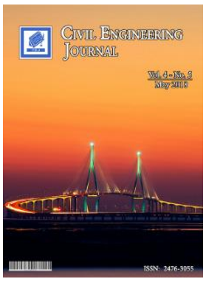

Evaluation the P-Delta Effect on Collapse Capacity of Adjacent Structures Subjected to Far-field Ground Motions

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Abstract

In urban areas, adjacent structures can be seen in any insufficient distance from each other, because of economic and refusal of acquired minimum separation distance according to seismic previsions. Collapse capacity assessment of structures is one of the important objectives of performance-based seismic engineering. The purpose of this study is to consider the pounding phenomenon and P-Delta effect in seismic collapse capacity assessment of structures. For this purpose, 2, 4, 6 and 8-story adjacent structures with different conditions of separation distance among them, were modelled in the OpenSees software. Furthermore, Incremental Dynamic Analyses (IDAs) were performed using 78 far-field ground motion records to compute the collapse capacities of adjacent structures. The results obtained from IDAs for adjacent structures show that during pounding, taller structure reaches its collapse capacity earlier than shorter one. In addition, by considering the P-Delta effect and increasing the distance between adjacent structures, time of collapse and number of impacts increases. According to results, considering the P-Delta effect in modeling has significant influence in seismic collapse capacity assessment of pounding structures.

Keywords: P-Delta Effect; Collapse Capacity; Pounding Phenomenon; Linear Viscoelastic Element; Incremental Dynamic Analysis.

1. Introduction

Recent studies show that impact forces generated between two pounding structures have significant influence on dynamic behavior of both the structures and may cause higher story shear forces. When adjacent structures have different dynamic characteristics, if they do not have a sufficient separation distance from each other, they may collide resulting in critical impact forces especially on roof levels. To prevent the occurrence of the pounding phenomenon during an earthquake, seismic provisions prescribe providing a minimum seismic separation distance between adjacent structures. However, for a large number of existing buildings not designed according to seismic provisions this separation distance has not been considered, and therefore structural pounding during earthquakes is expected.

Collapse is a state that structure or a part of it loses its ability to withstand gravity loads under strong ground motions, and the P-Delta effect exacerbates this instability. Owing to the fact that the P-Delta effect can influence the stability of structure, many studies have investigated considering the P-Delta effect in modeling [1-4]. The P-Delta effect induces additional moments because of lateral deformations and axial gravity loads. The magnitude of P-Delta effect is related to the lateral deformation, Delta, and axial load, P [5, 6]. Adam and Jäger [7] introduced a collapse assessment methodology to assess the P-Delta effect on the seismic collapse capacity of Single-Degree-of-Freedom (SDOF) systems by means of the so-called collapse capacity spectra. They used 44 far-field ground motion records for creating collapse capacity spectra to assess the dynamic stability of multi-story structures. Black [8] derived two closed-form expressions

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