Seismic Pounding Analysis between Adjacent Buildings to Achieve More Safety towards Earthquakes

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Abstract: Insufficient separation distance between adjacent buildings during strong earthquakes would probably result into striking of the buildings and subsequently create an excessive dynamic force called pounding. It produces undesirable forces resulting in large displacements, local damage and possible failure of the entire structure. Among the possible structural damages, seismic induced pounding has been commonly observed in several earthquakes. This project aims at studying seismic pounding effect between adjacent buildings by linear and nonlinear dynamic analysis using ETABS (Non Linear) computer program. A detailed parametric study is carried out to investigate the effect of various parameters on the structural pounding by Response Spectrum (Linear Dynamic) Analysis for medium soil at zone Vand Time History (Non-Linear Dynamic) Analysis for Bhuj earthquake recorded excitation on different models with varying separation distances. Pounding produces acceleration and shear at various storey levels that are greater than those obtained from the no pounding case, while the peak drift depends on the input excitation characteristics. Also, increasing gap width is likely to be effective when the separation is sufficiently wide practically to eliminate contact. Finally the results are observed to study the effect of structural displacements and pounding forces between two adjacent buildings.

Keywords: Seismic pounding, separation distance, seismic gap, adjacent buildings, storey displacements, pounding force.

I. INTRODUCTION
Pounding of adjacent buildings could have worse damage as adjacent buildings with different dynamic characteristics which vibrate out of phase and there is insufficient separation distance or energy dissipation system to accommodate the relative motions of adjacent buildings. A large separation is controversial from both technical (difficulty in using expansion joint) and economical (loss of land usage) views. The highly congested building system in many metropolitan cities constitutes a major concern for seismic pounding damage. For these reasons, it has been widely accepted that pounding is an undesirable phenomenon that should be prevented or mitigated zones in connection with the corresponding design ground acceleration values will lead in many cases to earthquake actions which are remarkably higher than defined by the design codes used up to now. The most simplest and effective way for pounding mitigation and reducing damage due to pounding is to provide enough separation but it is sometimes difficult to be implemented due to detailing problem and high cost of land. An alternative to the seismic separation gap provision in the structure design is to minimize the effect of pounding through decreasing lateral motion which can be achieved by joining adjacent structures at critical locations so that their motion could be in-phase with one another or by increasing the pounding buildings damping capacity by means of passive structural control of energy dissipation system or by seismic retrofitting. According to the 2000 edition of the

II. STRUCTURAL MODELING
The models, which have been adopted for study, are asymmetric ten storey and fifteen storey buildings having the 50mm separation gap between them. Two models have been considered for the purpose of the study.

Model 1: Fifteen storey adjacent buildings.
Model 2: Ten and Fifteen storey adjacent buildings.

III. METHODS OF SEISMIC ANALYSIS
The finite element analysis software’s ETABS and SAP2000 Nonlinear is utilized to create 3D model and run all analyses. The software is able to predict the geometric nonlinearity behaviour of space frames under static or dynamic loadings, taking into account both geometric nonlinearity and material inelasticity. The software accepts static loads (either forces or displacements) as well as dynamic (accelerations) actions and has the ability to perform Eigen values, nonlinear static pushover and nonlinear dynamic analyses.

IV. RESULTS AND DISCUSSIONS
ETABS and SAP2000 are used to compute the response of ten and fifteen storey buildings for rigid floor diaphragm Linear Dynamic (response spectrum) analysis. Results from Response Spectrum analysis are observed for the natural frequencies and modal mass participation ratios and Displacements of the joints to determine the seismic pounding gap between adjacent structures of two models.
Fig. 1 View of Ten and Fifteen storey adjacent buildings created in ETABS

Fig. 2 Defining response spectrum function (Sa/g) Vs. Period in ETABS

Fig. 3 Wind forces along X & Y directions

Fig. 4 Maximum storey displacement for Wind force along Y-direction (Model 1)
hence there is seismic pounding between adjacent buildings. Therefore, it was found that minimum seismic gap could be provided 0.010m (i.e. 10mm) per storey is sufficient in both the cases for no seismic pounding between buildings. Form the calculations of damping ratios for adjacent fifteen storey buildings is 8.274% and for adjacent Ten and Fifteen storey adjacent buildings is 7.958%. As we have already incorporated 5% inherent damping in the response spectrum analysis, so the excess damping results in the pounding between adjacent buildings.

REFERENCES