SEISMIC ANALYSIS OF EXPANSION GAP FOR MULTISTORIED BUILDINGS

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Abstract - *When a building experiences earthquake vibrations its foundation will move back and forth with the ground. These vibrations can be quite intense, creating stresses and deformation throughout the structure making the upper edges of the building swing from a few mm to many inches dependent on their height size and mass. This is uniformly applicable for buildings of all heights, whether single storeyed or muli- storeyed in high-risk earthquake zones. A building needs to be slightly flexible and also have components, which can withstand or counter the stresses caused in various parts of the building due to horizontal movements caused by earthquakes. In this study, analyzing the influence of expansion gap between adjacent high-rise buildings and determining optimum seismic gap between them.*

***Key Words*: Seismic Pounding, ETABS, Gap Element, Time History Analysis, Pushover Analysis, Storey Displacement**

1.INTRODUCTION *(Size 11 , cambria font)*

Investigations of past and recent earthquake damage have illustrated that the building structures are vulnerable to severe damage and/or collapse during moderate to strong ground motion. An earthquake with a magnitude of six is capable of causing severe damages of engineered buildings, bridges, industrial and port facilities as well as giving rise to great economic losses. Pounding between closely spaced building structures can be a serious hazard in seismically active areas. 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. Past seismic codes did not give definite guidelines to preclude pounding, because of this and due to economic considerations including maximum land usage requirements, especially in the high density populated areas of cities, there are many buildings worldwide which are already built in contact or extremely close to another that could suffer pounding damage in future earthquakes. 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 (Kasai et al. 1996, Abdullah et al. 2001, Jankowski et al 2000, Ruangrassamee & Kawashima 2003, Kawashima & Shoji 2000), 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.

1.1 OBJECTIVE OF THE STUDY

Safety and minimum level of damage of structure could be the prime requirement of high rise buildings. To meet these requirements, the structure should have adequate lateral strength and sufficient ductility. The main objectives of this thesis are:

- Studying seismic gap between adjacent buildings by dynamic and pushover analysis.
- To investigate seismic pounding between adjoining buildings.
- To determine the minimum seismic gap between buildings
- Find the optimal uniform gap between adjacent building structure and,
- Provide engineers with practical analytical tools for predicting pounding response and damage.

1.2 SCOPE OF THE STUDY

Scope of the project work includes:

- Studying the seismic gap between adjacent buildings by dynamic and pushover analysis
- evaluating the effects of structural pounding on the global response of building structures

2. STRUCTURAL MODELLING AND ANALYSIS

In order to evaluate the Seismic gap between buildings with rigid floor diaphragms using dynamic and pushover procedures two sample buildings was adopted. The finite element analysis software ETABS2013 is utilized to create 3D model and run all analyses. The software is able to predict the geometric nonlinear behavior 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 eigenvalues, nonlinear static pushover and nonlinear dynamic analyses.

2.1 MODEL CONFIGURATION

A regular plan for two adjacent building structures having 32m x 32m plan dimension with 75m and 90m high adjacent structures with storey height is 3m for each structures. There are three models for the comparative study with variation in seismic gap. Modeling and analysis of structures are carried out using ETABS 2013 software.

Physical properties and datas of structures considered for present study are follows:

Table -1: Physical properties and data of structures

Plan area	32m x 32m
Storey Height	3m
Steel Selections	Fe250
Concrete	M30
Dead Load	3 kN/m^2
Live Load	2.5 kN/m^2
Slab Thickness	200 mm
Earthquake Load	IS 1893 (Part I) : 2002
Wind Load	IS 875 (Part 3) : 1978
Steel design code	IS 800 :2007

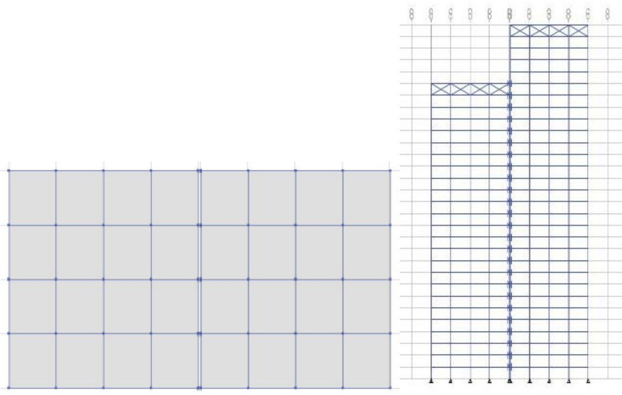

Fig -1: Typical plan and elevation of the adjacent buildings

2.2 TYPICAL MODELS

Model A – Adjacent structures with 0.3m gap

Model B – Adjacent structures with 0.4m gap

Model C – Adjacent structures with 0.5m gap

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3. RESULTS AND DISCUSSIONS

3.1 TIME HISTORY ANALYSIS

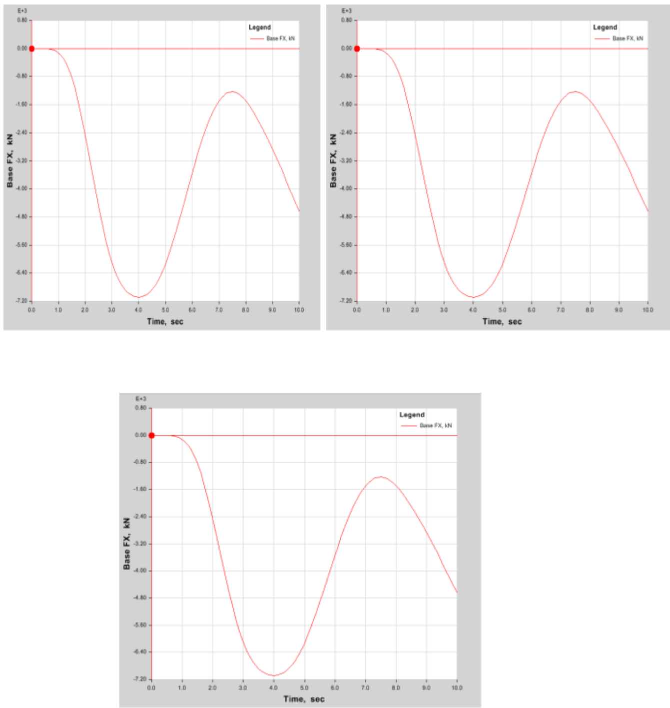

Fig -2: Time history analysis results of models A,B & C

3.2 PUSHOVER ANALYSIS RESULTS

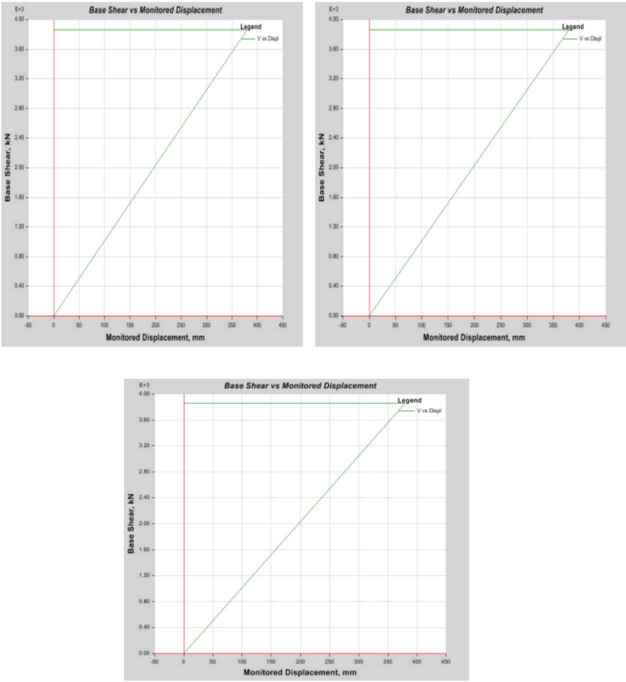

Fig -3: Pushover analysis results of models A,B & C

4. CONCLUSIONS

Based on the numerical study carried out in the present research work, following major conclusions can be drawn:

- Constructing separated buildings is the best way of preventing structural poundings.
- It can be concluded that constructing adjacent buildings with equal floor heights and separation distances reduces the effects of pounding considerably.
- Existing adjacent buildings which are not properly separated from each other can be protected from effects of pounding by placing elastic materials between them.
- Seismic performance of high rise buildings can be improved by providing links, bracings, shear walls, framed systems.
- From the analysis of three models, a seismic gap in the range of 0.3m to 0.5m is quite effective for reducing pounding effect.

5. REFERENCES

[1]Mohammed Jameel, A.B.M. Saiful Islam, Raja Rizwan Hussain, Syed Danish Hasa, " *Non-linear FEM analysis of seismic induced pounding between neighbouring Multi-storey structures",* Latin American journal of Solids and Structures, 2013, 921-939

[2]Abbas Moustafa and Sayed Mahmoud, " *Damage assessment of adjacent buildings under earthquake loads"*, Engineering Structures 61 (2014), pg 153 – 165

[3]Chetan J. Chitte, Anand S. Jadhav and Hemraj R. Kumavat. "*Seismic Pounding between adjacent building structures subjected to near field ground motion"*, International journal of research in engineering and technology, June 2014, volume 3, issue 9, pg 2319 – 7308

[4]Puneeth Kumar M SS Karuna, "*Effect of seismic Pounding between adjacent buildings and mitigation measures"*, International journal of research in engineering and technology, July 2015, volume 4, issue 7, pg 2321 – 7308

[5]S. Sorace and G. Terenzi, " *Damped Interconnection-Based Mitigation of Seismic Pounding between Adjacent R/C Buildings"*, International journal of engineering and technology, June 2013, Vol. 5, No. 3

[6]Jie Song, K.T. Tse, Yukio Tamura and Ahsan Kareem, "*Aerodynamics of closely spaced buildings : with application to linked buildings"*, Journal of Wind Engineering and Industrial Aerodynamics, 149 (2016) 1-16

[7]V.K. Agarwal, J.M. Niedzwecki and J.W. van de Lindt, "*Earthquake induced pounding in friction varying base isolated buildings",* Engineering Structures 29 (2007) 2825–2832