Theoretical Study On Seismic Pounding Effect Of Adjacent Multi Storied Buildings

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Abstract- *The aimof this paper is to study the effects, causes, consequences of seismic pounding in adjacent buildings.In metro cities structures are built very close to each other because cost of land is high and also due to deficiency of land. Due to this excessive closeness, the structures may collide with each other when subjected to any vibration or earthquake. This type of collision of adjacent structure or its different parts during the ground motion or earthquake is called pounding which result in architectural and structural damages or collapse of the entire structure. The difference in structural properties like floor height and floor level with insufficient gap between the buildings also effects in structural pounding. Here, a brief discussion regarding the structural pounding, its causes and the mitigation measures is being discussed.*

Keywords- Seismic Pounding, Adjacent Building, Structural Damage, Insufficient gap.

I. INTRODUCTION

Seismic pounding may be defined as the collision of two adjacent building which are vibrating out of phase during earthquake. The Pounding of adjacent buildings would have worse damage to an adjacent buildings with different dynamic characteristics like displacement, acceleration,etc which vibrate out of phase (means deflection curve crest of one building coincide with deflection curve trough of another building) and if there wasinsufficient gap or energy dissipation system so as to move independently then it could cause severe damage. Previous seismic codes didn't gave perfect guidelines to for pounding consideration point of view, because of this and due to economic considerations including maximum land usage requirements, especially in the high dense populated areas like metro cities, there are lot of buildings which are constructed very close to each other hence they may suffer pounding damage in future earthquakes. Hence providing large separation is controversial from both point of view i.e, technical point "difficulty in using expansion joint" and economic point of view"loss of land usage". An earthquake release large amount of seismic energy which hit the foundation and thus the superstructure vibrate in wave form. Hence two adjacent building will vibrate in wave form but if they were in contact with each other or very close to each other then there structural component will collide each other. Also if they were out of phase then consequences will be worst. And the areas of congested building system are highly prone to pounding damage since there were luckiness of availability of land.Consequently, it has been generally acknowledged that beating is an unwanted marvel that ought to be forestalled or relieved zones regarding the comparing configuration ground increasing speed esteems will lead as a rule to seismic tremor activities which are astoundingly higher than characterized by the structure codes utilized something like at this point. The most easiest and successful route for beating alleviation and diminishing harm because of beating is to give enough division yet it is once in a while hard to be actualized because of enumerating issue and significant expense of land.

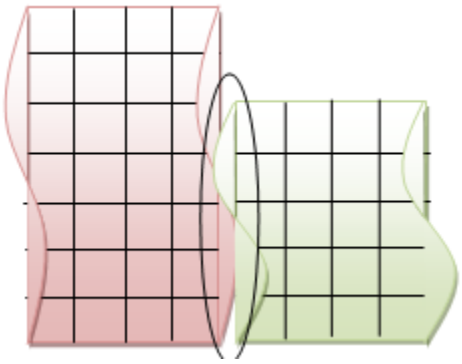

Fig-1: Pounding of Adjacent Buildings

Fig-2 :Pounding of Adjacent Buildings

II. CAUSES OF POUNDING

Possible reasons of forming structural pounding may be as follow:

Main reason of structural pounding is having insufficient gap or distance between two structures so as they can't be move independently during earthquake. Along with this condition many different causes may found as follow:

1. If foundation rest on soft soil and during earthquake may would led to slight settlement which cause deflection or may titling the structure, if it was not provided by sufficient gap then cause pounding.
2. Buildings subjected to torsion having irregular lateral loading systems will rotate in plan during an earthquake, and due to it, pounding may occurs near the building periphery & may damage to adjacent building.

Hence, basically to overcome pounding effect we have to analyze the structure using various method and cross verify it by our Indian Standards code norms.

III. MINIMUM SEPARATION DISTANCE TO OMIT POUNDING

In Indian Standards IS 4326:2013, special clause no 5 is given stated that adjacent structures with different dynamic characteristics like different total height should be provided by sufficient separation distance between them so as to avoid collision between structures during earthquake. Also in IS 1893:1984 gives clear standards for calculation of separation distance given as in Table 1,

Type of Construction	Gap width in mm for design seismic coefficient $\propto h = 0.12$
Frame with shear wall or Box system	15
Moment resistant reinforced concrete frame	20
Moment resistant steel frame	30

Recommendation as per IS 1893:2016 Part1

- Separation between adjoining structures should be R times the sum of displacements of individual structures. Calculated as per design base shear where R is response reduction factor (Clause 7.11.1)
- When floor level of adjacent building are at same level then separation distance shall be calculated by $R_1\Delta_1 + R_2\Delta_2$. Where R &$^{\Delta}$ are the respective response reduction factor & displacement of building calculated.

Recommendation as per IS 1893:2007 Part1

- Separation between adjoining structures should be R times the sum of displacements of individual structures. where R is response reduction factor (Clause 7.11.1) R may be replaced by R/2 when two buildings are at same levels.

Recommendation as per IS 4326:2013

1. Minimum seismic distance should be 25 mm.
2. Structure more than 40 meters height should be analyze using model or dynamic analysis so as to find drift & deflection at each level.
3. If separation of adjacentstructures is necessary then it is to be provided also temperature expansion & contraction aspect also have to considered safely.

Recommendation as per FEMA: 273-1997

- Distance between two adjoined structures shall be lessthan 4% of the building height and above so as to avoid pounding.

IV. METHOD OF CALCULATING MOVEMENT BETWEEN ADJOINING STRUCTURES

1. ABS Method

S = Ua + Ub

Where, S = separation distance
Ua, = peak displacement response of adjacent structures A
Ub = peak displacement response of adjacent structures B

2. SRSS (Square Root of Sum of Squares) Method:-

$$S = \sqrt{U_a{}^2 + U_b{}^2}$$

Where, S = disconnection movement between the structure
Ua, = top displacement response of adjoining structures A
Ub = top displacement response of adjoining structures B,

These are the method to analyze the distance between two structures. The method of SRSS is calculated by a formula.

3. As per IS 1893-2016 P1,

Seismic gap width should be,

$$Seismic\ Gap = (\Delta_1 + \Delta_2) \times R$$

Where, Δ_1, Δ_2 are storeydisplacement

V. CONSEQUENCES OF POUNDING IN ADJACENT STRUCTURES

Poundings can be created between tall structures, between low-ascent structures, just as between skyscraper and low-ascent structures during solid tremors. Beating during quake can likewise occur between a non-basic segment and the structure itself just as between two adjoining parts. Tremors cause ground shaking; the ground underneath a structure is dislodged horizontally. The heaps in the upper piece of the structure produces inactivity impacts of this uprooting. Thus, there will pound between neighboring structures. The subsequent shear powers and bowing minutes in a structure are (for the most part) greatest simply above establishment level.

Perception of past seismic tremors shows certain attributes identified with beating. Structures of comparable stature and with comparative auxiliary frameworks will in general endure less harm than structures of various tallness and with various basic frameworks. This is because of the way that structures with a similar tallness will have comparative common frequencies and will in general move in-stage relative to one another.

In actuality, structures of various tallness or with various auxiliary frameworks will have diverse regular frequencies and will in general influence out-of-stage concerning one another; this may prompt harm that is increasingly genuine. This comment shows that beating issues must be dealt with one case at a time case.

VI. VARIOUS TECHNIQUES TO AVOID POUNDING

Often existing buildings do not have sufficient seismic gap between adjacent buildings to withstand the lateral displacement due to earthquake forces and resulting large damage for moderate earthquake and possibly collapses for heavy earthquake. Arrangement of supplemental quality in type of extra horizontal power opposing components, for example, shear dividers, propped or second edges assists with lessening the parallel removal by expanding the firmness of the structures. A portion of the relief methods used to limit the harms from beating as follows:

1. Provide sufficient gap between structures calculated after analyzing the models.
2. Structures having straightforward standard geometry, consistently dispersed mass and firmness in plan just as in height, endure exceptionally less harm than structures with unpredictable designs.
3. The utilization of shear walls that are built at right points to the isolated line between two structures in contact, so they can be utilized as guard components on account of beating.
4. Seismic damper components are connect components that are enacted when gap is closed. Such components diminish the energy transferred during movement of structures at high frequencies. The damper will yield a little incentive for the coefficient of compensation.
5. Give adequate situated length between the decks or give stun retaining gadgets between the decks and orientation under the limits of the decks in spans.

VII. CONCLUSION

This paper gives successfully information about the subject seismic pounding, its causes, instances of pounding, disappointments and harms just as significant moderation measures.

1. Constructing separated structures with sufficient seismic gap is the most ideal method of forestalling auxiliary poundings.
2. When buildings are out of phase then they are prone to pounding as compared to in phase buildings.
3. In this examination, it is inferred that developing contiguous structures with equivalent floor statures and partition separations lessens the impacts of beating significantly.
4. Existing nearby structures which are not appropriately isolated from one another can be shielded from impacts of beating by putting flexible materials between them.
5. As the PGA esteem expands, the base division between the structures additionally increments.
6. The detachment separation between the two structures diminishes, the measure of effect is builds, which isn't relevant in all cases. It is just appropriate when the effect time is same. It might likewise diminishes when detachment separation diminishes, which prompts less effect time.
7. At reverberation condition the reaction of the structure is more and may prompt breakdown of the entire structure.
8. The span of solid movement increments with an expansion of greatness of ground movement.

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