Dynamic Analysis of Adjacent RCC Buildings for Pounding Effect

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***Abstract*—Collision of two adjacent buildings which are of different dynamic characteristics and having insufficient separation gap between the buildings is called seismic pounding. In present day scenario buildings are constructed very close each other in urban areas for the complete usage of limited land space. During earthquakes the buildings closely spaced have a chance of pounding on the adjacent building block. This study covers the effect of providing insufficient gap element between the two adjacent RCC buildings. A modal of two buildings close to each other one being G+7 storey and other being G+4 storey was considered. Model analysis and Response spectrum analysis is carried out for both buildings. The parameters like displacement and drifts were considered for the analysis by using Etabs and plotted them on graph to know the effect of pounding on adjacent buildings**.

Keywords— Seismic pounding, Gap elements, Response spectrum Analysis, Displacement and Storeydrifts.

1. INTRODUCTION

Pounding is one of the main causes of severe building damages in earthquake. Pounding effect refers to the collision of adjacent buildings during earthquake. It occurs when the distance between two buildings are lesser to face the relative motion during earthquake. When the seismic vibration occurs on the adjacent buildings, the load transfer from high rise building to the lower building and the lower storey building should not be constructed in such a way that to carry the transferred load. Its results in pounding between buildings which are narrow spaced, which causes severe damage. Investigation have shown that pounding damage was observed in Mexico (1985), Canada(1988),Kobe(1995),Nepal(2015)of earthquakes can be seen. The prevention measures to avoid the seismic pounding between the adjacent buildings are RC Shear Wall, Steel Cross Bracing, Dampers, sufficient separation gap between the adjacent buildings.

Fig1.1: 2015 Nepal Earthquake.Damages due to pounding effect

1.1 GAP ELEMENT

Gap element it is the link elements it is a compression memberor element which is required to access the force of pounding and to stimulate the effect of pounding the main purpose of the link or gap element is to transmit the force through the link only when contact occurs and the gap is closed.

Therefore, the stiffness of the gap element is found as below.

$K= (AxEx10^2)/L$

Where, K= stiffness of the gap elementA= W x tE= Youngs Modulust = Slab Thickness
W= Average Element Width

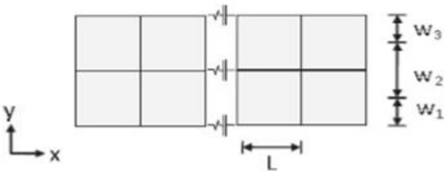

Fig: Shows the plan of the 2 colliding floors and the connecting gap element.

2. LITERATURE REVIEW

In this study, the pounding effect is analyzed. on the two adjacent buildings (G+7) and (G+4) • The gap taken of 50mm, 80mm, 100mm, 140mm is used the two adjacent buildings are analyzed for various cases equal floor level and different storey height, equal floor level and equal storey height and Setback of 3m with equal floor and different storey height. And Response spectrum analysis to carried out for both 3D buildings. Displacement and storey drifts are compared with all the gap on each case and Conclusions are arrived on their aspects of the study.

3. OBJECTIVES OF THE STUDY

1) To study the 3D buildings by considering seismic pounding effect during earthquake with different gap element.
a) 50 mm b) 80 mm c) 110 mm d) 140 mm
2) To study the seismic behaviour by analyzing the displacement value and storey drifts value.
3) Graph will be plotted for various gap and conditions and giving an idea how pounding will affect the 3D Building

4. METHODOLOGY

1) To carry out the proposed work 2 buildings models

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are considered (G+7&G+4).

2) Etabs is used to create 3D model and run all investigation models.

3) Model analysis is carriedoutfor both the buildings for (dead load, FF, l ive load, FF, EQ-X & EQ-Y)

4) Response spectrum analysis is carried out for both seven &four storey buildings.

5) Displacement and storey drifts obtained and plotted them on graph to see the pounding effect between the adjacent buildings

5. DEFINING THE MATERIAL PROPERTIES

Beam Sections (mm)	Column Sections (mm)
230X450	300X400
450X550	600X600
550X650	700X700
Slab Sections	All Slabs are 150mm Thick

5.1 : Load Configurations:

Wall Loads : For 3m Storey Height For 3.2m Storey Height	14.72KN/m^2 13.8 KN/m^2
Live Load	3.0 KN/m^2
Live Load on Roof	1.5 KN/m^2
Floor Finish	1.2 KN/m^2

5.2 Seismic Factors

Specifications	
Zone	V
Zone Factor	0.36
Importance factor (I)	1
Soil Type	III
Response reduction factor (R)	3

5.3 Geometric & section properties

	G+7	G+4
Number of Bays in X Direction	3	3
Spacing of Bays in X Direction (m)	5	5
Number of Bays in Y Direction	5	5
Spacing of Bays in Y Direction (m)	3	3
Storey Height (m)	3.2	3

6. MODELLING DIAGRAMS FROM ETABS

Case1: Adjacent Buildings at equal floor level with different storey height

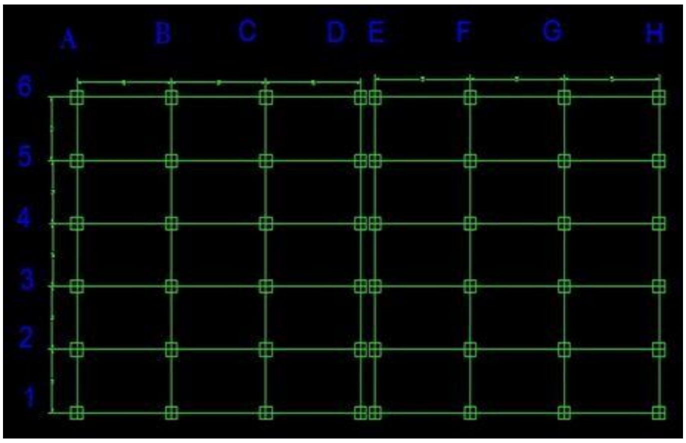


Fig 6.1: PLAN

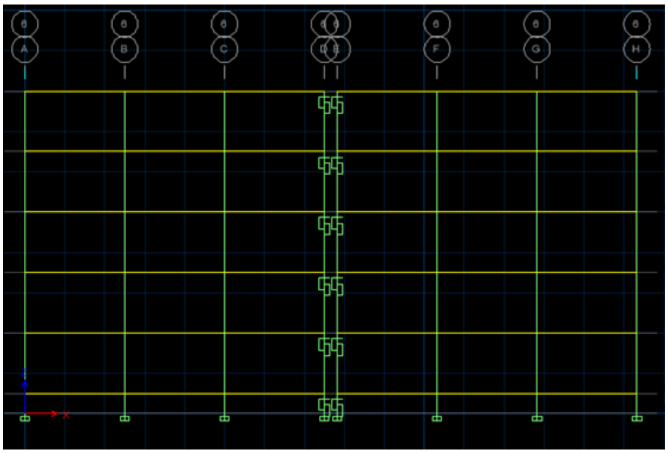


Fig 6.2: ELEVATION

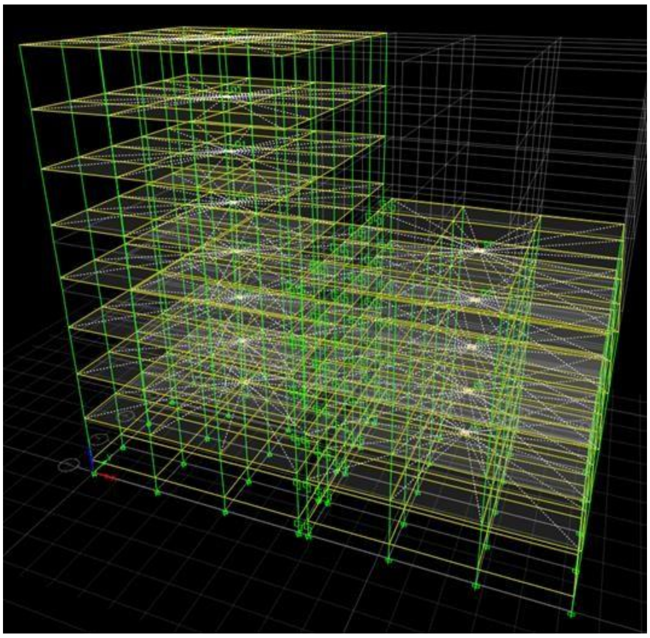


Fig 6.3: 3D Model of Case1

Case 2: Adjacent Buildings at equal floor level and storey height

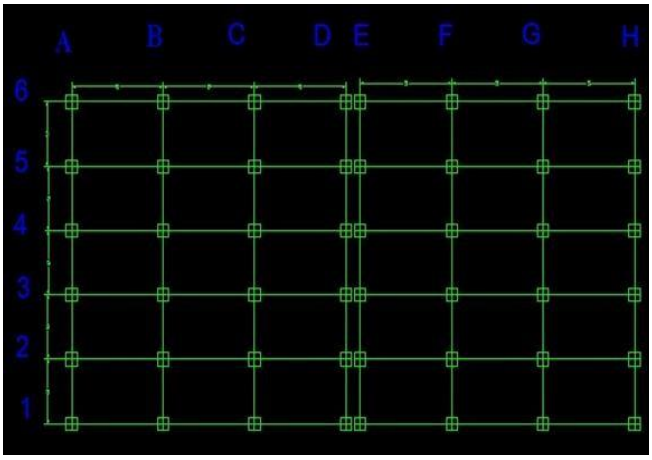


Fig 6.4: PLAN

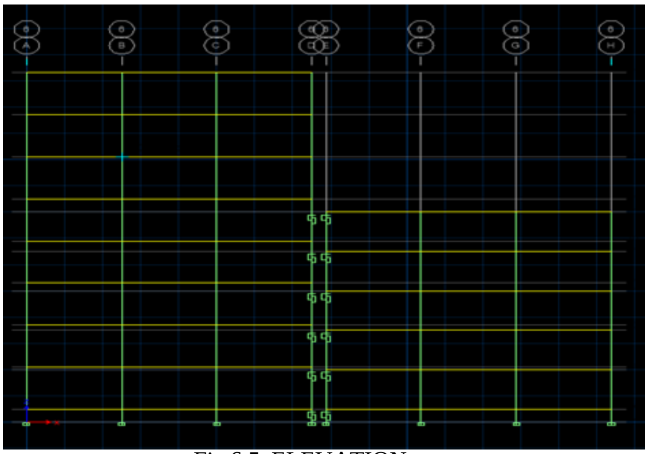


Fig 6.5: ELEVATION

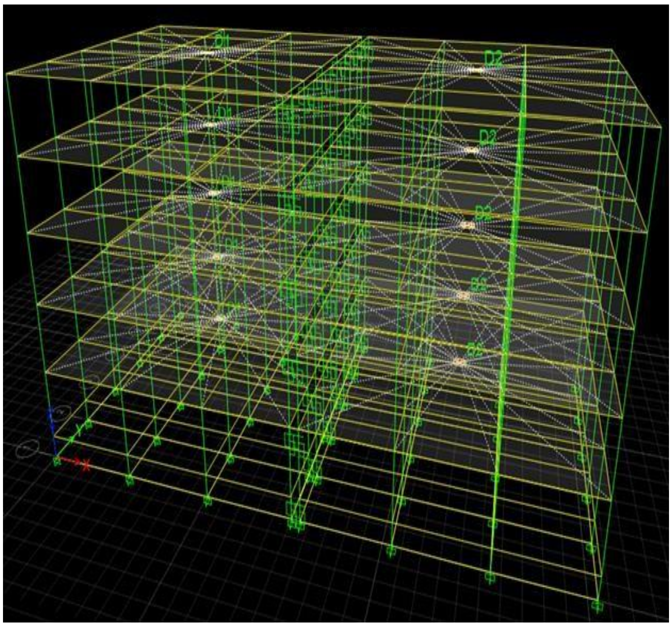


Fig 6.6: 3D Model of case 2

Case 3: Adjacent Buildings with a setback of 3m withequal floor level with and storeyheight.

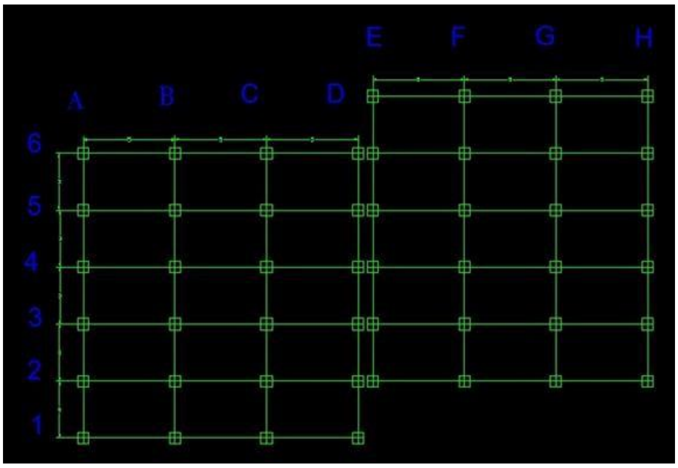


Fig 6.7: PLAN

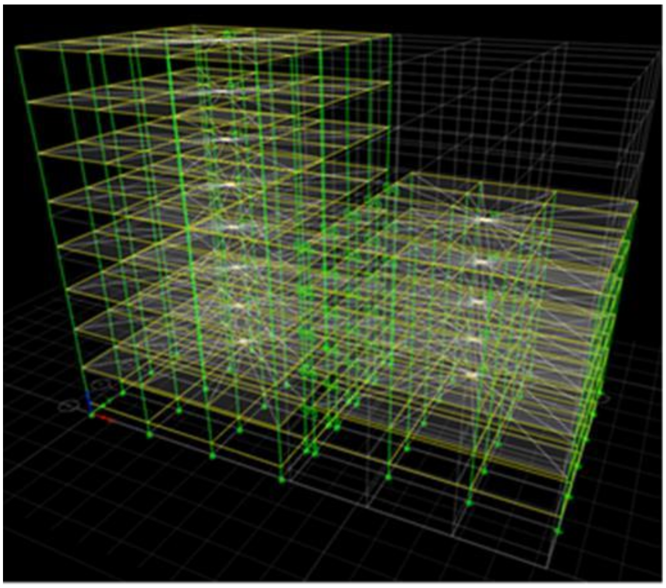


Fig 6.8: 3D Model of Case 3

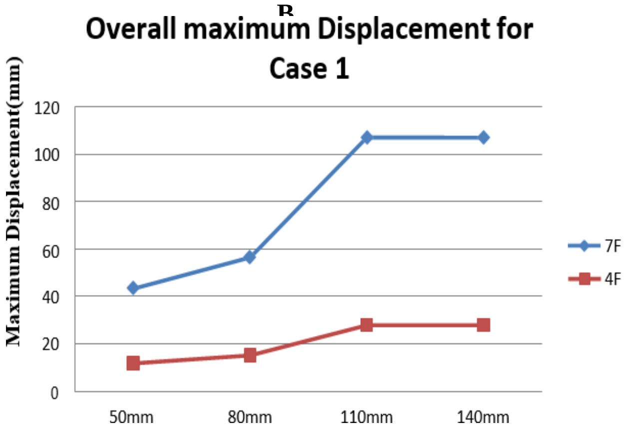
7: RESULTS AND DISCUSSIONS

A. Overall Maximum Displacement for 7 and 4 storey building for case 1 provided with 50, 80,110,140 mm gap element.

Building	Story	Maximum Displacements(mm)	Gap Element
G+7	7F	43.4	50mm
G+4	4F	11.8	50mm
G+7	7F	56.4	80mm
G+4	4F	15.2	80mm
G+7	7F	107.3	110mm
G+4	4F	27.9	110mm
G+7	7F	107.2	140mm
G+4	4F	27.9	140mm

Table 7A: Overall maximum storey displacements considering case 1

B



Overall Maximum Displacement for 4 storey buildings for case 2 provided with 50, 80,110,140mm gap element.

Building	Story	Maximum Displacements(mm)	Gap Element
G+4	4F	32.4	50mm
G+4	4F	50.5	80 mm
G+4	4F	74.3	110mm
G+4	4F	73.7	140mm

Table 7B: Overall maximum storey displacements considering case 2

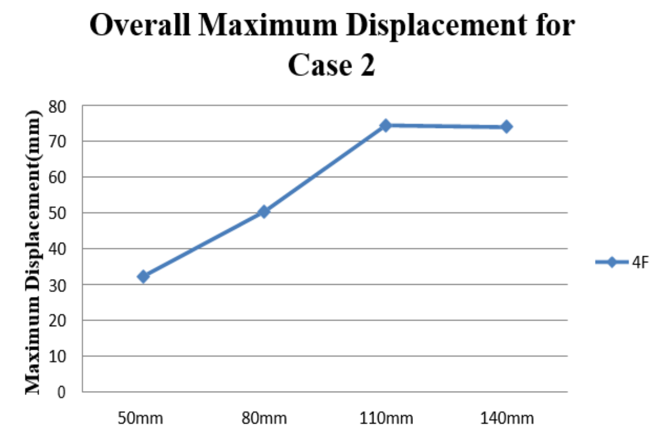


Fig 7B : Overall maximum storey displacementgraph considering case 2

C. Overall Maximum Displacement for 4 and 7 storey buildings for case 3 provided with 50, 80,110,140 mm gap element

Building	Story	Maximum Displacements(mm)	Gap Element(mm)
G+7	7F	43.3	50mm
G+4	4F	11.8	50mm
G+7	7F	56.5	80mm
G+4	4F	15.2	80mm
G+7	7F	107.1	110mm
G+4	4F	27.9	110mm
G+7	7F	107	140mm
G+4	4F	27.9	140mm

Table 7C: Overall maximum Storey displacement considering case 3

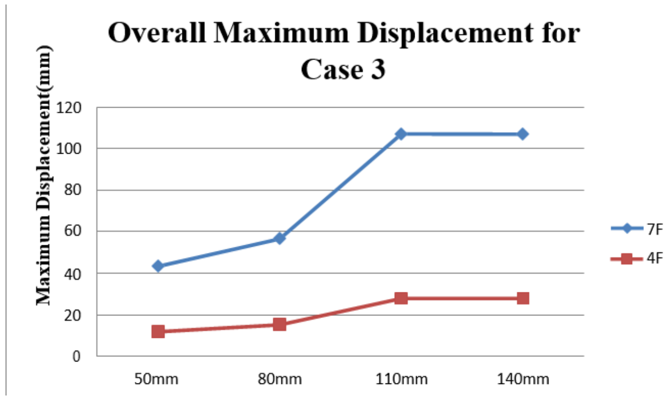


Fig7C. Storey displacement graph for 7 and 4 storey building

D. Maximum Displacement for 7 storey consideringall the cases

Building	Cases	Storey	Maximum Displacement(mm)	Gap elementsmm
G+7	Case1	7F	43.4	50
G+7	Case1	7F	56.4	80
G+7	Case1	7F	107.3	110
G+7	Case1	7F	107.2	140

Table 7D: Maximum Storey displacement consideringall the cases (7 storey)

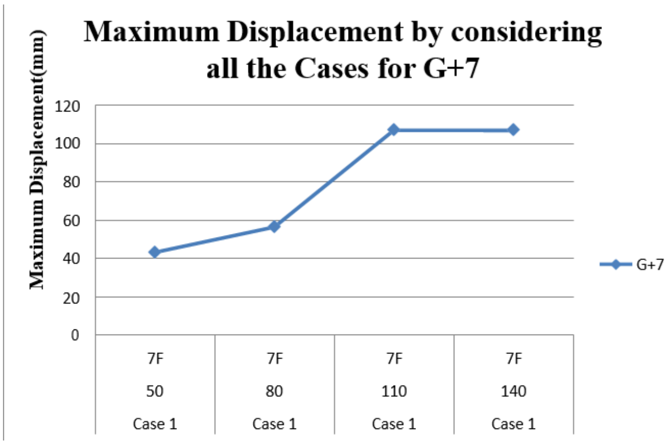


Fig7D: Maximum Storey displacement graph consideringall the cases (storey7)

E. Maximum Displacement for 4 storey considering allthe cases

Building	Cases	Storey	Maximum Displacem ent(mm)	Gap Element(m m)
G+4	Case 2	4F	32.4	50
G+4	Case 2	4F	50.5	80
G+4	Case 2	4F	74.3	110
G+4	Case 2	4F	73.7	140

Table 7E: Maximum Storey displacementconsidering all the cases (4 storey)

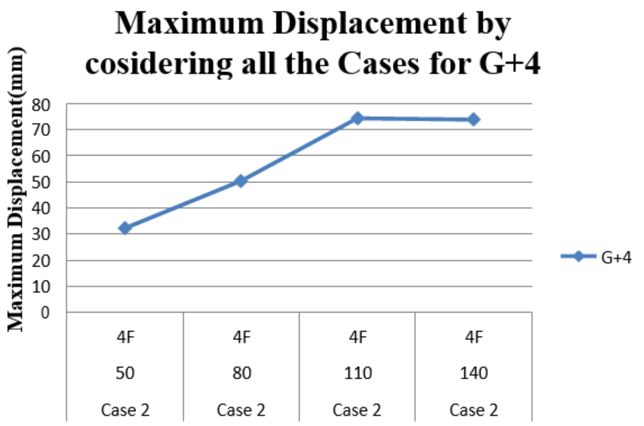


Fig7E: Maximum Storey displacement graphconsidering all the cases (4 storey)

F. Overall Maximum storey drifts for 7 and 4 storey buildings for case 1 provided with 50,80,110,140 mm gap element.

Building	Cases	Storey	Maximum Storey Drifts	Gap Element (mm)
G+7	Case1	1F	0.002459	50
G+4	Case1	1F	0.001019	50
G+7	Case1	1F	0.003288	80
G+4	Case1	1F	0.00132	80
G+7	Case1	1F	0.006017	110
G+4	Case1	1F	0.002476	110
G+7	Case1	1F	0.006014	140
G+4	Case1	1F	0.002475	140

Table 7F: Overall Maximum Storey driftsconsidering case 1

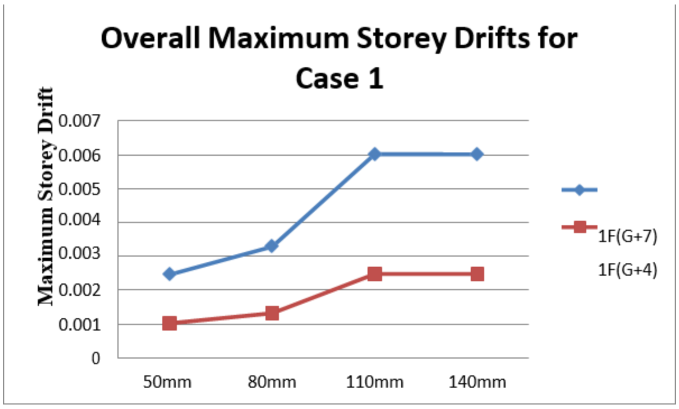


Fig7F: Overall maximum Storey drifts graphconsidering case 1

G. Overall Maximum storey drifts for 4 storey buildings for case 2 provided with 50, 80,110,140mm gap element.

Building	Cases	Storey	Maximum Storey Drifts	Gap Element (mm)
G+4	Case 2	1F	0.002757	50
G+4	Case 2	1F	0.004284	80
G+4	Case 2	1F	0.006381	110
G+4	Case 2	1F	0.00638	140

Table 7G: Overall Maximum Storey drifts considering case 2

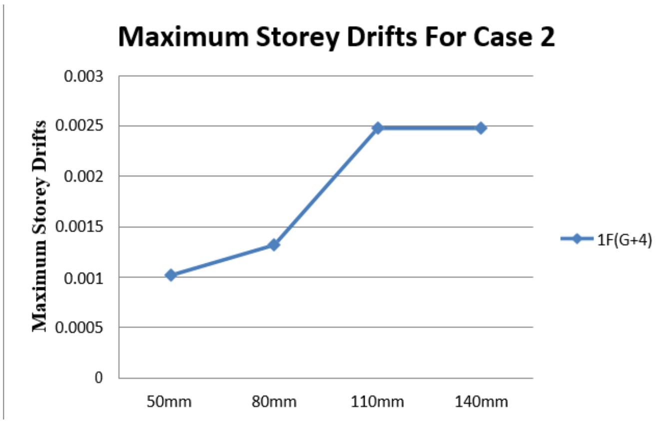


Fig7G: Overall Maximum Storey drifts graph considering case 2

H. Overall Maximum storey drifts for 4 and 7 storey buildings for case 3 provided with 50, 80,110,140 mm gap element

Building	Cases	Storey	Maximum Storey Drifts	Gap Element
G+7	Case 3	1F	0.002476	50
G+4	Case 3	1F	0.001023	50
G+7	Case 3	1F	0.004727	80
G+4	Case 3	1F	0.00184	80
G+7	Case 3	1F	0.005999	110
G+4	Case 3	1F	0.002489	110
G+7	Case 3	1F	0.006003	140
G+4	Case 3	1F	0.002489	140

Table 7H : Overall Story drift considering case 3

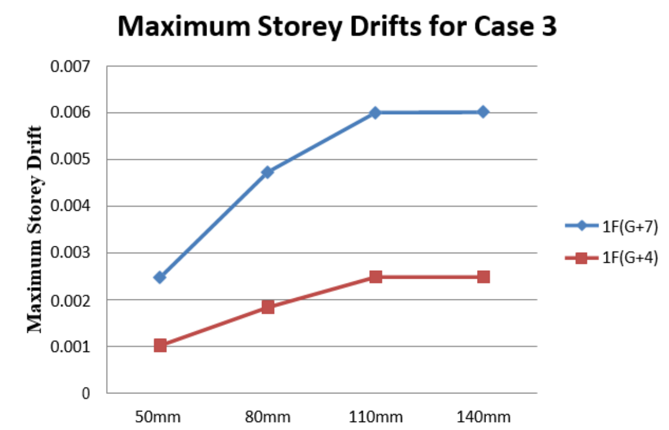


Fig 7H: Storey drifts graph considering case 3

I . Maximum Storey drifts considering all the cases for 7 storey budlinig.

Building	Cases	Storey	Maximum Storey Drifts	Gap Element
G+7	Case 3	1F	0.002476	50
G+7	Case 3	1F	0.004727	80
G+7	Case 3	1F	0.005999	110
G+7	Case 3	1F	0.006003	140

Table 7I: Maximum storey drift considering all the cases (7storey building)

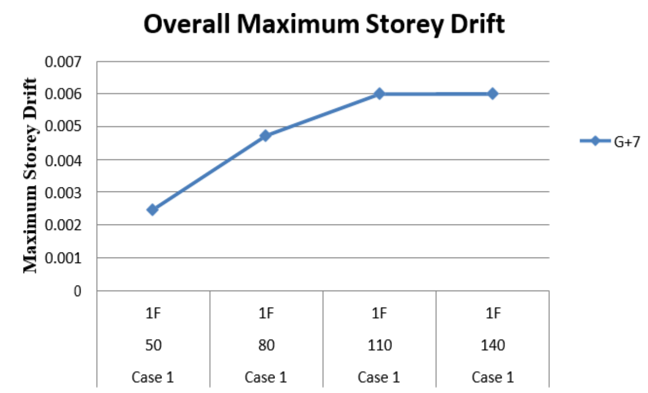


Fig7I:maximum storey drifts considering all thecases (7 storey building)

J. Maximum Storey drifts considering all the cases for 4 storey building

Building	Cases	Storey	Maximu m Storey Drifts(m m)	Gap Element (mm)
G+4	Case 2	1F	0.002757	50
G+4	Case 2	1F	0.004284	80
G+4	Case 2	1F	0.006381	110
G+4	Case 2	1F	0.00638	140

Table 7J: Maximum storey drift considering all the cases(4 storey building)

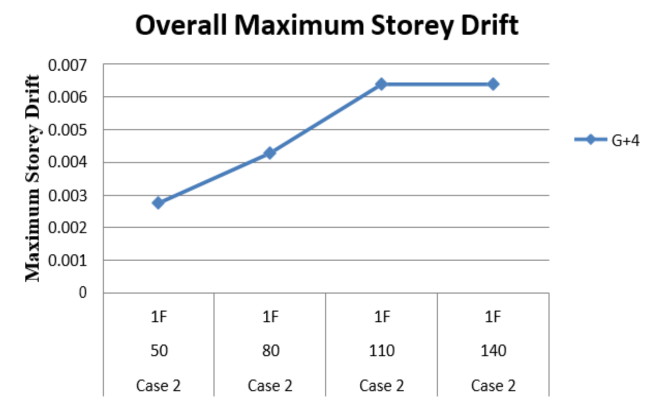


Fig 7J: Overall maximum storey drifts considering all the cases (4 storey building)

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8: CONCLUSION

Based on analysis carried out on the seismic pounding effect inthe buildings the following conclusions are:

a) The displacements value are less at lower storey building and gradually increasing at higher storey building**.**

b) The storey drifts value are less at higher storeys building and gradually increasing at lower and intermediate storeys.

c) With the buildings provided with the gapelement of 50, 80,110,140mm here the displacement as well as Storey drift is found to be gradually increasing for 50mm and 80mm gap element but with gap element of 110 and 140mm the displacement and the storey drift values are found to be constant i.e.., if the gap element size is further increased the displacement and the storey drift values becomes constant.

d) The displacement is found to be maximum at the higher storey i.e. seventh storey for Case 1 and fourth storey for Case 2 on comparison with all the cases respectively.

e) The drift is found to be maximum at the lower storey i.e., first floor for Case 1 and fourth storey for Case 2 on comparison with all the cases respectively.

f) Therefore, the effect of the gap distance between adjacent buildings on their pounding behavior was found to be highly significant.

9. FUTURE SCOPE

a) This study can further be extended for ta buildings

b) Seismic pounding effect can be studied forvarying spacing of buildings.

c) Time history analysis can be applied to study seismic pounding effect

10. REFERENCES

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