International Journal of Engineering Research and Development
e-ISSN: 2278-067X, **p**-ISSN : 2278-800X, www.ijerd.com
Volume 5, Issue 2 (December 2012), PP. 55-59

Inter-Relationship between Moment Values of Columns in a Building with Different Architectural Complexities and Different Seismic Zones

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Abstract:- Many high rise buildings are planned and constructed with architectural complexities. The complexities includes soft storey at lower level or at any intermediate level, floating column at various levels and shear wall provided in basements, etc. High rise buildings are critically analyzed for the effect of earthquake. Earthquake loads as specified in IS 1893 (part 1)**:** 2002 are considered in the analysis of building.

A G+15 storeyed high rise building with different architectural complexities is analyzed for various earthquake zones. In over all study of seismic analysis, critical load combinations are found out. For these critical load combinations, zone wise variation in moments on columns at ground floor level are compared and significant co-relationship between these moment values are established. Mathematical models developed can be used with reasonable accuracy.

Keywords:- Architectural Complexities, Seismic Zones, Seismic Analysis, Critical Load Combinations, Mathematical Models

I. INTRODUCTION

A G+15 storeyed high rise building with different architectural complexities such as soft storey at lower level or at any intermediate level, floating column at various levels and providing shear wall is analyzed for various earthquake zones. Details of the structure are given in table 1.

Table I

Type of Structure	R.C.C framed, G+15 with Basement for Parking
Area of individual floor	41677.54 Sq. ft.
Storey Height	3.5 m
Earthquake Zone	II, III, IV, V
Type of soil	Medium
Lateral Load Resisting System	Ordinary RC moment-resisting frame (OMRF)
Response Reduction Factor, R	3.0
Live Load	4 KN/m2
Number of Footings	121
Dead load	1. Self Wt. of whole Structure 2. Wt .of Brickwork = 13.34 KN/m 3. Slab Load = 4.125 KN/m2

II. ANALYSIS

The Commercial Complex with architectural complexities is analyzed for all the conditions including Earthquake load by STAAD Pro. The building chosen was 52.5 m in height above ground level. To study the effect of various loads in various Earthquake zone the building was modeled as per plan and the plan was remodified in two different ways so that total number of cases are three namely:

Case 1 : Commercial Complex with 7m Height Shear Wall at Basement.
Case 2 : Commercial Complex with Soft Storey at Basement & at every fourth floor
Case 3 : Commercial Complex with Floating Column at Various Levels.

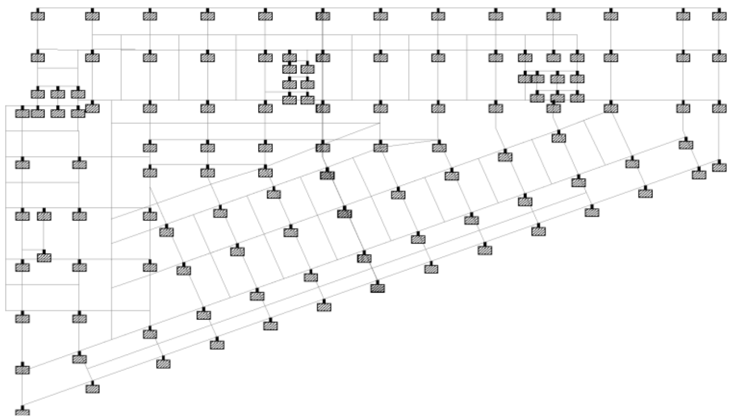

Fig. 1 Typical Plan of Commercial Complex (Columns Refer to All Floors)

III. LOAD COMBINATION

Following load combinations are considered in analysis of the building.

1. 1.5DL +1.5LL
2. 1.5DL +1.5EQX
3. 1.5DL -1.5EQX
4. 1.5DL +1.5EQZ
5. 1.5DL -1.5EQZ
6. 1.2DL +1.2LL+ 1.2EQX
7. 1.2DL +1.2LL -1.2EQX
8. 1.2DL +1.2LL+ 1.2EQZ
9. 1.2DL +1.2LL -1.2EQZ
10. 0.9DL +1.5EQX
11. 0.9DL -1.5EQX
12. 0.9DL +1.5EQZ
13. 0.9DL -1.5EQZ

Critical load combinations for Mx & Mz Values are found to be

1. 1.5DL -1.5EQZ
2. 1.5DL -1.5EQX

IV. ANALYSIS OF DATA GENERATED

The STAAD output generated is analyzed to determine relations between various parameters and develop mathematical models. Relations developed are given below.

1 Relation between Mx Values of Zone II with other Zone values for all Cases
2 Relation between Mz Values of Zone II with other Zone values for all Cases
3 Relation between Mx values of case1 with Mx values of other cases
4 Relation between Mz values of case1 with Mz values of other cases

V. OBSERVATIONS

The following observations are made from the mathematical models developed.

Model 1: Mx Values of column for Zone II with other zone values for case 1

Zone	Model	R^2 value	Observation 5-10%
III	$y = -3E\text{-}05x^2 + 1.627x - 3.027$	0.989	From 258 Results 20 60 20 0
IV	$y = -6E\text{-}05x^2 + 2.464x + 23.25$	0.992	
V	$y = 3.716x + 44.29$	0.988	

Model 2: Mx Values of column for Zone II with other zone values for case 2

Zone	Model	R^2 value	Observation
III	$y = -3E\text{-}05x^2 + 1.628x + 9.510$	0.997	From 258 Results 0 0
IV	$y = -6E\text{-}05x^2 + 2.464x + 23.25$	0.992	
V	$y = 3.716x + 44.29$	0.988	

Model 3: Mx Values of column for Zone II with other zone values for case 3

Zone	Model	R^2 value	Observation
III	$y = -5E\text{-}05x^2 + 1.657x - 15.51$	0.986	From 258 Results
IV	$y = -6E\text{-}05x^2 + 2.464x + 23.25$	0.992	
V	$y = -0.000x^2 + 3.716x + 44.29$	0.988	20

Model 4: Mz Values of column for Zone II with other zone values for case 1

Zone	Model	R^2 value	Observation
III	$y = -3E\text{-}05x^2 + 1.636x - 4.795$	0.997	From 258 Results
IV	$y = -6E\text{-}05x^2 + 2.464x + 23.25$	0.992	
V	$y = 3.716x + 44.29$	0.988	25

Model 5: Mz Values of column for Zone II with other zone values for case 2

Zone	Model	R^2 value	Observation
III	$y = -2E\text{-}05x^2 + 1.625x - 1.494$	0.997	From 258 Results
IV	$y = -6E\text{-}05x^2 + 2.464x + 23.25$	0.992	
V	$y = 3.716x + 44.29$	0.988	15

Model 6: Mz Values of column for Zone II with other zone values for case 3

Zone	Model	R^2 value	Observation
III	$y = -3E\text{-}05x^2 + 1.643x - 8.990$	0.997	From 258 Results
IV	$y = -6E\text{-}05x^2 + 2.464x + 23.25$	0.992	
V	$y = 3.716x + 44.29$	0.988	20

Model 7: Mx values of case 1 with Mx values of case 3

Case	Model	R^2 value	Observation
Case 3	$y = -9E\text{-}06x^2 + 0.998x + 9.697$	0.992	From 1032 Results

Model 8: Mz values of case 1 with Mz values of case 3

Case	Model	R^2 value	Observation
Case 3	$y = 1E\text{-}05x^2 + 0.943x - 7.975$	0.995	From 1032 Results

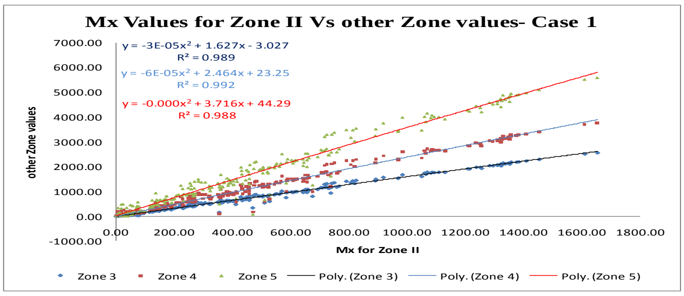

Fig. 2

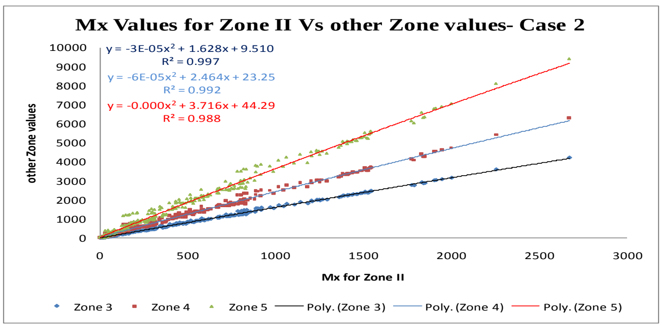

Fig. 3

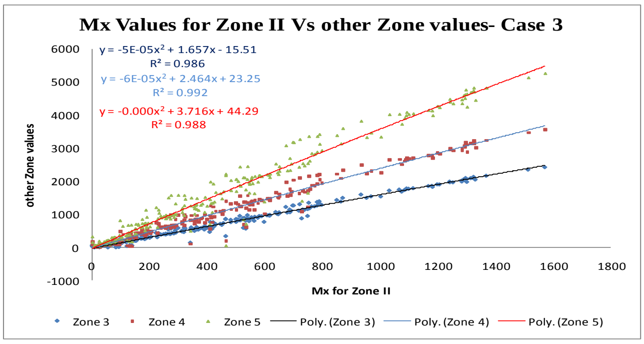

Fig. 4

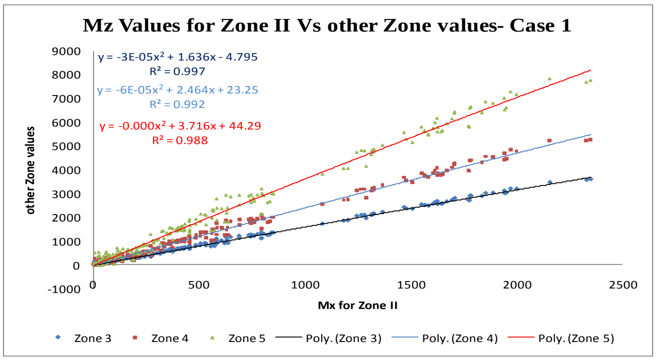

Fig. 5

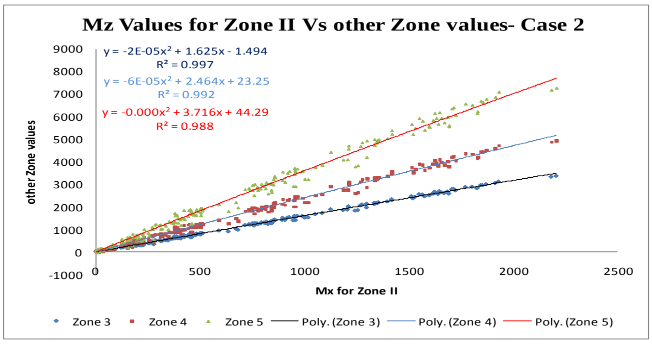

Fig. 6

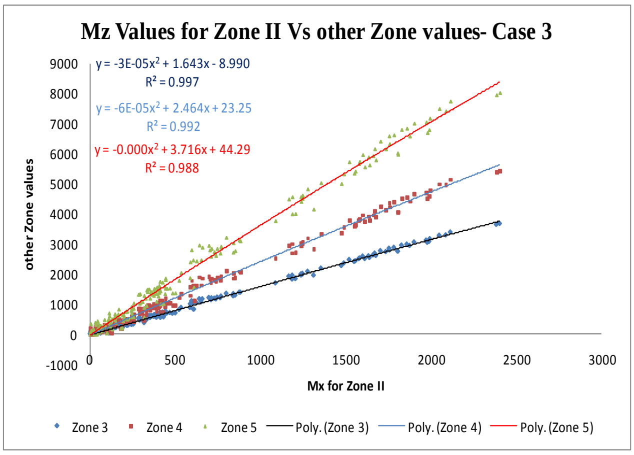

Fig. 7

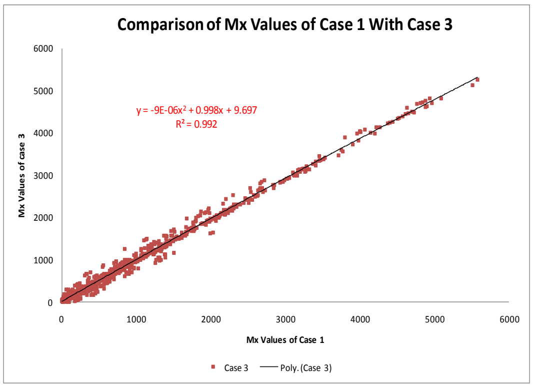

Fig. 8

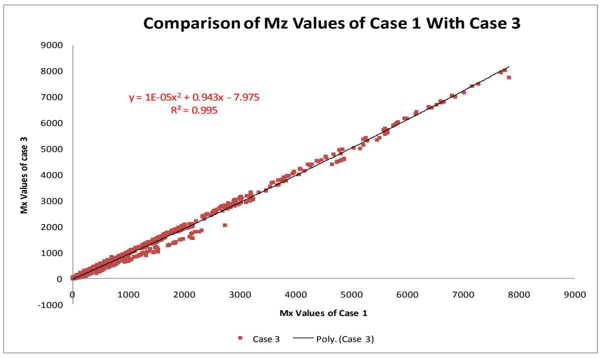

Fig. 9

VI. CONCLUSION

1. In all cases considered values of Mx and Mz is found to be increase significantly in higher earthquake zones as compared to lower zones.
2. The values of Mx increases more than twice in case 2 as compared to case 1. But in case 3 Mx and Mz values are found to be reducing as compared to case 1.
3. In case 2, Mx & Mz values are increasing or decreasing significantly depending upon position and orientation of column.
4. Significant co relationship is observed in between Mx & Mz values of zone II with other zone values for respective cases.
5. Significant co relationship is observed in between Mx & Mz values of Case1 with other cases value.
6. The mathematical models developed can be used for rough estimation of Mx or Mz values, if values for one zone with one of the cases are known.

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