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Seismic Behaviour of the Structure with Re-Entrant Corner Column

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***Abstract:*— In the event of an earthquake, people can be evacuated safely before the building collapses. Major causalities in the earthquakes around the world are due to the structural collapses, majorly structural collapse are due to irregularities in the buildings and due to the architectural complexities, In the present work, it is focused to study the seismic behavior of reinforced concrete structures with plan irregularities, as re-entrant corners for G+5, G+10 & G+15 storied buildings by considering T Shape buildings as a complete building. This study summarizes the effect of Seismic forces on column at re-entrant corners of the building. The building is analyzed as a complete building and separated in it three parts. There is a need to design such a column around 200% to 400% increase in torsion as per case.**

***Key word:*-- re-entrant corners, response spectrum analysis, vertical irregularity, torsional effects.**

I. INTRODUCTION

The behavior of multistoried building during earthquake motions depends on the distribution of mass, stiffness and strength in both the vertical and horizontal planes of the building. A building is said to be a regular when the building configurations are almost symmetrical about the axis and it is said to be the irregular when it lacks symmetry and discontinuity in geometry, mass or load resisting elements. It has been found that irregular structure for which poor performance have been observed during past earthquake. The main objective of the present work is to study the response of the irregular structures under dynamic loads. In this present study it is proposed to consider the building frames that are irregular in plan. The response and behavior of the structures under earthquake loads is to be studied the soft computing tool and commercial software STAAD-pro is used for modeling and analysis and post processing results. The irregularities are introduced by changing the properties of members of the story for vertical irregular frame. For this purpose, T Shape as a complete & as a separate RC building frames are selected and is proposed to analyses all the frames that are to be considered and modeled.

II. REVIEW OF LITERATURE-

Prof. Wakchaure M. et.al in this paper torsional behavior of asymmetrical building is studied by considering two cases in a building with considering torsion and without considering torsion. Building contains different irregularity and re-entrant corners irregularity. It concludes that torsion effect must be taken in to account in design practice for as-symmetrical high rise structure to understand the actual safety margins. Area of steel in concrete without torsion is smaller than with torsion in as-symmetrical buildings. [1]

Gopi Siddappa et.al the building with re-entrant corners causes abrupt changes in the strength or stiffness of the structure causes the rotation in the building. Thus convert the shape in to smaller regular shapes is one of the solution. One of the method to strengthen the re-entrant corner using elements such as shear wall, bracing, or mild steel splays. [2]

Raul Gonzalez Herrera et.al the effect of the commercial irregularities were studied with qualitative analysis as much in Mexico as abroad, The work described the geometric forms that are repeated more in the urban areas in Mexico. In all the studied system effect of different irregularities are analyzed based on the variation of displacement with respect to regular systems and irregular structure needs more careful structural analysis to reach a suitable. earthquake system. Result shows that the rectangular plan is the one that present minor irregularity effect. But in T & U the irregular figure denotes the unstable behavior under seismic demands and construction are more vulnerable when more irregular [3]

Anibal G. Costa et.al. In this paper walls interrupted in height and building having a soft first story is studied. The strength and displacement capacity of those building are obtained by nonlinear static incremental analysis. Where some walls interrupted in height, the distribution of shear and overturning moments in the vertical substructures present great variation in the zone of irregularity. That part of the building requires careful design and detailing. The result showed that irregular

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buildings not having walls in some stories have a brittle mode of failure and should be avoided. [4]

III. WORK DONE:

The analysis of frames with different vertical irregularities is to be performed. For this purpose, two frames are selected as shown in Figure 1. frame are of T shape as a complete building & T shape as separate building frame that consists of G+5,G+10,G+15 storey's with a asymmetrical plan configuration whose centre of mass is not coincides with the centre of rigidity. The structure is assumed to be in seismic zone II, medium soil, building contains re-entrant corner irregularity. Seismic analysis of T-shaped whole building and separate building details, the structural analysis of a five, ten & fifteen story reinforced concrete building is done. Building contains different irregularity like plan irregularity and re-entrant corner irregularity. Building is studied for case as mentioned below:-

- Re-entrant corner: Analysis of building is done for re-entrant corner column and axial forces and shear forces are calculated at each floor level for five, ten and fifteen floor buildings, these forces are calculated considering building as a whole & in separate parts. Plan configuration of structure and its lateral forces resisting system contain re-entrant corners, where both projection of the structure beyond the re-entrant corner are greater than 15 percent of its plan dimension in the given direction

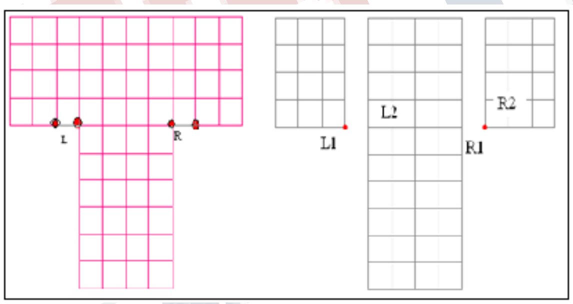

Fig.1 T Shapes Building Showing corners

Two frames are selected as shown in fig. 1, for the analysis. Properties of basic materials (concrete and reinforcing steel) must be defined before proceeding to structural analysis. The reinforcing steel grade FE415 is adopted for all structures, and the class of concrete compressive strength for the all structure is M-20 grade and appropriate software, STAAD Pro is used for the analysis of all structures, to get the all nodal displacements. Building structural data in order to understand behavior of structure of non realistic building configuration is chosen.

Building Details: Shape of Building: T shape as a complete building and separate building

No of Floors: Five, Ten & Fifteen storey
Purpose of Building: Residential
Ground Floor : Parking
Storey Height : 3.00 mt.
Length of Building: 40.00 Mt.
Width of Building: 40.00 Mt.
Slab Thickness : 125 mm
Wall thickness : 230 mm
Concrete Grade : M-20
Steel Grade : Fe-415
Density of Concrete: 25.00 kN/m3
Density of Wall : 20.00 kN/m3
Density of Plaster : 20.00 kN/m3
Density of water : 10.00 kN/m3
Density of Steel : 78.50 kN/m3
Earthquake Data
Zone II : 0.1
Response Reduction Factor : 3.0
Importance factor : 1.0
Soil site factor-Medium : 2.0
S.T. (Type of Structure- Frame : 1.0
D.M. (Damping Ratio) : 5.0
Period of Structure in X Dir. : 3.0
Period of Structure in Z Dir : 0.5

Earthquake zone II is assumed on the site with medium soil, as a general building importance factor is taken as 1, and as an ordinary RC moment resistance frames reduction factor is taken as 3, comparison of Axial Forces for T shape Complete Building and Separate Building.

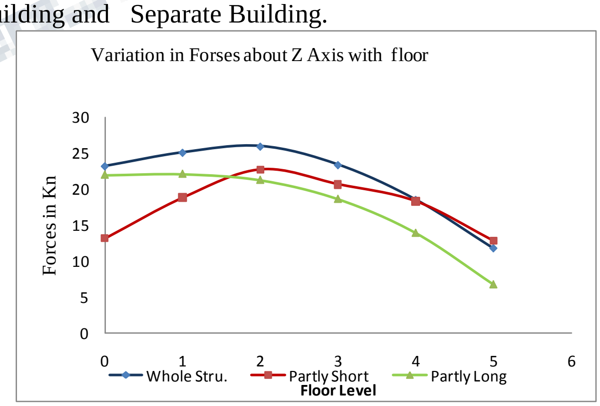

Fig. No. 2 Lateral Forces in the Z direction for G+5

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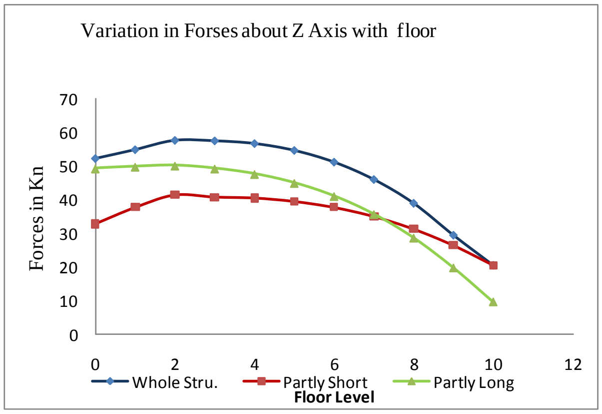

Fig. No. 3 Lateral Forces in the Z direction for G+10

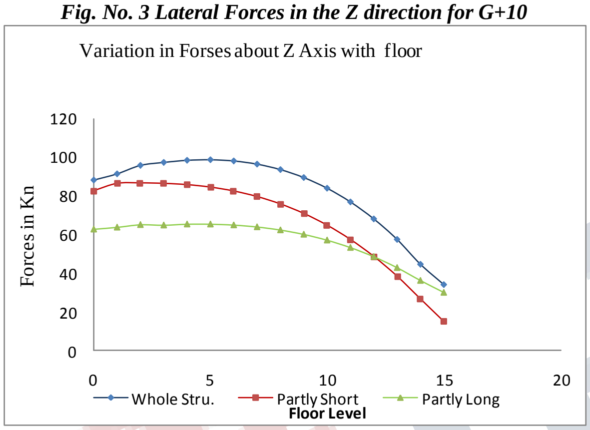

Fig.No.4 Lateral Forces in the Z direction for G+15

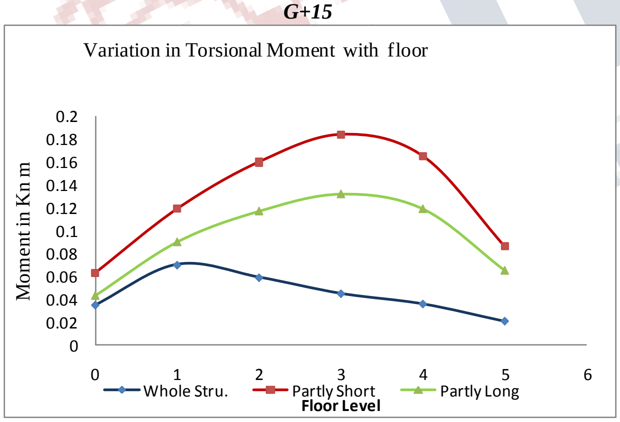

Fig No. 5, Variation of Torsional Moment @ Re-entrant column for G+5

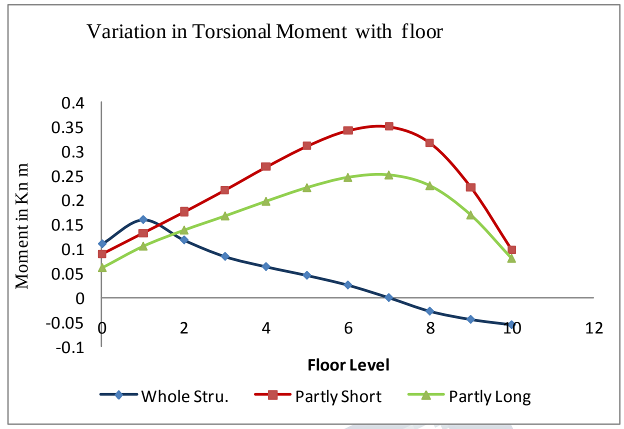

Fig No. 6, Variation of Torsional Moment @ Re-entrant column for G+10

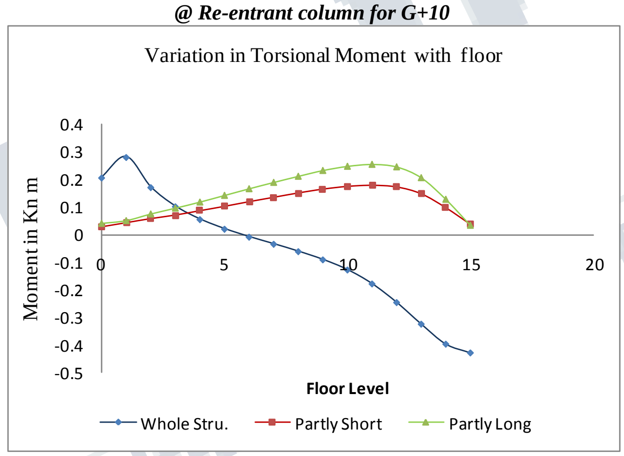

Fig No. 7, Variation of Torsional Moment @ Re-entrant column for G+15

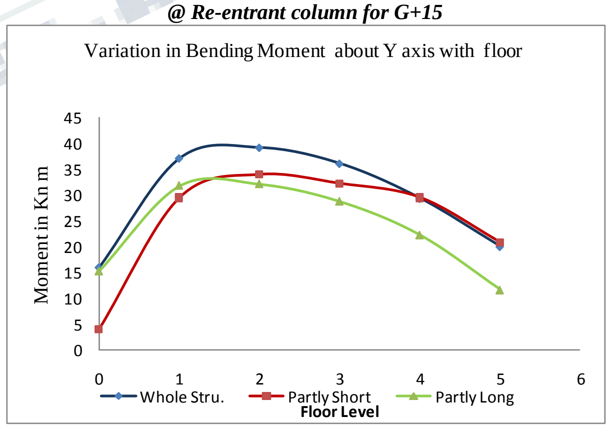

Fig No.8 Variation in Bending Moment about Y axis at Re-entrant column.

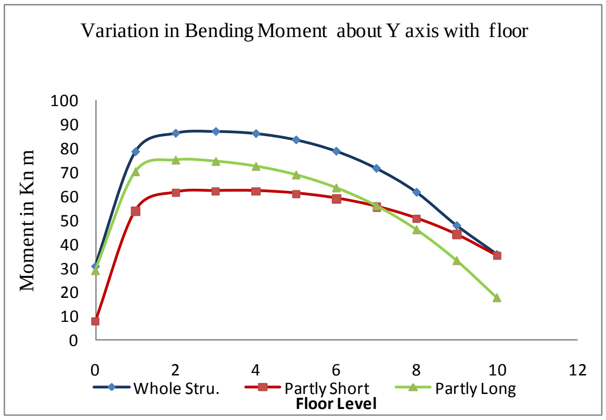

Fig No.9 Variation in bending moment about Y axis at Re-entrant column.

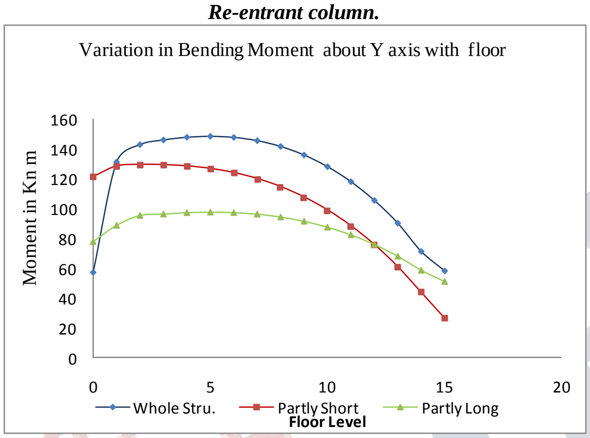

Fig No.10 Variation in Bending Moment about Y axis at Re-entrant column.

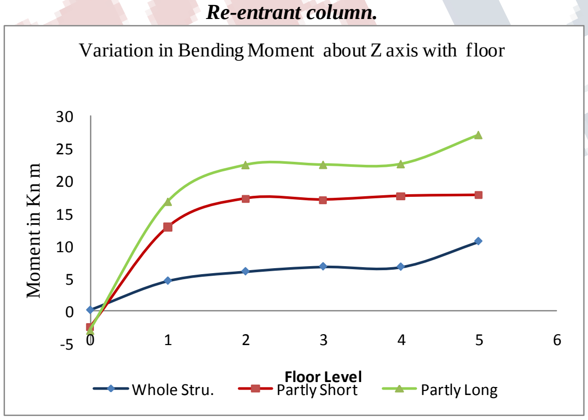

Fig No.11 Variation in Bending Moment about Z axis at Re-entrant column.

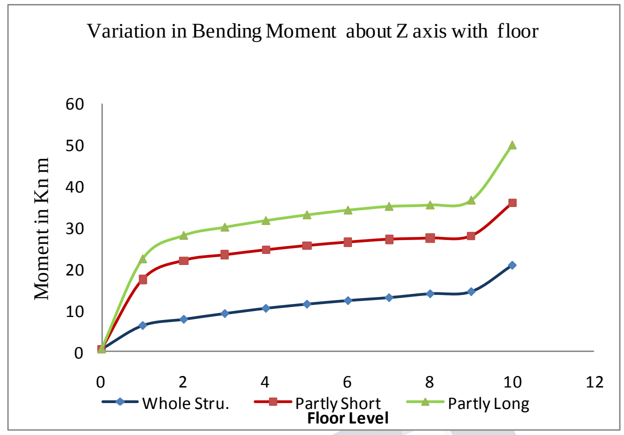

Fig No.12 Variation in Bending Moment about Z axis at Re-entrant column.

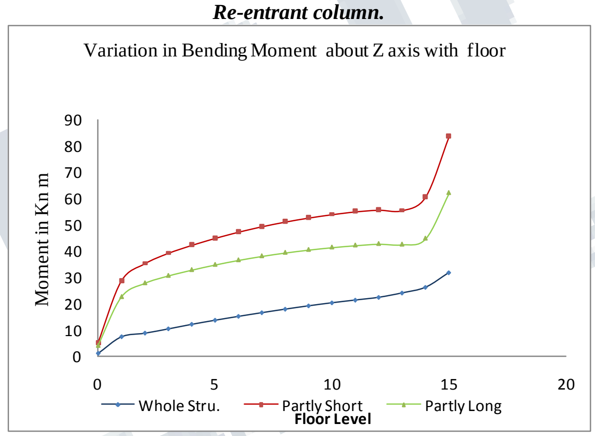

Fig No.13 Variation in Bending Moment about Z axis at Re-entrant column.

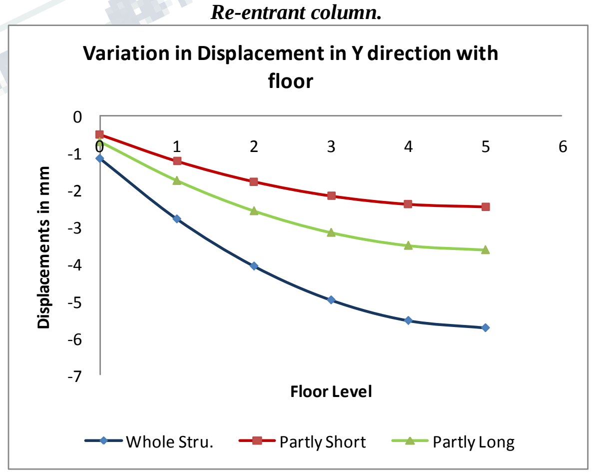

Fig.No.14, Variation in Displacement in Y direction

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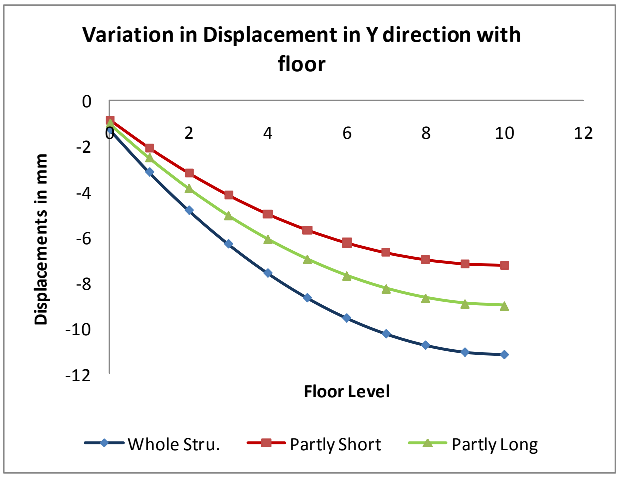

Fig.No.15, Variation in Displacement in Y direction

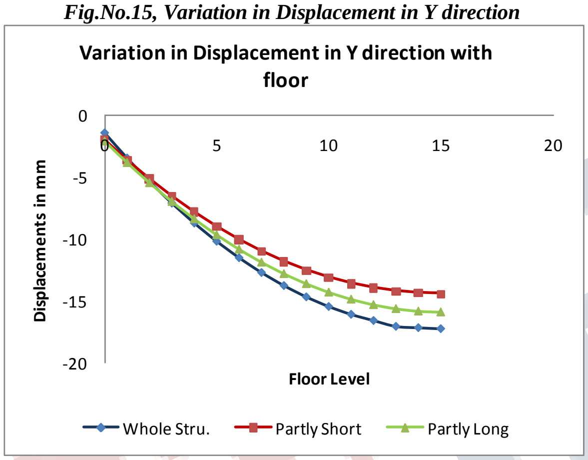

Fig.No.16, Variation in Displacement in Y direction

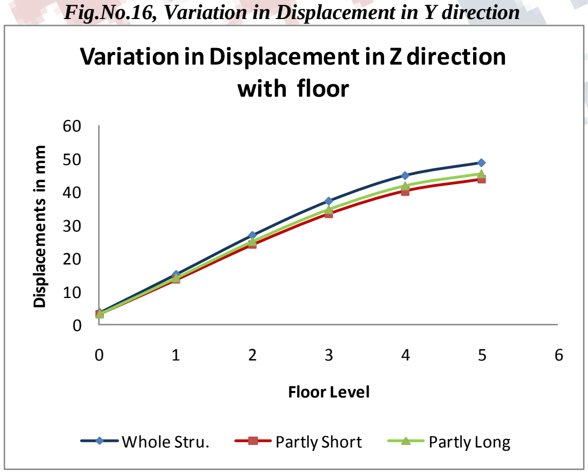

Fig.No.17, Variation in Displacement in Z direction

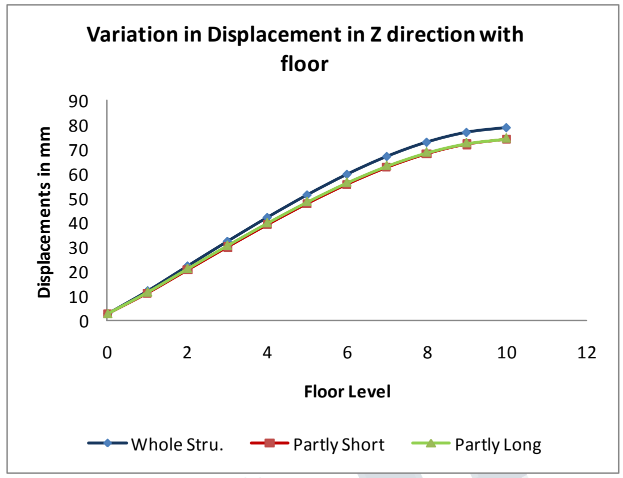

Fig.No.18, Variation in Displacement in Z direction

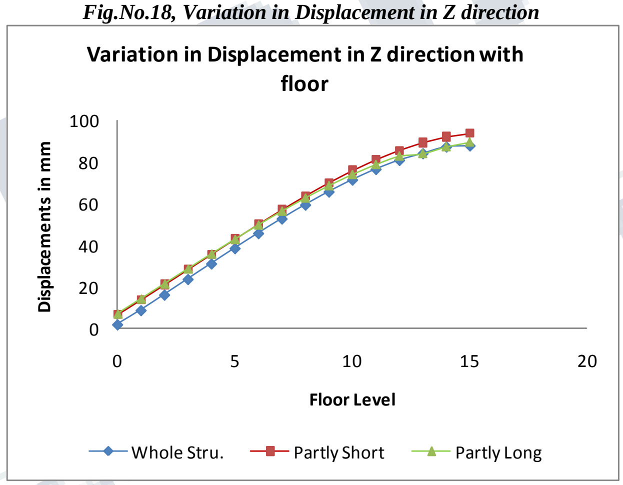

Fig.No.19, Variation in Displacement in Z direction

IV. OBSERVATIONS:

1. In the direction of earthquake forces, transverse forces vary significantly at re-entrant corner column location in the example considered. It is observed that these forces are higher towards top floor in case of the web (short) part of building and they are relatively less at lower floor than the flange (long) part of the building. This clearly indicates that the re-entrant corner column is subjected to torsion of different nature in the top floors and major part of bottom floors. This is indication of precaution to be taken in designing the re-entrant corner column for torsion as indicated by fig.no.2 to.4.
2. Fig. No.5 to 7, justifies this observation about torsion in the lateral direction
3. Fig.No.8 to 10 shows similar trends observed in bending moment about Y direction.
4. Fig. No. 11 to 13 clearly indicates that the torsion about Z axis is much higher when the building is analyzed in two separate parts, this indicates that the re-entrant corner

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column and connected beams must be designed for 2 to 4 times more torsion.(200% to 400% more torsion)

5. Connection of top floors with floors below must be strong enough to resist displacement of top floors and special precaution is nessessary in detiling the joint of top floor column with column below as indicated in figures 14 to 16.

6. No significant variation is observed in the displacements in the direction of earthquake forces as indicated by figures 17 to 19

V. CONCLUDING REMARK

Re-entrant corner column in unsymmetrical building are vulnerable from torsion point of view from case study on T section plan building it is observed that the relative displacement of web and flange part, development of torsion of different nature and the differential shear force result in development of torsion There is need to design such a column around 200% to 400% increase in torsion as per case.

REFERENCES

[1] Prof. Wakchaure M.R, Nagare YU "Effect of Torsion consideration in analysis of multistory frame" Aug.-2013

[2] Gopi Siddappa "Seismic behavior of RC buildings with re-entrant corners and strengthening "

[3] Raúl González Herrera and Consuelo Gómez Soberón," Influenvr of plan irregularity of Buildings". October 12-17, 2008

[4] Anibal G. Costa, Carlos s. olivera "Influence of vertical irregularities on seismic response of building" Aug.2-9, 1988

[5] Seymen A., Akın D., "Disaster Management System of Turkey and Lessons Learned From 1999 Big Earthquakes", Ministry of Public Works and Settlement General Directorate of Disaster Affairs,

[6] Devesh P. Soni, Bharat B. Mistry, "Qualitative Review Building Frames", ISET Journal of Earthquake Technology, Technical Note, Vol. 43, No. 4, December 2006, pp. 121-132.

[7] K.J. Elwood and M.O. Bernhard "Effective Stiffness of Reinforced Concrete Columns"

[8] Bing Li , School of Civil and Environmental Engineering, Nanyang Technological University,Singapore "Initial Stiffness of Reinforced Concrete Columns and Walls"

[9] Dr. G. P. Chandradhara Professor of Civil Engineering, S. J. College of Engineering, Mysore "Structural and Architectural Aspects of Earthquake Resistant design"