COMPARATIVE STUDY ON THE EFFECT OF TORSION IN A MULTISTORIED RC STRUCTURE

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ABSTRACT— *The architectural demands are changing day by day and new designs are being implemented in buildings which creates irregular structures .These structures will have varying mass and stiffness which imparts to the effect of Torsion .A Multi storied irregular RC structure is designed for different Seismic Zones and a comparative study is done with and without considering the effect of Torsion into account .The structure is modeled in STAAD.Pro and the analysis is done and the results shows that in higher seismic zones the effect of Torsion is predominant and proper care should be given to extreme columns and corner columns which are more vulnerable to failure .Torsional effect has to be taken into consideration by taking the diaphragm action into consideration while designing the structure.*

Key Words—Torsion, stiffness,Seismic Zones,diaphragm

1. INTRODUCTION

Torsinal behavior of structures are the frequent cause of failure in structures having an asymmetric plan. These failures are predominant in areas of high seismic zones.When the center of mass coincides with the center of resistance, the system is said to be balanced and when there comes an eccentricity between these two the system will become unbalanced and it will lead to torsion. Torsion in a structure may be developed due to irregular mass distribution, irregular stiffness distributionor irregular strength which may cause serious damages to the structure

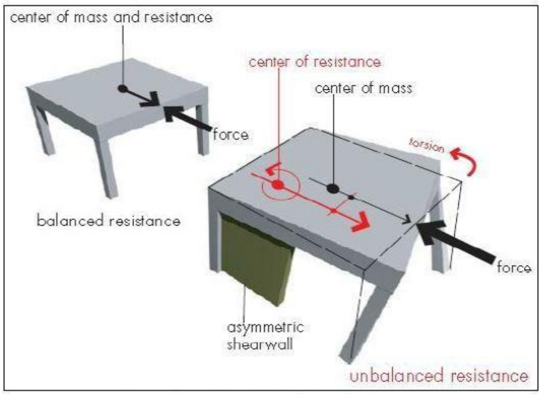
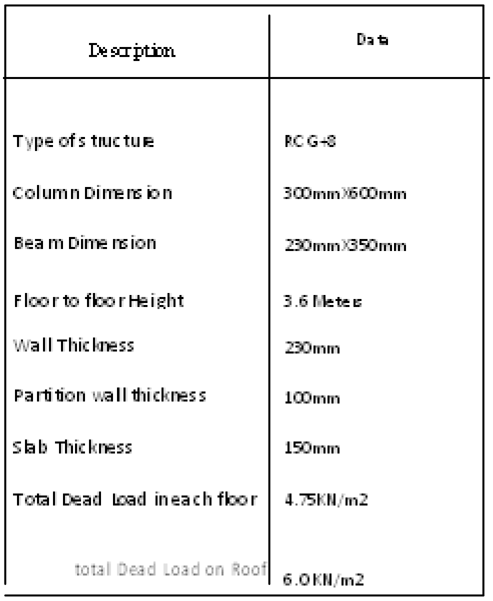


Fig. 1.Generation of Torsion

At the time of occurrence of an earthquake the inertial forces will act through the center of mass and the resisting force created will act through the center of rigidity of the structure as in Fig. 1.A Lateral Torsion Coupling will be created due to the eccentricity created between the center of mass and the center of rigidity of the structure. In this paper a G+8 residential apartment is taken for the study which is modeled in STAAD.Pro and analyzed it for two seismic zones that is zone II and zone IV as per the Earthquake classification of IS code IS 1893 – 2002 –Part I.Firstly the structure is analyzed without considering the effect of torsion. The designs for both zones are carried out based on the data from TABLE I and the design outputs are noted in terms of steel required in each members. The reinforcement details are prepared as per the ductile detailing code IS 13920 for the structure in Zone V.

TABLE I

DESIGN CONSIDERATIONS AND PROPERTIES



Description	Data
Type of structure	RC G+8
Column Dimension	300mmX600mm
Beam Dimension	230mmX350mm
Floor to floor Height	3.6 Meters
Wall Thickness	230mm
Partition wall thickness	100mm
Slab Thickness	150mm
Total Dead Load in each floor	4.75KN/m2
total Dead Load on Roof	6.0KN/m2

2. TORSIONAL DESIGN

The structure is considered for design by taking the effect of torsion into consideration by giving the floors as a rigid diaphragm with the cutouts and openings like staircase and atriums being removed. The diaphragms which imparts strength and increase the stiffness of the structure and creates a monolithic action which acts against the Torsion coming in the structure. Then the model is analyzedby taking accidental eccentricity into account and for the same loading conditions and an additional loading as, the modal masses are defined as reference loads in all three directions X,Y and Z.

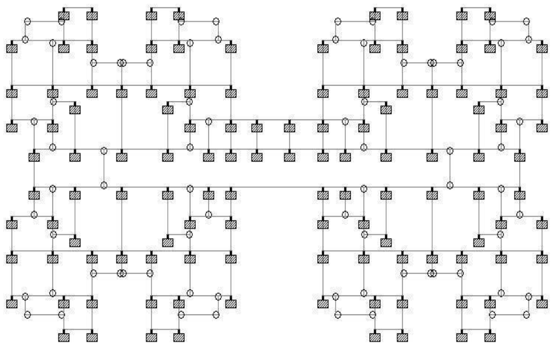
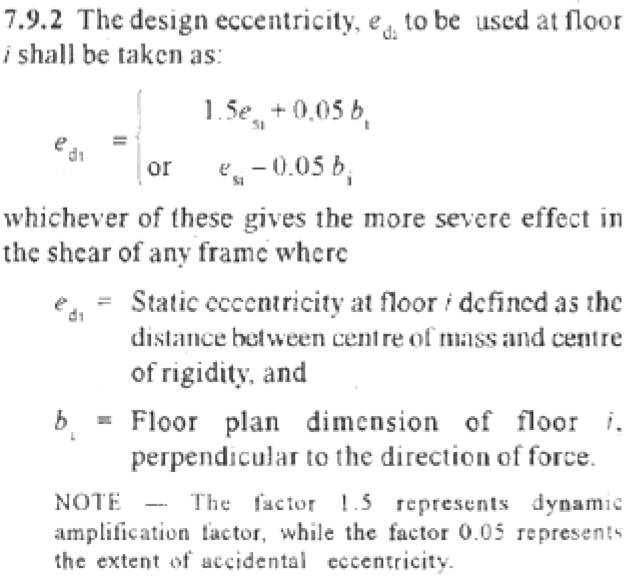


Fig. 2. Plan View of the Model

The design eccentricity has to be taken from the earthquake code IS 1893 2002 Part I



7.9.2 The design eccentricity, e_{di} to be used at floor i shall be taken as:

$$e_{di} = \begin{cases} 1.5e_{si} + 0.05\, b_i \\ \text{or} \quad e_{si} - 0.05\, b_i \end{cases}$$

whichever of these gives the more severe effect in the shear of any frame where

e_{di} = Static eccentricity at floor i defined as the distance between centre of mass and centre of rigidity, and

b_i = Floor plan dimension of floor i, perpendicular to the direction of force.

NOTE — The factor 1.5 represents dynamic amplification factor, while the factor 0.05 represents the extent of accidental eccentricity.

Fig. 3.Reference from IS Code

The time period for seismic vibrations shall be taken as per IS 1893 - 2002 Part I as

$$Ta = \frac{0.09h}{\sqrt{d}} \qquad (1)$$

–Time Period (Sec)

h–Total Height of the structure (m)

d –Base dimension of the building at plinth level (m)

Here in this case the total floor height is 32.4meters and the base dimension of the building along plinth is 44m in X direction and 23 meters in Z direction ,hence the time period for seismic vibration coming for the structure is 0.46seconds in X direction and 0.61seconds in Z direction.

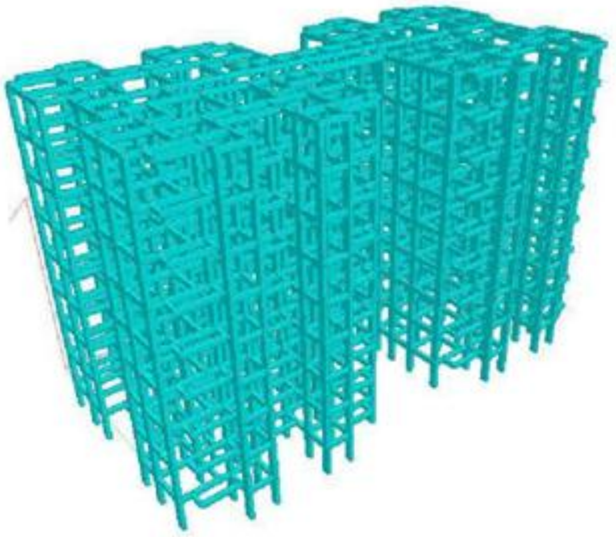


Fig. 4.3D Model in STAAD.Pro

3. RESULTS AND DISCUSSIONS:

Several components of the structure when designed for torsion fails when it comes from Zone II to Zone V as they are more prone to torsion. The column members failed are shown in Fig.5.It can be seen that the torsional effect is more active at the base of the structure and these are decreasing as we go up

The percentage of steel Ast of 5 critical columns are compared when it is designed as normal as well as when theeffect of torsion is considered for Zone II. It is represented graphically as shown in Fig.6 which shows that the reinforcement requirement is almost 5-10% more when effect of torsion is considered. Similarly same graph is plotted for Zone V and it shows a variation of around 20% at particular columns like corner columns as in Fig.7. Both the Zones II and V are compared and represented in graphical form as of Fig .8

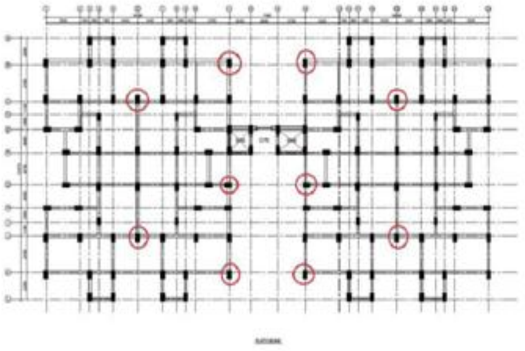


Fig. 5.Critical columns for Torsion

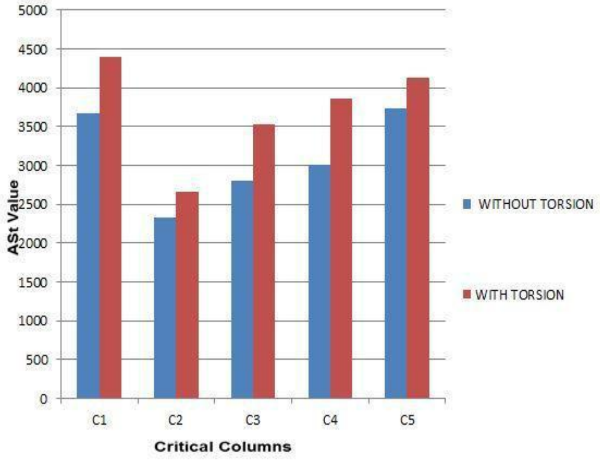


Fig. 6.Ast for critical columns in Zone II

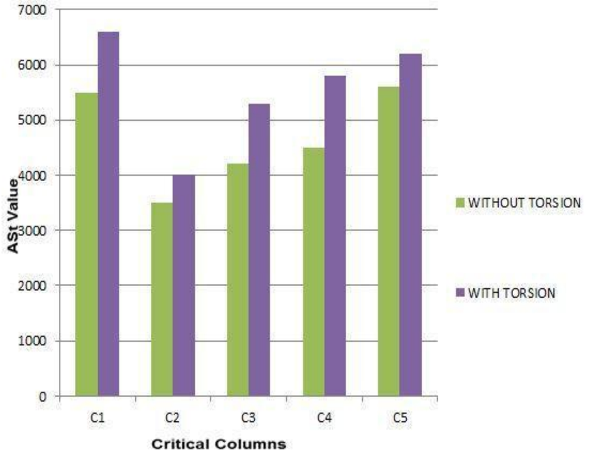


Fig. 7.Ast for critical columns in Zone V

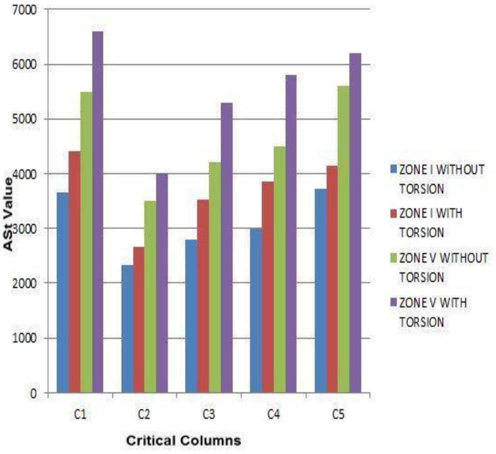


Fig. 8.Ast for critical columns in Zone II&Zone V

4. CONCLUSION:

It is clear that the effect of torsion should be taken into concern if the structure is in zones of high seismic intensities. It can be seen that corner as well as re-entrant columns are more vulnerable to the twisting effect or are more prone to failure, hence care should be taken in case of these columns and proper ductile detailing has to be done for such critical members.The columns which are far from the center of rigidity are more critical hence care should be taken for such columns as well.

5. REFERENCES

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