

A REVIEW PAPER ON TORSIONAL BEHAVIOR OF ASYMMETRICAL BUILDINGS

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Abstract:

The structures having discontinuity in their mass, stiffness and geometry, such structure is termed as asymmetric/ irregular structure. At the present scenario there are many buildings which are asymmetric in their plan as well as in elevation. These asymmetry leads to major damage during earthquake than regular buildings. Sometimes irregularities are not avoidable in construction of buildings. However the torsional behavior of asymmetric building during earthquake needs to be studied for appropriate design and better performance of building. Several studies of structural damage during past earthquake conclude that torsion is the most critical factor leading to major damage or complete collapse of a building. The object of the present work is to state a review on the past papers presented on torsional behavior of asymmetrical buildings. So the present work provides a good source of information to understand structural behavior of building with irregularities under strong ground motion.

Keywords: Earthquake, Asymmetrical Building, Torsion.

I. INTRODUCTION:

The earthquakes are the most unpredictable and devastating among all natural disasters, which causes the more damages to the buildings and living things. So it is very necessary to identify the behaviour of buildings, especially their torsional behaviour during an earthquake. Torsion response in a building is affected by coupling of translation vibration with rotational vibration.

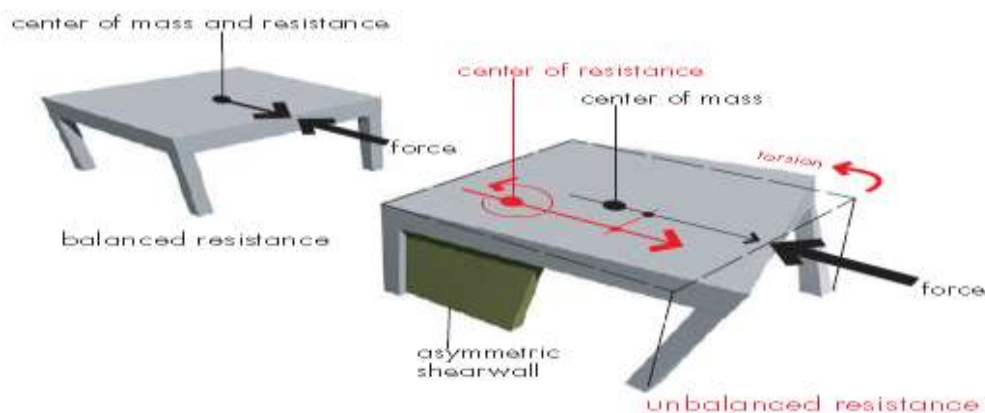


Fig1-

Generation of torsional moment in asymmetric structures during seismic excitation.

The past investigation regarding to earthquake reveals that irregular structures suffer from more damages than the regular one. An irregularity in dimensions affects the distribution of stiffness while a mass

irregularity tends to influence the imposed demand. At the present situation irregularities in the construction of buildings are unavoidable due to various demands of young generation. These irregularities are responsible for creation of torsion effect in a building. Torsional response in a building arises from mainly two reasons that is eccentricity in mass and stiffness distributions and accidental causes.

II. REVIEW OF LITRATURE:

Many research investigations have been carried out regarding the torsional effect of the multi-storey structures:

Vipin Gupta and Dr. P.S. Pajgade [1] presented a review about the Investigation Done On Torsional Behaviour Of Multistorey Buildings with plan as well as vertical irregularities. It also focuses on codal provision made for torsion. From their investigation on reviews they concluded that the torsion is the most critical factor leading to major damage or complete collapse of building; therefore, it is necessary that symmetric buildings should also be analyzed for torsion. As result the buildings should be designed by considering the design eccentricity & accidental eccentricity. It was observed that the irregular profile buildings got larger forces and displacement as compared to regular one. Structures are never perfectly regular and hence the designers routinely need to evaluate the likely degree of irregularity and the effect of this irregularity on a structure during an earthquake.

Sachin G. Maske and Dr. P.S. Pajgade [2] presented a paper on Torsional Behavior of Asymmetrical Buildings. In this experimental study, the focus was on the influence of the torsional effect on an asymmetrical structure. Two types of structural elements were considered for this study, which was considering the torsional effect and the other without considering the torsional effect. IS 1893 (Part 1: 2002) was adopted for the guidelines and methodology to analyze and design the building. For achieving results, the percentage of reinforcement was compared from the columns on the stiff side with the columns on flexible side of the structure. In case of the asymmetric building considering torsional effect, it was determined that the forces in the columns on the stiff side were much smaller than the forces on the flexible side of the building and also it was observed that there was not any significant change in the intensity of column forces close to the center of rigidity.

Prof. Wakchaure M. R. and Nagare Y. U. [3] presented a paper on Effect of Torsion Consideration in Analysis of Multi Storey Frame. Since the torsional behavior of asymmetric building is one of the most frequent cause of structural damage so it is necessary that all building should be analyzed for torsion. In this work they considered two cases one with considering torsion and another is without considering torsion. They conclude that In the asymmetric building case 2, that is without considering torsion, it was observed that the area of steel in the beams at critical stage are much smaller than those obtained in the case 1, that is with considering torsion. The bottom bars should be more critical, because they seem to be subjected to more tension than the top bars therefore torsional behavior of asymmetric building is one of the most frequent source of structural damage and failure during strong ground motions. The variation of A_{st} is much higher for small span beams.

Sumit Gurjar and Lovish Pamecha [4] published a paper on Seismic Behaviour of Buildings Having Vertical Irregularities. In this work they have studied on drift and displacement producing in a building, they have considered 6 models of 6 x 6 bays having 20 stories in which upto tenth storey structure is regular with and without shear wall. Also 2 x 2 bays from tenth floor to twentieth floor with unsymmetrical vertical configuration starting from tenth floor, placed at corner, at the center and at edge of the plan respectively. They concluded that for all the frames considered, drift values follow a similar path along storey height with maximum value lying somewhere near the thirteenth to fifteenth storey. In zone II and III all the frames are within permissible limit, hence there is no requirement of shear wall in these zones. From displacement point of view all the zone requires shear wall to control the permissible limit. Except only in zone II all the frames are within permissible limit.

Neha P. Modakwar and Sangita S. Meshram and Dinesh W. Gawatre [5] Published a paper on Seismic Analysis of Structure With Irregularities. This study was initiated to find effect of different degree of irregularity on structures designed for earthquake. They considered two types of irregularities. Horizontal Irregularity entrant corner. Vertical Irregularity Mass Irregularity. They studied to understand different

irregularity and torsional response due to plan and cross shape building while earthquake forces acts and to calculate additional shear due to torsion in column. From all the study they have concluded that Reentrant corner columns are needed to be stiffened strengthen for shear force. For torsion point of view reentrant columns must be strengthen at lower floors. They observed that behavior of torsion is same for all zones. Also, effect of torsion depend upon the diaphragms. It will be much more when diaphragms at some level are removed, So it is better to avoid reentrant corner buildings having irregularity in diaphragm.

Nonika N. and Gargi Danda De [6] Published a paper on Seismic Analysis of Vertical Irregular Multistoried Building. The main purpose of this study is to understand the effect of elevation irregularity and behavior of 3D RC building subjected to earthquake load. In the present study 5 X 5 bays, 16 storied having soft storey 3 D structure located in all zones Response Spectrum Method is used to find results. For this the behavior parameter considered are Maximum displacement Base shear Time period. All these 3 parameters are compared with different zone. From all these study it can be conclude that, base shear and lateral displacement will increase as seismic intensity increases. The drift is observed in the storey in which stiffness is reduced. Stiffness is dependent on mass of the structure in short stiffness and frequency are inversely proportional to each other.

Miss. Aadishri D. Kadam and Dr. P. S. Pajgade [7] published a paper on Designing of Soft Storey For RC Structure using IS-1893 (Part I)- 2016, And IS-13920-2016. At the present scenario we see the most of building have open ground storey for the various purpose. But this soft storey relates with vertical mass irregularities which is responsible for causing torsion effect in buildings. So in this paper design of soft storey for RC structure is done to reduce the torsion effect on building. They worked on plan of 5m X 5m grid building having 15 storey. They have compared various % of plan density for shear wall provision. Also compared all storey displacement with various plan density lesser than 2 %. From all study it can be concluded that, building with shear wall upto soft storey is sufficient. Rather than upto full height of building. Also 2% plan density of shear wall is not necessary, by providing lesser % of plan density of shear wall is also safe. Deflection observed was under permissible limit. So the effect of torsion will be under control.

Varsha R. Harne [8] presented a paper on Comparative Study of Strength of RC Shear Wall At Different Location On Multi Storied Residential Building. This paper investigates the more efficient location of shear wall. In this work she considered 4 model 1 without shear wall and another 3 model with shear wall at various position. These analysis were performed by using STAAD-PRO from the whole study it can be said that building with shear wall at each corner side i.e. upto corner pt to next grid point is more efficient than all other types of shear wall.

Richa Gupta, Alfiabano [9] focused on the Performance Evaluation of Various Shapes of Shear Wall Using Response Spectrum Analysis. In this paper the main object is to study the effectiveness for low rise (G+6), medium rise (G +16) and high rise (G+25) building for various shapes of shear wall i.e. L shaped, I shaped, rectangular and C shaped. Complete analysis is done by using ETAB software. There is comparison in the parameters like storey drift, storey stiffness and lateral displacement for the building with and without shear wall. It is observed that I shaped shear wall performed better than others. Storey drift and storey displacement is decreases in building with shear wall than the building without shear wall.

Ravi Sonani, Dhaval Isamaliya, Jemish Gadhiya, Nikunj Mangukiya [10] focused on The Behavior of RC Structure With and Without Provision of Shear Wall Including Openings Against Lateral Loads. The complete analysis is done with the help of ETAB software by providing opening in the shear walls. And there is a comparison in the resultant parameters like storey displacement, time period, storey stiffness. There are five different cases comparing with and without shear wall. Here is shear walls at weaker side as well as in all four sides with opening and without opening. It can be concluded that there is reduction in all parameters when the shear walls are provided in all four sides.

Govardhan Bhatt, Abhyuday Titiksh, Palash Rajepandhare [11] states Effect of Curtailment of Shear Walls For Medium Rise Structures. Present study states six different cases of shear wall curtailment considered by terminating the shear walls at intermediate heights of a G+9 storey building. The models are subjected to lateral and gravity loadings in accordance with IS provision and Response Spectrum Analysis is carried out using ETAB software. The models displaced acceptable performance in terms of drift and displacement. Even when the shear walls were curtailed upto half the height of original structure. It is observed that, shear walls at some intermediate levels instead of being detrimental, will prove to be a positive design

technique for medium rise and highrise structure. The optimum level of curtailment need to find out using continuum mechanics and same need to verify by software modelling using RSA.

M. Uzun, A. Unal, M. Kamanli, M. T. Cogurcu[12] states Investigation of the Effect of Torsional Irregularity on Earthquake Behaviour. In this research, the variation of the torsional irregularity according to the number of story and the earthquake analysis method was investigated. Two different plan types were chosen in which shear wall is used in first type and not used in another one. The number of floors was changed to examine the effect of analysis methods and number of storey on torsional irregularity. This can conclude that the base shear forces obtained by the Equivalent Earthquake Load(EL) method in the building with extreme torsional irregularity increase by approximately 50% for each number of storey. EL method was not suitable for the building with extreme torsional irregularity. It seems that coefficient of torsional irregularity increases while number of storey decreases. In order to use the EL method, there should be no building irregularities.

III. CONCLUSION:

From the study of literature presented in this paper, conclusions are drawn out on the response of torsional behavior of building:

- I. Irregularities in a building are responsible to create torsional effect during earthquake. As torsion is the most critical factor leading to major damages or complete collapse of building, so every irregular and regular building should be analyzed in particular zone for torsion.
- II. Irregular structures can behave as regular structure if proper precaution and modification are made.
- III. For the torsion point of view, re-entrant columns are needed to be stiffened and strengthened for resisting the horizontal forces during strong ground motion.
- IV. Shear wall should be located away from the centroid of the building and should be placed symmetrically in a plan to avoid torsional effect.
- V. Changing the shear wall position will affect the attraction of forces, so that wall must be in proper position.
- VI. Shear walls placed at the corners and at the center of all four sides of the building gives better performance in accordance with the parameters like storey displacement, storey drift, stiffness and time period.
- VII. Soft storey effect can be minimized by providing shear walls at proper location.

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