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A Review On Eeffect Of Vertical Stiffness Irregularity On Building With Shear Wall Framed Structures

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Abstract: *Now every day multi-story building is made for the aim of residential, industrial, and commercial etc. In general, for design of these tall structures both wind as well as earthquake loads are required to take in consideration for analysis. In addition to this there are many types of structures or buildings having different geometry in vertical and horizontal plan. This paper shows the analysis of vertically irregular structure with shear wall frame, the failure of structure starts from the points of weakness. This weakness arises because of separation in mass, stiffness and instant change in vertical plan of structure. The structures having this discontinuity in physical property or geometry are termed as Irregular structures. In the present study shows the review of modelling and analysis of vertical irregular structure by using different structural software and Many of standard codes are used for design of all elements and for designed Wind loads and end of this review paper with comparing of the structural behaviour like displacement, drift, etc. of these vertical irregular with symmetrical regular building.*
Keywords*: Geometry, irregularity, wind analysis, stiffness, shear wall*

I. Introduction

The high rise or multi-storied building is necessary part of urban locality and also part of developed country because congested land promotes the high rise buildings[1]. Since from past decade requirements of peoples and change in lifestyle become increases day by day over the expectations. For example in the 1800s century the plan of buildings or any other structureswas very simple and as well as symmetric geometry [2]. But now architectural demand arises due to this the plan of buildings becomes asymmetric and irregular in horizontal as well as vertical geometry [3]. This irregularity causes discontinuity in mass and stiffness of structure. In addition to this height of building also take in consideration at the time of analysis for stability of structure [1]. Now multi-storied buildings or skyscraper are trending. And these two factors namely high rise building and irregularity in geometry gives the task to the structural designer. Because the failure of structure starts from the points of weaknessand this weakness arises because of separation in mass, stiffness and instant change in vertical plan of structure. The structures having this discontinuity in physical property or geometry are termed as Irregular structures. There are two types in irregularity namely plan irregularity and vertical geometric irregularity. If Plan having different plan configurationscalled plan irregularity and in this seismic response is not only translational but also rotational causes eccentricity in mass and stiffness of structure [5]. In case of vertical irregularity can be defined as the horizontal dimension of the lateral force resisting system in a storey is more than 150% of that in its adjacent storeycalled as Vertical Geometric Irregularity [4].If the building is located in most sever zone having lateral forces such as wind and seismic then it becomes most critical for stability. At this stage various structural software are used for analyse and design of these structures such as STAAD PRO, ETABS, SAP2000, SAFE etc. This paper based on wind analysis of tall buildings having vertical irregularityby using ETABS software.

II. Effects Of Wind In Irregular Structure:

Vertical irregularity is most important to take in consideration during analysis and construction of multi-storied building.The behaviour of structures with these irregularities in case of earthquake has to be studied. Adequate precautions will be taken. An in depth study of structural behaviour of the buildings with irregularities necessary for design and behaviour. Multi-storied structures are primarily designed to resist static load [9]. Typically the result of dynamic masses acting on structure isn't taken. This feature of neglecting the dynamic forces generally becomes the reason behind disaster, Over the last 20 years, wind engineering has more and more focused on the modest low rise and high rise structures, since abundant of the damage and loss related to extreme wind events happens to those minimally designed buildings like low rise buildings and conjointly large loss if encountered by the high rise buildings [6]. In vertical irregular structure there is separation of mass, stiffness and geometry of structure and due this separation or sudden change in geometry causes failure of structure. The vertical irregularity is the main reason of sudden collapse and over turning of structure that's why the irregularity in structure is very essential parameter for structural engineer to take in consideration while designing [7].A mean wind force acts on a building. This mean wind force comes from the mean wind speed and therefore the unsteady wind force created by the unsteady flow field. The result of the unsteady wind force on the building or part therefrom depends not only on the characteristics of the unsteady wind force but additionally on the dimensions and vibration characteristics of the building. Therefore, so as to estimate the planning wind load. It is necessary to guage the characteristics of unsteady wind forces and therefore the dynamic characteristics of the building. The factors typically thought of in determinant the unsteady wind force are: 1) Wind turbulence (temporal and special fluctuation of wind) 2) Vortex generation in wake of building 3) Interaction between building vibration and encompassing air flow for many buildings, the result of unsteady windforce generated by wind turbulence is predominant[10]. Because of this reasons wind load is compulsory to take in consideration in high rise building or the building having the height is more than 10 meters with some factors depending upon type of structure, zone, topography, terrain category, etc.[8]

III. Literature Review

Venkata Sairam Kumar. N & et al (February 2014) carried out research mainly on application of cyclic load tests and behaviour of different types of shear walls in cyclic application of loads. Shear walls can be used as lateral load resisting Systems and also retrofitting of structures. Internal shear walls are more efficient than External shear walls when compared with cyclic load tests by researchers.

Ravikanth Chittiprolu, Ramacharla Pradeep Kumar, (June 2014) performed study on dynamic linear analysis using response spectrum method and lateral load analysis was done for structure with shear wall and structure without shear wall. Results were compared for the frame lateral forces and storey drifts of both the cases. It was inferred that shear walls are more resistant to lateral loads in an irregular structure. Storey drift is reduced in case of structure with shear wall. Also they can be used to reduce the effect of torsion.

Varsha R. Harne (2014) carried out a study to determine the strength of RC Shear wall of a multi-storied building by changing shear wall location. 3 different cases of shear wall position for a 6 storey building have been analyzed. Incorporation of shear wall has become inevitable in multi-storey building to resist lateral forces. Among all the load combination, the load combination of 1.5 DL + 1.5 EQX is found to be more critical combination for all the models. It was found that shear walls are more effective when located along exterior perimeter of the building. Such a layout increases resistance of the building to twisting.

S.Kumbhare, A.C. Saoji (2012) had carried out study on the effect of seismic Loading on placement of shear wall in medium rise building at different alternative location. They found that frame type structural system becomes economical as compared to dual type structural system and can be used for medium rise residential building situated in
high seismic zone.

Ashish S. Agrawal, S.D.Charkha (2012) carried out study on 25storey building in Zone V by changing various position of shear wall with different shapes for determining parameters like storey drift, axial load and displacement. From the results of analysis they came to a conclusion that placing shear walls away from centre of gravity resulted in increase in most of the member forces. Also they found that displacement of the building floor at storey 25 has been reduced due to the presence of shear wall place at the centre.

Y.M. Fahjan & J. Kubin & M.T. Tan (2010) found that in the countries with active seismicity, reinforced concrete structural walls are widely used in multi-storey structure systems. Therefore, a proper modelling of the shear walls is very important for both linear and nonlinear analyses of building structures. The shell element can be used efficiently for the analysis of building structures with shear walls. The shell element considered in most of the design software has 6 degrees of freedom at each node and an in-plane rotational degree of freedom, which makes it compatible with three-dimensional beam-type finite element models. Shear wall modelling requires mesh discretization in order to get realistic behaviour. The advantage of using shell elements is the ability to model very long, interacting and complex shear walls within the three dimensional model.

G. Nandini Devi, K.Subramanian & A.R.Santhakumar (June 2009) studied a three bay R.C frame without and with shear wall in middle bay which was subjected to static cyclic lateral load. Shear wall of one bay was subjected to static reversed cyclic lateral load to assess its individual behaviour. Cyclic effects on the shear wall frame were considered for comparison. Shear wall frame and dual frame was compared to assess the individual behaviour of shear wall and when it is designed with beam column Frame. It was found that in spite of carrying large load, the dual frame exhibited less top storey deflection. At the initial stage of loading the dual frame was

7.84 times stiffer than the bare frame and 4.84 times higher than the shear wall frame. At service load (50% of the ultimate load, the dual frame is 10.56 times stiffer than the bare frame and 6.76 times stiffer than the shear wall frame. When the frames are compared at service load, it was found that the dual frame can be used for a larger service load and can withstand higher seismic loads with small deflection.

J.Kubin, Y.M.Fahjan and M.T.Tan (2008) studied the different approaches of modelling the shear walls in structural analyses of buildings and compared their results. The shear walls within the building structures are generally modelled by either a composition of frame elements or a mesh of shell elements. In modelling shear walls with "shell elements" the drilling moment of the shear walls and the bending moment of the in-plane connected beams are changed dramatically with mesh density. For finer meshes, 10% reduction of the drilling moment can be estimated. Introduction
of top Chord frame stabilize the results considerably. Good estimation of the properties of the top chord frame is very important to not affect the overall stiffness of the structural system. Best results are obtained using a top chord frame element to enhance the fixity of the beams framing into the shear wall.

N.S. Potty, W.A.Thanoon, H.H. Hamzah, et al (ICCBT2008) investigated the suitability, simplicity, accuracy, effectiveness of different structural models used in the analysis of shear wall and coupled shear wall structures. They found that the beam element model is simple compared with shell element model. As the size of the SW increases, the modelling and analysis of the wall with shell element become more complex and tedious. Beam element shows very good result compared to the shell element. Finite element method is widely used for analyzing structural systems.

Devesh P. Soni and Bharat B. Mistry (2006) studied the seismic response of vertically irregular building frames and found that the largest seismic demand is found for the combined–stiffness–and–strength irregularity. The methodology proposed by Fragiadakis et al (2006) proposed a methodology based on Incremental Dynamic Analysis (IDA) to evaluate the response of structures with „single-story vertical irregularities" in stiffness and strength using a nine-story steel frame. The methodology proposed by him enables a full range performance evaluation via a highly accurate analysis method that pinpoints the effects of any source of irregularity. He concluded that vertical irregularities produce different effects which depend on the type of irregularity, the storey where it happens and most importantly, on the intensity of earthquake or equivalently on the response level or damaged state of the structure.

IV. Conculsion

In this study many papers are reviewed and now aware with irregularity of structure there are two types of irregularity such as plan irregularity and vertical irregularity. And vertical irregularity create weakness in structure and leads to its failure due to separation in mass, stiffness when it is subjected to lateral loads (wind and seismic). But in case of multi-storied building the wind analysis are most critical as compare to seismic. Many standard codes are available for different countries. In India IS 875 part-3 is used to calculate wind loads. To assign the wind loads structural software is used such as ETABS. It gives the analytical results and behaviour of structure. From this study it is observe that the amount of drift is increases from top storey to bottom storey. The zone 5 has the higher values of drift as compare to other zones. ETABS reduces the effort and time and easily operating software used for analysis specially for lateral loads and details of each and every member can be obtained.

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