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A Review Paper on Influence of Positioning of Shear Wall on the Torsional Response of Building

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Abstract: It would be ideal if all buildings have their lateral-load resisting elements symmetrically arranged and earthquake ground motions would strike in known directions. Due to scarcity of land in big cities, architects often propose irregular buildings in order to utilize maximum available land area and to provide adequate ventilation and light in various building components.
However, it is quite often that structural irregularity is the result of a combination of both types. Most buildings have some degree of irregularity in the geometric configuration or the distribution of mass, stiffness, and/or strength. Due to one or more of these asymmetries, the structure's lateral resistance to the ground motion is usually torsionally unbalanced creating large displacement amplifications and high force concentrations within the resisting elements which can cause severe damages and at times collapse of the structure. Eccentric arrangement of non-structural components, asymmetric yielding, presence of rotational component in ground motions and the variations in the input energy imparted by the ground motions also contribute significantly to the torsional response of buildings.
So, this research work demonstrates the importance oflocation of shear wall is should be checked before the sequential failure defined by the Response spectrum analysis method. In Numerical Tool like SAP-2000 which are uses worldwide for pushover analysis method.

I. INTRODUCTION

It would be ideal if all buildings have their lateral-load resisting elements symmetrically arranged, and earthquake waves would act in known directions. Due to scarcity of land in Metro cities, like Delhi, Mumbai architects many times propose irregular buildings to utilize the maximum available property and to provide adequate ventilation and light in various building components. Most buildings have some degree of irregularity in the geometric configuration or the distribution of mass, stiffness, and strength. Due to one or more of these irregularities, the structure's lateral resistance to the ground motion is usually torsionally unbalanced, creating massive displacement and high force concentrations within the resisting elements, which can cause severe damages and most of the times collapse of the structure. Eccentric arrangement of nonstructural components, unsymmetrical stiffness, asymmetric yielding, presence of a rotational element in ground motions, and the variations in the input energy imparted by the ground motions also contribute significantly to the torsional response of buildings. In India, the failure of the two most famous apartments during the 2001 Bhuj earthquake was noted due to torsional response.

In the last few years, shear walls became an essential part ofmid and high-rise structures. As a component of an earthquake-resistant building, shear walls are located in buildings, reducing lateral displacements under earthquake loads. So, shear-wall frame structures are obtained. Shear wall type buildings are generally regular in elevation and plan also**.**

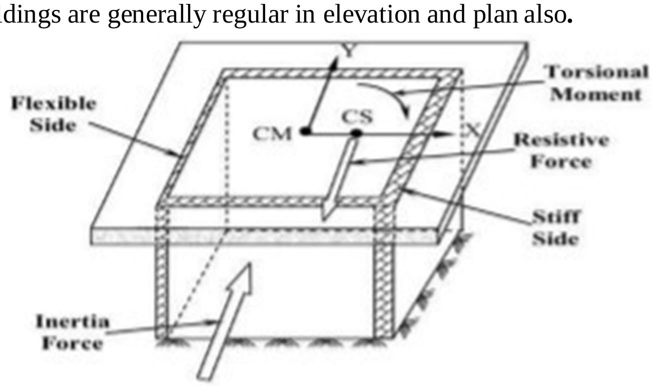


Figure 1 **-** Generation of the torsional moment inasymmetric structures during seismic excitation(Courtesy internet)

II. PURPOSE OF CONSTRUCTING SHEAR WALLS

Shear walls designed to resist lateral loads due to earthquakes and wind. The walls are structurally connected with diaphragms, and other lateral walls at right angles, therefore, give stability to the building structures. Shear wall structural systems are more stable during earthquakes than RCC framed structures. Shear walls also have to resist the uplift forces generated by the pull of the wind. Walls have to resist shear forces that try to push the walls. Shear walls are used to sell all torsional modes and diagonal translational modes to possess a natural time period outside the range of 0.04 to 2 sec by increasing the torsional stiffness of the building. Walls have to resist the lateral force of the wind that tries to push the walls in and pull them away from the building. These walls will attract shear forces and will prevent changing locations and positions of construction and consequently, destruction. Shearwall resists the lateral forces by combined axial-flexure-shear action. Construction of shear wall in talland even short buildings will strengthenthe structure significantly, and either more economical than the bending frames.

III. NEED OF THIS RESEARCH WORK

It will be ideal if all buildings have their lateral-load resisting elements symmetrically arranged, and earthquake ground motions would act in known directions. Due to the scarcity of land in metro cities, architects often propose irregular buildings in order to utilize the maximum available land area and to provide adequate ventilation andlight in various building components. However, it is quite often that structural irregularity is the result of a combination of both types. Most buildings have some degree of irregularity in the geometric configuration or the distribution of mass, stiffness, and strength. Due to one or more of these asymmetries, the structure's lateral resistance to the ground motion is usually torsionally unbalanced, creating significant displacement amplification and high force concentrations within the resisting elements like columns and shear walls which can cause severe damages and at times collapse of the structure. So this research work demonstrates the importance of the location of the shear wall it should be checked before the sequentialfailure defined by the pushover analysis method. The Numerical Tool like ETAB2017 and SAP-2000, which are uses worldwide for the pushover analysis method

IV. LITERATURE REVIEW

Rajlaxmi K. R. Harinarayanan S. (2015) has carried out a non-linear dynamic analysis on mass and stiffness irregular buildings. For that, they have prepared four different models, Regular building, Mass irregular building, Stiffness irregular building, Setback building. They have performed time history analysis using three various records. They have studied the location of plastic hinges formed. In most of cases, hinges are formed at regions of irregularities. This study confirms that the enhancement of member sizes required in the region of irregularities. [3]

Han-Seon Lee Dong-Woo-Ko (2004) have investigated the seismic response of high raised RC bearing wall structure with three types of irregularities at bottom stories. (Korea). For this purpose, they have made three 1: 12 scale, 17 storey RCC models with upper 15 storey have bearing wall system, with lower two stories have framed system (Piloti Type Structures). Model 1- Only MRF, Model 2- Infilled shear walls in central frame, Model 3 – Infilled shear walls in one exterior frame. The test results showed that the existence of shear wall reduces remarkably shear deformation at lower frame but has a negligible effect on reduction of overturning deformation, base shear, and OTM. Upper floors prove to behave almost as rigid bodies. Shear deformation in rigid and flexible Models is significantly different. [4]

Gaikwad Ujwala (2017) has performed a Response spectrum analysis on the horizontally unsymmetrical structure. Five different cases are used to analyze the structure, With-out shear wall, Shear walls parallel to X-axis, Shear walls parallel to Y- axis, Concentric shear walls, Shear walls at exterior corners, Shear walls at specified locations. They obtained Torsion, base shear, maximum displacement, and maximum drift results for five different cases. They obtain the optimum benefit in the case of shear walls provided at the exterior corners of buildings (base shear reduced to 28% to 35 %, Torsion reduced by 29% to 35%). They also suggested that a higher thickness of shear walls is uneconomical, and its effect on Torsion and base shear is comparatively less. [5]

Prof. Dr. Adnan Falih Ali (Iraq) 2014 has analyzed the U- shaped six story RCC building with and without shear walls using SAP 2000, ETABS, and ANSYS software, under excitation of El-Centro earthquake.

The first analysis on MRF showed that Torsion is a dominant mode of vibration, and there is no pure translational mode in the Y direction. They got the result that, left corner vibrates at the higher amplitude and lower frequency than the right corner, and they both move out of phase motion causes the Torsion.

The addition of shear walls at a particular location causes pure lateral mode in Y- direction. Now LHS and RHS corner displacement graph coincide with each other.[6]

Dr. Dushyanath and Dr. Babitha Rani (2017) have carried out a response spectrum analysis on G+4 L-shaped IT building.

Stiffness is calculated for each column in a corresponding frame will give frame stiffness. Earthquake force is distributed to all structures according to their stiffness. From this, they have observed that distributed force is maximum for some frames, so we can reduce the force by adding shear walls in frames having less lateral force. So, from this, we can choose the appropriate location for shear walls in the less lateral force frame. [7]

Rajan L. Wankhade, (2016) has studied the performance- based analysis on G+9 storey building under earthquake loading. In analysis, various cases are considered with an increase in the percentage of reinforcement in many frame elements at different construction stages. From the analysis it is observed that a combination of change of reinforcement increases the capacity of the structure and also satisfies given acceptance criteria. This paper presents the idea about the Performance-based methods allow designers to come up with a variety of solutions, and the performance- based approach enhances creativity and innovation in the design process. [8]

Hasan R. (2002) presented a simple computer-based pushover analysis technique for performance-based design of building frameworks subject to earthquake loading. Through the use of a plasticity-factor for measurement of the degree of classification, the elastic and geometric stiffness matrices were modified to account for non-linear elastic-plastic behavior under constant gravity loads and incrementally increasing lateral loads. The method accounted for first-order elastic and second-order geometric stiffness properties, and the influence that combined stresses have no plastic behavior.[18]

M.Mouzzoun, A.Taleb O.Moustachi, discussed that plastic hinges occur at the ends of beam and base columns, then propagates to upper stories and results in the yielding of members. Under low-intensity plastic hinges formed are in initial stages, so the structure remains stable. Under high- intensity plastic hinges formed in collapse states, making the structure unstable as it lost its rigidity and its original strength. So the pushover analysis is able to evaluate the seismic damage of buildings, to examine the state of the structure under the action of an earthquake, and thus provide information on the damage that can be sustained by a structure and the elements that will be affected in a future earthquake.

Kadid and A. Boumrkik Studied three structures representing low, medium, and high rise RC frame structures. The performance of reinforced concrete frames was investigated using the pushover analysis. Conclusions from the study are listed below,

The behavior of a building is shown by performance points and the distribution of hinges. In the case of adequately designed frames with adequate ductility, most of the hinges developed in the beams and few in the columns but with limited damage.

The results obtained in terms of demand, capacity and plastic hinges gave an insight into the real behavior of structures[21]

V. PROBLEM STATEMENT

Modelling of simple G+14, L-shaped building in ETABS 2017 by Influence of Positioning of Shear Wall on The Torsional Response of Building.

VI. OBJECTIVE OF THE STUDY

The objectives of the present research work were as follows,

1) To study the variation of base shear, Torsion, time period, and eccentricity between the center of mass and center of stiffness for different positions of shear walls.
2) To apply pushover analysis for locating development of plastic hinges and to study variation in ductility.
3) To suggest an effective structural system for a given building configuration

VII. SCOPE OF WORK

The above objectives have the following limitations of scope,

1) Reinforced concrete moment resisting frame with shear walls is considered.
2) Fixity is assumed in all the column Ends.
3) The project is focusing analysis part and that too only for earthquake loads by using numerical investigation technique, not an experimental investigation.
4) The analysis is performed by using numerical tool SAP 2000, ETABS 2017.
5) Other shapes of buildings are not in scope.
6) Research work is carried out as per Indian Codes, i.e., IS 875: 1987, IS 456: 2000, and IS 1893:2016.
7) Hinge properties are considered as per FEMA356.
8) The conclusions will be used to suggest the effective structural system for a given building configuration.

VIII. METHODOLOGY

A. *Literature Review*

Study of the torsional response of building by response spectrum analysis and non- linear static analysis and its need under this research work. Understanding of theimportance of the location of shear walls and its interpretation. Gap analysis is carried out by comparing previous Codal provision and revised one for Torsion and ductile detailing.

B. *Numerical Investigation*

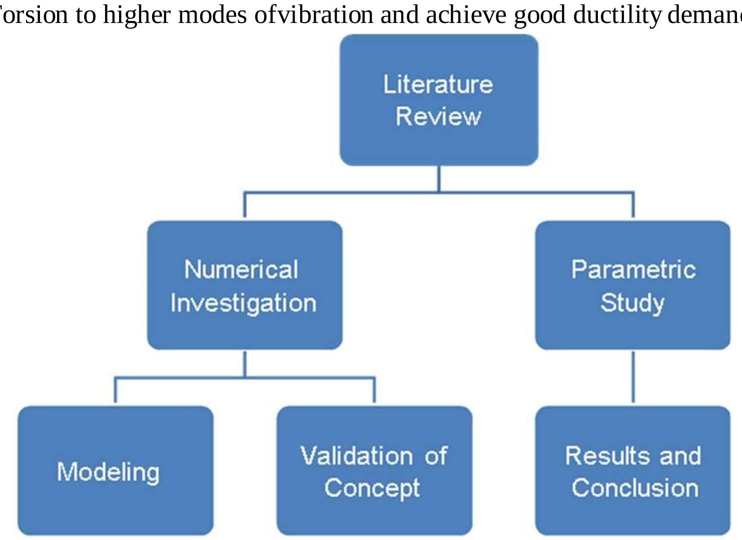
Modeling and Validation Of various concept in the research work by Modeled a 3bay 4 storey structure by using ETABS 2017 and by manual calculation for comparison of base shear. Location and stage of hinges is studied for increasing displacement using SAP2000.

C. *Parametric Study*

Response spectrum analysis is carried out on G+14 storey, L-shaped 5 models, which is under research work using ETABS 2017. Non-linear static analysis is carried out on (G+14) Storey L-shaped 5 models, which is under research work Using SAP-2000. For finding out the performance level of the structure for displacement controlling criteria. Optimum location of shear walls is to be found out.

D. *Result And Conclusion*

Recommendation for shifting Torsion to higher modes ofvibration and achieve good ductility demand.



IX. CONCLUSION

1) In this study, trying to find out torsional mode using shear wall
2) In this study, compares the torsional mode of vibration for five cases.
3) In this study, trying to find out plastic hinges.
4) In this study, trying to find out eccentricity between the center of mass and rigidity and top story displacement

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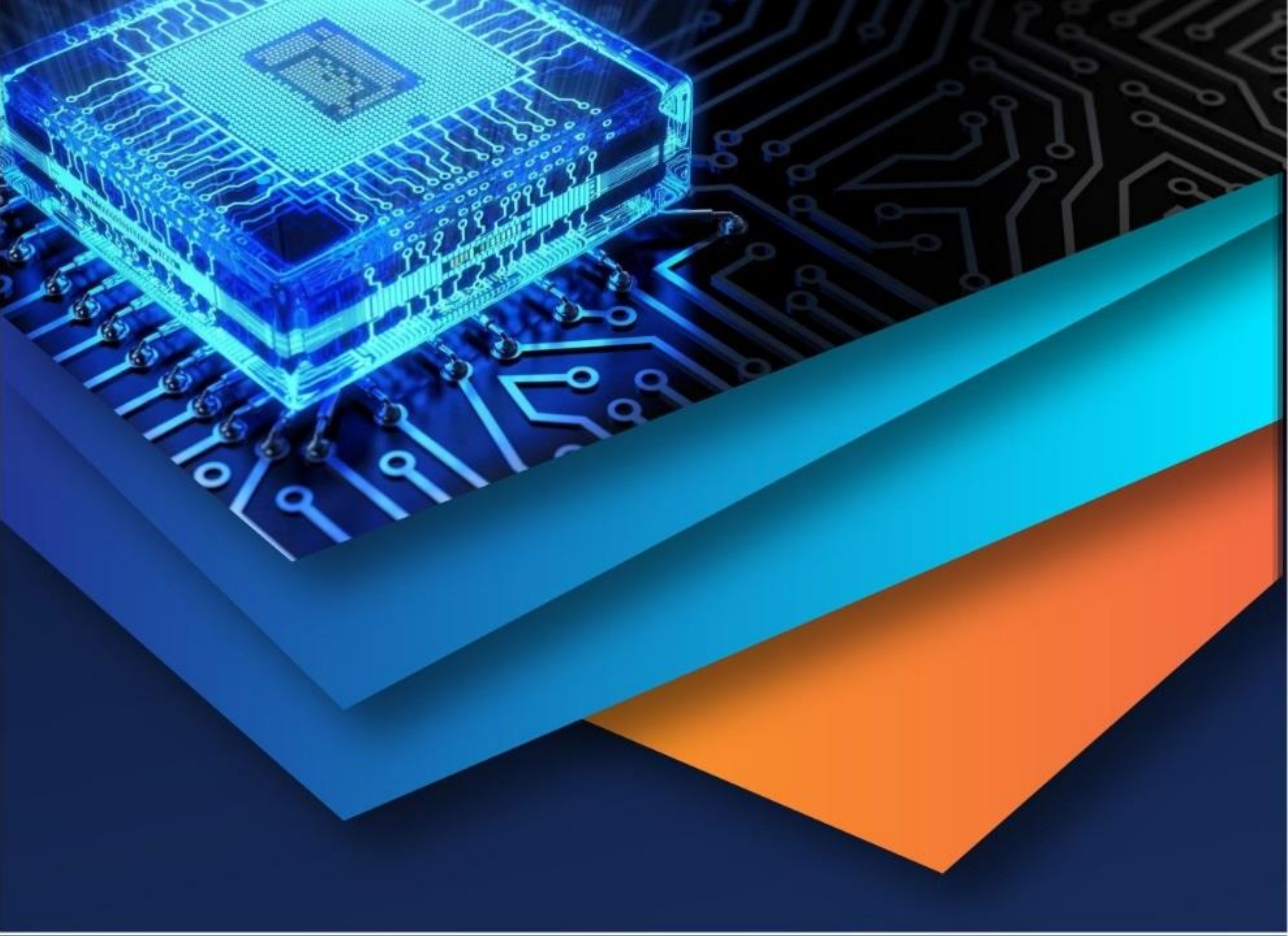

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