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Analysis and Design of A G+5 STORIED R.C.C. Framed Vertically Irregular Structure with Infill Wall (Brick Wall) & Shear Wall (Lift Wall)

Tapas Bera
M. Tech. Structure Student, Department of Civil Engineering, Swami Vivekananda University, Telinipara, Barasat-Barrackpore Road, West Bengal, India

Abstract- Designing of a structure to reduce damage during an earthquake makes the structures quite uneconomical. This is because of earthquake might or might not occur in its life time, it is a rare phenomenon. Shear wall is the best way to control deflection during earthquake. Lifts are the mandatory to be used in multi-storey building which are frequently used as core type shear walls. Infill walls are also to be used for exterior as well as interior walls. Response spectrum analysis is used to evaluate the seismic capacity of a structure. The present literature focuses on models with effects of shear walls (Lift) and infill walls (Brick wall) with vertical irregular R.C.C. frame structure.
In this paper a proposed G+5 storied R.C.C. framed structure with vertical irregularities has been analysed and designed using ETABS 21. The building is designed as per IS:1893 (Part-I) 2016 for earthquake forces.

Keywords- ETABS 21, R.C.C. frame, vertically irregular, Shear wall (Lift wall), Infill wall (Brick wall), Earth quake, Response spectrum, Deflection, Shear, Bending.

I. INTRODUCTION

- Shear walls:

Shear walls are structurally designed R.C. members. These are incorporated in R.C. frame structures to increase the lateral stiffness against ground motion to resist lateral forces. These are placed vertically from the base of foundation and will resist earthquake forces as well as wind force. These walls increase the strength of the structure and also resist the loads due to cantilever action. R.C. lift wall in multistorey building is also a shear wall.

- Infill walls:

These are non-load bearing structural members. There are several types of infill walls-

a) Masonry infill walls
b) Concrete infill walls
c) Timber framed infill walls

Masonry infill walls constructed from clay bricks. These are the traditional form of infill walls. Concrete infill walls are generally in the form of large precast concrete Pannel. Timber infill walls are timber section of 90 and 140 mm. This type of walls is not used with large openings.

- Seismic Analysis:

Seismic analysis is to assess the behaviour of a structure when subjected to dynamic load. Different type of seismic analysis-

1. Equivalent static analysis which is linear static
2. Response spectrum analysis which is linear dynamic.
3. Pushover analysis which is non-linear static
4. Time history analysis which is non-linear dynamic.

- Response Spectrum Analysis:

The Response Spectrum Analysis is used to evaluate the dynamic effect of ground motions. In this method the base shear is calculated based on the time period, mass participation of the structure. As an engineer, we need to check the base shear for static seismic as well as for dynamic seismic loads.

II. LITERATURE REVIEW

Dr. B. Kameshwari et al. analysed the influence of drift and inter storey drift of the structure on various configuration of shear wall panels on high rise structures. The bare frame was compared with various configurations like i) Conventional shear wall ii) Alternate arrangement of shear wall iii) Diagonal arrangement of shear wall iv) Zig Zag arrangement of shear wall v) Influence of lift core shear wall. From the study it was found that Zig Zag shear wall enhanced the strength and stiffness of structure compared to other types. In earthquake prone areas diagonal shear wall was found to be effective for structures.

Nanjma Nainan et al. conducted analytical study on dynamic response of seismic resistant building frames. The effects of change in height of shear wall on storey displacement in the dynamic response of building frames were obtained. From the study it was concluded that it is sufficient to raise the shear wall up to mid height of building frames instead of raising up to entire height of the building.

Shahzad Jamil Sardar et al. modelled a 25 storey building zone V and analysed by changing the location of shear wall to determine various parameters like storey drift, storey shear and displacement using ETABS. Both static and dynamic analysis was done to determine and compare the base shear. Compared to other models, when shear wall placed at centre and four shear walls placed at outer edge parallel to X and Y direction model showed lesser displacement
and inter storey drift with maximum base shear in addition strength and stiffness of the structure has been increased.

Varsha. R. Harne considered a six storey RCC building which is subjected to earthquake loading in zone II to determine the strength of R.C. wall by changing the location of shear wall using STAAD. Pro. Seismic coefficient method is used to calculate the earthquake load as per IS 1893(Part I): 2002. Four different models like structure without shear wall, structure with L type shear wall, structure with shear wall along periphery, structure with cross type shear wall were modelled for analysis. Compared to other models the shear force and bending moment, for structure with shear wall along the periphery is found to be maximum at the ground level and roof level respectively. Hence the shear wall provided along the periphery of the structure is found to be more efficient than all other types of shear wall.

Anuj Chandiwala studied a 10 storey R.C. building located in seismic zone III which is on medium soil. The different building configurations were i) Shear wall at end of L section ii) L Shear wall at junction of 2 flange portion iii) Two parallel L shear wall at junction of 2 flange portion iv) Tube type shear wall at junction of 2 flange portion v) Two parallel shear wall at end of flange portion. From the analysis, it was observed that compared to other models shear wall placed at end of L section is best suited for base shear since end portion of the flange always oscillate more during earthquake.

Shahabodin Zaregarizi conducted comparative investigation on using shear wall and infill to improve seismic performance of existing buildings. Static nonlinear analysis was done to compare the effectiveness of both methods. From the results, it was observed that concrete infills have considerable strength while brick one showed lower strength. On the contrary, brick infills accepted large displacement experimental results. To evaluate the performance of “Dual systems” which is designed as per Indian code, these models were implemented. It has been noted that buildings with shear walls placed at periphery showed excellent performance than buildings with centrally placed shear wall core.

Valmundsson and Nauhave (1997), studied the seismic behaviour of multi-storeyed buildings having vertical structural irregularities and concluded that 30% decrease in stiffness have increased the storey drift in the range of 20-40%.

Pradeep and Jacob (2014) studied the seismic behaviour of reinforced concrete framed structures with varying height of column within one storey. The results shows that the short column in the ground storey fails very easily on a sloping terrain. Shear cracks also found on the beam column joint of short column. Due to higher ductility in the long column, it attracts lesser lateral force which results the more stable to the long column.

Rana and Raheen (2015), has shown the performance, behaviour of regular and vertical geometric irregular RCC framed structure under seismic motion. It is concluded that as the amount of setback increases the shear force also increases. The fluctuation of critical shear force from regular to vertical geometric irregular is very high

Imranullahkhan and Roa (2017), the main intension of this study is to understand irregularity and to analyse L-shape building under earthquake forces. Story drift response along the height of the building shows that the middle stories are more affected than Lower and upper stories. Displacements gradually increase from ground storey to top storey.

Ozmen et al. (2014), performed parametric studies on six buildings with varying shear wall positions. Based on the floor rotations, a torsional irregularity coefficient was proposed. According to their findings, as the number of storey decreases, the torsional irregularity coefficient increases and the maximum storey rotations occur for the top storeys.

Momen et al. (2016), have studied the effect of seismic response of L shaped buildings. Equivalent static and response spectrum methods were performed using ETABS software. They observed that the response of L shaped building is higher than that of the regular frame due to torsion.

Dhananjay (2017), analysed G+25 storey rectangular shape, L shape and I shape building using STADD pro software in zone III and zone IV for hard and medium soils. It was found out that L shape had less maximum bending moment and maximum displacement in z direction.

Naik and Shetty (2019), this research paper involves the modelling and analysis of G+10 storied building of Rectangular shape, L shape snd C shape structure using ETABS 2016. The L shape structure and C shape structure has less shear force carrying capacity. The storey overturning moment is also more in rectangular shape which indicates that more moment is required to overturn the storey.

Naveen et al. (2019), the present study addresses the seismic response of RC structures possessing various combinations of irregularities. It is observed that irregularity considerably affects the seismic response. Out of various types of single irregularities analysed, stiffness irregularity is found to have maximum influence on the among the cases having combinations of irregularities, the configuration with mass, stiffness and vertical geometric irregularities has shown maximum response.

Arvind and Fernandes (2015), worked on reinforced regular and reinforced irregular structures in zone IV and zone V. The results found out from the analysis included lesser storey displacement values in static analysis method as compared to dynamic analysis method.

Bahador et al. (2012), studied Multi-storey irregular buildings with 20 stories have been modelled using software packages ETABS and SAP 2000 v.15 for seismic zone V in India. Time history analysis is an elegant tool to visualize the performance level of building and static analysis is not sufficient for high rise building. The result of equivalent static analysis are uneconomical because values of displacement are higher than dynamic analysis.

Jaimin Dodiya et al. (2018) investigated the study of multi-story buildings employing shear walls at various points throughout the structure. Three models have been created, and it has been demonstrated that when shear walls are situated in the opposite directions of the structure, displacement is minimised.

III. RESEARCH GAP

After studying several journals, research papers, eBooks finally I have found a research gap i.e. Behaviour due to combined effect of Lift as shear wall and Brick wall as infill wall in a R.C.C. framed G+5 storied vertical irregular structure.

IV. OBJECTIVE

The objectives of the study are:

- Structural analysis of a G+5 storied R.C.C. vertical irregular framed structure with Lift as a shear wall brick wall as a infill wall using ETABS 21 and determine lateral displacement and storey drift.
- Study of behaviour of structure (Moment, Shear and Axial) with Lift shear wall and Brick infill wall.
- Study of optimum location of lift shear wall for G+5 storied R.C.C. vertical irregular framed structure keeping other parameters same.

V. METHODOLOGY

MODELLING OF R.C.C. FRAME STRUCTURE

RCC framed structures are assemble of slabs, beams, columns and foundation inter-connected to each other as a unit. The load transfer mechanism in these structures is from slabs to beams, from beams to columns, and then ultimately from columns to the foundations which transfer loads to the soil.

In this structural analysis, I have adopted one vertically irregular R.C.C. frame structure with a lift as shear wall as explained below.

- G+5 Storey
- Rectangular different shape floor plan
- Vertically Irregular R.C.C. frame
- Shear walls (Lift wall)
- Infill walls (Brick wall)

IV. CONCLUSION

- Plan irregularities with structure quite often suffer damage in earthquake.
- Behaviour of a framed R.C.C. structure during earthquake depend upon stiffness, ductility, strength and configuration of structure.
- Structure irregularities causes eccentricity between mass and stiffness centres, give rise to damaging effect on structure.
- Structure should be designed considering the seismic loads. To overcome this situation the seismic behaviour of structure should be improved.
- Generally Response spectrum analysis method is used for analysis and design of earthquake resistance structure.

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