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Dynamic Analysis of the RC Structure in Non-Parallel System with Different Position of Shear Wall: A Review

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Abstract - *In this paper, we have studied the regular and irregular shape building according to the Indian standard code 1893 part-1:2016. There are two types of irregular RC buildings first is in the horizontal irregularity (plan irregularity) and the second is vertical irregularity (elevation irregularity), but here we mainly focus on the horizontal irregularity on the structure such as torsion effect, re-entrant corner, non-parallel system, etc. After about these irregularities in the structure and different position of the shear wall in the RC structure for high rise building. We found some conclusions regarding these irregularities through the previous research paper. We will see that which type of the horizontal irregularity building is more stable to resist the seismic effect at the different position of the shear wall.*

Key Words: RC Building, Seismic analysis, shear wall, Non-parallel system, horizontal irregularities, vertical irregularities.

1. INTRODUCTION

The component of the building, which resists the seismic forces, is known as the lateral force-resisting system (L.F.R.S). The L.F.R.S of the building may be of different types. The most common forms of these systems in a structure are special moment resisting frames, shear walls, and frame-shear wall dual systems. The damage in a structure generally initiates at the location of the structural weak planes present in the building systems. These weaknesses trigger further structural deterioration which leads to structural collapse. These weaknesses often occur due to presence of the structural irregularities in stiffness, strength, and mass in a building system. The structural irregularity can be broadly classified as plan and vertical irregularities.

A structure can be classified as vertically irregular if it contains the irregular distribution of mass, strength, and stiffness along with the building height. As per IS 1893:2002, a storey in a building is said to contain mass irregularity if its mass exceeds 200% than that of the adjacent storey. If the stiffness of a storey is less than 60% of the adjacent storey, then a storey is termed as „weak storey". If the stiffness of a storey is less than 70% or above as compared to the adjacent storey, then the storey is termed as „soft storey". In reality, many existing buildings contain irregularity, and some of them have been designed initially to be irregular to fulfill different functions e.g. basements for commercial purposes created by eliminating central columns. Also, reduction of the size of beams and columns in the upper storeys to fulfill functional requirements and for other commercial purposes like storing heavy mechanical appliances, etc. This difference in usage of a specific floor concerning the adjacent floors results in irregular distributions of mass, stiffness, and strength along with the building height. In addition, many other buildings are accidentally rendered irregular due to a variety of reasons like non-uniformity in construction practices and material used. The building can have irregular distributions of mass, strength, and stiffness along with plan also. In such a case it can be said that the building has a horizontal irregularity.

Type of the plan irregularity

1. Torsional Irregularity
2. Re-entrant Corners
3. Diaphragm Discontinuity
4. Non-Parallel System

1.1 Non-Parallel System

The vertical elements resisting the lateral force are not parallel to or symmetric about the major orthogonal axes or the lateral force-resisting elements.

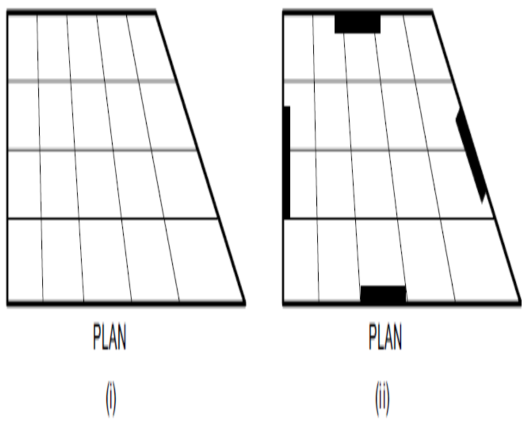

Fig-1: Non-Parallel System

1.2 Shear Wall

In structural engineering, a shear wall is a vertical element of a seismic force-resisting system that is designed to resist in-plane lateral forces, typically wind and seismic loads. In many jurisdictions, the International Building Code and International Residential Code govern the design of shear walls.

A shear wall resists loads parallel to the plane of the wall. Collectors, also known as drag members, transfer the diaphragm shear to shear walls and other vertical elements of the seismic force-resisting system. Shear walls are typically light-framed or braced wooden walls with shear panels, reinforced concrete walls, reinforced masonry walls, or steel plates.

Fig-2:Shear Wall

2. LITERATURE SURVEY

From the previous research work related to seismic analysis of the RC structure with horizontal and vertical irregularities and at the different position of the shear wall, the following conclusion is given below:

[1] M. Santhosh (2014) In this study the bare frame and the bare frame with a shear wall of G+5 storey are designed and analyzed by using Response Spectrum analysis. The dimensions of the elements of frames are taken by considering the structure to be safe. From the analysis, the base shear for a structure without a shear wall will be less due to reduced self-weight compared with the structures with the shear wall. If we compare the structure with PSW and NPSW, both the self-weights are the same but the base shear is lesser for PSW compared to NPSW. And also it is observed that the lateral displacement and the storey drift for the structure with PSW are less compared to the other two structures. From all the above analysis, it is concluded that the structure with PSW is much efficient than the other two structures i.e., NPSW and WSW during lateral force.

[2] S.Varadharajan (2014) A structure can be classified as irregular if it contains irregular distributions of mass, strength, and stiffness. The structural irregularity can be further classified as horizontal and vertical irregularity. In reality, many existing buildings contain irregularity, and some of them have been designed initially to be irregular to fulfill different functions e.g. basements for commercial purposes created by eliminating central columns, and reduction of sizes of beams and columns in the upper storeys to fulfill functional requirements and for other commercial purposes like storing heavy mechanical appliances, etc. This difference in usage of a specific floor concerning the adjacent floors results in irregular distributions of mass, stiffness, and strength in the building. Also, many other buildings are accidentally rendered irregular due to a variety of reasons like non-uniformity in construction practices and material used. However, these irregular structures (designed as per code provisions) exhibit poor seismic performance as evident from the records. The different seismic design codes prescribe different limits of irregularity as discussed. The review of previous seismic design codes showed that the irregularities have been classified in terms of magnitude only ignoring the irregularity location.

[3]A. Murali Krishna (2014) All the structures are symmetrical about the y-axis and unsymmetrical about the x-axis. The center of mass and center of rigidity are influenced by the positioning of different shapes of shear walls. The structures with shear walls show that the CM and CR getting closer compared to the structure without shear walls. MODEL 7 has the least difference between the center of mass and the center of rigidity. The shape of the shear wall and its position have significantly influenced the period. Significant difference concerning period compared to the model without shear walls. The shape of the shear wall and its position has decreased the diaphragm displacement compared to the structure without a shear wall. MODEL 2 shows good results concerning displacement compared to other models according to the ESA method. According to the RSM method MODEL 5 shows good results concerning displacement. Positioning and the shape of shear walls do not show much difference on Base shear. But the base shear increases with the addition of the shear wall since the seismic weight increases. MODEL 5 shows the least increase in the base shear. The provision of shear wall and shape of the shear wall has a significant effect on storey drift in middle storeys. MODEL 6 shows good performance according to both the ESA and RSA methods of analysis.

[4] Milind V. Mohod(2015) Effects on chosen models have been shown in the form of graphs and bar charts in the earlier part of performance analysis, by comparing various parameters such as nodal displacements and storey drifts. Hence from the obtained results following conclusions can be made. Considering the effect of lateral displacement on different shapes of the building structure. it has been observed that Plus-shape, L-shape, H-shape, E-shape, T-shape, and C-shape building has displaced more in both directions (X and Y) in comparison to other remaining simple shaped building (Core-rectangle, Core-square, Regular building). The storey drift being the important parameter to understand the drift demand of the structure is considered while collecting the results from both the software as per (IS 1893-2002), limiting value of drift for the given structure as per (7.11.1) is 16 cm, which is not exceeded in any of the structure but L-shaped and C-shaped models showed larger drift than other shaped models. Considering all these above conclusions made on the analysis of irregular structures, we may finally say that simple geometry attracts less force and perform well during the effect of an earthquake. It is inevitable to omit complex geometries but these can be sorted into simpler ones by providing seismic joint to reduce the earthquake effect.

[5] Anshul Sharma (2016) Considering the storey displacement, the frame, and structure with floating columns (frame 2) is the weakest since it suffers the maximum displacement while the base frame and structure exhibit the least displacement. As far as storey drift is concerned, frame 2 (with bottom two soft storeys) is the weakest since it has the maximum storey drift which changes abruptly. Frame 8 also shows a similar pattern for the bottom two storeys. Storey shear is however maximum in frame 4 and structure 4 (with 3rd and 6th storeys heavy). It can be inferred clearly that the frame and structure with floating columns represent the worse scenario since it faces the maximum displacement and is most prone to damages under this lateral loading. While, on the other hand, it can be seen that the base frame and structure have the least displacement and drift, hence least susceptible to damage. In this work, various frames and structures having different irregularities but with the same dimension have been analyzed to study their behavior when subjected to lateral loads. All the frames and structures were analyzed with the same method as stated in IS 1893- part 1: 2002. The base frame and structure (Ideal) develops the least story drifts while the building with floating column shows maximum storey drifts on soft-story levels. Hence this is the most vulnerable to damages under this kind of loading. The other buildings with irregularities also showed unsatisfactory results to some extent. The frame with heavy loads develops maximum storey shears which should be accounted for in the design of columns suitably. The analysis shows that the dynamic approach gives us more defined results as compared to static analysis of the building.

[6] Q. U. Z. Khan (2016) In this study, various shapes of shear walls i.e. Rectangular, L, T, C, H, and I are incorporated in the structural farming of 20 storey tall RC building. To find the optimized structural framing concerning the safest, the economical and desirable shape of shear wall. Following are the conclusions of the present investigation:

Shear walls play an important role in reducing the enlarged seismic parameters i.e. storey drifts, storey displacements and storey shears concerning the code specified values/limitations. The higher the moment of inertia of a shear wall along a plane perpendicular to the direction of lateral loading, the higher is its tendency towards resisting seismic impacts and vice versa. Rectangular and L-shaped walls are most effective

in resisting seismic forces along with both orthogonal directions and reduce seismic forces remarkably. H-shaped and T-shaped walls show less resistance towards lateral loading. Each shape of the shear wall produces the same amount of storey shears in both axes (Shear force at each storey level) which concludes that the shape of the shear wall has no impact on the reduction of storey shears.

[7]MD Afroz Patel (2016) There was a much difference in seismic base shear values obtained from ETABS analysis compared to the IS: Code method. Time history analysis gives the higher value of seismic base shear for all the models compared to the other methods of analysis. Storey drift values are within the limits recommended by the code IS 1893:2002 (Part 1). Storey drift has been significantly influenced by the addition of shear walls and the shapes of shear walls. In model 8 storey drift values are decreased due to the presence of I shaped shear wall when analyzed by the time history analysis. Storey displacements are generally reduced by the provision of the shear wall the reason behind this is the shear wall increases the stiffness of the structure. On comparison of storey displacements values of different models along the longitudinal and transverse directions using the ESA, RSA, and time history analysis. Model 1 showed the highest value of storey displacements due to the absence of a shear wall. By the addition of an I-shaped shear wall model, 8 showed the least value of storey displacement obtained by time history analysis.

[8] Lalapeta Sudha (2017) Comparing self-weight of both buildings. Higher weights of the building, higher earthquake loads are attracted. So, with the weight of steel to be efficient. While comparing both buildings, steel has a higher period than R.C.C. It shows steel building is flexible and R.C.C is a rigid building much lesser than steel. The deflection of the beam and steel is an average of 5.5 times higher than R.C.C. When comparing the support reactions, the reaction of the base of the steel is very less and compared to R.C.C. It shows that the size of the footing for R.C.C will be holistic view after results steel buildings are found to be structural efficient as well as results in maximum material economy. Compared to RCC, the Steel structure has more ductility which is most appropriate in the effect of lateral forces.

[9] Livian Teddy (2017) from the explanations above, some conclusions could be useful for architects in designing the building, as follows. The ideal building structure is when the beams and columns are on one axis but if it is inevitable, connect the columns with the triangle module beams so that they will have more rigidity. Columns that are not in one axis have weaker rigidity than the beams which are not in one axis. The random seismic motion requires both axes to have equal ability in facing the seismic loads. Primarily, eccentricity occurs by the geometric shape of the building mass and the effect of irregularity of the beam/column arrangement is relatively minimal but can cause another irregularity, the non-parallel irregularity configuration. Avoiding the excessive formation of torque irregular configuration and non-parallel irregular configuration in the building design can be done by evaluation using formulas 1 and 2 above. For future research can be investigated the effect of the earthquake on geometry architecture with non-parallel system irregularity configuration in irregular form.

[10] Malavika Manilal (2017) Re-entrant buildings undergo maximum displacement and drift compared to the regular frame. In this study building with 80% re-entrant deflects more compared to the other buildings. The displacement of all the models is exceeding the maximum limit prescribed by IS 1893-2002. The regular models undergo the minimum storey drift compared to the irregular models. The storey drift of 80% re-entrant building is maximum. The drift ratios of all the models are found to satisfy the limit prescribed by IS 1893-2002. Due to lesser area and mass, the model has 80% re-entrant is having the least base shear. The regular model is having higher bae shear indicating greater stiffness.

[11] Anju Nayas (2017) When earthquake load is applied in X direction the base shear was maximum for H model with L column, i.e L column has 62.37% more base shear capacity than cross and 69.8% than Tee column. The base shear value will be least for L-shaped buildings so this shape of structure should be avoided in earthquake-prone areas. The base shear capacity of the T-shaped building is increased by providing Tee shaped column in the re-entrant corners, i.e Tee column has 58.7% more base shear capacity than the cross column and 59.67% more base shear capacity than the L column.

[12] Rajesh G. Patel (2018) The values of storey displacement and drift are generally reduced by the provision of the shear wall the reason behind this is the shear wall increases. The shape of the shear wall has a significant influence on the period. The values of the period are more with T and Z shaped shear wall than I and U shaped shear wall. The displacement values of the I-shear wall are more effective in X-direction while in Y-direction U shear wall is more effective. Values of drift are reduced with I-and U-shaped shear walls. For the constant volume of concrete, it is also observed that shear wall with less thickness and large flange length is more effective than others so model 2 of I shaped and U shaped shear wall.

[13] Mohd Abdul Aqib Farhan (2019) From the graphical representations we conclude that the story shear variation decreases when compared to the regular building. The average range for the G+6 structure, when compared to the regular building, decreases by 12% and in asymmetrical decreases by 34%. The average range for the G+9 structure, when compared to the regular building, decreases by 13% and in asymmetrical decreases by 35%. The average range for the G+14 structure, when compared to the regular building, decreases by 18% and in asymmetrical decreases by 36%. From the graphical representations, we conclude that the story drift variation for irregular cases decreases and increases for the asymmetrical case when compared to the regular building. The average range for the G+6 structure, when compared to the regular building, decreases by 3% and in asymmetrical increases by 13%. The average range for the G+9 structure, when compared to the regular building, decreases by 3% and in asymmetrical increases by 14%. The average range for the G+6 structure, when compared to the regular building, decreases by 3% and in asymmetrical increases by 17%.

3. CONCLUSIONS

From the above conclusion of the previous research paper, we found a few conclusions regarding the non-parallel system which is given below:

A. Due to the high effect of the lateral forces on the non-parallel structure, there are chances to produced torsion in that building.
B. The value of the storey displacement, storey overturning moment, and base shear at any load combination is different in the X- and Y direction.
C. In the case of the rectangular RC building with a shear wall at the inner side of the building, the effect of the earthquake is low.
D. In the non-parallel system RC structure, the chances to provide the torsion reinforcement to resist the effect of the torsional force in the building.

REFERENCES

[1] M. Santhosh, S. Pradeep "Seismic Analysis and Design of Multi Storey Building with Non-Parallel Shear Wall System" Volume-4, Issue-2, April-2014, ISSN No.: 2250-0758 International Journal of Engineering and Management Research. Page Number: 157 160.
[2] S.Varadharajan "Study of Irregular RC Buildings under Seismic effect" NATIONAL INSTITUTE OF TECHNOLOGY KURUKSHETRA. JANUARY, 2014
[3] A Murali Krishna "Optimum Location of Different Shapes of Shear Walls in Unsymmetrical High Rise Buildings" International Journal of Engineering Research & Technology (IJERT) IJERTV3IS090859 www.ijert.org Vol. 3 Issue 9, September- 2014
[4]Milind V. Mohod "Effect Of Shape And Plan Configuration On Seismic Response Of Structure" INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 4, ISSUE 09, SEPTEMBER 2015.
[5] Anshul Sharma "Study Of Structurally Irregular Building Frames Subjected To the Seismic Excitations" Jaypee University Of Information Technology. June-2016

[6]Q. U. Z. Khan1, A. Ahmad2, F. Tahir3, M. A. Iqbal4 “Effect Of Shape Of Shear Wall On Performance Of Mid-Rise Buildings Under Seismic Loading” Technical Journal, University of Engineering and Technology (UET) Taxila, Pakistan Vol. 21 No. IV-2016

[7]MD Afroz Patel “A Study on Positioning of Different Shapes of Shear Walls in L Shaped Building Subjected to Seismic Forces” International Journal of Engineering Research & Technology (IJERT) http://www.ijert.org ISSN: 2278-0181 Published by Vol. 5 Issue 07, July-2016.

[8] Lalapeta Sudha “comparison of the efficiency of the trapezoidal shape of the Steel and RCC Structure” International Journal of Civil Engineering and Technology (IJCIET). Volume 8, Issue 1, January 2017, page number 662–669.

[9] Livian Teddy1*, Gagoek Hardiman2, Nuroji3, Sri Tudjono4 “The effect of the earthquake on architecture geometry with nonparallel system irregularity configuration” IOP Conf. Series: Earth and Environmental Science 99 (2017) 012004 doi:10.1088/1755-1315/99/1/012004

[10] Malavika Manilal1, S.V Rajeeva2 “DYNAMIC ANALYSIS OF RC REGULAR AND IRREGULAR STRUCTURES USING TIME HISTORY METHOD” IJRET: International Journal of Research in Engineering and Technology eISSN: 2319-1163 | pISSN: 2321-7308.

[11] Anju Nayas “Pushover Analysis of Plan Irregular RC Buildings with Special Columns” International Journal of Engineering Research & Technology (IJERT) http://www.ijert.org ISSN: 2278-0181 IJERTV6IS050049 (This work is licensed under a Creative Commons Attribution 4.0 International License.) Vol. 6 Issue 05, May – 2017

[12] Rajesh G. Patel1, Bhavin S. Bhagat2 “ PARAMETRICAL STUDY OF DIFFERENT SHAPES OF SHEAR WALL IN HIGH RISE SYMMETRICAL BUILDING” International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 04 | Apr 2018.

[13] Mohd Abdul Aqib Farhan “ Seismic Analysis of Multistoried RCC Buildings Regular and Irregular in Plan” International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 http://www.ijert.org IJERTV8IS110097 (This work is licensed under a Creative Commons Attribution 4.0 International License.) Published by: www.ijert.org Vol. 8 Issue 11, November-2019.