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Analysis of a High-Rise Structure Considering Shear Walls of different Materials with different Positioning : A Review

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ABSTRACT

Shear walls are the structural systems which counteracts the effect of lateral loads such as wind and earthquake loads acting on a structure. They are usually provided as an encasement for the elevator cores, stairwells etc., thereby resisting the horizontal and vertical forces effectively. In the present study, analysis of RCC building has been carried out by changing the locations of shear walls in the building. Also, the effect of variations in seismic zones as per IS codes has been presented. The seismic analysis performed is linear dynamic response spectrum analysis using the well known analysis and design software ETABS16.2.0. Seismic performance of the building has been investigated based on parameters such as storey drift, base shear and storey displacements.

Keywords : ETABS, Asymmetric building, Shear walls, Response spectrum, seismic zones.

I. INTRODUCTION

Tremor is a type of calamity which happens because of Natural or Man-made mistakes bringing about outrageous harms to human progress and any type of design made by us. Late illustration of a particularly tragic tremor was found in our adjoining nation Nepal, bringing about huge obliteration to the whole nation annihilating its economy and putting a mishap of over 10 years. It was a particularly surprising calamity, that it is amazingly essential for endurance to guarantee the strength of the constructions against seismic powers. Along these lines, there is relentless exploration work going on around the world, pivoting around the headway of new and better techniques that can be combined in structures for better seismic execution. Constructions planned considering excellent strategies to oppose such powers and seismic powers have an extensively greater expense of improvement than common designs, yet for flourishing against strain on the construction under seismic powers, it is essential.

II. LITERATURE REVIEW

Priyanka Soni et. Al. (2016) the research paper presented modelling of a multistory building and analysis was considered with all loads like Dead load, Live load, Wind Load as per as IS standard and Seismic load as per as IS standard. The three models G+10, G+20 and G+26 RCC Shear wall structure was modelled using STAAD.Pro where the shear wall placement was prepared in three different locations. The parameters considered in the investigation was inter-storey drift, base shear and lateral displacement.

It was concluded that the G+10 structure shear wall was generated less value of von-misses stress and deformation on structure. In the G+20 structure shear wall was generated less value of von-misses stress and less deformation on structure. The G+26 structure shear wall was generated less value of von-misses stress and less deformation on structure.

Karnati Vijetha and Dr. B. Panduranga Rao (2019) in the research work, G+15 multi Storey building was analysed by using shear wall and braced frame at outer most of the structure and Comparison with multistoried structure with primary purpose to compare the seismic response of the structure. For linear elastic study, RC plane frames with and without shear wall were analysed and designed for gravity loads as per IS 456:2000 and lateral loads (earthquake loads) as per IS 1893 (part-1):2002.

The results concluded that introducing shear walls reduces the sway or displacement. Providing shear walls at adequate locations substantially reduces the displacements due to earthquake. Base Shear of Mentioned Structures Heavily Increases and makes the Structure stable against seismic loading. The Natural Time period of the designed Structures are highly reduced after placing of bracings and Shear walls with comparison to Normal structure. The lateral forces are resisting capacity is highly increased after the placement of Shear wall.

When comparing the above Structures Lateral displacements are minimal when Shear wall and results values stated Shear wall could improve the lateral Stability of the structures.

Ambreshwar et. Al. (2018) the project considered 5x5 bay plan with G+14 storey height of building to be constructed in zone III by providing shear walls of uniform thickness (200mm) in various locations of buildings. "Linear equivalent static method" analysis of the building was done using ETABs 2015. In the research, main focus was to determine the solution for shear wall location in multi storey building. Effectiveness of shear wall was investigated considering five different models. Model -I is bare frame structural system and other four models are dual type structural system. An earthquake load was applied to a building of 15 stories located in zone III. The building act as a vertical cantilever in the form of separate planner walls.

The results stated that the optimum location of shear wall is found in the corners of the building. Provision of Shear wall in the structure reduces the lateral storey displacements in the building compared to Bare frame. Storey drift of the building with the Shear walls is found within the permissible limits, the storey drift is more in the middle storeys compared with the base and gradually reduces up to the top of the building. The storey shear of the structure varies with the provision of Shear walls in structure, the Storey Shear is maximum in the bottom storeys because it is fixed at the bottom and hence gradually decreases at the above storeys. Base shear of the structure with Shear walls is found to be more compared to Bare frame. The provision of Shear wall decreases the time period comparatively with Bare frame in comparison. Providing Shear wall increases the seismic performance of the structures and the location of shear wall affects various structural parameters like mass, stiffness matrices.

Sylviya B and P. Eswaramoorthi (2018) the research paper presented analysis of RCC building by changing the locations of shear walls in the building. Also, the effect of variations in seismic zones as per IS codes has been presented. The seismic analysis performed is linear dynamic response spectrum analysis using the well known analysis and design software ETABS16.2.0. Seismic performance of the building has been investigated based on parameters such as storey drift, base shear and storey displacements.

Results stated that the structural walls should be provided throughout the height of buildings for best earthquake performance. Placing the structural walls towards the centre of the building allows flexibility for buildings to undergo torsion as the first mode of oscillation, which is not desirable. It was analyzed that structural walls are most effective when placed at the periphery of the building. Zone factor of a particular location plays a major role in the behaviour of a building. Risk of damage for buildings of higher seismic zone is more and so, adopting special moment resisting frames are highly necessary. The storey drifts and displacements are found to be more in Seismic Zone V building compared to other zones. It was observed that the values of storey shears are found to be increasing in higher seismic zones

Mohammed Imran and Dr.Uttam Kalwane (2018) the research paper presented comparative study on behaviour of High Rise R.C.C Structure with Shear Wall and High Rise R.C.C. Composite Structure with consideration of Non-linear P-Delta Analysis. The P-Delta effect are the second order effects which increase lateral displacement(The lateral displacements can be caused by wind or seismically induced inertial forces) in the high rise structure. The increase in number of storey in the structure directly proportion to the delta effect in the structure. Comparative investigation included deflections of the structure, size and material consumption of members in composite with respect to R.C.C. shear wall, seismic forces and behaviour of the building under seismic condition in composite with respect to R.C.C. shear wall structure, foundation requirements and type of foundation can be selected for Composite structure with respect to R.C.C. shear wall structure and total weight of the building.

As per storey stiffness results the R.C.C structure with shear wall having better stiffness results when compared with column because shear wall capture in plane as well as out of plane stiffness. While onsidering non-linear P-delta effect in the both R.C.C structure with shear wall and composite structure the effect of P-delta will compensate the results as where the additional displacement occurs at that area it will increase the additional moments. The results

presented that the composite structure is having more drift and displacement values when compared with R.C.C structure with shear wall, because the composite structure is more ductile than R.C.C shear wall structure The weight of the R.C.C structure with shear wall is 10% greater than composite structure. The composite structure is better in case of handling and Execution and completion of the work. Also it will save time when compared with R.C.C structure with shear wall.

Ashish Kumar Gupta et. Al. (2020) the research paper presented seismic analysis on G+ 10 storeys building in Zone IV. The analysis has been done considering shear wall of RCC and steel plate. Parameters like axial load, displacement, Overturning moment, stiffness etc. are determined for different location of shear wall. The objectives of the research included preparation of 3D model of a tall building for detailed analysis with and without RCC shear wall and steel plate shear wall. The modelling and analysis was performed using ETABS application.

It has been observed that the values of storey displacement in concrete shear wall was more than steel plate shear walls (SPSW) while the values of storey stiffness in steel plate shear wall are more than concrete shear wall. When compared to other models for the best location in the building, the steel plate shear wall (SPSW) provided at the middle (tubular form) and corner of the building has been found the best. It was concluded that steel plate shear wall system is comparatively more suitable than concrete shear wall system in a building.

Rama Krishna Kolli and Lingeshwaran Nagarathinam (2019) the research paper dealt with the Load Vs deflection curve, crack pattern, mode of failure of shear wall without boundary elements and three specimens of 200mm thick are casted with different reinforcement alignment types are examined and analysis of shear walls by using STAAD Pro, comparing the results of both experimental and analyze the shear walls to further crack deflections patterns. The obejectives of the project included Comparison between conventional type and diagonal type reinforced shear wall. Stress development due to application of loads on walls by axial and horizontal. Development of deflection due to application of walls and identify the crack patterns in the wall.

Results stated that the load carrying capacity of shear wall specimens with diagonal reinforcement is found to be greater than that of wall specimen with conventional reinforcement. By adding extra reinforcement in the form of diagonal type, load carrying capacity of walls increasing gradually but along with that stresses are also increasing. The analytical results stated that the stresses were increasing mostly at the supports.

Pallavi G. A and Nagaraja C (2017) the research paper presented analysis of G+9 storey building, along with shear wall and bracings. The performance of building was evaluated on the basis of following parameters as Storey displacement, Storey drift, Base shear. In this work, the shear walls and bracings was provided at different locations with the overall analysis to be carried out using Etabs9.7 software.

Results stated that providing a shear wall element are more efficient in reducing lateral displacement of building as drift and horizontal deflection induced in shear wall are much less when compared with bare frame and bracings. The location of shear walls at corner, at sides and bracings at corner has more significant effect on the seismic response than the bare frame. Location of shear wall at corners are effective in reducing actions induced in frame with less deflection and drift. Storey drift for Zone-V is decreased by 64.9% and in Zone-IV it is decreased by 64.93% for placing of shear wall at corners when compared with bare model frame. Storey displacement for Zone-V is decreased by 35.33% and in Zone-IV, it is decreased by 24.56% for placing of shear wall at corners when compared with bare model frame. Base shear value for Zone-V is increased by 41.24% and in Zone-IV, it is increased by 52.47% for placing of shear wall at corners compared to bare model frame. Results concluded that providing shear wall at corner gives more strength when compared with bare model frame and also with bracings.

Nitish A. Mohite et. Al. (2015) research paper presented comparative analysis of steel-concrete-composite and RCC considering a model (B+G+11storey) commercial building. The structure was analyzed considering Equivalent linear Static Method with the use of ETABS version 15. Comparative parameter includes roof deflections, base shear, storey drifts, for the building and axial forces and bending moments for column's and beams at different level.

Results stated that reduction in the self-weight of the Steel-Concrete Composite structure is reduced by is 9.48 % as compared to R.C.C. frame Structure. Shear forces in main beams in composite structure are increased by average 39.43% as compared to R.C.C. framed structure while in secondary beams in composite structure are reduced by average 14.39 % as compared to RCC framed structure. Bending moments in main beams in composite structure are increased 52.57% as compared to R.C.C. framed structure while in secondary beams in composite structure are reduced by average 28.93 % as compared to RCC framed structure. Axial forces in column in Composite framed structure have been reduced by average reduced by average 9.08 % as compared to RCC framed structure. Overall response of composite structure is better than RCC structure i.e. composite structure produces less displacement, resist more structure forces/ action. Earthquake response is more than wind load. In both the options the values of story displacements are within the permissible limits as per code limits. Still roof displacement and drift with earthquake in X and Y direction are less in Composite framed structure as to R.C.C. framed structure. This may be due to more ductility in case of

Composite structure as compared to the R.C.C. which is best suited under the effect of lateral forces. The observations stated that Steel-Concrete-Composite option is better than RCC for high rise building.

Nehal A. Bhavsar et. Al. (2016) the main goal research was to find out up to which base dimension the effectiveness of shear wall. This study was an attempt to understand the effectiveness of shear wall on different aspect ratio of building (HB/LB). Three different aspect ratio of building (R= HB/LB i.e. 1,2,3) has been taken. The effectiveness was checked up to G+30 storey building with every five incremental storey. To avoid torsional behaviour, symmetrical building with rectangular type of shear wall at the center of face of the building on both directions building was taken. The shear wall dimensions were restricted by shear wall aspect ratio (Hw/Lw).The response spectrum analysis of building without shear wall and with shear wall was carried out using ETABS® software and later building response parameter Displacement was compared.

Results concluded that the effectiveness of shear wall does not depend on building aspect ratio. As the aspect ratio of shear wall increases (length of shear wall decreases), the displacement of the building increases. The effectiveness of shear wall is maintained up to G+20 storey for shear wall at the centre of faces. To achieve effectiveness beyond twenty storey the core shear wall or couple shear wall mechanism is required which increase the capacity of the building.

Krunal P Suthar and Arjun M Butala (2020) the primary aim of the research was to compare seismic performance of a 3D (G+10) story RCC, Steel and Composite building frame situated in earthquake zone IV. All frames are designed for same gravity loadings. In RCC slab are used in all three types buildings. The sections of Beam and Column are made of either RCC, Steel or Steel-concrete composite sections. In a Seismic analysis Equivalent static method and Response Spectrum method are used. ETABS 2017 software is used and results are compared based on fundamental time period, displacements, story drift, base shear, story weight and story stiffness.

Comparative study based on seismic analysis concludes that, RCC construction is best suited for low rise buildings among all the three types of constructions, but in a High rise building construction are Composite is a better options among the RCC and Steel Structures. As the weight of the Steel concrete composite frame is more compared to RCC and Steel frame, it concludes that Steel concrete composite structure has maximum base shear value.

P. A. Nikam and Gayake Prasad (2018) the primary aim of the research was to determine the solution for shear wall location in multi-storey building. Effect of shear wall was analyzed with the help of two different models. The model was designed as per zone four with and without shear wall. An earthquake load is applied to a building of G+13 stories. Parameters like Lateral joint displacement and joint drift required for each floor are calculated in both cases of shear wall. The analysis of this parameter is carried out by using ETABS software.

Results stated that in 14 story building, constructing with shear wall along short span at middle was effective in resisting seismic forces as compare to building without shear wall. It was also observed that joint displacement & joint drift of the structure was reduced by providing shear wall.

Dr. Hadihosseini et. Al. (2014) the research paper analyzed the structural performance of the framed building with shear wall.

Based on the analysis and discussion, shear wall are very much suitable for resisting earthquake induced lateral forces in multistoried structural systems when compared to multistoried structural systems whit out shear walls. They can be made to behave in a ductile manner by adopting proper detailing techniques. The vertical reinforcement that is uniformly distributed in the shear wall shall not be less than the horizontal reinforcement .This provision is particularly for squat walls (i.e. Height-to-width ratio is about 1.0).However ,for walls whit height-to-width ratio less than 1.0, a major part of the shear force is resisted by the vertical reinforcement. Hence, adequate vertical reinforcement should be provided for such walls.

Wadmare Aniket et. Al. (2018) in the research paper 11 story RCC building was considered for the seismic analysis which is located in zone V is considered for the analysis. Three models are considered for the analysis out of which one is bare frame model and remaining two models are structures with shear wall at various positions is considered. The modelling and analysis is done using ETABS -2013 software package. An attempt is made to study and compare the parameters such as story displacement, story drift, story shear, natural period and base shear.

Results stated that Base shear for structure with shear wall at corners is greater than the other two structures. Hence it is feasible to provide to shear wall at corners than at centre. Natural period for structure with shear wall at corners is less i.e the structure displaces less in case of shear wall at corners than at centre. Hence it is feasible to provide shear wall at corners. Storey displacement for structure with shear wall at corners is less as compared to that of structure with shear wall at centre and structure without shear wall. Hence it is feasible to priovide shear wall at corners. Storey shear for structure with shear wall at corners gives higher values as compared to that with centre. Hence it is feasible to provide shear wall at corners.

Conclusion stated that structure with shear wall at corners gives better results as in case of the other two structures.

Tushar Loya et. Al. (2020) the research paper reviewed analysis and designing of steel members or sections to be used in construction of apartment building in steel structure, and its comparative study with conventional rc building. New techniques was investigated to perform more fast and precise work on field. A G+4 storied apartment building whose ground floor was considered as parking floor, is situated in second tier city of Nasik. Nasik city belongs to the earthquake zone-III. As ground floor is considered as parking floor rest other floors have same plan comprising of 8 2BHK flats on each floor. As 4 storied building is earthquake dominating so keeping the wind analysis deprived and analyzing the building for various combinations of earthquake loads. Provision of IS: 1893(Part 1)-2016 is reviewed using commercial software for the analysis of models. As earthquake forces are associated with inertia, they are related to mass of the structure and so reducing the mass inevitably leads to lower the seismic forces. The design work is carried out using IS: 800-2007and IS: 456:2000 for steel and RC work respectively. Parameters of the comparison were structural parameters such as reactions, moments, shear force, displacements, story drift, etc. at various junctions of both buildings.

Results stated that Steel structures are expected to show superior performance under earthquake due to high ductility than the conventional RCC structure. Axial forces are lower in steel structure due to lower weight of steel structure compared to RCC structure. Due to this the reaction obtained in steel is lesser than RCC, which gives better response during earthquake conditions. According to the results of analysis when maximum displacement and story drift is compared it is quite higher in steel structure than in RCC. This shows that RCC is more durable and sturdy. Bending moment and Shear force in beams of RCC structures is more as compared to that of steel structures. Preferred boards fire protection a system simultaneously helps the building for resisting fire cause and hides all the exposing structural members.

Axay Thapa and Sajal Sarkar (2017) the research paper considered three models with varying height with and without shear wall. G+5, G+10 and G+15 R-C frame models with and without shear walls are generated with varying structural member dimensions according to height. The models was analysed by Static Method and Response Spectrum Method considering seismic zone V in STAAD. Pro V8i. Parameters like lateral displacement, story drift, base shear and mode shapes are determined for all the models (with and without shear walls) by the three methods and are compared and the effectiveness of shear walls was enumerated.

The results stated that the design seismic coefficient parameters such as fundamental natural period and spectral acceleration coefficient calculated by IS 1893:2002 match accurately by STAAD software. The design horizontal seismic coefficient obtained by STAAD also matches with code. The most important parameter for earthquake design i.e. base shear obtained from all models matches perfectly with the code. The weight of building is also calculated manually and matched with that obtained by software. Bare-frame model showed higher displacement, than shear walled-frame model. A significant amount of increase in the lateral stiffness has been also observed in all models of shear wall frame as compared to bare frame. The variation in displacement between the bare frame and shear walled frame model increase with the increase of height, the variation in displacement of the two frames for G+5 floors was comparatively less than that of G+15 floors. The displacement values will depend upon frequency of earthquake and natural frequency of the structure and building with short time period tends to suffer higher accelerations but smaller displacement.

A.P.Nagendra Babu and Sk.Jain Shahab (2017) the primary focus was to determine the solution for shear wall location in multistory building. A RCC building of G+10 placed in AHMEDABAD, subjected to earthquake loading in zone-II is considered. An earthquake load is calculated by seismic coefficient method using IS 1893 (PART–I):2002. A study has been carried out to determine the strength of RC shear wall of a multistoried building by changing shear wall location. Three different cases of shear wall position for a G+10 building have been analyzed. Incorporation of shear wall has become inevitable in multi-storey building to resist lateral forces.

Results stated that the analysis of building with Core shear wall and edge shear wall shows that Shear wall at core shows stiffer behaviour. When shear walls are provided on edge maximum storey displacement of buildings is increased comparing to when shear walls are provided on center portion. When dynamic analysis is done storey drift decreases. When shear wall is placed on edge time period of building increases. When shear walls are provided on edge storey drift of buildings is increased comparing to when shear walls are provided on center portion. For good seismic performance a building should have adequate lateral stiffness. Low lateral stiffness leads to large deformation and strains, damage to non-structural component, discomfort to occupant. Conclusion stated that building with shear wall at core proves to be a better alternative for building in earthquake prone area. Dynamic analysis reduces storey shear, storey displacement, storey drift etc; stated that dynamic analysis gives improved estimate of forces and therefore analysis of building become more accurate as well as economical.

III. CONCLUSION

The entire research in past shows that authors tried to analyze structure with differet lateral load resisting members under lateral loading condition. But none of them shows variations observed due to effect of different positioning of walls.

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