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A Review on Analysis and Design of Shear Walls in High Rise Irregular Building

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Abstract: The usefulness of shear walls in the structural planning of multistory buildings has long been recognized. When walls are situated in advantageous positions in a building, they can be very efficient in resisting lateral loads originating from wind or earthquakes. Reinforced concrete framed buildings are adequate for resisting both vertical and horizontal loads acting on them. Extensive research has been done in the design and analysis of shear wall high rise buildings. A residential building of G+15 irregular structure is considered for the analysis. To evaluate the seismic response of the buildings and analysis was performed by using response spectrum method using Finite element based software-ETABS. The properties of these seismic shear walls dominate the response of the buildings, and therefore, it is important to evaluate the seismic response of the walls appropriately. A study on an irregular highrise building with shear wall and without shearwall was studied to understand the lateral loads, story drifts and torsion effects. From the results it is inferred that shear walls are more resistant to lateral loads in an irregular structure.

Keywords: Walls, Lateral Loads, Irregular, Torsion, ETABS.

I. INTRODUCTION

Shear walls are specially designed structural walls included in the buildings to resist horizontal forces that are induced in the plane of the wall due to wind, earthquake and other forces. They are mainly flexural members and usually provided in highrise buildings to avoid the total collapse of the highrise buildings under seismic forces. Shear wall has high in-plane stiffness and strength which can be used to simultaneously resist large horizontal loads and support gravity loads. However, when the buildings are tall, say more than twelve story or so, beam and column sizes workout large and reinforcement at the beam and column junction works out quite heavy, so that, there is a lot of congestion at these joints and it is difficult to place and vibrate concrete at these places, which does not contribute to the safety of buildings. These practical difficulties call for introduction of shear walls in highrise buildings. Deep straight walls or angular, U shaped and box shaped shear walls were used based on functional and architectural requirement of the highrise building. The section 7 of IS 1893(part1):2002 enlists the irregularity in buildings. These irregularities are categorised as follows

- Vertical irregularities referring to sudden change of strength, stiffness, geometry and mass results in irregular distribution of forces or distribution over the height of the building.
- Plan irregularities which refer to asymmetrical plan shapes(L-,T-,U-,F-) or discontinuities in the horizontal resting elements (diaphragms) such as cut-outs, large openings, re-entrant corners and other abrupt changes resulting in torsion, diaphragm deformations and stress concentration.

II. STORY DRIFT

It is defined as the difference in lateral deflection between two adjacent stories. During an earthquake, large lateral forces can be imposed on structures; Lateral deflection and drift have three primary effects on a structure; the movement can affect the structural elements; the movements can affect non-structural elements; and the movements can affect adjacent structures. Without proper consideration during the design process, large deflections and drifts can have adverse effects on structural elements, nonstructural elements, and adjacent structures.

III. RESPONSE REDUCTION FACTOR (R)

Response Reduction factor (R) is the ratio of the strength required to maintain the elastic to the inelastic design strength of the structure. R factor is the factor by which the actual base shear should be reduced, to obtain the design lateral force. R factor reflects the capacity of structure to dissipate energy through inelastic behavior. It is a combined effect of over strength, ductility and redundancy. The basic principle of designing a structure for strong ground motion is that the structure should not collapse but damage to the structural elements is permitted. Since a structure is allowed to be damaged in case of severe shaking, the structure should be designed for seismic forces much less than what is expected under strong shaking, if the structure were to remain linearly elastic. Commonly the Response reduction factor is expressed as a function of various parameters of the structural system, such as strength, ductility, damping and redundancy:

$$R=R_S\,R_\mu\,R_\xi\,R_R \quad (1)$$

Where
R_S is the strength factor,
R_R is the redundancy factor,
R_μ is the ductility factor,
R_ξ is the damping factor.

IV. RESPONSE SPECTRUM METHOD

In order to perform the seismic analysis and design of a structure to be built at a particular location, the actual time history record is required. However, it is not possible to have such records at each and every location. Further, the seismic analysis of structures cannot be carried out simply based on the peak value of the ground acceleration as the response of the structure depend upon the frequency content of ground motion and its own dynamic properties. To overcome the above difficulties, earthquake response spectrum is the most popular tool in the seismic analysis of structures. There are computational advantages in using the response spectrum method of seismic analysis for prediction of displacements and member forces in structural systems. The method involves the calculation of only the maximum values of the displacements and member forces in each mode of vibration using smooth design spectra that are the average of several earthquake motions. Response spectra are curves plotted between maximum response of SDOF system subjected to specified earthquake ground motion and its time period (or frequency). Response spectrum can be interpreted as the locus of maximum response of a SDOF system for given damping ratio. Response spectra thus helps in obtaining the peak structural responses under linear range, which can be used for obtaining lateral forces developed in structure due to earthquake thus facilitates in earthquake-resistant design of structures.

V. LITERATURE REVIEW

O. Esmaili, Epackachi et al (2008): In this paper study the structural aspects of one of the tallest RC buildings, located in the high seismic zone, with 56 stories. In this Tower, shear wall system with irregular openings are utilized under both lateral and gravity loads, and may result some especial issues in the behavior of structural elements such as shear walls, coupling beams and etc. Some especial aspects of the tower and the assessment of its seismic load bearing system with considering some important factors will be discussed. We introduce the highest reinforced concrete tower, located in high seismic zone. The tower is a 56-story tall building, located in Tehran, which is the most high seismicity zone of Iran and extensively populated now a days. The tower has three transverse main walls with the angle of 120° and multiple sidewalls perpendicular to each of them. Author concludes that the concrete structural elements with different longitudinal stiffness makes the tower to be more sensitive to differential displacements due to concrete time dependency. A level of ductility for seismic bracing systems, conceptually, should be provided for energy absorption but axial loads have an adverse effect on their acceptable performance. Using shear walls for both gravity and bracing system is unacceptable neither conceptually nor economically. Coupling beams are assumed to be cracked prematurely in earthquake, it take place under permanent gravity loads as a result of concrete time dependency. By considering both time dependency of concrete and construction sequence loading simultaneously in analyses, the critical demands occur in the middle height of the structure.

Dr. S.K. Dubey et al (2011): The main objective of this study is to understand different irregularity and torsional response due to plan and vertical irregularity, and to analyze "T"-shaped building while earthquake forces acts and to calculate additional shear due to torsion in the columns. Additional shear due to torsional moments needs to be considered because; this increase in shear forces causes columns to collapse. Irregularity lead to building structures with irregular distributions in their mass, stiffness and strength along the height of building. When irregular features are included in buildings, a considerably higher level of engineering effort is required in the structural design and yet the building may not be as good as one with simple architectural features. Modeling and analysis of five storey framed structure, using Staad-pro is presented in this chapter. The main purpose of taking this type of building is to understand basic behaviour of soft storey structure. Buildings with irregularities are prone to earthquake damage, as observed in many earthquake occurrences. It was concluded that necessary to develop a simple analytical procedure based on rigorous computations and experiments on the seismic response of irregular structures. Necessary that irregular buildings should be carefully analyzed for torsion. Soft storey-For all new RC frame buildings, the best option is to avoid such sudden and large decrease in stiffness and/or strength in any storey; it would be ideal to build walls in the ground storey also. The existing open ground storey buildings need to be strengthened suitably so as to prevent them from collapsing during strong earthquake shaking.

Sharmin Reza Chowdhury et al (2012): In this paper at attempt is made to apply the finite element modelling in analysing and exploring the behavior of shear wall with opening under seismic load actions. This study is carried out on 6- story frame-shear wall buildings, using linear elastic analysis with the help of finite element software, ETABS under earthquake loads in equivalent static analysis. Sometimes it is inevitable to have openings such as doors, windows, and other types of openings in shear wall. The size and location of openings may vary depending on purposes of the openings. Analysis is divided into two main parts; Analysis regarding shear wall placed in-plane of loading and analysis regarding shear wall placed at out of plane of loading. As we know that structural behavior regarding in-plane of loading is much more important than that of out of plane of loading. Opening in shear wall placed in plane of loading is more critical than that of opening in shear wall placed out of plane of loading since there is a significant change in displacement noticed after having opening in shear wall placed in plane of loading. Stiffness as well as seismic responses of structures is affected by the size of the openings as well as their locations in shear wall. It is also concluded that more the area of opening more the displacements conceded by the building and this trend increases with increasing story level. It is clearly understood that opening in shear wall placed in plane of loading is more critical than that of opening in shear wall placed out of plane of loading. Shear wall with different opening sizes and locations considering coupling beam actions may be considered for future research.

AnujChandiwala (2012): In the present paper the researcher, had tried to get moment occur at a particular column including the seismic load, by taking different lateral load resisting structural systems, different number of floors, with various positions of shear wall for earthquake zone III in India has been found. The structural system designed to carry vertical load may not have the capacity to resist lateral load or even if it has, the design for lateral load will increase the structural cost substantially with increase in number of storey. Moment Resistant Frames, Braced Frames, Shear Wall Structures, Tube Structures, Multi-Tube Structures are the system used to resist lateral load in economy. The shear wall can be either planar, open sections, or closed sections around elevators and stair cores. Dynamic analysis of structure involves free vibration analysis to determining the mode shapes and frequencies of the structure .The structure can be analyzed for seismic loading in form of response Spectrum or acceleration/force time history. After the analysis of the different position of shear wall in the building configuration following is the comparison in maximum base shear in X & Y-direction. Among different location of shear wall (F- shear wall at end of "L" section) gives best result. Main reason is "END PORTION OF FLANGE ALWAYS OSCILLATE MORE DURING EARTHQUAKE". Here shear wall directly obstruct this end oscillation, hence reduce overall bending moment of building.

BahadorBagheri et al (2012): In present study, Multi-storey irregular buildings with 20 stories have been modeled using software packages ETABS and SAP 2000 v.15 for seismic zone V in India and also deals with the effect of the variation of the building height on the structural response of the shear wall building. It highlights the accuracy and exactness of Time History analysis in comparison with the most commonly adopted Response Spectrum Analysis and Equivalent Static Analysis. Selected ground motions response spectrum around fundamental period of structure can be different than target response spectrum determined from seismic hazard analysis. Therefore records are scaled by single-factor scales It's clear that the static analysis gives higher values for maximum displacement of the stories in both X and Y directions rather than other methods of analysis, especially in higher stories. It is obserbed that the displacement obtained by static analysis are higher than dynamic analysic including response spectrum and time history analysis. Static analysis not sufficient for high-rise buildings and it is necessery to provide dynamic analysis. The displacement of each storey at centre of mass is lower compare to those at joint of maximum displacement. The result of equivalent static analysis are approximately uneconomical because values of displacement are higher than dynamic analysis.

P. P. Chandurkar et al (2013): In this present paper one model for bare frame type residential building and three models for dual type structural system are generated with the help of ETAB and effectiveness has been checked. The sections of structural elements are square and rectangular and their dimensions are changed for different building. Storey heights of buildings are assumed to be constant including the ground storey.

The Building Model Are Given Below:

- **Model 1** – Floor plan of the bare framed structure.
- **Model 2 –** Floor plan of the dual system with shear wall one on each side.
- **Model 3** - Floor plan of the dual system with shear wall on corner with L = 4.5m
- **Model 4** – Floor plan of the dual system with shear wall on corner with L = 2m.

From results it is observed that the displacement of all models in zone II, III, IV is reduced upto 40% as compared with zone V. Constructing building with shear wall in short span at corner (model 4) is economical as compared with other models. Also observed that Changing the position of shear wall will affect the attraction of forces, so that wall must be in proper position. If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall. Providing shear walls at adequate locations substantially reduces the displacements due to earthquake.

Pravin Ashok Shirule et al (2013): In this project a parametric study on Reinforced Concrete structural walls and moment resisting frames building representative of structural types using response spectrum method is carried out. To evaluate the seismic response of the buildings, elastic analysis was performed by using response spectrum method using the computer program SAP2000. Response spectrum of any building gives us a plot of peak or steady state response of a series of oscillators of a varying natural frequency, that are forced into motion by the same base vibration or shock. The method involves the calculation of only the maximum values of the displacements and member forces in each mode using smooth design spectra that are the average of several earthquake motions. While analysis this asymmetrical building by using SAP2000, it was observed that this building is failed in first mode only. It means building is not safe in seismic area. So it is a need to provide a shear wall to the building then only the chances of failure of the structure can be minimised. It is observed that deflection is reduces in X direction than that in Y direction which is about 15%. After the all analysis of the asymmetrical building, it is better to provide shear wall to the asymmetrical building. From the parametric study on Reinforced Concrete buildings the following conclusions are drawn as:- IS code depict the higher values of base shear for similar ground types defined in the other codes which may lead to overestimate the overturning moment and could results in heavier structural members in the building. For the buildings, UBC code gives the maximum and IS gives the minimum displacement values.

Shaikh Abdul Aijaj Abdul Rahman et al (2013): The present paper attempts to investigate the proportional distribution of lateral forces evolved through seismic action in each storey level due to changes in stiffness of frame on vertically irregular frame. To response parameters like story drift, story deflection and story shear of structure under seismic force under the linear static & dynamic analysis is studied. In the present paper, response of a G+ 10-storeyed vertically irregular frame to lateral loads is studied for stiffness irregularity at fourth floor in the elevation. Stiffness irregularities include the height of the column increased on the fourth floor which is applied on vertically irregular frame. Irregularities are divided into two groups—plan and vertical irregularities. The base model having the shape irregular to know the effect of stiffness irregularity on the shape (vertical geometric) irregular building the excess height of column at fourth floor as per the IS 1893:2002 (part-1).It is clear that the frame having stiffness irregularity on vertically irregular frame is susceptible to damage in earthquake prone zone. Two frames having different irregularities but with same dimensions have been analyzed to study their behavior when subjected to lateral loads. Now a day, complex shaped buildings are getting popular, but they carry a risk of sustaining damages during earthquakes. Therefore, such buildings should be designed properly taking care of their dynamic behavior.

C.M. Ravi Kumar et al (2013): The study includes seismic vulnerability assessment of RC buildings without shear wall, with shear wall at centre, shear wall at diagonal corners, shear wall at mid along X-direction, and shear wall at mid along Y direction, lastly shear wall at mid along X&Y-directions. Constructing the shear wall in tall, medium and even short buildings will effect and intern reinforce the significantly and either more economical than the bending frames. It is necessary and important to know and investigate analytically/experimentally, what should be the location of the shear wall that can induce minimum stresses in all the structural members of the multistoried buildings. The moment resisting frames are designed to independently resist at least 25% of design seismic base shear. The analysis and design of multistoried building with shear wall by hand calculation is very tedious and time consuming process. So the problem statement is carried out with the help of structural analysis software “ETABS”. Time period will be less when shear wall is constructed in centre but with the consideration of first mode will be creating torsion; hence that type construction should be avoided. Scale-up factor X & Y direction will be high when no shear wall is provided, further it will decrease slightly after providing wall at different location and less when wall is provided at the X-direction. Maximum story displacement will be less when shear wall is at X direction. Maximum story drift will increase slightly when shear wall is provided at different locations.

Mr. S.Mahesh et al (2014): In this paper a residential of G+11 multi story building is studied for earth quake and wind load using ETABS and STAAS PRO V8i.A building shall be considered as irregular for the purposes of this standard, if at least one of the conditions are applicable as per IS 1893(part1):2002 As per IS-1893:2002, Methods Adopted are Equivalent Static Lateral Force (or) Seismic Coefficient Method and Response Spectrum Method Time history method. To design the earth quake loads to calculate the internal forces will be reasonable approximate of expected during to design earth quake. Base shear value is more in the zone 5 and that in the soft soil in irregular and regular configuration. When compared the both the regular and irregular configuration and the base shear value is more in the regular configuration. Because of the structure have more symmetrical dimensions. Story drift value is more in the story 12 and 13 in the irregular and regular configuration respectively. When compared the both the regular and irregular configuration and the story drift value is more in the regular configuration. Because of the structure has more dimensions. Finally when compared the both software’s the STAAD PROV8i has more value. The area of the steel is 5 to 10% .

Le Yee Mon (2014): In this study, comparative analysis of high-rise reinforced concrete irregular building with shear walls are present. In this project, study of 14 storey building is presented with some investigation which is analyzed by changing various location of shear wall for determining parameters like storey drift, storey shear and storey moment .A response spectrum is the graphic representation of maximum response i.e. displacements, velocity and acceleration of a damped single-degree-of-freedom system to a specified ground motion, plotted against the frequency or modal periods. The model must be constructed as an elastic system and a single value of damping is used for each model response. Results obtained from the analysis are recorded for the four cases of the building separately for comparison of storey drift, storey shear and storey moment. The story moment is depending on the seismic load. So, the story moment is the largest at base. Structure without shear wall has the least story moment and structure with core shear wall and planar shear wall has the greatest story moment. Storey shears are greatest at the base and gradually decrease from base to top storey for four models. Storey moments are slightly increased from top to bottom storey for all models. The influence of shear wall location on the selected irregular building is more stable by providing the location of shear walls in the symmetric side. Story drift is increased as height of building increased and reduced at top floor so that shear wall frame interaction systems are very effective in resisting lateral forces induced by earthquake. The selection of especially the location and amount of shear walls is of the highest importance in strengthening. Strengthening shear wall may vary in various positions according to their positions in the plan.

Lakshmi K.O. et al (2014): This study aims at comparing various parameters such as storey drift, storey shear, deflection, reinforcement requirement in columns etc of a building under lateral loads based on strategic positioning of shear walls and software used is ETABS 9.5 and SAP 2000.V.14.1.Shear walls in buildings must be symmetrically located in plan to reduce ill-effects of twist in buildings. Load is applied incrementally to frameworks until a collapse mechanism is reached. It enables determination of collapse load and ductility capacity on a building frame. Base shear is the maximum expected lateral force that will occur due to seismic ground motion at the base of structure. The percentage of steel required in columns in ground floor has come down by 44%, 18% and 49% and up to 34.7% , 13.4% and 26.3% respectively in top floors when compared with bare frame model. In medium high rise buildings provision of shear walls is found to be effective in enhancing the overall seismic capacity characteristics of the structure. The comparison of story drift values maximum reduction in drift values is obtained when shear walls are provided at corners of the building .Response spectrum analysis can be seen that the displacement values in both X and Y directions are least in model with shear wall in core and corners when compared to all other models. Reduction in steel requirement up to 44.6% when shear wall is provided at the core and 34.7% when shear wall is located at core and corner of the structure.

Ravikanth Chittiprolu et al (2014): A residential building of G+15 irregular structure having the base dimension of plan 24.38m x 25.98m with a stilt floor of height 4m and typical floor of height 3m is considered for the analysis. Dynamic linear analysis using response spectrum method is performed by taking zone factor Z=0.1, importance factor I=1 and response reduction factor R=3.Lateral forces are distributed to frames along X direction for structure without shear wall and with shear wall. Centre of mass (CM) of structure without shear wall and with shear wall is extracted from analysis results. Maximum story drift is extracted from analysis results and compared for structure without shear wall and with shear wall. Story drift is reduced in case of structure with shear wall. Dynamic linear analysis using response spectrum method is performed and lateral load analysis is done for structure without shear wall and structure with shear wall. Results are compared for the frame lateral forces and story drifts of both the cases. It is also observed that lateral forces are reducing when the shear walls are added at the appropriate locations of frames having minimum lateral forces. Therefore, it is inferred that shear walls are more resistant to lateral loads in an irregular structure. Also they can be used to reduce the effects of torsion.

Er. Puneet Sharma et al (2014): The phenomenon of soil-structure interaction is more pronounced in multi-storied building frames especially, when resting on poor soil, due to possibility of large unequal column loads. The effect of SSI, however, becomes prominent for heavy structures resting on relatively soft soils for example high-rise buildings, nuclear power plants and elevated-highways on soft soil. By constructing shear walls, damages due to effect of lateral forces due to earthquake and high winds can be minimized. From economic, structural strength and stiffness considerations. Soil -structure-interaction (SSI) effects may be either beneficial or detrimental to the performance of structures. Then the difference between the cases is compared with each other on the bases of axial forces, bending moments, shear force, storey drift and time period. Shear walls are provided in the internal frame of the building, similarly L shaped shear walls are provided in the extreme corners of the frame and the middle portion of the structure is provided with lift well. In the Elastic half space approach, the foundation is idealized as the vibrating mechanical oscillator with a circular base resting on the ground. The ground is assumed to be an elastic, homogeneous, isotropic semi infinite body which is elastic half space. Considerable change in the member forces when shear walls and soil interaction is incorporated in the analysis. The axial force in columns decreases when the effect of shear wall is considered in the analysis and outer columns other than corner columns with maximum increase up to 11.41%.Large variation in bending moment was observed in exterior frame as compared to interior frame. Decrease in shear force is observed for end spans of all the frames and increase is observed for the inner spans.

M. S. Aainawala et al (2014): An earthquake load is applied to a building for G+12, G+25, G+38 located in zone II, zone III, zone IV and zone V for different cases of shear wall position, analysis using ETAB v 9.0.7 software. It was observed that Multistoried R.C.C. Buildings with shear wall is economical as compared to without shear wall. A response spectrum may be visualized as a graphical representation of the dynamic response of a series of progressively longer cantilever pendulums with increasing natural periods subjected to a common lateral seismic motion of the base. Dynamic analysis is performed by Response Spectrum Method. Size of members like column can be reduced economically in case of structure with shear wall as compared to the same structure without shear wall. More carpet area will be available in the building as the sizes of columns are reduced when shear wall is provided. It is concluded that displacement at different level in multistoried building with shear wall is comparatively lesser as compared to R.C.C. building Without Shear Wall. It is concluded that building with shear wall is constructed in lower cost as compared to structure without shear wall. Less obstruction will be there because of reduced size of column and provision of shear wall.

RakshithGowda K.R et al (2014): This paper deals the behavior of multi storyed RC 3-D frame regular building and vertically irregular (stepped) building in which soft storey's are provided at different level for different load combinations. It is necessary to study and examine various alternative models of reinforced concrete moment resisting frame building with soft storey at different level. Two different buildings, regular and vertically irregular building in which soft storey are provided at different storey level are modeled using ETABS (9.7.4) package and analyzed. Models are analyzed as special moment resisting frame using equivalent static analysis and response spectrum analysis. The results are presented by plotting the graph for each models considered in the study. The analysis carried out is equivalent static analysis and dynamic analysis. The result of Storey displacement, Inter storey drift, Base shear and Fundamental time period at the first mode is presented for all models. In this study regular building is compared with irregular building, the performance of all the building models is observed in high seismic zone V. The inter storey drift was observed to be maximum in vertically irregular structure. The Base shear values are observed to be more for the frames with complete infill, whereas the bare frame models exhibit the minimum value in both X and Y-direction. The displacement is observed to be minimum in regular building when compared with the irregular building for time period mode-1.Hence it can be concluded that the regular building is safer than irregular building.

S Monish et al (2015): In this paper attempt has been made to study two types of plan irregularities namely diaphragm discontinuity and re-entrant corners in the frame structure as per clause 7.1 of IS 1893:2002(part1) code. The models were analysed using static and dynamic methods, parameters considered being displacement, base shear and fundamental natural period. In equivalent Static Method design horizontal coefficient depends on the zone factor of site, importance of the structure, response reduction factor of the lateral load resisting elements and the fundamental natural time period of the structure. In response spectrum method the maximum response of the building is estimated directly from elastic or inelastic design spectrum characterizing the design earthquake for the site and considering the performance criteria of the building. The software solves the Eigen value problem of the model and calculates the fundamental natural period values. When comparing static and dynamic method the magnitude of displacement is more in static as the response of the building is assumed to behave in a linear elastic manner. Hence the results are more accurate in nonlinear dynamic analysis. When comparing static and dynamic method of analysis the magnitude of base shear is more in linear static method which is an approximate value. Irregular structural configurations are affected severely during earthquakes especially in high seismic zones. The results obtained from response spectrum method are accurate, when compared with results of equivalent static method, since the method is based only on empirical formula. The results of fundamental natural periods have proved that, the code IS 1893:2002 doesn't consider the irregularity of buildings.

Mahesh N. Patil et al (2015): In this paper, the earthquake response of symmetric multistoried building is studied by manual calculation and with the help of ETABS 9.7.1 software (IS 1893:2002). The responses obtained by manual analysis as well as by soft computing are compared. This paper provides complete guide line for manual as well s software analysis of seismic coefficient method. A 22.5m x 22.5 m, 8 storey multi storey regular structure is considered for the study. Storey height is 3m.Loads acting on the structure are Dead load, Live Load and Earthquake Load, DL: Self weight of the structure, Floor load and Wall loads. Modeling and analysis of the structure is done on ETABS software. As per IS 1893:2002, Page No. 24, The total design lateral force or design seismic base Shear (VB) along any principal direction shall be determined by the expression:

$$VB = A_h \text{ x } w \quad (2)$$

Where A_h = Design horizontal acceleration spectrum Value, w = Seismic weight of the building.

Analysed base shear for the structure. Seismic analysis was done by using ETABS software and successfully verified manually as per IS 1893-2002. There is a gradual increase in the value of lateral forces from bottom floor to top floor in both manual as well as software analysis. Calculation of seismic weight by both manual analysis as well as software analysis gives exactly same result. There is slight variation in the values of base shear in manual analysis as well as software analysis. Results as compared and approximately same mathematical values are obtained for 8-story building. To conclude a complete design involving several parameters so as to result the earthquake has been done and a 3D prospective is shown for easy understanding and use.

HemaMukundan et al (2015): The provision of shear wall in building has been found effective and economical. In this paper, a 10 storey building in Zone IV is presented to reduce the effect of earthquake using reinforced concrete shear wall-framed structures in the building. The results were tabulated by performing Response spectrum analysis using ETABS version 9.7.4 in the form of maximum storey displacements, base shear reactions, mode shapes and storey drifts. In this paper, study was done on a regular Multi-storey building (G+9) with / without shear wall understanding parameters like storey drifts, lateral loads, mode shape patterns, time period, base shear, and storey deflections. To improve the understanding of the seismic behaviour of building structures with vertical irregularities. Seismic analysis is a major tool in earthquake engineering used to understand the response of buildings due to seismic excitations in a simpler manner. Shear walls are quick in construction, because concreting of the members is done using formwork. Since Shear walls give such a high level of precision. Using Response Spectrum Analysis, it is found that out of all the mode shapes, mode Shape 2 has the maximum base reaction force for the building with/without shear wall.

Provision of shear wall results in a huge decrease in base shear and roof displacement both in symmetrical building and un-symmetrical building. It is observed that in the regular frame, there is no torsional effect in the frame because of symmetry. In an irregular frame, there is torsional rotation in the structure. They should be placed symmetrically along one or both directions in plan. It is inferred that shear walls are more resistant to lateral loads in regular/Irregular structure. The moments in the columns got reduced when shear wall is introduced in the structure. The maximum storey displacement of the building is reduced by 50% when shear wall is provided. Shear wall with openings and with varying thickness is still strong & stable enough to resist seismic loads. For safer design, the thickness of the shear wall should range between 150mm to 400mm.

Mohammad Abdul Imran Khan et al (2015): Due to the varied configurations of buildings in sloping areas, these buildings become highly irregular and unsymmetrical, due to variation in mass and stiffness distributions on different vertical axis at each floor. The structural analysis software ETABS V9.7.4 is used to study the effect of sloping ground on building performance during earthquake. Seismic Analysis is done by Equivalent static method and Response spectrum method. Shear force, bending moment, axial forces are critically analyzed to study the effect on various sloping ground. Hill buildings are different from those in plains; they are very irregular and unsymmetrical in horizontal and vertical planes, and torsionally coupled. Hence, they are susceptible to severe damage when affected by earthquake ground motion. They studied seismic analysis of a G+4 storey RCC building on varying slope angles i.e., 7.5° and 15° and compared with the same on the flat ground as per IS: 1893-2002.There are significant computational advantages using response spectra method of seismic analysis for prediction of displacements and member forces in structural systems. In this present study 12 models are studied

- Buildings on Plain Ground
- Buildings on Sloping ground of 8° slope
- Buildings on Sloping ground of 16° slope

The lateral displacements for each model are plotted in graphs for Equivalent static method and Response Spectrum method. The bending moments for the ground floor columns for ground slopes 0° and 8° are calculated. Lateral displacements and Storey drifts in both Equivalent lateral force method and response spectrum method on plain and sloping ground in both X and Y directions is reduced by the presence of shear wall. Among all three cases studied Base shear is more, Lateral displacements and Storey drifts are less in building with shear wall provided at the center. The presence of shear wall in the building influence the overall behavior of the structure and it increases the strength and stiffness of the structure. Bending moment and Shear force in critical ground floor columns increases with increase in slope and the presence of shear wall reduces the bending moment and Shear force in all the cases respectively. Axial force on the columns remains same on all ground slopes.

VI. CONCLUSION OF THE LITERATURE REVIEW

- Lateral forces are reducing when the shear walls are added at the appropriate locations (centre and edges) of frames having minimum lateral forces.
- Shear walls are more resistant to lateral loads in an irregular structure. Also they can be used to reduce the effects of torsion.
- If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall.
- UBC code gives the maximum and IS gives the minimum displacement values.
- Static analysis not sufficient for high-rise buildings and it is necessery to provide dynamic analysis.
- The result of equivalent static analysis are approximately uneconomical because values of displacement are higher than dynamic analysis.
- When compared both the regular and irregular configuration, the base shear and the story drift value is more in the regular configuration. Because of the structure have more symmetrical dimensions.
- Response spectrum analysis can be seen that the displacement values in both X and Y directions are least in model with shear wall in core and corners when compared to all other models.
- Size of members like column can be reduced economically in case of structure with shear wall as compared to the same structure without shear wall.
- Displacement at different level in multistoried building with shear wall is comparatively lesser as compared to R.C.C. building Without Shear Wall.
- The inter storey drift was observed to be maximum in vertically irregular structure when compared with that of regular structure.(not exceed 0.015h)
- Stiffness as well as seismic responses of structures is affected by the size of the openings as well as their locations in shear wall.
- The results obtained from response spectrum method are accurate, when compared with results of equivalent static method.
- Considerable change in the member forces when shear walls and soil interaction is incorporated in the analysis.
- Bending moment and Shear force in critical ground floor columns increases with increase in slope and the presence of shear wall reduces the bending moment and Shear force in all the cases respectively.
- Axial force on the columns remains same on all ground slopes.
- Irregular buildings should be carefully analyzed for torsion.
- The existing open ground storey buildings need to be strengthened suitably so as to prevent them from collapsing during strong earthquake shaking. (increase the lateral strength and stiffness of the soft/open storey)
- The maximum storey displacement of the building is reduced by 50% when shear wall is provided.(by analysing structure)
- The thickness of the shear wall should range between 150mm to 400mm.

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