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Research Article

A STUDY OF SHEAR WALL LOCATION IN REGULAR AND IRREGULAR BUILDING

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ABSTRACT

Location of shear wall construction, we discuss herein, is the combination of two materials viz. Reinforced concrete and structural steel used for the purpose of building yielding to behave together, increase safety and more economic without any damage to the aesthetic appearance,shear walls are more efficient in resisting lateral loads in multi storied buildings. Shear walls are made with steel, reinforced concrete are kept in major positions of multi storied buildings which are made in consideration of earthquake forces, wind forces. Shear wall must provide necessary lateral strength to resist horizontal earthquake. When shear wall are strong enough, they will transfer these horizontal forces to the next element in the load path below them, such as other shear wall, floors, foundation walls, footings. When building is designed without shear wall, beam and column sizes are quite heavy and there is problem arises at these joint and it is congested to place and vibrate concrete at these places and displacement is quite heavy which induces heavy forces in building member. Shear wall may become essential from the point of view of economy and control of horizontal displacement.

INTRODUCTION

Properly designed and detailed buildings with shear walls have shown very good performance in past earthquakes. Shear walls in high seismic regions require special detailing. However, in past earthquakes, even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well distributed reinforcement) were saved from collapse. Shear wall buildings are a popular choice in many earthquake prone countries, like Chile, New Zealand and USA. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straightforward and therefore easily implemented at site. Shear walls are efficient, both in terms of construction cost and effectiveness in minimizing earthquake damage in structural and non structural elements (like glass windows and building contents).

On the other hand, shear walls present barriers, which may interfere with architectural and services requirement.

Architectural Aspects of Shear Walls

Added to this, lateral load resistance in shear wall buildings is usually concentrated on a few walls rather than on large number of columns. Architectural Aspects of Shear Walls: Most RC buildings with shear walls also have columns; these columns primarily carry gravity loads (i.e., those due to self-weight and contents of building). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large. Thus, design of their foundations requires special attention. Shear walls should be provided along preferably both length and width. However, if they are provided along only one direction, a proper grid of beams and columns in the vertical plane (called a moment-resistant frame) must be provided along the other direction to resist strong earthquake effects. Door or window openings can be provided in shear walls, but their size must be small to ensure least interruption to force flow through walls. Moreover, openings should be symmetrically located. Special design checks are required to ensure that the net cross-sectional area of a wall at an opening is sufficient to carry the horizontal earthquake force. Shear walls in buildings must be symmetrically located in plan to reduce will effects of twist in buildings. They could be placed symmetrically along one or both directions in plan. Shear walls are more effective when located along exterior perimeter of the building-such a layout increases resistance of the building to twisting.

Ductile Design of Shear Walls

Just like reinforced concrete beams and columns, reinforced concrete shear walls also perform much better if designed to be

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ductile. Overall geometric proportions of the wall, types and amount of reinforcement, and connection with remaining elements in the building help in improving the ductility of walls.

Overall Geometry of Walls

Shear walls are rectangular in cross-section, i.e., one dimension of the cross-section is much larger than the other. While rectangular cross-section is common, L- and U-shaped sections. Thin-walled hollow reinforced concrete shafts around the elevator core of buildings also act as shear walls, and should be taken advantage of to resist earthquake forces.

Braced Frames

A braced frame is a truss system of the concentric or eccentric type in which the lateral forces are resisted through axial stresses in the members. Just as with a truss, the braced frame depends on diagonal members to provide a load path for lateral forces from each building element to the foundation a simple one-story braced frame. At one end of the building two bays are braced and at the other end only one bay is braced. As this building is only braced in one direction and uses compression braces because the diagonal member may be either in tension or compression, depending on which way the force is applied two methods of bracing a multi-storey building.

A single diagonal compression member in one bay can be used to brace against lateral loads coming from either direction. Alternately, tension diagonals can be used to accomplish the same result, but they must be run both ways to account for the load coming from either direction. Braced framing can be placed on the exterior or interior of a building, and may be placed in one structural bay or several. Obviously, a braced frame can present design problems for windows and doorways, but it is a very efficient and rigid lateral force resisting system.

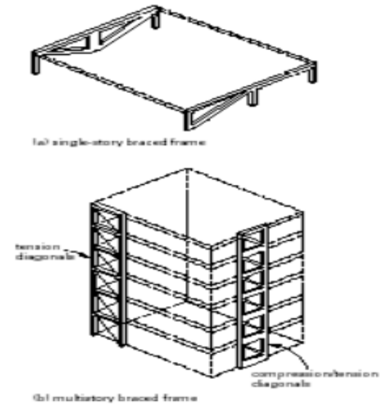


Figure 1

Behaviour & design aspect of shear wall

There are many types of analysis techniques to take seismic effects into consideration when analyzing and designing structures. And depending on certain parameters such as number of stories, ground conditions, importance factor and risk and consequences associated with its construction and failure, many of the codes of practices incorporate dynamic analyses on top of static analyses for more accurate simulation and results. Static analysis or equivalent static procedure to compute equivalent lateral force of the earthquake is easier and require less computation as compared to the dynamic analyses. Because of this it carries a great amount of uncertainties during analyses because of so many over simplifications. However dynamic analyses in earthquake analyses are divided in parts: time history analysis and response spectrum analysis. Time history dynamic analysis consist of recording a range or earthquake accelerations with respect to time in the form of a plot called response history and evaluate the response of the structure over time. It has the advantage of being utilized for nonlinear and linear analysis. Additionally, for dynamic analyses, there is another method called response spectrum method which is a plot of peak periods or an earthquake to accelerations which are used to obtain the acceleration to be applied on the structure.

Static Analysis: In this method of seismic analysis, the total base shear is distributed alongside the height of the building to describe the effects of seismic ground motion on the structure. The base shear is first computed based on simple formulas which depend on the codes used alongside some empirical multiplier. It takes into consideration the seismic weight of the building and the design horizontal seismic coefficient or the structure which depends on the seismic hazard exposure of that particular zone. Albeit, it is a static method, somehow it includes some dynamic factors of the building such as the fundamental period **T** and the response reduction factor **R**.

According to the Clause 7.5 of IS 1893 (Part 1): 2002, 161 the design base shear along any Principal direction can be determined by the following formula:

$V_b = A_h W$

Where, A_h = Design horizontal seismic coefficient of the structure

W = Seismic weight of the building

The design horizontal seismic coefficient for a structure A_h is given by:

$A_h = (ZIS_a)/2Rg$

Z is the zone factor given in Table 2 of IS **1893:2002 (part 1)** [6] for the maximum considered earthquake (MCE) and service life of a structure in a zone.

I is the importance factor, depending upon the functional use of the structure, characterized by hazardous consequences of its failure, post-earthquake functional needs, historical or economic importance. The minimum values of importance factor are given in table 6 of IS1893:2002.

R is the response reduction factor, depending on the perceived seismic damage performance of the structure, characterized by ductile or brittle deformations. The need for introducing R in base shear formula is an attempt to consider the structure's inelastic characteristics in linear analysis as it is undesirable as well as uneconomical to design a structure on the basis that it will remain in elastic range for all major earthquakes. Note: IS code recommends that the value of I/R should not exceed 1.0 the values of R are given in Table 7 of IS 1893:2002 (part 1). Sa/g is the average response acceleration coefficient for rock and soil sites as given in figure 2 of Is 1893:2002 (part 1). The values are given for 5 % of damping of the structure.

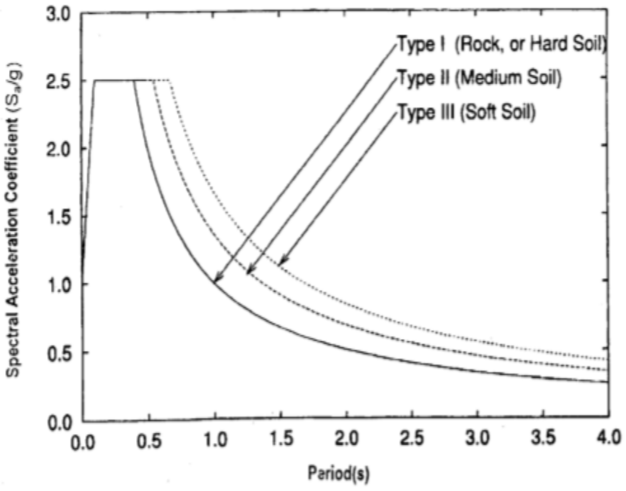


Figure 2 Response Spectra for Rock and Soil sites for 5% damping

Dynamic Analysis

Time History Analysis

The Time history analysis involves a time-step by step integration of dynamic equilibrium equation. The general Equation for a dynamic response of a multi-degree of-freedom system subjected to ground motion is given by the D' Alembert principle by the following equation as:
MX+ CX + KX = F
The same equation can be used for response spectrum analyses with the only differences in input as for time history will make use of response history and for response spectrum analyses will be using response spectra graphs.

Response Spectrum Analysis

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 frequencies 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.

This chapter deals with response spectrum method and its application to various types of the structures. The codal provisions as per IS: 1893 (Part 1)-2002 code for response spectrum analysis of multi-story building is also summarized.

Response Analysis of SDOF System

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 (liven 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. Usually response of a SDOF system is determined by time domain or frequency domain analysis, and for a given time period of system. Maximum response is picked. This process is continued for all range of possible time periods of SDOF system. Final plot with system time period on X-axis and response quantity on y-axis is the required response spectra pertaining to specified damping ratio and input ground motion. Same process is carried out with different damping ratios to obtain overall response spectra.

Modelling Building Structures

As stated previously, forming a realistic mathematical model that reflects actual behaviour of the structural system is very important in analysis, in engineering practice, structural analysis of a reinforced concrete building is generally performed in elastic range. However, in actual cases, the behaviour of the structural system may be in the nonlinear range, nonlinearity can be approximated and converted to a linear structural behaviour by making a series of assumptions which simplify the problem significantly.

Modelling techniques that are proposed in the literature for building structures can he investigated in two main groups as follows:

1. Modelling with a series of two dimensional systems.
2. Modelling with three dimensional systems.

Modelling Building Structures with a Series of Iwo Dimensional Systems: There are several methods that reduce the three dimensional building structure to a two dimensional system. In this part, the most common approaches that are often cited in the literature are presented.

The most widely applied technique for two dimensional modelling is connecting all bents of the structure at storey levels by rigid links, which simulate the in-plane rigidity of the floors. The lateral deflections of columns and shear walls can he defined in terms of the slab's horizontal translation and this allows the possibility of representing a three dimensional structure by a two dimensional model.

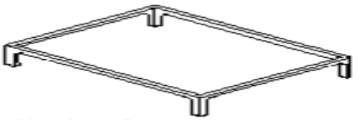
The stiffness method may be used to solve the reduced system. This technique may be applied only to structures that do not twist, since the forces in the vertical and horizontal members of the structure obtained after analysis do not depend on their locations in the plan of the building. In other words, in the model, the torsional effect of lateral loading is not taken into consideration.

Another method was presented by Rotenberg and Eisenberger[18] for the planar analysis of building structures. In their approach, shear force-axial force and torque- bending moment analogies are used to model the three dimensional behavior, or the structures. The combined effects of bidirectional shear due to lateral and torsional displacements on columns of two orthogonal frames are considered in their model.

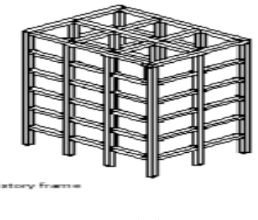
Modelling Building Structures by Three Dimensional Systems: In a typical three dimensional systems, the frame elements that are used in mc jelling beams and columns have six degrees of freedom per node: three translations and three rotations. If the building structure has shear walls, probably a mesh of rectangular plane stress elements having six degrees of freedom at every corner should be used for modelling each single shear wall. If the whole system is considered, there will be too many unknowns and a large system of equations would have to be solved in order to obtain results from such an analysis. Several methods and computer programs have been developed for the analysis of building systems to which the total number of unknowns are reduced by some assumptions.

In addition to these methods, generalized 3D computer programs are also available. In this section, a review of these methods and computer programs that model the building structures using three dimensional systems is reviewed.

Moment-Resisting Frames: Moment-resisting frames carry lateral loads primarily by flexure in the members and joints. Joints are designed and constructed so they are theoretically completely rigid, and therefore any lateral deflection of the frame occurs from the bending of columns and beams. They are used in low-to medium rise buildings. The UBC differentiates between three types of moment resisting frames. The first type is the special moment-resisting frame that must be specifically detailed to provide ductile behavior and comply with the provisions of the UBC. The second type is the intermediate moment-resisting frame, which is a concrete frame with less restrictive requirements than special moment-resisting frames. However, intermediate frames cannot be used in seismic zones 3 or 4. The third type is the ordinary moment-resisting frame. This concrete moment-resisting frame does not meet the special detailing requirements for ductile behavior. Ordinary concrete frames cannot be used in zones 3 or 4. Moment-resisting frames are more flexible than shear wall structures or braced frames; the horizontal deflection, or drift, is greater, and thus non-structural elements become more problematic. Adjacent buildings cannot be located too close to each other, and special attention must be paid to the eccentricity developed in columns, which increases the column bending stresses. Two types of moment-resisting frames are shown in Figure 3



(a) single-story frame



(b) multistory frame

Figure 3 Moment resisting Frames

Horizontal Elements (Diaphragms): In all lateral force-resisting systems, there must be a way to transmit lateral forces to the vertical resisting elements. This is done with several types of structures, but the most common way used is the diaphragm. A diaphragm acts as a horizontal beam resisting forces with shear and bending action.

There are two types of diaphragms

Flexible and rigid. Although no horizontal element is completely flexible or rigid, distinction is made between the two types because the type affects the way in which lateral forces are distributed. A flexible diaphragm is one that has a maximum lateral deformation more than two times the average story drift of that story. This deformation can be determined by comparing the midpoint in-plane deflection of the diaphragm with the story drift of the adjoining vertical resisting elements under equivalent tributary load. The lateral load is distributed according to tributary areas.

With a rigid diaphragm, the shear forces transmitted from the diaphragm to the vertical elements will be in proportion to the relative stiffness of the vertical elements (assuming there is no torsion), If the end walls in the diagram are twice as stiff as the interior walls, then one-third of the load is distributed to each end wall and one-third to the two interior walls, which is equally divided between these two. The illustration shows symmetrically placed shear walls, so the distribution is equal. However, if the vertical resisting elements are asymmetric, the shearing forces are unequal. Concrete floors are considered rigid diaphragms, as are steel and concrete composite deck construction. Steel decks may be either flexible or rigid, depending on the details of their construction. Wood decks are considered flexible diaphragms.

Load Path: The structure shall contain one complete load path for Life Safety for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. There must be a complete lateral-force-resisting system that forms a continuous load path between the foundation, all diaphragm levels, and all portions of the building for proper seismic performance. The general load path is as follows: seismic forces originating throughout the building are delivered through structural connections to horizontal diaphragms; the diaphragms distribute these forces to vertical lateral-force resisting elements such as shear walls and frames; the vertical elements transfer the forces into the foundation; and the foundation transfers the forces into the supporting soil. If there is a discontinuity in the load path, the building is unable to resist seismic forces regardless of the strength of the existing elements. Mitigation with elements or connections needed to complete the load path is necessary to achieve the selected performance level. The design professional should be watchful for gaps in the load path. Examples would include a shear wall that does not extend to the foundation, a missing shear transfer connection between a diaphragm and vertical element, a discontinuous chord at a diaphragm notch, or a missing collector. In cases where there is a structural discontinuity, a load path may exist but it may be a very undesirable one. At a discontinuous shear walls, for example, the diaphragm may transfer the forces to frames not intended to be part of the lateral-force-resisting system. While not ideal, it may be possible to show that the load path is acceptable.

Primary Load-Path Elements

Within every building, there are multiple elements that are used to transmit and resist lateral forces. These transmitting and resisting elements define the building's lateral-load path. This path extends from the uppermost roof or parapet, through each element and connection, to the foundation. An appreciation of the critical importance of a complete load path is essential for everyone involved in the design, construction, and inspection of buildings that must resist earthquakes. There are two orientations of primary elements in the load path: those that are vertical, such as shear walls, braced frames, and moment frames, and those that are essentially horizontal, such as the roof, floors, and foundation. The roof and floor elements are known as diaphragms. Diaphragms serve primarily as force-transmitting or force distributing elements those take horizontal forces from the stories at and above their level and deliver them to walls or frames in the story immediately below. Diaphragms are classified as either flexible or rigid, and the method of distributing earthquake forces from the diaphragm to the resisting elements depends on that classification. Concrete diaphragms are considered rigid. Shear walls and frames are primarily lateral force- resisting elements but can also perform force-transmitting functions. For example and while not necessarily desirable, an upper story interior shear wall may not continue to the base of the building and therefore must transmit its forces to a floor diaphragm. Also, at the base of a frame or a shear wall, forces are transmitted into a foundation element. The primary structural elements that participate in the earthquake load path are shown in Fig. (3.10).

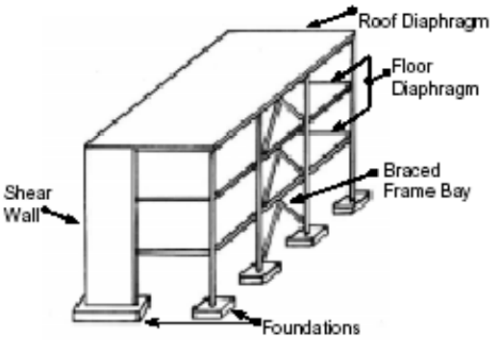


Figure 4 Primary Structural Load Path Elements

Foundations form the final link in the load path by collecting the base shear and transmitting it to the ground. Foundations resist lateral forces through a combination of frictional resistance along their lower surface and lateral bearing against the depth of soil in which they are embedded. Foundations must also support additional vertical loads caused by the overturning forces from shear walls and frame columns.

Secondary Load-Path Elements: Within the primary load-path elements, there are individual secondary elements needed to resist specific forces or to provide specific pathways along which lateral forces are transmitted. Particular attention must be given to transmitting forces between horizontal seismic elements (diaphragms) and vertical seismic elements. Two important secondary elements are chords and collectors. A chord is a structural member along the boundary of a diaphragm that resists tension and compression forces. A collector is a structural member that transmits diaphragm forces into shear walls or frames. Fig. (3.11) depicts the overall function of chords and collectors.

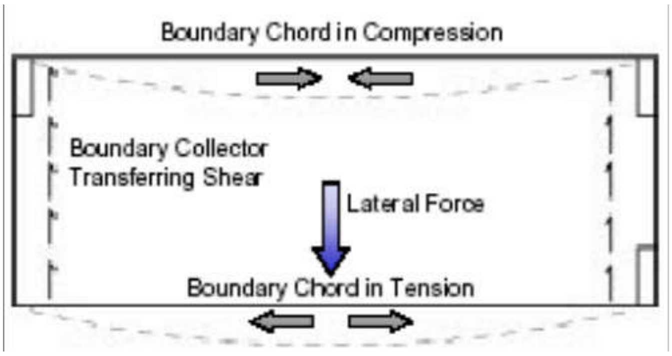


Figure 5 Function of Diagram Chords and Collectors

In the case of floors and roofs, the perimeter edges or boundaries are critical locations because they form the interface between the diaphragms and the perimeter walls. The perimeter is typically the location for vertical seismic elements, although many buildings also have shear walls or frames at interior locations. An interior line of resistance also creates a diaphragm boundary. Boundary elements in diaphragms usually serve as both chords and collectors, depending on the axis along which lateral loads are considered to be applied. As shown in Fig. (3.11), the forces acting perpendicular to the boundary elements tend to bend the diaphragm and the chord member must resist the associated tension and compression. Similar to a uniformly loaded beam, a diaphragm experiences the greatest bending stress and largest deflection at or near the centre of its span between vertical resisting seismic elements. The chord on the side of the diaphragm along which the forces are being applied is in compression, and the chord on the opposite side is in tension. These tension and compression forces reverse when the earthquake forces reverse. Therefore, each chord must be designed for both tension and compression. In concrete walls, reinforcing steel is placed at the diaphragm level to resist the out-of-plane bending in the wall. Collectors are needed when an individual shear wall or frame in the story immediately below the diaphragm is not continuous along the diaphragm boundary (See Figure 3.12). This is a very common situation because shear walls are often interrupted by openings for windows and doors, and because resisting frames are normally located in only a few of the frame bays along a diaphragm boundary. A path must be provided to collect the lateral forces from portions of a diaphragm located between vertical resisting seismic elements and to deliver those forces to each individual shear wall or frame.

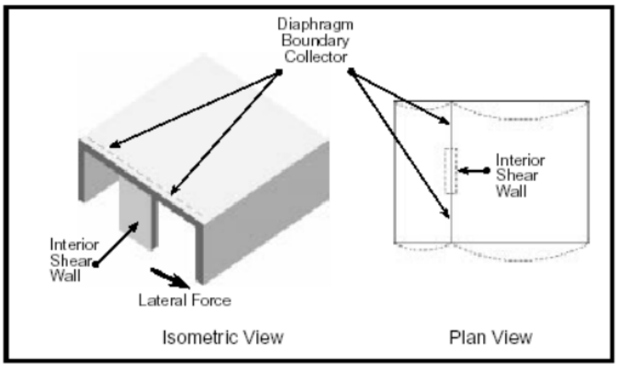


Figure 6 Use of Collector Element at Interior Shear Wall

The collector member provides that path. Collectors are commonly called drag struts or ties. Collectors are also needed when an interior shear wall or frame is provided (see Fig. 3.12). In this case, the collector is placed in the diaphragm, aligned with the wall or frame, and extends to the diaphragm edges beyond each end of the wall or frame. Collectors can occur in spandrel beams, of concrete, that link sections of shear walls together. The following statements contained in the 1997 UBC clearly require that a complete load path be provided throughout a building to resist lateral forces. "All parts of a structure shall be interconnected and connections shall be capable of transmitting the seismic force induced by the parts being connected." "Any system or method of construction shall be based on a rational analysis... Such analysis shall result in a system that provides a complete load path capable of transferring all loads and forces from their point of origin to the load resisting elements." To fulfil these requirements, connections must be provided between every element in the load path. When a building is shaken by an earthquake, every connection in the lateral force load path is tested. If one or more connections fail because they were not properly designed or constructed, those remaining in parallel paths receive additional force, which may cause them to become overstressed and to fail. If this progression of individual connection failures continues, it can result in the failure of a complete resisting seismic element and, potentially, the entire lateral-force resisting system. Consequently, connections are essential for providing adequate resistance to earthquakes and must be given special attention by both designers and inspectors. Connections are details of construction that perform the work of force transfer between the individual primary and secondary structural elements discussed above.

Modelling and design between location of shear wall

Structural Behavior: The multistory building systems analyzed in this study are considered to be rigid frame structures. In such systems, all structural elements of the system are assumed to have infinitely rigid moment resistant connections at both ends. Another assumption about the structural system is the linear elastic structural system behavior, in which the deformations are proportional to the loads. It is widely used in structural analysis and leads to a very important simplification called superposition. In superposition, if a linear elastic structure is subjected to a number of simultaneously/ applied loads, the overall response can be determined by summing the responses of the structure to the loads applied at one time. Based 4n this assumption, the behavior of the structural system under eccentric lateral loads can be determined by superposing the behavior under the considered lateral loads, which are applied ax symmetrically, and the behavior under the pure torsion produced by these eccentric lateral loads.

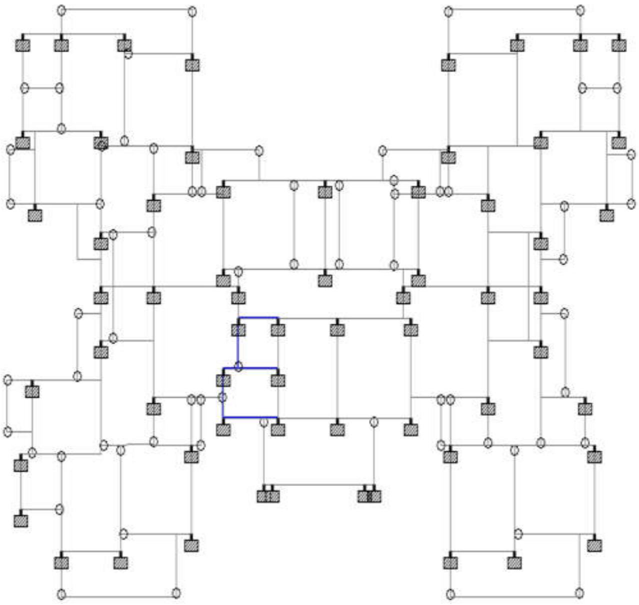


Figure 7 Plan of Building

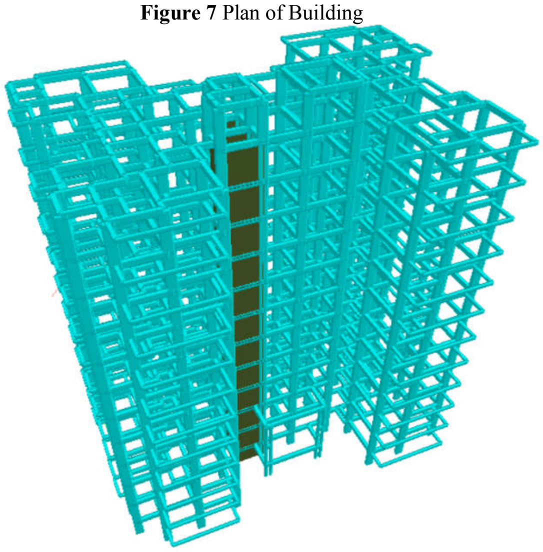


Figure 8 3D View of Building

Building Model: The first model is a dual structural system with moment resisting frames are assumed to carry lateral loads in longitudinal direction while shear wall at all four corner having L shapes will take lateral loads in the transverse direction as shown in figure. The width of shear wall is 300 mm while its height is equal to the height of the building. It is assumed that the columns and shear walls are rigidly connected to the floor slabs, where as the floor slabs act as rigid diaphragm in both directions. The floor height is taken as 3.0 meters throughout the building. The foundation is assumed to be structurally rigid.

Irregular Model-1

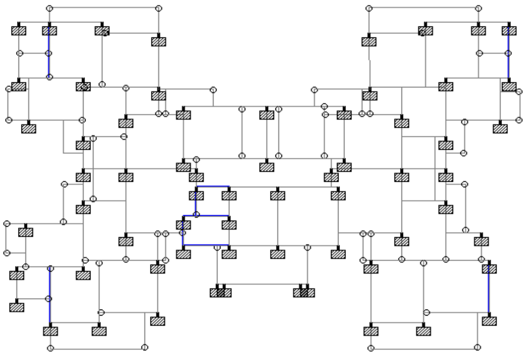


Figure 9 Plan of Irregular Model 1

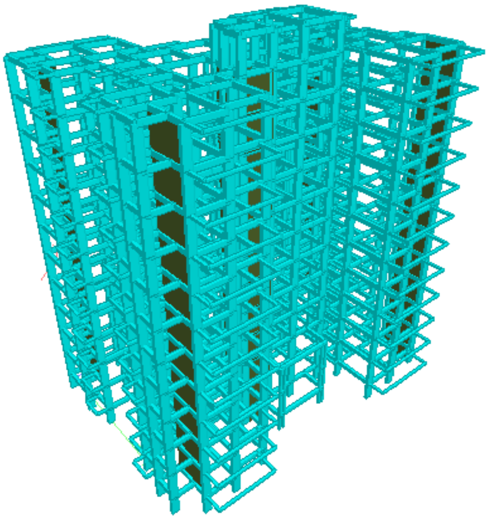


Figure 10 3D Model of Irregular Model 1

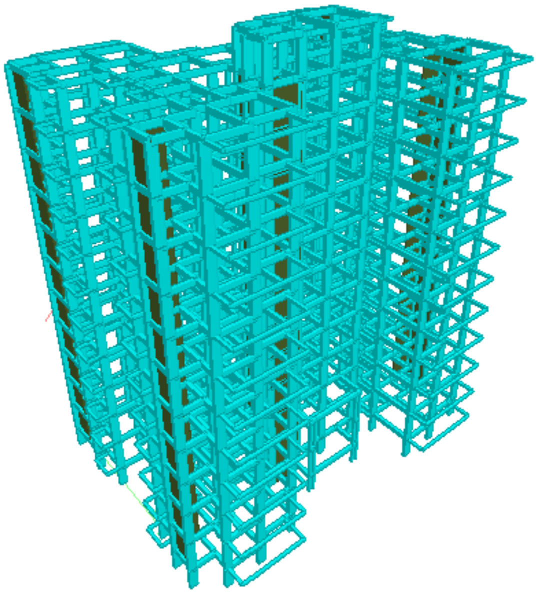


Figure 123D Model of Irregular Model 2

Irregular Model-2

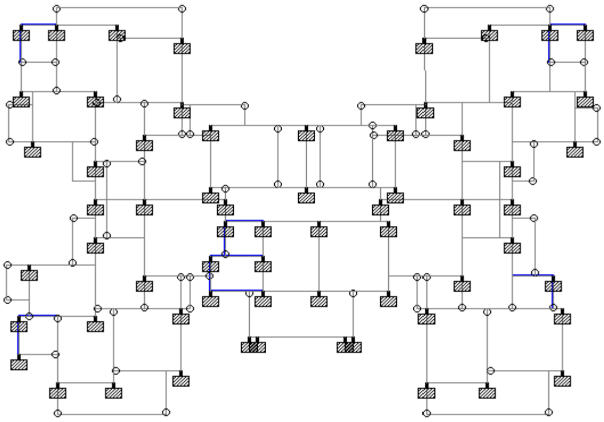


Figure 11 Plan of Irregular Model 2

Irregular Model-3

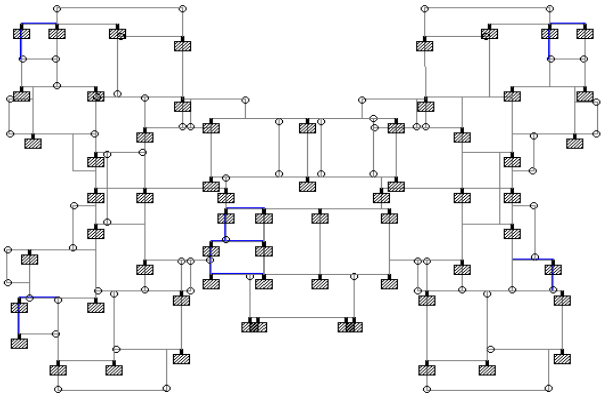


Figure 13 Plan of Irregular Model 3

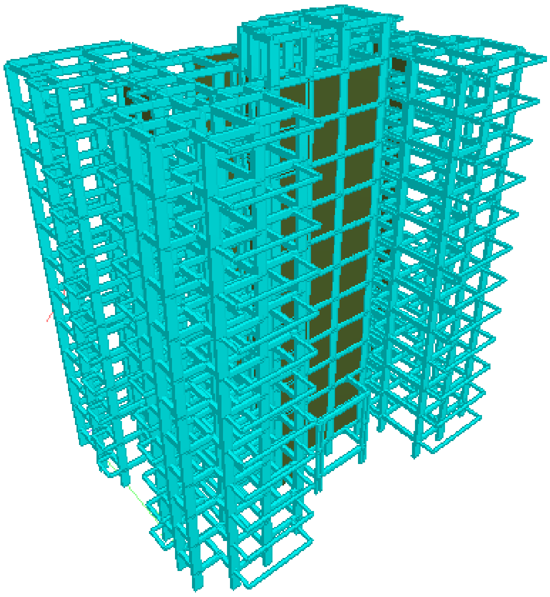


Figure 14 3D Model of Irregular Model 3

Irregular Model-4

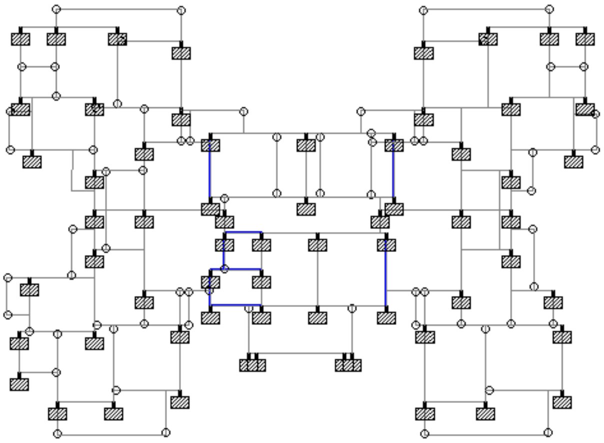


Figure 15 Plan of Irregular Mode 14

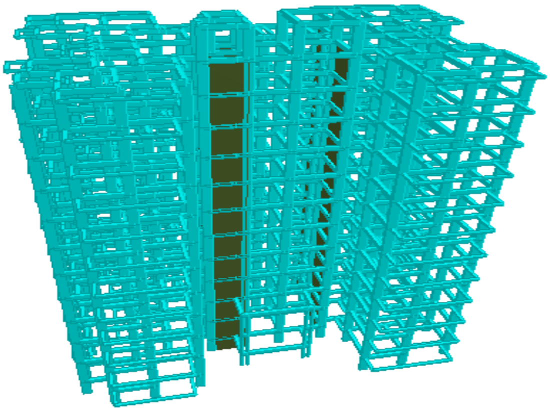


Figure 16 3D Model of Irregular Model 4

Regular Model-1

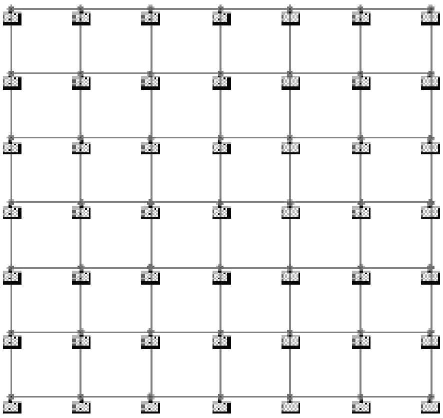


Figure 17 Plan of Regular Model 1

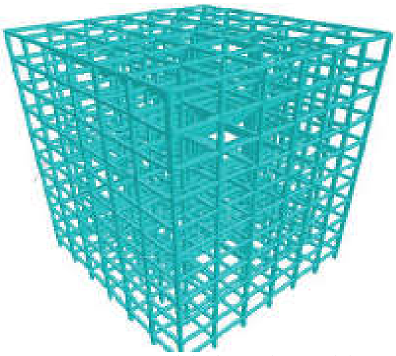


Figure 18 3D Model of Regular Model 1

Regular Model-2

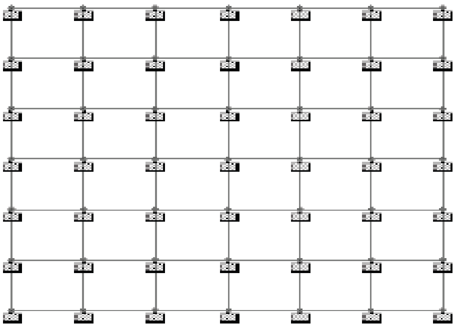


Figure 19 Plan of Regular Model 2

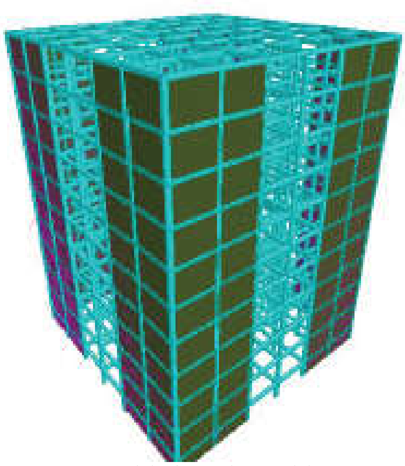


Figure 20 3D Model of Regular Model 2

Regular Model-3

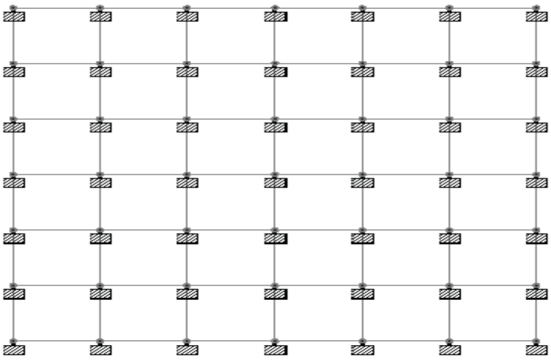


Figure 21 Plan of Regular Model 3

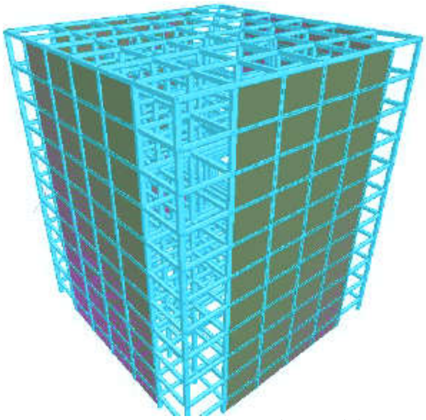


Figure 22 3D Model of Regular Model 3

Model-4

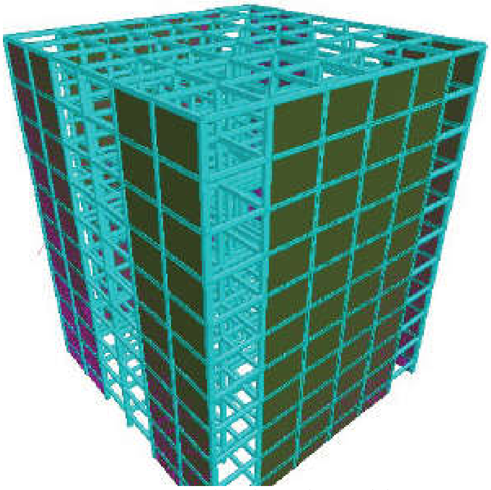


Figure 233D Model of Regular Model 3

Graphical Representation of Shear Wall

Irregular building Linear Static Analysis

Displacement- The displacement of all models has been compared for different position of shear wall. All displacement of all models are tabulated in form of table and graph for different stories for both x and y direction.

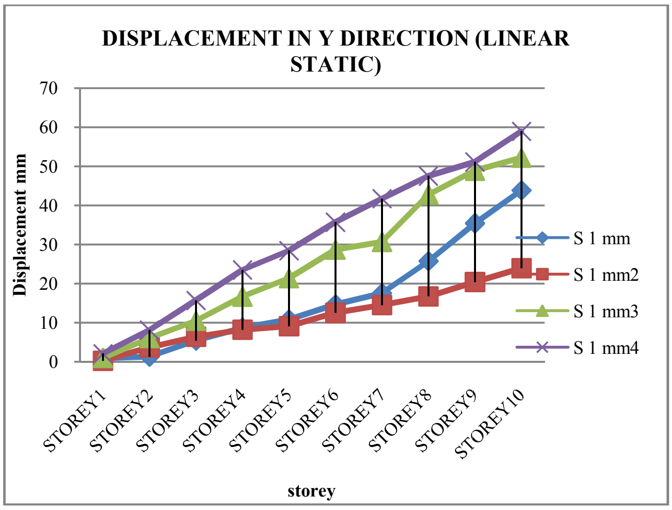


Figure 24 Plot for displacement in y direction (linear static)

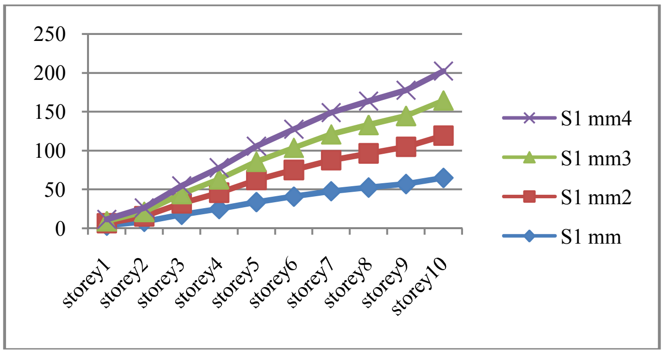


Figure 25 Plot for displacement in x direction (linear static)

Figure 26 shows the value of storey displacement in x direction. It can be seen displacement of the storey's of location S1 is minimum in compare to other models and maximum displacement is in location S4. The top storey displacement of S2 is 34.21% less than S1 42% less in compare to S3 and 46% less in compare to S4.

Similar on observing displacement values in Y direction, S2 is minimum in compare to other models and maximum displacement is in location S4. It is clear from Fig 4.1 displacement values are larger than as compared to x direction. The top story displacement of S2 is 33.5% less than S1, 41% less in compare to S3 and 46% less in compare to S4.

Storey Drift- Storey drift can be defined as the lateral displacement of one level relative to the level above or below it. As per clause no. 7.11.1 of IS 1893 (Part-1): 2002, the storey drift in any storey due to specified design lateral force with partial factor of 1.0 shall not exceed 0.004 time the storey height. Maximum drift permitted = 0.004x3200 = 12.8 mm. Below Table 3 and 4 gives the value of storey drift in x and y direction.

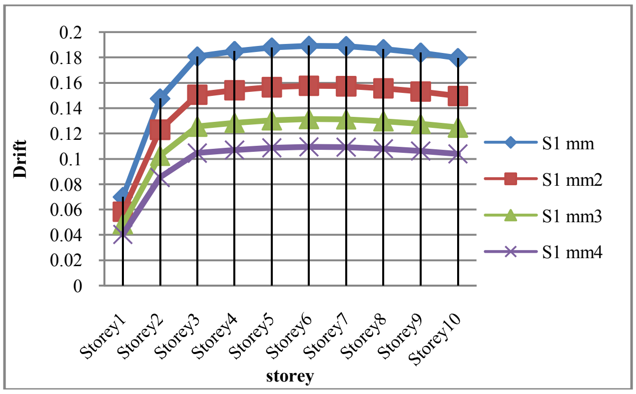


Figure 26 Drift (in mm) in X direction (Linear static)

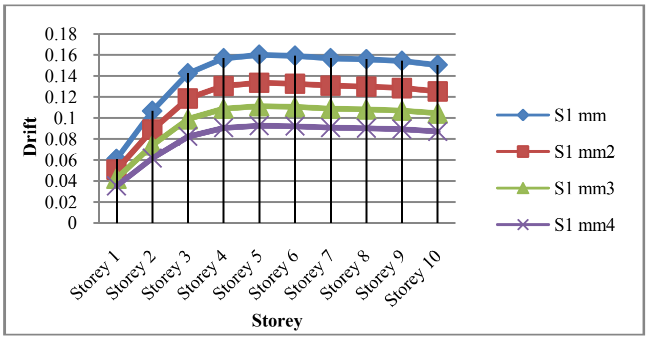


Figure 27 Drift (in mm) in Y direction (Linear static)

It can be seen from fig 4.3 and fig 4.4 drift of the location of the model and maximum displacement is in location S4 in both x and y direction. The top storey drift of S2 is 69.5% less than S1, 68.5% less in compare to S3 and 70.12% less in compare to S4 in x direction.

The top story drift of S2 is 17.59% less than S1, 5.8% less in compare to S3 and 18.1% less in compare to s4 in Y direction.

Base shear- Base shear is the maximum expected lateral force that will occur due to seismic ground motion at the base of structure. Below figures compares the shear values of the models in X and y directions respectively using linear static method.

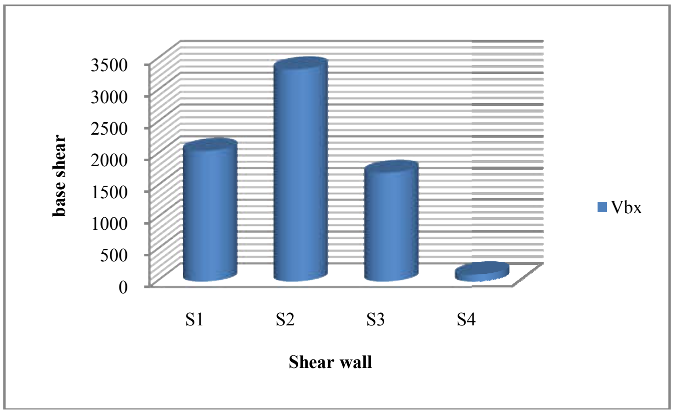


Figure 28(a) Plot for base shear in x direction for linear static analysis

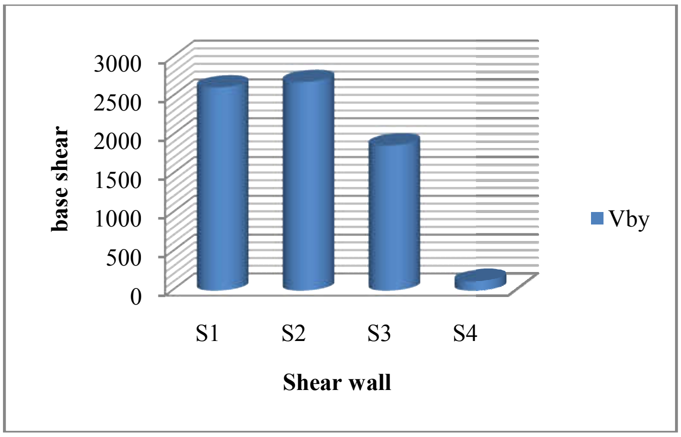


Figure 28 (b) Plot for base shear in Y direction for linear static analysis

Time History Analysis result

Displacement in x direction time history analysis

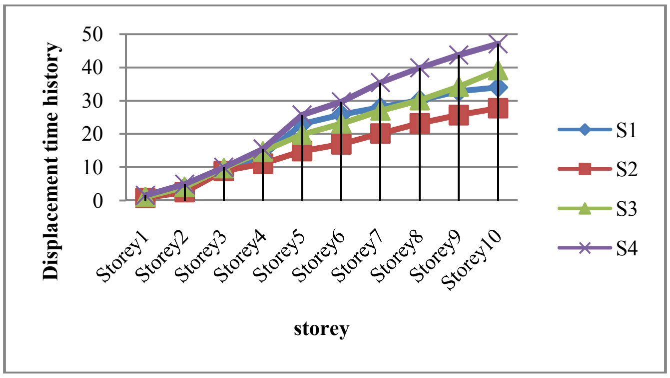


Figure 29 Displacement in mm in x direction (Time history analysis)

Displacement in y direction time history analysis

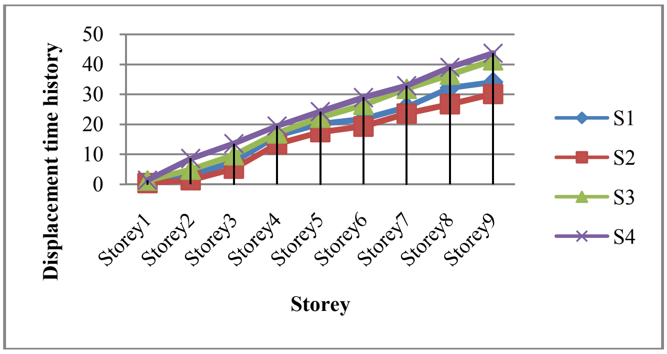


Figure 30 Plot for Displacement in y direction (Time History Analysis)

Regular building Linear Static Analysis

Displacement- The displacement of all models has been compared for different position of shear wall. All displacement of all models are tabulated in form of table and graph for different stories for both x and y direction.

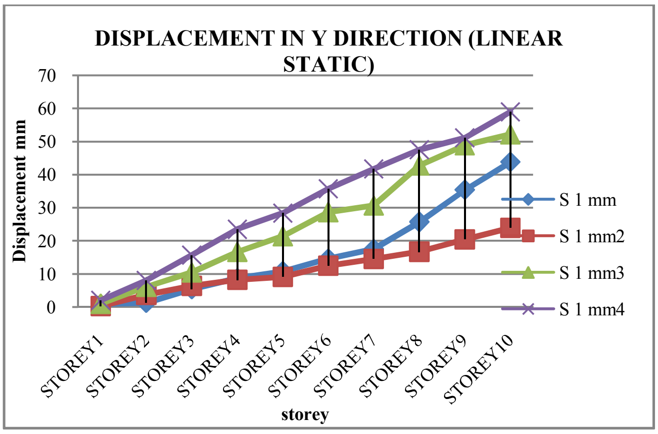


Figure 31 Plot for displacement in y direction (linear static)

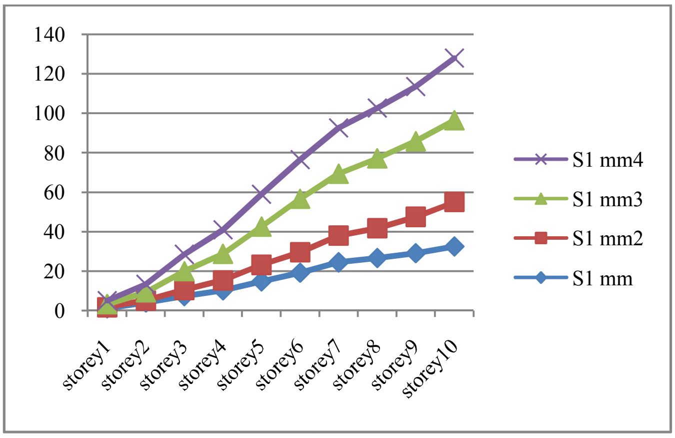


Figure 32 Plot for displacement in x direction (linear static)

Fig 4.2 shows the value of storey displacement in x direction. It can be seen displacement of the storey's of location S1 is minimum in compare to other models and maximum displacement is in location S4. The top storey displacement of S2 is 34.21% less than S1 42% less in compare to S3 and 46% less in compare to S4.

Similar on observing displacement values in Y direction, S2 is minimum in compare to other models and maximum displacement is in location S4. It is clear from Fig 4.1

displacement values are larger than as compared to x direction. The top story displacement of S2 is 33.5% less than S1, 41% less in compare to S3 and 46% less in compare to S4.

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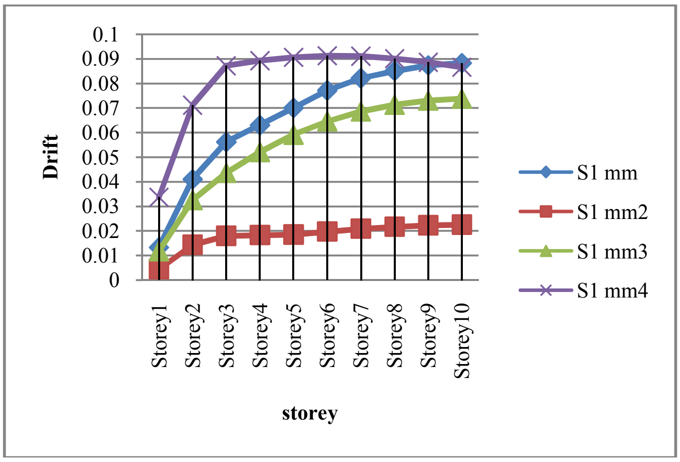

Figure 33 Drift (in mm) in X direction (Linear static)

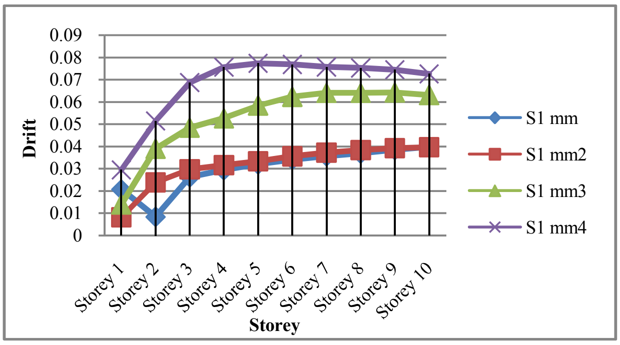

Figure 34 Drift (in mm) in Y direction (Linear static)

It can be seen from fig 4.3 and fig 4.4 drift of the location of the model and maximum displacement is in location S4 in both x and y direction. The top storey drift of S2 is 69.5% less than S1, 68.5% less in compare to S3 and 70.12% less in compare to S4 in x direction.

The top story drift of S2 is 17.59% less than S1, 5.8% less in compare to S3 and 18.1% less in compare to s4 in Y direction.

Base shear – base shear is the maximum expected lateral force that will occur due to seismic ground motion at the base of structure. Below figures compares the shear values of the models in X and y directions respectively using linear static method.

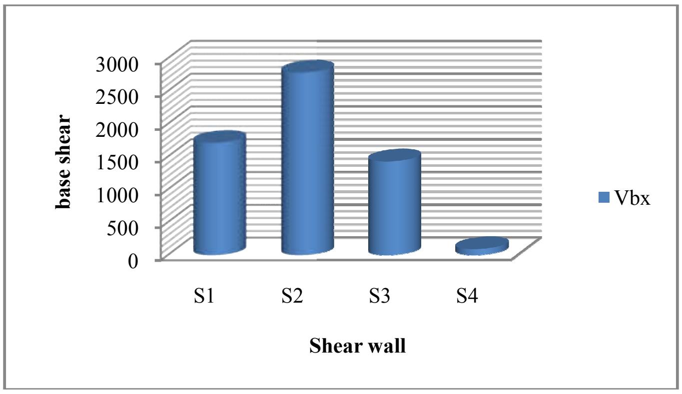

Figure 35(a) Plot for base shear in x direction for linear static analysis

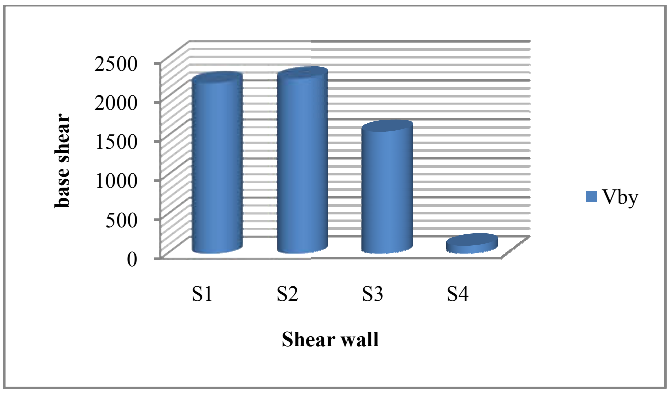

Figure 35(b) Plot for base shear in Y direction for linear static analysis

Displacement (Response spectrum)

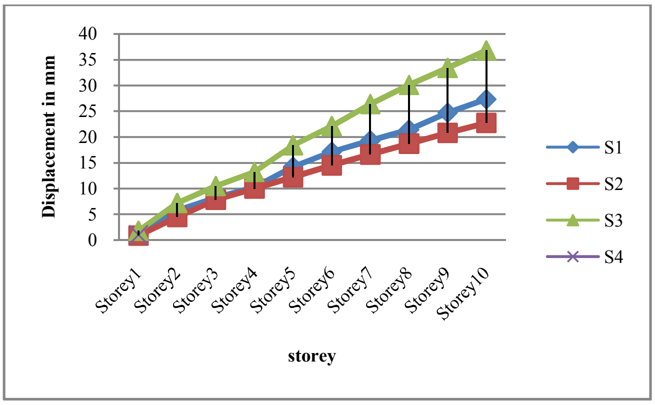

Figure 36 Plot for Displacement in x direction (Response spectrum)

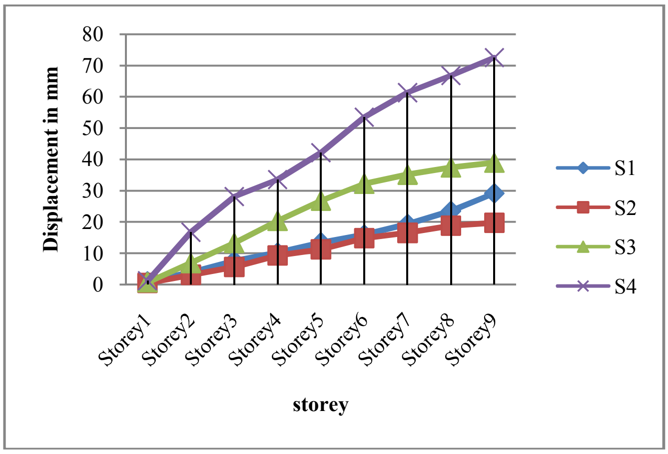

Figure 37 Plot for Displacement in y direction (Response spectrum)

Displacement Time History Analysis result

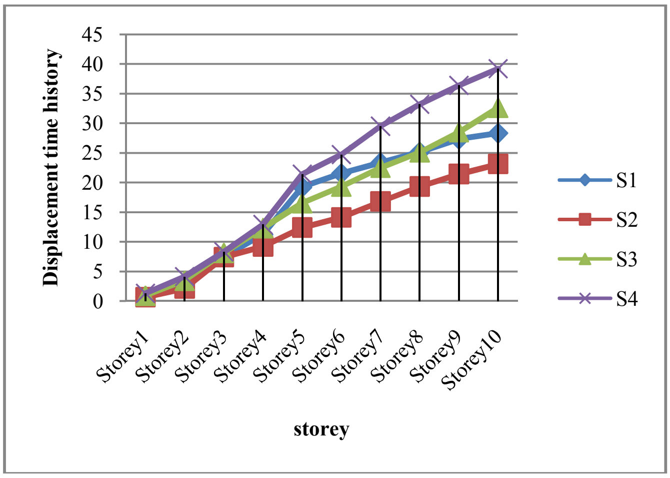

Figure 38 Displacement in mm in x direction (Time history analysis)

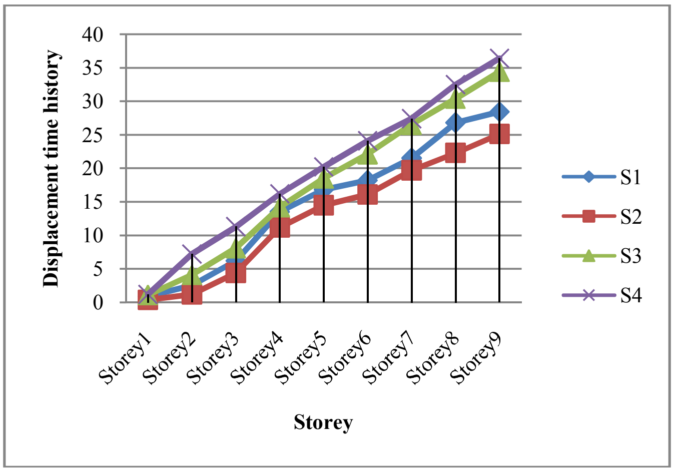

Figure 39 Plot for Displacement in y direction (Time History Analysis)

CONCLUSION

The performance of reinforced concrete dual structural system specified in this study is investigated using the linear static analysis and dynamic analysis. The effect of placing or arranging shear walls in different position along longer direction of building is assessed in terms of the whole building performance. After careful inspection and comparison of the output of static and dynamic analysis for different arrangement of shear walls, the following conclusions are drawn.

1. Among all three type of seismic analysis. It is observed that Time History analysis gives lesser displacement and drift values as compared to linear and response spectrum analysis. So it can be concluded that history time analysis is economical for building structures in seismic zone IV.
2. For important structures Time History Analysis should be performed as it predicts the structural response more accurately' in comparison with other two methods.
3. Among the four developed models, the one with shear walls are placed at mid of building in the both direction has better seismic resistance capacity of the of earthquake load.
4. On observing displacement results of all models it can be concluded that model M2 having shear wall at mid shows lesser displacement in comparison to other model.
5. Displacement values follow increasing pattern means its values increase with increase in storey.
6. Story drill results also clears that model M2 having shear wall at mid have lesser story drift.
7. Story drift results does not follow increasing pattern like displacement results.
8. The structure with shear wall at exterior are subjected to less displacement in comparison to structure with shear wall at the interior.

Scope of Future Work

1. The volume of work undertaken in this study is limited to comparison of seismic response parameters in a building with different shear wall positions using linear static and dynamic analysis. The study could be extended by including various other parameters such as torsion effects and soft storey effects in a building. Nonlinear dynamic and Performance level evaluation using Pushover analysis may be carried out for further study for better and realistic evaluation of structural response under seismic forces. Determining the earthquake response of tall building structures by doing experimental setup on shake table test to assess the exact response of model. Performance of building may be checked taking different heights of shear wall.
2. Shear wall systems are one of the most commonly used lateral load resisting systems in high rise buildings. 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. Based on linear and nonlinear analysis procedures adopted, the effect of shear wall location
3. On various parameters are to be compared. Pushover analysis is used to evaluate the expected performance of the structure by estimating its strength and deformation demands in design earthquakes by means of static inelastic analysis, and comparing these demands to available capacities at the performance levels of interest. The capacity spectrum method is used to obtain the overall performance level of a structure. The software used is STAAD PRO.

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