

Vertical Irregularities in RC Building Controlled By Finding Exact Position of Shear Wall

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ABSTRACT: Shear walls are used in high rise buildings for supporting elements to resist earthquake loading. In order to enhance the ductility of the structural system the walls are connected together with lateral beams. Many researchers have investigated the behavior of shear walls using different methods. Analytical methods are one of the early techniques used in the analysis of shear walls. During an earthquake, damage to buildings is largely caused by dynamic loads. Therefore, in order to design buildings resistant to earthquakes, the dynamic characteristics of the building must be known. Generally asymmetric tall buildings may consist of any combination of structural forms, such as frames, shear walls, structural cores, and coupled shear walls. Lateral forces caused by wind, earthquake, and uneven settlement loads, in addition to the weight of structure and people living; create torsion in structure. In this study Response Spectrum method is used to analyse vertically unsymmetrical structure with different location of shear wall in structural. Attempt has been made to decrease torsion using four concentric shear wall in structure using ETAB software.

KEYWORDS: Torsion, Concentric shear wall, positioning, thickness of shear wall.

I. INTRODUCTION

1.1 General

Structural irregularities are commonly found in constructions and structures. Architectural demands are usually the cause of such irregularities. Current earthquake codes define structural configuration as either regular or irregular in terms of size and shape of the building, arrangement of the structural and non-structural elements within the structure, distribution of mass in the building etc. A regular structure can be envisaged to have uniformly distributed mass, stiffness, strength and structural form. When one or more of these properties is non-uniformly distributed, either individually or in combination with other properties in any direction, the structure is referred to as being irregular. Structural irregularity may occur for many reasons. Torsional response in structure arise from two sources (a) Eccentricity in mass and stiffness distribution, which cause a torsional response coupled with translational response and (b) torsion arising from accidental causes, including the rotational component of ground motion about a vertical axis, the difference between assumed and actual stiffness and mass, uncertain live load distribution, uncertainties in dead load due to variation in workmanship and material, asymmetrical patterns of non linear force deformation relations and subsequent alternation that may be made in building which not only change the dead load but may change the position of the centre. For symmetrically building, the elementary analysis does not disclose the slightest torque; while actually, the probability that there will be such a generalized forces during the earthquake is one. Even non linear behavior can introduce torque that is not accounted by conventional analysis. The current state of scientific advancement in this field predicts an accurate estimate of this accidental additional torsion. To allow for effects such as the ones listed above, seismic codes often required that buildings be designed to resist the additional torsional moment. Provision should be made in all the buildings for increase in the shear forces and lateral forces resisting elements, which is a result of horizontal torsional moment arising due to an eccentricity between the centre of mass and centre of rigidity. The design forces calculated are to be applied at the centre of mass, which is appropriately displayed so as to cause the designed

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eccentricity between the displaced centre of mass and centre of rigidity. There are various types of structural Irregularities, they are categorized as follows:

1. Vertical Stiffness Irregularity
2. Weight (mass) irregularities
3. Vertical geometric irregularities
4. In-plane discontinuity
5. Out-of-plane offsets
6. Discontinuity in capacity (weak storey)
7. Torsional sensitivity
8. Non-orthogonal systems

1.2 Purpose of constructing shear walls

Shear walls designed for lateral loads of earthquakes and wind. The walls are structurally connected with diaphragms and other lateral walls at right angles, therefore gives stability to the building structures. Shear wall structural systems are more stable than RCC framed structures. Walls have to resist the uplift forces caused by the pull of the wind. Walls have to resist the shear forces that try to push the walls over. Walls have to resist the lateral force of the wind that tries to push the walls in and pull them away from the building. These walls will consume shear forces and will prevent changing locations and positions of construction and consequently destruction. Constructing the shear wall in tall, medium and even short buildings will reinforce the structure significantly, and either more economic than the bending frames.

1.3 Comparison of shear wall with construction of conventional load bearing walls

Load bearing masonry is very brittle material. Due to different kinds of stresses such as shear, tension, torsion, etc., caused by the earthquakes, the conventional unreinforced brick masonry collapses instantly during the unpredictable and sudden earthquakes. The RCC framed structures are slender, when compared to shear wall concept of box like three-dimensional structures. Though it is possible to design the earthquake resistant RCC frame, it requires extraordinary skills at design, detailing and construction levels, which cannot be anticipated in all types of construction projects. On the other hand even moderately designed shear wall structures not only more stable, but also comparatively quite ductile. In safety terms it means that, during very severe earthquakes they will not suddenly collapse causing death of people. They give enough indicative warnings such as widening structural cracks, yielding rods, etc., offering most precious moments for people to run out off structures, before they totally collapse. For structural purposes we consider the exterior walls as the shear-resisting walls. Forces from the ceiling and roof diaphragms make their way to the outside along assumed paths, enter the walls, and exit at the foundation.

1.4 Forces on shear walls

Shear walls resist two types of forces: shear forces and uplift forces. Shear forces are generated in stationary buildings by accelerations resulting from ground movement and by external forces like wind and waves. This action creates shear forces throughout the height of the wall between the top and bottom shear wall connections. Uplift forces exist on shear walls because the horizontal forces are applied to the top of the wall. These uplift forces try to lift up one end of the wall and push the other end down. In some cases, the uplift force is large enough to tip the wall over. Uplift forces are greater on tall short walls and less on low long walls. To form an effective box structure, equal length shear walls should be placed symmetrically on all four exterior walls of the building. Shear walls should be added to the building interior when the exterior walls cannot provide sufficient strength and stiffness. When exterior shear walls do not provide sufficient strength, other parts of the building will need additional strengthening.

1.5 Torsion in building

Torsional response in structure arise from two sources (a) Eccentricity in mass and stiffness distribution, which cause a torsional response coupled with translational response and (b) torsion arising from accidental causes, including the rotational component of ground motion about a vertical axis, the difference between assumed and actual stiffness and mass, uncertain live load distribution, uncertainties in dead load due to variation in workmanship and material, asymmetrical patterns of nonlinear force deformation relations and subsequent alternation that may be made in building which not only change the dead load but may change the position of the center. Even nonlinear behavior can introduce

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torque that is not accounted by conventional analysis. The current state of scientific advancement in this field predicts an accurate estimate of this accidental additional torsion. To allow for effects such as the ones listed above, seismic codes often required that buildings be designed to resist the additional torsional moment. Provision should be made in all the buildings for increase in the shear forces and lateral forces resisting elements, which is a result of horizontal torsional moment arising due to an eccentricity between the center of mass and center of rigidity. The design forces calculated are to be applied at the center of mass, which is appropriately displayed so as to cause the designed eccentricity between the displaced center of mass and center of rigidity. The designed eccentricity e_{di} , to be used at the floor 'I' should be

$$e_{di} = \begin{cases} 1.5 e_{si} + 0.05 b_i \\ e_{si} - 0.05 b_i \end{cases}$$

Whichever gives the more severe effect in the shear of any frame.

Here e_{si} is the static eccentricity at the floor i , defined as the distance between center of mass and center of rigidity, and b_i is the floor plan dimension of the floor i , perpendicular to the direction of force. The factor 1.5 represents dynamic amplification factor, while the factor 0.05 represents the extent of accidental eccentricity. The dynamic and amplification factor is also known as response amplification factor, is used to convert the static torsional response to dynamic torsional response. Highly irregular buildings are analyzed by using modal analysis. The value of accidental eccentricity is assumed as 5% of the planned dimension of the building storey, particularly for the accidental torsional response during the applied ground motion. Therefore, additive shear have been superimposed for statically applied eccentricity. $\pm 0.05 b_i$ with respect to center of rigidity.

1.6 Response Spectrum Method

In response spectrum method the peak response of structure during an earthquake is obtain directly from the earthquake response spectrum. This procedure gives an approximate peak response, but this is quite accurate for structural design applications. In this approach, the multiple modes of response of building to an earthquake are taken in account. For each mode, a response is read from design spectrum, based on modal frequency and modal mass. In this method the load vectors are calculated corresponding to predefined number of modes. These load vectors are applied at the design center of mass to calculate the respective modal responses. These modal responses are then combined according to Square Root of Sum of Squares (SRSS) or Complete Quadratic Combination (CQC) rule to get the total response. From the fundamentals of dynamics it is quite clear that modal response of the structure subjected to particular ground motion, is estimated by the combination of the results of static analysis of the structures subjected to corresponding modal load vector and dynamic analysis of the corresponding single degree of freedom system subjected to same ground motion. Static response of Multiple Degrees of Freedom (MDOF) system is then multiplied with the spectral ordinate obtained from dynamic analysis of Single Degree of Freedom (SDOF) system to get that modal response. Same procedure is carried out for other modes and the results are obtained through SRSS or CQC rule.

In response spectrum analysis the spectral values are read from the design spectrum which are directly multiplied with the modal load vector and the static analysis is performed to determine the corresponding modal peak responses. This method is known as the Classical Modal Analysis.

The loads acting on the structure are contributed from slabs, beams, columns, walls, ceilings and finishes. They are calculated by conventional methods according to IS: 456 – 2000 and are applied as gravity loads along with live loads as per IS: 875 (Part II) in the structural model. The lateral loads and their vertical distribution on each floor level are determined as per IS: 1893 – 2002 and calculated. These loads are then applied in response spectrum method.

1.7 Necessity of this study

Reinforced concrete wall, which include lift walls or shear walls, are the usual requirements of multi storey building. Design by coinciding centroid and center of mass of building is the ideal for structure. However on many occasion the design has to base on the off center posing of lift and stair case walls with respect to the center of mass. The design in this case results into an excessive stresses in most of the structural members, unwanted torsional moment and sways. It is found that structure forces are found to increase on to the eccentric position of shear wall away from

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the centroid of the building. Twisting moments in members are observed to be having increasing trend with enhancement in the eccentricity between geometrical centroid of the building and shear wall position. Stresses in shear wall elements have more pronounced effect in elements parallel to displaced direction of shear wall as compared to those in perpendicular direction. The lateral loads acting on high-rise buildings, induced by wind and earthquake, are generally resisted by shear walls.

1.8 Objective

The objective of the present analytical research work is to investigate influence of positioning of shear wall on the torsional value of Building. The present study focused onto find out how we can avoid torsion in building by using concentric shear wall and avoiding eccentric shear wall. The literature surveys carried out on the topic has not enabled me to trace any research work carried out on the optimum value of torsion for structure. Many times merely providing shear wall in structure didn't solve problem. Proving shear wall at eccentric position can increase force on structure that can lead to uneconomical structure. Four different cases of shear wall position for a 11-storey building have been analysed as a space frame system using a ETABS software.

II. REVIEW OF LITERATURE

In this analytical study, it is required to search different existing cases and the available literature on related subject. On the basis of literature review the researcher contributions discussed below.

Thuat et al. [1] investigated that story-safety factor was larger than the corresponding dynamic shear magnification factor proposed by Paulay and Priestley minus unity, a story mechanism did not occur in all cases. The effects of the flexural hinge location and geometrical irregularity on the required story-safety factor were minor. The practical procedures of using the story-safety factor for preventing a story mechanism at irregular stories are discussed.

Misam et al. [2] proposed that, on adding shear wall to the building in different arrangement in order to reduce soft story effect on structural seismic response. It was found that location and numbering of shear wall acts an important factor for the soft story structures to displace during earthquake. Also the soft story has been eliminated as the shear wall is added to the consider floor, the horizontal and vertical movements of building with shear wall installed in most bays are much reduced during earthquake compare with other models. So it shows that the use of shear wall is effectively reduced effect of soft story on structure response in earthquake excitation. And vulnerability level of multi-storied buildings is assessed by analysis of different arrangement of shear wall on building and it can also advantages for retrofitting of structure on consider level of operation and safety with minimum requirements.

Alireza et al. [3] proposed the concept of an Artificial Neural Network (ANN) based model was developed and its predictions compared with the results obtained from numerical analysis. The dynamic response of 112 different buildings were selected and used as a database. 84 of these data were employed as the training set and 28 data were used as the validation set. The ANN model was checked with a testing set that was not used in the training process. They proved that the ANN-based model can successfully determine the response of buildings in terms of roof displacements, base shear forces and base bending moments. Results obtained by the ANN model were truly competent and showed good generalization. A careful study of the results leads to observations of excellent agreement between ANN predictions and FEA outcomes. Their study has shown the feasibility of the use of ANN model in determining the response of buildings subjected to earthquakes. The promising results were observed in their study is dynamic analysis of RC buildings indicate that the ANN models enable the designers to rapidly evaluate the buildings' responses during the preliminary design stage.

Zeynep et al. [4] they investigated, earthquakes will not affect human's lives negatively as a result of buildings designed and constructed according to earthquake-resistant design principles. For preventing negative effects of earthquakes, following topics must be taken into consideration immediately. Basis of earthquake codes must be taken in architecture students undergraduate program. Existing buildings must be reinforced and repaired according to the regulations given in earthquake codes. During the construction period, the new structures must be inspected attentively to be adapted to the earthquake code.

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Clifford et al. [5] Presented analysis in graphical and tabular forms and compared for the two soil conditions to bring the effects of soil-structure on the response of the building. The maximum earthquake response of the building alone by assuming it to be fixed at its base is evaluated by the Response Spectrum method for Buildings (RSB) and compared with the absolute maximum response obtained by FDGS (Frequency Domain General Substructure method) for the two soil conditions. The evaluation of the mode shapes and natural frequencies of the building pile foundation system for this purpose shows that these are not significantly different from those of the building on fixed base. This means that RSB can still be used for predicting satisfactorily the earthquake response of the buildings on soft soil provided a correct damping ratio is chosen. Computer programs have been developed to carry out the different aspects of the numerical work. The results of this investigation bring forth the actual effects of soil-structure interaction in a building-pile system for the first time.

Saher et al.[6] they studied effect of interaction parameters on response of coupled shear wall systems considering the effect of foundation soil flexibility on the first two fixed-base structure modes is important for these systems. Currently available simplified methods of analysis consider only the effect of interaction soil flexibility on the fundamental mode. Therefore the effect of interaction on an equivalent two degree of freedom (2DOF) system that represents the two structure modes is studied. The proposed approximate response spectrum methods compare favorably with "exact" response history analysis whereas the existing response spectrum method considering effect of soil flexibility on the fundamental mode only overestimates responses for some coupled shear walls.

Adnan et al.[7] they investigated a Component Element idealization method is developed for idealizing shear-wall cores; the method considers all significant factors that affect earthquake response behavior of typical cores. The method has wider range of applicability than the Discrete Element (DE) method. Although the number of d.o.f needed to adequately represent the core behavior in both methods is comparable, the main advantage of the Component Element (CE) method is that the cross-sectional properties need not to be computed, therefore, the method can be used to idealize all practical shear-wall core systems. Shear and warping deformations are shown to be of significant effect in cases of squat cores and affect the torsional behavior of these cores.**Edward et al . [8]** they suggested, stiffness and strength degradation mainly due to diagonal cracking of the concrete; plastic deformations due to yield of the horizontal reinforcement; and sliding shear across diagonal cracks ("pinching effect"). A good correlation between experiment and model can be appreciated. Most parameters of the model can be determined from conventional reinforced concrete theory.

R.K.L. et al.[9] they carried out experimental study on three reinforced concrete wall specimens to study the effects of axial load ratio (ALR) and confinement on their performance to artificial earthquake loads. The effectiveness of confinement is found to be highly dependent on the arrangement of the transverse reinforcement. Simply increasing the amount of the transverse reinforcement in the specimen might not produce a larger degree of confinement. Axial load ratio (ALR) has significant influence on the deformability and failure mode of the specimens. The maximum rotation ductility decreased with increases in ALR. An abrupt out-of-plane compressive failure mode was observed when ALR was high. Furthermore, an increase in ALR has a detrimental effect on strength degradation and energy dissipation of reinforced concrete walls

Rashed et al.[10] they proposed the use of regular collocation technique seems to be more accurate for slender structures. Quadratic elements were more suitable in the analysis than constant elements which require finer discretization. The use of continuous elements when modeling (using quadratic elements) are essential and it highly improves the results. The results of the boundary element technique are accurate even with coarse discretization (mesh 2 with continuous quadratic element). Therefore the boundary element method saves more computer time and storage than those of the finite element method.

Ahmed et al.[11] they investigated, utility and accuracy of the method is demonstrated by a numerical example, in which the proposed method is compared with finite element calculations. In this paper, a dynamic analysis of tall buildings braced by shear walls and thin-walled open section structures is presented. In such a structural configuration, the lateral displacements in two perpendicular directions and the torsional rotation can no longer be treated separately

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due to their coupling in the governing differential equations of free vibration. Hence, if the flexural vibrations in one direction are coupled with the torsional vibrations, the resulting phenomenon is called double coupling.

Youssef et al. [12] they investigated development of a simplified structural engineering model to study the inelastic performance predictions of RC structural walls as equivalent frame elements and for seismic vulnerability assessment of reinforced concrete existing frame wall buildings.

Meftah et al. [13] demonstrated the feasibility of mitigating the seismic response of RC coupled shear walls building structures by using composites plates having variable fibers spacing. New reinforcement approaches are rising; they are based on the idea that the strengthening should be light and removable. Composite materials appear to be good candidates to substitute standard materials. Since they are light, simple to install and are also removable. Composite materials are characterized by high strength, good durability and lower installation and maintenance cost. RC strengthened coupled shear walls were analyzed under three different earthquakes. Significant improvement in the seismic deflections was observed when the fibers are group together near the wall edges.

Meftah et al. [14] they investigated the bonding of composite thin plates to the original wall using adhesives layers lead system. In general the elastic properties of the original shear wall differ from those of the bonded plates, while those of the adhesives layers are also different. In the analytical formulation, the adherents and the adhesives layers are all modeled as shear walls, by using a mixed finite element method to deduce the stiffness matrix of the equivalent composite shear wall element. The finite element method is employed to determine the deflection and dynamic characteristics in free vibration analyses. Numerical results are presented that relate to the performance of reinforced concrete shear walls strengthened with composite sheets, in which reinforced concrete shear walls strengthened with steel plates is treated as a limiting case. The effects of bonded plates on vibration characteristics of RC shear walls are also studied.

Pekau et al. [15] they investigated that if the design of this precast panel shear wall satisfies the seismic requirements, it will automatically meet the demands of shear ductility of connectors in vertical joints and shear slip in horizontal joints with respect to progressive collapse without earthquakes. The influence of collapse time of local failure on the response of a precast panel wall has been examined. Results show that the speed at which an element is removed in a dynamic analysis should not be ignored and if the time period of local panel collapse is long enough the solution of the dynamic model converges to the static one which gives a lower limit of design requirements.

Paknahad et al. [16] presented satisfactory with a wide range of element aspect ratio. In this study an alternative formulation of OPT optimal triangle element was employed and its computational algorithm has been implemented in an FE code. The implemented code was verified, using standard benchmark examples, and was found to be suitable for further use. The implemented code has been applied to the analysis of shear wall structures with and without openings.

Weena et al. [17] analyzed high-rise buildings, a higher probability of damage is obtained for a softer site condition, and damage is more severe for far field earthquakes than for near field earthquakes. Therefore, site effect is very important and not to be neglected. Similar site and epicentral effects should also be expected for other types of high-rise structures.

Choo et al. [18] Result demonstrated that the introduction of the stiffening beams into coupled shear walls can considerably reduce the lateral deflection of the structural, shear force in the connecting beams and the bending moment in the walls at the base level.

Aksogan et al. [19] presented method, compared with those obtained using the SAP2000 structural analysis program and a good match has been observed. The two advantages of the proposed method are the simplicity of its data and the extremely short computation time, which render it an effective method for the predesigned of high-rise buildings.

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Tasnimi et al. [20] presented experimental investigation are presented in the form of load displacement plots and compared with the values calculated on the basis of (American Concrete Institute) ACI recommendations. The following conclusions drawn from this Research that, For all specimens the plastic hinge was formed at the extreme fiber of the wall section and at the vicinity of the base. The strength and deformational responses of the specimens were found to be independent of the cyclic loading sequence. Results of this experimental investigation are presented in the form of load-displacement plots and compared with the values calculated on the basis of ACI recommendations.

III. CODAL PROVISIONS

In this chapter various instructions and requirements are given for torsion in structure and shear wall, included in the various codes consisting of Indian standard codes. Structure should be analysed considering given points.

3.1 IS: 13920-1993

3.1.1 General Requirements

1. The requirements of this section apply to the shear walls, which are part of the lateral force resisting system of the structure.
2. The thickness of any part of the wall shall preferably, not is less than 150 mm.
3. The effective flange width, to be used in the design of flanged wall sections, shall be assumed to extend beyond the face of the web for a distance which shall be the smaller of (a) half the distance to an adjacent shear wall web, and (b) 1/10 of the total wall height.
4. Shear walls shall be provided with reinforcement in the longitudinal and transverse directions in the plane of the wall. The minimum reinforcement ratio shall be 0.0025 of the gross area in each direction. This reinforcement shall be distributed uniformly across the cross section of the wall.
5. If the factored shear stress in the wall exceeds 0.25 or if the wall thickness exceeds 200 mm, reinforcement shall be provided in two curtains, each having bars running in the longitudinal and transverse directions in the plane of the wall.
6. The diameter of the bars to be used in any part of the wall shall not exceed 1/10th of the thickness of that part.
7. The maximum spacing of reinforcement in either direction shall not exceed the smaller of $L_w/5$, $3T_w$, and 450 mm, where L_w is the horizontal length of the wall, and T_w is the thickness of the wall web.

3.1.2 Boundary Elements

Boundary elements are portions along the wall edges that are strengthened by longitudinal and transverse reinforcement. Though they may have the same thickness as that of the wall web it is advantageous to provide them with greater thickness.

Where the extreme fibre compressive stress in the wall due to factored gravity loads plus factored earthquake force exceeds $0.2f_{ck}$, boundary elements shall be provided along the vertical boundaries of walls.

3.2 IS: 1893(PART 1) 2002

Provision shall be made in all the building for increase in shear forces on the lateral force resisting elements resulting from the horizontal torsional moment arising due to eccentricity between the centre of mass and Centre of rigidity. The design forces calculated are to be applied at the centre of mass appropriately displaced so as to cause design eccentricity between the displaced centre of mass and centre of rigidity. However, negative torsional shear shall be neglected.

In case of highly irregular buildings analyzed according to, additive shears will be superimposed for a statically applied eccentricity of $\pm 0.05b$, with respect to the centre of rigidity.

IV. METHODOLOGY

In this work, 11th floor unsymmetrical structure in plan is shown. In this structure, various positions to shear walls were taken. The loads acting on the structure are contributed from slabs, beams, columns, walls, ceilings and finishes. They are calculated by conventional methods according to IS: 456 – 2000 and are applied as gravity loads along with live loads as per IS: 875 (Part II)-1987 in the structural model. The lateral loads and their vertical distribution on each

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floor level are determined as per IS: 1893 – 2002. These loads are then applied in response spectrum method. With the availability of high-speed digital computers, a rigorous three-dimensional analysis of a multi storey building is performed. Three dimensional analysis is relatively more realistic. It gives significantly more exact results than those by two-dimensional analysis. Three-dimensional analysis is the only solution in case of an unsymmetrical loading or geometry of the structure.

4.1 Analytical work

The Analytical work from creating model upto the calculating the results may adopts following stepwise procedure in ETABS software.

1. Define Material
2. Define Section
3. Define Method
4. Select Section
5. Assign Load
6. Check Model
7. Perform Analysis
8. Export Results

4.2 Types of cases used for analysis of structure

There are thirteen different cases considered to analyse 11-storey structure so that proper position of shear wall can be predicted.

- Torsional values per storey without shear wall for EQX
- Torsional values per storey without shear wall for EQY
- Torsional values per storey due to four concentric 150 mm shear wall for EQX
- Torsional values per storey due to four concentric 150 mm shear wall for EQY
- Torsional values per storey due to four concentric 200 mm shear wall for EQX
- Torsional values per storey due to four concentric 200 mm shear wall for EQY
- Torsional values per storey due to shear wall at lift of 150 mm for EQX
- Torsional values per storey due to shear wall at lift of 150 mm for EQY
- Torsional values per storey due to shear wall at lift of 200 mm for EQX
- Torsional values per storey due to shear wall at lift of 200 mm for EQY
- Torsional values per storey due to two shear wall 150 mm parallel to y-axis for EQX
- Torsional values per storey due to two shear wall 150 mm parallel to y-axis for EQY
- Torsional values per storey due to two shear wall 200 mm parallel to y-axis for EQX
- Torsional values per storey due to two shear wall 200 mm parallel to y-axis for EQY
- Torsional values per storey due to two shear wall 150 mm parallel to x-axis for EQX
- Torsional values per storey due to two shear wall 150 mm parallel to x-axis for EQY
- Torsional values per storey due to two shear wall 200 mm parallel to x-axis for EQX
- Torsional values per storey due to two shear wall 200 mm parallel to x-axis for EQY
-

4.3 Structural Data used for modeling

The required structural preliminary data which was used for creating a model of 11- story building in ETABS software is shown in following table.

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Sr. No.	Data	Description	Sr. No.	Data	Description
1	Length of Building	11m (Short Direction) 16.95m (Long Direction)	9	Slab Floor Finish Dead Load	1KN
2	Column Size	600mm x 600mm	10	Load on Beam	9.5KN/m
3	Beam Size	300mm x 450mm (150mm Thick)	11	Imposed Load for typical floors	2KN/m ²
4	Shear wall Thickness	150mm and 200mm	12	Earthquake Zone	V
5	Storey Height	3m	13	Top Storey	Storey-11
6	Steel Grade	Fe 415deformed Rolled	14	Bottom Storey	Base
7	Concrete grade	M-20	15	R	5
8	Building Height H	33m	16	I	1

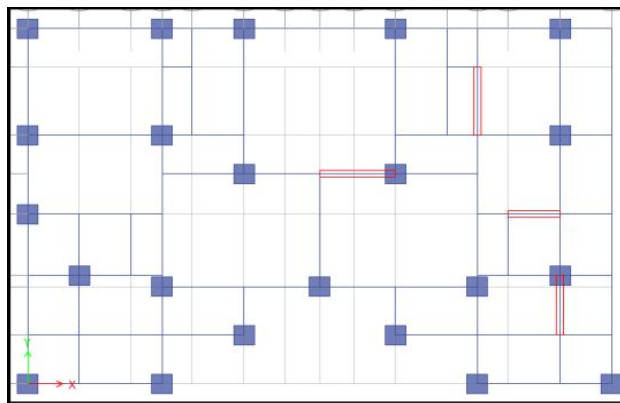


Fig. 4.4 : Plan showing structure with Four concentric shear wall

V. RESULT AND DISCUSSION

The torsion, Base shear, maximum displacement, and maximum drift results for the 11storey structure are obtained on the of four different cases i.e. four concentric shear wall, shear wall at lift, two shear wall parallel Y-axis, two shear wall parallel to X-axis for EQX (earthquake force from X-direction), EQY (earthquake force from Y-direction) are presented in this study. Different thickness of shear wall 150 mm and 200 mm are used to calculate torsional effect on structure. Relative torsional values of structure having above conditions are compared with a structure without shear wall.

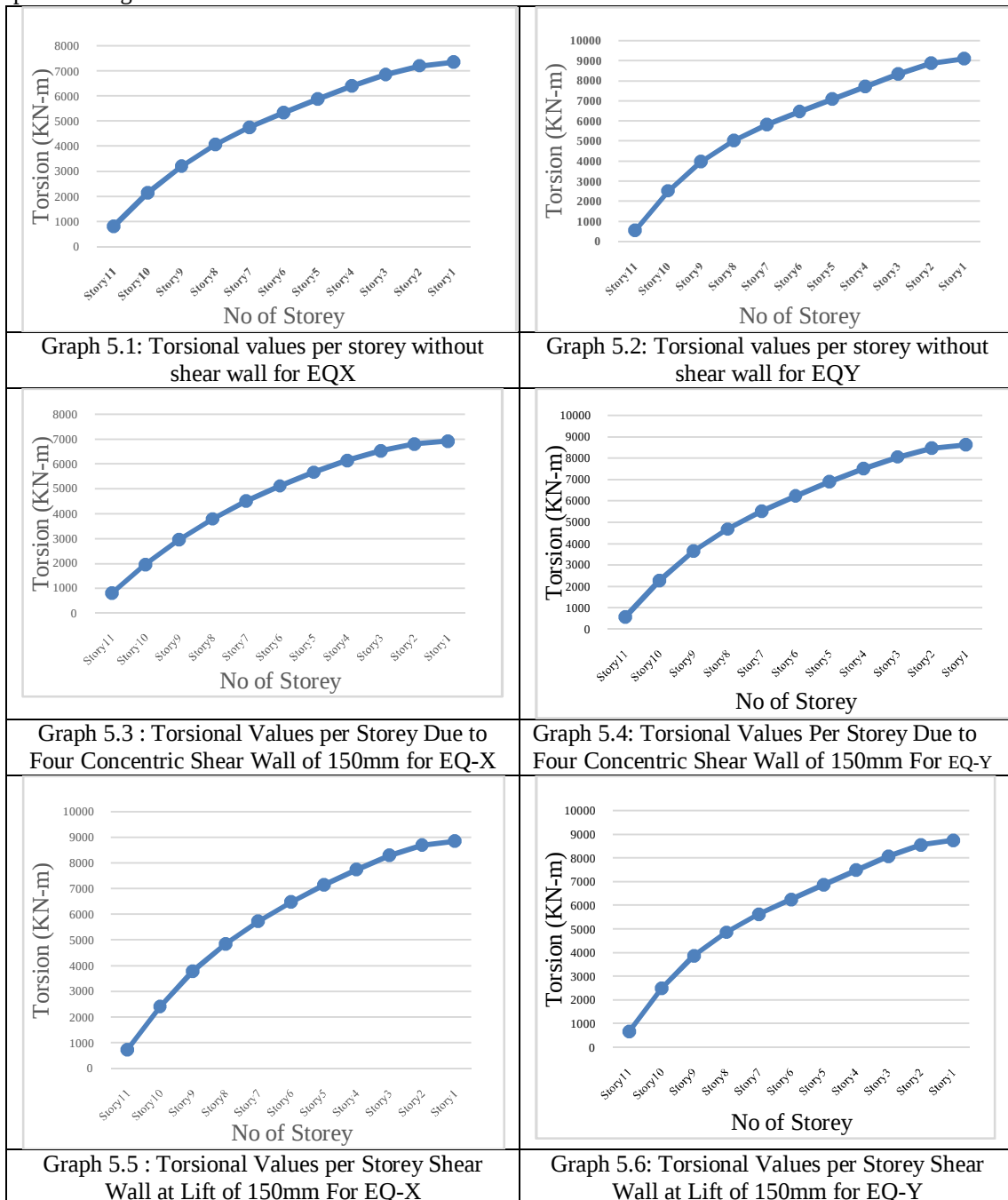
Many times merely providing shear wall in structure didn't solve problem. Proving shear wall at eccentric position can increase force and torsion on structure. That can lead to uneconomical structure. Four different cases of shear wall position for a 11storey building have been analyzed as a space frame system using a ETABS.

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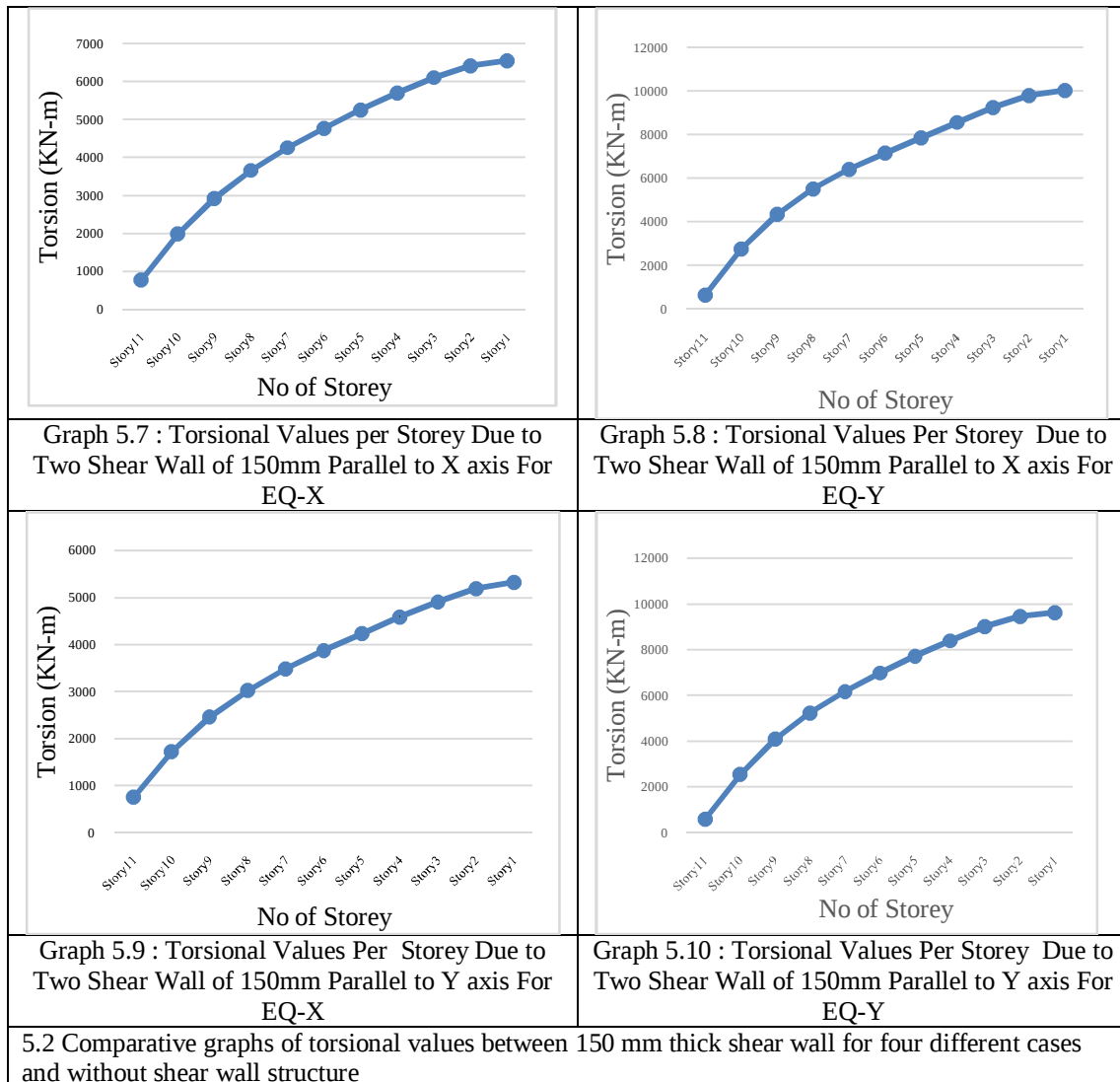
5.1 Graphs showing Base shear and Torsional values



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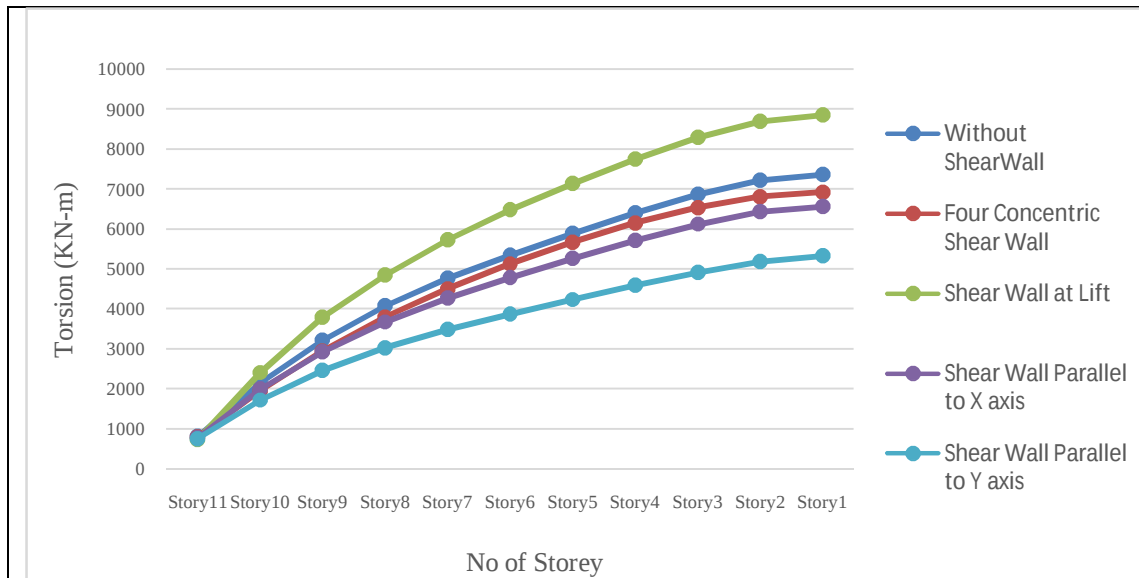
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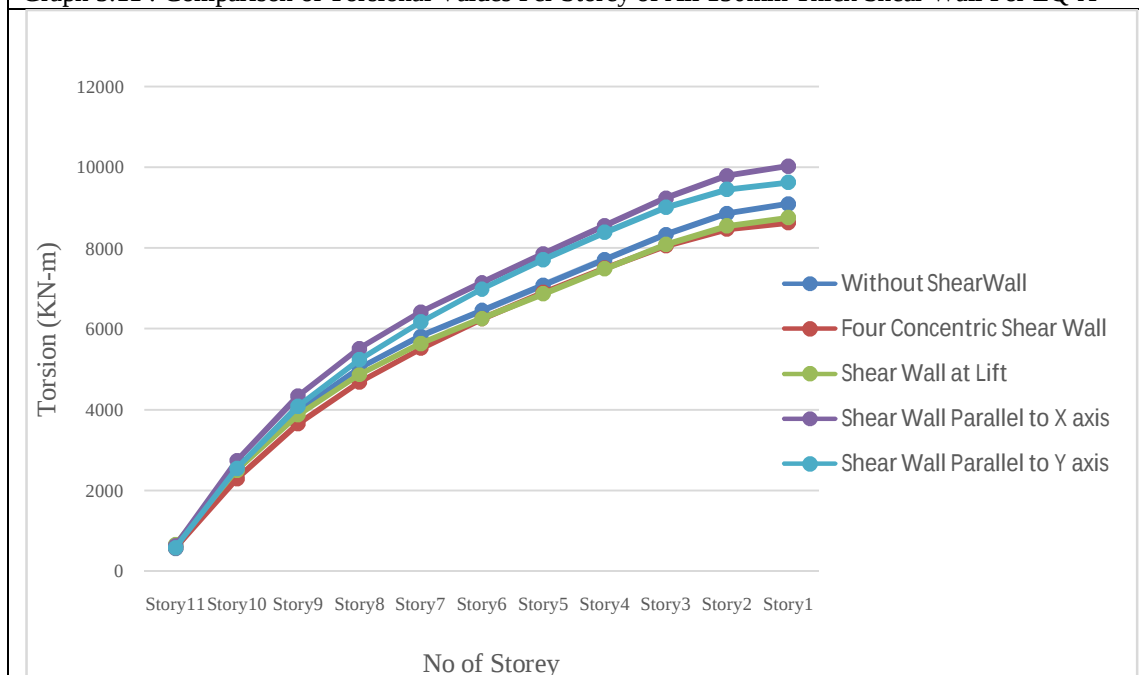
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Graph 5.11 : Comparison of Torsional Values Per Storey of All 150mm Thick Shear Wall For EQ-X

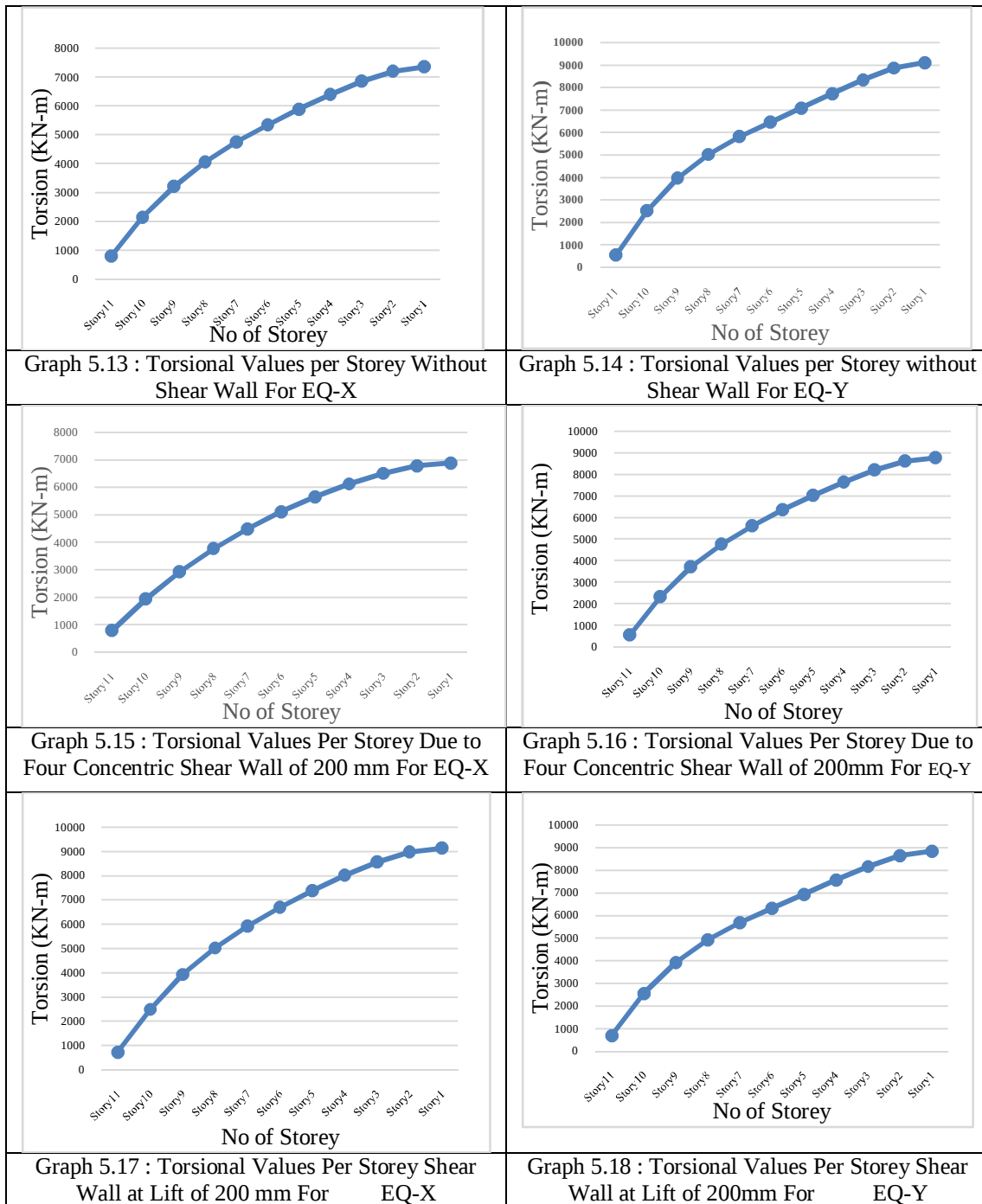


Graph 5.12 Comparison of Torsional Values per Storey of All 150mm Thick Shear Wall For EQ-Y

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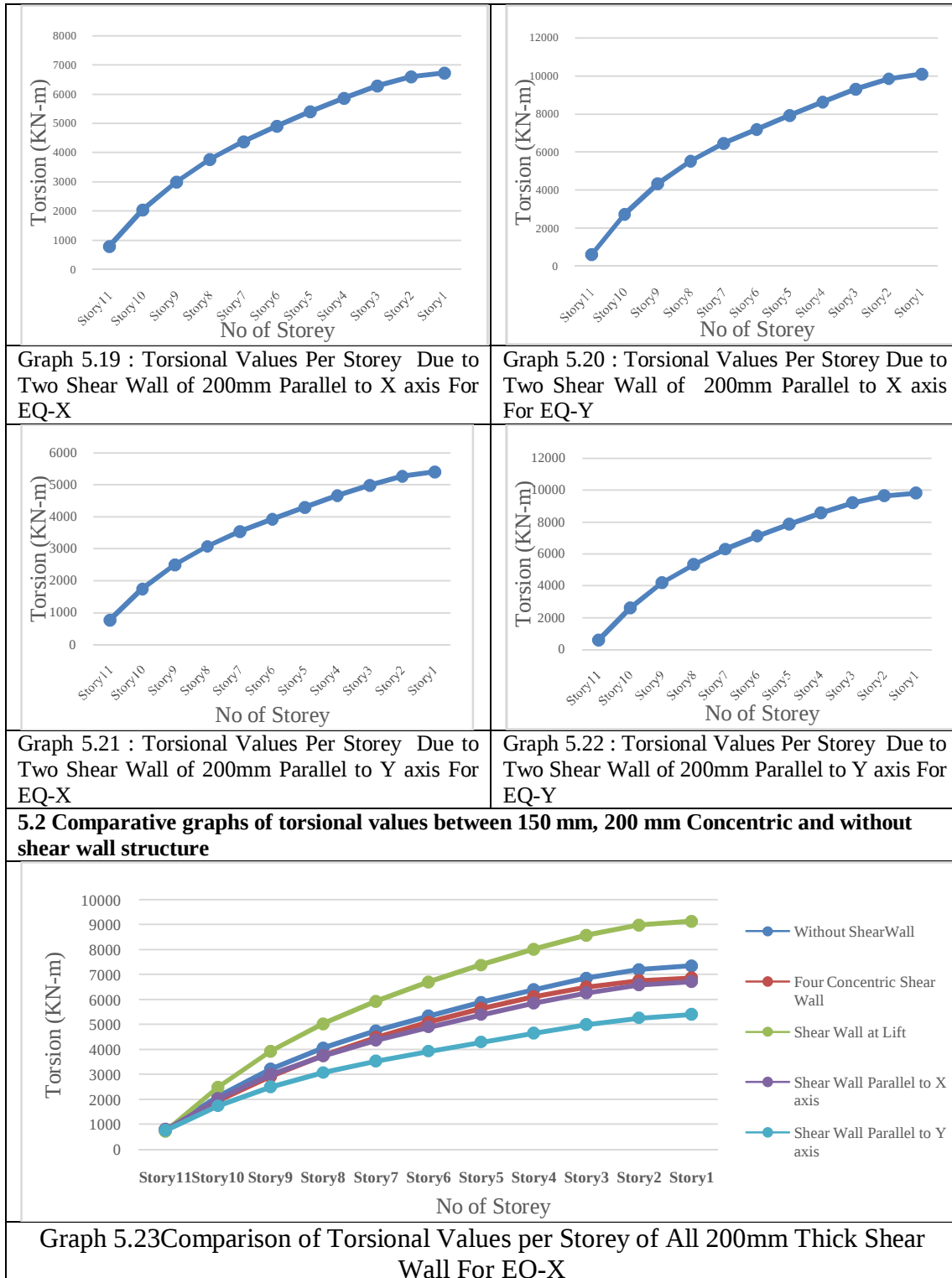
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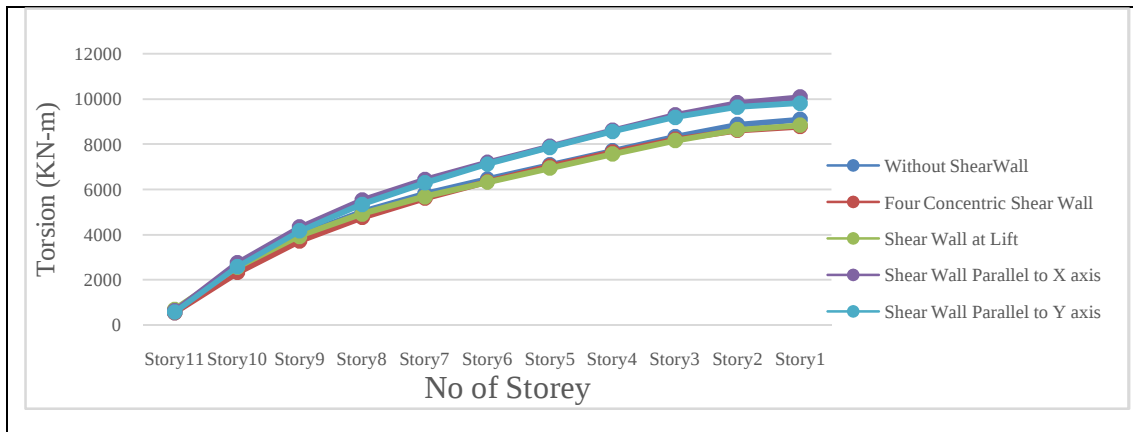
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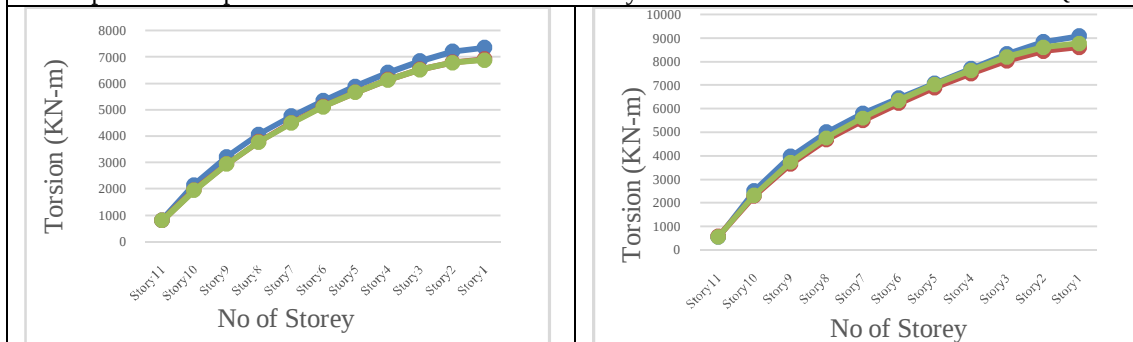
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Graph 5.24 Comparison of Torsional Values Per Storey of All 200mm Thick Shear Wall For EQ-Y



Graph 5.25 Comparison of Torsional Values Per Storey of Concentric Shear Wall of Different Thickness For EQ-X

Graph 5.26 Comparison of Torsional Values Per Storey of Concentric Shear Wall of Different Thickness For EQ-Y

In the present study effect of location of shear walls of the same length in each direction with respect to centre of the plan has been studied. The points of comparison are

- Torque of each floor
- Shear force acting on each floor

This study shows that, it is very important to locate position of shear wall in building to minimise torsion and also lateral loads on columns as well as column moments due to these lateral loads. The lateral displacements of the building are uniform for a zero eccentricity case. It is concluded that, the shear wall should be placed at a point by coinciding center of gravity and centroid of the building.

VI. CONCLUSION

Four different cases of shear wall position for an eleven storey building are studied as a space frame system using a standard package ETAB subjected to lateral and gravity loading. Two different thickness of shear wall i.e. 150 mm and 200 mm are also used in all four cases. On the basis of above analysis following conclusions has been drawn:

- Twisting in building is observed to be having increasing trend with enhancement in the eccentricity between geometrical centroid of the building and centre of mass.
- It is observed that, torsional values of structure for shear wall at lift is much greater (for EQX) than a structure without shear wall so the purpose of providing shear wall is not fulfilled. It increases eccentricity in both directions. Also, two shear walls parallel to X-axis didn't show good result for EQX and EQY.

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- There is considerable amount (EQY for the four concentric shear walls and EQY for two shear walls parallel to Y-axis) of decreased in eccentricity observed for the four concentric shear walls and two shear wall parallel to Y-axis. Two shear walls parallel to y-axis gives best result for EQX. Four concentric shear wall decreases eccentricity which in turn decreases torque acting on floor for both EQX and EQY.
- Four concentric shear walls of 150 mm thick decrease torque in best possible way for this structure.

VII. FUTURE SCOPE

The future scope for this study carried out is as follows

- In the present study analysis of 11- storey building has been performed using ETABS. The same exercise can be carried out for more tall buildings.
- Unsymmetrical in the building is considered in the vertical plan. Asymmetry can also be introduced in horizontal plane also.
- The effect of the location of the shear walls can also be studied by shifting these walls symmetrically towards the centre.
- Effect of soft storey has not been considered, the analysis can be performed by considering soft storey
- Thickness of shear wall throughout the height of building is constant. Analysis can be performed considering different thickness in building height. Other software or method can be used to analysis.

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