Seismic Analysis of Shear Wall at Different Location on Multi-storey RCC Building

Prof. N. K. Meshram[1], Gauravi M. Munde[2]

[1,2] Department of Structural Engineering, Jagdamba College of Engineering & Technology, Yavatmal, Maharashtra, India

ABSTRACT

Looking to the past records of earthquake, there's increase within the demand of earthquake resisting building which might be consummated by providing the shear wall systems within the building. Additionally attributable to the foremost earthquakes within the recent pats the codal provisions revised and implementing additional weightage on earthquake style of structure. Usually shear wall will be outlined as structural vertical member that's ready to resist combination of shear, moment and axial load iatrogenic by lateral load and gravity load transfer to the wall from different support. Ferro concrete walls, that include raise wells or shear walls, square measure the standard needs of Multi structure Buildings. Style by coinciding centre of mass and mass centre of the building is that the ideal for a Structure. Associate in Nursing introduction of shear wall represents a structurally economical answer to stiffen a building structural system as a result of the most operate of a shear wall is to extend the rigidity for lateral load resistance.

Shear wall systems square measure one amongst the foremost usually used lateral load resisting systems in high-rise buildings. Shear walls square measure incorporated in building to resist lateral Forces and support the gravity masses. RCC shear wall has high in plane stiffness, which may be accustomed at the same time resist massive horizontal masses and support gravity masses, creating them quite advantageous in several structural engineering applications. There square measure several literatures offered to style and analyze the shear wall. However, the choice concerning the placement of shear enclose multi-storey building isn't a lot of mentioned in any literatures. Positioning of shear wall has influence on the general behaviour of the building. For effective and economic performance of building it's essential to position shear enclose a perfect location.

The main aim of the project is to work out the solution for shear wall location in multi-storey building. it's administrated to work out the strength of RC shear wall of a high-rise building by dynamical shear wall location. three completely different cases of shear wall position for a building are analysed. associate degree earthquake load is calculated by the unstable constant technique victimisation IS 1893 (PART–I):

2002.STAAD professional V8i software is used for the analysis of structures. The structures area unit compared on four completely different parameters specifically joint displacement, axial force, bending moment and base shear

1. INTRODUCTION

Generally shear wall are often outlined as structural vertical member that's able to resist combination of shear, moment and axial load elicited by lateral load and gravity load transfer to the wall from alternative support. Reinforced concrete walls, that embrace raise wells or shear walls, area unit the same old requirements of Multi story Buildings Style by coinciding centre of mass and mass centre of the building is the ideal for a Structure. Shear walls have terribly high in-plane stiffness and strength, which may be wont to at the same time resist massive horizontal masses and support gravity masses, creating them quite advantageous in several structural engineering applications. associate degree introduction of shear wall represents a structurally economical resolution to stiffen a building structural system as a result of the most operate of a shear wall is to extend the rigidity for lateral load resistance.

Fig1. Damage of building because of earthquake

In trendy tall buildings, shear walls are usually used as a vertical structural component for resisting the lateral masses that may be elicited by the impact of wind and earthquakes. Shear walls of varied cross sections i.e. rectangular shapes to a lot of irregular cores like channel, T, L, barbell shape, box etc. will be used. Provision of walls helps to divide AN enclose area, whereas of cores to contain and convey services like elevator. Wall openings are inevitably needed for windows in external walls and for doors or corridors in inner walls or in elevate cores. the dimensions and placement of openings might vary from architectural and useful purpose of view.

The use of shear wall structure has gained quality in high rise building structure, particularly within the construction of service flat or office/ industrial tower. it's been well-tried that this method provides economical structural system for multi construction building within the vary of 30-35 storey's (MARSONO & SUBEDI, 2000). Within the past thirty years of the record service history of tall building containing shear wall component, none has folded throughout robust winds and earthquakes (FINTEL, 1995).

Fig2. Construction of shear wall

1.1 Reinforced Concrete Shear Wall

Reinforced concrete (RC) buildings usually have vertical plate-like RC walls known as Shear Walls (Figure2) additionally to slabs, beams and columns. These walls typically begin at foundation level and square measure continuous throughout the building height. Their thickness will be as low as 150mm, or as high as 400mm in high rise buildings. The overwhelming success of buildings with shear walls in resisting robust earthquakes is summarized within the quote: "We cannot afford to make concrete buildings meant to resist severe earthquakes while not shear walls." Mark Fintel, a noted consulting engineer in USA.
RC shear walls give massive strength and stiffness to buildings within the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces harm to structure and its contents. Since shear walls carry massive horizontal earthquake forces, the overturning effects on them area unit massive. Shear walls in buildings should be symmetrically located in decide to cut back ill-effects of twist in buildings. They may be placed symmetrically on one or each directions in arrange. Shear walls area unit more effective once situated on exterior perimeter of the building – such a layout will increase resistance of the building to twisting.

1.2 Function of Shear wall

Shear walls should give the mandatory lateral strength to resist horizontal earthquake forces. once shear walls square measure strong enough, they'll transfer these horizontal forces to future part within the load path below them. These alternative components within the load path are also other shear walls, floors, foundation walls, slabs or footings. Shear walls additionally give lateral stiffness to prevent the roof or floor on top of from excessive side-sway. once shear walls square measure stiff enough, they'll stop floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff can sometimes suffer less non-functional damage.

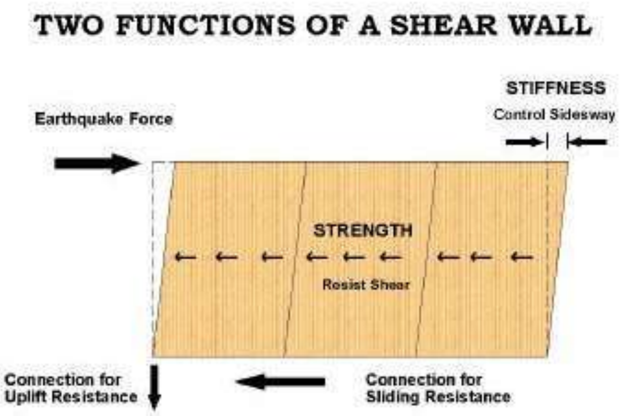


Fig. 1.2Function of shear wall

Shear walls conjointly offer lateral stiffness to stop the roof or floor higher than from excessive side- sway. once shear walls are stiff enough, they're going to stop floor and roof framing members from moving off their supports. Also, buildings that are sufficiently stiff can typically suffer less non-structural damage. (Fig. 1.2)

1.5 Types of seismic analysis Code based Procedure for Seismic Analysis (IS 1893:2002)

- **Equivalent Lateral Force**

Seismic analysis of most of the structures remains applied on the premise of lateral force assumed to be equivalent to the particular loading. the bottom shear that is that the total horizontal force on the structure is calculated on the premise of structure mass and elementary amount of vibration and corresponding mode shape. the bottom shear is distributed on the peak of structures in terms of lateral force in line with code formula. This technique is conservative for low to medium height buildings with regular conformation.

- **Response Spectrum Analysis**

This technique is applicable for those structures wherever modes apart from the elemental one affect significantly the response of the structure. during this technique the response of Multi-Degree-of-Freedom(MDOF) system is expressed because the superposition of modal response, every modal response being determined from the spectral analysis of single -degree-of-freedom (SDOF) system, that is then combined to compute total response. Modal analysis ends up in the response history of the structure to a such ground motion; however, the strategy is sometimes utilized in conjunction with a response spectrum. A response spectrum is simply a plot of the height or steady-state response (displacement, rate or acceleration) of a series of oscillators of varied natural frequency, that square measure forced into motion by an equivalent base vibration or shock. The resulting plot will then be wont to decide off the response of any linear system, given its natural frequency of oscillation. One such use is in assessing the height response of buildings to earthquakes. The science of strong ground motion could use some values from the bottom response spectrum (calculated from recordings of surface ground motion from seismographs) for correlation with seismal harm. If the input used in calculating a response spectrum is steady-state periodic, then the steady-state result's recorded. Damping must be gift, alternatively the response are going to be infinite. For transient input (such as seismal ground motion),the peak response is reported . Some level of damping is usually assumed, however a worth are going to be obtained even with no damping. Response spectra can even be utilized in assessing the response of linear systems with multiple modes of oscillation (multi-degree of freedom systems), though they're solely correct for low levels of damping. Modal analysis is performed to spot the modes, and also the response in this mode will be picked from the response spectrum. This peak response is then combined to estimate a complete response. Atypical combination technique is that the root of the add of the squares (SRSS) if the modal frequencies are not shut. The result's generally completely different from that which might be calculated directly from associate degree input, since phase info is lost within the method of generating the response spectrum. The main limitation of response spectra is that they're solely universally applicable for linear systems. Response spectra will be generated for non-linear systems, however ar solely applicable to systems with an equivalent non-linearity, though tries have been created to develop non-linear seismal style spectra with wider structural application. The results of this cannot be directly combined for multi-mode response.

- **Time History Analysis**

A linear time history analysis overcomes all the disadvantages of modal response spectroscopy, provided non-linear behavior isn't concerned. This methodology needs larger machine efforts for calculating the response at discreet time's .One attention-grabbing advantage of such procedure is that the relative signs of response quantities square measure preserved within the response histories. This is often necessary once interaction effects square measure thought of in style among stress resultants. Though this is often too oversimplified to use to a real structure, the physicist Step perform may be a cheap model for the applying of the many real masses, such as the fulminate addition of a chunk of furnishings, or the removal of a prop to a freshly forged concrete floor. However, in reality masses square measure ne'er applied instantly - they build up over a amount of your time (this is also very short indeed). now is termed the increase time. As the range of degrees of freedom of a structure increases it terribly quickly becomes too tough to calculate the time history manually - real structures square measure analyzed using non-linear finite part analysis software package. Time-history analysis is more and more employed in style of new Structures and analysis of existing ones .In the case of time-history analysis, seismal action is represented by suite of ground acceleration records.

- **Objective of the study**

(i) The gift study on Dynamic analysis reveals an effort to see the elemental natural frequency of various buildings victimisation Matrix methodology based mostly software package, STAAD.
(ii) To analyze a high-rise RC framed building (G+9) for earthquake zone III by response spectrum methodology.
(iii) To study behavior of RC building (G+9) with totally different position of shear wall.
(iv) To measure the displacements in structure at numerous levels, relative to ground displacements in horizontal direction.
(v) To aim at the determination of elementary natural frequency for the various building models. (vi) To notice the bottom shear price for various structures.

2. LITERATURE REVIEW

Anshuman, DipenduBhunia, BhavinRamjiyani(2011) it's been determined that the each bending moment and shear force within the first and twelfth frame were reduced and high deflection is additionally reduced once providing the shear wall up any of the sixth and seventh frame and first and twelfth in close the shorter direction. Hence, it is said that shear wall is provided in sixth and seventh frame or first and twelfth in close shorter direction. In analysis hinge formation has additionally been determined.

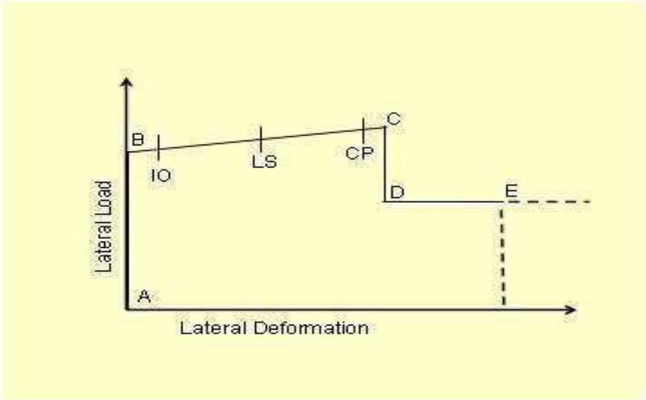


Fig. 2.1 Graph showing Hinge Formation Levels

Hinge formation levels square measure divided as yield level (B), immediate occupancy level (IO), life safety level (LS), collapse level (CP),full collapse level (E) [Figure 3]. At the immediate occupancy level structures haven't any sever damage and structures may be used for more lifetime of structure. Life safety level indicates there won't be any casualty because of earthquake however structure cannot be used for more living. At collapse level member can begin to collapse and full collapse member can already collapse.

Ashish S. Agrawal and S. D. Charkha 2012This paper highlights on the impact of amendment in position of shear wall with totally different shapes for crucial parameters like structure drift, axial load and displacement. inserting shear wall far away from the centre of gravity resulted in increase in most of the member forces. They conclude like the rise in eccentricity, the building shows non-uniform movement of right and left edges of roof owing to torsion and induce excessive moment and forces in member.

R.Chittiprolu, R.Pradeep Kumar (2014), during this paper study the importance of Shear enclose High rise Irregular Buildings. A study on associate degree irregular high rise building with shear wall and while not shear wall was studied to grasp the lateral hundreds, story drifts and torsion effects. From the results it's inferred that shear walls area unit a lot of proof against lateral hundreds in associate degree irregular structure. and it had been determined that the dynamic linear analysis mistreatment response spectrum methodology is performed and lateral load analysis is completed for structure while not shear wall and structure with shear wall. Results area unit compared for the frame lateral forces and story drifts of each the cases. it's additionally determined that lateral forces area unit reducing once the shear walls area unit intercalary at the acceptable locations of frames having minimum lateral forces. Therefore, it's inferred that shear walls area unit a lot of proof against lateral hundreds in associate degree irregular structure. additionally they'll be accustomed cut back the results of torsion.

Mohammed yousuf, P.M. shimpale (2013) the most objective of earthquake engineering is to style associate degreed build a structure in such the way that the injury to the structure and its structural part throughout an earthquake is decreased . This paper aims towards the dynamic analysis of concrete building with set up irregularity. Four models of G+5 building with one symmetrical set up and remaining irregular set up are taken for the investigation. The analysis of R.C.C. building is dispensed with the metal based mostly computer code ETABS nine.5. Estimation of response such as; lateral forces, base shear, construction drift, construction shear is dispensed. Four cross sectional variation in columns section ar thought of for finding out effectiveness in resisting lateral forces. The paper additionally deals with the impact of the variation of the building set up on the structural response building. Dynamic responses underneath distinguished earthquake, associated with IS 1893–2002(part1) are dispensed. In dynamic analysis; Response Spectrum methodology is employed. The CQC (complete quadratic combination) methodology has additionally been utilized for every model for estimation of dynamic response for five, 10%, 15%, and 2 hundredth damping and dynamic responses were compared.

H.Rahangdale, S.R.Satone (2013), dispensed the survey of style and analysis of multi-storied building with result of shear wall. In this paper Study of G+5 construction building in Zone IV is conferred with some preliminary investigation that is analyzed by ever-changing numerous position of shear wall with totally different shapes for confirm parameter like axial load and moments. This analysis is completed by victimization customary package STADD-pro. currently the project describes the analysis of structure with result of shear wall. In Structural engineering, a shear wall could be a wall composed of braced panels (also referred to as shear panels) to counter the results of lateral load performing on a structure. Wind and earthquake hundreds square measure the foremost common hundreds braced wall lines square measure designed to counteract. it had been found that the various location of shear wall result on axial load on the column. In absence of shear wall axial load and moments square measure most on column. Case-3 is safe as compare to case-1 and case-2. Shear walls square measure simple to construct, as a result of reinforcement particularization of walls is comparatively clear-cut and thus simply enforced at website. therefore shear walls square measure one in every of the foremost effective building components in resisting lateral forces throughout earthquake. By constructing shear walls damages owing to result of lateral forces owing to earthquake and high winds are often reduced. Shear walls construction can offer larger stiffness to the buildings there by reducing the injury to structure and its contents.

P. P. Chandurkar, Dr.P.S.Pajgade(2013) was studied the unstable Analysis of RCC Building with and while not Shear Wall. during this paper, effectiveness of shear wall has been studied with the assistance of 4 completely different models. Model one is blank frame structural system and different 3 models square measure twin sort structural system. AN earthquake load is applied to a building of 10 stories placed in zone II, zone III, zone IV and zone V. Lateral displacement, story drift and total value needed for ground floor square measure calculated in each the cases commutation column with shear wall.And discovered that in ten story building, constructing building with shear shut in short span at corner (model 4) is economical as compared with different models. From this it may be ended that giant dimension of shear wall isn't effective in ten stories or below ten stories buildings. it's discovered that the shear wall is economical and effective in high rise building.

O. Esmaili, S. Epackachi(2008) allotted the Study of Structural RC Shear Wall System in a56-Story RC Tall Building. during this paper, study the structural aspects of 1 of the tallest RC buildings, set within the high unstable zone, with fifty six stories. during this Tower, shear wall system with irregular openings square measure used beneath each lateral and gravity masses, and will result some exceptional problems within the behavior of structural components like shear walls, coupling beams and etc. to own a unstable analysis of the Tower, plenty of non-linear analyses were performed to verify its behavior with the foremost rife retrofitting pointers like FEMA 356. during this paper; some exceptional aspects of the tower and therefore the assessment of its unstable load bearing system with considering some necessary factors are going to be mentioned.
Finally when a general study of malleability levels in shear walls; we are going to conclude the optimality and construct of the tower style. Finally, having some technical info concerning the structural behavior of the case would be terribly fascinating and helpful for designers. As is treated here, mistreatment shear walls for each gravity and bracing system is unacceptable neither conceptually nor economically. Not solely main walls square measure assumed to hold unstable masses, however conjointly they're about to bear a big proportion of gravity masses. Despite the actual fact that coupling beams square measure assumed to be cracked untimely in earthquake, this event would possibly occur beneath permanent gravity masses as a results of concrete time dependency. distribution of masses consistent with creep and successive loading can intensely modification the primitive assumptions on gravity load tributaries and consequently the extent of malleability. By considering each time dependency of concrete and construction sequence Loading at the same time in analyses, the vital demands would be found to occur within the middle height of the structure.

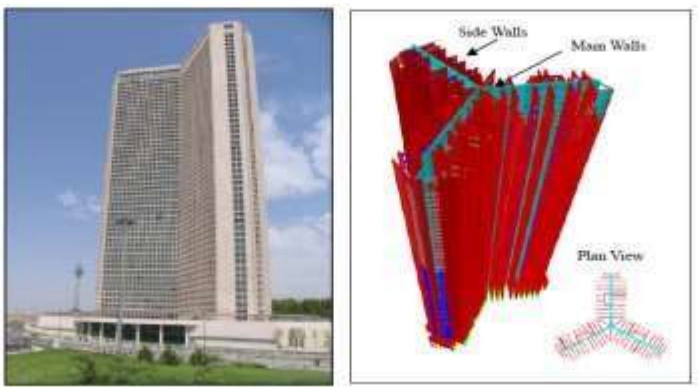
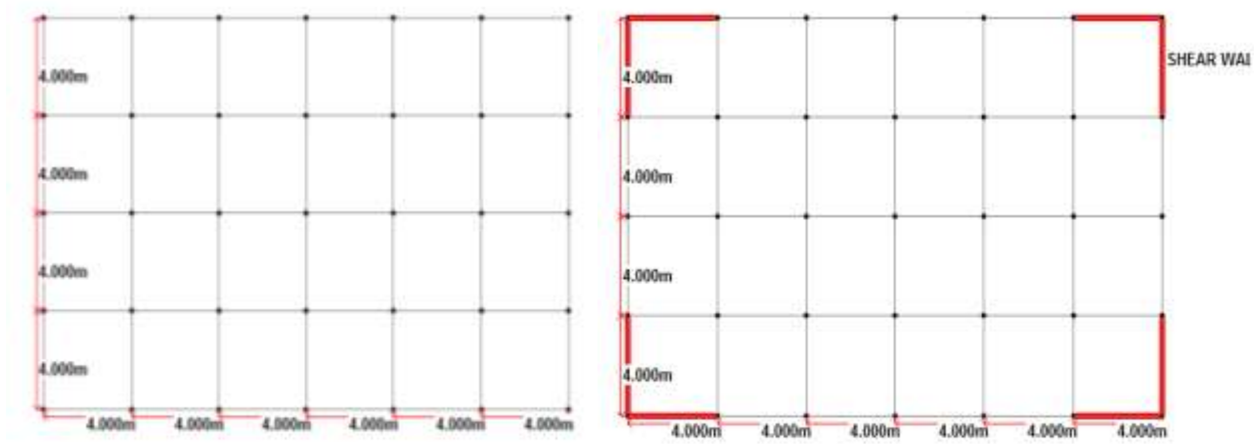


Figure 2.1 the view and structural system of the tower

3. ANALYSIS AND MODELING

3.1 General

This chapter deals with the mathematical modelingof building with totally different positions of shear wall. So as to match the seismal response of various models are modeled exploitation STAAD-PRO.For every cases response spectrum analysis has been discussed. Complete analysis is carried out for loading, live load & seismal load. All combinations are considered as per IS 1893:2002.



3.2 Description of the building

The typical framing plan of G+9 storey building is shown in figure 3.1 the building is rectangular in plan. Length and width of the building is considered as 24m and 16m respectively. Each storey height is considered as 3m. Height of the building is 30m. Spacing of frame along length and width is 4m.
Material grades of M35& Fe500 were used for the design.

3.3 Building properties

Site Properties:
Details of building:: G+9
Outer wall thickness:: 230mm
Inner wall thickness:: 230mm
Floor height ::3 m
Depth of foundation :: 1500mm

Seismic Properties
Seismic zone:: III
Zone factor:: 0.16
Importance factor:: 1.0
Response Reduction factor R:: 3
Soil Type:: medium

Material Properties
Material grades of M35& Fe415 were used for the design.

Loading on structure
Dead load :: self-weight of structure
Weight of 230mm wall
Live load:: Floor 2.5kN/m^2
Roof 1.5 kN/m^2
Wind load :: Not considered
Seismic load:: Seismic Zone III

Preliminary Sizes of members
Column::400mm x 700mm
Beam :: 300mm x 500mm
Slab Thickness:: 125mm
Shear wall Thickness:: 300mm

3.4 Load Combinations

Load combinations that are to be used for Limit state Design of reinforced concrete structure are listed below.
1. 1.5(DL+LL)
2. 1.2(DL+LL±EQ-X)
3. 1.2(DL+LL±EQ-Y)
4. 1.5(DL±EQ-X)
5. 1.5(DL±EQ-Y)
6. 0.9DL±1.5EQ-X
7. 0.9DL±1.5EQ-Y

3.5 Method of Analysis of Building as per IS 1893 (part I):2002

Seismic codes are unique to a particular region or country. In India, Indian standard criteria for Earthquake Resistant Design of Structures IS 1893 (Part-I): 2002 is the main code that provides outline for calculating seismic design force. This force depends on the mass and seismic coefficient of the structure and the latter in turn depends on properties like seismic zone in which structure lies, importance of the structure, its stiffness, the soil on which it rests, and its ductility. The code recommends following method of analysis.

1. Equivalent static analysis.
2. Dynamic Analysis.

3.5.1 Equivalent static analysis:

Regular structure with limited height can be analyzed using equivalent static analysis or linear static analysis. Seismic analyses of most of the building are still carried out on the basis of lateral force assumed to be equivalent to the actual loading. Base shear which is the total horizontal force on the structure is calculated on the basis of mass of structure, fundamental period of vibration etc. The base shear is distributed along the height of structure in terms of lateral forces according to code formula.

Equivalent static analysis is performed on all the models. Step by step procedure for calculating lateral force along each storey is given below.

1)The weight of all the floors and the roof is calculated and total seismic weight of the building is found out.

$W = \sum W_i$ … (3.1)

2) The approximate fundamental natural period of vibration (T_a), in seconds, of all buildings, including moment-resisting frame buildings with brick infill panels, is estimated by the empirical expression 3.2 (a) and for moment-resisting frame buildings without brick infill panels is estimated by the empirical expression

$T_a = \frac{0.09h}{\sqrt{d}}$ … (3.2.a)

$T_a = 0.075h^{0.75}$ … (3.2.b)

3) The design horizontal seismic coefficient A_h for a structure is determined by the following expression.

$Ah = \frac{Z}{2}\frac{I}{R}\frac{Sa}{g}$…..(3.3)

4) The total design lateral force or design seismic base shear is determined by the following expression.

$V_B = A_h x W$… (3.4)

5) The design base shear computed as above is distributed along the height of building as per the following expression.

$$Q_i = V_B \frac{W_i h_i^2}{\sum_{j=1}^{n} W_j h_j^2}$$

3.5.2 Dynamic analysis:

This method of analysis, produce the effect of the higher modes of vibration and the actual distribution of forces in the elastic range in better way. This method is an improvement over linear static analysis. The significant difference between linear static and nonlinear dynamic analysis is the level of force and their distribution along the height of the structure.

Dynamic analysis shall be performed to obtain the design seismic force and its distribution to different levels along the height of the building and to the various lateral load resisting elements, for the following buildings:

a) Regular buildings – Those greater than 40m in height in zone IV and V and those greater than 90m in height in zone II and III.

b) Irregular buildings – All framed buildings higher than 12m in zone IV and V, and those greater than 40m in height in zone II and III.

For irregular buildings lesser than 40m in height in zone II and III, dynamic analysis even though not mandatory, is recommended.

3.5.2.1 Response spectrum analysis:

Response spectrum analysis allow the users to analyze the structure for seismic loading. For any supplied response (either acceleration v/s period or displacement v/s period) joint displacements, member forces and support reaction may be calculated. Model response may be combined either square root of sum of squares (SRSS) or complete quadratic combination (CQC) method to obtain the resultant response as given in clause 7.8.4.4 of code IS 1893 (part I): 2002.

Building with regular or nominally irregular plan configuration may be modeled as the system of masses lumped at the floor levels with each mass having one degree of freedom, that of lateral displacement in the direction under consideration. In such case, the following expression shall hold in the computation of various quantities.

1) The modal mass *(M_k)* of mode K is given by

$$M_k = \frac{\left[\sum_{i=1}^{n} W_i \Phi_{ik}\right]^2}{g\left[\sum_{i=1}^{n} W_i (\Phi_{ik})^2\right]}$$

2) The motion of participation factor *(P_k)* of mode k is given by

$$p_k = \frac{\sum_{i=1}^{n} W_i \Phi_{ik}}{\sum_{i=1}^{n} W_i (\Phi_{ik})^2}$$

3) The peak lateral forces *(Q_{ik})* at floor i in mode k is given by

$$Q_{ik} = A_k \Phi_{ik} P_k W_i$$

4) The peak shear force acting *(V_{ik})* in the storey i in mode k is given by

$$V_{ik} = \sum_{j=i+1}^{n} Q_{ik}$$

5) The peak storey shear force *(V_i)* in storey I due to all modes considered is obtained by combining those due to each mode in accordance with clause 7.8.4.4 of code.

6) The design lateral forces, $F_{roof\ and}$ F_i , at roof and at floor i is given by

$F_{roof} = V_{roof}$

$F_i = V_i - V_{i-1}$

The method of square root of sum of square (SRSS) is used for combining modal response. Damping factor is taken as 1, this corresponds to the 5% damping ratio. Spectra is applied in both X and Y direction.

3.5.2.2 Time history analysis:

In this method, the structure is subjected to real ground motion records. This analysis method quite different from all of the other approximate analysis method as the inertial forces are directly determined from these ground motions and the response of the building are calculated as a function of time, considering the dynamic properties of the building structure.

In this present study method of analysis is made for Dynamic analysis method (only response spectrum method) for seismic loads acting on the structure.

1. Seismic analysis is the calculation of the building response of structure to earthquake and is a relevant part of structural design where earthquakes are prevalent.

2. The seismic analysis of a structure involves evaluation of the earthquake forces acting at various levels of the structure during an earthquake and the effectiveness of such forces on the behavior of the overall structure. The analysis may be static or dynamic in approach as per the code provisions.
3. In the process of structural analysis system the analysis is carried out to predict its behaviors by using mathematical equation and physical laws.
4. Under various load effects, the main objective of structural analysis is to determine internal forces, stresses and deformation of structures.

The analysis of the building is carried out by following
Dynamic analysis: It should be performed to get the design seismic force, and its allotment to different levels along the height of the building and to different lateral load resisting elements. Dynamic analysis can be performed by time history method or by the response spectrum method. Though in both methods, the design base shear (Vb) should be compared with a base shear (vb) calculated using a basic period Ta. When (Vb) is less than (vb) all the response quantities shall be multiplied by Vb /vb .The values of damping for a building may be taken as 2 and 5 percent of the critical, for the purpose of dynamic analysis of steel and reinforced concrete buildings, respectively.

3.5 Modeling
This building has been modeled as 3D Space frame model with six degree of freedom at each node using STAAD PRO software for stimulation of behavior under gravity and seismic loading. The isometric 3D view and plan of the building model is shown as figure. The support condition is considered as fully fixed

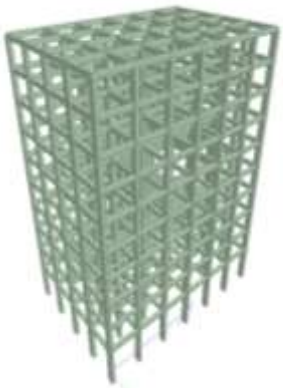


Fig. 3.5-1 Elevation and 3D view of G+9 story building

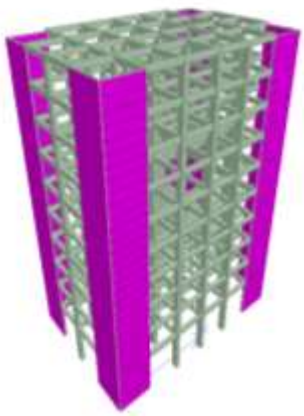


Fig. 3.5-2 Elevation and 3D view of G+9 story building with SW1

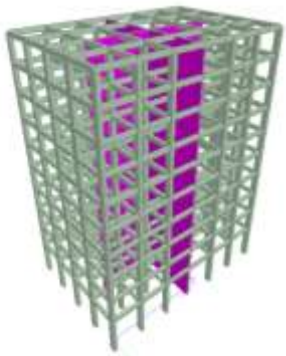


Fig. 3.5-3 Elevation and 3D view of G+9 story building with SW2

4. ANALYSIS AND GRAPHS

4.1 Calculated Base shear in x-dir/z-dir

The calculated base shear for structures are presented in Table - 4.1,4.2

Table 4.1 Base shear in x-dir (KN)

Maximum Base Shear in X - dir (kN)	
Model Type	X-dir
Bare Frame	2264.54
Frame with SW1	2245.2
Frame with SW2	2204.92
Frame with SW3	2303.82

Table 4.2 Base shear in z-dir (KN)

Maximum Base Shear in Z - dir (kN)	
Model Type	Z-dir
Bare Frame	2226.61
Frame with SW1	2252.66
Frame with SW2	2211.24
Frame with SW3	2271.15

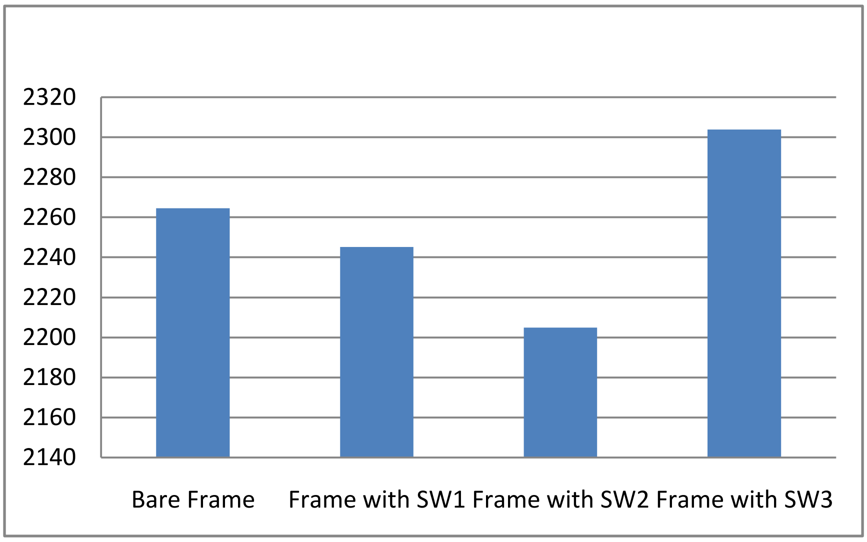


Fig. 4.1 Maximum Base shear in x-dir in KN

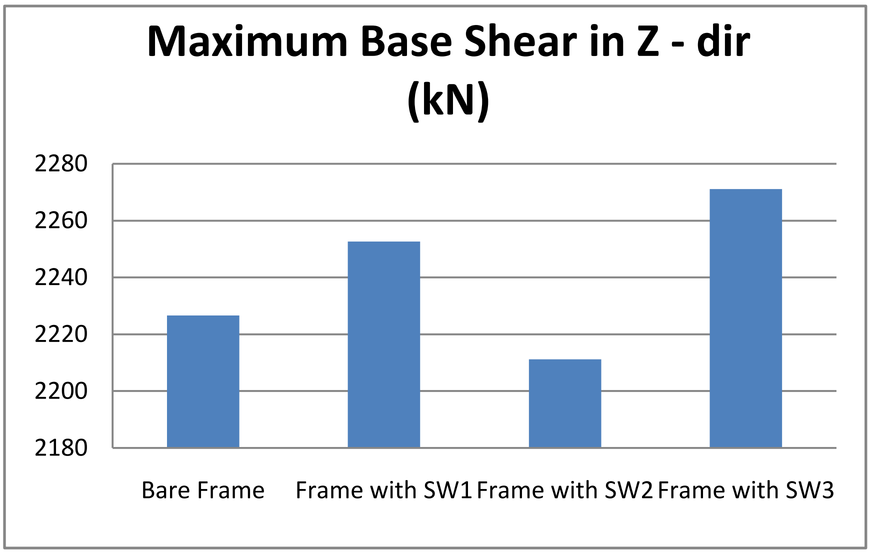


Fig. 4.2Maximum Base shear in z-dir in KN

4.2Maximum Lateral Displacement in x-dir/z-dir

The maximum lateral displacement for structures are presented in Table - 4.3,4.4

Table 4.3 Maximum Lateral Displacement in x-dir (mm)

Maximum Lateral Displacement in X - dir (mm)	
Model Type	X-dir
Bare Frame	44.394
Frame with SW1	20.547
Frame with SW2	18.328
Frame with SW3	12.545

Fig. 4.3Maximum Lateral Displacement in x-dir in mm

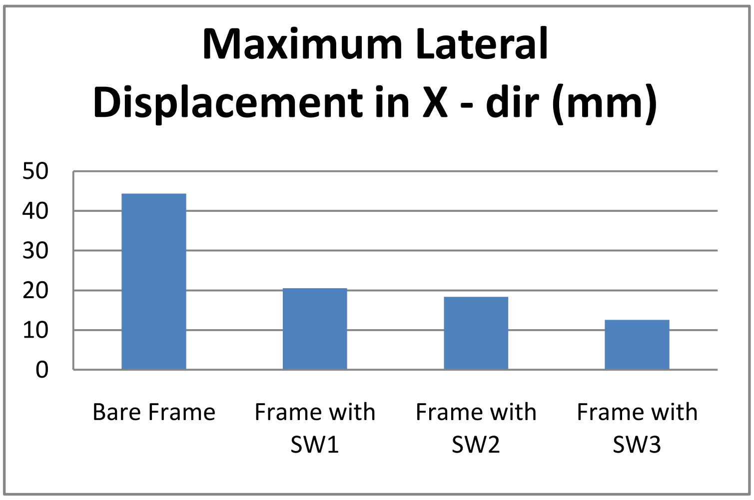
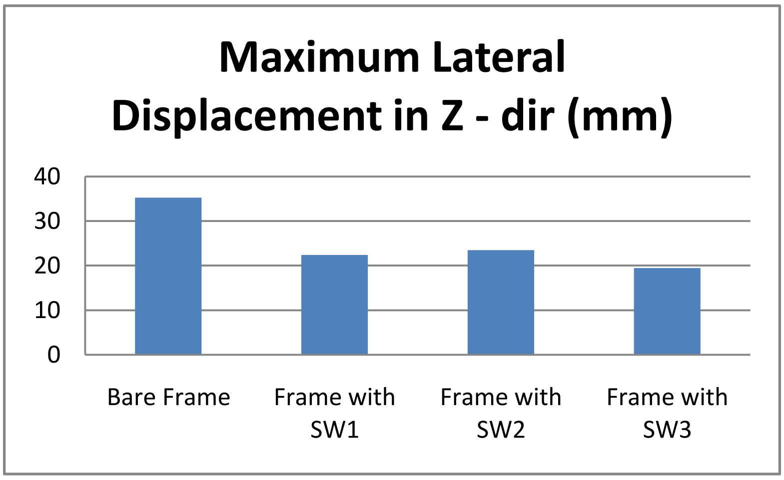


Table 4.4 Maximum Lateral Displacement in z-dir (mm)

Maximum Lateral Displacement in Z - dir (mm)	
Model Type	Z-dir
Bare Frame	35.252
Frame with SW1	22.398
Frame with SW2	23.486
Frame with SW3	19.493

Fig. 4.4Maximum Lateral Displacement in z-dir in mm



4.3Maximum Axial Force

The maximum axial force for structures are presented in Table - 4.5

Table 4.5 Maximum Axial Force (kN)

Maximum Axial Force (kN)	
Bare Frame	3675.63
Frame with SW1	3708
Frame with SW2	3670.64
Frame with SW3	3119.03

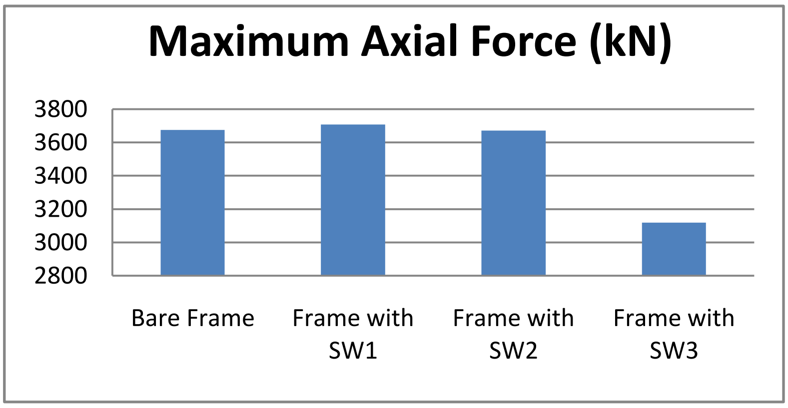


Fig. 4.5Maximum Axial Force in kN

4.4MaximumShear Force in y-dir/z-dir

The maximum shear force for structures are presented in Table - 4.6,4.7

Table 4.6 Maximum shear Force in y-dir (kN)

Maximum Shear Force - Y (kN)	
Bare Frame	113.673
Frame with SW1	73.898
Frame with SW2	61.264
Frame with SW3	40.209

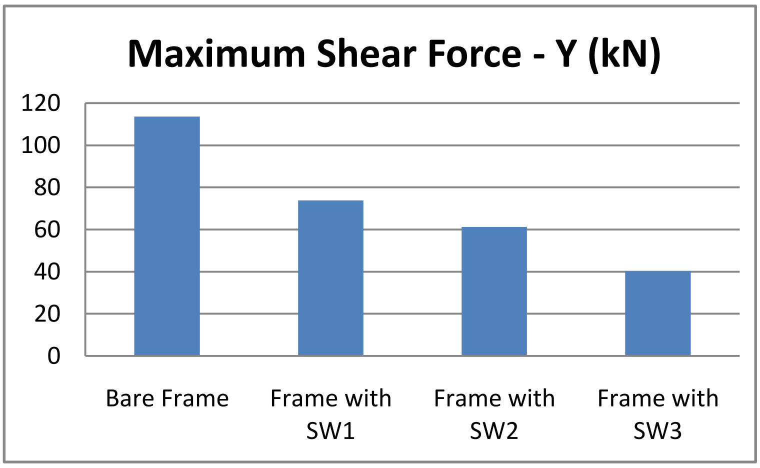


Fig. 4.6Maximum Shear Force in y-dir in kN

Table 4.7 Maximum shear Force in z-dir(kN)

Maximum Shear Force - Z (kN)	
Bare Frame	123.961
Frame with SW1	78.041
Frame with SW2	93.44
Frame with SW3	68.836

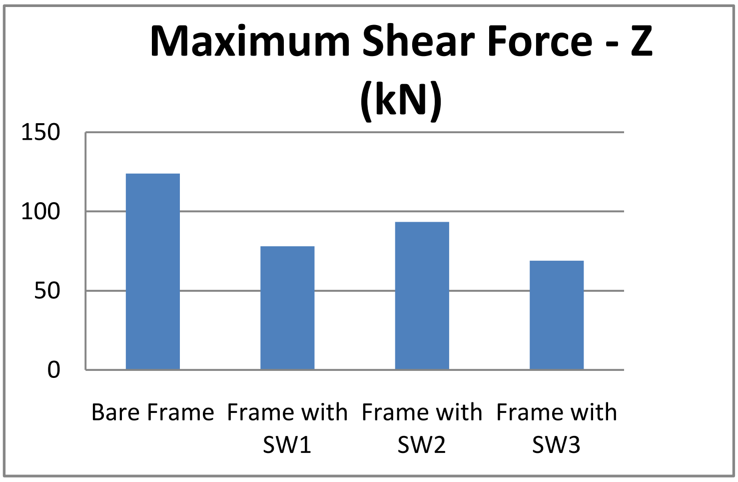


Fig. 4.7Maximum Shear Force in z-dir in kN

4.5Maximum Moment in y-dir/z-dir

The maximum moment for structures are presented in Table - 4.8,4.9

Table 4.8 Maximum Moment in y-dir(kNm)

Maximum Moment - Y (kN)	
Bare Frame	335.088
Frame with SW1	204
Frame with SW2	241.767
Frame with SW3	186.994

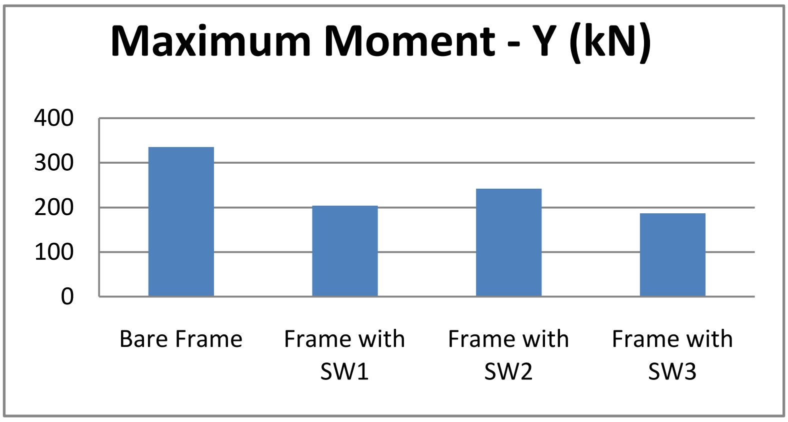


Fig. 4.8Maximum Moment in y-dir in kNm

4.5Maximum Moment in y-dir/z-dir

The maximum moment for structures are presented in Table - 4.8,4.9

Table 4.8 Maximum Moment in y-dir(kNm)

Maximum Moment - Y (kN)	
Bare Frame	335.088
Frame with SW1	204
Frame with SW2	241.767
Frame with SW3	186.994

Table 4.9 Maximum Moment in z-dir(kNm)

Maximum Moment - Z (kN)	
Bare Frame	265.439
Frame with SW1	121.498
Frame with SW2	93.765
Frame with SW3	67.874

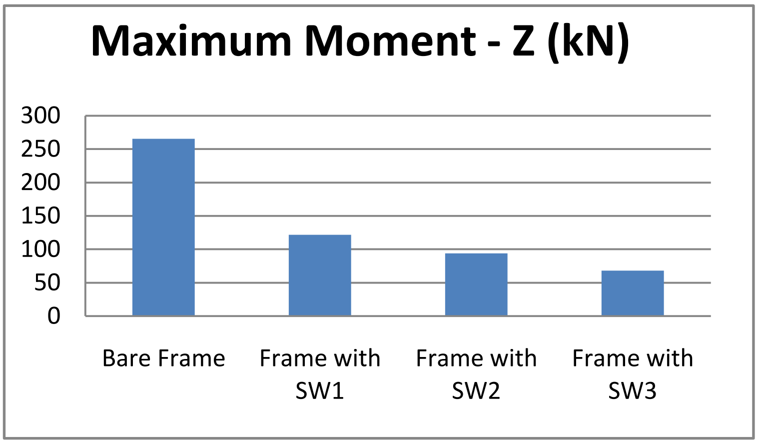


Fig. 4.9Maximum Moment in z-dir in kNm

4.6Mode vs Frequency and Time period

The mode vs frequency and time period for structures are presented in Table - 4.10,4.11,4.12,4.13

Table 4.10 Mode, Frequency and Time Period For Bare Frame

Mode	Frequency Hz	Period seconds	Participation X %	Participation Y %	Participation Z %	Type
1	1.32	0.758	85.545	0	0	Elastic
2	1.544	0.648	0	0	81.673	Elastic
3	1.563	0.64	0	0	0	Elastic
4	3.292	0.304	0	0	0	Elastic
5	3.995	0.25	0	0	0.011	Elastic
6	4.037	0.248	8.426	0	0	Elastic

Table 4.11 Mode, Frequency and Time Period For Frame with SW1

Mode	Frequency Hz	Period seconds	Participation X %	Participation Y %	Participation Z %	Type
1	2.02	0.495	0	0	72.651	Elastic
2	2.032	0.492	73.16	0	0	Elastic
3	2.87	0.348	0	0	0	Elastic
4	3.401	0.294	0	0	0	Elastic
5	4.222	0.237	0	0	0.776	Elastic
6	5.22	0.192	8.055	0	0	Elastic

Table 4.12 Mode, Frequency and Time Period For Frame with SW2

Mode	Frequency Hz	Period seconds	Participation X %	Participation Y %	Participation Z %	Type
1	2.001	0.5	0	0	70.245	Elastic
2	2.181	0.459	73.486	0	0	Elastic
3	3.216	0.311	0	0	0	Elastic
4	3.917	0.255	0	0	0	Elastic
5	4.407	0.227	0	0	0.145	Elastic
6	4.697	0.213	0	0	12.336	Elastic

Table 4.13 Mode, Frequency and Time Period For Frame with SW3

Mode	Frequency Hz	Period seconds	Participation X %	Participation Y %	Participation Z %	Type
1	1.502	0.666	0	0	0	Elastic
2	2.416	0.414	0	0	62.921	Elastic
3	2.812	0.356	69.603	0	0	Elastic
4	3.665	0.273	0	0	0	Elastic
5	4.547	0.22	0	0	0	Elastic
6	5.108	0.196	5.373	0	0	Elastic

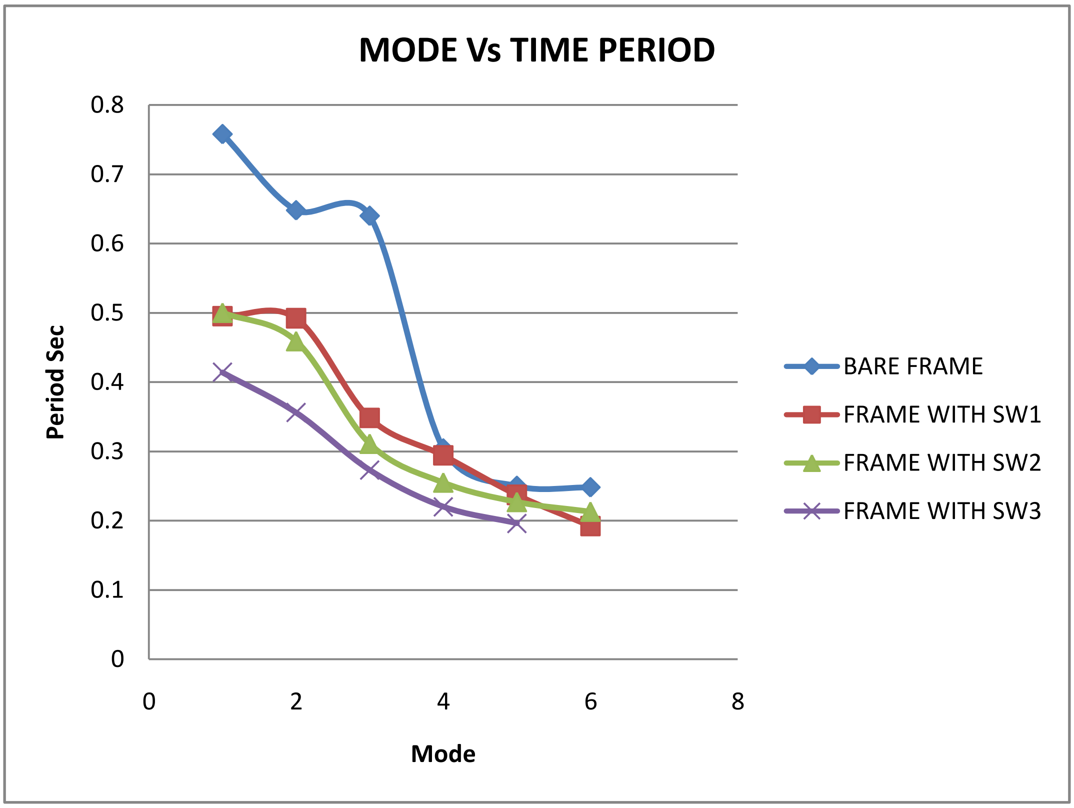


Fig. 4.11Comparision of Mode Vs Time Period

4.6MaximumStorywise Lateral Displacement in x-dir/z-dir

The maximum lateral displacement for structures are presented in Table - 4.14,4.15

Table 4.14MaximumStorywiseLateral Displacement in x-dir (mm)

Storywise Lateral Displacement (mm) in X-dir				
Story Ht (m)	Bare Frame	Frame with SW1	Frame with SW2	Frame with SW3
30	44.394	20.547	18.328	12.514
27	43.306	19.666	17.598	12.202
24	41.534	18.338	16.606	11.646
21	38.952	16.555	15.173	10.81
18	35.624	14.276	13.413	9.754
15	31.621	12.236	11.438	8.534
12	27.017	9.944	9.348	7.19
9	21.89	7.679	7.22	5.746
6	16.314	5.49	5.102	4.217
3	10.196	3.364	2.978	2.602
0	0	0	0	0

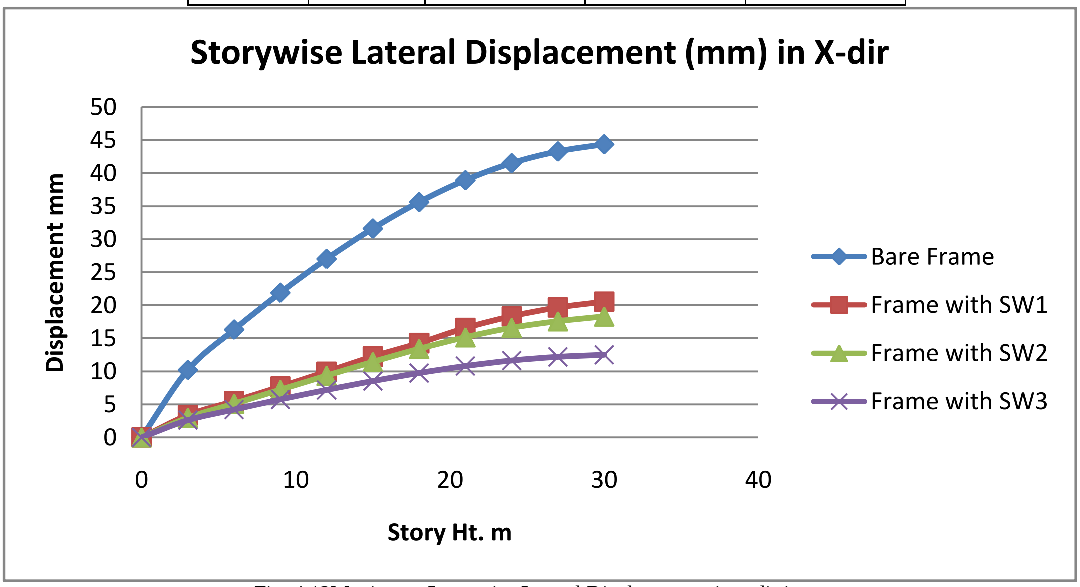


Fig. 4.12Maximum Story wise Lateral Displacement in x-dir in mm

Table 4.15 Maximum Story wise Lateral Displacement in z-dir (mm)

Story wise Lateral Displacement (mm) in Z-dir				
Story Ht (m)	Bare Frame	Frame with SW1	Frame with SW2	Frame with SW3
30	35.252	22.398	23.486	19.493
27	34.055	21.579	22.755	18.882
24	32.334	20.419	21.707	17.971
21	29.946	18.81	20.178	16.665
18	26.926	16.4	18.203	14.988
15	23.335	14.45	15.846	12.983
12	19.261	11.839	13.166	10.708
9	14.805	9.04	10.218	8.226
6	10.104	6.139	7.058	5.613
3	5.361	3.254	3.807	2.984
0	0	0	0	0

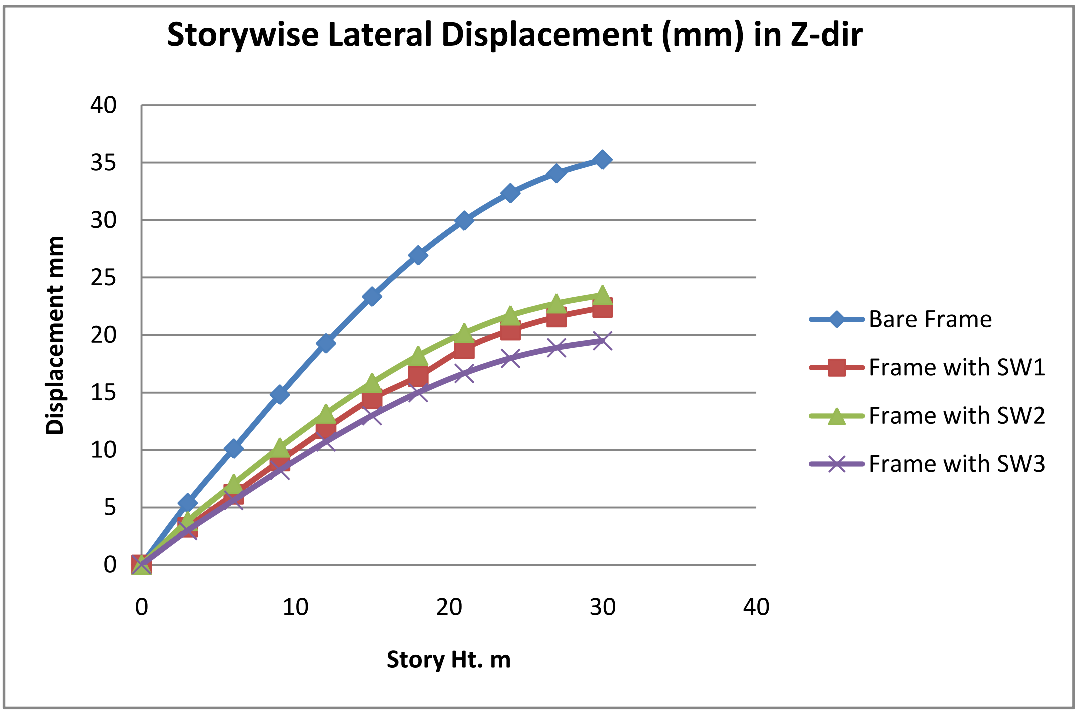
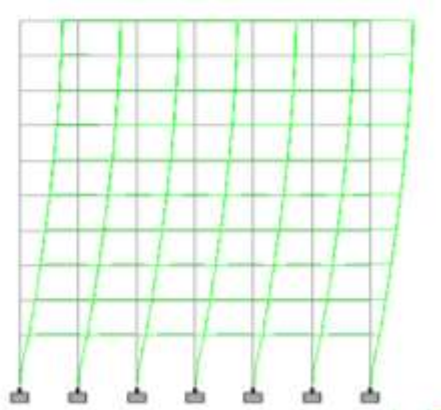


Fig. 4.13Maximum Storywise Lateral Displacement in z-dir in mm

4.2 Deflected shape of structures



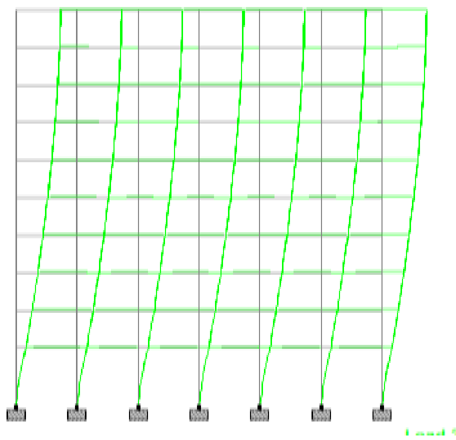


Fig. 4.14Deflected shape of Bare Frame in X-dir

Fig. 4.15Deflected shape of Bare Frame in Z-dir

ISSN: 2456-236X
Vol. 02 Issue 02 | 2018

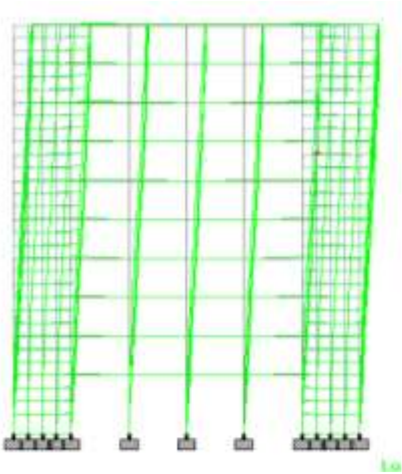


Fig. 4.16Deflected shape of Frame with SW1 in X-dir

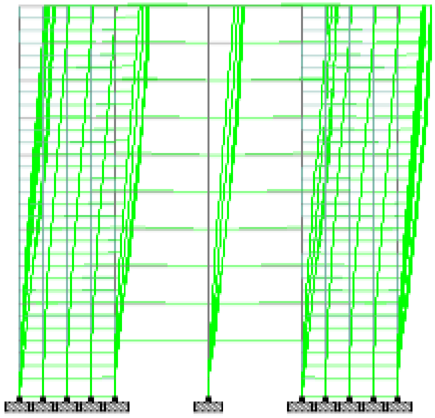


Fig. 4.17Deflected shape of Frame with SW1 in Z-dir

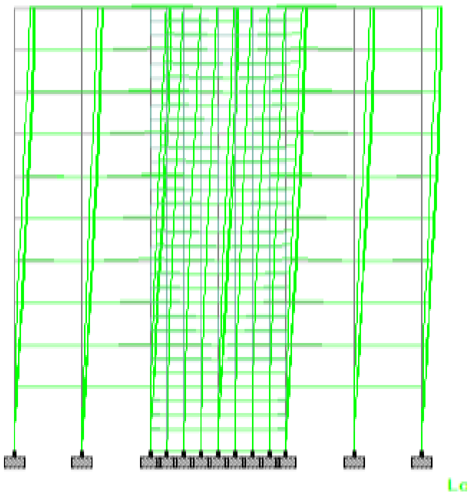


Fig. 4.18Deflected shape of Frame with SW2 in X-dir

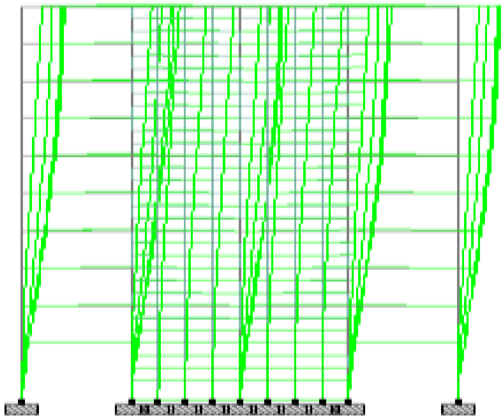


Fig. 4.19Deflected shape of Frame with SW2 in Z-dir

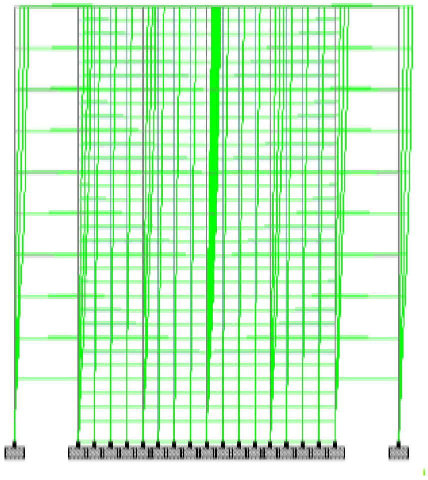


Fig. 4.20Deflected shape of Frame with SW3 in X-dir

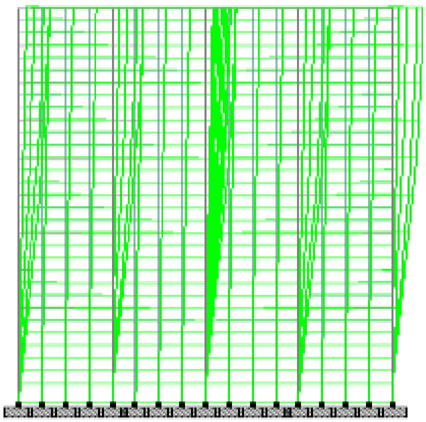


Fig. 4.21Deflected shape of Frame with SW3 in Z-dir

5. CONCLUSIONS

In this study, the analysis of multistoried buildings are done by STAAD PRO software using response spectrum analysis and we have got the following conclusions

1. In this study we concluded that time period decreases as the mode frequency increases for all model.
2. Maximum lateral displacement increases as storey height increases for all models.
3. Minimum lateral displacement of the building has been reduce due to the presence of shear wall placed at the center model 4 – SW3 compare to all models.
4. The maximum base shear observed in model 4 as compare to other models in x direction.
5. In y direction, the base shear is more in model 4 compare to other models.
6. The moment is minimum for model 4 as compare to other models.
7. Comparing the all models, maximum axial force is found to be in model 2.
8. Comparing the all models, maximum shearforce and moments are found to be in model 1.
9. Max. Displacements in type 2, 3,4 are reduced to 40 to 50 % as that of bare frame type.
10. Max. Base shear in type 2, 3,4 are reduced to 10 to 20 % as compare to bare frame type.
11. Max. Shear force in type 2, 3,4 are reduced to 30 to 50 % as that of bare frame type.
12. Hence, it can be said that building with type 3 shear wall is more efficient than all other types of shear wall.

6. FUTURE SCOPE

1. The study can be further extended to analysis of irregular building.
2. Irregular buildings with different position of shear wall can be analysed.
3. Analysis can be done by using software SAP 2000, ETAB etc.
4. Analysis can be carried out using time history method.
5. Comparison of Time history method and response spectrum method can be done.
6. Analysis can be doing with different soil conditions.
7. Analysis can be done with different ground slope.

7. REFERENCES

1. Solution of shear wall in multi-storey building", Anshuman, DipenduBhunia, BhavinRamjiyani, International journal of civil and structural engineering, Volume 2, no.2, 2011.
2. "Review on Shear wall for soft storey high rise building, MisamAbidi and MangulkarMadhuri N. ,International Journal of Civil and Advance Technology, ISSN 2249-8958,Volume-1,Issue-6, August 2012
3. "Effect of change in shear wall location on storey drift of multi-storey residential building subjected to lateral load", Ashish S. Agrawal and S. D. Charkha, International journal of Engineering Research and Applications, Volume 2, Issue 3,may-june 2012, pp.1786-1793.
4. "Configuration of multi-storey building subjected to lateral forces", M Ashraf, Z. A. Siddiqui, M. A. Javed, Asian journal of civil engineering ,vol. 9,no.5, pp. 525-535, 2008.
5. Shrikhande Manish, AgrawalPankaj(2010)."Earthquake Resistant Design of Structures." PHI Learning Private Limited New Delhi.
6. Duggal S K (2010), "Earthquake Resistance Design of Structure", Fourth Edition, Oxford University Press, New Delhi.
7. Haselton C B and Whittaker A S (2012), "Selecting and Scaling Earthquake Ground Motions for Performing Response-History Analyses", The 15th World Conference on Earthquake Engineering.
8. Romy M and Prabha C (2011), "Dynamic Analysis of RCC Buildings with Shear Wall", International Journal of Earth Sciences and Engineering, ISSN 0974- 5904, Vol. 04, 659-662.
9. Shaha V and Karve S (2010), "Illustrated Design of Reinforced Concrete Buildings", Sixth Edition, Structures Publication, Pune.
10. Wilkinson S and Hiley R (2006), "A Non- Linear Response History Model for the Seismic Analysis of High-Rise Framed Buildings", Computers and Structures, Vol. 84.
11. Watson-Lamprey, J.A. and N.A. Abrahamson (2006), "Selection of Ground Motion Time Series and Limits on Scaling", Soil Dynamics and Earthquake Engineering, 26(5) 477-482.