ANALYSIS OF HIGH RAISED RCC FRAME STRUCTURE STIFFNESS USING SHEAR WALL AND BRACING

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Abstract -In less space, more people can live and this can be achieved by high raised buildings. The main drawback in high raise buildings is in earthquake condition, the tall structure of the building gets damaged. In order to avoid such damage, we have to opt for an alternate option. In this present work, I have concentrated on seismic and response spectrum analysis. Initially problem was taken from reference article. To avoid the seismic damage, concentration is done on shear wall and bracings. Validation work was done using, theoretically in STAAD PRO software. Storey displacement, stiffness, lateral load on each storey and base shear are analyzed using seismic zone 2, 3, 4 and 5. As well as vibration analysis of G+9 RCC structure is implemented in present study.

Key Words**:** Seismic and spectrum Analysis, STAAD PRO, Storey Displacement.

1.INTRODUCTION

Most of the multi storey buildings in our country are not constructed in favor of seismic code due to various reasons like lack of awareness of damage due to earth quakes, economic considerations etc.But if suddenly severe earthquake occurs then maximum number of structures has a chance to collapse which are seismic deficient structures, which may leads to human loss and property loss. Generally the importance given to the structures is that it must safe against gravity loads. These structures can also take lateral loads up to some limit due to its strength and stiffness. Once the limit is crossed then the structure experiences displacements which makes the structure disturb, leads to damage weak structural elements which gives the way to collapse of structure. Some of the buildings could operate even for post-earth quake. Some there is a need to retrofit for post-earth quake with damage of structural elements, some may total collapse with human loss. If earth quake occurs then our structure must be able to resist earth quake loads and structure must at least life safe even it may not operational for further use. For this they are various retrofit techniques to resist lateral loads, Installation of steel bracing is the effective technique in those.

1.2 Objective of the Work

The main objective of this work is to reduce the displacements of the structure in the event of earth quake by introducing lateral resisting system. By Evolution of response of the structure with various bracing systems subjected to seismic loads and to identify the suitable bracing system for resisting seismic loads; which gives way in the reduction of human loss and property loss in the event of earth quake.

1.3 Description of the Model

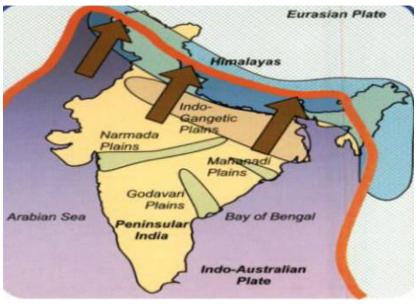
An n 9-story residential RC building is to be constructed in an area of seismic Zone IV having hard soil. The plan dimension of the building is 15m x 20m with storey height of 3.6m. Determine the base shear as per the IS:1893-2002 (Part 1) code. Use both seismic coefficient and response spectrum approach. Take the inter-story lateral stiffness of floors i.e. $k1=k2=k3=1326x10^6$ N/m,$k4=k5=k6=994.5x10^6$ N/m and k7=k8=k9 =663×106 N/m. The loading on the floors shall be taken as:

Location	SelfWeight+Dead load(KN/m^2)	Live Load(KN/m^2)
Roof	5	1.5
Floors	10	4

1.4 Material Property

Grade of Concrete	M30
Grade of Steel	Fe415
Young's modulus of M30 Grade Concrete	30×10^6 kN/m^2
Density of Reinforced Concrete	25 kN/m^3

India lies at the northwestern end of the Indo-Australian Plate, which encompasses India, Australia, a major portion of the Indian Ocean and other smaller countries. This plate is colliding against the hugeEurasian Plate (Figure 2.1) and going under the Eurasian Plate; this process of one tectonic plate getting under another is called subduction. A sea, Tethys, separated these plates before they collided. Part of the lithosphere, the Earth's Crust, is covered by oceans and the rest by the continents. The former can undergosubduction at great depths when it converges against another plate



1.5 Earthquake in India

A number of significant earthquakes occurred in and around India over the past century. Some of these occurred in populated and urbanized areas and hence caused great damage. Many went unnoticed, as they occurred deep under the Earth's surface or in relatively un-inhabited places. Some of the damaging and recent earthquakes are listed in (Table2.1).Most earthquakes occur along the Himalayan plate boundary (these are inter-plate earthquakes), but a number of earthquakes have also occurred in the peninsular region (these are intra-plate earthquakes). Four Great earthquakes (M>8) occurred in a span of 53 years from 1897 to 1950; the January 2001 Bhuj earthquake (M7.7) is almost as large. Each of these caused disasters, but also allowed us to learn about earthquakes and to advance earthquake engineering

Showing Maximum Earth Quakes in India

Date	Event	Time	Magnitude	Max. Intensity	Deaths
16 June 1819	Cutch	11:00	8.3	VIII	1,500
12 June 1897	Assam	17:11	8.7	XII	1,500
8 Feb. 1900	Coimbatore	03:11	6.0	X	Nil
4 Apr. 1905	Kangra	06:20	8.6	X	19,000
15 Jan. 1934	Bihar-Nepal	14:13	8.4	X	11,000
31 May 1935	Quetta	03:03	7.6	X	30,000
15 Aug. 1950	Assam	19:31	8.5	X	1,530
21 Jul. 1956	Anjar	21:02	7.0	IX	115
10 Dec. 1967	Koyna	04:30	6.5	VIII	200
23 Mar. 1970	Bharuch	20:56	5.4	VII	30
21 Aug. 1988	Bihar-Nepal	04:39	6.6	IX	1,004
20 Oct. 1991	Uttarkashi	02:53	6.6	IX	768
30 Sep. 1993	Killari (Latur)	03:53	6.4	IX	7,928
22 May 1997	Jabalpur	04:22	6.0	VIII	38
29 Mar. 1999	Chamoli	12:35	6.6	VIII	63
26 Jan. 2001	Bhuj	08:46	7.7	X	13,805

1.6 OBJECTIVES

Create computer models of building structures – Bracing and shear wall for investigation Study the effects of important parameters such as bracing and shear wall properties, locations and configuration of the shear wall, type f bracing and earthquake types This research was carried out using computer simulations. Finite element models of buildings was set up and analyzed under five earthquake excitations.

2. Literature Review

P.PChandurkar. did a detail study to determine the solution for shear wall location in multi-storey building with the help of four different models. The buildings were modeled using software ETAB Nonlinear v 9.5.0.After analysing ten storey building for earthquake located in zone II, zoneIII, zoneIV and zoneV essential parameters like lateral displacement, story drift and total cost required for ground floor were found in both the cases by replacing column with shear wall and conclusion was drawn that shear wall in short span at corner(model 4) is economical as compared with other models. It was observed that shear wall is economical and effective in high rise buildings and providing shear walls at adequate locations substantially reduces the displacement due to earthquake. If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall

Varsha R. Harne. Analysed a six storey building subjected to earthquake loading in zone II using STAAD

Pro andcalculated earthquake load using seismic coefficient method (IS 1893 Part II). Four different cases were analysed comprising of a structure without shear wall, structure with L type shear wall, structure with shear wall along periphery, structure with cross type shear wall. The lateral deflection of column for building with shear wall along periphery is reduced as compared to other types of shear walls .It was found that shear wall along periphery is most efficient among all the shear walls considered.

Anshuman S.et al .performed elastic and elasto-plastic analyses using STAAD Pro and SAP V 10.0.5(2000) on a fifteen storey building located in earthquake zone IV and calculated bending moment and storey drift in both the cases. Shear forces and bending moment were considerably reduced after providing shear wall. It was observed that the inelastic analysis performance point was small and within elastic limit therefore results obtained using elastic analysis are adequate.

Dr. B.Kameswarie t.al studied the drift and inter storey drift of a high rise structure for different configuration of shear wall panels and compared it with that of bare frame. The configurations considered are (1)Conventional shear walls(2)Alternate arrangement of shear walls(3)Diagonal arrangement of shear walls (4)Zigzag arrangement of shear walls(5)Influence of lift core walls. The zigzag arrangement of shear wall was found to be better than other configurations as it enhances the strength and stiffness of the structure by reducing the lateral drift and inter storey drift than other types of walls and is most effective in earthquake prone areas.

Shahabodin.Zaregairiziinvestigated on using shear wall and infill to improve seismic performance of existing buildings. On doing static analysis to compare effectiveness of both methods it was observed that concrete in-fills showed greater strength than brick one but brick in-fills accepted large displacement than concrete in-fills. So if they are used in combination their individual negative effects will be reduced.

Chun Ni et al studied the performance of shear wall with diagonal lumber sheathing by testing on 16 full scale shear walls and determining the effects of hold owns, vertical load and width of lumber sheathing on in plane shear capacity. The in plane shear capacities of shear walls with double diagonal lumber sheathing was found to be 2 - 3 times higher than that of shear walls with single diagonal lumber sheathing.

3. DESIGN PARAMETERS OF MULTI STOREY BUILDING

In this present work seismic analysis and response spectrum analysis is performed for different shape of multi storey building. Here to improve the resistance of earth quake displacement, three types of building shapes are considered. All beams, columns and slab sizes are tabulated as below.

Table 3.1 Shape and sizes of the building

	SQUARE SHAPE
BEAM SIZE	0.4 X 0.25
COLUMN SIZE	0.9 X 0.9
SLAB THICKNESS	0.15
SUPER DEAD LOAD	14 KN/m2
LIVE LOAD	5KN/m2
ROOF LOAD	1.5KN/m2
FLOOR AREA	600m2

Square shape building base shear calculation:

W1 = W2 = ………… W8 = total dead + super dead load + live load = 7200N.

W9 = total dead load + roof load = 3000N.

$V_b = A_h \times w$

$T_a = 0.075 \times (32.5)^{0.75} = 1.029$

$S_a/g = 1/1.029 = 0.9717$

$A_h = Z/2 \times I/R \times S_a/g = 0.16/2 \times 1/3 \times 0.9717 = 0.02591$

$V_b = 0.02591 \times 60600 = 1570.2$ Kn.

4. Analysis Of RCC Frame

In this chapter the underground retaining wall have been modeled and analyzed in Staad pro.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 03 | March-2021 ISSN: 2582-3930

PROCEDURE

- Open Staad pro
- Go to file and click on new model then dialog box will opens.

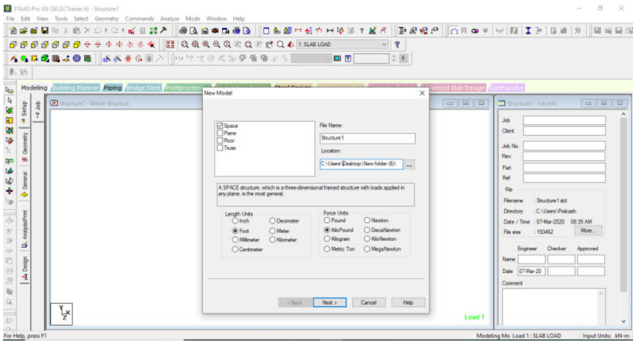


Figure 4.1: preference window.

In the above image shows select of preference, in this we can select the required models like space, plane, floor and truss etc.

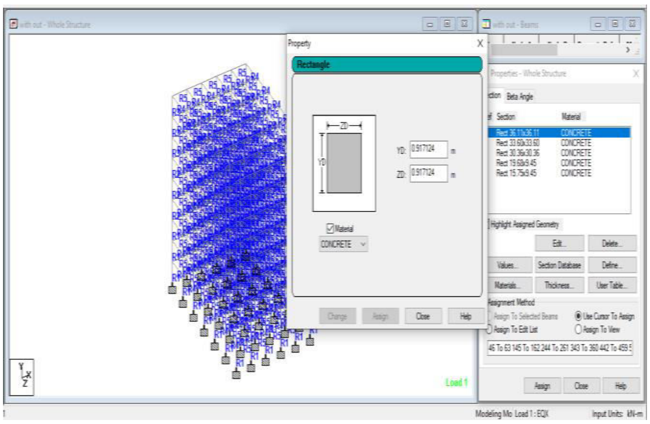


Fig: Figure 4.2: section selection window.

Here selection cross section is important for beam and column. Here concrete model has selected for both column and beams. Rectangular cross section is selected.

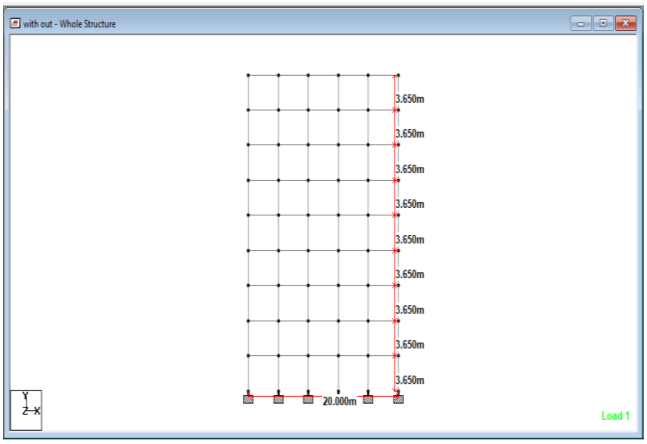


Figure 4.3: Elevation of RCC frame.

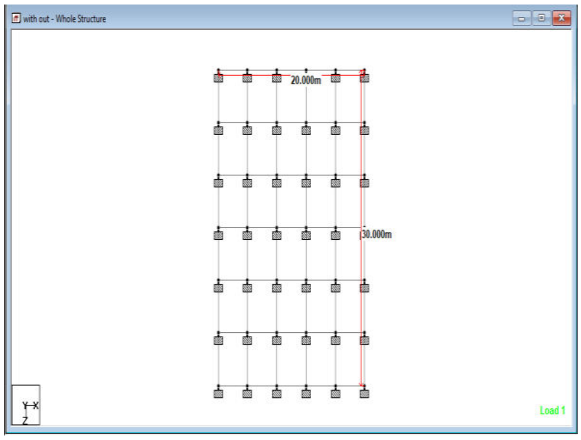


Fig 4.4:Plan of RCC frame.

The active earth pressure which is acting on the underground retaining wall, The active earth pressure acting on the different direction on the retaining wall .Which determine by the below diagram

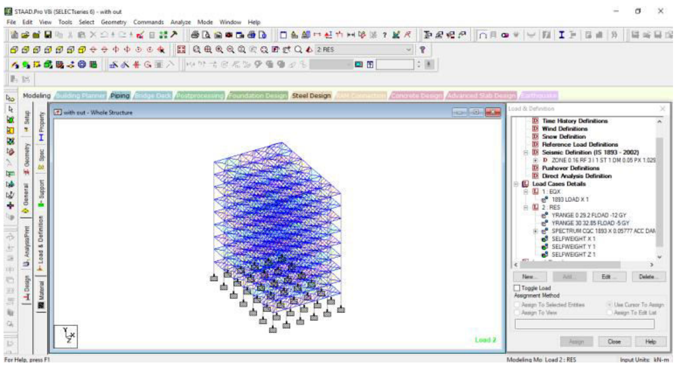


Fig 4.5: Live load and dead load on frame.

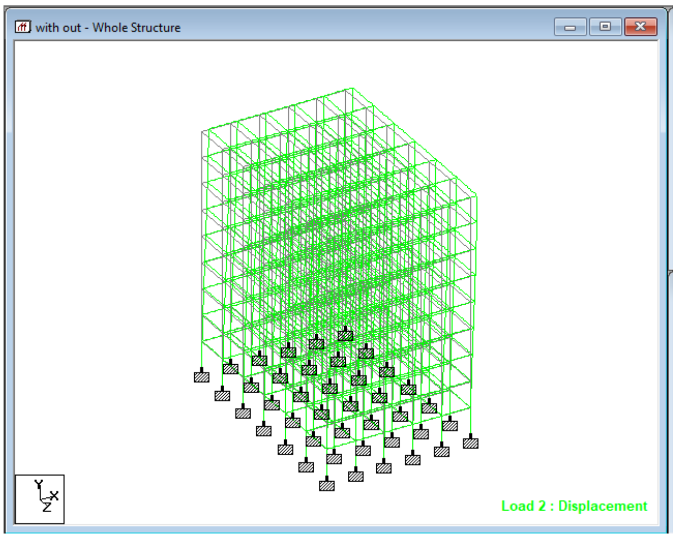


Fig 4.6: displacement of RCC frame

In the above image shows the total deformation of RCC frame wall. Combination load applied on entire structure and Maximum deformation occurs at the roof

.Minimum deformation appears at bottom of RCC frame and we can clearly able to see in the above image. All together maximum deformation is 30.713 mm.

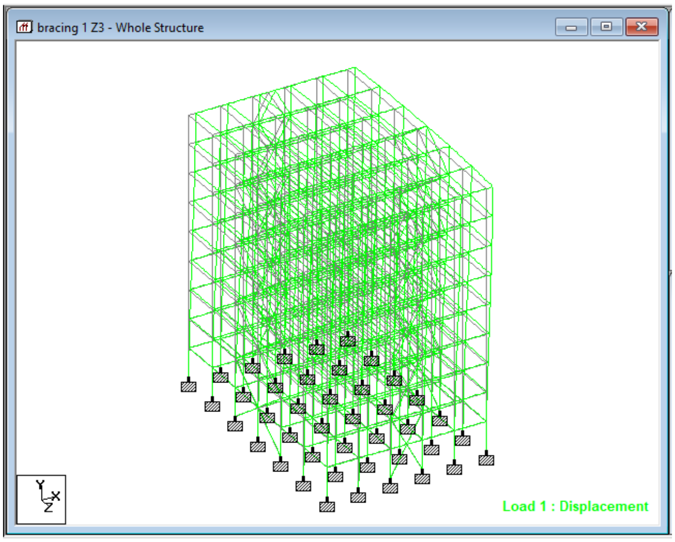


Fig 4.7: Displacements of RCC frame with bracing.

In the above image shows the total deformation of RCC frame with bracing. Combination load applied on entire structure and Maximum deformation occurs at the roof .Minimum deformation appears at bottom of RCC frame with bracing. And we can clearly able to see in the above image. All together maximum deformation is 24.56 mm.

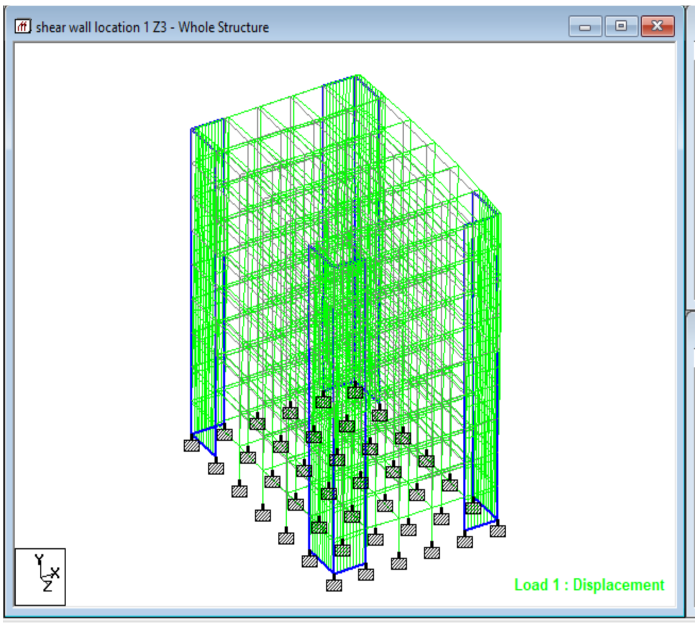


Fig 4.8: Displacement of RCC frames with Shear wall.

In the above image shows the total deformation of RCC frame with Shear wall. Combination load applied on entire structure and Maximum deformation occurs at the roof .Minimum deformation appears at bottom of RCC frame with Shear wall. And we can clearly able to see in the above image. All together maximum deformation is 14.8 mm.

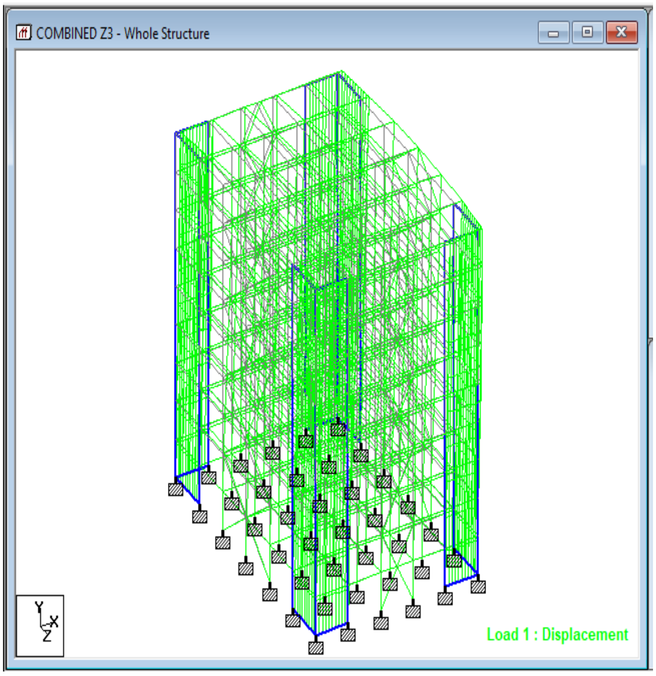
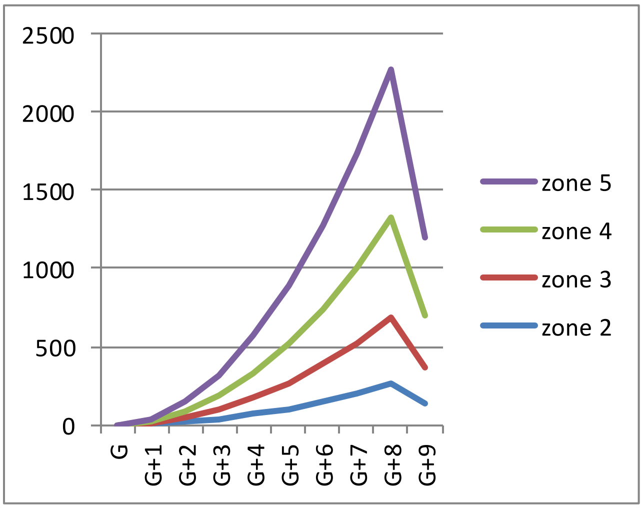


Fig 4.9: Displacements of RCC frame with bracing and Shear wall.

In the above image shows the total deformation of RCC frame with bracing and Shear wall. Combination load applied on entire structure and Maximum deformation occurs at the roof .Minimum deformation appears at bottom of RCC frame with bracing and Shear wall. And we can clearly able to see in the above image. All together maximum deformation is 13.32 mm.

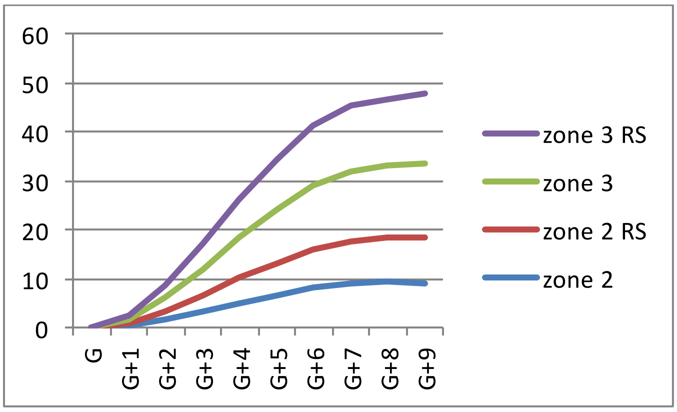
5. Results and discussion

In this work, seismic and response spectrum analysis is performed by considering the seismic zones II, III, IV and V. Here three types of RCC structures are considered. Initially RCC frame is prepared by reference problem in textbook. Results are validated with SAAD PRO software. Same loading consideration is taken in further analysis. X-type Steel bracing and Shear wall is placed in Same RCC structure, again analysis is performed to find out the best frame to resist the seismic effect. And results are plotted below.



Graph: Base shear of G+9 RCC frame.

The graph above represents the base shear on G+9 RCC frame. The x axis represents zone numbers and y axis represents base shear. The zones used are zone 2, zone 3, zone 4, and zone 5. The base shear increases the zones increases. And base shear is high on zone 5.



Graph: Base Moment of G+9 RCC frame.

The graph above represents the base moment on G+9 RCC frame. The x axis represents zone numbers and y axis represents base moment. The zones used are zone 2, zone 3, zone 4, and zone 5. The base moment increases the zones increases. And base moment is high on zone 5.

Table 5.1: lateral forces on G+9 Rcc frame

	zone 2	zone 3	zone 4	zone 5
G	0	0	0	0
G+1	4.12	6.61	9.9	14.85
G+2	16.503	26.4	39.6	59.4
G+3	37.131	59.4	89.11	133.67
G+4	66.01	105.6	158.42	237.64
G+5	103.14	165	247.54	371.3
G+6	148.52	237.63	356.45	534.68
G+7	202.15	323.45	485.1	727.7
G+8	264	422.47	633.7	950.558
G+9	139.24	222.78	334.18	501.27

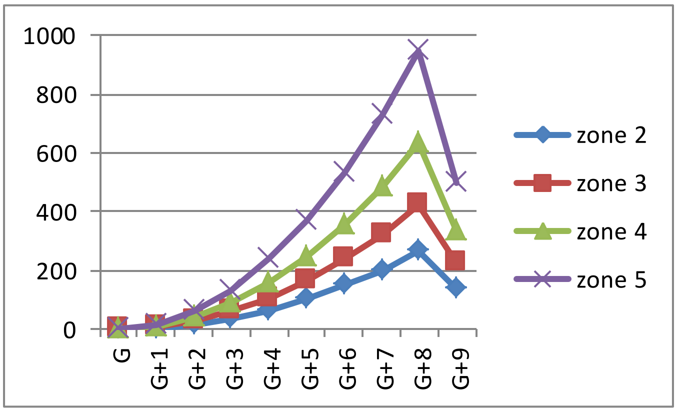


Table 5.9: Storey displacement on G+9 RCC frame with shear wall.

	zone 2	zone 2 RS	zone 3	zone 3 RS	zone 4	zone 4 RS
G	0	0	0	0	0	0
G+1	0.514	0.518	0.822	0.813	1.33	1.23
G+2	1.752	1.747	2.8	2.5	4.2	4.16
G+3	3.369	3.324	5.39	5.24	8.08	7.92
G+4	5.125	4.995	8.2	7.88	12.3	11.9
G+5	6.787	6.527	10.85	10.29	16.28	15.55
G+6	8.169	7.75	13.07	12.23	19.6	18.47
G+7	9.069	8.524	14.5	13.44	21.76	20.31
G+8	9.361	8.911	14.7	13.72	22.46	21
G+9	9.255	9.332	14.8	14.36	22.21	21.18

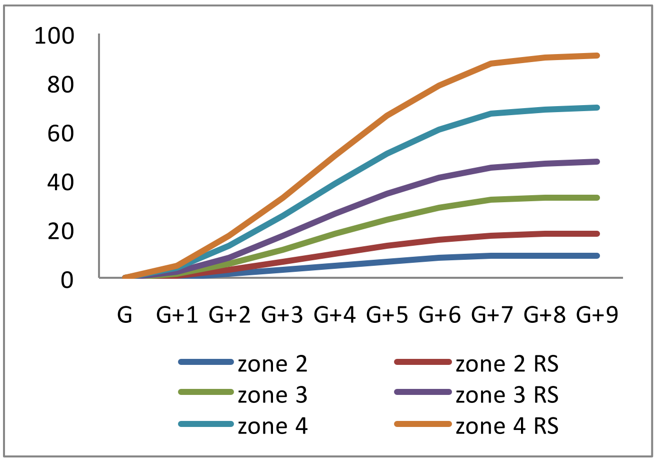
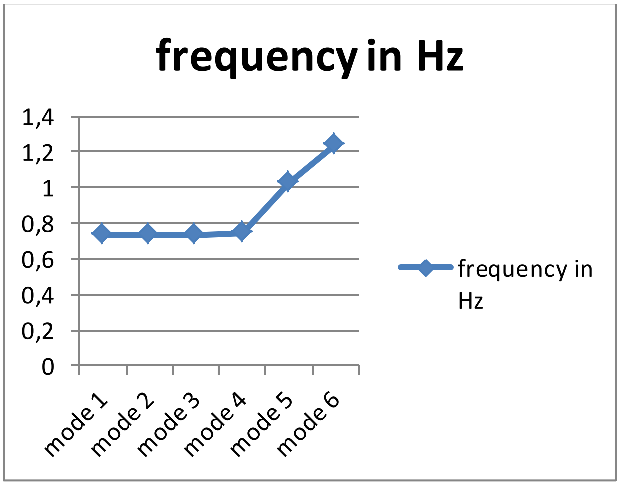


Figure 5.10: storey displacement on G+9 RCC framewith shear wall.

The graph above represents the storey displacement on G+9 RCC frame with shear wall. The x axis represents number of storey and y axis represents storeydisplacement. The zones used are zone 2, zone 2 RS, zone 3, zone 3 RS, zone 4, zone 4RS, zone 5 and zone 5 RS. The storey displacement increases when there is increase in storey. From the graph it is seen that the zone 5 has high storey displacement compared to others.



6. CONCLUSION

Initially, frame structure dimension and number of storey, frame structure floor area and number storey data are taken from reference article. In this a theoretical analysis has been done to find out the base shear and lateral forces on each storey. In this study same structure is crated in STAAD PRO and analysis has been done and the results are validated and have good agreement. The work is further extended to improve the structure stiffness by adding shear wall and bracing technique in RCC frame. Shear walls are placed at four corners of the building and bracings are placed at middle portion of four sides of the building. As well as, according to Indian earthquake codes, four types of zones are considered and implemented in current study for all type of geometrical structure. In this, if we increase the zone levels, the maximum storey displacement increases, due to this it results in damage. When compared with RCC frame without bracing and shear wall, the storey stiffness is improved by 55% due to bracings and 60% due to shear wall and bracings. As compared to seismic coefficient method, response spectrum analysis has less storey displacement. If we increase from zone 2 at zone 5, maximum storey displacement is increased by 66%. Finally we conclude that RCC frame with shear wall and bracings has important factor by improving structure stiffness and reduce the damage. This work is very useful to RCC frames in high earthquake risk zone locations.

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