iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** VIII **Month of publication:** August 2019

DOI: http://doi.org/10.22214/ijraset.2019.8013

Effect of Change in Location of Shear Wall in RC Irregular Building Subjected to Wind and Seismic Loading

Shashikumar S R[1], Prof. Vinayak Vijapur[2]
[1]P.G. Student, [2]Assistant Professor, Department of Civil Engineering, Govt engineering college, Devagiri, Haveri, Karnataka, India

Abstract: Shear walls are good structural vertical slandered member to resist the gravity and lateral forces in high raised structure. The slandered shear wall make more bending deformations to resists the load, due to cantilever action and controls the torsional effects at the high rise R C structure. In this study analysis is done by G+21 storey high raised irregular R C structure are located in the seismic zone IV in medium soil type and wind zone is class-C. These analysis is done five different models first model is plan without shear walls and core walls, second model is plan with core walls and without shear walls, and another three models is plan with core walls and optimum position of shear walls are modelled and analysed by using computer application software ETABS version 16.0.0 package. In this analysis is special moment resisting frame by equivalent static analysis method, using the seismic force are calculated as per IS1893 (part-1)-2002 and wind load are calculated as per IS875 (part-3)-1987, the results are shown in tables and graphical forms in the discussions.

Keywords: E-TABS, multi-storey structure, nodal displacement, storey drift, optimum position, lateral forces.

I. INTRADUCTION

Earthquake is to be sudden vibration of the earth crust, it is developed by the disturbance of the surface of the ground. Earthquake can develop in the parallel or perpendicular to the surface of the earth, the perpendicular earthquake do not cause more effects of the structure than the parallel earthquake. The parallel earthquakes are much greater than the perpendicular earthquakes. The force calculation of the earthquakes is corresponding to newton's second low f = m x a; where (f) is initial force, (m) is mass of the structure, (a) is ground acceleration. The building responds to the earthquake incident. Air movement on the surface of the earth. The initial cause of wind is drown to earth's rotation and modifications in terrestrial radiation. The radiation impacts are mainly responsible for convection each upwards and downwards. The wind usually blows parallel to the ground at extreme wind speeds. Since vertical constituents of atmospheric movements are relatively small, the name wind indicates almost entirely the horizontal, vertical winds are constantly identified as such. The wind speeds are calculated with time help of anemometers or anemography which are connected at meteorological observatories at heights usually varying from 10 to 30 meters above ground. In all events the calculating wind loads affect normal to the surface to which they direct. The construction of high rise R C buildings will have more effects of wind and seismic forces. The buildings will be subjected to lateral sway. To increase the strength, it is necessary to increase the dimensions of the structural members, if we increase the dimension of the members it becomes more expensive. In recommendation to above, they introduce for the construction for shear walls. The shear wall will act as a structural member to resist the lateral forces with economy, by providing the shear walls in the structure strength will be increase but its locations will be more important. The shear walls are generally provided in the high rise R C buildings. Hence the structure less in displacement and more stiffened, shear wall will be a slander member with an excellent resistant to impact, fire and other lateral loadings.

II. OBJECTIVE OF THE PROJECT

A. The main important objective of this study is to determine appropriate positions of shear walls by taking irregular structural plan.
B. To determine the appropriate positions of the shear walls, with the same cross sectional area on structural response under lateral loading.
C. To find parameters like storey stiffness, story displacement, base shear, and relative storey drifts.
D. To study the response for the torsion irregularities.
E. Finding optimum position for shear walls to counteract plan irregularities.
F. To know the behaviour of irregular structure subjected to seismic and wind loading considering for the time period, frequency and modal mass participating ratio, and stress resultants.

III. ARCHITECTURAL AND STRUCTURAL PARAMETERS CONSIDERED FOR ANALYSIS

Table 1. Model data

Sl.no	Data	Description
1	Structure	Special moment resisting frame
2	Dimension of building	30.864m X 20.060m
3	Number of storey	G + 21
4	Storey height	Ground floor – 3.5m. & 1st-21st floor – 3.0m
5	Grade of concrete and steel	M30 and Fe500
6	Thickness of slab	150mm
7	Beam size	300mm X 600mm
8	Column size	300mm X 700mm
9	Seismic zone	Zone-4
10	Soil type	Medium (type 2)
11	Importance factor	1
12	Response reduction factor	5
13	Live load	2 KN/m^2
14	Floor finishes	1.5 KN/m^2
15	Thickness of shear wall	200mm
16	Wall load	10.5 KN/m
17	Top storey	21st storey
18	Bottom storey	Basement
19	Building height (H)	66.5m

IV. MODELLING

In this study E-TABS is used to perform analysis and to develop 3D virtual models. In this investigations we considered five models of irregular building plan.

1) *Model 1:* Plan with beams and columns, without shear wall and core walls
2) *Model 2:* Plan with beams columns and lift core walls, without shear walls
3) *Model 3:* Plan with beams columns lift core walls and external corner shear walls
4) *Model 4:* Plan with beams columns lift core walls and internal corner shear walls
5) *Model 5:* Plan with beams columns lift core walls, internal and external corner shear walls

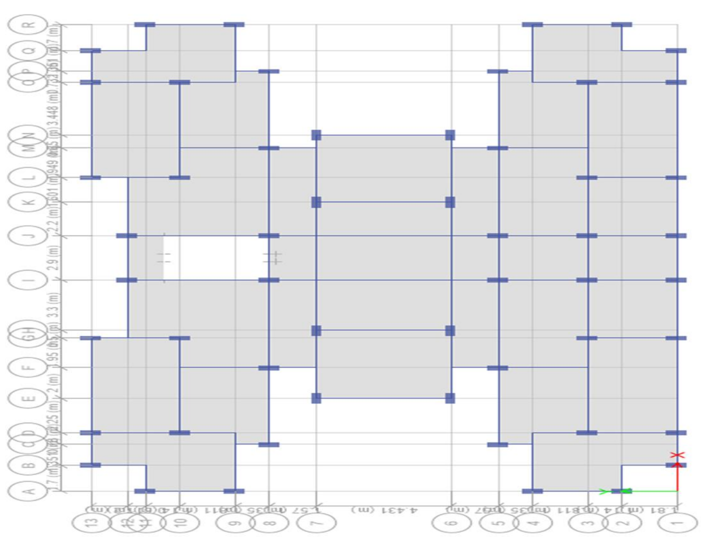

Fig.1: Model 1, plan without shear wall and core walls

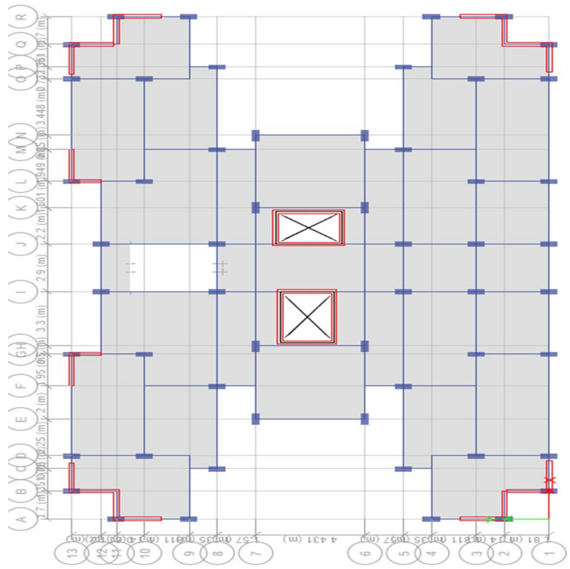

Fig.3: Model 3, plan with out side corner shear walls and core walls

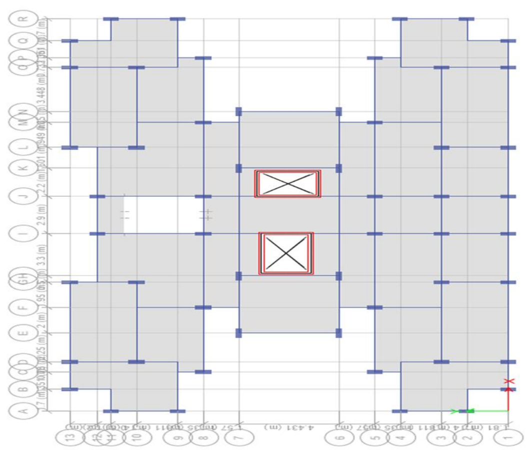

Fig.2: Model 2, plan without shear walls with core walls

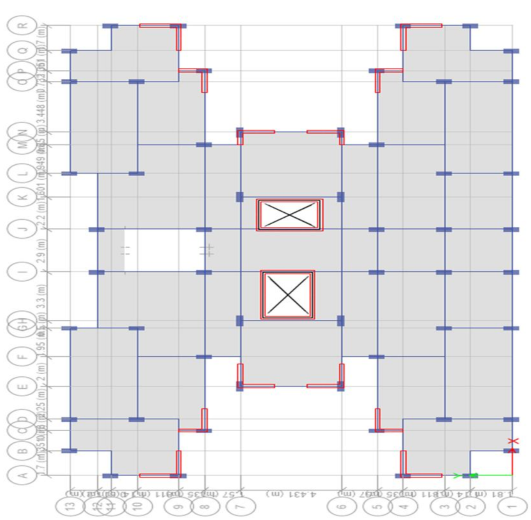

Fig.4: Model 4, plan with inside corner shear walls and core walls

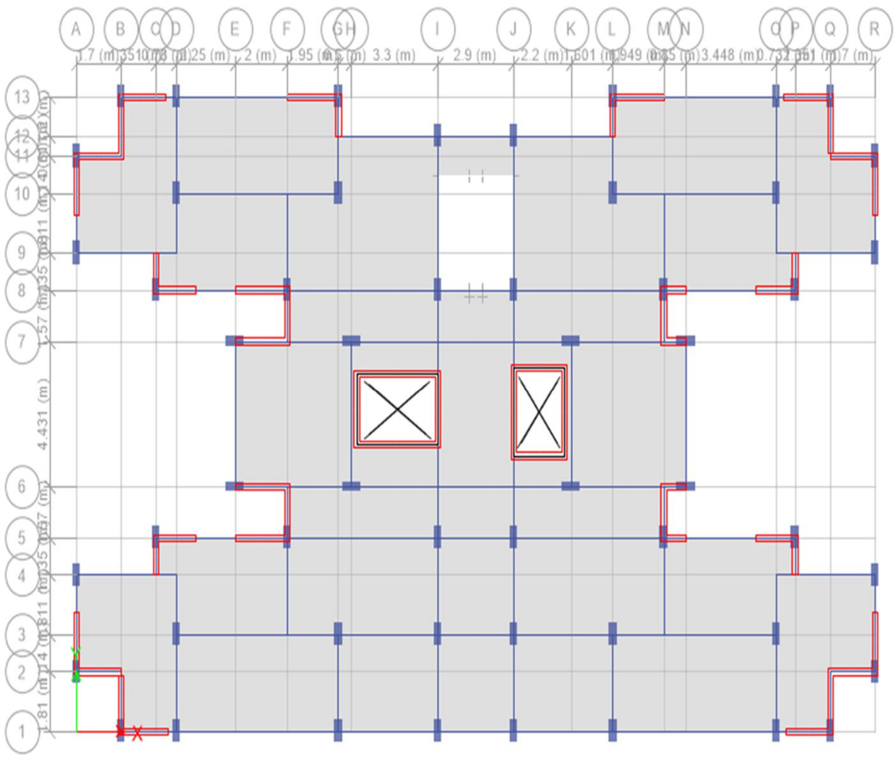

Fig.5: Model 5, plan with inside and outside corner shear walls and core walls

V. RESULTS AND DISCUSSIONS

A. Nodal Displacement

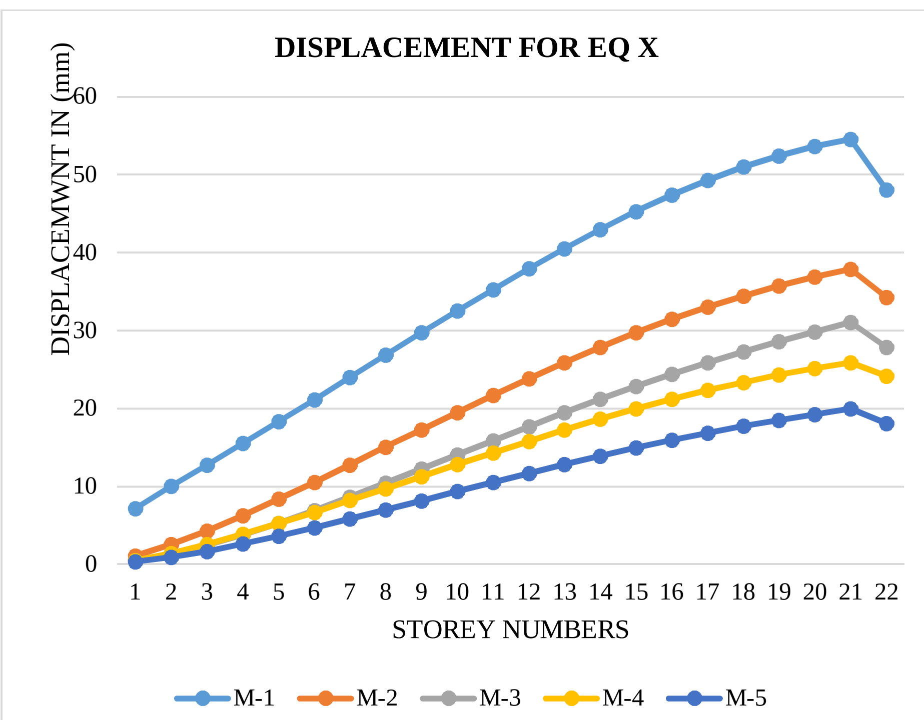

Fig.6: Graph showing Displacement for EQ X v/s all model storey numbers

Table.2: Showing Storey wise Nodal Displacement for EQ X

NODEL DISPLACEMENT FOR EQ X					
STORY	M-1	M-2	M-3	M-4	M-5
22	48.067	34.295	27.83	24.186	18.116
21	54.529	37.876	31.028	25.928	19.953
20	53.618	36.868	29.861	25.158	19.268
19	52.436	35.739	28.628	24.312	18.531
18	50.984	34.463	27.316	23.371	17.734
17	49.285	33.032	25.916	22.331	16.873
16	47.364	31.447	24.428	21.193	15.947
15	45.245	29.722	22.856	19.965	14.961
14	42.954	27.868	21.208	18.655	13.92
13	40.514	25.904	19.494	17.275	12.831
12	37.949	23.846	17.727	15.836	11.703
11	35.283	21.712	15.921	14.351	10.545
10	32.537	19.52	14.093	12.832	9.368
9	29.732	17.289	12.261	11.294	8.183
8	26.889	15.039	10.445	9.751	7.003
7	24.027	12.788	8.666	8.218	5.841
6	21.165	10.561	6.95	6.712	4.712
5	18.323	8.383	5.324	5.253	3.634
4	15.517	6.289	3.822	3.865	2.628
3	12.764	4.329	2.482	2.58	1.72
2	10.061	2.576	1.355	1.449	0.945
1	7.142	1.146	0.504	0.544	0.347

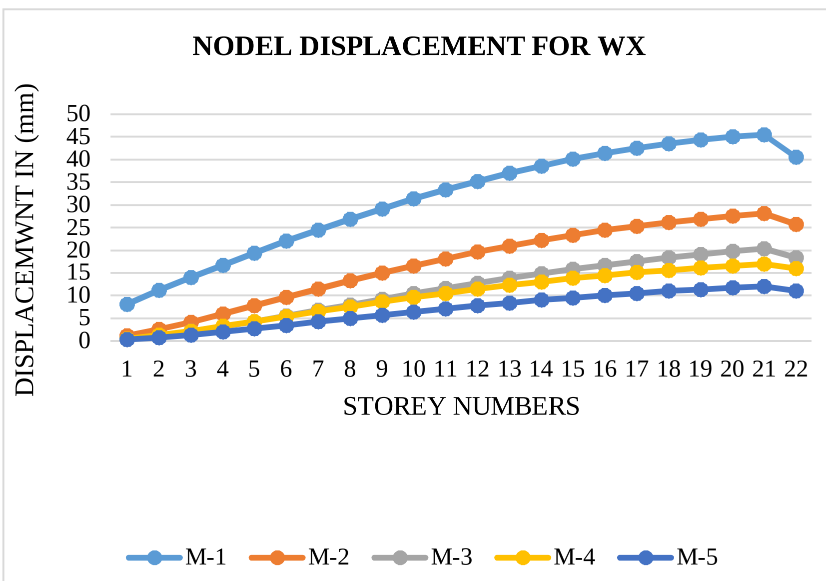

Fig.7: Graph showing Displacement for WX v/s all model storey numbers

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VIII, Aug 2019- Available at www.ijraset.com

Table.3: Showing Storey wise Nodal Displacement for WX

NODEL DISPLACEMENT FOR WX					
STORY	M-1	M-2	M-3	M-4	M-5
22	40.494	25.749	18.338	16.022	11.007
21	45.537	28.092	20.388	16.965	12.091
20	45.002	27.512	19.742	16.562	11.746
19	44.328	26.868	19.064	16.122	11.377
18	43.498	26.141	18.34	15.633	10.978
17	42.51	25.315	17.562	15.088	10.544
16	41.364	24.386	16.726	14.483	10.072
15	40.061	23.349	15.829	13.816	9.56
14	38.605	22.204	14.869	13.087	9.009
13	36.999	20.954	13.848	12.298	8.418
12	35.246	19.6	12.769	11.451	7.79
11	33.352	18.148	11.638	10.549	7.127
10	31.323	16.603	10.461	9.595	6.433
9	29.164	14.971	9.247	8.596	5.713
8	26.884	13.263	8.008	7.559	4.973
7	24.491	11.489	6.759	6.491	4.222
6	21.995	9.665	5.517	5.404	3.468
5	19.408	7.814	4.304	4.313	2.726
4	16.745	5.969	3.15	3.237	2.01
3	14.018	4.18	2.089	2.205	1.343
2	11.224	2.525	1.168	1.265	0.754
1	8.06	1.134	0.447	0.485	0.285

From the above Fig.6 and table.2 showing the variation of displacement v/s storey number and it shows the displacement in earthquake in X direction.

From the above Fig.7 and table.3 showing the variation of displacement v/s storey number and it shows the displacement in wind force in X direction.

B. Story Drift

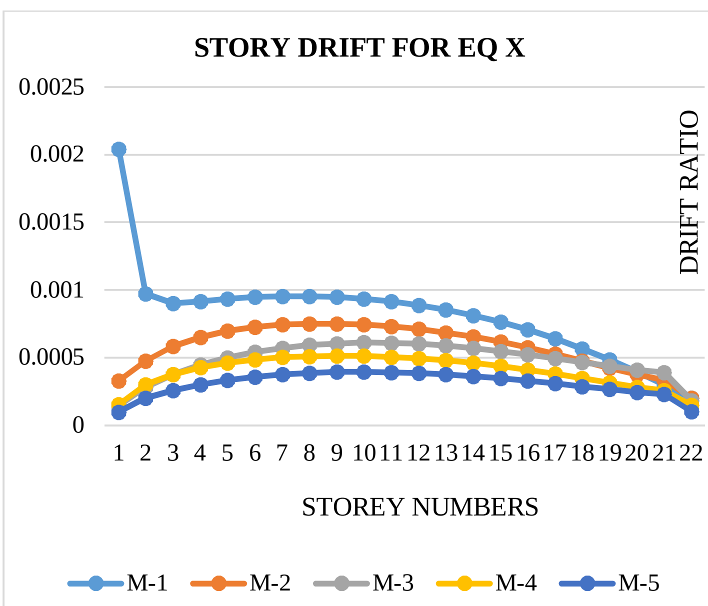

Fig.8: Graph showing drift for EQ X v/s all model storey numbers

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VIII, Aug 2019- Available at www.ijraset.com

Table.4: Storey drift for EQ X

STORY DRIFT FOR EQ X					
STORY	M-1 ($X10^{-4}$)	M-2 ($X10^{-4}$)	M-3 ($X10^{-4}$)	M-4 ($X10^{-4}$)	M-5 ($X10^{-4}$)
22	2.01	2.0	1.81	1.48	1.01
21	3.03	3.36	3.89	2.57	2.28
20	3.94	3.76	4.11	2.82	2.46
19	4.84	4.25	4.38	3.14	2.66
18	5.66	4.77	4.67	3.47	2.87
17	6.4	5.28	4.96	3.79	3.08
16	7.06	5.75	5.24	4.09	3.29
15	7.64	6.18	5.49	4.37	3.47
14	8.13	6.55	5.71	4.6	3.63
13	8.55	6.86	5.89	4.8	3.76
12	8.89	7.11	6.02	4.95	3.86
11	9.15	7.31	6.09	5.06	3.92
10	9.35	7.44	6.11	5.13	3.95
9	9.48	7.5	6.05	5.14	3.93
8	9.54	7.5	5.93	5.11	3.87
7	9.54	7.43	5.72	5.02	3.76
6	9.47	7.26	5.42	4.86	3.59
5	9.35	6.98	5.01	4.63	3.35
4	9.18	6.53	4.47	4.28	3.03
3	9.01	5.84	3.76	3.77	2.59
2	9.73	4.77	2.84	3.02	1.99
1	20.4	3.27	1.44	1.55	0.99

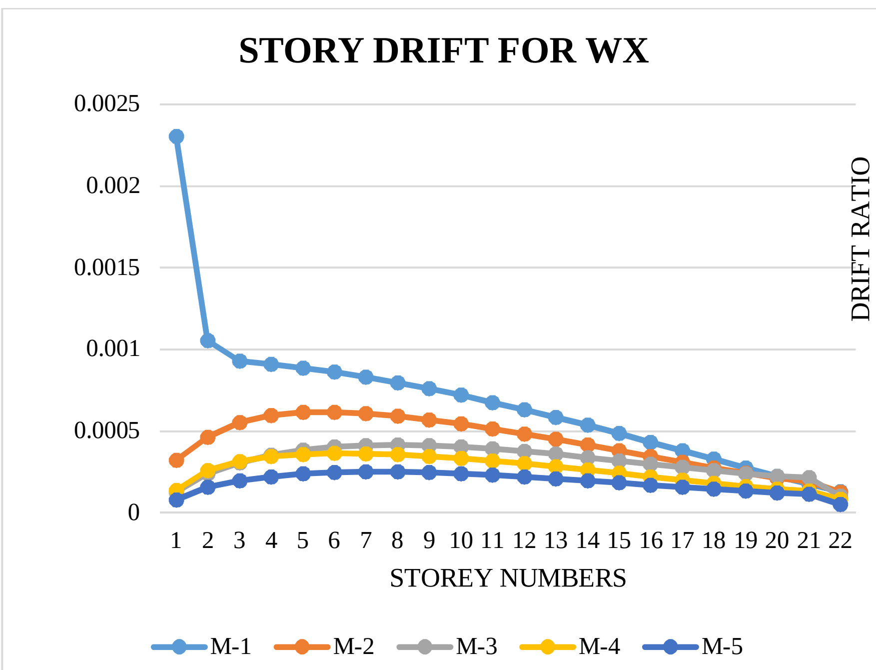

Fig.9: Graph showing drift for WX v/s all model storey numbers

Table.5: Storey drift for WX

STORY DRIFT FOR WX					
STORY	M-1 ($X10^{-4}$)	M-2 ($X10^{-4}$)	M-3 ($X10^{-4}$)	M-4 ($X10^{-4}$)	M-5 ($X10^{-4}$)
22	1.3	1.26	1.03	0.82	0.51
21	1.78	1.93	2.15	1.35	1.15
20	2.25	2.14	02.26	1.47	1.23
19	2.77	2.43	2.41	1.63	1.33
18	3.29	2.75	2.59	1.82	1.45
17	3.82	3.1	2.79	2.02	1.57
16	4.34	3.46	2.99	2.22	1.71
15	4.85	3.82	3.2	2.43	1.84
14	5.36	4.17	3.4	2.63	1.97
13	5.84	4.51	3.6	2.82	2.09
12	6.31	4.84	3.77	3.01	2.21
11	6.76	5.15	3.92	3.18	2.31
10	7.2	5.44	4.05	3.33	2.4
9	7.6	5.7	4.13	3.46	2.47
8	7.98	5.91	4.16	3.56	2.51
7	8.32	6.08	4.14	3.62	2.51
6	8.62	6.17	4.04	3.64	2.48
5	8.88	6.15	3.85	3.59	2.39
4	9.09	5.96	3.54	3.44	2.22
3	9.31	5.52	3.07	3.13	1.96
2	10.55	4.64	2.4	2.6	1.57
1	23.03	3.24	1.28	1.39	0.81

From the above Fig.8 and table.4 showing the variation of drift ratio v/s storey number and it shows the storey drift in earthquake in X direction.

From the above Fig.9 and table.5 showing the variation of drift ratio v/s storey number and it shows the storey drift in wind force in X direction.

C. Comparative Percentage (%) Variation in Displacements

Table.6: Nodal displacement compare to model-1

Load cases	EQ X		EQ Y		WX		WY	
Compare to M5	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)
M2	-	37.77	-	23.6	-	45.54	-	30.47
M3	-	52.65	-	32.45	-	63.75	-	47.68
M4	-	58.34	-	35.01	-	67.95	-	48.73
M5	-	68.96	-	39.72	-	78.03	-	56.38

There is a nominal decrease in nodal displacement in model-2 to model-5, when subjected to all types of loading in comparison with model-1, where there is a decrease of nodal displacement with maximum of 78.03% decrease in model-5 when subjected to WX loading in comparison with model-1 as shown in table 6.

Table.7: Nodal displacement compare to model-5

Load cases	EQ X		EQ Y		WX		WY	
Compare to M5	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)
M1	68.96	-	39.72	-	78.03	-	56.38	-
M2	50.12	-	21.1	-	59.66	-	37.26	-
M3	34.44	-	10.76	-	39.4	-	16.63	-
M4	25.49	-	7.24	-	31.45	-	14.92	-

The model-5 is better exhibiting a very positive response in reducing the displacement in compare with all other models. These model is maximum of 78.03% increase in model-1 for WX loading. As shown in table 7.

D. Comparative Percentage (%) Variation in Storey Drift

Table.8: storey drift compare to model-1

Load cases	EQ X		EQ Y		WX		WY	
Compare to M5	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)
M2	-	29.19	-	16.71	-	36.77	-	23.41
M3	-	41.77	-	22.6	-	53.92	-	38.52
M4	-	51.4	-	26.37	-	61.7	-	40.68
M5	-	62.66	-	31.87	-	72.74	-	49.34

The storey drift ratio for floors to floors are compered in table 8. The model-5 is better and maximum decrease in the story drift ratio the decreases ratio model-1 to model-5 is EQX-62.66%, EQY-31.87%, WX-72.74% and WY-49.34%.

Table.9: storey drift compare to model-5

Load cases	EQ X		EQ Y		WX		WY	
Compare to M5	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)
M1	62.66	-	31.87	-	72.74	-	49.34	-
M2	47.27	-	18.19	-	56.88	-	33.86	-
M3	35.87	-	11.97	-	40.83	-	17.61	-
M4	23.17	-	7.46	-	28.81	-	14.61	-

The storey drift ratio for floors to floors are compered in table 9. The model-5 is better and maximum decreases in the story drift ratio. Increases ratio model-5 to model-1 is EQX-62.66%, EQY-31.87%, WX-72.74% and WY-49.34%.

VI. CONCLUSIONS

A. The nodal displacement is greater in model-1 compare to other models, the model-1 is structure without core walls and shear walls and the other models are building with core walls and shear walls.
B. The optimum position of the shear walls in building decreases to the nodal displacement due to wind and earthquake forces.
C. Placing the shear walls at correct places significantly reduces the nodal displacement caused by lateral forces.
D. In that study, found the model-5 building shows lesser in nodal displacement compare to other models for lateral forces.
E. The storey drift ratio is more reduced by core walls and shear walls presence and proper positions in a building.
F. The storey drift ratio of model-1 building is maximum, Compare to the other models, model-5 building to be less drift ratio.
G. The storey stiffness is maximum in model-5, and lesser story stiffness in model-1.
H. In that study can be said that appropriate positions of core walls and shear walls results in good. And proper position of shear walls is useful and efficient performance of building subjected to wind and earthquake forces.
I. Results compare to the positions of shear walls in all five models, the model-5 is good and better performance for lateral forces.

REFERENCES

[1] WASEEM RAJA GANAI "The Effect of Change in the Seismic Stability of Tall RC Buildings by Changing the Position of Shear Walls". Vol.2, issue 2, ppi:(101-112) month : October 2014 - march 2015

[2] M.R SURESH "The optimum location of shear wall in high rise R.C building under lateral loading". eISSN: 2319-1163, pISSN: 2321-7308.

[3] ANIL BARAL "Seismic analysis of R.C framed building for different position of shear wall". Volume 4, Issue 5, 2015 May.

[4] TARUN MAGENDRE, "Optimum Positioning of Shear Walls in Multistorey Buildings" International journal of trend in research and development, volume 3(3), ISSN: 2394-9333, May-June 2016

[5] RAKSHIT PATIL, "Optimal location of shear wall in high rise building subjected to seismic loading", International Journal For Technological Research In Engineering Volume 3, Issue 10, ISSN: 2347 – 4718, June-2016

[6] UMESHA. N. KARADI, "Effect of change in shear wall location on storey drift of multi-storey building subjected to lateral loads" vol.2, issue 9, September 2013.

[7] SYLVIYA B, P. ESWARAMOORTHI, " Analysis of RCC Building with Shear Walls at Various Locations and In Different Seismic Zones", International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-2S December, 2018.

[8] Mr. MADHU SUDHAN RAO. KONDAPALLI, "Optimum location of a shear wall in a R.C building" international journal of scientific & engineering research, ISSN: 2229-5518, volume 9, issue 7, july-2018

[9] A MURALI KRISHNA, "Optimum Location of Different Shapes of Shear Walls in Unsymmetrical High Rise Buildings", International Journal of Engineering Research and Technology (IJERT), Issn: 2278-0181, Vol.3, Issue 9, Sept - 2014

[10] PREM SHANKAR SINGH. JAY KUMAR SAH. CHINMAY KUMAR KUNDU, "The optimum location of the shear wall in irregular plan multistorey RC frame structure under lateral loads" International Journal of Advance Research, Ideas and Innovations in Technology, ISSN: 2454-132X, Volume 4, Issue 2, 2018.

CODES / BOOKS

[11] IS: 875 (part-1) – 1987 design loads (except earth quake loads) for structures and buildings - dead loads.

[12] IS: 875 (part-2) – 1987 design loads (except earth quake loads) for structures and buildings - imposed loads.

[13] IS: 875 (part-3) – 1987 design loads (except earth quake loads) for structures and buildings - wind loads.

[14] IS: 1893 (part 1) – 2002 criteria for earthquake resistant design of structure.

[15] Pankaj agarval and Manish shrikandhe "earthquake resistant design of structure. Earthquake engineering department, IIT rookie.