Evaluation of Multi-Storey Building by Changing the Location of Shear Walls

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***Abstract*:- In this study the 15 storey building is considered with each storey height of 3m. These buildings are analysied and designed as per Indian Code of Practice for Seismic Resistant Design and for wind load calculation. For the buildings base supports are assumed to be fixed. The sections of structural elements like beams and columns are considered as square and rectangular shapes. Constant storey height is maintained for all storeys of the buildings are assumed to be constant including the ground storey. The buildings are modeled and analyzed using software ETAB Nonlinear V9.7.0.Seven different models are studied with and without shear wall at different position in the building.**

In the present study an attempt has been made to check the performance of high rise building with shear wall at the different position with seismic zone IV. Both Elastic static analysis and dynamic analysis (ESA) are carried out to compare the results

Keywords: Shear walls, Evaltion, Locations, Muti-storey

1. INTRODUCTION

A vertical plate like RC wall in reinforced concrete building, referred to as SHEAR WALL. Walls of the building are continuous throughout the height and usually start at foundation level. Shear walls acts a vertical oriented wide beams that carry earthquake loads downward to the foundation. Shear walls are provided along both length & width of building. Most RC building has columns with shear walls. These columns & shear walls carry lateral loads & gravity load respectively. Shear walls offer high strength & stiffness to building in the direction of their orientation, that considerably reduces damage to structure and its contents and thereby reduces lateral sway of the building. Shear wall buildings are typically regular in elevation and in plan. As a part of an earthquake resistant building design, under the earthquake load the lateral displacement is decreased by inserting the walls in building plans and shear wall structure can be obtained.

2.RC SHEAR WALL IN BUILDING

Shear walls should give the required lateral strength to resist horizontal earthquake forces. Shear walls are strong enough to transfer the horizontal forces to the other element in the load path under them. These other elements in the load path may be slabs, floors, foundation walls or footings.

Shear walls additionally give lateral stiffness to protect the floor or roof above from excessive side-sway. Shear walls are stiff enough to prevent the roof and floor framing members from sliding off their supports. Sufficiently stiff buildings typically suffer less non-structural harms.

RC shear walls gives great strength and stiffness to buildings within the direction of their orientation, that considerably reduces lateral sway of the building and therefore it decrease the structure damages. Due to the large horizontal force of earthquake on shear wall, the effect of overturning on shear wall will also be large. Therefore shear walls in buildings should be located symmetrically in plan to reduce ill-effects of twist in buildings. They can be placed symmetrically along both the directions of plan.

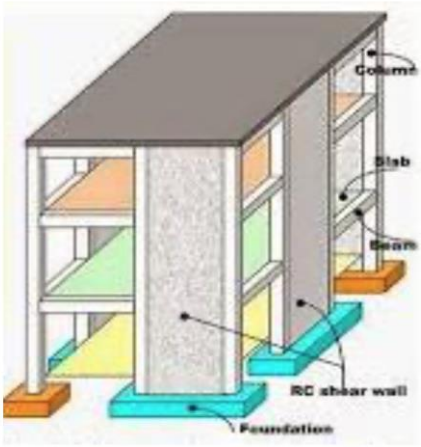


Fig 1. RC Shear Wall in Building

3.SEISMIC BEHAVIOUR OF SHEAR WALL

According to position of shear wall, the nature of stresses generation in the shear wall is different. Placing the shear wall at very near to the Centre of stiffness behave as a Vertical bending element and also the shear wall placing at corner of the building are can be in axial tension or in axial compression followed by the Lateral Force direction.

The drift generated is more compare to shear walls placed at the corner of the building. That's why it is important and necessary to consider the correct or optimum location of the shear walls in the structure that may helps to reduce the stresses in all the structural members of the structure.

4.METHODOLOGY

In this study the 15 storey building is considered with each storey height of 3m. These buildings are analysied and designed as per Indian Code of Practice for Seismic Resistant Design and for wind load calculation. For the buildings base supports are assumed to be fixed. The sections of structural elements like beams and columns are considered as square and rectangular shapes. Constant storey height is maintained for all storeys of the buildings are assumed to be constant including the ground storey. The buildings are modeled and analyzed

using software ETAB Nonlinear V9.7.0.four different models are studied with and without shear wall at different position in the building.

4.1.Model Details

Consider RC frame shear wall building of 15 stories with and without shear wall at different position for regular and irregular structure. Total of 4 models are considered for analysis: Model 1: Regular building without shear wall Model 2: Regular building with shear wall at position 1 (corners)
Model 3: Regular building with shear wall at position 2 Model 4: Regular building with shear wall at position 3 (centre)

4.2.Material Properties

-Modulus of elascity , $E_c = 5000\sqrt{f_{ck}}$

-Modulus of elascity for M30 – 27386 N/mm^2

- Modulus of elascity for M25 - 25000 N/mm^2

- Weight/unit volume of concrete - 25 kN/m^3

- Mass/unit volume of concrete - 2.55 kN/m^3

- Grade of steel – Fe 415

S.No	ELEMENTS	GRADE OF CONCRETE
1	COLUMN	M25
2	BEAM	M25
3	SLAB	M25
4	SHEAR WALL	M30

Table.1 Grade of Concert

4.3.Sizes of the Members

The details and the sizes of the members will be clarified clearly in the table below:

S.No	Specifications	Size
1	Dimensions for Plan	30 m x 30 m (X*Y)
2	Length along X-direction	30 m (6 Bays)
3	Length along Z-direction	30 m (6 Bays)
4	storey height	3.0 m
5	Plinth Level	1.7 m
6	Building height (G+15)	46.7 m
7	Thickness of Slab	150 mm
8	Beam dimensions	0.35 m x 0.45 m
9	Column dimension	0.35 m x 0.60 m
10	Shear wall size	150 mm

Table.2 Specification of members

4.4. Figures of models

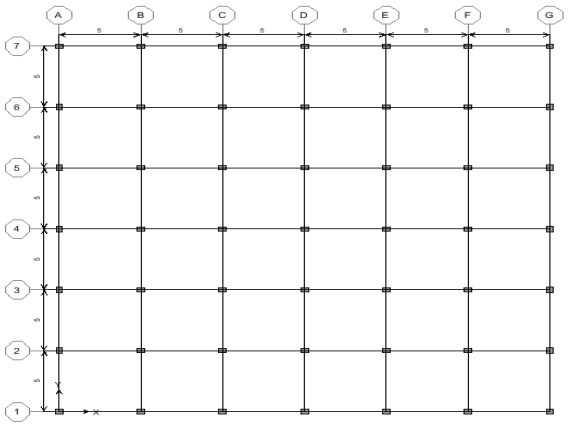


Fig.1.Model 1: Regular Building without Shear Wall

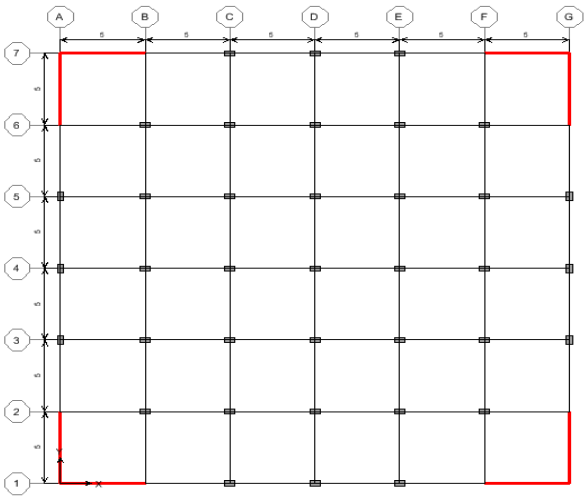


Fig.2.Model 2: Regular Building with Shear Wall at Position 1 (corners)

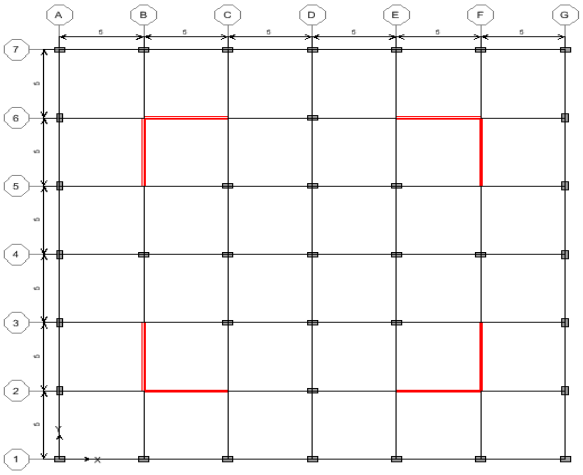


Fig.3.Model 3: Regular Building with Shear Wall at Position 2

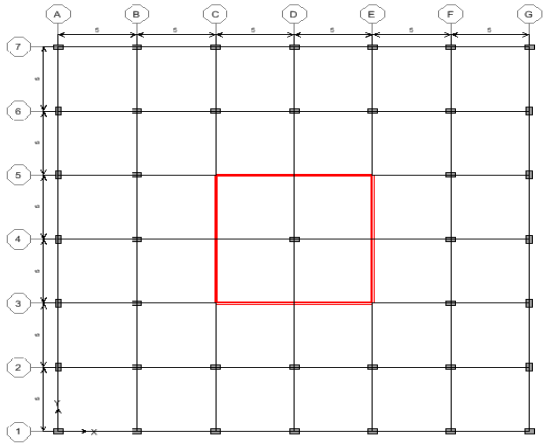


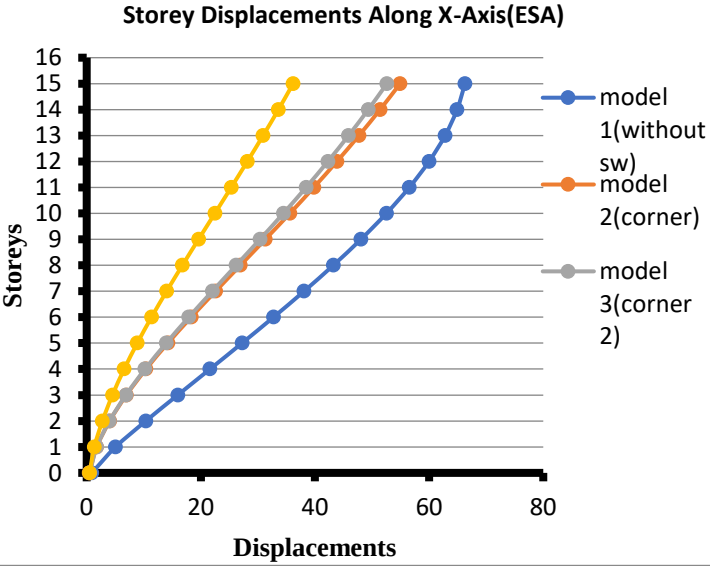
Fig.4.Model 4: Regular Building with Shear Wall at Position 3 (center)

5.RESULTS AND DISCUSSION

To study the response of lateral load effect on structure we used RC frame 15 storied regular and irregular building with shear wall at different location for seismic zone IV and wind load.

Lateral Storey Displacement for Building in X-Direction for Elastic Static Analysis (ESA):

STOREY DISPLACEMENT (mm) – ESA				
STOREYS	**model 1**	**model 2**	**model 3**	**model 4**
TERRACE	66.2879	54.9242	52.6011	36.1676
STORY14	64.8978	51.4099	49.3385	33.6024
STORY13	62.7989	47.7079	45.8852	30.9126
STORY12	59.9823	43.8372	42.2536	28.1465
STORY11	56.5244	39.794	38.4393	25.3202
STORY10	52.5177	35.6012	34.4637	22.4606
STORY9	48.0538	31.2975	30.3642	19.5986
STORY8	43.2183	26.9363	26.1925	16.7691
STORY7	38.0892	22.5834	22.0122	14.0099
STORY6	32.7371	18.3157	17.8983	11.3614
STORY5	27.2253	14.2213	13.9365	8.8662
STORY4	21.6121	10.3995	10.2239	6.5688
STORY3	15.9594	6.9619	6.8702	4.5153
STORY2	10.363	4.0351	4.001	2.755
STORY1	5.0666	1.7651	1.7621	1.3374
GF	0.8984	0.474	0.538	0.501

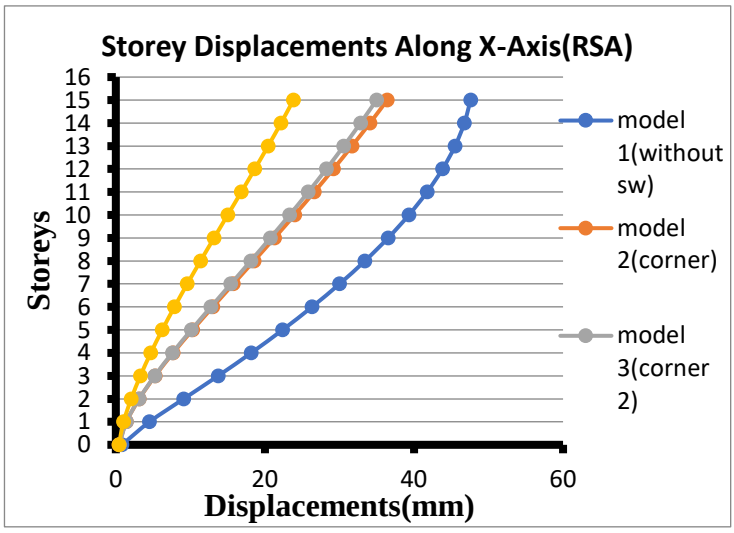


Above fig shows displacement v/s no. of storeys for regular and irregular model having shear wall at different location along X-direction for seismic zone IV and wind load, analyse is carried out for Elastic Static Analysis (ESA).From graph plotted indicates that:

1) The maximum displacement along X-direction for regular structure without shear wall is 66.29mm
2) The maximum displacement along X-direction for regular structure with shear wall at position 1 (corner) is 54.92mm
3) The maximum displacement along X-direction for regular structure with shear wall at position 2 is 52.60mm
4) The maximum displacement along X-direction for regular structure with shear wall at position at position 3 (centre) is 36.17mm

Lateral Storey Displacement for Building in X-direction for Response Spectrum Analysis (RSA)

STOREY DISPLACEMENT (mm) – RSA				
STOREYS	**model 1**	**model 2**	**model 3**	**model 4**
TERRACE	47.5969	36.4151	34.9802	23.8291
STORY14	46.76	34.0971	32.831	22.1649
STORY13	45.5097	31.6835	30.5822	20.4273
STORY12	43.833	29.1922	28.2465	18.6476
STORY11	41.759	26.6211	25.8207	16.835
STORY10	39.3161	23.9787	23.3125	15.005
STORY9	36.529	21.2771	20.7334	13.1743
STORY8	33.4205	18.5325	18.0995	11.361
STORY7	30.0118	15.766	15.4321	9.5843
STORY6	26.3226	13.0074	12.7607	7.8653
STORY5	22.3703	10.2981	10.1268	6.2269
STORY4	18.1669	7.6956	7.5871	4.6942
STORY3	13.7242	5.277	5.2178	3.2958
STORY2	9.098	3.143	3.119	2.065
STORY1	4.5202	1.4223	1.4183	1.0381
GF	0.8109	0.4124	0.4708	0.4174



Above Fig shows displacement v/s no. of storeys for regular and irregular model having shear wall at different location along X-direction for seismic zone IV and wind load, analyse is carried out for Response Spectrum Analysis (RSA).From graph plotted indicates that:

1) The maximum displacement along X-direction for regular structure without shear wall is 47.60mm
2) The maximum displacement along X-direction for regular structure with shear wall at position 1 (corner) is 36.42mm
3) The maximum displacement along X-direction for regular structure with shear wall at position 2 is 34.98mm
4) The maximum displacement along X-direction for regular structure with shear wall at position at position 3 (centre) is 23.83mm

6.CONCLUSIONS

1. Shearwall affects the stiffness of the structure , walls increase the strength to the structure to resists the lateral forces by increasing the performance of the structure.

2.Storey displacement, has been reduced for all structures with shear walls in the middle as compared to corner for regular structure.

3.The maximum lateral storey displacement exists at the terrace level for all types of structures.

REFERENCES

[1] *BurucBurak and HakkiGurhanComlekoglu (2013)* ,"Effect of Shear Wall Area to Floor Area Ratio on the Seismic Behavior of Reinforced Concrete Buildings.", Journal of Structural Engineering © ASCE,Volume139, ISSN: 0733-9445.

[2] *Ahmet Tuken and Nadeem A. Siddiqui (2012)* ,"Assessment of ShearWall Quantity in Seismic-Resistant Design of Reinforced Concrete Buildings" Department of Civil Engineering, King Saud University,springer

[3] *IlkerFatih Kara and Cengiz Dundar (2009)* ,"Prediction of deflection of reinforced concrete shear walls" ,ELESVIER.

[4] *Hyun-Su Kima , Dong-Guen Lee and Chee KyeongKimb (2005)* ,"Efficient Three-Dimensional Seismic Analysis of a High-Rise Building Structure with Shear walls",Engineering Structure, ELESVIER.

[5] *Adrián Beko, Peter Rosko, Helmut Wenzel, Pierre Pegon, Damijan Markovic and Francisco Javier Molina(30 July 2015),* "RC shear walls: Full-scale cyclic test, insights and derived analytical model", Engineering Structure, ELESVIER.

[6] *Jinhan Kwon and Wassim M. Ghannoum (2016)* , "Assessment of international standard provisions on stiffness of reinforced concrete moment frame and shear wall buildings" Engineering Structure, ELESVIER.

[7] *Farid Chalah, Lila Chalah-Rezguia ,KamelFaleka , Salah Eddine Djellaba and Abderrahim Bali(2014)* , "Fundamental Vibration Period of SW Buildings",Science Direct, ELESVIER.

[8] *P.V. Sumanth Chowdary and Senthil Pandian. M (2014)* , "A Comparative Study on RCC Structure with and without Shear wall", International Journal for Scientific Research & Development (IJSRD) , Vol. 2, ISSN : 2321-0613.

[9] *Prof. Jayasree Ramanujan, Mrs. Bindu Sunil , Dr. LajuKottalliland Prof. Mercy Joseph Poweth (2014)* , "Effect of Shear Wall Location in Buildings Subjected to Seismic Loads", ISOI Journal of Engineering and Computer science,Volume 1 Issue 1; Page No. 07-17.

[10] *N. Janardhana Reddy, D. GosePeera and T. Anil Kumar Reddy(2015)* ,"Seismic Analysis of Multi-Storied Building with Shear Walls Using ETABS-2013" International Journal of Science and Research (IJSR), Volume 4, ISSN: 2319-7064.