SEISMIC ANALYSIS OF RC MULTI-STORIED STRUCTURES WITH SHEAR WALLS AT DIFFERENT LOCATIONS

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Abstract -*Shear wall is an basic important structural component. These walls can be utilized for giving more strength & safety to the structure, when the structures are subjected to external loads, such as earthquake loads, wind loads etc. the these type of walls , basically play a main role for the construction of tall structure. In the present study, the buildings with different number of stories i.e, 20 storie building is considered for the investigation of structure. These buildings are assumed to be situated in zone IV. These are analyzed by changing the positions of shear walls symmetrically by considering different shape and locations of the shear walls in buildings.*

Key Words: *Shear wall, ETABS, different shape & locations, Equivalent static method, response spectrum analysis, time history analysis,*

1. INTRODUCTION

1.1 General

Seismic waves reasons arbitrary ground motions in all possible directions, transmitting from the epicentre. If the structure has not been designed to resist these additional forces it may fail causing loss of life and property. In this way the impacts of sidelong loads like wind loads, quake forces & impact loads, etc. are achieving growing significance and every design engineer will face the issue of giving sufficient strength & stability for the structures against the imposed total lateral loads.

1.2 Shear wall

Shear walls are utilized to withstand the bending moments of a building, because of lateral loads. They act as vertical cantilevers to give the essential stiffness in a building. Shear deformation are of course present but are negligible compared to bending wall rather than a shear wall. They are usually given between columns, in stairs, lift walls, etc, in the structures under seismic forces. However since recent observations have shown consistency the excellent performance of building with shear walls under seismic forces, such wall are now extensively used for all earthquake resistance designs.

2. METHODOLOGY

To determine the basic components like displacement and base shear this analysis has been carried using the software ETABS V 9.7.1. for the analysis purpose Equivalent static method, Response spectrum method and time history methods are adopted.

2.1 BUILDING MODELING

In this building model RC multi storied structures of 20 stories is considered with shear walls of different locations like L shape, Rectangular shape, semi core and bare frame.the bottom stories height is 4.4m and the rest stories means upper stories' height is kept constant as 3.2m for the building models, properties of the considered building models are detailed below here.

2.2 Material Properties

The materials used for analysis of building models construction is reinforced concrete with m-25grade of concrete and fe-415 grade of steel. and the stress-strain relationship is used as per is 456:2000.

the basic material properties are in given table 1.

Material Properties	Values
Characteristic strength of concrete, f_{ck}	25 MPa
Yield stress for steel, f_y	415 MPa
Modulus of Elasticity of steel, E_s	20,0000 MPa
Modulus of Elasticity of concrete, E_c	25000 MPa

2.3 SECTION PROPERTIES:

The section properties of four storied building model are given in table 2.

Thickness of slab	0.15 m
Beam size	0.25 x 0.45 m
Column size	0.45 x 0.45 m
Thickness of wall	0.23 m
Thickness of shear wall	0.15 m
Assumed dead load intensities	
Roof finishes	1 kN/m^2
Floor finishes	1 kN/m^2
Live load intensities	
Roof	1.5 kN/m^2
Floor	3.0 kN/m^2

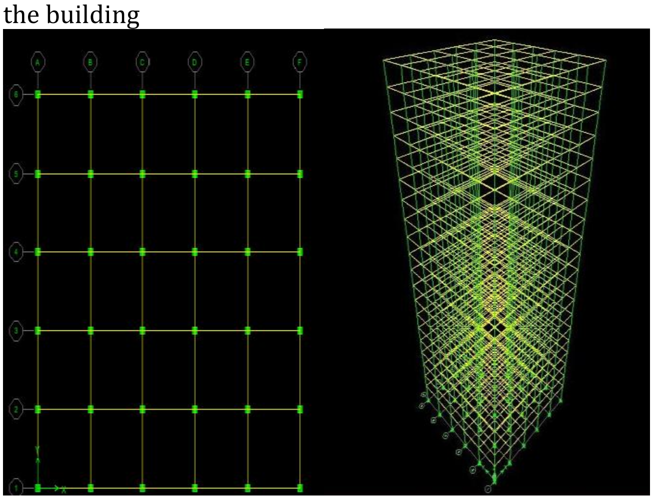
2.4 Geometry of the Considered Model:

The geometry of the building of 20 storied building model are given in table 3.

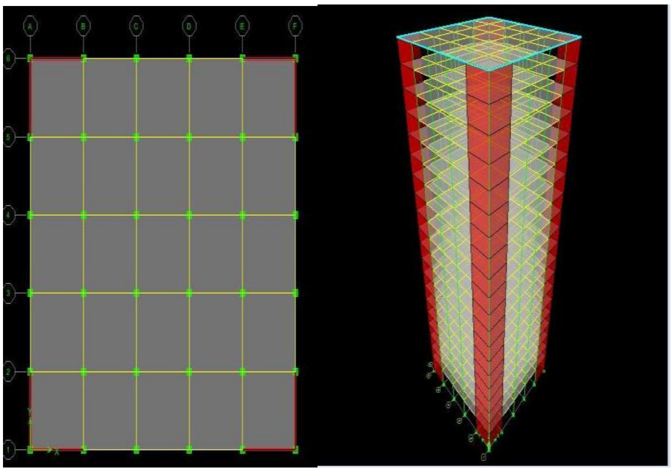
No. of Storeys	No. Bays in X direction	Bay width in X direction	No. of Bays in Y direction	Bay width in Y direction	Bottom Storey Ht	Storey Ht
20	5	5 m	5	5 m	4.4 m	3.2m

2.5 Plans and models

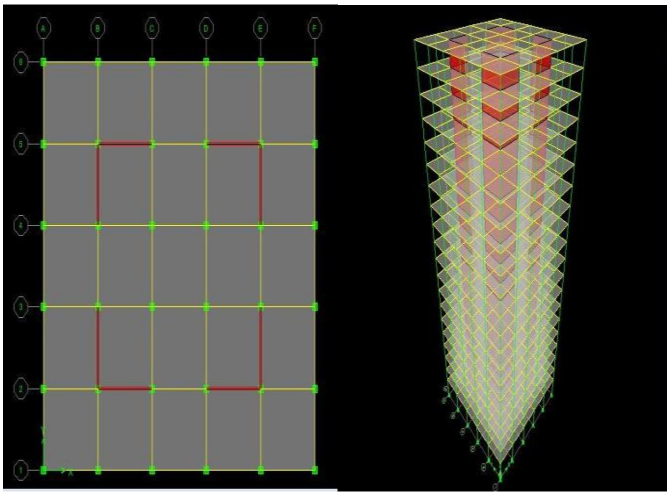
Plans and 3d models considered for the analysis purpose shear walls with different shape and different locations in the building



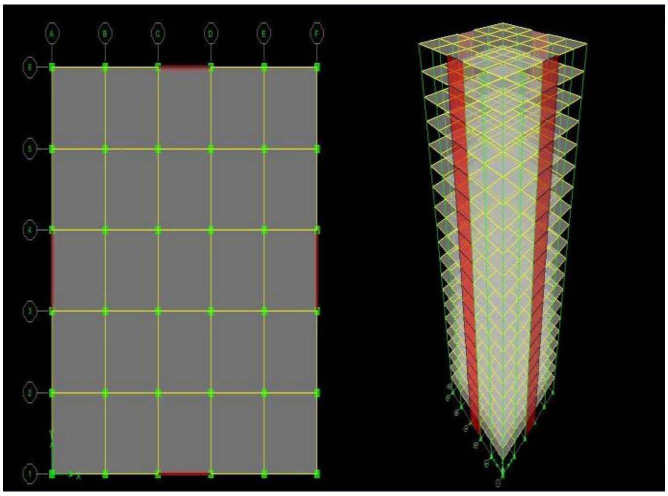
The plan and 3d model of the G+19 bare frame building (model 1)



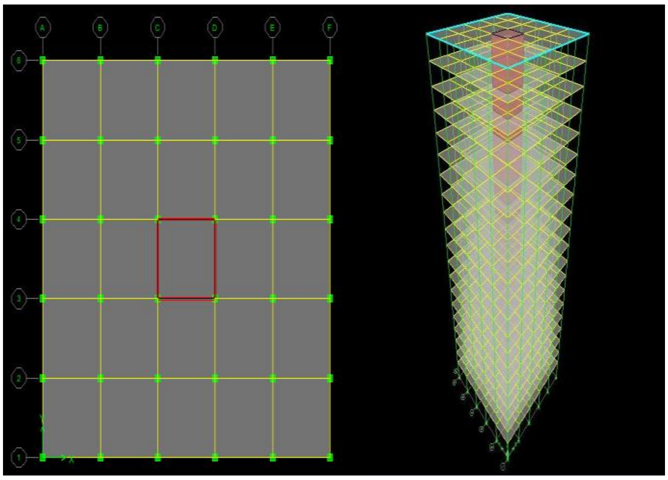
The plan and 3d model the G+19 building shear wall at exterior corner (model 2)



The plan and 3d model of the G+19 building shear wall at interior corner(model 3)



The plan and 3d model of the G+19 building shear wall at mid frame(model4)



The plan of the G+19 building shear wall at centre (core) of the building (model 5)

2.6 LOAD COMBINATIONS CONSIDERED FOR THE BUILDING ANALYSIS

The following are the load combinations are adopted for the0analysis & design of building as per IS-1893(Part1):2002, as shown in table no 4

Sl. No	Load Combination	Load Factors
1	Gravity analysis	1.5(DL+LL)
2	Equivalent static method	a) 1.2(DL+LL+EQX) b) 1.2(DL+LL+EQY) c) 1.2 (DL+LL- EQX) d) 1.2(DL+LL- EQY)
3	Response spectrum analysis	a) 1.2(DL+LL+RSX) b) 1.2(DL+LL+RSY) c) 1.2(DL+LL-RSX) d) 1.2(DL+LL-RSY)

Where,
DL= Dead load.
LL = Live load.
EQX,EQY= Earthquake load in X & Y directions.
RSX,RSY= Earthquake load in X & Y directions

3. RESULTS & DISCUSSIONS

Lateral displacement profile for building models obtained from the equivalent static, response spectrum & time history methods are shown in figures for G+19,

3.1 LATERAL DISPLACEMENT FOR G+19 BUILDING BY EQUIVALENT STATIC ANALYSIS

Lateral displacement along X-direction & Y-direction (Equivalent static analysis) as shown in table no 5

storey	Model 1 Bare frame.		Model 2 SW at exterior corner.		Model 3 SW at interior corner.		Model 4 SW at mid frame.		Model 5 SW at core.	
	X-Axis	Y-Axis	X-Axis	Y-Axis	X-Axis	Y-Axis	X-Axis	Y-Axis	X-Axis	Y-Axis
20	187.4	187.4	74.9	74.9	88.6	88.6	121.2	121.2	109.7	109.7
19	183.2	183.2	73.6	73.6	83.1	83.1	115.5	115.5	96.8	96.8
18	181.2	181.2	69.2	69.2	79.6	79.6	111.8	111.8	91.4	91.4
17	172.3	172.3	63.4	63.4	74.2	74.2	104.3	104.3	85.1	85.1
16	169.6	169.6	58.4	58.4	68.6	68.6	99.6	99.6	81.4	81.4
15	161.1	161.1	53.2	53.2	63.9	63.9	93.9	93.9	74.7	74.7
14	153.3	153.3	51.3	51.3	58.7	58.7	86.1	86.1	69.2	69.2
13	142.4	142.4	49.8	49.8	53.8	53.8	79.4	79.4	63.5	63.5
12	135.2	135.2	41.1	41.8	47.3	47.3	72.7	72.7	57.8	57.8
11	123.6	123.6	38.3	38.3	42.4	42.4	65.3	65.3	51.3	51.9
10	114.2	114.2	32.9	32.9	37.6	37.6	58.2	58.2	44.6	44.6
9	99.9	99.9	29.8	29.8	31.1	31.1	51.1	51.1	38.9	38.9
8	92.1	92.1	23.1	23.1	26.6	26.6	43.6	43.6	32.2	32.2
7	83.3	83.3	21.2	21.2	21.1	21.1	35.9	35.9	26. 7	26.7
6	71.1	71.1	15.3	15.3	17.1	17.1	28.9	28.9	21.9	21.9
5	62.9	62.9	11.6	11.6	13.4	13.4	22.5	22.5	16.6	16.6
4	46.8	46.8	8.9	8.9	9.7	9.7	15.7	15.7	11.6	11.6
3	33.2	33.2	4.2	4.2	5.2	5.2	11.4	11.4	7.4	7.4
2	23.5	23.5	2.5	2.5	3.5	3.5	5.6	5.6	4.8	4.8
1	12.3	12.3	1.8	1.8	1.8	1.8	2.2	2.2	1.1	1.1
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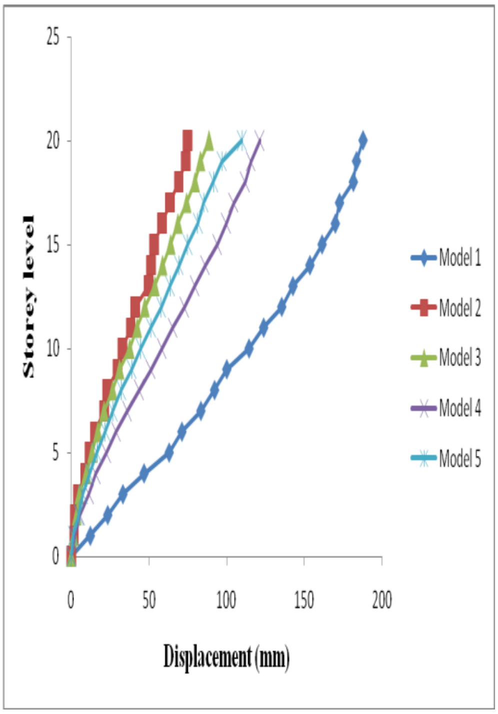

Lateral displacement for G+19 by equivalent static method

3 .2 LATERAL DISPLACEMENT FOR G+19 BUILDING BY RESPONSE SPECTRUM ANALYSIS

Lateral displacement along X-direction & Y-direction (Response spectrum analysis) as shown in table no 6

storey	Model 1 Bare frame.		Model 2 SW at exterior corner.		Model 3 SW at interior corner.		Model 4 SW at mid frame.		Model 5 SW at core.	
	X-Axis	Y-Axis	X-Axis	Y-Axis	X-Axis	Y-Axis	X-Axis	Y-Axis	X-Axis	Y-Axis
20	139.3	139.3	44.5	44.5	48.1	48.1	49.1	49.1	71.1	71.1
19	138.8	138.8	42.6	42.6	46.6	46.6	47.8	47.8	67.4	67.4
18	135.4	135.4	40.1	40.1	43.2	43.2	45.6	45.6	64.7	64.1
17	132.1	132.1	38.8	38.8	39.8	39.8	43.2	43.2	60.8	60.8
16	129.3	129.3	35.2	35.2	37.2	37.2	41.1	41.1	57.5	57.5
15	124.2	124.2	33.8	33.8	34.1	34.1	38.4	38.4	51.2	51.2
14	119.7	119.7	30.1	30.1	32.7	32.7	36.8	36.8	49.3	49.3
13	110.8	110.8	28.7	28.7	29.6	29.6	33.9	33.9	46.6	46.6
12	107.2	107.2	25.9	25.9	26.2	26.2	31.2	31.2	41.9	41.9
11	99.6	99.6	23.6	23.6	24.8	24.8	29.3	29.3	39.8	39.8
10	93.6	93.6	20.1	20.1	22.9	22.9	25.2	25.2	33.7	33.1
9	83.9	83.9	18.7	18.7	20.1	20.1	23.7	23.7	29.9	29.9
8	77.1	77.1	15.6	15.6	18.3	18.3	19.2	19.2	24.3	24.3
7	70.5	70.5	13.1	13.1	16.2	16.2	17.6	17.6	21.2	21.2
6	60.8	60.8	10.7	10.7	12.5	12.5	13.3	13.3	17.2	17.2
5	49.7	49.7	8.2	8.2	9.3	9.3	9.9	9.9	13.1	13.1
4	41.5	41.5	5.8	5.8	8.6	8.6	7.3	7.3	9.2	9.2
3	29.9	29.9	3.9	3.9	6.9	6.9	5.6	5.6	6.5	6.5
2	21.9	21.9	2.8	2.8	4.8	4.8	2.5	2.5	3.3	3.3
1	11.5	11.5	1.7	1.7	3.5	3.5	1.5	1.5	1.6	1.6
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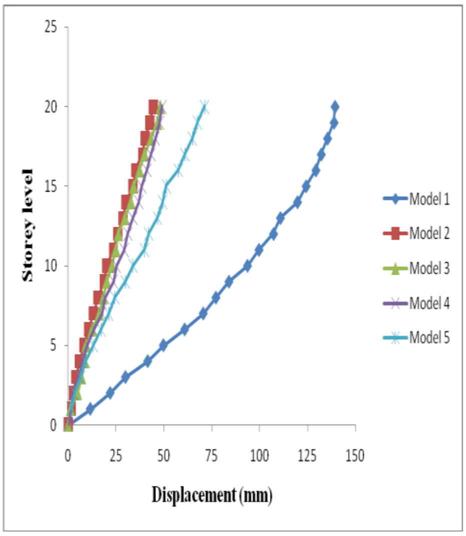

Lateral displacement for G+19 by response spectrum

3 .3 LATERAL DISPLACEMENT FOR G+19 BUILDING BY TIME HISTORY METHOD

Lateral displacement along X-direction & Y-direction (Time history analysis) as shown in table no 7

Storey	Model 1 Bare frame.		Model 2 SW at exterior corner.		Model 3 SW at interior corner.		Model 4 SW at mid frame.		Model 5 SW at core.	
	X-Axis	Y-Axis	X-Axis	Y-Axis	X-Axis	Y-Axis	X-Axis	Y-Axis	X-Axis	Y-Axis
20	195.1	195.1	88.9	88.9	114.8	114.8	155.8	155.8	128.9	128.9
19	191.4	191.4	83.6	83.6	102.9	102.9	143.9	143.9	110.6	110.6
18	202.7	202.7	79.3	79.9	98.5	98.5	137.9	137.9	109.5	109.5
17	173.8	173.8	71.2	71.8	90.4	90.4	129.2	129.2	99.4	99.4
16	166.5	166.5	68.1	68.1	85.9	85.9	121.5	121.5	95.6	95.6
15	161.2	161.2	63.4	63.4	79.6	79.6	110.8	110.8	89.2	89.2
14	155.9	155.9	58.7	58.7	73.4	73.4	98.8	98.8	82.7	82.7
13	149.6	149.6	52.8	52.8	68.6	68.6	96.1	96.1	78.6	78.6
12	142.3	142.3	47.4	47.4	60.8	60.8	92.7	92.7	71.2	71.2
11	132.3	132.3	41.5	41.5	51.1	51.1	88.5	88.5	63.3	63.9
10	126.2	126.2	37.6	37.6	46.2	46.2	84.6	84.6	56.1	56.1
9	113.1	113.1	32.6	32.6	41.5	41.5	79.8	79.8	49.2	49.2
8	102.5	102.5	26.6	26.6	38.9	38.9	73.7	73.7	44.6	44.6
7	94.6	94.6	21.4	21.4	37.1	37.1	63.1	63.1	38.6	38.6
6	82.7	82.7	17.1	17.1	34.4	34.4	58.6	58.6	33.1	33.1
5	73.5	73.5	12.2	12.2	29.2	29.2	46.6	46.6	29.6	29.6
4	62.8	62.8	9.4	9.4	24.6	24.6	39.8	39.8	21.9	21.9
3	49.9	49.9	6.9	6.9	18.1	18.1	26.2	26.2	16.8	16.8
2	35.6	35.6	3.6	3.6	11.8	11.8	16.1	16.1	09.5	09.5
1	19.3	19.3	1.2	1.2	5.3	5.3	7.6	7.6	04.1	04.1
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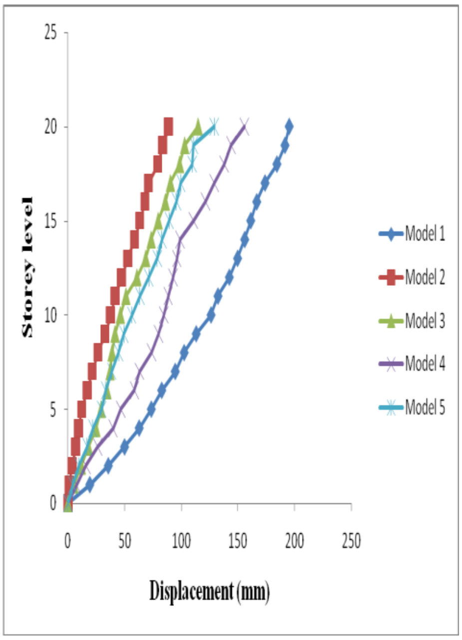

Lateral displacement for G+19 by time history analys

3.4 SUMMARY

It can be noted that for equivalent static, response spectrum and time history analysis the lateral displacement is more predominant in bare frame (model 1), less and slightly more when the shear wall is located at exterior and interior corner of the building (model 2 and model 3) respectively when compared to building in which shear wall is located at mid frame (model 4) and at core (model 5). And as the level of the storey increased the lateral displacement also goes on increases.

3.5 CALCULATION OF BASESHEAR

Base shear and scaling factor for 20 storied building model as shown in table 8

	Longitudinal direction and transverse direction				
Baseshear (KN)	Model 1 Bare frame	Model 2 SW at exterior corner.	Model 3 SW at interior corner.	Model 4 SW at mid frame.	Model 5 SW at core.
VB	2530.8	3026.19	2800.61	2673.16	2907.69
Vb	1907.2	2804.68	2057.27	1789.63	2610.23
Scaling factor	1.3269	1.0789	1.3613	1.4936	1.113

The base shear value of the building in case of equivalent static method and response spectrum method for different models of 20 storied building are given in table 8. In the response spectrum method the design base shear (VB) is made equal to the base shear obtained from equivalent static method (Vb) as perIS : 1893-2002 (Part 1) by applying the scaling factors calculated as shown in table 8

4. CONCLUSIONS

The linear static analysis and dynamic analysis Response Spectrum Analysis& time history analysis have been completed to focus the suitable position of shear wall in the building and the outcomes have been looked at. The analysis has been completed on G+19 structures for different locations of shear walls.

The following specific conclusions are drawn from the present work.

- The seismic analysis of R C frame structure is finished by both static and dynamic analysis to focus and think about the base shear. It has been found that most extreme base shear in building with shear walls at exterior corner when contrasted with alternate models.
- The presence of shear wall can influence the seismic conduct of frame structure to extensive degree, and the shear wall increases the strength and stiffness of the structure. It has been found that the building with shear wall at exterior corner shows better location of shear wall since lateral displacement and base shear are compared with different models.
- The results from static and dynamic analysis exhibit the typical expected behavior for building with shear walls at different locations.
- In equivalent static analysis it has been found that model-2 shows lesser displacement when contrasted with different models in longitudinal and transverse direction when contrasted with alternate models. In response spectrum analysis model-2 shows lesser displacement when contrasted with other models in longitudinal and transverse direction when contrasted with alternate models.

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