ANALYZING OF MULTISTORY BUILDING BY STATIC AND DYNAMIC ANALYSIS BY USING ETABS WITH AND WITHOUT SHEAR WALLS

[1]Abdul Naveed Abdul Waheed, [2]Mohammad Salman Abdul Raheman Shaik

[1]M.E.Student, [2]Assistant Professor
[1]Department of Civil Engineering,
[1]Sanmati Engineering College, Washim, India

Abstract :As we know that in the present scenario buildings with shear walls are gaining more popularity than buildings without shear wall in earthquake prone areas mainly under zones III, IV and V, Due to its capability to the resistance during earthquake. In this study 11 storey RCC building is considered for the seismic analysis which is located in zone V is considered for the analysis using Equivalent static analysis and Response spectrum analysis. Six models are considered for the analysis out of which one is bare frame model and remaining five models are structures with shear wall at various positions is considered. The modeling and Analysis is done using ETABS -2016 software package. An attempt is made to study and compare the parameters such as storey displacement, storey drift and storey stiffness by both equivalent static analysis and response spectrum method.

***Index Terms*-Response Spectrum, equivalent static method, ETABS, storey drift, storey stiffness and storey displacement.**

I. INTRODUCTION

Reinforced concrete framed buildings are adequate for resisting both the vertical and the horizontal loads acting on them. However, when the buildings are tall, say, more than twelve storey's or so, beam and column sizes work out large and reinforcement at the beam-column junctions works out quite heavy, so that, there is a lot of congestion at these joints and it is difficult to place and vibrate concrete at these places, which fact, does not contribute to the safety of buildings.

These practical difficulties call for introduction of shear walls in tall buildings. There will be no architectural difficulty in extending them thought the height of the building; care shall be taken to have symmetrical configuration of walls in plan so that torsional effect in plan could be avoided. Further, shear walls should get enough vertical load from floors, for which reason, nearby columns should be omitted and load taken to the shear walls by means of long span beams if required. Now a day's earthquake is frequency occurrence in many areas .The magnitude of disaster caused due to

Calamities by way of loss of life and property is shocking. Now the areas which were coming in safe zone are not safe for earthquake loads, therefore code has updated the seismological maps of the terrains in a hurry. Therefore, some areas are considered to be safe against earth quake are no longer safe. All these factors put an additional burden and great responsibility to search safe methods of construction on the shoulders of the structural engineer presently with the task of awarding safe certification to the structures active areas. Apart from these, any new structures to be taken up in these areas have to be designed to withstand the earth quake forces.

In this work we have taken G+11 residential building having area 500sq.m with five shear walls at different locations and one without shear wall of the same building and comparison of the following parameters such as storey displacement, storey drift and storey stiffness by using Equivalent Static Method and Dynamic Method (i.e. Response Spectrum Method) by using ETABS-2016 software package.

II. STRUCTURAL AND GEOMETRICAL PROPERTIES

Table: 2.1 Preliminary data for G + 11 plane frame

Type of structure	Multi-storey rigid jointed plane frame
Zone	V
Number of stories	G + 11
Imposed load	3.5kN/m^2 at floor and 2.5kN/m^2 at roof
Floor & roof finish	1.5kN/m^2
Depth of slab	150 mm
Materials	M30 concrete and Fe500 steel
Unit weight of RCC	25kN/m^3
Unit weight of masonry	20kN/m^3
Height of storey	3m
Depth of foundation	2m
Beam Sizes	300 x 600 mm
Columns Sizes	500 x 500 mm
Clear cover of beam	30mm
Clear cover of Column	40mm
Type of Soil	Medium
Thickness of all walls	230mm
Thickness of parapet wall	150mm
Thickness of shear wall	250mm
Height of shear wall	38m

2.2 Plan Area:

Length of building: 20m
Width of building: 25m
Total height of building : 38m

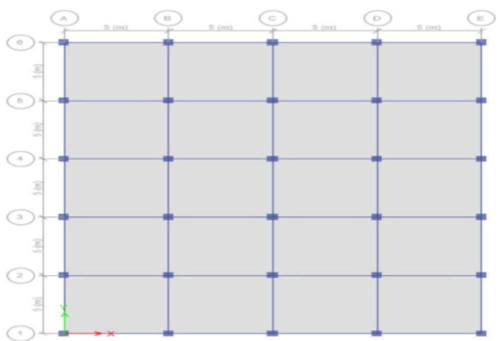


Figure 1 : PLAN

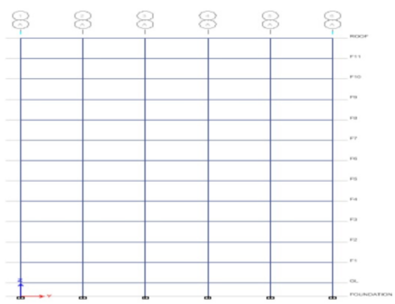
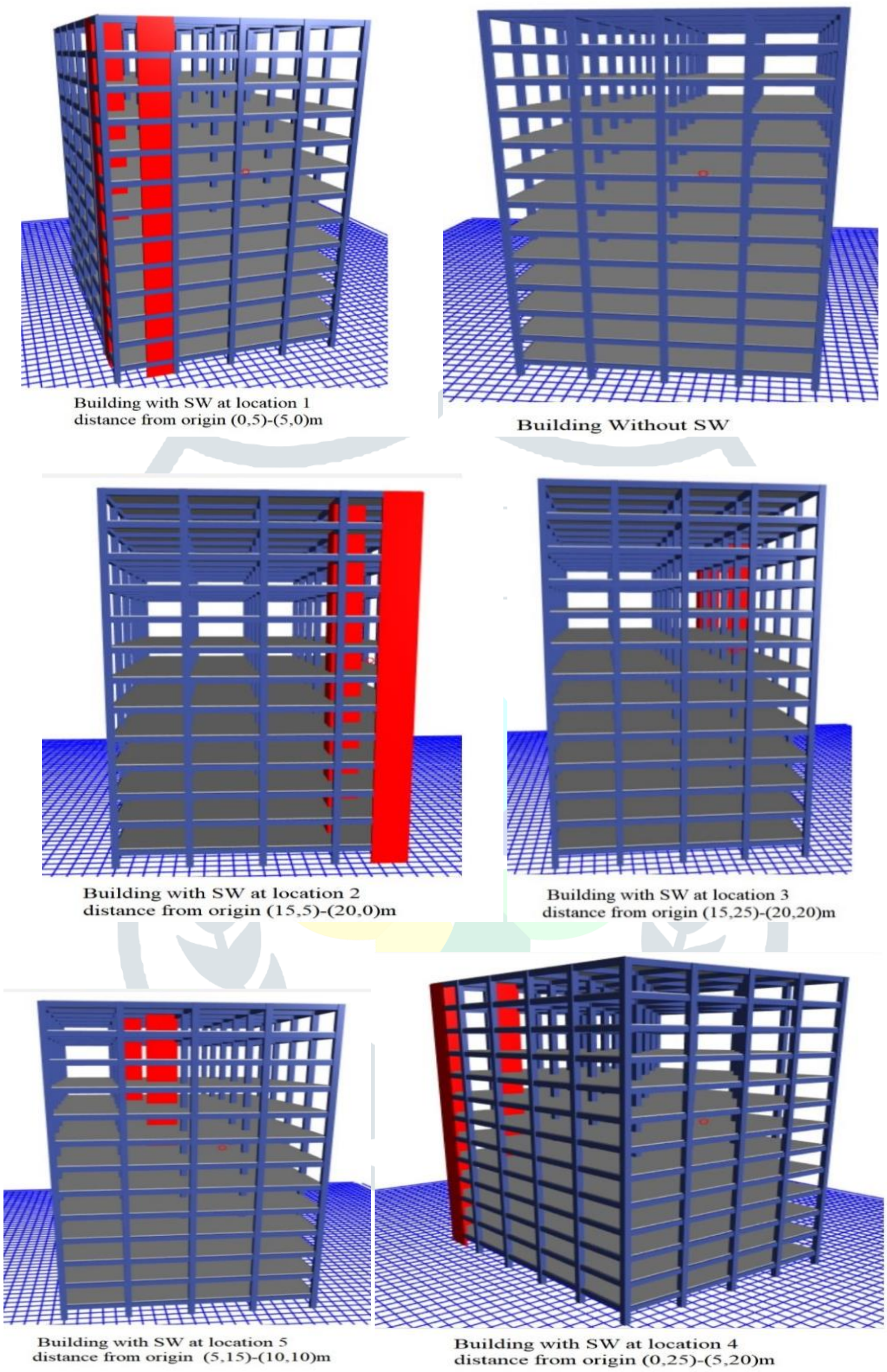


Figure 2 : Elevation

III. MODELING AND ANALYSIS OF BUILDINGS

The building is modeled using the software ETABS-2016. The analytical models of the building include all components that Storey displacement, storey drift, storey stiffness of structure. The building structural system consists of beams, columns, slab, stair case. Wall load is uniformly distributed over beams. Brief descriptions of all these models are given below:-



3.1 Analysis Methods:

There are two types of method for the seismic analysis .

1) Linear Static Analysis
2) Linear Dynamic Analysis

3.1.1 Linear Static Analysis:-

All design against seismic loads must consider the dynamic nature of the load. However, for simple regular structures, analysis by equivalent linear static methods is often sufficient. This is permitted in most codes of practice for regular, low- to medium-rise buildings. It begins with an estimation of base shear load and its distribution on each story calculated by using formulas given in the code. Equivalent static analysis can therefore work well for low to medium-rise buildings without significant coupled lateral-

tensional modes, in which only the first mode in each direction is considered. Tall buildings (over, say, 75 m), where second and higher modes can be important, or buildings with torsional effects, are much less suitable for the method, and require more complex methods to be used in these circumstances.

3.1.2 Linear Dynamic Analysis:-

This method is applicable for those structures where other than the fundamental one affect significantly the response of the structure. The response of the structure can be defined as the combination of modes. The modes of structure can be analyzed by any software. A response of mode can be analyzed from design spectrum, based on modal mass and modal frequency. Magnitude of forces in all directions is calculated based upon the different combinations as follows:

- Absolute – peak values
- Square root of sum of the squares (SRSS)
- Complete quadratic combination (CQC) – for closely spaced modes

IV. RESULTS:

Table 4.1: Storey Displacement (mm):

Building	Static Analysis	Dynamic Analysis
Building Without SW	X-Direction:- 48.998 Height:- Roof Y-Direction:-46.146 Height:- Roof	79.115 Height :- Roof
Building With SW at location 1 distance from origin (0,5)-(5,0)m	X-Direction:- 47.558 Height:- Roof Y-Direction:- 49.126 Height:- Roof	93.799 Height :- Roof
Building With SW at location 2 distance from origin (15,5)-(20,0)m	X-Direction:- 49.676 Height:- Roof Y-Direction:- 40.765 Height:- Roof	92.947 Height :- Roof
Building With SW at location 3 distance from origin (15,25)-(20,20)m	X-Direction:- 37.690 Height:- Roof Y-Direction:- 41.549 Height:- Roof	94.04 Height :- Roof
Building With SW at location 4 distance from origin (0,25)-(5,20)m	X-Direction:- 40.434 Height:- Roof Y-Direction:- 47.377 Height:- Roof	92.905 Height :- Roof
Building With SW at location 5 distance from origin (5,15)-(10,10)m	X-Direction:- 40.287 Height:- Roof Y-Direction:- 46.413 Height:- Roof	76.153 Height :- Roof

Table 4.2: Storey Drift (Unitless):

Building	Static Analysis	Dynamic Analysis
Building Without SW	X-Direction:- 0.002009 Height:- F3 Y-Direction:-0.0019 Height:- F3	0.003202 Height:- F2
Building With SW at location 1 distance from origin (0,5)-(5,0)m	X-Direction:- 0.001872 Height:- F4 Y-Direction:-0.001888 Height:- F4	0.003627 Height:- F3
Building With SW at location 2 distance from origin (15,5)-(20,0)m	X-Direction:- 0.002033 Height:- F3 Y-Direction:-0.001653 Height:- F4	0.003691 Height:- F3
Building With SW at location 3 distance from origin (15,25)-(20,20)m	X-Direction:- 0.001471 Height:- F4 Y-Direction:-0.001584 Height:- F4	0.00363 Height:- F3
Building With SW at location 4 distance from origin (0,25)-(5,20)m	X-Direction:- 0.001664 Height:- F3 Y-Direction:-0.001918 Height:- F4	0.00369 Height:- F3
Building With SW at location 5 distance from origin (5,15)-(10,10)m	X-Direction:- 0.001526 Height:- F4 Y-Direction:-0.001814 Height:- F4	0.002736 Height:- F4

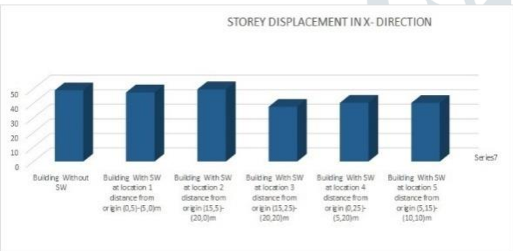
Table 4.3 : Storey Stiffness (KN/M):

Building	Static Analysis	Dynamic Analysis
Building Without SW	X-Direction:- 1432074	1496702
	Height:- GL	
	Y-Direction:-1472215	Height :- GL
	Height:- GL	
Building With SW at location 1 distance from origin (0,5)-(5,0)m	X-Direction:- 2572901	2742928
	Height:- GL	
	Y-Direction:-3010246	Height :- GL
	Height:- GL	
Building With SW at location 2 distance from origin (15,5)-(20,0)m	X-Direction:- 2296189	2295778
	Height:- GL	
	Y-Direction:-2790794	Height :- GL
	Height:- GL	
Building With SW at location 3 distance from origin (15,25)-(20,20)m	X-Direction:- 2746175	2640524
	Height:- GL	
	Y-Direction:-3074565	Height :- GL
	Height:- GL	
Building With SW at location 4 distance from origin (0,25)-(5,20)m	X-Direction:- 2539202	2306836
	Height:- GL	
	Y-Direction:-2614348	Height :- GL
	Height:- GL	
Building With SW at location 5 distance from origin (5,15)-(10,10)m	X-Direction:- 3322362	3230030
	Height:- GL	
	Y-Direction:-3211712	
	Height:- F4	

V. COMPARISON OF RESULTS:

5.1 Equivalent Static Method:

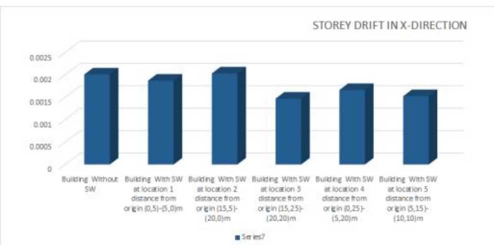
5.1.1 Storey Displacement (mm)



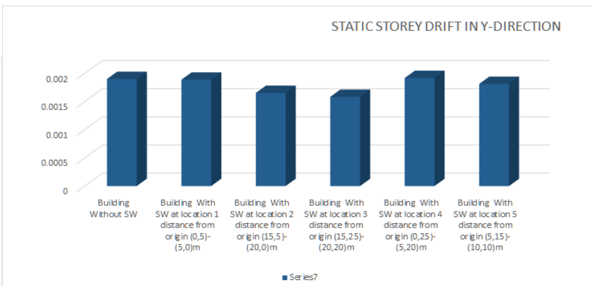
Static
Storey Displacement in X-Direction (mm)

Static
Storey Displacement in Y-Direction (mm)

5.1.2 Storey Drift (Unitless)

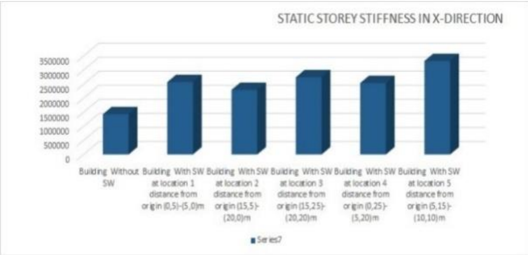


Static
Storey Drift in X-Direction (Unitless)

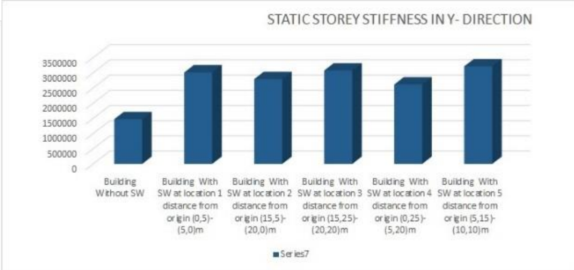


Static
Storey Drift in Y-Direction (Unitless)

5.1.3 Storey Stiffness (KN/M)



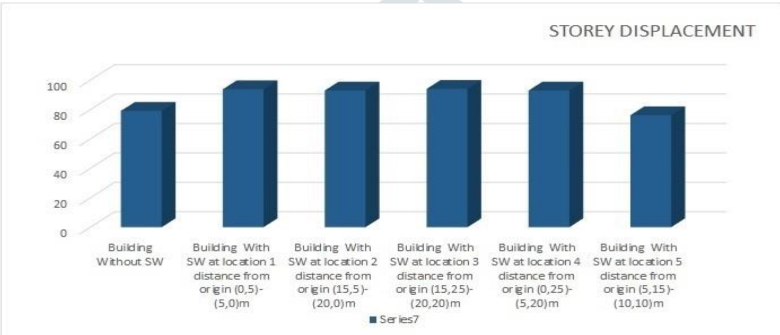
Static
Storey Stiffness in X-Direction (KN/M)



Static
Storey Stiffness in Y-Direction (KN/M)

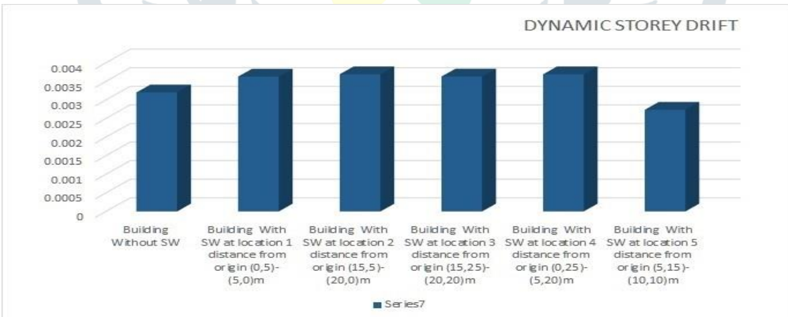
5.2 5.2 Dynamic Method (Response Spectrum Method):

5.2.1 Storey Displacement (mm)



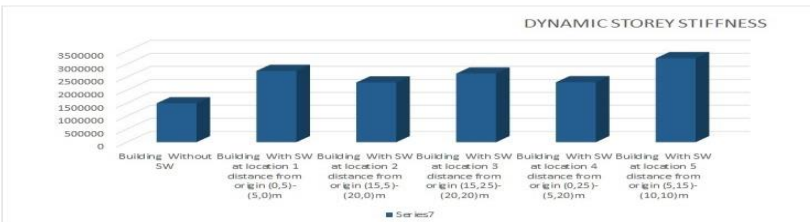
Dynamic
Storey Displacement (mm)

5.2.2 Storey Drift (Unitless)



Dynamic
Storey Drift (Unitless)

5.2.3 Storey Stiffness (KN/M)



Dynamic
Storey Stiffness (KN/M)

I) Storey Displacement (mm)				II) Storey Drift (Unitless)			III) Storey Stiffness (KN/M)		
Building	Static Analysis		Dynamic Analysis	Static Analysis		Dynamic Analysis	Static Analysis		Dynamic Analysis
	X-Direction	Y-Direction		X-Direction	Y-Direction		X-Direction	Direction	
Building Without SW	48.998	46.146	79.115	0.002009	0.0019	0.003202	1432074	1472215	1496702
Building With SW at location 1 distance from origin (0,5)-(5,0)m	47.558	49.126	93.799	0.001872	0.001888	0.003627	2572901	3010246	2742928
Building With SW at location 2 distance from origin (15,5)-(20,0)m	49.676	40.765	92.947	0.002033	0.001653	0.003691	2296189	2790794	2295778
Building With SW at location 3 distance from origin (15,25)-(20,20)m	37.69	41.549	94.04	0.001471	0.001584	0.00363	2746175	3074565	2640524
Building With SW at location 4 distance from origin (0,25)-(5,20)m	40.434	47.377	92.905	0.001664	0.001918	0.00369	2539202	2614348	2306836
Building With SW at location 5 distance from origin (5,15)-(10,10)m	40.287	46.413	76.153	0.001526	0.001814	0.002736	3322362	3211712	3230030

. Figure 5 Comparison between Storey Displacement ,Storey Drift & Storey Stiffness

VI. Results & Discussion:

6.1 Equivalent Static Method:

1) SW at upper right corner in plan (i.e. Building with SW at location 3 distance from origin (15,25)-(20,20)m) shows minimum Storey Displacement in X-Direction.

2) SW at lower right corner in plan (i.e. Building with SW at location 2 distance from origin (15,5)-(20,0)m) shows maximum Storey Displacement in X-Direction.

3) SW at lower right corner in plan (i.e. Building with SW at location 2 distance from origin (15,5)-(20,0)m) shows minimum Storey Displacement in Y-Direction.

4) SW at lower left corner in plan (i.e. Building with SW at location 1 distance from origin (0,5)-(5,0)m) shows maximum Storey Displacement in Y-Direction.

5) SW at upper right corner in plan (i.e. Building with SW at location 3 distance from origin (15,25)-(20,20)m) shows minimum Storey Drift in X-Direction.

6) SW at lower right corner in plan (i.e. Building with SW at location 2 distance from origin (15,5)-(20,0)m) shows maximum Storey Drift in X-Direction.

7) SW at upper right corner in plan (i.e. Building with SW at location 3 distance from origin (15,25)-(20,20)m) shows minimum Storey Drift in Y-Direction.

8) SW at upper left corner in plan (i.e. Building with SW at location 4 distance from origin (0,25)-(5,20)m) shows maximum Storey Drift in Y-Direction.

9) Building without SW shows minimum Storey Stiffness in X-Direction.

10) SW at center in plan (i.e. Building with SW at location 5 distance from origin (5,15)-(10,10)m) shows maximum Storey Stiffness in X-Direction.

11) Building Without SW shows minimum Storey Stiffness in Y-Direction.

12) SW at center in plan (i.e. Building with SW at location 5 distance from origin (5,15)-(10,10)m) shows maximum Storey Stiffness in Y-Direction.

6.2 Dynamic Method (Response Spectrum Method):

1) SW at center in plan (i.e. Building with SW at location 5 distance from origin (5,15)-(10,10)m) shows minimum Storey Displacement.

2) SW at upper right corner in plan (i.e. Building with SW at location 3 distance from origin (15,25)-(20,20)m) shows maximum Storey Displacement.

3) SW at center in plan (i.e. Building with SW at location 5 distance from origin (5,15)-(10,10)m) shows minimum Storey Drift.

4) SW at lower right corner in plan (i.e. Building with SW at location 2 distance from origin (15,5)-(20,0)m) shows maximum Storey Storey Drift.

5) Building Without SW shows minimum Storey Stiffness.

6) SW at center in plan (i.e. Building with SW at location 5 distance from origin (5,15)-(10,10)m) shows maximum Storey Stiffness.

VII. CONCLUSION :

1) As seen from the above results & Discussion & also from the comparative chart between Storey Displacement, Storey Drift & Storey Stiffness it is seen that Building With SW at location 5 distance from origin (5,15)-(10,10)mis the best design& location having least Dynamic Displacement, least Dynamic Storey Drift & maximum Storey Stiffness.

2) It is seen from the above result a Shear Wall at the Centre of the Plan gives best result in Dynamic Displacement, Dynamic Storey Drift & Storey Stiffness compared to Shear Wall at the Corners of the Buildings.

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