Seismic Performance Evaluation of Multi-Storey Building Having Soft Storey With Different Location of Shear Walls

Kashif Ahmer, Sharat. S. Chouka

***Abstract:** Present scenario growth of Multistory building is incredibly high attributable to fast growth everywhere around the globe. Open first story is usually provided for congested parking space, reception lobbies, party areas or any purpose in multistory building. However just in case of multistory building with soft story provides reduced performance. There are numerous aspects that effects on the behavior of multistory building like irregular plan within the structure. In the present work, study of various locations of weak stories is being considered for the analysis. To study of various locations on the seismic behavior of multistory building, linear static analysis (ESA) and linear dynamic analysis (RSA) in ETABs 2016 version is applied. Some seismic constraints like time period, story shear, story displacement, story drift and base shear are tried. The seismic behaviors of multistorey building with soft stories are administered.*

***Key words:** ETABS. Seismic, shearwalls, stiffness, Soft storey effect, weak storey*

I. INTRODUCTION

A soft storey referred to as weak storey is outlined as a storey in a very building that has considerably less resistance or inadequate plasticity .

Soft storey buildings are taken into account by having a story that has a lot of open spaces. Some buildings include banks, different types of Parking facilities for different and convenient floors and garages, are typically soft stories are connected to column of the higher floor and bottom storey is left void of infill walls.

In such buildings, major share of the base shear is needed to be resisted by the beam-column joints of the bottom storey. This ends up in ultimate collapse of the building. thus it's important to calculate the seismic performance to mitigate the result of soft storey in buildings to a bigger extent. Vertical RC walls of plate type referred to as Shear Walls additionally to slabs, beams and columns are used. The best way to eliminate the failure of soft storey is by introducing shear walls to the buildings.

Whenever there's demand, the load resisting system like shear wall ought to be introduced in a very building to eliminate soft storey effect.

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II. LITERATURE REVIEW

Mangulkar Madhuri, Misam. A [1] tried to analyze on adding shear wall to the building in several arrangement so as to cut back soft story impact on structural seismic response. it had been found that location and listing of shear wall acts a vital issue for the soft story structures to displace throughout earthquake.

Additionally the soft story has been eliminated because the shear wall is additional to the particularly considered floor'.'Jaswant N. Arlekar et al [2] centered on immediate measures got to be adopted to forestall seismic responses of soft first story's in buildings, by avoiding the existents of soft initial story's and by providing adequate lateral strength within the 1st story. Shear walls placed at corners of the building provides lesser lateral displacement however creates most base shear'.'Khan and Sbarounis [3] projected a unique style approach of combining the frame with shear wall for soft story building to reduce the weak story effects throughout earthquake. The lateral load resistance of tall wall-frame building structures comprising a mix of moment resisting frames and shear walls were used which reduced the effect in both the directions'.'Syed Ehtesham Ali, MohdMinhaj Uddin Aquil [4] differing kinds of shear wall and these are situated at completely different location like on outer boundary, at corner and at middle positions.. The lateral deflection of column for building with L type shear wall is reduced as compared to all or any models. Also the bending moment was found to be maximum at roof level'.'Md. Rokanuzzaman, FarjanaKhana, Anik das, S. Reza Chowdhury [5] investigated that the model analysis is completed by using varied parameters and with a similar relationship by comparison with the pattern of identical parameters.

They created four models with shear at completely different locations and without shear wall. This study concludes that that reinforced concrete frame building without shear wall can exhibit a poor performance to resist any kind of lateral load. They realized that edge side is more effective in comparison with all different types'

III. OBJECTIVES

A. To carryout lateral load analysis for building models as per codes.
B. To compare the structural response of multistorey building having soft storey with different type of shear wall arrangements on building structure and finding of best soft storey seismic forces resistant building from the models.

C. To find the constraints such as time period, storey displacement, storey driftt, storey stiffness and base shear.
D. To identify the best building configuration among different model analysis

IV. METHODOLOGY

In this project there is an attempt to investigate the seismic effect on G+11(12 storied) multistoried reinforced cement concrete building model with soft storey.
The modeling of 12 storey R.C.C. framed building is created in ETABS 2016 version.
Once the models are created, the best arrangement of shearwall is determined by varying the location of shearwall in the building structure to mitigate the seismic response. Various models were then created then the results are compared with other model.
The flow diagram of methodology of the project is as follows:

Plan of multistory building (G+11)

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Modelling of different models in ETABS 2016 Software

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Analyzing models with different location of shearwalls and finding out the most favorable position of shear wall

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Assigning shear wall at optimum position for all models with different soft storey locations and analyzing with different seismic methods.

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ResuLts and discussion

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Conclusions

V. ANALYTICAL MODELING AND PROBLEM FORMULATION

In ETABS 2016, for modelling we require some preliminary data to input such as codes for design, material properties, building requirement with the dimensions of each structural component, load case and load patterns

A. Codes used for Design

i. IS456-2000 code for plain and reinforce concretedesign
ii. IS1893-2016 (part I) code for seismic loading
iii. IS875-1987 (part I) code for deadload
iv. IS875-1987 (part II) code for liveload

B. Material properties

TABLE I. Material properties

Sl. No.	Materials	Unit
1	Grade of conc	M25
2	Grade of steel	Fe-415
3	D_c	25.0 KN/m^3
4	D_s	78.50 KN/m^3
5	Density of brick wall	20 KN/m^3

C. Building Specifications

TABLE II. Building Specifications

No. of storeys	G+11 (12 storey)
Storey height	Bottom storey- 2.2m All storeys – 3.2m Soft storey – 4 m
Column size	400 X 625 mm
Beam size	Beam 1 - 300 X 600 mm Beam 2 - 230 X 450 mm
Wall thickness	230mm
Slab thickness	150mm
Shear wall thickness	230mm

D. Load Patterns

Load Patterns are the types of load considered in ETABS. Here for this building, DL, LL & EQL for Zone V is considered.

i. *Dead Loads*

a) Selfweight of slab = 3.750 KN/m^2
(Calculated automatically by ETABS 2016)
b) FF= 1.0 KN/m^2

ii. *Live Load*

Live load = 4.0KN/m^2

iii. *Earthquake loads*

TABLE III. Earthquake details as per code

Zone	V
R	5
I	1.5
Z Factor	0.36
Soil type	Medium

E. Load Cases

The (D.L), (L.L) and the equivalent earthquake loads (In X as (EQX) & in Y as (EQY)) are considered as linear static load. Whereas, the earthquake loads due response spectrum (in X as (RSX) and in Y as (RSY)) are consider as linear dynamic load.

F. Description of Models

<u>**CASE 1**</u>
M1: Bare frame building having ground soft storey without shearwalls
M2: Framed building having ground soft storey with shear wall at middle of periphery sides
M3: Framed building having ground soft storey with shearwall at corners
M4: Framed building having ground soft storey with shearwall at core
<u>**CASE 2**</u>
M5: Framed building having ground soft storey plus middle weak storey without shearwall
M6: Framed building having ground soft storey plus middle weak storey with shearwall at middle of periphery sides

M7: Framed building having ground soft storey plus middle weak storey with shearwall at corners

M8: Framed building having ground soft storey plus middle weak storey with shearwall at core

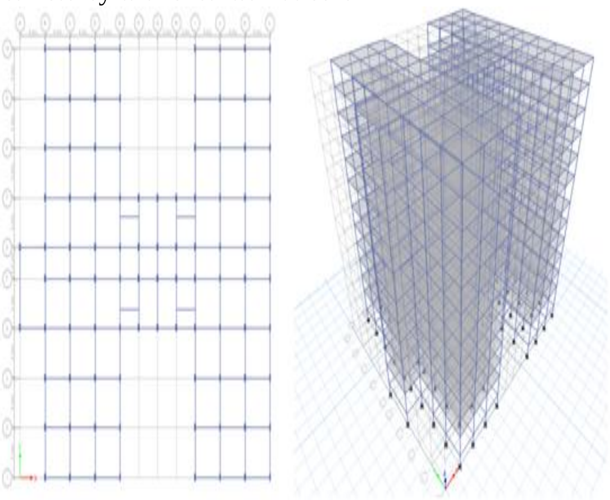

Fig.1 Bare Frame Model

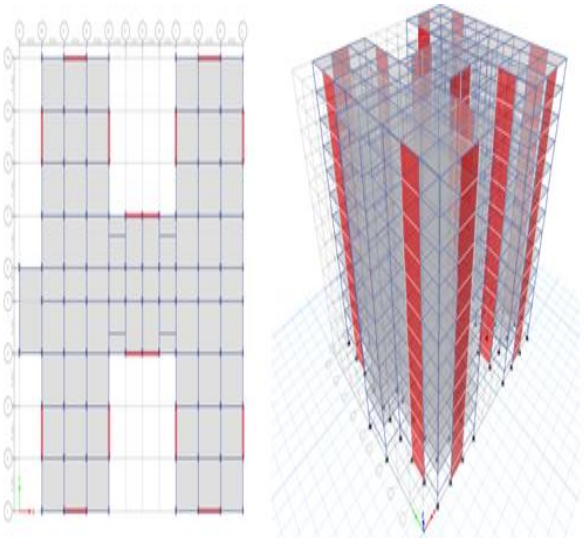

Fig.2 Shear walls at periphery

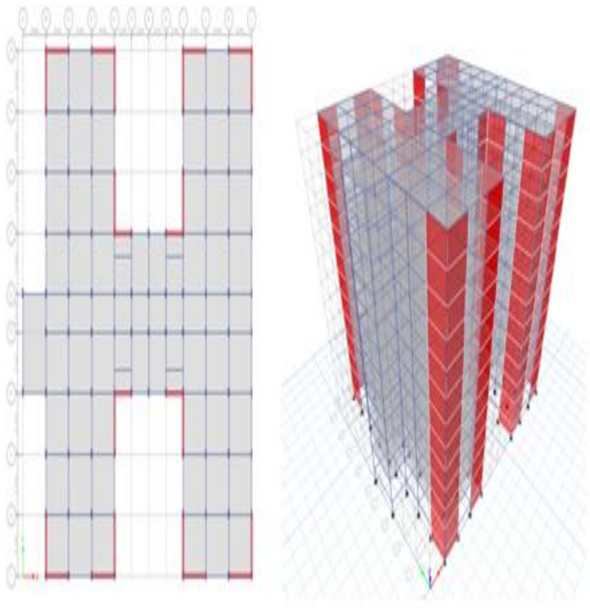

Fig. 3 Shear walls at corners

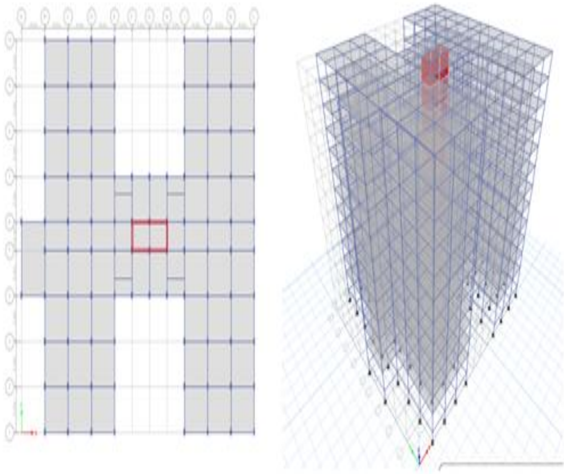

Fig. 4Shear walls at core

VI. RESULTS, OBSERVATIONS AND DISCUSSIONS

This project mainly focuses on the seismic performance of the building. After modelling different models and the completion of analysis of the building, the results are extracted and are tabulated accordingly and the effect of various parameters such as Base Shear, Time Period, Displacement, stiffness & Drift are observed and discussed.

A. Seismic results

i. Storey displacements

TABLE IV. Storey displacement (mm) for case 1 and case 2

CASE 1		M1	M2	M3	M4
ESA	EQX	66.908	48.019	43.898	57.993
	EQY	57.115	43.504	39.723	55.328
RSA	RSX	50.351	36.605	34.016	41.116
	RSY	49.965	39.709	35.625	44.369

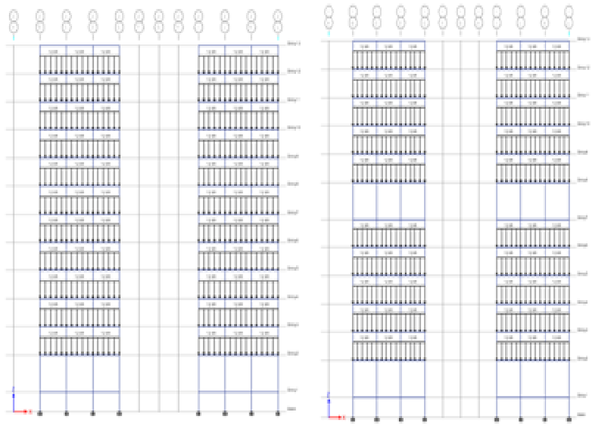

Fig.5 Elevation for Case 1 and Case 2

ii. Storey Drift

TABLE V. Storey drift for case 1

CASE 1		M1	M2	M3	M4
ESA	EQ X	0.002546	0.000771	0.000658	0.001189
	EQ Y	0.001991	0.000747	0.000607	0.001487
RSA	RSX	0.002328	0.000671	0.000577	0.000864
	RSY	0.002085	0.000779	0.000608	0.001391

CASE 2		M5	M6	M7	M8
ESA	EQ X	68.806	51.946	44.908	59.307
	EQ Y	58.55	47.056	40.629	56.698
RSA	RS X	50.643	38.544	34.354	41.082
	RS Y	50.337	42.061	36.108	44.85

TABLE VI. Storey drift for case 2

CASE 2		M5	M6	M7	M8
ESA	EQ X	0.002434	0.000786	0.000639	0.001144
	EQ Y	0.001908	0.000761	0.00059	0.00143
RSA	RSX	0.002221	0.000672	0.000555	0.000823
	RSY	0.001994	0.000783	0.000587	0.001338

iii. Storey Stiffness

TABLE VII. Storey stiffness for case 1

CASE 1		M1	M 2	M3	M 4
ESA	EQ X	893124.22	4576590.7	6692051.31	3241552.6
	EQ Y	1542656	5189690.3	8118449.6	2414754
RSA	RS X	901708.94	4964823.2	7184948.8	3666737.3
	RS Y	1518156	5288516	8421884.9	2434209.1

TABLE VIII. Storey stiffness for case 2

CASE 2		M5	M6	M7	M8
ESA	EQ X	892461.14	4513376.7	6598968	3204636.1
	EQ Y	1541230.7	5131935.2	8012788.7	2404747.4
RSA	RS X	902650.83	4979740.4	7151762.49	3671135.1
	RS Y	1519910.3	5296097.6	8374189	2436407.2

iv. Base shear

TABLE IX. Base shear for all models

	ESA		RSA	
MODELS	**EQX**	**EQY**	**RSX**	**RSY**
M1	8381.30	10451.86	8381.32	10448.45
M2	12868.91	14026.12	12868.88	14026.22
M3	16066.85	17893.76	16066.88	17893.78
M4	12068.65	11632.63	12068.63	11632.6
M5	8006.99	10005.86	8006.99	10005.83
M6	12929.93	14124.99	12929.93	14124.99
M7	15391.30	17152.94	15391.34	17152.97
M8	11508.68	11152.67	11508.68	11152.67

v. Time Period

TABLE X. Time period in sec for all models

MODEL	Time Period
Model 1	1.929
Model 2	1.154
Model 3	1.045
Model 4	1.56
Model 5	1.952
Model 6	1.246
Model 7	1.064
Model 8	1.567

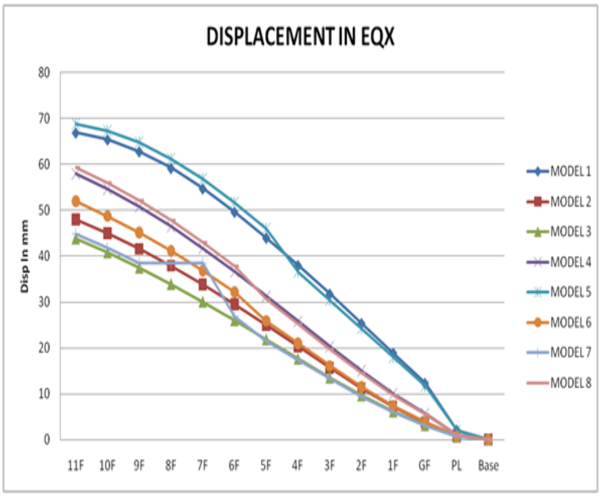

Fig. 6 Displacement in EQX

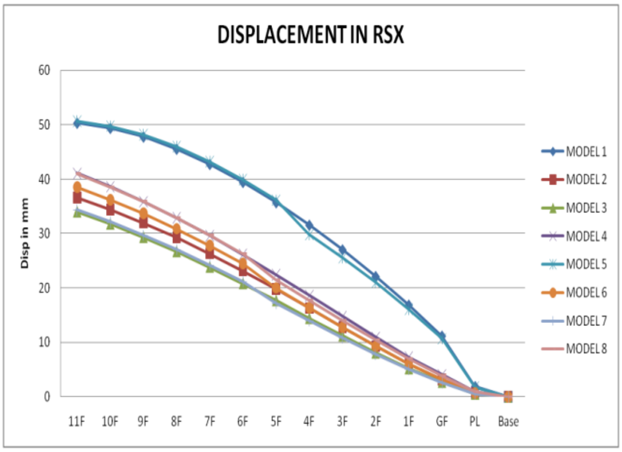

Fig. 7 Displacement in RS

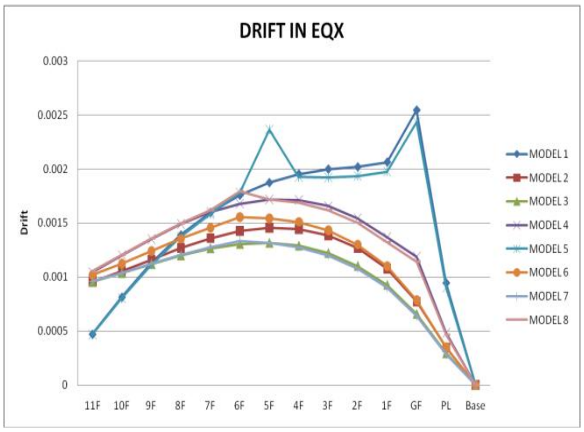

Fig. 8 Drift in EQX

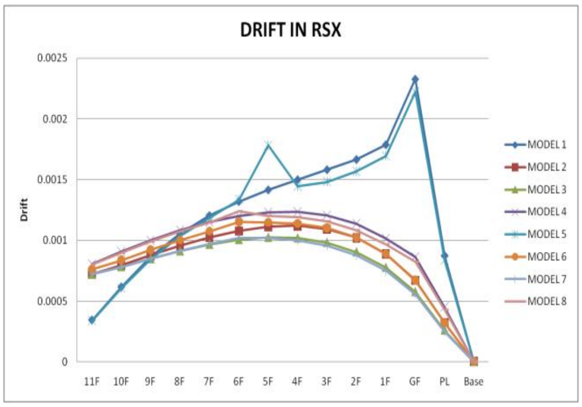

Fig.9 Drift in RSX

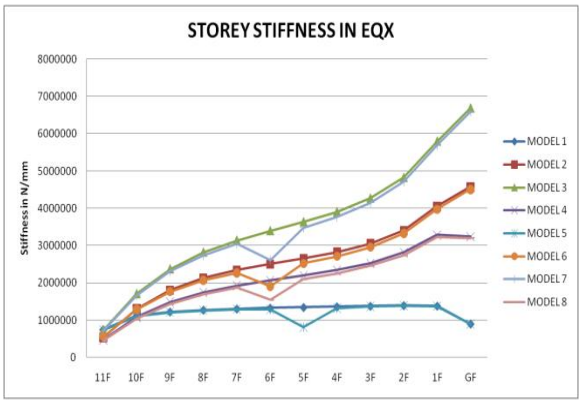

Fig. 10 Stiffness in EQX

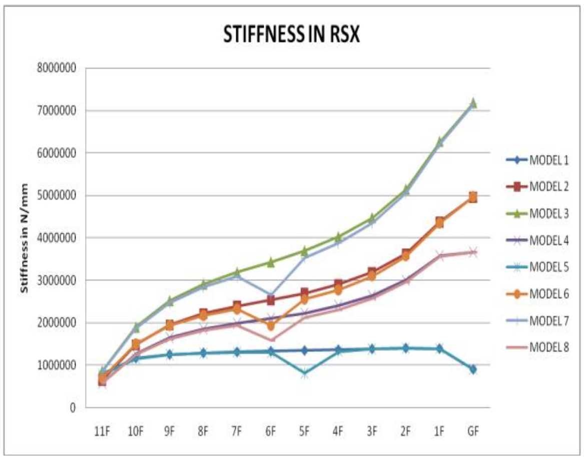

Fig. 11 Stiffness in RSX

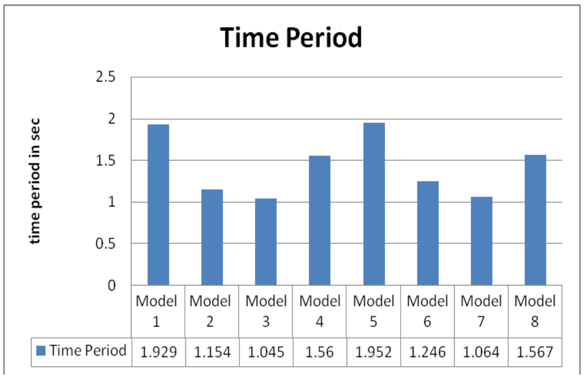

Fig. 12 Time period (seconds) for all models

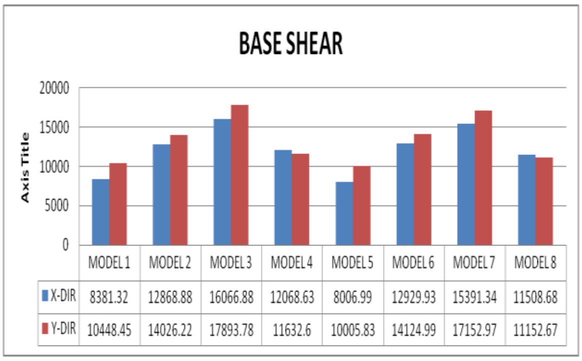

Fig. 13 Base shear (KN) for all models

B. Observations and Discussions

The following are the observations and discussions that are found out when evaluating the results.

1) From the study, For case 1, The displacement of M3 is 34.39% reduced when compared to M1 , M2 reduced by 28.23% ,whereas M3 reduced by 13.32%.
2) Similarly for case 2, the displacement of M7 is reduced by 34.73% when compared to M5, M6 is reduced by 24.50%. Whereas M8 is reduced by 13.81%. The Same trend was observed for storey displacement in Y direction, as well as in RSA.
3) From the study, the storey drift is maximum at the level at which soft storey is considered.
4) For case 1, model 1 at storey 1 And for case 2, model 7 at storey 1 are having 3.87 times less and 3.67 lesser when compared to model 1 at storey1 and model 5 at storey 1 respectively. The Same trend was observed for storey drift in Y direction, as well as in RSA.
5) The storey stiffness was observer to be minimum for storey having soft storey. For case 1 Storey stiffness of Model 3 at storey 1 and for case 2, model 7 at storey 1 is having 7.49 times more and 7.39 times more stiffness when compared to model 1 at storey1 and model 5 at storey 1 respectively. Model 2 gave 5.12 times; model 4 gave 3.63 times more stiffness when compared with model 1.
6) From the results of the current study, base shear is highest in M3 and minimum in M5 which is of case 2.
7) For case 1, Base shear of M3 has 1.92 times increases base shear when compared to M1.

For case 2, base shear of M7 model has 1.44 times increased base shear when compared to M5.

8) As it is also observed that, the fundamental Time period is more for model 5 with soft storey at ground and middle storey.
9) For case 1, Time period obtained from model 3 was reduced 1.85 times when compared with model 1. For case 2, Time period obtained from model 7 was reduced 1.83 times when compared with model 5.

VII. CONCLUSIONS

The below points are the most important conclusions of this project.

1) The storey displacement of the building with shear wall at corner is least compared to additional types of models. This is due to as these arrangements reduce BM concentration. Storey displacement of the structure is also reduced when we provide shear wall at periphery side but displacement reduction is less than that of corner.
2) In soft storey structure, the storey drift is utmost at the storey at which the soft storey level is considered. The storey drift with shear wall at corner is least compared to other types of models. This is due to the Shear walls acts as a resistive layer connected to structure. Storey drift is also reduced when we provide shear wall at periphery side but drift reduction is less than that of corner.
3) The model with shear wall at corner provides max. Base shear when compared with other models in both cases and in both X-Y directions. SW position will influence the attraction of forces
4) From the study it has been found that storey stiffness increased when shear walls are provided at corners when compared to other models. Stiffness is the leading factor with increase in height of the building. The soft storey gets converted into a normal storey due shear walls are provided as it increases the horizontal stiffness and stability of the building structure.
5) From the study it is also seen that by providing shear walls at corners the time period also get decreases during strong seismic forces.

When results compared between ESA and RSA, RSA gave much better results due to superiority in modal analysis for all models. Case 1 and case 2 provides the results quite nearer and similar for all type of models. Hence it is found out that one can go for Ground storey plus middle storey structure in practice.

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