

# Analysis of RCC multistoried building with and without shear wall and optimum location of shear wall

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**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 paper 11 story 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 story displacement, story drift and story stiffness by both equivalent static analysis and response spectrum method.

- To study and compare the parameters such as storey shear, storey displacement and storey drift by both methods.
- To determine the optimum location of the structure.

**Key Words:** Response Spectrum, equivalent static method, ETABS, storey drift, storey stiffness and storey displacement.

## 1. INTRODUCTION

The major criteria now-a-days in designing RCC structures in seismic zones is control of lateral displacement resulting from lateral forces. In this thesis effort has been made to investigate the effect of Shear Wall position on lateral displacement and Storey Drift in RCC Frames. Six types of G + 10 structures are considered, out of which one is bare frame model i.e. without shear wall and for remaining five models shear wall is considered at various 5 locations. All the 5 models are analyzed both by equivalent static method which is a linear static analysis and Response spectrum method which is linear dynamic analysis. And after the analysis, obtained results are compared with respect to displacement and storey drift for both methods and then by comparing the results optimum location of shear wall is determined.

### 1.1 Objectives

- To analyze the multi storied building with shear wall by Equivalent static method and Response spectrum method.
- To study behavior of the structure under different location of shear wall.

## 1.2 Methodology

- 1) Modeling and analysis of multistoried building without and with shear wall at various locations by ESA and RSM for seismic loads.
- 2) Comparison of results and graph of all models for the parameters displacement, story drift and stiffness.
- 3) For above parameters comparison is also done for both ESA and RSM methods.
- 4) Optimum location of shear wall with suitable method is also found.

## 2. MODELING AND ANALYSIS

For this study, a 11-story building with each story height as 3 meters is considered and modeled in etabs. The buildings are assumed to be fixed at the base. The sections of structural elements considered are rectangular in nature. In this project including the ground storey each storey heights of buildings are assumed to be constant. The dimensions of the building considered along X and Y directions are 13.83m and 24m respectively. The buildings are modeled using software ETAB Nonlinear v 9.7.2. Six different models were considered, out of which one is bare frame model and other five models includes various positions of shear wall. Models are studied in zone V comparing lateral displacement story drift, story stiffness for all models.

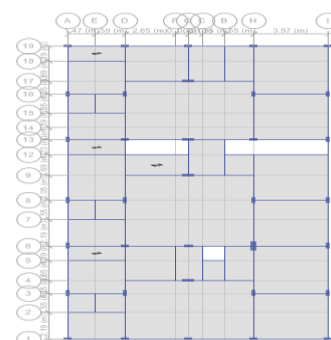
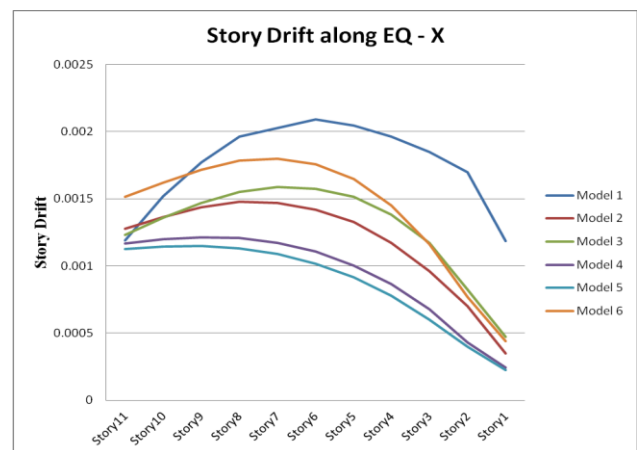
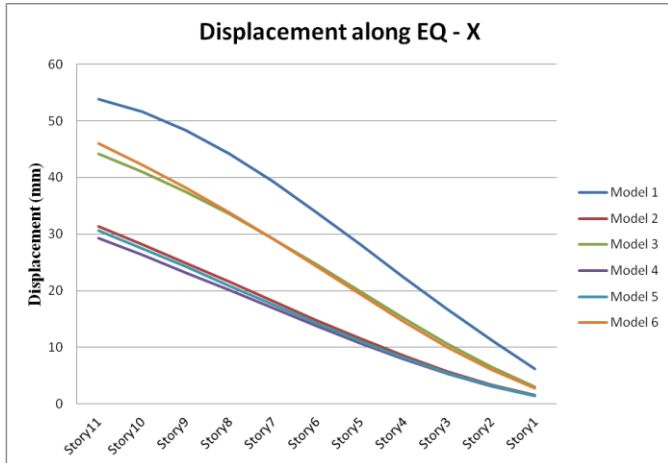


Fig. 1 : Model 1



Displacement along EQ X								
Model 1			Model 2			Model 3		
Story	Case/Cor	UX	Story	Case/Cor	UX	Story	Case/Cor	UX
Story11	EQ X	53.809	Story 11	EQ X	31.399	Story11	EQ X	44.185
Story10	EQ X	51.598	Story10	EQ X	28.182	Story10	EQ X	40.999
Story9	EQ X	48.326	Story9	EQ X	24.902	Story9	EQ X	37.464
Story8	EQ X	44.15	Story8	EQ X	21.541	Story8	EQ X	33.518
Story7	EQ X	39.26	Story7	EQ X	18.144	Story7	EQ X	29.202
Story6	EQ X	33.81	Story6	EQ X	14.781	Story6	EQ X	24.61
Story5	EQ X	28.163	Story5	EQ X	11.537	Story5	EQ X	19.885
Story4	EQ X	22.377	Story4	EQ X	8.501	Story4	EQ X	15.17
Story3	EQ X	16.648	Story3	EQ X	5.764	Story3	EQ X	10.642
Story2	EQ X	11.289	Story2	EQ X	3.429	Story2	EQ X	6.524
Story1	EQ X	6.243	Story 1	EQ X	1.591	Story1	EQ X	3.06
Model 4			Model 5			Model 6		
Story	Case/Cor	UX	Story	Case/Cor	UX	Story	Case/Cor	UX
Story11	EQ X	29.329	Story11	EQ X	30.677	Story11	EQ X	46.041
Story10	EQ X	26.325	Story10	EQ X	27.496	Story10	EQ X	42.275
Story9	EQ X	23.231	Story9	EQ X	24.232	Story9	EQ X	38.191
Story8	EQ X	20.073	Story8	EQ X	20.913	Story8	EQ X	33.795
Story7	EQ X	16.889	Story7	EQ X	17.581	Story7	EQ X	29.122
Story6	EQ X	13.74	Story6	EQ X	14.291	Story6	EQ X	24.253
Story5	EQ X	10.706	Story5	EQ X	11.122	Story5	EQ X	19.339
Story4	EQ X	7.864	Story4	EQ X	8.154	Story4	EQ X	14.526
Story3	EQ X	5.308	Story3	EQ X	5.484	Story3	EQ X	10.005
Story2	EQ X	3.128	Story2	EQ X	3.217	Story2	EQ X	6.017
Story1	EQ X	1.429	Story1	EQ X	1.462	Story1	EQ X	2.792

Story Drift along EQ X								
Model 1			Model 2			Model 3		
Story	Case/Cor	Drift	Story	Case/Cor	Drift	Story	Case/Cor	Drift
Story11	EQ X	0.001191	Story11	EQ X	0.001276	Story11	EQ X	0.001232
Story10	EQ X	0.001519	Story10	EQ X	0.001362	Story10	EQ X	0.001359
Story9	EQ X	0.001773	Story9	EQ X	0.001438	Story9	EQ X	0.001471
Story8	EQ X	0.001963	Story8	EQ X	0.00148	Story8	EQ X	0.001553
Story7	EQ X	0.002029	Story7	EQ X	0.001467	Story7	EQ X	0.001588
Story6	EQ X	0.00209	Story6	EQ X	0.001417	Story6	EQ X	0.001576
Story5	EQ X	0.002045	Story5	EQ X	0.001326	Story5	EQ X	0.001514
Story4	EQ X	0.001962	Story4	EQ X	0.001173	Story4	EQ X	0.001382
Story3	EQ X	0.00185	Story3	EQ X	0.000962	Story3	EQ X	0.00117
Story2	EQ X	0.001698	Story2	EQ X	0.000698	Story2	EQ X	0.000822
Story1	EQ X	0.001186	Story1	EQ X	0.000348	Story1	EQ X	0.000472
Model 4			Model 5			Model 6		
Story	Case/Cor	Drift	Story	Case/Cor	Drift	Story	Case/Cor	Drift
Story11	EQ X	0.001167	Story11	EQ X	0.001126	Story11	EQ X	0.001513
Story10	EQ X	0.001197	Story10	EQ X	0.001144	Story10	EQ X	0.001621
Story9	EQ X	0.001214	Story9	EQ X	0.001147	Story9	EQ X	0.001717
Story8	EQ X	0.001209	Story8	EQ X	0.001131	Story8	EQ X	0.001783
Story7	EQ X	0.001173	Story7	EQ X	0.001088	Story7	EQ X	0.001797
Story6	EQ X	0.001107	Story6	EQ X	0.001018	Story6	EQ X	0.001757
Story5	EQ X	0.001004	Story5	EQ X	0.000914	Story5	EQ X	0.001646
Story4	EQ X	0.000864	Story4	EQ X	0.000776	Story4	EQ X	0.001451
Story3	EQ X	0.000677	Story3	EQ X	0.0006	Story3	EQ X	0.001163
Story2	EQ X	0.000429	Story2	EQ X	0.000396	Story2	EQ X	0.00077
Story1	EQ X	0.000242	Story1	EQ X	0.000225	Story1	EQ X	0.000438



Model having lesser displacement comparably is the model 4 i.e. when shear walls are located in the intermediate position along X direction as a result resistance to the displacement offered by the building is more when compared with remaining all 5 models along X direction.

### 3.1.2 Story Drift:

It is nothing but the difference between storey displacements of one storey with respect to the other storey. As per codes its value should not exceed the limit of 0.004 of height of the storey. Its value is usually maximum at mid stories.

In model 5 location of shear wall is at the extreme end of the building along X direction, as a result story drift along X direction is reduced by that model 5 along X direction.

### 3.1.3 Story Stiffness:

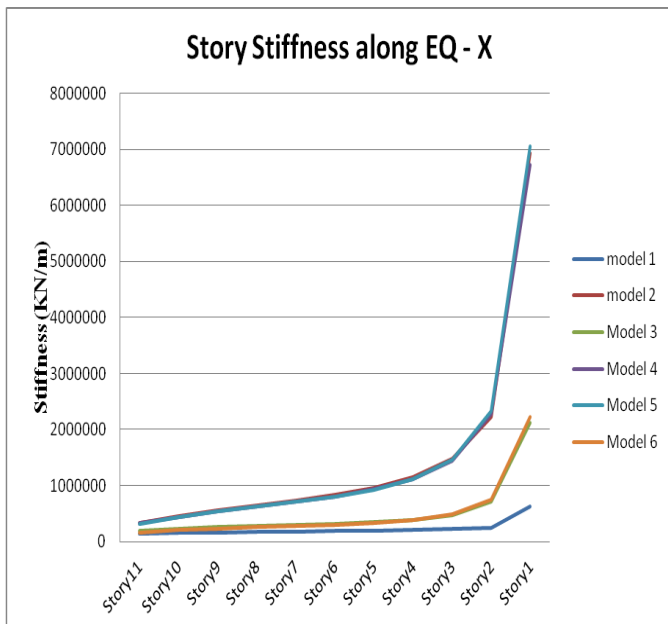
The lateral stiffness  $K_s$  of a story is generally defined as the ratio of story shear to story drift.

Story Stiffness along EQ - X								
Model 1			Model 2			Model 3		
Story	Load Case	Stiffness X	Story	Load Case	Stiffness X	Story	Load Case	Stiffness X
		kN/m			kN/m			kN/m
Story11	EQ X	143728.323	Story11	EQ X	334750.5	Story11	EQ X	185637.4
Story10	EQ X	156612.689	Story10	EQ X	456091.3	Story10	EQ X	232072.1
Story9	EQ X	163926.153	Story9	EQ X	554054.1	Story9	EQ X	260452.5
Story8	EQ X	168330.852	Story8	EQ X	640830.5	Story8	EQ X	280261.1
Story7	EQ X	177950.487	Story7	EQ X	728692.4	Story7	EQ X	298567
Story6	EQ X	184647.26	Story6	EQ X	827253.2	Story6	EQ X	318158.1
Story5	EQ X	194032.499	Story5	EQ X	954670.7	Story5	EQ X	344678.2
Story4	EQ X	212404.721	Story4	EQ X	1144461	Story4	EQ X	388142.6
Story3	EQ X	228348.078	Story3	EQ X	1474802	Story3	EQ X	467099.4
Story2	EQ X	253105.556	Story2	EQ X	2224983	Story2	EQ X	715113.3
Story1	EQ X	620609.536	Story1	EQ X	6941315	Story1	EQ X	2115000
Model 4			Model 5			Model 6		
Story	Load Case	Stiffness X	Story	Load Case	Stiffness X	Story	Load Case	Stiffness X
		kN/m			kN/m			kN/m
Story11	EQ X	323880.797	Story11	EQ X	318834.9	Story11	EQ X	157131.3
Story10	EQ X	442559.753	Story10	EQ X	437545.4	Story10	EQ X	203584.6
Story9	EQ X	538954.726	Story9	EQ X	534803.3	Story9	EQ X	234981.8
Story8	EQ X	623820.297	Story8	EQ X	620397.1	Story8	EQ X	258285
Story7	EQ X	709213.997	Story7	EQ X	705758.2	Story7	EQ X	280402.7
Story6	EQ X	805567.42	Story6	EQ X	801547.3	Story6	EQ X	304469.8
Story5	EQ X	931458.696	Story5	EQ X	926897.4	Story5	EQ X	337314.8
Story4	EQ X	1119624.86	Story4	EQ X	1117969	Story4	EQ X	391624.2
Story3	EQ X	1452601.44	Story3	EQ X	1462328	Story3	EQ X	490299.4
Story2	EQ X	2278398.4	Story2	EQ X	2334617	Story2	EQ X	749245.5
Story1	EQ X	6723816.31	Story1	EQ X	7053325	Story1	EQ X	2233035

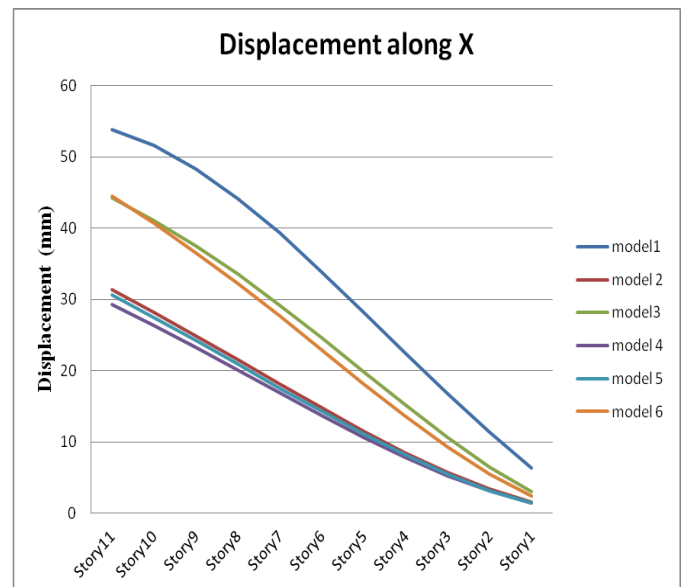
### 3.2 RESULTS AND GRAPHS FROM RSM:

#### 3.2.1 Storey Displacement:

Displacement along X								
Model 1			Model 2			Model 3		
Story	J Case/Cor	UX	Story	J Case/Cor	UX	Story	J Case/Cor	UX
Story11	EQ X	53.8	Story11	EQ X	31.389	Story11	EQ X	44.204
Story10	EQ X	51.596	Story10	EQ X	28.174	Story10	EQ X	41.021
Story9	EQ X	48.336	Story9	EQ X	24.895	Story9	EQ X	37.486
Story8	EQ X	44.175	Story8	EQ X	21.535	Story8	EQ X	33.542
Story7	EQ X	39.302	Story7	EQ X	18.138	Story7	EQ X	29.228
Story6	EQ X	33.872	Story6	EQ X	14.776	Story6	EQ X	24.637
Story5	EQ X	28.245	Story5	EQ X	11.533	Story5	EQ X	19.913
Story4	EQ X	22.48	Story4	EQ X	8.498	Story4	EQ X	15.198
Story3	EQ X	16.771	Story3	EQ X	5.762	Story3	EQ X	10.668
Story2	EQ X	11.419	Story2	EQ X	3.428	Story2	EQ X	6.546
Story1	EQ X	6.31	Story1	EQ X	1.591	Story1	EQ X	3.069
Model 4			Model 5			Model 6		
Story	J Case/Cor	UX	Story	J Case/Cor	UX	Story	J Case/Cor	UX
Story11	EQ X	29.333	Story11	EQ X	30.674	Story11	EQ X	44.481
Story10	EQ X	26.329	Story10	EQ X	27.494	Story10	EQ X	40.647
Story9	EQ X	23.234	Story9	EQ X	24.231	Story9	EQ X	36.561
Story8	EQ X	20.075	Story8	EQ X	20.913	Story8	EQ X	32.217
Story7	EQ X	16.89	Story7	EQ X	17.58	Story7	EQ X	27.644
Story6	EQ X	13.739	Story6	EQ X	14.291	Story6	EQ X	22.923
Story5	EQ X	10.703	Story5	EQ X	11.122	Story5	EQ X	18.188
Story4	EQ X	7.86	Story4	EQ X	8.155	Story4	EQ X	13.579
Story3	EQ X	5.304	Story3	EQ X	5.486	Story3	EQ X	9.281
Story2	EQ X	3.127	Story2	EQ X	3.219	Story2	EQ X	5.509
Story1	EQ X	1.431	Story1	EQ X	1.463	Story1	EQ X	2.493



Model having lesser story stiffness comparably is the model 1 i.e. when no shear walls are located, lower the stiffness more flexible the structure.



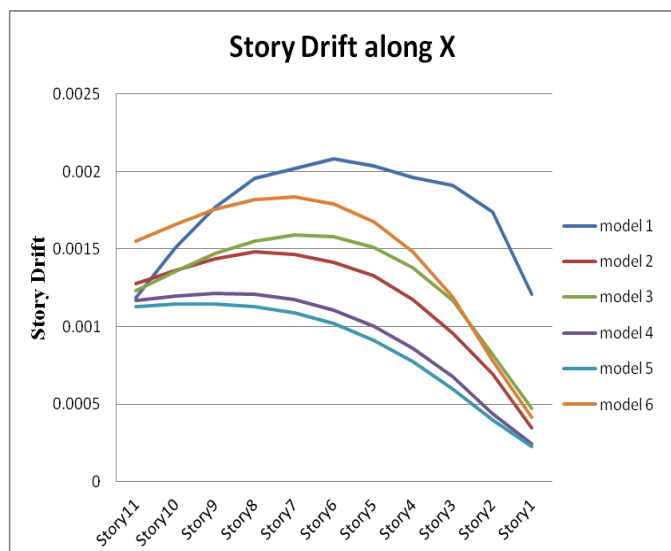
Model having lesser displacement comparably is the model 4 i.e. when shear walls are located in the intermediate position along X direction as a result resistance to the displacement offered by the building is more when compared with remaining all 5 models along X direction.

### 3.2.2 Story Drift:

Story Drift along X								
Model 1			Model 2			Model 3		
Story	Case/Cor	Drift	Story	Case/Cor	Drift	Story	Case/Cor	Drift
Story11	EQ.X	0.001187	Story11	EQ.X	0.001275	Story11	EQ.X	0.001232
Story10	EQ.X	0.001514	Story10	EQ.X	0.001361	Story10	EQ.X	0.001359
Story9	EQ.X	0.001766	Story9	EQ.X	0.001437	Story9	EQ.X	0.001472
Story8	EQ.X	0.001956	Story8	EQ.X	0.00148	Story8	EQ.X	0.001554
Story7	EQ.X	0.002022	Story7	EQ.X	0.001467	Story7	EQ.X	0.001589
Story6	EQ.X	0.002083	Story6	EQ.X	0.001416	Story6	EQ.X	0.001578
Story5	EQ.X	0.002039	Story5	EQ.X	0.001326	Story5	EQ.X	0.001512
Story4	EQ.X	0.001962	Story4	EQ.X	0.001173	Story4	EQ.X	0.001381
Story3	EQ.X	0.001912	Story3	EQ.X	0.00096	Story3	EQ.X	0.00117
Story2	EQ.X	0.00174	Story2	EQ.X	0.000697	Story2	EQ.X	0.000822
Story1	EQ.X	0.001207	Story1	EQ.X	0.000348	Story1	EQ.X	0.000474

Story	Case/Cor	Drift	Story	Case/Cor	Drift	Story	Case/Cor	Drift
Story11	EQ.X	0.001167	Story11	EQ.X	0.001126	Story11	EQ.X	0.001552
Story10	EQ.X	0.001197	Story10	EQ.X	0.001143	Story10	EQ.X	0.00166
Story9	EQ.X	0.001214	Story9	EQ.X	0.001147	Story9	EQ.X	0.001756
Story8	EQ.X	0.001209	Story8	EQ.X	0.001131	Story8	EQ.X	0.001821
Story7	EQ.X	0.001173	Story7	EQ.X	0.001088	Story7	EQ.X	0.001835
Story6	EQ.X	0.001107	Story6	EQ.X	0.001018	Story6	EQ.X	0.001793
Story5	EQ.X	0.001003	Story5	EQ.X	0.000914	Story5	EQ.X	0.001679
Story4	EQ.X	0.000862	Story4	EQ.X	0.000776	Story4	EQ.X	0.001481
Story3	EQ.X	0.000675	Story3	EQ.X	0.0006	Story3	EQ.X	0.00119
Story2	EQ.X	0.000435	Story2	EQ.X	0.000397	Story2	EQ.X	0.000781
Story1	EQ.X	0.000244	Story1	EQ.X	0.000225	Story1	EQ.X	0.000416



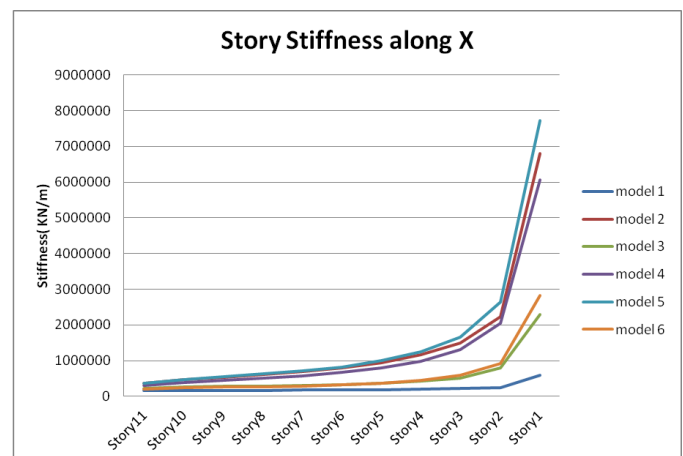
In model 5 location of shear wall is at the extreme end of the building along X direction, as a result story drift along X direction is reduced by that model 5 along X direction

### 3.2.3 Story Stiffness:

Story Stiffness along X								
Model 1			Model 2			Model 3		
Story	Load Case	Stiffness X (kN/m)	Story	Load Case	Stiffness X (kN/m)	Story	Load Case	Stiffness X (kN/m)
Story11	RX	153281	Story11	RX	358210.9	Story11	RX	232466.6
Story10	RX	159169.4	Story10	RX	464879.1	Story10	RX	266799.2
Story9	RX	162534.7	Story9	RX	540127.6	Story9	RX	282849.9
Story8	RX	165184.3	Story8	RX	607089.9	Story8	RX	293224.6
Story7	RX	173586.9	Story7	RX	685024	Story7	RX	306601.8
Story6	RX	180095.7	Story6	RX	789439.5	Story6	RX	328755.7
Story5	RX	189758.1	Story5	RX	939124.6	Story5	RX	363979
Story4	RX	206637.4	Story4	RX	1155774	Story4	RX	420097.9
Story3	RX	219357.4	Story3	RX	1502949	Story3	RX	515489.7
Story2	RX	241642.6	Story2	RX	2225439	Story2	RX	794240.2
Story1	RX	595456.5	Story1	RX	6792448	Story1	RX	2291725

Model 4			Model 5			Model 6		
Story	Load Case	Stiffness X (kN/m)	Story	Load Case	Stiffness X (kN/m)	Story	Load Case	Stiffness X (kN/m)
Story11	RX	302308.7	Story11	RX	362585.2	Story11	RX	200435
Story10	RX	392588	Story10	RX	474290.9	Story10	RX	235838
Story9	RX	456949.6	Story9	RX	554559.4	Story9	RX	254962.5
Story8	RX	514196.5	Story8	RX	625297.7	Story8	RX	269584.1
Story7	RX	581552.6	Story7	RX	709638.5	Story7	RX	289018
Story6	RX	671238.1	Story6	RX	825380.3	Story6	RX	320721.5
Story5	RX	798893.3	Story5	RX	992141.1	Story5	RX	370506.9
Story4	RX	987842.2	Story4	RX	1242973	Story4	RX	449179.4
Story3	RX	1304355	Story3	RX	1665718	Story3	RX	587592.2
Story2	RX	2047289	Story2	RX	2650889	Story2	RX	916491.5
Story1	RX	6058719	Story1	RX	7726558	Story1	RX	2832203



Model having lesser story stiffness comparably is the model 1 i.e. when no shear walls are located, lower the stiffness more flexible the structure.

### 4. CONCLUSIONS

Following conclusions are drawn based on the work carried out

1. From the results it is evident that storey displacement values are maximum at top story.
2. Story drift values initially goes on increases with increase in height of story till the maximum value is reached and then drift value starts to decrease even though there is increase in the story height.
3. Story stiffness of a structure at the bottom story is more when compared with top story, as s story height increases

drift value decreases drastically initially and then it has decreased gradually.

4. Model without shear wall has more displacement, more story drift and has lesser stiffness when compared to remaining all 5 models with shear wall.

5. Comparing all models model 4 i.e. location of shear wall at position 3 has less story drift, less displacement and medium stiffness value when compared to remaining all 5 models along X direction for both equivalent static method and response spectrum method.

6. Model 3 and model 6 i.e. location of shear wall at position 2 and 5 respectively also has shown less story drift, less displacement and medium stiffness value when compared to remaining all 5 models along Y direction for both equivalent static method and response spectrum method.

7. By comparing both the methods Response spectrum analysis has shown less displacement and less story drift values when compared to ESA method.

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