

Seismic Performance of High Rise Building with Slits in Shear Wall Using E-TABS

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ABSTRACT: Shear walls are the excellent means of providing earthquake resistance to multi-storeyed reinforced concrete building. Behaviour of structure during earthquake force depends on distribution of weight, Stiffness and strength in both horizontal planes of building. The stiffness of the wall directly contributes to improve in lateral resistance of reinforced concrete frame. However, flexible structures are recommended when the buildings are subjected to high magnitude of earthquake. In this criteria opening are implemented in shear wall to dissipating energy and change them to flexible structures. The present study focuses the how the openings affects the performance of shear wall when subjected to lateral load by using dynamic analysis and comparison at zone II, zone III in ETABS.

KEYWORDS: Shear wall opening, dissipating energy, displacements, flexible structures.

I. INTRODUCTION

Reinforced concrete shear walls are widely used in high rise buildings to resist the lateral loads. When a shear wall is subjected to lateral load it acts as a vertical cantilever beam. The maximum displacement is occurred due to horizontal load at the top of the structure. Most of the stiffness resources of the wall remain unused. By some method if the stiffness of the shear wall is to be increased, its performance during the earthquake can be improved. Slits are introduced in shear walls to dissipating energy. Opening shear walls are connected together by shear connectors. The ductility of the shear wall is used until shear connectors yield first. Then shear walls changes from rigid to flexible during the earthquake.

II. RELATED WORK

1. Vishal A. Itware and Dr. Uttam B. Kalwane (2015) studied the effects of openings in shear wall on seismic response of structure. A regular structure of 6 and 12 storied 7x3 bays apartment buildings with typical floor plan of 35mx15m and floor height of 3m with different openings size and location in shear walls were modelled in STAAD pro.

2. Seyed M. Khatami (2012) studied the comparing effects of openings in concrete shear walls under near-fault ground motions in this paper. A regular structure G+9 was modelled with 5x3 bays, having the area of 25m X 12m, storey height 3m, three different types of lateral resisting systems complete shear walls, shear walls with square opening in the centre and shear wall with opening at right end side. Studied models were analyzed with nonlinear software SAP 2000 and ANSYS under the two mentioned records.

3. Makoto warashina and susumukono (2008) studied the shear behaviour of multi storey RC storey walls with eccentric openings. Specimen configuration was determined from a typical six-storey building. The study is done by using FEM analytical method.

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OBJECTIVES

The present work is focused on the study of seismic performances of G+11 multi storey structures when retrofitted with shear wall and with staggered openings of shear wall under influence of two seismic zones (Zone-II, III). The analysis will be done in both dynamic analysis (Response Spectrum Analysis).

III. METHODOLOGY

The methodology adopted for this study is, first modelling the considered structure in ETABS 2016 software and analyzing the same by Response Spectrum Method. The seismic analysis in India is done as according to the IS 1893 (Part 1).

Response spectrum analysis- The Response Spectrum method consists of determining the response in each mode of vibration and their superimposing the responses in various modes to obtain the total response. The seismic analysis of all buildings is carried out by Response Spectrum Method according to IS 1893:2002^[3] (part 1), including the effect of eccentricity (static and accidental). Damping considered for all modes of vibration was 5%.

Plan Details

Description of the structure:

No. of storeys – G+11
Type of building – Residential
Plan dimensions – 30m X 35m
Height of the ground floor – 1.5m
Height of each floor – 3.2m
Thickness of slab – 150mm
Wall thickness – 230mm
Shear wall thickness – 250mm
Beams – 230mm X 375mm
Columns – 450mm X 300mm
Self-weight – $0.15 \times 25 = 3.75 \text{ Kn/m}^2$
Floor finish –
Unexpected load –
Cement grade – M25
Steel grade – Fe415

Earthquake parameters

Type of frame – SMRF
Seismic zones – zone II (0.10), zone III (0.16)
Importance factor – 1
Response reduction factor – 5
Percentage of damping – 5%
Soil type – Medium

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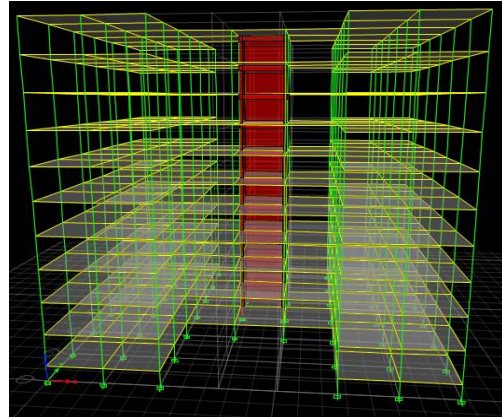
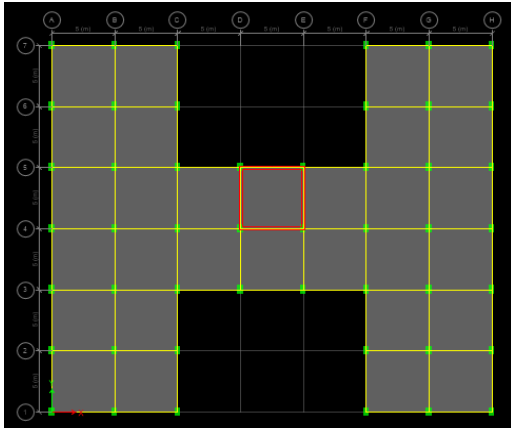


Fig 1 Plan view shear wall building without staggered openings **Fig 2** 3D view shear wall building without staggered openings

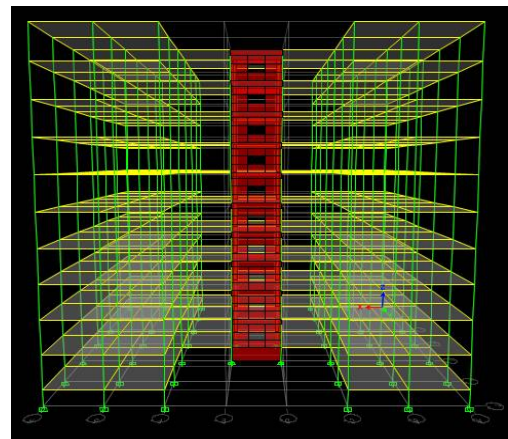
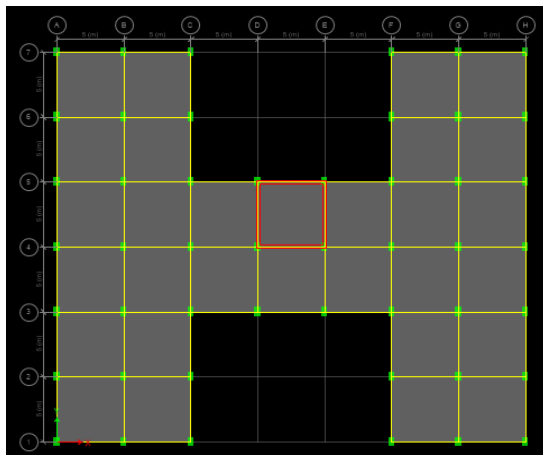


Fig 3 Plan view shear wall building with staggered openings **Fig 4** 3D view shear wall building with staggered openings

Model 1: G+11 residential building without staggered openings in shear wall at Centre position analysed in zone 2 as shown in fig 1.

Model 2: G+11 residential building with staggered openings in shear wall at Centre position analysed in zone 2 as shown in fig 3.

Model 3: G+11 residential building without staggered openings in shear wall at Centre position analysed in zone 3 as shown in fig 2.

Model 4: G+11 residential building with staggered openings in shear wall at Centre position analysed in zone 3 as shown in fig 4.

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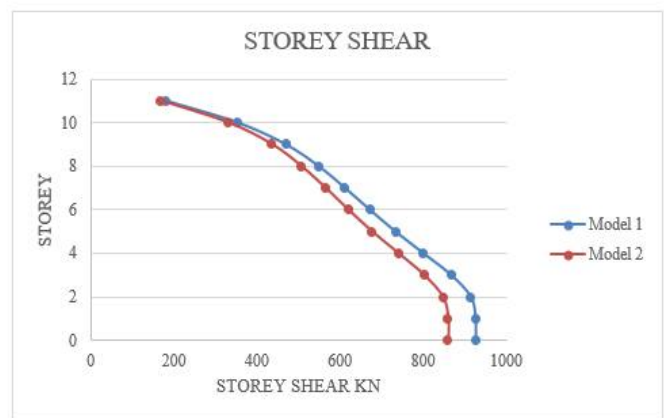
IV. RESULTS AND DISCUSSIONS

Storey shear:

The response of both the models in case of storey shear are observed. From the result it have been seen that storey shear decreases 8% in X – direction and 10.01% Y- direction due to provision of openings at zone II.

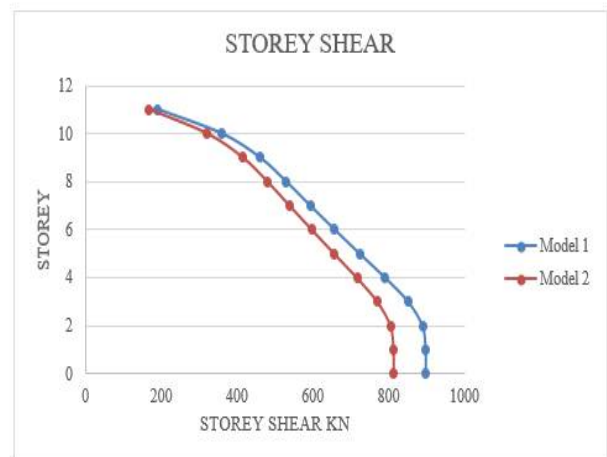
X- Direction :-

Storey	Elevation	Model 1	Model 2
	M	KN	KN
Base	0	925.8555	859.6714
Storey1	1.5	925.8555	859.6714
Storey2	4.7	914.9534	847.3229
Storey3	7.9	867.9306	802.4485
Storey4	11.1	800.8357	740.5576
Storey5	14.3	733.3785	676.7714
Storey6	17.5	671.6741	619.4379
Storey7	20.7	611.6997	564.7301
Storey8	23.9	548.2838	506.2145
Storey9	27.1	468.7324	435.8029
Storey10	30.3	352.5248	329.8785
Storey11	33.5	179.5072	167.9781



Y- direction:

Storey	Elevation	Model 1	Model 2
	M	KN	KN
Base	0	897.8701	813.8107
Storey1	1.5	897.8701	813.8107
Storey2	4.7	889.3687	805.5912
Storey3	7.9	851.6435	770.7841
Storey4	11.1	791.0753	716.605
Storey5	14.3	723.5308	656.5317
Storey6	17.5	657.4409	597.1564
Storey7	20.7	592.7854	538.5166
Storey8	23.9	529.3748	480.2236
Storey9	27.1	460.056	415.084
Storey10	30.3	358.5963	320.3661
Storey11	33.5	190.6119	168.3302



The response of both the models in case of storey shear are observed. From the result it have been seen that storey shear decreases 1% in X – direction and 4.09% Y- direction due to provision of openings at zone III.

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Vol. 6, Issue 8, August 2017

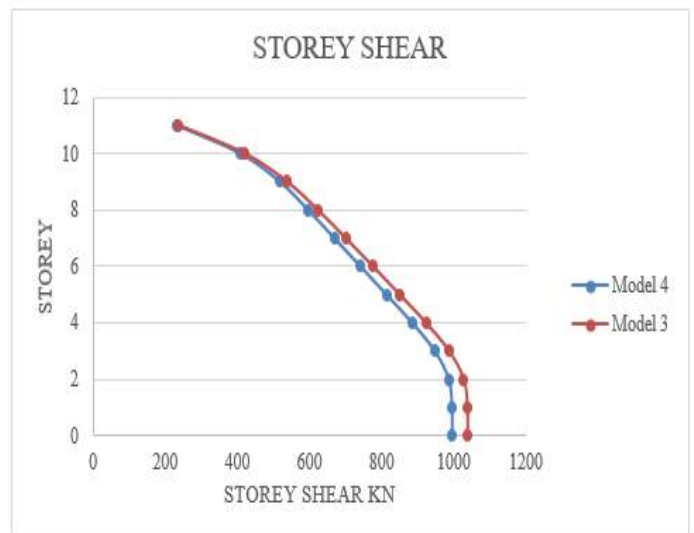
X- direction:

Storey	Elevation	Modal 3	Modal 4
	M	KN	KN
Base	0	1220.082	1218.53
Storey1	1.5	1220.082	1218.53
Storey2	4.7	1208.465	1208.716
Storey3	7.9	1161.424	1162.585
Storey4	11.1	1091.958	1092.496
Storey5	14.3	1013.277	1014.303
Storey6	17.5	932.0381	932.8156
Storey7	20.7	845.0748	844.9602
Storey8	23.9	746.6427	746.5039
Storey9	27.1	629.5726	626.8887
Storey10	30.3	472.386	467.8298
Storey11	33.5	252.7306	249.2797



Y- direction:

Storey	Elevation	Modal 3	Modal 4
	M	KN	KN
Base	0	1036.857	995.7067
Storey1	1.5	1036.857	995.7067
Storey2	4.7	1027.151	986.9395
Storey3	7.9	986.7048	948.4598
Storey4	11.1	922.8517	885.7878
Storey5	14.3	850.1192	814.1126
Storey6	17.5	775.8125	741.8479
Storey7	20.7	700.1402	669.2827
Storey8	23.9	623.0373	596.6182
Storey9	27.1	537.6431	517.9216
Storey10	30.3	419.4122	408.1351
Storey11	33.5	235.7203	231.4863



Displacements:

The response of both the models in case of displacements are observed. From the result it have been seen that displacements increases 7.8% in X- direction and 17.6%in Y- direction due to provision of openings at zone II.

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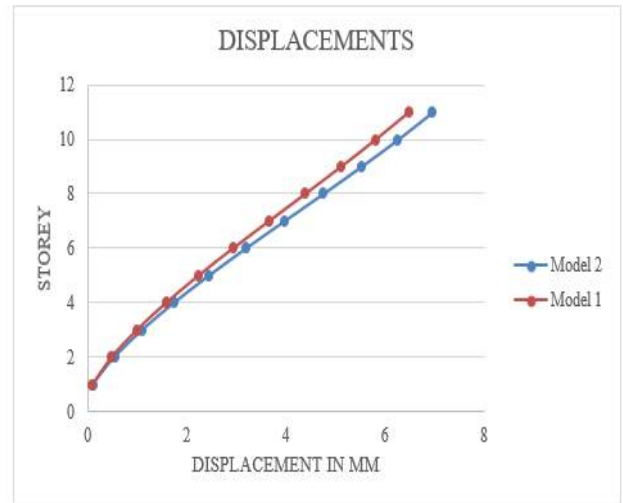
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Vol. 6, Issue 8, August 2017

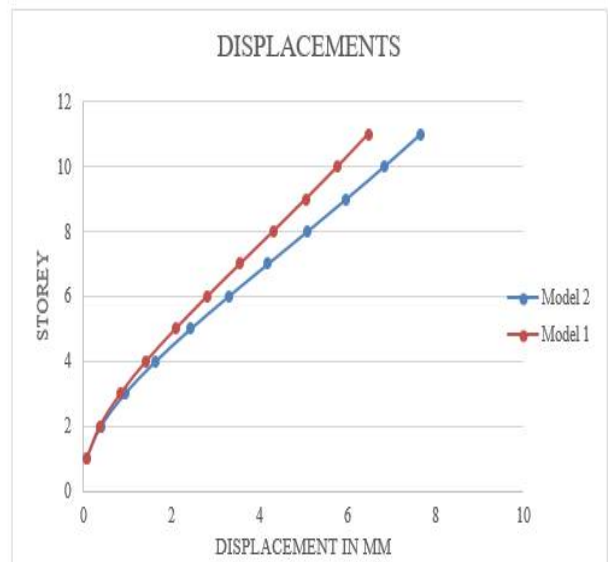
X- direction:

Storey	Elevation	Model 1	Model 2
	M	MM	MM
Storey1	1.5	0.098	0.1
Storey2	4.7	0.486	0.542
Storey3	7.9	0.994	1.1
Storey4	11.1	1.586	1.743
Storey5	14.3	2.239	2.447
Storey6	17.5	2.935	3.195
Storey7	20.7	3.658	3.97
Storey8	23.9	4.389	4.751
Storey9	27.1	5.111	5.52
Storey10	30.3	5.811	6.261
Storey11	33.5	6.476	6.955



Y-direction:

Storey	Elevation	Model 1	Model 2
	M	MM	MM
Storey1	1.5	0.062	0.063
Storey2	4.7	0.362	0.394
Storey3	7.9	0.828	0.938
Storey4	11.1	1.415	1.635
Storey5	14.3	2.086	2.435
Storey6	17.5	2.807	3.298
Storey7	20.7	3.555	4.191
Storey8	23.9	4.309	5.089
Storey9	27.1	5.053	5.973
Storey10	30.3	5.779	6.834
Storey11	33.5	6.475	7.662



The response of both the models in case of displacements are observed. From the result it have been seen that displacements increases 1% in X- direction and 4% in Y- direction due to provision of openings at zone III.

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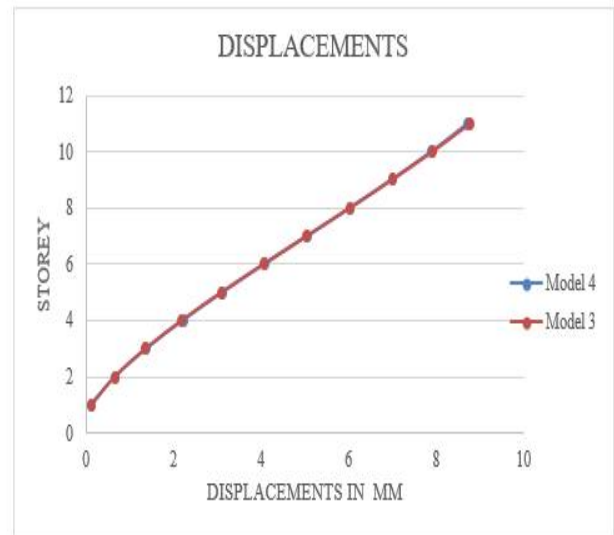
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Vol. 6, Issue 8, August 2017

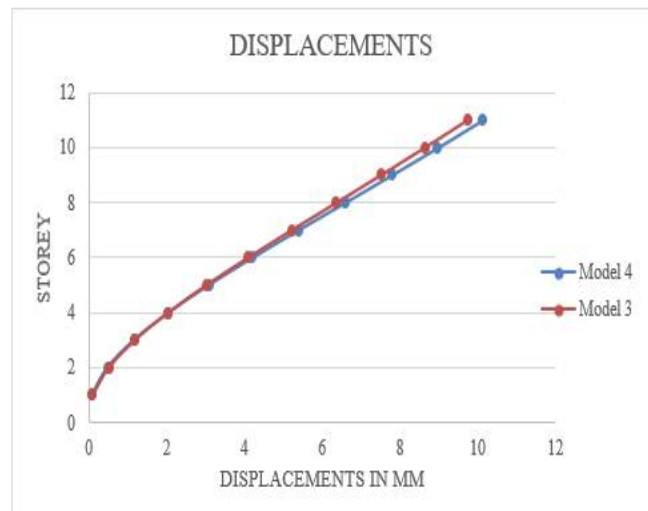
X-direction:

Storey	Elevation	Modal 3	Modal 4
	M	MM	MM
Storey1	1.5	0.124	0.119
Storey2	4.7	0.656	0.676
Storey3	7.9	1.361	1.393
Storey4	11.1	2.189	2.224
Storey5	14.3	3.098	3.132
Storey6	17.5	4.06	4.088
Storey7	20.7	5.047	5.067
Storey8	23.9	6.035	6.043
Storey9	27.1	6.999	6.993
Storey10	30.3	7.923	7.9
Storey11	33.5	8.78	8.729



Y- direction:

Storey	Elevation	Modal 3	Modal 4
	M	MM	MM
Storey1	1.5	0.088	0.077
Storey2	4.7	0.507	0.481
Storey3	7.9	1.174	1.162
Storey4	11.1	2.027	2.048
Storey5	14.3	3.014	3.08
Storey6	17.5	4.089	4.207
Storey7	20.7	5.217	5.388
Storey8	23.9	6.365	6.591
Storey9	27.1	7.512	7.79
Storey10	30.3	8.64	8.971
Storey11	33.5	9.738	10.121



Stiffness:

The response of both the models in case of stiffness are observed. From the result it have been seen that stiffness increases 2.10% in x direction and 4.23% in Y- direction due to provision of openings at zone II.

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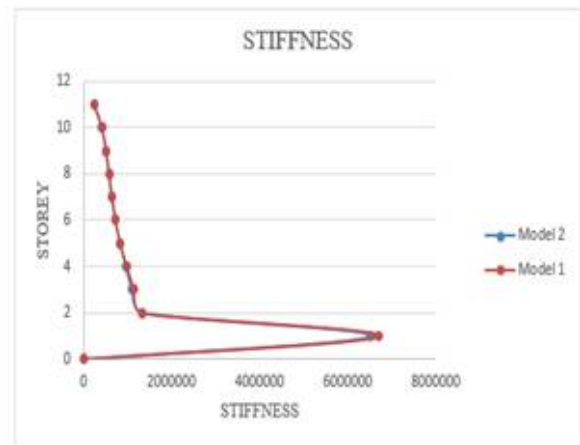
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Vol. 6, Issue 8, August 2017

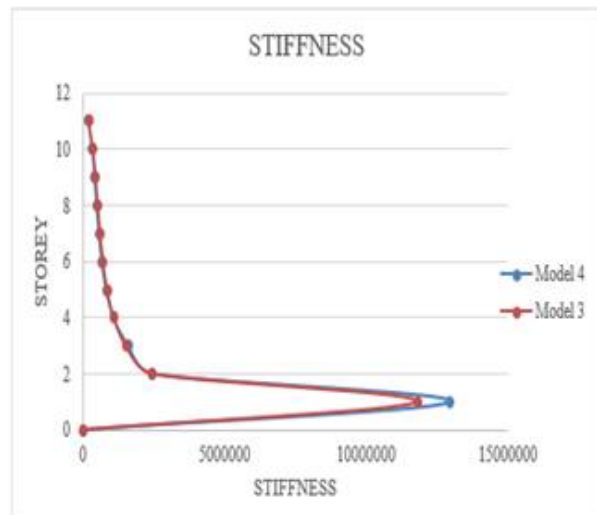
X-direction:

Storey	Elevation	Modal 1	Modal 2
	M	<u>kN/m</u>	<u>kN/m</u>
Base	0	0	0
Storey1	1.5	13027544	14183189
Storey2	4.7	2686604	2682542
Storey3	7.9	1702702	1805833
Storey4	11.1	1234991	1222959
Storey5	14.3	981180.4	938929.4
Storey6	17.5	821548.6	772330.7
Storey7	20.7	709741.8	660469.8
Storey8	23.9	624270.7	577838.8
Storey9	27.1	544380.9	504942.3
Storey10	30.3	430957.8	402366.5
Storey11	33.5	235936.4	222011.3



Y-direction:

Storey	Elevation	Model 1	Model 2
	M	<u>kN/m</u>	<u>kN/m</u>
Base	0	0	0
Storey1	1.5	6703358	6507598
Storey2	4.7	1325709	1332142
Storey3	7.9	1146983	1101579
Storey4	11.1	982516.2	960188.3
Storey5	14.3	832691.1	831896.5
Storey6	17.5	728105.9	723381.6
Storey7	20.7	648022.7	642065.6
Storey8	23.9	582986.5	574693.1
Storey9	27.1	515900.8	510362.9
Storey10	30.3	415947.1	411850.5
Storey11	33.5	237238.7	233012.4



The response of both the models in case of stiffness are observed. From the result it have been seen that stiffness increases 1.98% in x direction and 4.8% in Y- direction due to provision of openings at zone III.

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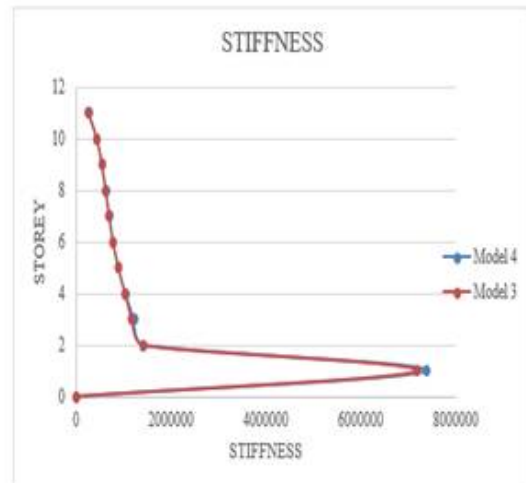
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Vol. 6, Issue 8, August 2017

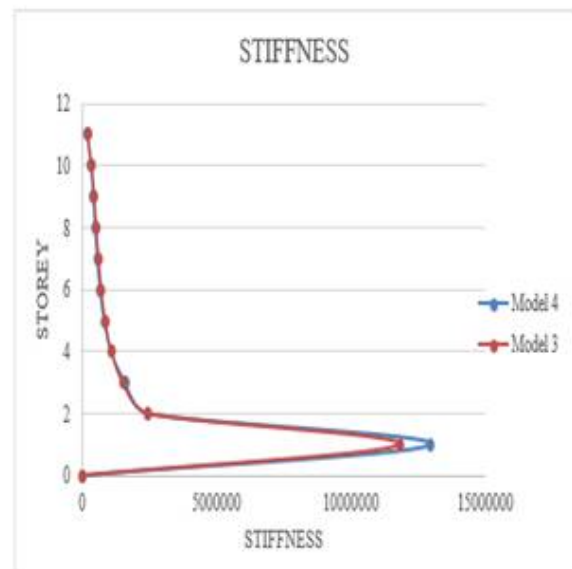
X-direction:

Storey	Elevation	Modal 3	Modal 4
	M	kN/m	kN/m
Base	0	0	0
Storey1	1.5	11802611	12964551
Storey2	4.7	2448083	2435874
Storey3	7.9	1522336	1615004
Storey4	11.1	1095730	1081337
Storey5	14.3	864858.5	823306.8
Storey6	17.5	718850.4	670985.1
Storey7	20.7	615291.7	567835.3
Storey8	23.9	534794	490764.9
Storey9	27.1	460941.1	423669.4
Storey10	30.3	365196.9	337575.7
Storey11	33.5	210676.9	196166.2



Y- direction:

Storey	Elevation	Modal 3	Modal 4
	M	kN/m	kN/m
Base	0	0	0
Storey1	1.5	7186340	7378471
Storey2	4.7	1411996	1420580
Storey3	7.9	1177764	1225807
Storey4	11.1	1037613	1046283
Storey5	14.3	894605	895641.3
Storey6	17.5	784186.2	788996.8
Storey7	20.7	698616.8	706376.3
Storey8	23.9	624686.2	633586.9
Storey9	27.1	546907.9	554415.5
Storey10	30.3	442298.8	448293.2
Storey11	33.5	268046.6	272572



V. CONCLUSION

Based on the analytical study carried out following conclusions are arrived at

- i. The opening greatly influences the deformation characteristics of the shear wall structure.
- ii. In the study, the solid shear walls absorb more energy than the slits shear walls in the structure.
- iii. In the study, deformation is delayed in the slit shear wall when compared to the solid shear wall.
- iv. The decrease in the storey shear of the opening shear wall structure is lesser than the solid shear wall structure.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 6, Issue 8, August 2017

- v. The displacements of the opening shear wall slit variation, when compared to the solid shear wall structure.
- vi. The increase in the stiffness of the opening shear wall structure is greater than the solid shear wall structure.
- vii. The opening shear wall decreasing the lateral load carrying capacity when compared to the solid shear wall.

REFERENCES

- [1] Vishal A. Itware, Dr. Uttam B. Kalwane "Effects of Openings in Shear Wall on Seismic Response of Structure" International Journal of Engineering Research and Applications ISSN: 2248-9622, Vol. 5, Issue 7, (Part - 1) July 2015.
- [2] Makoto warashina and susumukono "Shear storey of multi storey RC storey walls with eccentric openings" World Conference on Earthquake Engineering October 2008.
- [3] SeyedM.Khatami, Alireza Mortezaei "Comparing effects of openings in concrete shear walls under near-fault ground motions" World Conference on Earthquake Engineering October 2012.
- [4] SuchitaTuppad, R.J.Fernandes "Optimum location of shear wall in a multi-storey building subjected to seismic behavior using genetic algorithm" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 02 Issue: 04 Jul-2015 p-ISSN: 2395-0072.
- [5] R.S.Mishra, V.Kushwaha, S.Kumar "A Comparative Study of Different Configuration of Shear Wall Location in Soft Story Building Subjected to Seismic Load" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 02 Issue: 04 Oct-2015 p-ISSN: 2395-0072.
- [6] Ms. Priyanka Soni, Mr. Purushottam Lal Tamrakar, VikkyKumhar "Structural Analysis of Multistory Building of Different shear Walls Location and Heights" International Journal of Engineering Trends and Technology (IJETT) – Volume 32 Number 1- February 2016.
- [7] Harish J N, Arunkumar B N "Effect of Lateral Load Resisting Systems in High Rise Buildings in Seismic Zone IV" International Journal of Engineering Science and Computing, Volume 6 Issue No. 6 June 2016.
- [8] TarunMagendra, AbhyudayTitiksh, A.A. Qureshi "Minimizing the Effects of Lateral Loads on Multistorey Structure by Optimum Positioning of Shear Walls" Journal of Structural Technology Volume 1 Issue 2.