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SEISMIC ANALYSIS AND COMPARATIVE STUDY OF A STRUCTURE WITH SHEARWALL AND WITHOUT SHEARWALL FRAME SYSTEM

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Abstract-*The main objective of the research work presented in this paper is to study the seismic behavior and to compare the results of buildings with reinforced concrete shearwall and without shearwall. Three buildings with same plan and equal number of storeys with two different configurations of shearwalls and one structure with no shearwall are considered. A brief review of design concept is presented and need of shear wall, effect of earthquake are discussed.Response spectrum analysis has been done to buildings with different configurations of shearwall with same plan.The storey displacements are obtained and compared to each other for different models to meet the shear wall effect.The analysis and design of models are done according to IS codes in an eco friendly software ETAB 2015.*

Key Words: - Etabs , Response spectrum,Shearwall, Stiffness, Story drifts

1. INTRODUCTION

Shear walls are vertical elements that resists the horizontal forces. Shear walls are like vertically-oriented wide beams that carry earthquake loads , wind loads and transfers them to the foundation. Shear wall system is often used for resisting the lateral forces caused by seismic excitation, because of their high stiffness and strength. Shear wall can be used effectively for controlling the drift against seismic loads acting on them.

1.1 MODEL CONFIGURATION

Three buildings with thirty five story regular reinforced concrete building are considered in seismic zone IV. The beam length in (x) transverse direction are 6m ,and beams in (y) direction are of length 6m. Figure 1 and 2 shows the plan and 3D view of the thirty five story building having 7 bays in x-direction and seven bays in y-direction upto twenty story and five bays in x-direction and five bays in y-direction from story twenty one to thirty five. Story height of each building is assumed 3m.Beam cross section 450X600 mm and Column cross section is 750x750 mm (upto 10 floors), 600x600 (from 11th story to 20th storey) and 450x450 above.

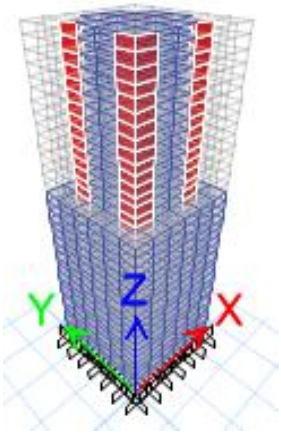

Fig-1.1:Building1

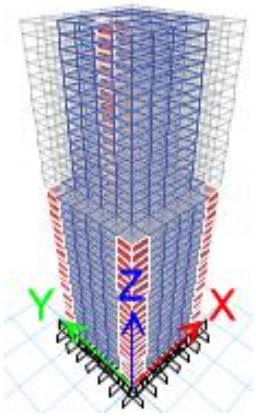

Fig-1.2:Buildind2

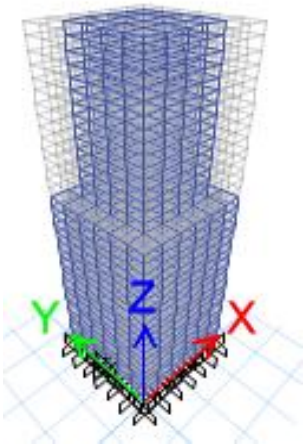

Fig-1.3:Building 3 without shearwall

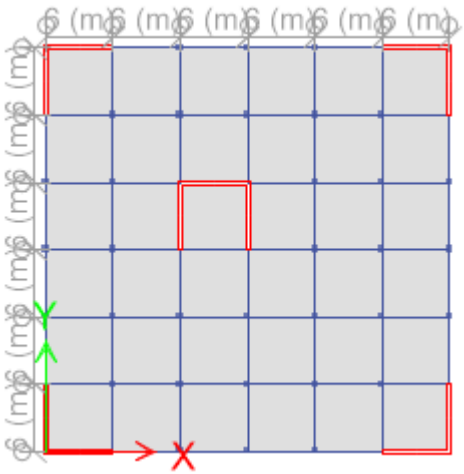

Fig-1.4:Plan Of Building 2

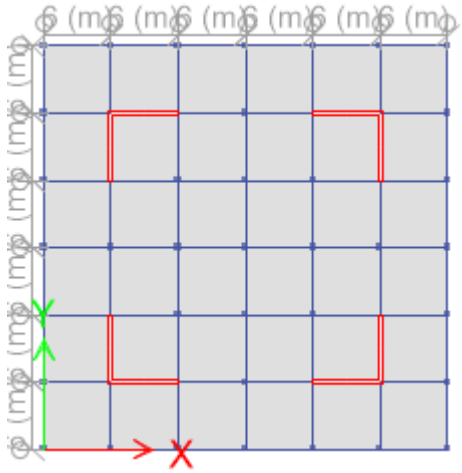

Fig-1.5:Plan Of building 1

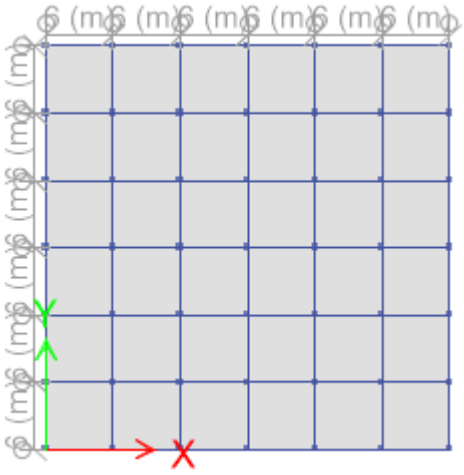

Fig-1.6:Plan Of Building3

1.2 TIME PERIOD

IS-1893-2016 defines different Sa/g values for different values of approximate time period (T).
The fundamental natural period (Ta) is taken for moment resisting frame building without brick infill panels as $Ta = 0.075h^{0.75}$, Where, h = Height of the building in m

Table 1.1- Time Period for Building 1,2 and 3 .

Time Period	Building 1	Building 2	Building 3
Global x	2.46sec	2.46sec	2.46sec
Global y	2.46sec	2.46sec	2.46sec

1.3 DESIGN BASE SHEAR

The design base shear of a building can be calculated by using the code IS-1893-2002

$V_b = A_h * W$

Where A_h=design horizontal seismic coefficient

W= seismic weight

The Design horizontal seismic coefficient (Ah) is a function of peak ground acceleration (z), Importance Factor (I), Response Reduction Factor (R) and Design acceleration coefficient (Sa/g) for different types of soil normalized corresponding to 5 % damping.

$$A_h = \frac{Z I S_a}{2 R g}$$

Sa/g values for medium soil according to IS-1893-2002

For medium soil sites

$$\frac{S_a}{g} = \begin{cases} 1 + 15T; & 0.00 \le T \le 0.10 \\ 2.50 & 0.10 \le T \le 0.55 \\ 1.36/T & 0.55 \le T \le 4.00 \end{cases}$$

Table 1.2- Design Base Shear of Building 1,2 and 3 for Equivalent Static Load

Design base shear	Building 1	Building 2	Building 3
Global X(KN)	4524.8659	4647.1664	1949.8072
Global Y(KN)	4507.9978	4860.1705	1894.1824

1.4 STIFFNESS

Table-1.3:Story Stiffness in x direction for equalent static loads

Story	SW2	SW1	WSW
Story35	118793.7	120253.7	177090.4
Story34	248371.8	231602	264527.4
Story33	366247.6	321026.3	309371.3
Story32	471965.9	391462.8	337344.7
Story31	566407.5	447765	356611.4
Story30	650790.7	493787.8	370874.1
Story29	726590	532496.3	382037.7
Story28	795403.3	566181.5	391199.9
Story27	858858.6	596746.5	399041.5
Story26	918594.3	626009	406011.8
Story25	976279.2	656094.7	412431.8
Story24	1033621	690058.6	418554
Story23	1092718	733406.6	425075.7
Story22	1155339	795987.3	435797.6
Story21	1227680	922322.9	508573
Story20	1381498	1476312	1228143
Story19	1482575	1589763	1251401
Story18	1585220	1700410	1264875
Story17	1678840	1803913	1273926
Story16	1767401	1904355	1282296
Story15	1852962	2004154	1290421
Story14	1938149	2106076	1298612
Story13	2025946	2213332	1307026
Story12	2119832	2330048	1315901
Story11	2225127	2459581	1325328
Story10	2340574	2617225	1337849
Story9	2512603	2811380	1526922
Story8	2678568	3026401	1541771
Story7	2902680	3306739	1558958
Story6	3198674	3677287	1588130
Story5	3616874	4197985	1654464
Story4	4255396	4988078	1848429
Story3	5354901	6339829	2712356
Story2	7675323	9175584	9790680
Story1	16868653	20218692	9787738
Base	0	0	0

Table -1.4Storey Stiffness in Y Direction for equalent static loads

Story	SW2	SW1	WSW
Story35	109819.6	118793.7	176903.3
Story34	220006.3	248371.8	264322
Story33	316896.7	366247.6	309180.8
Story32	400453.5	471965.9	337170.6
Story31	472488.3	566407.5	356451.3
Story30	535119.8	650790.7	370725.3
Story29	590571.8	726590	381898
Story28	641014	795403.3	391067.4
Story27	688548.8	858858.6	398914.5
Story26	735282.7	918594.3	405889.2
Story25	783481.4	976279.2	412312.4
Story24	835811.1	1033621	418436.9
Story23	895917.9	1092718	424959.1
Story22	968583.5	1155339	435674.7
Story21	1068614	1227680	508338.4
Story20	1390491	1381498	1226435
Story19	1504897	1482575	1249737
Story18	1618667	1585220	1263255
Story17	1724348	1678840	1272349
Story16	1825441	1767401	1280750
Story15	1924372	1852962	1288895

Story14	2024081	1938149	1297098
Story13	2127940	2025946	1305513
Story12	2240151	2119832	1314382
Story11	2364400	2225127	1323796
Story10	2514230	2340574	1336297
Story9	2698239	2512603	1524914
Story8	2905313	2678568	1539730
Story7	3175510	2902680	1556866
Story6	3535163	3198674	1585953
Story5	4045141	3616874	1652073
Story4	4828176	4255396	1845557
Story3	6188443	5354901	2705164
Story2	9112720	7675323	9789972
Story1	20854936	16868653	9787049
Base	0	0	0

1.5 MAXIMUM STORY DISPLACEMENTS

Table-1.5:Max Displacement in Y Direction

story	WSW	SW1	SW2
Story35	111.432	70.293	77.939
Story34	109.978	68.087	75.615
Story33	108.007	65.848	73.16
Story32	105.52	63.574	70.566
Story31	102.547	61.258	
Story30	99.12	58.896	64.92
Story29	95.272	56.489	61.872
Story28	91.034	54.039	58.687
Story27	86.439	51.55	55.381
Story26	81.518	49.03	51.974
Story25	76.301	46.486	48.494
Story24	70.82	43.929	44.97
Story23	65.106	41.373	41.443
Story22	59.196	38.832	37.965
Story21	53.177	36.322	34.6
Story20	47.833	33.869	31.549
Story19	45.45	31.54	29.326
Story18	42.961	29.24	27.134
Story17	40.366	26.98	24.98
Story16	37.672	24.754	22.862
Story15	34.891	22.563	20.78
Story14	32.037	20.409	18.738
Story13	29.122	18.295	16.74
Story12	26.159	16.229	14.793
Story11	23.159	14.218	12.906
Story10	20.133	12.273	11.089
Story9	17.096	10.402	9.355
Story8	14.406	8.641	7.723
Story7	11.72	6.976	6.192
Story6	9.045	5.43	4.782
Story5	6.407	4.021	3.509
Story4	3.864	2.771	2.391
Story3	1.578	1.707	1.453
Story2	0	0.86	0.719
Story1	0.196	0.269	0.219
Base	0	0	0

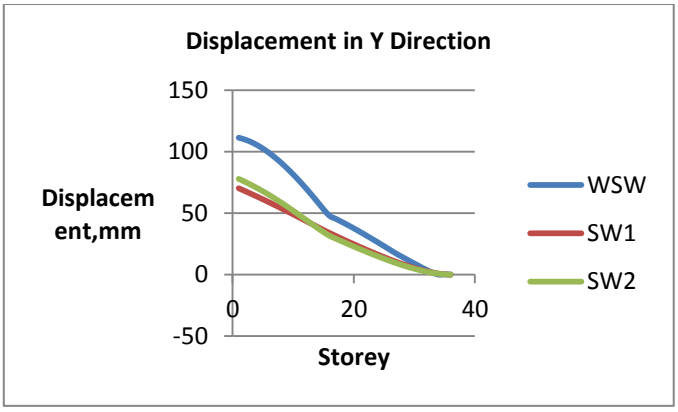

Chart-1:Max Displacement in mm in Y direction

Table-1.6:Max Displacement in x direction

story	WSW	SW1	SW2
Story35	111.323	70.293	91.451
Story34	109.87	68.087	89.366
Story33	107.901	65.848	86.971
Story32	105.415	63.574	84.228
Story31	102.444	61.258	81.113

Story30	99.019	58.896	77.629
Story29	95.172	56.489	73.79
Story28	90.936	54.039	69.618
Story27	86.342	51.55	65.144
Story26	81.422	49.03	60.403
Story25	76.207	46.486	55.438
Story24	70.728	43.929	50.309
Story23	65.015	41.373	45.097
Story22	59.107	38.832	39.928
Story21	53.09	36.322	34.999
Story20	47.737	33.869	31.158
Story19	45.358	31.54	29.013
Story18	42.872	29.24	26.888
Story17	40.281	26.98	24.788
Story16	37.589	24.754	22.713
Story15	34.812	22.563	20.665
Story14	31.961	20.409	18.65
Story13	29.05	18.295	16.675
Story12	26.09	16.229	14.748
Story11	23.094	14.218	12.878
Story10	20.071	12.273	11.075
Story9	17.038	10.402	9.355
Story8	14.352	8.641	7.735
Story7	11.669	6.976	6.215
Story6	8.998	5.43	4.813
Story5	6.364	4.021	3.544
Story4	3.828	2.771	2.428
Story3	1.552	1.707	1.487
Story2	0	0.86	0.745
Story1	0.187	0.269	0.232
Base	0	0	0

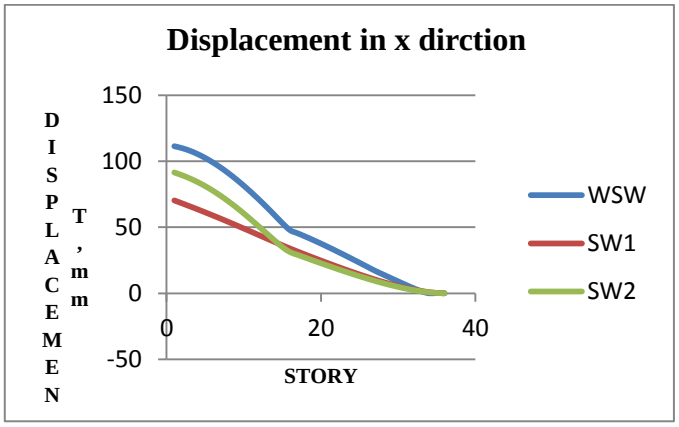

Chart-2:Displacement in X Direction

1.6STORY DRIFTS

Table-1.7:Story drifts of buildings with shearwalls i.e building 1(B1) &building 2(B2) due to Response spectrum.

story	B2 RSX	B2 RXY	B1 RSX	B1 RXY
Story35	0.00044	0.000548	0.000481	0.000479
Story34	0.00053	0.000556	0.000489	0.000487
Story33	0.00063	0.000563	0.000496	0.000494
Story32	0.00072	0.000587	0.000504	0.000502
Story31	0.00081	0.000613	0.000512	0.00051
Story30	0.00088	0.000637	0.000518	0.000516
Story29	0.00094	0.000657	0.000523	0.000521
Story28	0.001	0.000673	0.000525	0.000523
Story27	0.00105	0.000685	0.000526	0.000524
Story26	0.0011	0.000691	0.000525	0.000523
Story25	0.00113	0.000691	0.000521	0.000519
Story24	0.00114	0.000684	0.000515	0.000513
Story23	0.00112	0.000667	0.000506	0.000504
Story22	0.00106	0.00064	0.000494	0.000493
Story21	0.00087	0.000583	0.000478	0.000477
Story20	0.0004	0.000415	0.00045	0.000449
Story19	0.0004	0.000411	0.000443	0.000441
Story18	0.0004	0.000406	0.000434	0.000433
Story17	0.0004	0.000402	0.000428	0.000427
Story16	0.0004	0.000398	0.000424	0.000422
Story15	0.00039	0.000393	0.00042	0.000419

Story14	0.00039	0.000388	0.000417	0.000415
Story13	0.00038	0.000382	0.000413	0.000412
Story12	0.00037	0.000374	0.000409	0.000407
Story11	0.00036	0.000366	0.000402	0.000401
Story10	0.00035	0.000354	0.000395	0.000394
Story9	0.00033	0.000339	0.000381	0.000379
Story8	0.00032	0.000324	0.000369	0.000367
Story7	0.0003	0.000305	0.000351	0.00035
Story6	0.00027	0.000281	0.000329	0.000327
Story5	0.00025	0.000253	0.0003	0.000299
Story4	0.00021	0.000218	0.000263	0.000262
Story3	0.00017	0.000175	0.000216	0.000215
Story2	0.00012	0.000123	0.000156	0.000155
Story1	7.00E-05	6.60E-05	8.80E-05	8.70E-05
Base	0	0	0	0

Table-1.8:Story drifts of buildings with shearwalls i.e building 3(B3) due to Response spectrum.

Story	B3 RSX	B3 RSY
Story35	0.000369	0.000367
Story34	0.000522	0.000519
Story33	0.000671	0.000668
Story32	0.000803	0.000799
Story31	0.000915	0.00091
Story30	0.001007	0.001002
Story29	0.001082	0.001077
Story28	0.001145	0.00114
Story27	0.0012	0.001194
Story26	0.001252	0.001245
Story25	0.0013	0.001294
Story24	0.001345	0.001339
Story23	0.001384	0.001377
Story22	0.0014	0.001393
Story21	0.001235	0.001229
Story20	0.000544	0.000541
Story19	0.000574	0.000571
Story18	0.000609	0.000606
Story17	0.000645	0.000642
Story16	0.000678	0.000675
Story15	0.000706	0.000703
Story14	0.000729	0.000725
Story13	0.000748	0.000744
Story12	0.000765	0.000761
Story11	0.000782	0.000778
Story10	0.000799	0.000795
Story9	0.000723	0.000719
Story8	0.000737	0.000733
Story7	0.000751	0.000747
Story6	0.000766	0.000763
Story5	0.000786	0.000782
Story4	0.000816	0.000812
Story3	0.000872	0.000867
Story2	0.000993	0.000988
Story1	0.001311	0.001305
Base	0	0

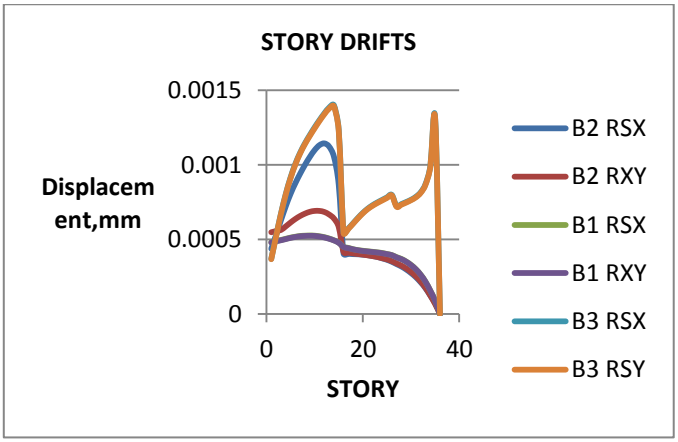

Chart-3:Story Drifts of buildings 1,2 and 3 due to response spectrum

2. CONCLUSIONS

The analysis of buildings considering shear wall at different positions and orientation we conlude by the results given in tables above that the maximum displacement at top story occurs in building with no shear wall (building 3) with a displacement of

111.432mm while in building 1 and 2 with shearwalls 70.293mm and 77.939mm in Y direction While in x direction displacements are shown inn table1.6 this shows us that the minimum displacement occurs in building 1 with shearwall as shown in fig-1.1.

The stiffness in building without shear wall is most as compared to buildings with shear walls as shown in Table1.3 and 1.4 in both orthogonal directions.

Also the story drifts are found maximum in building 3 that is without shear wall fom story 21 upto 30 as we can read it in the chart-3 also from tables 1.7 and 1.8.

As a result of analysis, it is clearly cosiderd that building 1 is the safest among the three models assessed in the research purpose. Positioning of shear wall is a dominant point and the position of the shear wall in building 1 was found to be most appropriate.

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