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Performance Based Analysis of Building with Steel Plated Shear Wall

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***Abstract*: A performance-based analysis of building with steel plated shear walls systems with rigid beam-to-column connections is proposed in this work, which sets a specific ductility demand and a preferred yield mechanism as its performance targets. This dissertation presents the fragility analysis of Steel Plate Shear Walls (SPSW) i.e., lateral load resisting systems with conventional RCC shear wall building under seismic excitation. Steel plated shear walls are investigated as a lateral load resisting system towards seismic loads. The investigation includes the seismic behaviour of building for different parameters of IS 1893: 2016 like Torsional Irregularity, Story drift, Story Stiffness, Base Shear, Plate Stresses etc. The design includes 9 story building with conventional RCC shear wall and trending steel plate shear wall governed by earthquake loading. The existing codes and design guidelines for steel plate shear walls (SPSWs) fail to utilize the excellent ductility capacity of SPSW systems to its fullest extent, because these methods do not consider the inelastic displacement demand or ductility demand as their design objective. The effectiveness of the proposed method in achieving these targets is illustrated through sample case studies of 9-story SPSW systems for varied design scenarios. This modified method is found to be more effective than the original proposal, whenever P-Delta effects are significant. Recommendations are made for future projects.**

***Keywords*: RCC SW, SPSW, base shear, torsional irregularity, story stiffness, story drift, lateral seismic forces, seismic weight.**

1. Introduction

Steel plated shear walls are an innovative lateral load resisting system capable of effectively bracing a building against both wind and earthquake. This is achieved forces by constructing a stiff section vertically spanning the height of a particular building. Generally, steel plated shear walls span one bay and the entire height of the building, welded or bolted to the surrounding boundary elements. Currently reinforced concrete is widely used to construct shear walls in building.

An alternate of RCC SW is the use of thin steel plate. A relatively new lateral system is the SPSW, which has many distinct performance benefits when compared to other lateral load resisting systems. SPSW systems typically have large energy dissipating capabilities than most lateral systems, which is an important consideration in seismic design.

Seismic fragility analysis is the comparison of seismic capacity & demand and to estimate whether the seismic capacity is exceeded for a well-defined performance level when the structural subjected to specified levels of ground motion intensity**.** In building structure, loads are resisted by two different systems; a gravity load system and a lateral load system. The gravity load system is used to transfer vertical loads to the foundation while wind and seismic loads are resisted by the lateral load resisting system. Figure 1 shows a typical SPSW system.

The Project is planned as, Multi-storey Residential Towers having Stilt floor + 9 Floors + Terrace, with overall height of building of about 29.7m. This TOWER consists of Typical Floor Plate having 4 number of 2BHK Residential units arranged with common areas and passages at each Floor Plate. Stilt floor area is meant for Car Parking and to House Hold Services.

A. 9 Story RCC building (Typical Floors)

The conventional Beam Slab system for Residential Towers is proposed with Peripheral Beams, along with slab and beams to form Closed Network of Structural Framing. Shear walls of approximate thickness of 200 mm thickness in typical floors, accordingly parking space and MEP Spaces have been planned. Average Slab thickness of 125mm has been considered along with sunk for Toilets and 150mm for Balconies. Average size of beams shall be 200mmX450mm which may alter as per span requirements and architectural/services constraints. All Shear Walls has been proposed as Ductile Element to meet codal requirements.

B. 9 Story Steel building (Typical Floors)

The Structural Steel system for Residential Towers is proposed with ISMB 550 Peripheral Beams, along with steel deck slab and ISMB 300 inner beams to form Closed Network of Structural Framing. Average Slab thickness of 125mm has been considered along with sunk for Toilets and 150mm for Balconies. The Major column sizes are taken as 2-ISMC 400 for building whereas 2-ISMC 300 taken near the staircase well and shear wall. All Shear Walls has been replaced by 8mm steel plate connected by horizontal and vertical boundary elements as Ductile Element to meet codal requirements.

The objectives of this study to compare the performance-based analysis of 9-Storey building with conventional RCC shear wall & Steel plated shear wall to enhance its ductility and

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*Corresponding author: ankitr279@gmail.com lateral stability under followings seismic parameters of IS 1893:2016:

1. Base shear value.
2. Model mass participating ratio.
3. Torsional irregularity.
4. Stiffness irregularity.
5. Relative story drift.
6. Load of Superstructure.
7. Lateral seismic forces.
8. Behaviour of shear wall
    (a) Stresses in shear wall.
    (b) BM in the shear wall.
    (c) SF in the shear wall.
    (d) Lateral displacement of shear wall.

In this study, the scope of work is classified into 4 categories.

1. To analyse the 9-storey RCC building with RCC SW with the help of ETABS.
2. To analyse the 9-storey RCC building with SPSW with the help of ETABS.
3. To analyse the 9-storey Steel building with SPSW with the help of ETABS.
4. To compare the seismic behaviour of buildings under the different parameters of IS 1893:2016.

2. Structural Analysis with RCC & Steel Plated Shear Walls

Proposed Structure is planned as a combination of Columns, Shear walls, Beams, and Slabs (paneled) forming framed structure. After preliminary sizing of various structural members, a computer model of the structural frame of Building shall be generated for carrying out computer analysis for the effects of vertical and lateral loads that are likely to be imposed on the structure. The building structure will be analyzed using ETABS. Above mentioned Analysis/Design software has been thoroughly tested, validated and recognized internationally by several organizations and is well suited for the analysis of building system.

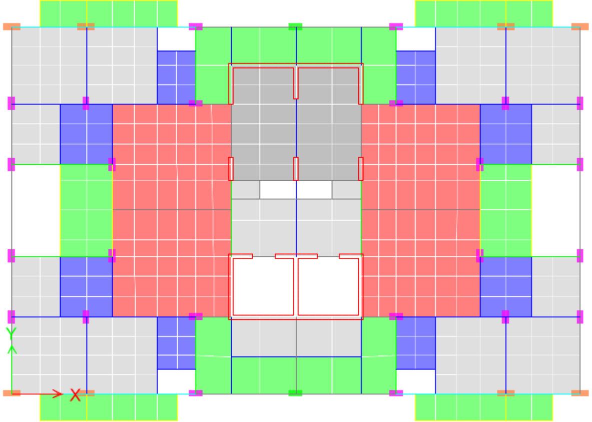


Fig. 1. RCC building with conventional shear wall

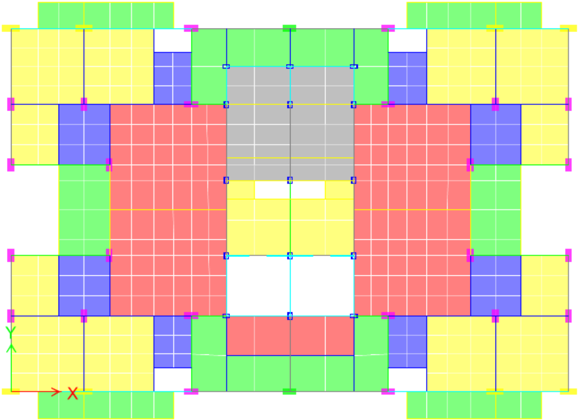


Fig. 2. RCC building with steel plated shear wall

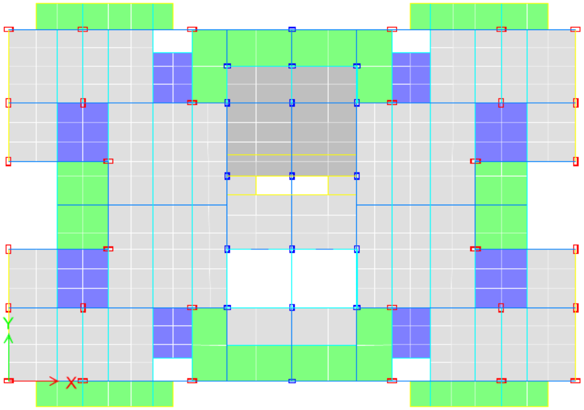


Fig. 3. Steel structure with steel plated shear wall

A. *Response Spectrum Method*

As the assumed building lies in the seismic zone IV, the adopted method of analysis is Response Spectrum method. Response spectra is the representation of maximum responses of a spectrum of idealized single degree of freedom system of different natural periods but having the same damping, under the action of the same earthquake ground motion at their bases.

B. *Base Shear Calculation*

Base shear is an estimate of the maximum expected lateral force on the base of the structure due to seismic activity. In other words, it is the horizontal lateral force in the considered direction of the earthquake shaking that the structure shall be designed for.

Building shall be designed for the design lateral force given by,

$V_b = A_h.W$ = 2025 KN (As per Etabs Modal)

where,

A_h = Design horizontal seismic coefficient

$= (ZI/2R)*(Sa/g) = 0.0288*1.43 = 0.041$

W = Seismic weight of the building = 54661 KN

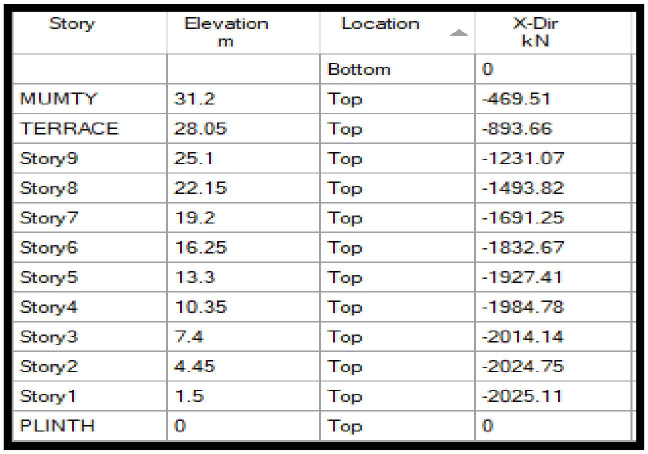
Z = Seismic Zone factor = 0.24 (IS 1893, Table-3)

I = Importance factor = 1.2 (IS 1893, Table-8))

R = Response reduction factor = 5 (IS 1893, Table-9)

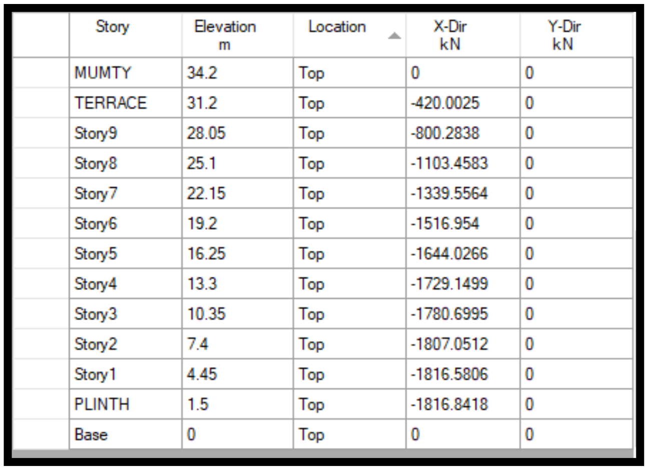
Sa/g = Design acceleration coefficient for different soil

$= 1.36/T = 1.36/0.95 = 1.43$



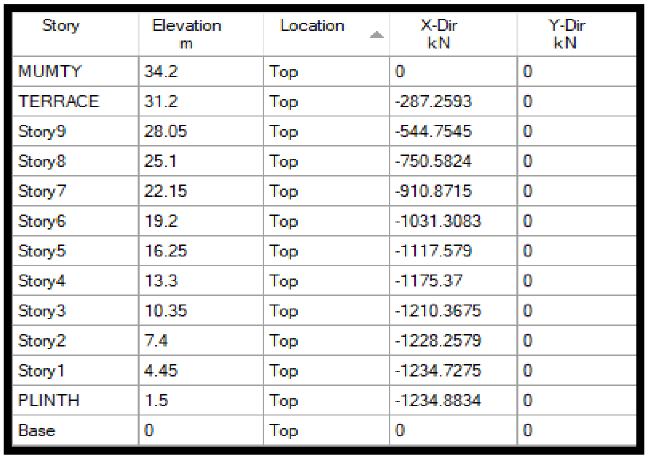
Story	Elevation m	Location	X-Dir kN
		Bottom	0
MUMTY	31.2	Top	-469.51
TERRACE	28.05	Top	-893.66
Story9	25.1	Top	-1231.07
Story8	22.15	Top	-1493.82
Story7	19.2	Top	-1691.25
Story6	16.25	Top	-1832.67
Story5	13.3	Top	-1927.41
Story4	10.35	Top	-1984.78
Story3	7.4	Top	-2014.14
Story2	4.45	Top	-2024.75
Story1	1.5	Top	-2025.11
PLINTH	0	Top	0

Fig. 4. Base Shear in the X-direction (RCC SW)



Story	Elevation m	Location	X-Dir kN	Y-Dir kN
MUMTY	34.2	Top	0	0
TERRACE	31.2	Top	-420.0025	0
Story9	28.05	Top	-800.2838	0
Story8	25.1	Top	-1103.4583	0
Story7	22.15	Top	-1339.5564	0
Story6	19.2	Top	-1516.954	0
Story5	16.25	Top	-1644.0266	0
Story4	13.3	Top	-1729.1499	0
Story3	10.35	Top	-1780.6995	0
Story2	7.4	Top	-1807.0512	0
Story1	4.45	Top	-1816.5806	0
PLINTH	1.5	Top	-1816.8418	0
Base	0	Top	0	0

Fig. 5. Base Shear in the X-direction (SPSW)

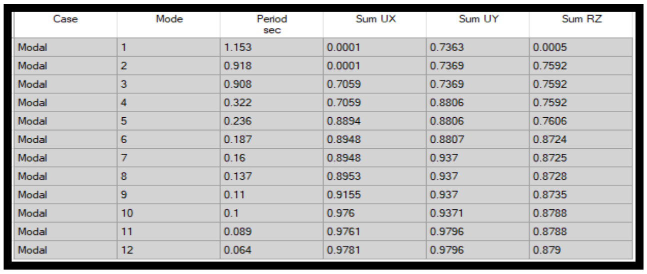


Story	Elevation m	Location	X-Dir kN	Y-Dir kN
MUMTY	34.2	Top	0	0
TERRACE	31.2	Top	-287.2593	0
Story9	28.05	Top	-544.7545	0
Story8	25.1	Top	-750.5824	0
Story7	22.15	Top	-910.8715	0
Story6	19.2	Top	-1031.3083	0
Story5	16.25	Top	-1117.579	0
Story4	13.3	Top	-1175.37	0
Story3	10.35	Top	-1210.3675	0
Story2	7.4	Top	-1228.2579	0
Story1	4.45	Top	-1234.7275	0
PLINTH	1.5	Top	-1234.8834	0
Base	0	Top	0	0

Fig. 6. Base Shear in the X-direction (Steel Structure)

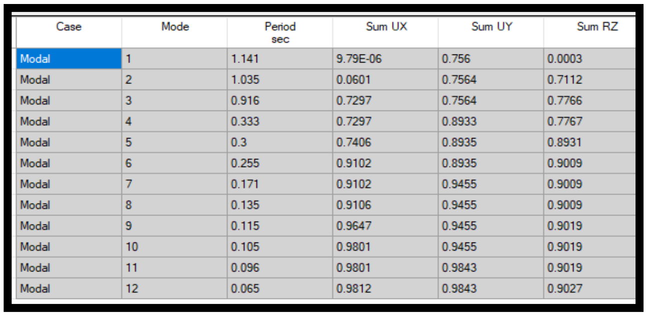
C. *Model Participating Mass Ratio*

It is a part of the total seismic mass of the structure that is effective in natural mode k of oscillation during horizontal or vertical ground motion. The amount by which natural mode contributes to overall oscillation of the structure during horizontal or vertical earthquake ground motion is called the Modal participation factor (P_k).



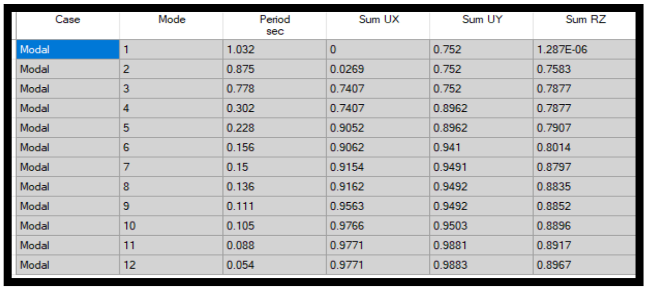
Case	Mode	Period sec	Sum UX	Sum UY	Sum RZ
Modal	1	1.153	0.0001	0.7363	0.0005
Modal	2	0.918	0.0001	0.7369	0.7592
Modal	3	0.908	0.7059	0.7369	0.7592
Modal	4	0.322	0.7059	0.8806	0.7592
Modal	5	0.236	0.8894	0.8806	0.7606
Modal	6	0.187	0.8948	0.8807	0.8724
Modal	7	0.16	0.8948	0.937	0.8725
Modal	8	0.137	0.8953	0.937	0.8728
Modal	9	0.11	0.9155	0.937	0.8735
Modal	10	0.1	0.976	0.9371	0.8788
Modal	11	0.089	0.9761	0.9796	0.8788
Modal	12	0.064	0.9781	0.9796	0.879

Fig. 7. Mass Participating Ratio (For RCC SW)



Case	Mode	Period sec	Sum UX	Sum UY	Sum RZ
Modal	1	1.141	9.79E-06	0.756	0.0003
Modal	2	1.035	0.0601	0.7564	0.7112
Modal	3	0.916	0.7297	0.7564	0.7766
Modal	4	0.333	0.7297	0.8933	0.7767
Modal	5	0.3	0.7406	0.8935	0.8931
Modal	6	0.255	0.9102	0.8935	0.9009
Modal	7	0.171	0.9102	0.9455	0.9009
Modal	8	0.135	0.9106	0.9455	0.9009
Modal	9	0.115	0.9647	0.9455	0.9019
Modal	10	0.105	0.9801	0.9455	0.9019
Modal	11	0.096	0.9801	0.9843	0.9019
Modal	12	0.065	0.9812	0.9843	0.9027

Fig. 8. Mass Participating Ratio (For SPSW)

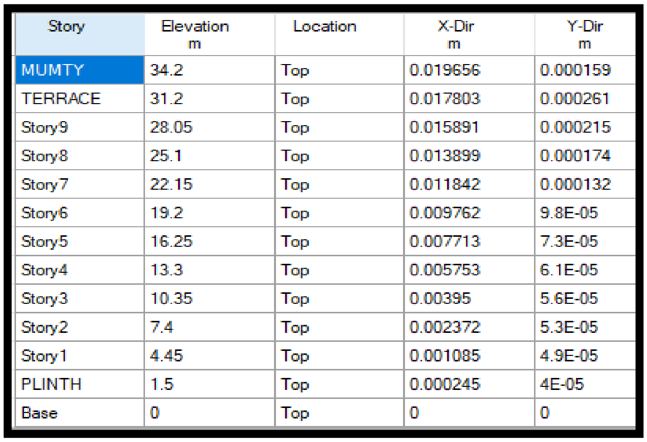


Case	Mode	Period sec	Sum UX	Sum UY	Sum RZ
Modal	1	1.032	0	0.752	1.287E-06
Modal	2	0.875	0.0269	0.752	0.7583
Modal	3	0.778	0.7407	0.752	0.7877
Modal	4	0.302	0.7407	0.8962	0.7877
Modal	5	0.228	0.9052	0.8962	0.7907
Modal	6	0.156	0.9062	0.941	0.8014
Modal	7	0.15	0.9154	0.9491	0.8797
Modal	8	0.136	0.9162	0.9492	0.8835
Modal	9	0.111	0.9563	0.9492	0.8852
Modal	10	0.105	0.9766	0.9503	0.8896
Modal	11	0.088	0.9771	0.9881	0.8917
Modal	12	0.054	0.9771	0.9883	0.8967

Fig. 9. Mass Participating Ratio (Steel Structure)

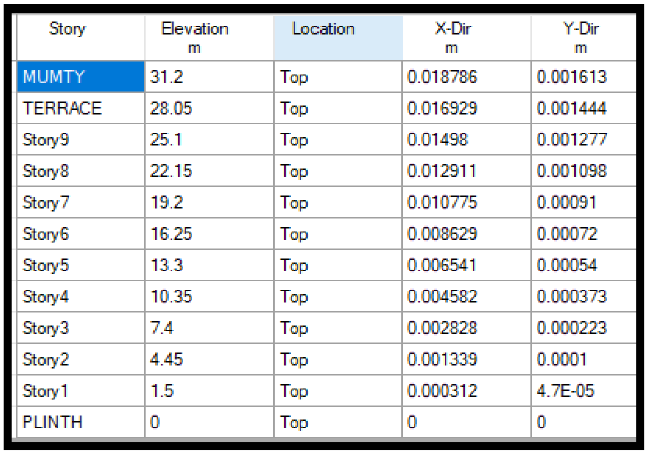
D. *Torsional Irregularity*

Building with simple regular geometry and uniformly distributed mass and stiffness in plan and in elevation, suffer much less damage, than building with regular configurations.



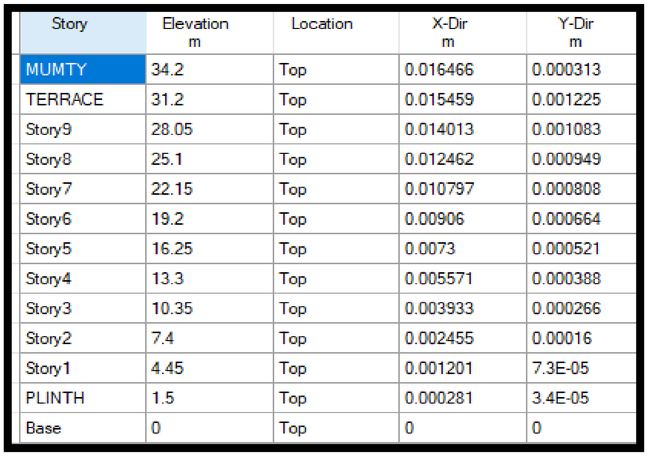
Story	Elevation m	Location	X-Dir m	Y-Dir m
MUMTY	34.2	Top	0.019656	0.000159
TERRACE	31.2	Top	0.017803	0.000261
Story9	28.05	Top	0.015891	0.000215
Story8	25.1	Top	0.013899	0.000174
Story7	22.15	Top	0.011842	0.000132
Story6	19.2	Top	0.009762	9.8E-05
Story5	16.25	Top	0.007713	7.3E-05
Story4	13.3	Top	0.005753	6.1E-05
Story3	10.35	Top	0.00395	5.6E-05
Story2	7.4	Top	0.002372	5.3E-05
Story1	4.45	Top	0.001085	4.9E-05
PLINTH	1.5	Top	0.000245	4E-05
Base	0	Top	0	0

Fig. 10. Lateral displacement at terrace (RCC SW)



Story	Elevation m	Location	X-Dir m	Y-Dir m
MUMTY	31.2	Top	0.018786	0.001613
TERRACE	28.05	Top	0.016929	0.001444
Story9	25.1	Top	0.01498	0.001277
Story8	22.15	Top	0.012911	0.001098
Story7	19.2	Top	0.010775	0.00091
Story6	16.25	Top	0.008629	0.00072
Story5	13.3	Top	0.006541	0.00054
Story4	10.35	Top	0.004582	0.000373
Story3	7.4	Top	0.002828	0.000223
Story2	4.45	Top	0.001339	0.0001
Story1	1.5	Top	0.000312	4.7E-05
PLINTH	0	Top	0	0

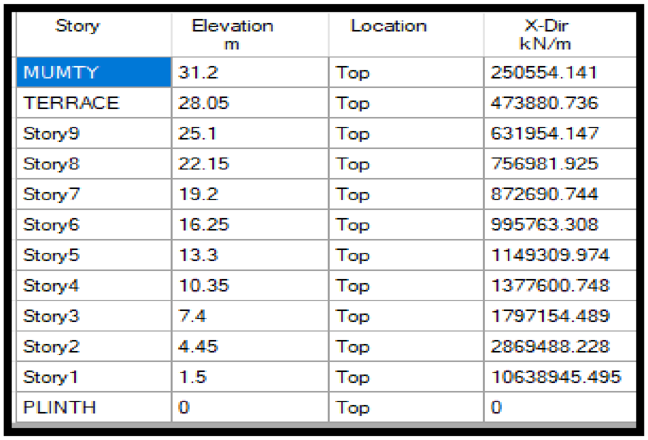
Fig. 11. Lateral displacement at terrace (For SPSW)



Story	Elevation m	Location	X-Dir m	Y-Dir m
MUMTY	34.2	Top	0.016466	0.000313
TERRACE	31.2	Top	0.015459	0.001225
Story9	28.05	Top	0.014013	0.001083
Story8	25.1	Top	0.012462	0.000949
Story7	22.15	Top	0.010797	0.000808
Story6	19.2	Top	0.00906	0.000664
Story5	16.25	Top	0.0073	0.000521
Story4	13.3	Top	0.005571	0.000388
Story3	10.35	Top	0.003933	0.000266
Story2	7.4	Top	0.002455	0.00016
Story1	4.45	Top	0.001201	7.3E-05
PLINTH	1.5	Top	0.000281	3.4E-05
Base	0	Top	0	0

Fig. 12. Lateral displacement at terrace (Steel Structure)

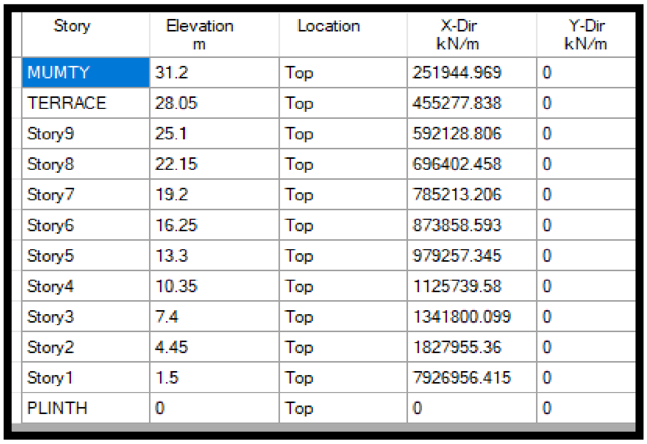
E. Stiffness Irregularity (Soft Story)



Story	Elevation m	Location	X-Dir kN/m
MUMTY	31.2	Top	250554.141
TERRACE	28.05	Top	473880.736
Story9	25.1	Top	631954.147
Story8	22.15	Top	756981.925
Story7	19.2	Top	872690.744
Story6	16.25	Top	995763.308
Story5	13.3	Top	1149309.974
Story4	10.35	Top	1377600.748
Story3	7.4	Top	1797154.489
Story2	4.45	Top	2869488.228
Story1	1.5	Top	10638945.495
PLINTH	0	Top	0

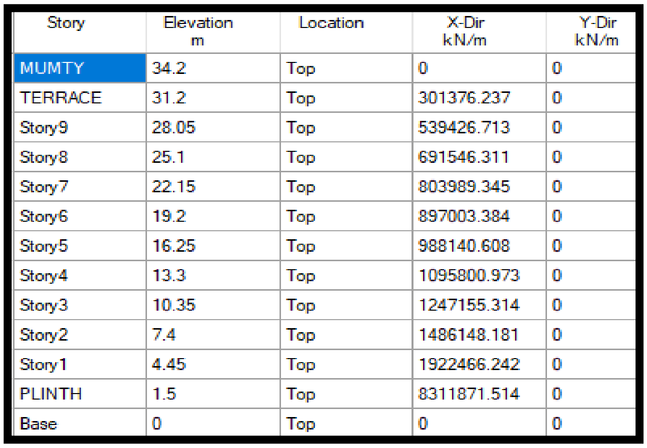
Fig. 13. Story Stiffness in X-Direction (RCC SW)

A soft story is a story whose lateral stiffness is less than that of the story above. In other word, buildings in which one or more floors have windows, wide doors, large unobstructed commercial spaces or other openings in places where a shear wall would normally be required for stability as a matter of earthquake engineering design. When RCC Shear walls are introduced in the structure, the behaviour of entire structure shift towards the more rigidity and stiffness gets increased in that direction. In a structure that is made up of many different structural elements, those elements will carry load proportionate to their relative stiffness. Therefore, the load an element will attract increases the stiffer it is.



Story	Elevation m	Location	X-Dir kN/m	Y-Dir kN/m
MUMTY	31.2	Top	251944.969	0
TERRACE	28.05	Top	455277.838	0
Story9	25.1	Top	592128.806	0
Story8	22.15	Top	696402.458	0
Story7	19.2	Top	785213.206	0
Story6	16.25	Top	873858.593	0
Story5	13.3	Top	979257.345	0
Story4	10.35	Top	1125739.58	0
Story3	7.4	Top	1341800.099	0
Story2	4.45	Top	1827955.36	0
Story1	1.5	Top	7926956.415	0
PLINTH	0	Top	0	0

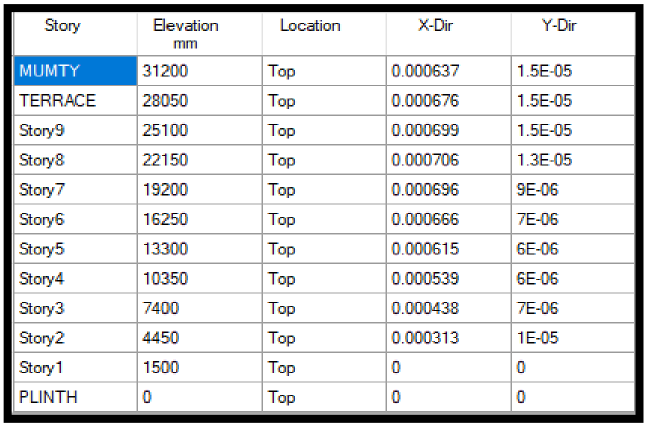
Fig. 14. Story Stiffness in X-Direction (For SPSW)



Story	Elevation m	Location	X-Dir kN/m	Y-Dir kN/m
MUMTY	34.2	Top	0	0
TERRACE	31.2	Top	301376.237	0
Story9	28.05	Top	539426.713	0
Story8	25.1	Top	691546.311	0
Story7	22.15	Top	803989.345	0
Story6	19.2	Top	897003.384	0
Story5	16.25	Top	988140.608	0
Story4	13.3	Top	1095800.973	0
Story3	10.35	Top	1247155.314	0
Story2	7.4	Top	1486148.181	0
Story1	4.45	Top	1922466.242	0
PLINTH	1.5	Top	8311871.514	0
Base	0	Top	0	0

Fig. 15. Story Stiffness in X-Direction (Steel Structure)

F. Relative Story Drift

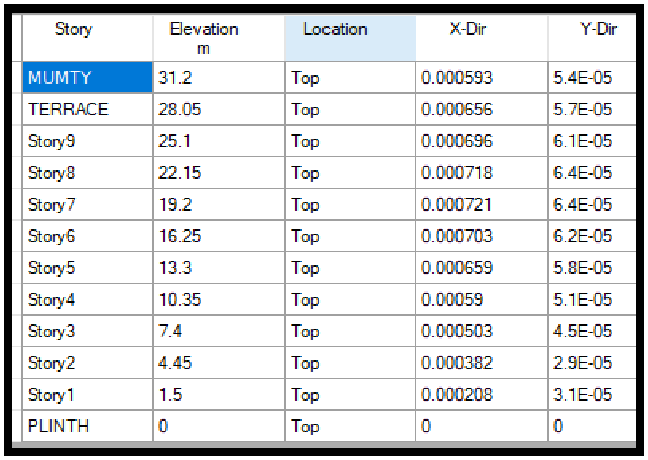


Story	Elevation mm	Location	X-Dir	Y-Dir
MUMTY	31200	Top	0.000637	1.5E-05
TERRACE	28050	Top	0.000676	1.5E-05
Story9	25100	Top	0.000699	1.5E-05
Story8	22150	Top	0.000706	1.3E-05
Story7	19200	Top	0.000696	9E-06
Story6	16250	Top	0.000666	7E-06
Story5	13300	Top	0.000615	6E-06
Story4	10350	Top	0.000539	6E-06
Story3	7400	Top	0.000438	7E-06
Story2	4450	Top	0.000313	1E-05
Story1	1500	Top	0	0
PLINTH	0	Top	0	0

Fig. 16. Story Drift in X-Direction (RCC SW)

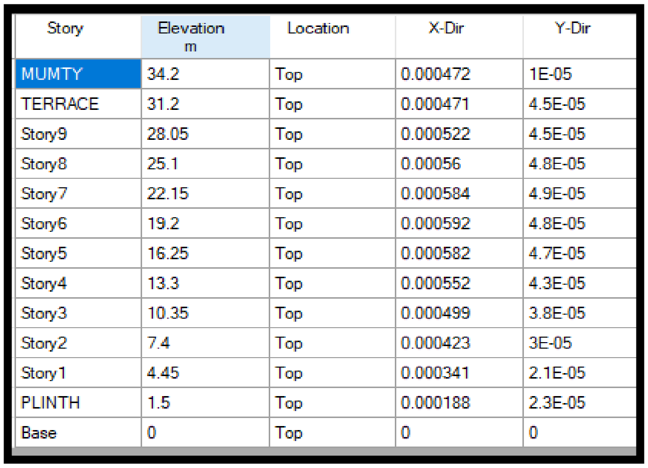
It is the relative displacement between the floors above and below the story under consideration. Story drift is the difference of displacements between two consecutive stories' divided by the height of that story. And story displacement is the absolute value of displacement of the story under action of the lateral forces.

Story drift in any story shall not exceed 0.004 times the story height, under the action of design base of shear V_b with no load factors.



Story	Elevation m	Location	X-Dir	Y-Dir
MUMTY	31.2	Top	0.000593	5.4E-05
TERRACE	28.05	Top	0.000656	5.7E-05
Story9	25.1	Top	0.000696	6.1E-05
Story8	22.15	Top	0.000718	6.4E-05
Story7	19.2	Top	0.000721	6.4E-05
Story6	16.25	Top	0.000703	6.2E-05
Story5	13.3	Top	0.000659	5.8E-05
Story4	10.35	Top	0.00059	5.1E-05
Story3	7.4	Top	0.000503	4.5E-05
Story2	4.45	Top	0.000382	2.9E-05
Story1	1.5	Top	0.000208	3.1E-05
PLINTH	0	Top	0	0

Fig. 17. Story Drift in X-Direction (For SPSW)

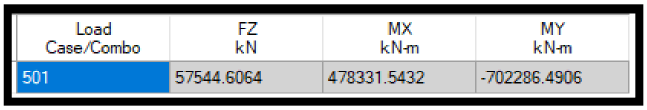


Story	Elevation m	Location	X-Dir	Y-Dir
MUMTY	34.2	Top	0.000472	1E-05
TERRACE	31.2	Top	0.000471	4.5E-05
Story9	28.05	Top	0.000522	4.5E-05
Story8	25.1	Top	0.00056	4.8E-05
Story7	22.15	Top	0.000584	4.9E-05
Story6	19.2	Top	0.000592	4.8E-05
Story5	16.25	Top	0.000582	4.7E-05
Story4	13.3	Top	0.000552	4.3E-05
Story3	10.35	Top	0.000499	3.8E-05
Story2	7.4	Top	0.000423	3E-05
Story1	4.45	Top	0.000341	2.1E-05
PLINTH	1.5	Top	0.000188	2.3E-05
Base	0	Top	0	0

Fig. 18. Story Drift in X-Direction (Steel Structure)

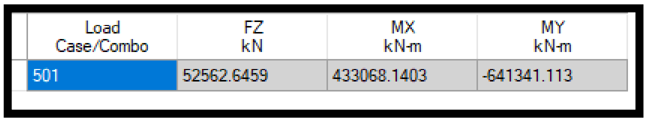
G. *Load of Superstructure*

Seismic weight of each floor is its dead load plus appropriate amount of imposed load specified in Table 10 of IS 1893 (Part-1):2016, while computing the seismic weight of each floor, the weight of columns and walls in any story shall be proportioned to the floors above and below the story.



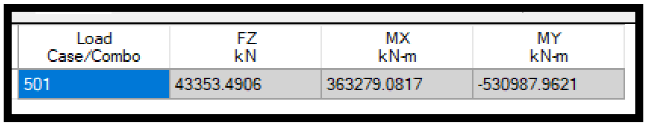
Load Case/Combo	FZ kN	MX kN-m	MY kN-m
501	57544.6064	478331.5432	-702286.4906

Fig. 19. Unfactored Structure (RCC SW)



Load Case/Combo	FZ kN	MX kN-m	MY kN-m
501	52562.6459	433068.1403	-641341.113

Fig. 20. Unfactored Structure (For SPSW)



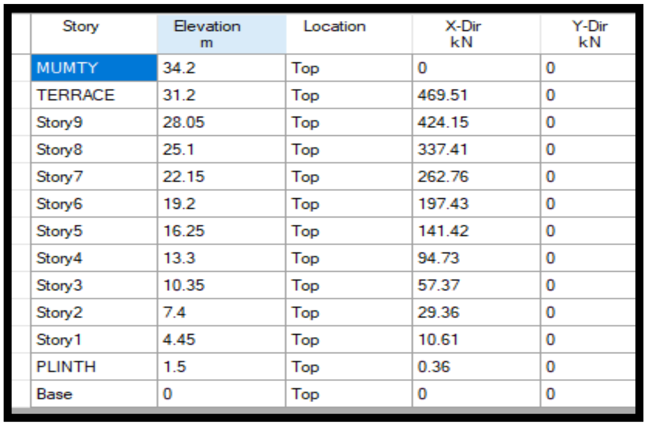
Load Case/Combo	FZ kN	MX kN-m	MY kN-m
501	43353.4906	363279.0817	-530987.9621

Fig. 21. Unfactored Structure (Steel Structure)

H. *Design Lateral Seismic Forces*

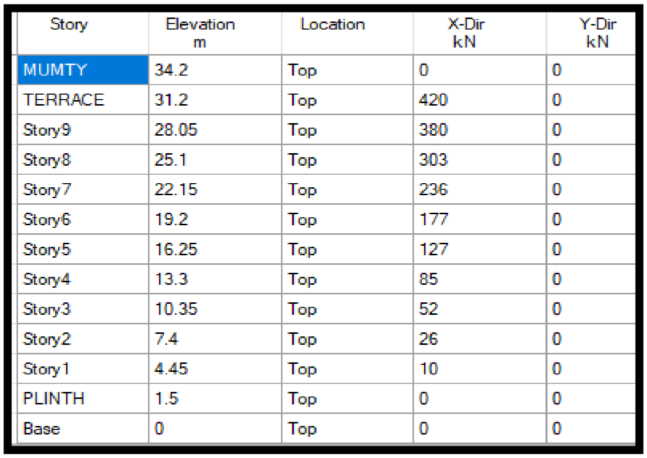
The structural configuration plays an important role on the seismic behaviour of structures. In the shear building, each floor is assumed as a lumped mass that is concentrated by perfect elastic-plastic springs which only have shear deformations

when subjected to lateral forces the total mass of the structure is distributed uniformly over its height, the modeling of engineering structures usually involves a great deal approximation. The horizontal distribution of forces helps us to find the internal forces in the structural elements induced due to the external forces at each floor.



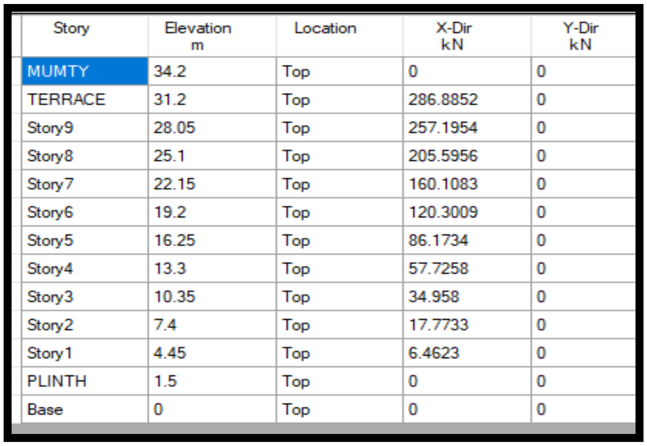
Story	Elevation m	Location	X-Dir kN	Y-Dir kN
MUMTY	34.2	Top	0	0
TERRACE	31.2	Top	469.51	0
Story9	28.05	Top	424.15	0
Story8	25.1	Top	337.41	0
Story7	22.15	Top	262.76	0
Story6	19.2	Top	197.43	0
Story5	16.25	Top	141.42	0
Story4	13.3	Top	94.73	0
Story3	10.35	Top	57.37	0
Story2	7.4	Top	29.36	0
Story1	4.45	Top	10.61	0
PLINTH	1.5	Top	0.36	0
Base	0	Top	0	0

Fig. 22. Lateral Seismic Forces in X-Direction



Story	Elevation m	Location	X-Dir kN	Y-Dir kN
MUMTY	34.2	Top	0	0
TERRACE	31.2	Top	420	0
Story9	28.05	Top	380	0
Story8	25.1	Top	303	0
Story7	22.15	Top	236	0
Story6	19.2	Top	177	0
Story5	16.25	Top	127	0
Story4	13.3	Top	85	0
Story3	10.35	Top	52	0
Story2	7.4	Top	26	0
Story1	4.45	Top	10	0
PLINTH	1.5	Top	0	0
Base	0	Top	0	0

Fig. 23. Lateral Seismic Forces (For SPSW)



Story	Elevation m	Location	X-Dir kN	Y-Dir kN
MUMTY	34.2	Top	0	0
TERRACE	31.2	Top	286.8852	0
Story9	28.05	Top	257.1954	0
Story8	25.1	Top	205.5956	0
Story7	22.15	Top	160.1083	0
Story6	19.2	Top	120.3009	0
Story5	16.25	Top	86.1734	0
Story4	13.3	Top	57.7258	0
Story3	10.35	Top	34.958	0
Story2	7.4	Top	17.7733	0
Story1	4.45	Top	6.4623	0
PLINTH	1.5	Top	0	0
Base	0	Top	0	0

Fig. 24. Lateral Seismic Forces (Steel Structure)

I. Behaviour of RCC Shear Walls

Shear walls are designed to resist bending moment, shear, axial and uplift forces, especially when they are subjected to lateral actions. The lateral forces acting in the plane of a shear walls attempts to lift up one end of the wall and push the other end down Results are collected in terms of stresses, maximum nodal displacement, maximum shear force & maximum bending moments.

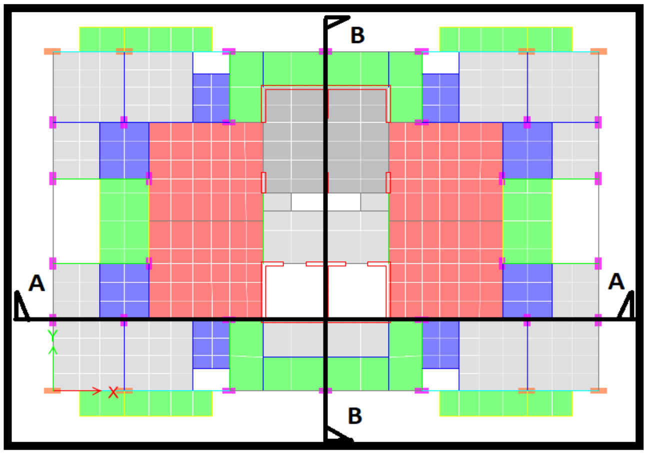


Fig. 25. Shear Wall Section A-A & B-B

1) Stresses in the shear walls

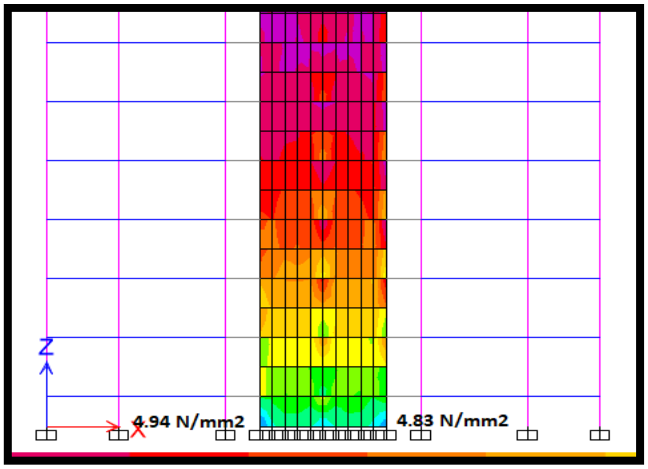


Fig. 26. SW Stresses along A-A section

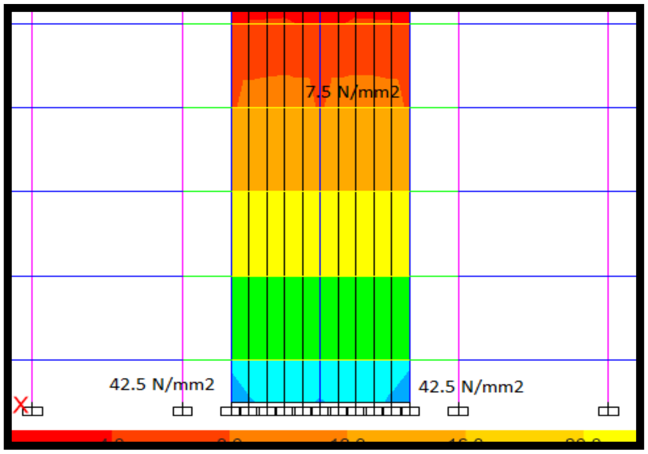


Fig. 27. SW Stresses along A-A Section (For SPSW)

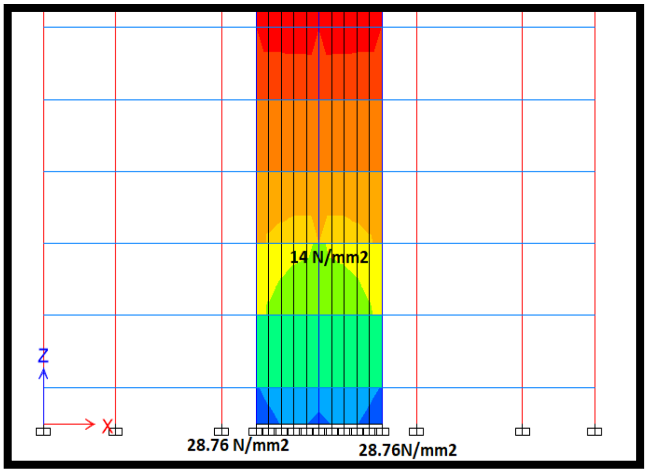


Fig. 28. SW Stresses along A-A Section (Steel Structure)

2) Bending moments in the shear walls

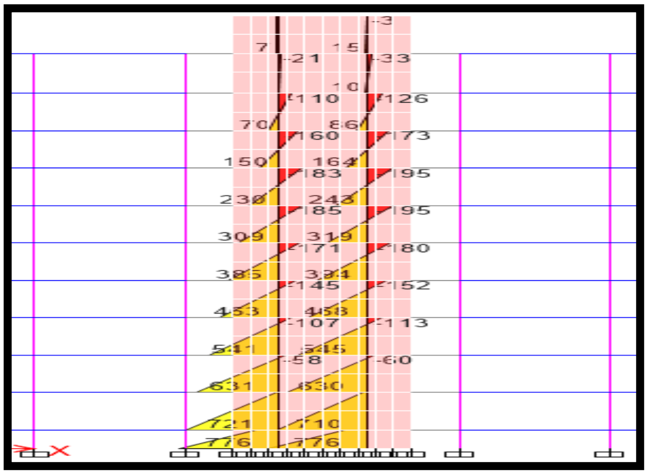


Fig. 29. BM along A-A section

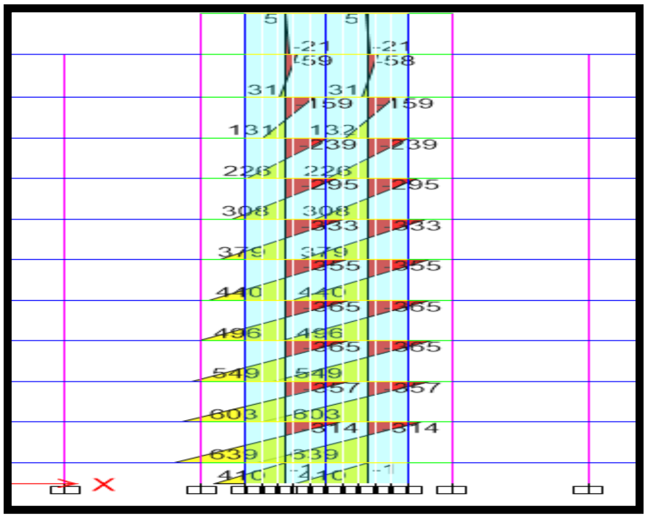


Fig. 30. BM along A-A section (For SPSW)

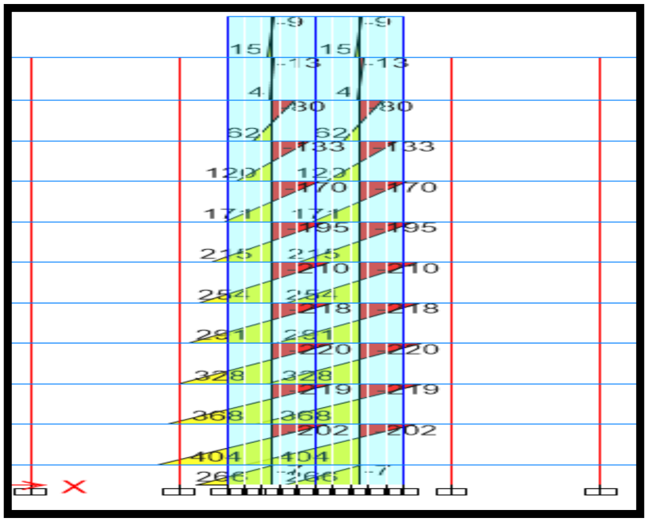


Fig. 31. BM along A-A section (Steel Structure)

3) *Shear force in the shear walls*

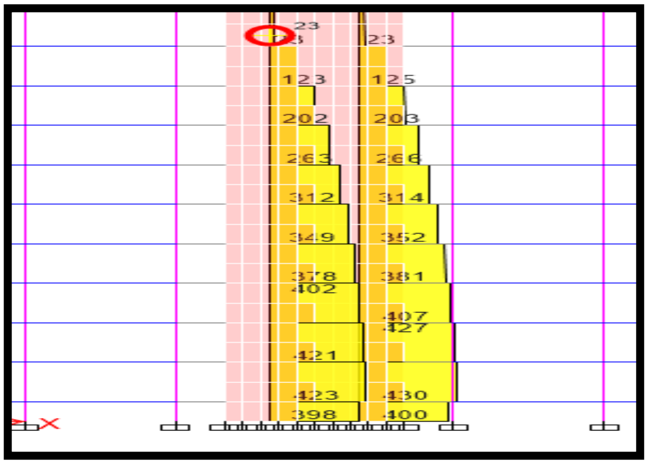


Fig. 32. Shear Force along A-A section

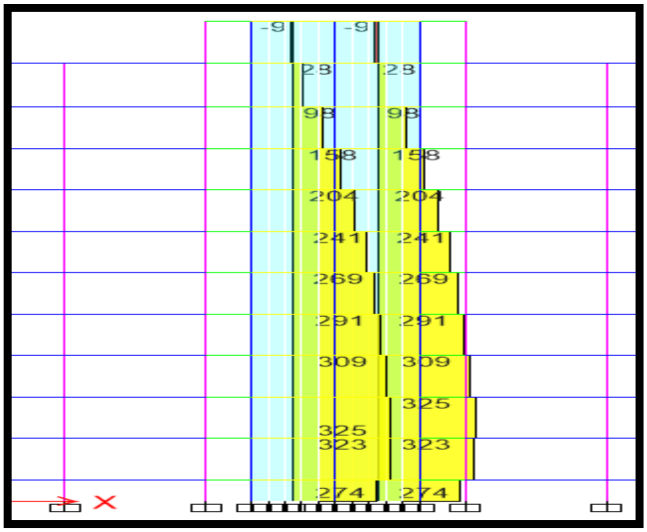


Fig. 33. Shear Force along A-A section (For SPSW)

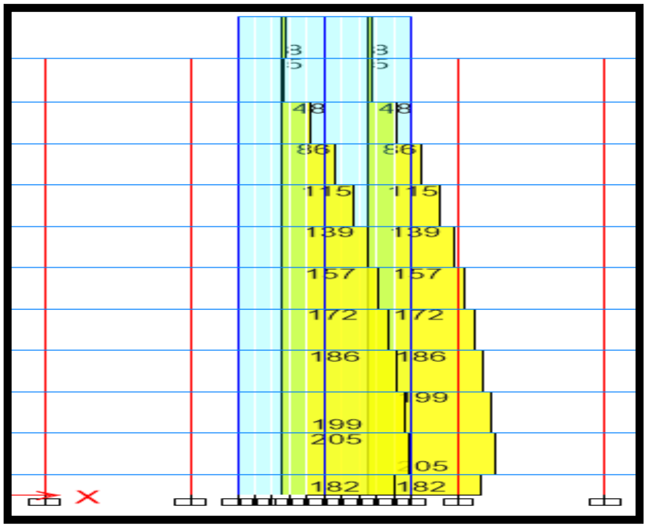


Fig. 34. Shear Force along A-A section (Steel Structure)

Table 1
Comparison of different structures

S. No.	Seismic parameters as per IS: 1893-2016	RCC building with RCC Shear Wall	RCC building with Steel plated Shear wall	Steel building with Steel plated Shear wall
1.	Base shear value	2029 KN@ base lvl	1816 KN@ base lvl	1234 KN@ base lvl
2.	Mass participating ratio	Ux =70% Uy =73%	Ux =72% Uy =75%	Ux =74% Uy =75%
3.	Torsional Irregularity of the building	Ux = 17mm Uy = 21mm	Ux = 16mm Uy = 20mm	Ux = 15mm Uy = 18mm
4.	Overall Stiffness of the building	Ux= 10.6 X 10^6 KN/m Uy= 7.1X10^6 KN/m	Ux= 7.92 X 10^6 KN/m Uy= 5.37X10^6 KN/m	Ux= 8.31 X 10^6 KN/m Uy= 5.47X10^6 KN/m
5.	Relative storey Drift	Ux = 0.00071@ Story 8 Uy = 0.00088@ Story 6	Ux = 0.000721@ Story 7 Uy = 0.00082@ Story 7	Ux = 0.000592@ Story 6 Uy = 0.000749@ Story 5
6.	Load of super-structure	Fz= 57544 KN	Fz= 52562 KN	Fz= 43353 KN
7.	Lateral seismic forces	Fx = 469 KN @ Terrace Fx = 0.36 KN @ Plinth	Fx = 420 KN @ Terrace Fx = 0.12 KN @ Plinth	Fx = 287 KN @ Terrace Fx = 0 KN @ Plinth
8.	Behaviour of the SW			
a.	Stresses in the SW	σ_x=4.94 N/mm^2@ bottom σ_y=3.66 N/mm^2@ bottom	σ_x=42.5 N/mm^2@ bottom σ_y=39.6 N/mm^2@ bottom	σ_x=28.7 N/mm^2@ bottom σ_y=26.5 N/mm^2@ bottom
b.	BM in the shear wall	Mx= 1178KN-m @bottom My= 776KN-m @bottom	Mx= 786 KN-m @bottom My= 640 KN-m @bottom	Mx= 538 KN-m @bottom My= 404 KN-m @bottom
c.	SF in the shear wall	Fx = 430 KN @bottom Fy = 428 KN @bottom	Fx = 323 KN @bottom Fy = 332 KN @bottom	Fx = 205 KN @bottom Fy = 230 KN @bottom

3. Comparison of Different Structures

All the 3 analytical models are analysed to check the behaviour of conventional RCC shear wall and steel plated shear wall under seismic parameters of IS 1893:2016.

4. Results & Observations

1. *Base Shear Value* – The base shear value of Steel building has the least value with respect to conventional Shear wall system and SPSW system due to less seismic weight of steel building. It has been noted that RCC building with SPSW system does not have much more difference with conventional building (approx. 10% decreased), whereas Steel structure has much more difference of 795 KN (approx. 40% decreased).
2. *Mass Participating Ratio* – When RCC shear wall replaced with steel plated shear wall, it has been observed that mass participating ratio get increased by 3% and when RCC building with SPSW is replaced by Steel building with SPSW system, the mass participating ratio get increased further by 6%.
3. *Torsional Irregularity* – Even there is no torsional irregularity in the building, but by introducing the steel plated shear wall instead of RCC shear wall, the lateral displacement of building is restrained by 6% and by introducing steel structure with SPSW system, the building displacement is restrained by approx. 12%.
4. *Overall Stiffness of the building* - When RCC shear wall replaced with steel plated shear wall, it has been observed that overall stiffness of building gets decreased by 25% but when steel building with SPSW system was replaced with conventional building, the overall stiffness is decreased by 20%.
5. *Relative Storey drift of the building* - There is no much more difference between the RCC building with conventional shear wall and the SPSW system. But in the case of steel structure with SPSW, the storey drift is limited by 15%.
6. *Load of Super-Structure* - The overall seismic weight of building is reduced by 8%, when RCC building shifted by SPSW system and approx. 25% building seismic weight is reduced by introducing steel structure with SPSW system. So, it is noticed here that overall cost of superstructure and substructure will be reduced with same built-up area.
7. *Lateral Seismic Forces* - The lateral seismic forces get reduced up to 10% in RCC building with SPSW system, whereas they have reduced to 40% in Steel structure with SPSW due to reduction in overall seismic weight of building.
8. *Behaviour of the steel plated shear wall*
    a) *Stresses in the shear wall* - The in-plane stresses in the Steel plated shear walls are induced up to 700% more than conventional SW, whereas in Steel structure building with SPSW system, it induced up to 480% more than conventional RCC SW building.
    b) *BMs in the shear wall* - The Bending Moments in the RCC building with SPSW is 33% less than Conventional building, whereas in Steel building with SPSW system, the BM is 54% less than the conventional RCC SW building.
    c) *SF in the shear wall* - The Shear Force in the RCC building with SPSW is 25% less than Conventional building, whereas in Steel building with SPSW system, the shear force is 50% less than the conventional RCC SW building.
    d) *Lateral deflection of shear wall* - By introducing the steel plated shear wall instead of RCC shear wall, the lateral displacement of building is restrained by 6% and when RCC structure with SPSW system is replaced with steel structure with SPSW, the building displacement is restrained by approx. 12%.

5. Conclusion

With the above iteration of steel plated shear wall, it is concluded that the steel structure with steel plated shear walls have better functionality over RCC building with steel plated shear walls in terms of better mass participating ratio, less story drift, less seismic weight, less torsional irregularity, less BMs & SFs in the walls and less lateral seismic forces for same built-up area. RCC structure with steel plated shear wall does not provide much better performance under different seismic parameters of IS 1893 for small height structures. It would be beneficial for tall building structure to limit the story drift and lateral displacements of the building and to provide better ductility and energy dissipation system.

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