Effect of Position of Shear-Wall on an Aerial High Building

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Abstract— As there is a maximum number possibilities of earthquake to hit a vicinity there are much more chances of a tall building being hit with huge and enormous structural loss of property and life. Shear-walls helps to overcome such catastrophe. A symmetrical building is taken into consideration of G+13 and is analyzed for three different cases, without shear-wall, with shear-wall at core and with shear-wall at periphery. This thirteen storeys is analyzed for base shear values, sling effect, strength and stability by the use of software Staad.Pro. The analysis of the building using equivalent static method and dynamic method. All the foot-prints of this paper are rendered in a two-dimensional composition.

Key words: Staad.Pro, Shear-Wall, IS 1893-2002, Concrete Structure, Seismal Region

I. Introduction

As time is making ahead the mastery or grasping in structural engineering is on a procure momentousness. With the harsh and tough situation, the Earth is being showing with a very drastic change in its intensities we as structural engineers have to advance in the fields related to it. A shear-wall is a vertical component which acts like a fixed cantilever structure. These are the strength and sturdiness contributor and hanger-on for a structure. As we all know that the collapse of a building is generally due to the inertia force which are the root causes of a building to vibrate and as these vibrations gets on nervous as the intensity magnify.

There are various reasons which can get a building down and cause destructions like a blast, high intensity wind, etc. these are the reason for giving us a chance for the detailed and through way to study a shear-wall in a high rise building.

The modelling can be done for best shape figures like the triangle and a circular shaped shear-wall but the application of such shape is quite difficult to construct on site, hence the construction left with is the rectangular shaped.

The basic but the main aim of the application of shear wall in tall or high rise building is to prevent high sling effects and to minimize the collapse of the structure. In short a shear-wall is form of lateral resisting force system which is highly efficient. The main is to determine the best fit of shear-wall inside the structure and best kind of suitable position of it.

The main of this modelling and analyzing is to check the sling effect on the structure on all the three cases of the model as stated before.

II. Literature review

The main concern of shear-wall in reality is installing so as to improve the seismic resistive. Following are a few of the research studies:

N. Janardhan at al., analysis of a 14 storey's building in E-tabs based in different seismic zones with different soil conditions.

V. Patil et al., a theoretical paper based on the facts of need of a shear-wall, effect of seismic waves with architectural aspect in design consideration were discussed.

Bayat et al., he innovated the space frame with its respective shear-wall, details of micro-connections, ductility, highly fast fabrication, etc.

Kaplan et al., external diaphragm to be provided at floor level which is applied to precast skeletal structure.

Sucuoglu et al., external way of providing strength which as per provers to be more cost efficient and are advantageous in ease of construction.

Sonuvar et al., his demonstration was based on the global behavior of the system and a further study helped to increase the ductility of the elemental of the structure.

Paulay, he demonstrated the response of a building to the excitation of an earthquake which is more complex than the behavior of an individual shear-wall component.

III. Methodology

The methodology consists of a procedure which can be solved by three different ways.

1) External Action.
   - Static Analysis
   - Dynamic Analysis
2) Behaviour of Structure.
   - Elastic Analysis
   - Elastic-Plastic Analysis
3) Types of Model.

A. 3D, 2D & 1D

In this modelling the analysis is carried out by Equivalent Static Analysis (ESA) which is a conservative method which is carried out by the design of seismic co-efficient which is well specified according to the IS 1893-(2002). In this method it deals with various parameters associated with the calculations of end base shear. Some of those are ~Importance Factor~ ~Zone Factor~, ~Response Reduction Factor~, Average Response Acceleration Co-efficient~ and ~Time Period~.

The another method dealing with calculation of is Dynamic Analysis which allows free vibration analysis for determination of modal shapes and frequencies' of the structure at various levels. This method is again sub-categorized under Linear and Non-Linear Analysis-Linear Structure – Response Spectrum Analysis (RSA) Non-Linear Structure – (RSA) & Time History Analysis.

IV. Building modelling

For this study, a 13-story building with a 3m (meter) height in-between floor-to-floor height, a regular symmetrical model is generated using Staad.Pro software. The building indeed is thoroughly designed in accordance with the specification as mentioned in the IS codes. The building is assumed to be fixed at the base level and the floors are rigid ones. A symmetrical building is taken into consideration of G+13 and is analyzed for three different cases. This thirteen storeys aerial building is perused for base shear values, sling effect, vehemence or sturdiness and stability by the use of software Staad.Pro.

The respective plan of the building model is given below as:

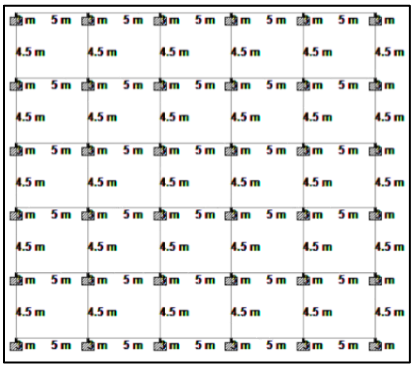

Fig. 1: Line Plane of the Building.

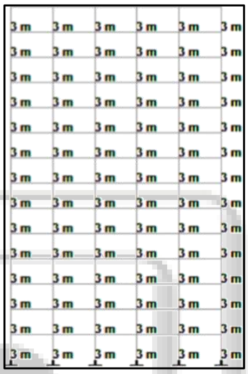

Fig. 2: Elevation of the Building.

- Model-1 Building Without Shear-Wall.
- Model-2 Building with Shear-Wall at Core.
- Model-3 Building with Shear-Wall at Periphery.

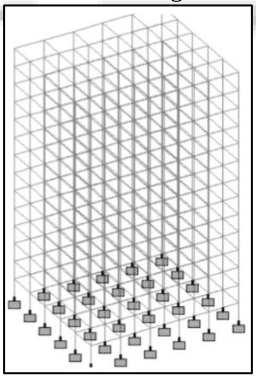

Fig. 3: Model 1

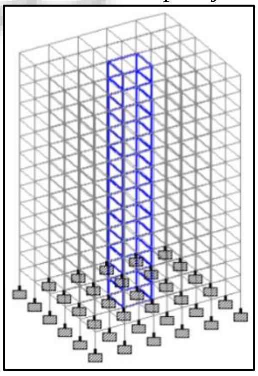

Fig. 4: Model 2

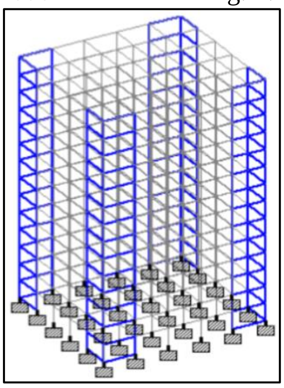

Fig. 5: Model 3

All Dimensions Are In `mm`.

No of storeys'	G+13
Thickness of Slab	130
Load due to Roof Finish	2kN/m^2
Load due to Floor Finish	1 kN/m^2
Imposed Load	4 kN/m^2
Size of Column at GL	300 × 600
Thickness of Slab	150
Type of Foundation	Isolated Footing
Soil Condition	Medium
Seismic Zone	IV
Damping Ratio	5%
Importance Factor	1
Response Reduction Factor	5
Type of Structure	SMRF
Grade of Concrete and Steel	M20 & Fe415

Table 1: Preliminary Data.

V. RESULTS AND DISCUSSION

A. Computed values of Base Shear for all the Three Cases

The following table is further represented by a graph which shows the depiction of Base Shear Values for all the three cases wrt. SA.

No of Storeys'	Without Shear-Wall	With Shear-Wall At Core	With Shear-Wall at Periphery
13	645.64	328.65	161.82
12	851.29	426.98	213.49
11	726.94	365.62	182.78
10	607.38	304.08	152.94
9	502.165	252.89	126.27
8	406.51	205.96	102.73
7	320.42	161.9	81.08
6	243.909	122.53	61.24
5	181.73	92.86	47.38
4	124.34	63.7	31.96
3	76.52	39.32	20.26
2	47.82	25.02	12.83
1	28.69	15.96	8.59
0	19.13	11.07	5.53

Table 2: Base Shear Values.

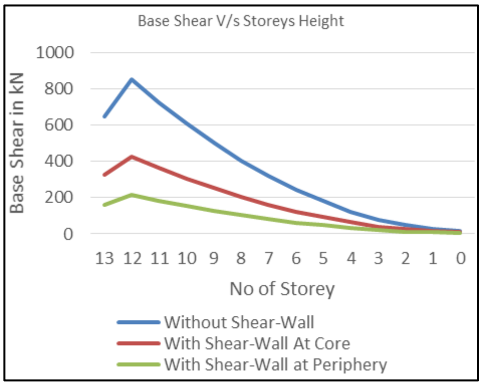

Fig. 6: Base Shear Values V/s Storeys Height.

B. Computed values of Maximum Displacement Aspect with respect to Static Analysis

The following table is further represented by a graph which shows the depiction of Maximum Displacement for all the three cases.

Without Shear-Wall	With Shear-Wall At Core	With Shear-Wall at Periphery
65.5394mm	32.2222mm	23.8952mm

Table 3: Study on Displacement Aspect.

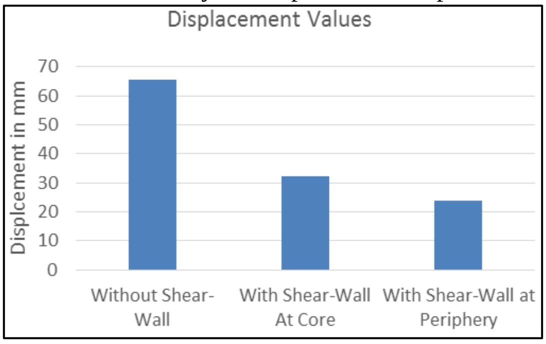

Fig. 7: Displacement V/s Model

C. Computed values of Maximum Displacement Aspect with respect to Dynamic Analysis

The following table is further represented by a graph which shows the depiction of Maximum Displacement for all the three cases wrt. DA.

No of Storeys'	Without Shear-Wall	With Shear-Wall At Core	With Shear-Wall at Periphery
13	346.1	112.5	37.5
12	343.9	103.5	34.5
11	329.5	93.8	31.3
10	288.6	89.3	29.76
9	245.1	75.6	25.2
8	235.3	65	21.6
7	209.9	52.9	17.3
6	185.6	44	14.6
5	160.4	37.1	12.4
4	137.9	27	9.2
3	107.9	19.3	7.1
2	80.9	13.2	5.8
1	50.1	8.2	2.3
0	0	0	0

Table 4: Study on Maximum Displacement.

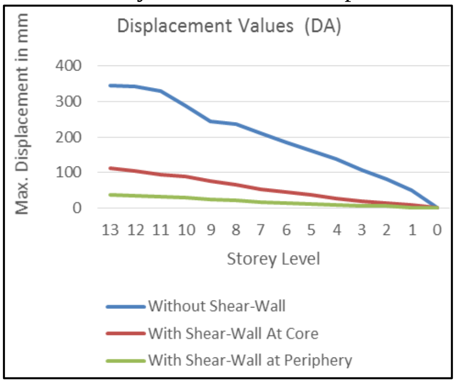

Fig. 8: Maximum Displacement V/s Storeys Height.

D. Computed values of Moment Values Aspect with respect to Dynamic Analysis

The following table is further represented by a graph which shows the depiction of Maximum Moment for all the three cases wrt. DA.

In general, there is a huge fluctuations difference seen inter-storeys moment values which is much greater on the higher side of the building and humongous difference with shear walls when provided.

No of Storeys'	Without Shear-Wall	With Shear-Wall At Core	With Shear-Wall at Periphery
13	36.4932	1.2396	0.8285
12	17.7592	2.9543	1.8964
11	20.3597	1.9648	2.4698
10	20.3621	1.3245	2.3955
9	37.3395	12.3951	2.3954
8	25.5478	12.3697	2.6547
7	23.1036	13.4984	12.396
6	23.1456	14.3954	12.3964
5	21.3215	13.1258	14.1802
4	19.9314	10.3694	10.0257
3	17.2389	5.2369	3.2145
2	16.2478	4.3215	4.0631
1	13.2987	1.9236	1.0365
0	0.2365	1.2366	2.3014

Table 5: Study on Moment Values.

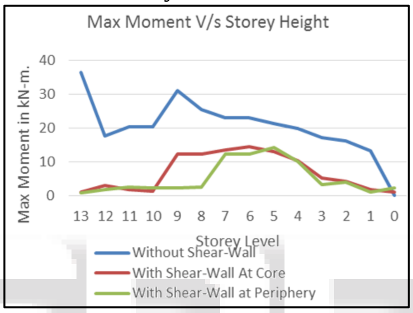

Fig. 9: Maximum Moment V/s Storeys Height.

VI. DISCUSSIONS

For the above analysis worked out above on various models the conclusion drawn and concluded were/are stated below:

1) The Base Shear Value was highly reduced to both the models i.e. the 2nd and the 3rd ones. There was nearly an average 45% reduction for the 2nd model and an average of 70% for the 3rd model. (Both were compared with the 1st model).
2) There were humongous variation in both the displacements SA and DA, in the SA Method there were 49% and 63% reduction respectively, whereas in the DA Method far much reductions were seen on a scale of 35% to 65% with variations.
3) In case of the Moment values there was a tremendous reduction change in the values and was seen that there was an increase of approximately of 42%

VII. CONCLUSIONS

After successfully completing the work analysis the conclusions jotted down can be:

1) The true prerequisite and a urge of providing a stiff structural element by completing the family of the structural elements is the Shear-Wall.
2) There were a far more and a better-tech for curtailment of Base Shear Values which provides more stability during any unforeseen circumstances'.
3) There was a far way difference in the fling effect of the structure thus defining the high sturdiness to the entire building.

4) There was brisk change in the moment values which were highly positive for a structure.

Apart from being exorbitant but it is recommendable for a defended and secure for an aerial high building.

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