

# Effective Location of Shear Wall in Irregular Multi-Story Building

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**Abstract:** — Shear wall is a plate like structural member provided in building system to resist lateral loads such as earthquake or wind forces. It provide in building from foundation level to through height of building. For earthquake resistant building shear wall is one of the best option, Shear wall perform better if it is provide at effective location on the outer periphery of building plan. The main concern of this paper is to be analyzed the 2 models of ‘H’ Shape plan with shear wall at varying location and compared with one model of ‘H’ Shape without shear wall, and concluded the best model that perform better on the basis of different parameter such as Time period, story displacement and story stiffness. All analysis weredone by using ETABS 2016 software.

**KEY WORDS:** Shear wall, irregular plan, earthquake forces, ETABS etc.

## 1. INTRODUCTION

Shear wall is slender structural member which resist lateral forces in their own plane and act as cantilever, and provide large stiffness to the building system in direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. It provided in both direction length and width of building. Like moment-resisting frames, shear walls alone can not resist loads applied in the direction perpendicular to their plane. Thus, to resist lateral loads in both horizontal plan directions, buildings need to be provided with walls in both directions. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large. Thus, design of their foundations requires special attention. Shear wall gives better response if it is provide at effective location of the building plan. Main objective of this research work is to study about behaviour of shear wall for different location in ‘H’ shape irregular building for different models. Five models, chosen for study to find the effective location of shear wall, which give better response against seismic excitation. All analysis is performed by Time History Analysis using ETABS 2016 software.

## 2. BUILDING DISCRPTION

Discription of Community Building (Office) with 20 story Located in Raxul (Bihar) are given below

### *a. GEOMETRICAL PROPERTIES:*

S.No.	Structural Part	Dimension
1.	Length in X-direction	45 m
2.	Length in Y-direction	40 m
3.	No of bays in X-direction	9 No@5m

4.	No of bays in Y-direction	8 No @5m
3.	Floor to floor height	3 m
4.	Total height of building	60 m
5.	Slab thickness	150 mm
6.	Shear wall thickness	250 mm
7.	Column size	350×350 mm
8.	Beam size	200×400 mm

### *b. MATERIAL PROPERTIES:*

S.No	Material	Grade
1.	Concrete(Beam, column)	M30
2.	Concrete(Slab)	M30
3.	Rebar	HYSD-415

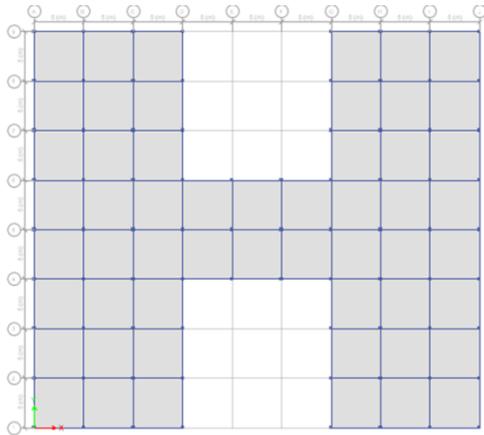
### *c. SEISMIC DATA:*

1.	Earthquake Zone	IV
2.	Damping Ratio	5%
3.	Importance Factor	1.5
4.	Type of soil	Medium soil
5.	Response Reduction factor	5
6.	Time Period	Program calculated
7.	Time History Data used	Raxul (Bihar)

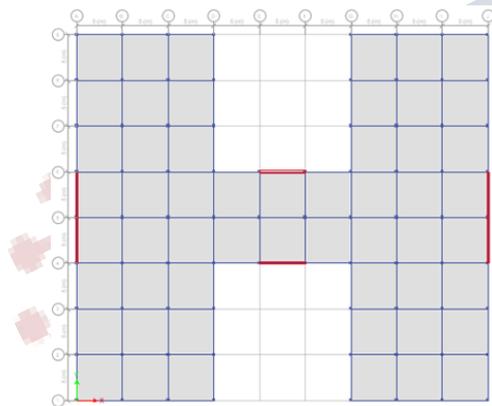
### *d. LOADING:*

- i. Live load 3.5kN/m<sup>2</sup> as per IS 875 Part- II
- ii. Earthquake load as per IS 1893 part-I

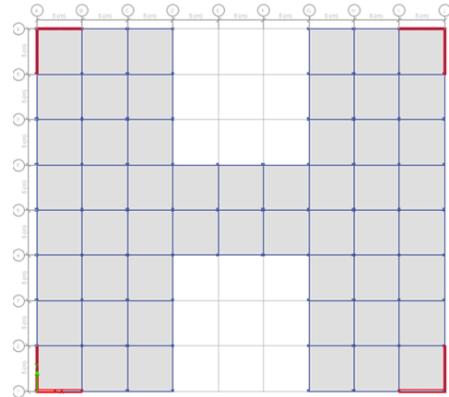
**3.PLAN DETAILS OF BUILDING FOR DIFFERENT MODELS**



**Model 1 (without shear wall)**



**Model 2**



**Model 3**

**4.METHOD OF ANALYSIS:**

The plan shape used for analysis is 'H' shape irregular Multi story building. Time history method gives better result in case of irregular and high rise building. In time history analysis actual ground acceleration data in both 'X' and 'Y' direction is used during earthquake analysis which leads to a more better and quick assessment of the structure. Hence this method for analysis was adopted.

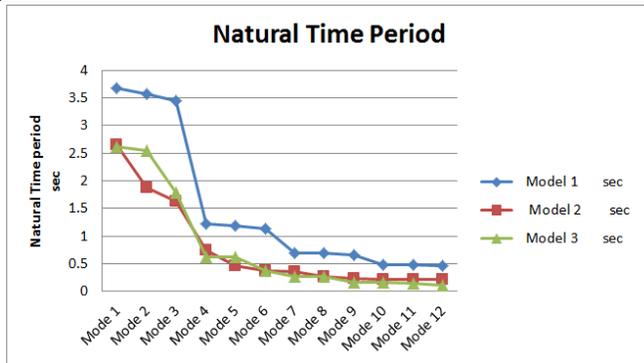
**5.ANALYSIS RESULT:**

The analysis of all the models that includes different location of shear walls has been done and results are shown below. The parameters which were studied are on the behaviour of building during seismic excitation are Time period, base shear and story stiffness.

**5(a).Natural Time Period:**

Mode no	Model 1 sec	Model 2 sec	Model 3 sec
Mode 1	3.677	2.66	2.615
Mode 2	3.572	1.877	2.553
Mode 3	3.44	1.626	1.784
Mode 4	1.219	0.756	0.631
Mode 5	1.183	0.465	0.626
Mode 6	1.139	0.375	0.373
Mode 7	0.701	0.362	0.272

Mode 8	0.688	0.277	0.272
Mode 9	0.662	0.242	0.159
Mode 10	0.49	0.222	0.159
Mode 11	0.481	0.219	0.155
Mode 12	0.463	0.218	0.108

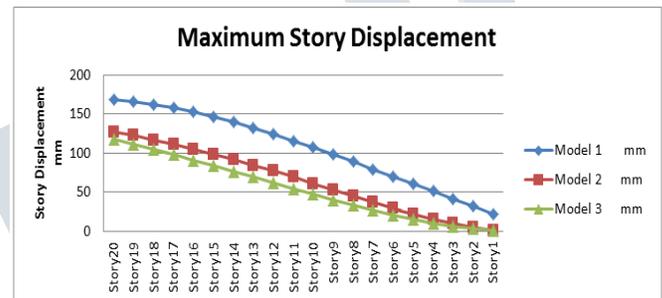

**Figure 5(a): Natural time period V/S Mode**

Natural time period is inversely proportional to the square root of stiffness, in above figure the value of maximum time period were observed in model 1 and minimum value observed in Model 3. Because shear wall provided large stiffness to the building so the value of natural time period is decreases from model 1 to model 3.

**5(b).Story Displacement:**

Story	Model 1 mm	Model 2 mm	Model 3 mm
Story20	168.055	127.542	117.795
Story19	165.711	122.504	111.313
Story18	162.302	117.17	104.686
Story17	157.875	111.488	97.916
Story16	152.539	105.405	90.992
Story15	146.401	98.907	83.924
Story14	139.563	92.007	76.735
Story13	132.121	84.739	69.462
Story12	124.167	77.155	62.149
Story11	115.787	69.319	54.854
Story10	107.061	61.311	47.642
Story9	98.063	53.218	40.584

Story8	88.861	45.143	33.762
Story7	79.519	37.202	27.262
Story6	70.092	29.526	21.181
Story5	60.63	22.271	15.621
Story4	51.179	15.616	10.694
Story3	41.76	9.776	6.522
Story2	32.294	5.013	3.239
Story1	21.657	1.656	0.998

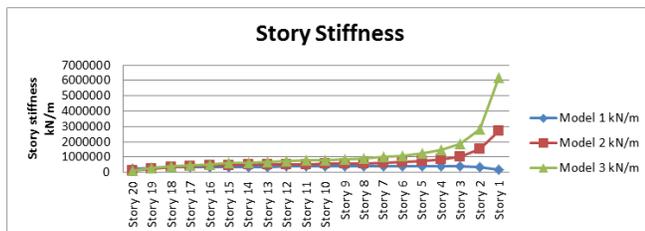

**Figure 5(b): Comparison of maximum story displacement**

Maximum value of displacement observed in model 1 . In model 1 the value of maximum story displacement from story 1 to 4 exceed the maximum allowable value as per is code so model 1 failed in story displacement and othres models are safe. Model 3 were shows minimum value of displacement, so the better performance is to be given by model 3 during seismic exitation among all models.

**5(c).Story Stiffness:**

Story	Model 1 kN/m	Model 2 kN/m	Model 3 kN/m
Story 20	220533.9	137834.5	141797.4
Story 19	296823	246216.1	272392.4
Story 18	329166.7	333054.2	383411.8
Story 17	347507.7	396464.7	473492.5
Story 16	359406.2	441268	546784.8
Story 15	367850.5	473195.6	606734
Story 14	374261	496609.5	656900.4
Story 13	379417.8	514758.5	700553.1
Story 12	383790.9	530095.5	740660.9
Story 11	387686.4	544591.3	780047.7
Story 10	391318.4	559976.6	821637.6

Story 9	394846.9	578098.7	868786.7
Story 8	398399.6	601182.7	925815.4
Story 7	402084.7	632392.4	999044
Story 6	405993.2	676797.9	1098696
Story 5	410168.5	743512.8	1243315
Story 4	414136.9	851296.2	1471295
Story 3	413628.5	1049171	1877362
Story 2	368344.6	1516874	2816446
Story 1	181258.1	2710758	6182560



**Figure 5(c): Comparison of maximum story stiffness**

From above figure we conclude that except model 1 all models were passed in story stiffness criteria as per given allowable value of IS code. Here soft story case occurs in model 1 at 11st story. The maximum value of stiffness observed in model 3, so model 3 gives better response among all models.

## 6.RESULTS AND CONCLUSIONS:

The purpose of this study was to analyzed and compare the seismic performance of the 20 Story plan of H Shape irregular R.C framed building.

The maximum value of natural time period observed in model 1 and minimum value in model 3. Time period of model 1 is 1.4 times more than model 3. It mean that Model 1 building is more flexible .

The value of story displacement for all models lies within the maximum allowable value as per IS 1893 code except model 1. The values in model 1 exceeds the allowable value from 1st story to 5th story.

The softness or rigidity of any particular story depends upon the stiffness of the structure, describe as per IS 1893. Behaviour of story stiffness is also change between top story to bottom story.

The overall observation of the structure performance shows that Model 1 building failed in case of soft story, because the value of stiffness in 1st story is 70% less than that of 2nd story.

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