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STUDY ON SEISMIC BEHAVIOUR OF AAC AND BRICK WALL WITH DIFFERENT SHEAR WALL LOCATION USING ETABS

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Abstract- **Autoclaved aerated concrete (AAC) blocks are used widely in infill panels and load-bearing walls due to their superior properties of thermal insulation and fire resistant. To use the such technology in areas which are subjected to more seismic, however, still requires further investigation of seismic performance and overall structural performance. Shear wall is one of the most commonly used lateral load resisting technique in tall buildings. In this paper we will investigate the seismic performance of AAC blocks and brick wall when used in framed structure with different positions of shear wall is used and thus we will find which will be better locations of shear wall when used in the G+11 multistoried building in ETABS 18. The structure is located in seismic zone IV (Shimla). The floor to floor height is taken as 3.3m and plinth height is taken as 0.6 above ground level. Seismic parameters such as damping ratio, response reduction factor and importance factor is taken as 0.05, 5 and 1.5 respectively. The load combinations are based on IS 1893:2016 and design loads have been taken from IS 875 (part 1,2 and 3). In this study four model load with AAC block and four model of Brick wall with different location of shear wall is used with the same structural configuration. Tabular and graphical representation is shown based on the analysis and results. A comparative analysis is performed based on lateral displacement, story drift, story shear, overturning moment and quantity of concrete and reinforcement required.**

Keywords- Etabs, Story Shear, Lateral Displacement, Overturning Moment, Story Drift, Shear wall, Seismic loading, Wind load, etc.

1. INTRODUCTION

In past we have seen that during few decade earthquake has been one of the most disastrous natural havoc faced by the human. If we look at the past, many architects and engineers are involved to tackle the calamity and to reduce the impact of earthquake on various types of structure. As far as design of structure from the seismic point of view is considered it is necessary to understand the reason for seismicity as well as the propagation type and nature of seismic waves being emitted.

During earthquake the structures undergo lateral movement that is shear movements under seismic waves. As design point of view if we design only for vertical loads (dead load and imposed load) then building may collapse due to lateral loads. Hence to remove the failure of structure they are designed to resist the lateral loads. The IS code 1893 has defined the design criteria of the structure based on the different zones as II, III, IV and V.

In India, Nowdays lightweight brick is most important component of building construction. It constitute about 24% total cost of the building. We must find the material which are cost reducing. AAC stabilized blocks are more efficient in reducing the cost of construction by removing the mortar joints. AAC blocks have good fire resistant and thermal insulation properties. The process of manufacturing these AAC blocks are eco-friendly as compared with the traditional brick wall. The whole purpose of this paper is to check how effectively a wall built using interlocking block will resist the lateral loading like earthquake load.

As far as high rise buildings are considered, the wind load is also a major challenge. In high rise structure it was observed that as we go up high in structure the wind load characteristics has to be implemented in design. Hence the stiffness od structure was observed while designing for wind and seismic resistance.

A shear wall may be defined as structural member which can resist lateral forces coming on it. Lateral forces may be defined as those forces that are parallel to the plane of the wall i.e. seismic and wind loads. Shear walls are most important in large, or high-rise buildings, or buildings in areas of high wind and seismic activity. Shear walls are typically constructed from materials such as concrete or masonry. Efficiency of a shear wall is purely depends upon its rigidity or its stiffness. A solid shear wall is more efficient than a shear wall with openings. But sometimes it is not possible to construct a shear wall without openings such as openings for doors, windows etc.

2. LITERATURE REVIEW

1. Avdhooot Bhosale, Nikhil P. Zade, Pradeep Sarkar

Title-Experimental Investigation of autoclaved aerated concrete masonry

In this paper, the experimental result of an investigation of the structural property of AAC block masonry required mathematical modeling of AAC masonry infilled framed structure. It also investigated some of the physical properties of AAC block that influence their structural properties and overall behavior".

2. Yuan Quan

Title-Applications of Autoclaved aerated concrete block in new energy-saving building Structure.

The autoclaved aerated concrete block was based on cement, lime, gypsum, fly ash and sand as a raw material. It had many advantages such as lightweight, high performance thermal insulation, sound absorption and so on. Application of AAC block in new energy saving building structure was introduced in this paper"

3. Vidhya P. Namboothiri

The objective of this paper was to modeled the building with the infill wall and AAC block and to perform the seismic analysis using the software ETABS. The assumed structure is an apartment building of G+3 storys in seismic zone III with medium soil strata. seismic coefficient method of analysis is adopted. Influence of AAC blocks on various responses of RC framed structure is studied.

4. Prof. R.R. Shinde

In this paper seismic analysis of four different models is performed. The fundamental time period, story drift, Maximum Bending Moment was checked by modelling the building. The story displacement of (G+7) building model with core shear wall is decreased by 51.83% as compared with building with masonry infills whereas story drift was decreased by 74.6%.

5. Bhawani Shankar

Title-Seismic analysis of interlocking block as infill wall

In this paper the field test has been performed to check the efficiency of AAC blocks. The six models have been created and the stress and displacement result has been checked with the help of ansys software which is based on the FEM of analysis.

4. Prof. Supriya Shinde, Mr. Zeeshan Ali

Title- Parametric Study And Seismic Analysis Of AAC Block Using Sttad Pro V8i SS6

In this paper the detailed parameter of AAC block have been studied and lab test is being conducted on AAC block and clay brick to find chemical and physical properties. Seismic analysis of AAC block using staad pro software is also performed

3. OBJECTIVE OF STUDY

1. To Analyze the structure using conventional brick walls and AAC blocks with different locations of shear wall in seismic zone IV by using E-tabs software .
2. To calculate analytically the boundary loading conditions on frequency of earthquake to apply on the model.
3. To compare the outcomes of ordinary and AAC blocks and check practically whether AAC blocks are suitable as a earthquake resistant blocks.
4. To check the most economical and seismic resistant location of shear wall so that the better position of shear wall is decided in the building.
5. To compare the graphs formed from the different work.
6. The study comprises of derivation of base shear, story drift and displacement results and comparison with the ordinary bricks placed in infill walls.
7. To compare the results of different position of shear wall.

4. METHOD USED FOR ANALYSIS

RESPONSE SPECTRUM METHOD (DYNAMIC ANALYSIS)

RSA (earthquake response spectrum method) is the most advance method in the seismic analysis and design of structures. It is a linear-dynamic statistical analysis method which measures the contribution from each natural mode of vibration to indicate the likely maximum seismic response of an elastic structure.

Response-spectrum analysis is useful for design and decision-making because it relates structural type-selection to dynamic performance. Structures which are subjected to shorter period experiences greater acceleration, whereas those which are subjected to longer period experiences greater displacements. Structural performance objectives should be taken into account during preliminary design and RSA.

5. MODELLING OF BUILDING

I. GENERAL DESCRIPTION OF BUILDING

In this study, a 12-story building with 3.3-meters height of each story including the ground floor. The building was modelled in ETABS. We have modelled 8 different models of the building which include 4 models of conventional brick wall and 4 models of AAC block work. Model 1-4 are analyzed with the conventional brick and model 5-8 comprised of AAC block work. In 1 model we have note considered the shear wall. In model-2 we have considered shear wall location at each cornor of building. In model-3 shear wall location changed to mid face of the building and in between the building. Model-4 comprises of shear wall location at the side face of the building. Similarly model 5-8 are modelled considering AAC block for each model. The all models are studied in seismic zone IV (z=0.24) comparing lateral displacement, story drift, story shear and total volume of concrete and reinforcement required.

II. GEOMETRICAL DETAILS OF BUILDING

Sr. No.	Description	
1	No. of story	12(G+11)
2	Floor to floor height	3.3m
3	Column size	0.6m X 0.6m
4	Beam size	0.230m x 0.450m
5	Slab thickness	130mm
6	Shear wall thickness	250mm
7	Grade of concrete and steel	M30 and Fe500
8	Thickness of brick wall	230mm and 115mm
9	Thickness of AAC block	200mm and 100mm

III. SEISMIC PARAMETERS CONSIDERED-

Dead Load (DL)	Based on IS 875 (Part 1) (1987) A. Self-weight of structure B. Floor Load (4.5 KN/sq. m.), C. 230mm Wall load (15 KN/sq. m.), D. 115mm Wall load (7.5 KN/sq. m.)
Live Load (LL)	Based on IS IS 875 (Part 2) (1987) A. Live Load (5 KN/sq. m.), is considered.
Wind Load (WL)	As per IS 875 (Part 3) (2015) With basic wind speed (Vb)= 47 m/sec
Seismic Load (SL)	As per IS 1893 (Part 1) (2002//2005) A. Zone-IV (Z=0.24) B. Rock/soil type : Medium C. Rock and Soil site factor :-1 D. Response Reduction Factor-5 E. Importance factor :-1.5 F. Damping :- 0.05%

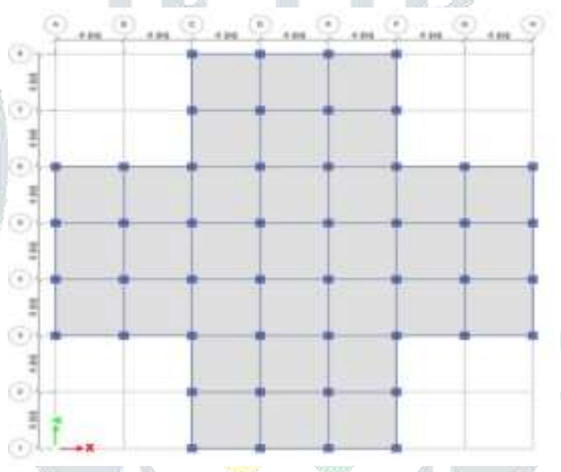
IV. LOAD COMBINATIONS

COMB-1	1.5 DL
COMB-2	1.5DL+1.5LL
COMB-3	1.2 DL+1.2 LL+1.2WX
COMB-4	1.2 DL+1.2 LL-1.2WX
COMB-5	1.2 DL+1.2 LL+1.2WY
COMB-6	1.2 DL+1.2 LL-1.2WY
COMB-7	1.5DL+1.5WX

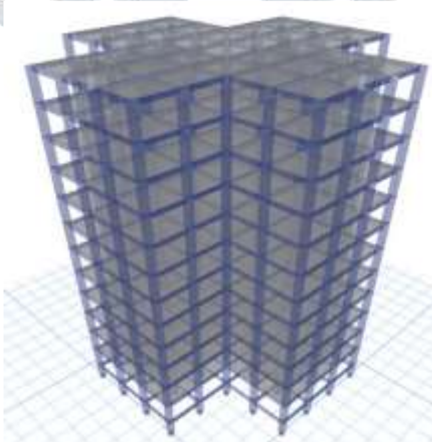
COMB-8	1.5DL-1.5WX
COMB-9	1.5DL+1.5WY
COMB-10	1.5DL-1.5WY
COMB-11	0.9DL+1.5WX
COMB-12	0.9DL-1.5WX
COMB-13	0.9DL+1.5WY
COMB-14	0.9DL-1.5WY
COMB-15	1.2DL+1.2LL+1.2 RSX
COMB-16	1.2DL+1.2LL-1.2 RSX
COMB-17	1.2DL+1.2LL+1.2 RSY
COMB-18	1.2DL+1.2LL-1.2 RSY
COMB-19	0.9DL+1.5RSX
COMB-20	0.9DL+1.5RSX

V. MODELLING OF BUILDING WITH AND WITHOUT SHEAR WALL-

1) Model 1 & 5 without shear wall

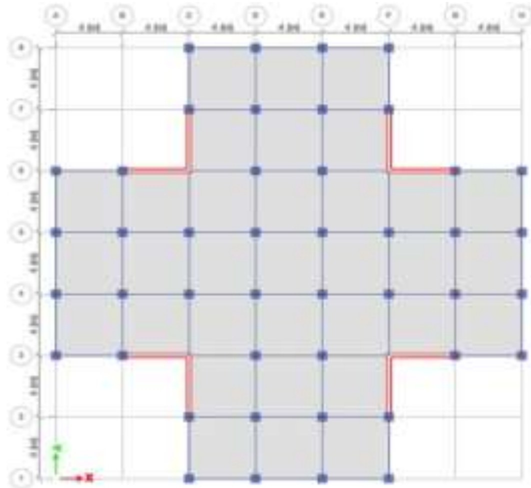


Plan of building

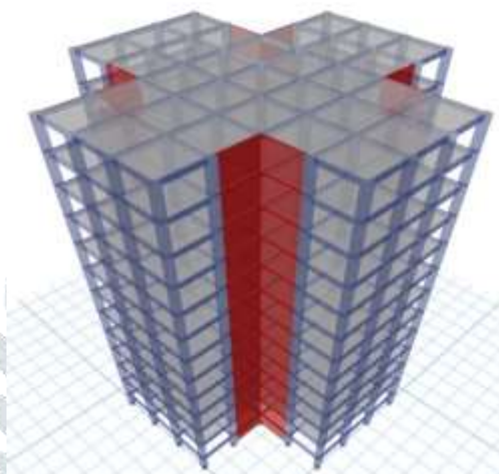


3-D extruded view of building

2) Model 2 & 6 with shear wall placed at cornor of building

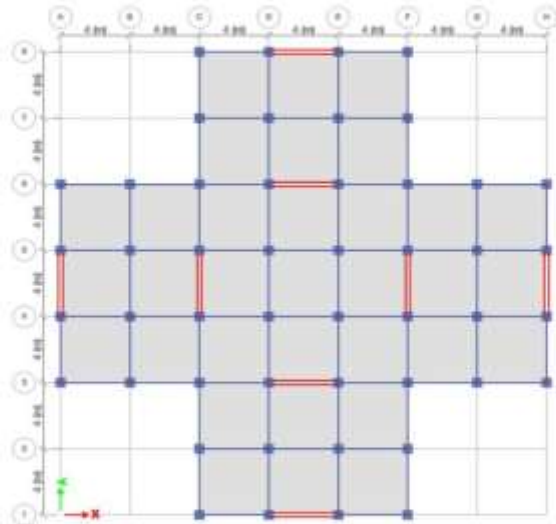


Plan of building

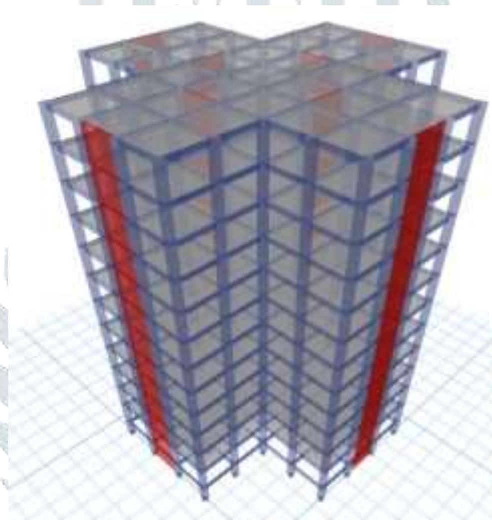


3-D extruded view of building

3) Model 3 & 7 with shear wall placed at sides and middle of building

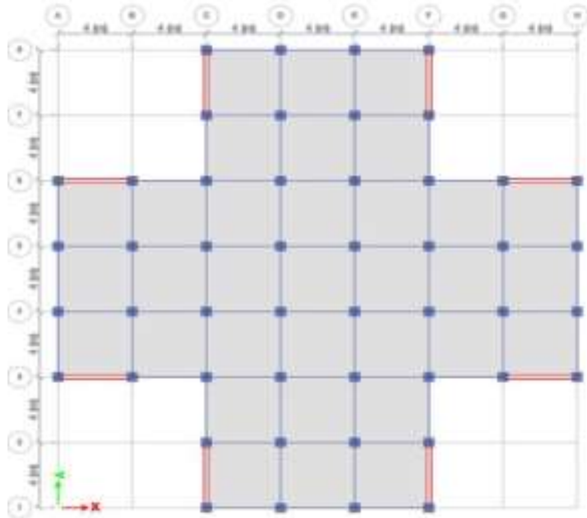


Plan of building

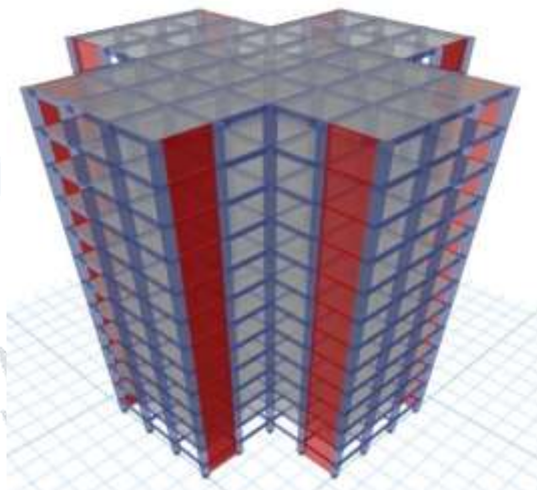


3-D extruded view of building

4) Model 4 & 8 with shear wall placed at adjacent sides of wall



Plan of building



3-D extruded view of building

5. RESULTS AND DISCUSSIONS

A. LATERAL DISPLACEMENT

The lateral displacement in both directions (X and Y) for the respective models are summarised here. The model 1 to 4 is one the Brick work and 5 to 8 is on the AAC block work.

1) Lateral displacement in X-direction

Story Name And Height		Lateral Displacement in X-direction (in mm)							
		1	2	3	4	5	6	7	8
Base	0	0	0	0	0	0	0	0	0
Story-1	2.1	3.2	0.5	0.5	0.5	2.8	0.3	0.5	0.5
Story-2	5.4	7.9	1.4	1.5	1.6	7.1	1.2	1.3	1.2
Story-3	8.7	12.7	2.9	3.1	3.5	11.3	2.7	2.9	3.0
Story-4	12	17.3	4.9	5.2	5.8	15.3	4.6	4.8	5.2
Story-5	15.3	21.5	7.0	7.6	8.4	19.1	6.5	7.0	7
Story-6	18.6	25.5	9.3	10.1	11.2	22.5	8.1	8.8	10.5
Story-7	21.9	29.1	11.7	12.7	14.1	25.6	10.5	11.1	12.2
Story-8	25.2	32.3	14.2	15.4	17.0	28.5	13.2	13.6	15.2
Story-9	28.5	35.1	16.6	18.0	19.8	30.9	15.1	15.8	15.9
Story-10	31.8	37.4	18.9	20.5	22.5	33.1	17.9	18.6	19.2
Story-11	35.1	39.3	21.2	22.9	25.2	34.8	20.0	21.8	23.4
Story-12	38.4	40.7	23.4	25.2	27.7	36.1	22.1	22.9	24.8
Story-13	41.7	41.6	25.4	27.3	30.1	36.9	23.0	23.9	26.5

2) Lateral displacement in Y-direction

Story Name And Height		Lateral Displacement in Y-direction (in mm)							
		1	2	3	4	5	6	7	8
Base	0	0	0	0	0	0	0	0	0
Story-1	2.1	4.1	0.5	0.5	0.5	3.6	0.3	0.5	0.5
Story-2	5.4	9.8	1.4	1.5	1.6	8.7	1.2	1.3	1.2
Story-3	8.7	15.5	2.9	3.1	3.5	13.4	2.7	2.9	3.0
Story-4	12	19.9	4.9	5.2	5.8	17.7	4.6	4.8	5.2
Story-5	15.3	24.4	7.0	7.6	8.4	21.7	6.5	7.0	7
Story-6	18.6	28.5	9.3	10.1	11.2	25.4	8.1	8.8	10.5
Story-7	21.9	32.3	11.7	12.7	14.1	28.7	10.5	11.1	12.2
Story-8	25.2	35.6	14.2	15.4	17.0	31.7	13.2	13.6	15.2
Story-9	28.5	38.6	16.6	18.0	19.8	34.4	15.1	15.8	15.9
Story-10	31.8	41.1	18.9	20.5	22.5	36.5	17.9	18.6	19.2
Story-11	35.1	43.1	21.2	22.9	25.2	38.4	20.0	21.8	23.4
Story-12	38.4	44.5	23.4	25.2	27.7	39.7	22.1	22.9	24.8
Story-13	41.7	45.4	25.4	27.3	30.1	40.5	23.0	23.9	26.5

B. STORY DRIFT

The story drift in both directions (X and Y) for the respective models are summarised here. The model 1 to 4 is one the Brick work and 5 to 8 is on the AAC block work.

1) Story Drift in X-direction

Story Name And Height		Story drift in X-direction							
		1	2	3	4	5	6	7	8
Base	0	0	0	0	0	0	0	0	0
Story-1	2.1	1.6	.08	0.10	0.12	1.8	0.10	0.12	0.14
Story-2	5.4	3.21	0.16	0.25	0.16	3.29	0.19	0.22	0.25
Story-3	8.7	4.05	0.20	0.29	0.28	4.5	0.24	0.29	0.33
Story-4	12	4.21	0.21	0.31	0.35	4.28	0.26	0.33	0.37
Story-5	15.3	4.39	0.22	0.33	0.39	4.44	0.28	0.37	0.41
Story-6	18.6	3.91	0.24	0.39	0.45	4.15	0.30	0.41	0.44
Story-7	21.9	3.61	0.23	0.37	0.43	3.45	0.32	0.40	0.43
Story-8	25.2	3.54	0.22	0.35	0.41	3.51	0.30	0.39	0.41
Story-9	28.5	3.35	0.21	0.31	0.38	3.55	0.29	0.38	0.39
Story-10	31.8	3.19	0.20	0.30	0.37	3.29	0.28	0.37	0.37
Story-11	35.1	2.98	0.19	0.27	0.31	3.56	0.27	0.35	0.36
Story-12	38.4	2.82	0.18	0.24	0.29	3.12	0.24	0.33	0.34
Story-13	41.7	2.71	0.17	0.22	0.26	3.85	0.22	0.30	0.32

6. CONCLUSION

A G+11 building was analysed with AAC and brick wall with different models. In the model, on different positions shear wall is applied and checked the result with the help of E-tabs software. It was found that shear walls are much efficient in reducing lateral displacement of structural frame. The location of shear wall has also significant effect on the seismic response. By using shear wall we can reduce the damage to the structure by providing large stiffness.

If we compare the result of Ordinary brick wall with different position of shear wall we get the following points.

1. Displacement of top story in X-direction in model-2 is 39% less as compared to model-1, model-3 is 34% less in comparison to model-1 and model-4 is 27%less in comparison with model-1
2. Displacement of top story in Y-direction in model-2 is 43% less as compared to model-1, model-3 is 39% less in comparison to model-1 and model-4 is 34% less in comparison with model-1
3. By comparing model 1, 2, 3 and 4 we will reach on the conclusion that minimum story drift in X direction is in model-2 (0.24).

If we compare the result of AAC block wall with different position of shear wall we get the following points.

1. Displacement of top story in X-direction in model-2 is 36% less as compared to model-1, model-3 is 33% less in comparison to model-1 and model-4 is 28%less in comparison with model-1
2. Displacement of top story in Y-direction in model-2 is 44% less as compared to model-1, model-3 is 37% less in comparison to model-1 and model-4 is 35% less in comparison with model-1
3. By comparing model 5, 6, 7 and 8 we will reach on the conclusion that minimum story drift in X direction is in model-2 (0.30).
4. The location of shear wall at the inner edge of building of in “L” shaped is preferable are they are effective in reducing deflection and drift
5. The overall conclusion is that if we provide shear wall at the inner edges it wil be most effective as compared to another.

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