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# EFFECT OF SHEAR WALL THICKNESS ON STRUCTURAL BEHAVIOR BUILDING

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***Abstract:*** In seismic prone regions, structures are provided with the reinforced concrete walls called as shear wall. In Seismic design buildings, reinforced concrete structural walls perform as major seismic activities resisting members. Reinforced concrete structural walls provide an competent bracing system and put forward great prospective for lateral load resistance. Shear wall properties are responsible for structure stiffness and strength, reinforced concrete structural walls are important to assess the earthquake movements of the walls appropriately.

An analytical study is carried out on different shear wall area to floor area ratio over earthquake loading to determine building performance. For this purpose two different storey buildings are chosen i.e., five and ten storey buildings of Eight building models with different shear wall ratio ranging from 0.5% to 2.0% are generated in both the direction using ETABS software. The performance of the building over earthquake loading checked by the linear analysis in time history and response spectrum method. Displacements and storey drifts are considered as main parameters for the study. The analytical results are intend that atleast 1.0% shear wall is required to control the storey drift in the building and 1.5% shear wall ratio is sufficient for structure when compared to 2.0% shear wall due to approximately equal results between 1.5% and 2.0% shear wall area.

***Keywords:*** ETABS, Linear analysis, Time history method, Response spectrum method, Shear wall, Structural behavior.

## I. Introduction

Shear walls performs a very high in-plane stiffness and strength, which is used for resisting the huge horizontal loads, and which are able to support concurrently the large gravity loads. The shear wall area to floor area ratio, the wall aspect ratio, and the wall configuration in plan are indicated as main parameters that influence the detailing of a shear wall for RC design.

The endeavor of the present study is to know the effect of shear wall thickness of structural behavior of reinforced concrete structures. In the first stage three dimensional models with shear wall ratios 0.5, 1, 1.5 and 2%.Will be developed and magnitude design check will be carried out using ETABS software. In Second stage to study the analysis of building by time history analysis and response spectrum analysis. In the third stage the calculations of displacement and story drift.

The analysis is done in following steps such as, problem description is briefly explained about the response of a structure with shear wall during the earthquake and main objectives of the study are presented, different methods of seismic analysis is briefly discussed, and design procedure are explained. modeling of reinforce concrete buildings, analysis, results and discussions.

## II. Literature Review

"Anshuman (2011) Most of the literatures are found how to design and analyse the shear wall but there is no proper discussion is made for proper location of shear wall in the multi-storey buildings. The center of attention of the paper of determining the locating the shear wall in multi-storey building depending on its both elastic and elasto-plastic behavior. For this purpose in zone-4 an earthquake load used for calculation and applied to fifteen story building. Using the software STAAD Pro 2004 and SAP V 10.0.5 elastic and elasto-plastic analyses were taken. Finally based on above calculations shear forces, bending moment and story drift were take and location of shear wall was established.

"Burcu Burak and Hakki Gurhan (2013) The paper says the different shear wall area to floor area ratios is used in mid-rise building for detecting its action over earthquake loading. 0.51 to 2.17% shear wall area ratio is generated by 24 mid-rise building models with 5 and 10 storey. Then the activities of the structure over earthquake loading is focused by non-linear time history analysis and found 7 different ground motions records and average record is used for computation of seismic performance. Base shear and storey drifts are parameters considered for the study. the study says that by increasing shear area storey drift is decreasing and above 1.5% shear area decreasing of drift values are less compared with 0.5%. At least 1.0% is enough for 5-storey building for controlling storey drifts.

"Jayasree Ramanujan **(**2014**)** The paper focused, based on a planned position of building over lateral loads deflection, storey drift, shear and reinforced requirement in column etc., is compared and also effect of shear wall location from linear and non-linear analysis. By means of static inelastic analysis deformation demand in earthquake design and for calculating the strength pushover analysis is used. To get overall performance capacity spectrum method is considered. ETABS 9.5 and SAP 2000.V.14.1 software are used here."

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Nikam .N.M. and Kalurkar.L.G (2016) This paper aims to conduct the non -linear static analysis (Pushover Analysis) of reinforced concrete building with shear walls. The performance of reinforced concrete frames was investigated using the pushover analysis. They concluded that the fundamental time period of building decreases due to provision of shear wall as provision of shear wall increases the global stiffness of building. The pushover analysis is a relatively simple way to explore the nonlinear behavior of buildings. Connection of demand, capacity curves and distribution of hinges in beams and columns shows the performance enough with accurately complete reinforced concrete frame building. Damages in beams and columns are minimal which is developed through hinges.

Mahdi Hosseini (2015) From paper effective of earthquake load on behavior of rectangular shear wall in rc frame building, analyzing the structural performance of the RC framed building with Rectangular shear wall and significance of effect of shear wall on conventional frame system and resisting lateral loadings with shear wall, location of shear wall near center of mass and center of gravity . Paper overall study is using shear wall progress in the structural piece of the building with frame system.

## III. Methodology

A study how research is done systematically and a procedure to methodically solve the problem and by adopting various steps and there by Methodology helps to recognize products of scientific inquiry and the process aims to describe and analyze methods, clarify their assumptions relating in their potentialities.

In static linear analysis, under the effect of external loads displacements , strains, stresses and reaction forces are evaluated.Dynamic linear analysis is used to find natural frequency, dynamic displacements, time history results, modal analysis.

Response spectrum is defined as corresponding to harmonics it is a combination of many special modes. So load cases are defined in seismic zone in x and y directions as per IS 1893 2002, then response spectrum is done earthquake load in both x and y directions with base reactions.Time history method of analysis is based upon ground motions, looks over dynamic response when base exposed.

## IV. Modeling and Analysis

Modeling and design of RCC buildings with shear wall ratio is determined by dividing the total area of shear wall in one principal direction to the plan area of the ground floor. In the building models shear wall ratios of about 0.5, 1.0, 1.5, and 2.0% are used to investigate the seismic behavior of RCC buildings.

TABLE1: Geometrical dimentions and detailing

| | |
|---|---|
| Rectangular section | 2 m × 16.5m |
| Beam dimensions | 400 × 250 mm |
| Column dimensions | 400 × 400mm |
| Thickness of slab | 125mm |
| Grade of concrete | M20 |
| Grade of reinforcement | Fe415 |
| Live load | 3 $KN/m^2$ |
| Floor finishes | 1.5 $KN/m^2$ |
| Seismic zone | 5 |
| Importance factor | 1 |
| Zone factor | 0.16 |
| Density of concrete | 25 $KN/m^3$ |

For modeling five storey building , the above structural properties are taken and for modeling ,ETABS software is used.

**Case-1: Plan of Building With 0.5% Shear Wall Ratio in Each Direction**

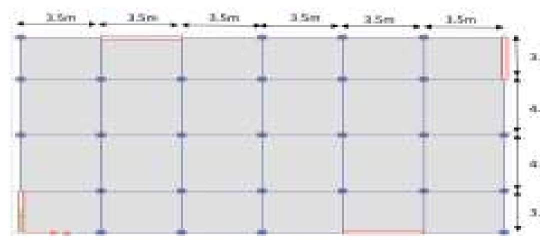

Fig1.Elevation of building with 0.5% shear wall ration in each direction

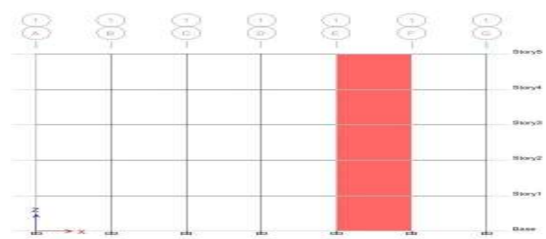

Fig2.Elevation of building with 0.5% shear wall ration in each direction

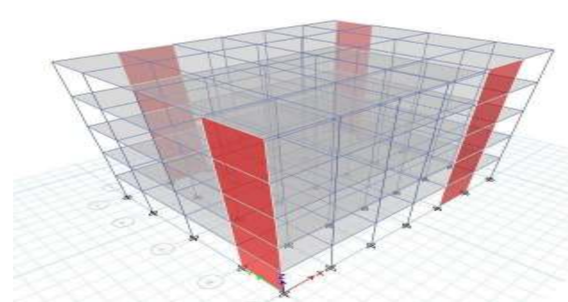

Fig3

Case-2: Plan of Building 1% Shear Wall Ration in Each

Fig3.3D Modeling of Building with 0.5% shear wall ratio

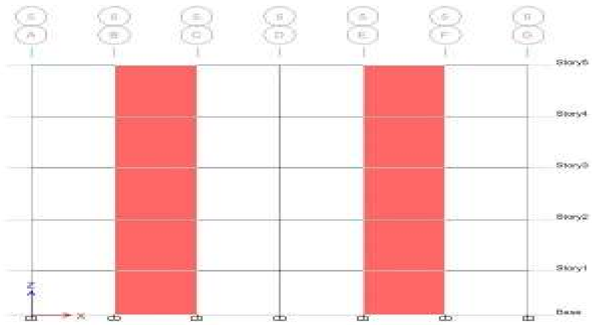


Fig4.Elevation of building with 1% shear wall ration in each direction

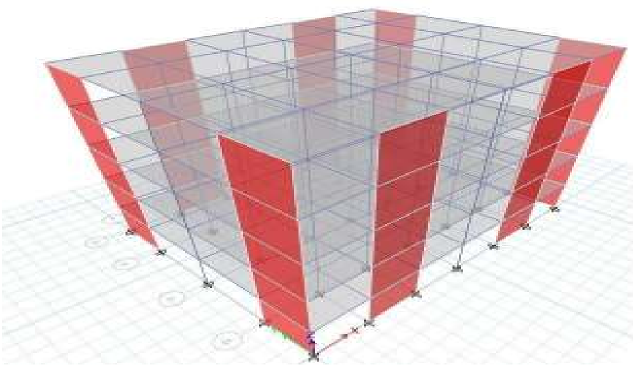

Fig5.3D Modeling of Building with 1% shear wall ratio

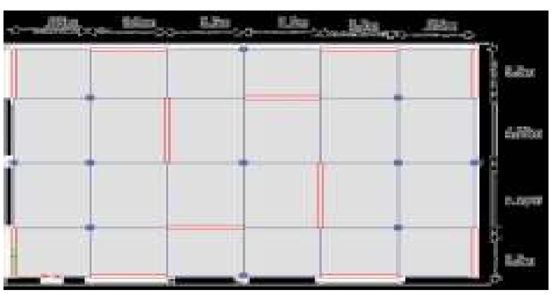

Fig6. Plan of Building with 1.5% Shear Wall Ration in Each Direction

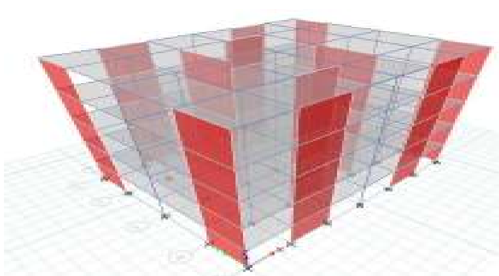

Fig7.3D Modeling of Building with 1.5% shear wall ratio

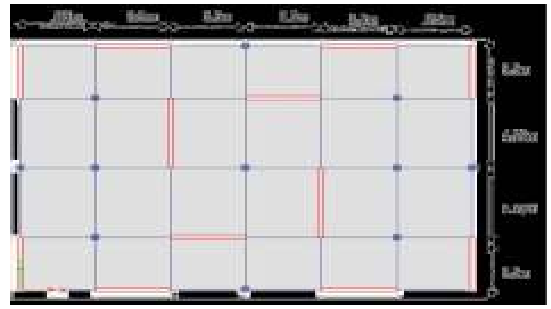

Fig8.Plan of Building 2.0% Shear Wall Ration in Each Direction

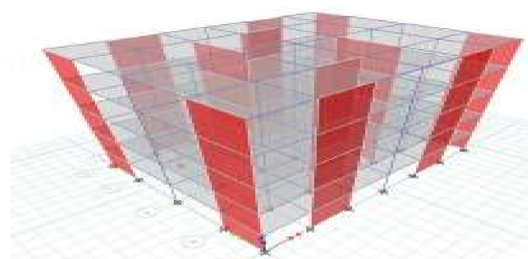

Fig9.3D Modeling of Building with 2.0% shear wall ratio

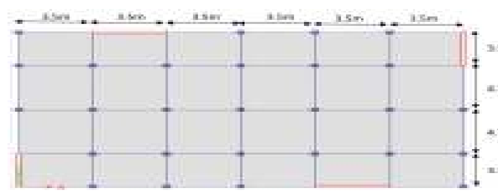

Fig10.Modeling of Ten Story Building and Plan of Building with 0.5% Shear Wall Ration in Each Direction

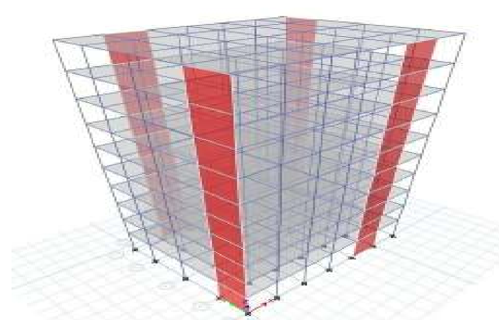

Fig11.3D Modeling of Ten Story Building with 0.5% shear wall ratio

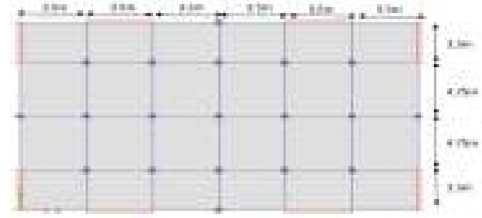

Fig12. Plan Building with 1.0% Shear Wall Ration in Each Direction

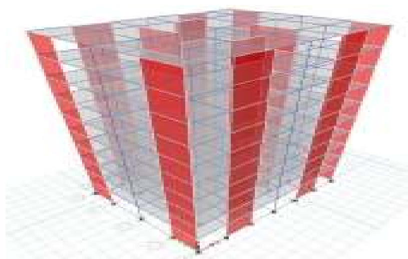

Fig13.3D Modeling of Building with 1.0% shear wall ratio

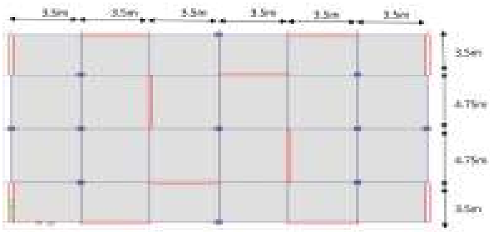

Fig14.Plan of Building with 1.5% Shear Wall Ration in Each Direction

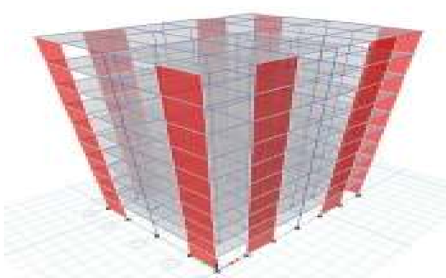

Fig15.3D Modeling of Building with 1.5% shear wall ratio

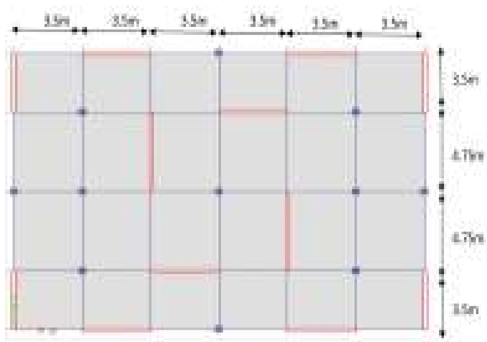

Fig16.Plan of Building with 2.0% Shear Wall Ration in Each Direction

Fig17.3D Modeling of Building with 2.0% shear wall ratio

## V. Results and Discussion

**Time History Analysis Results are as follow:**

For time history analysis following three earthquake ground motions is used.Properties of selected ground motion records:

TABLE 2: Earthquake details

| **Earthquake** | **Magnitude** | **Epicenter Distance (km)** |
|---|---|---|
| Uttarakasi (1991) | 6.8 | 15.0 |
| Loma (1989) | 6.9 | 14.0 |
| El Centro (1940) | 6.9 | 10.0 |

TABLE 3: Time period and frequency of different mode shapes of the building

| Mode Shape No. | Shear wall ratio (%) | | | |
|---|---|---|---|---|
| | 0.5 | | 1.0 | |
| | Time Period | Frequency | Time Period | Frequency |
| 1 | 0.51 | 1.94 | 0.42 | 2.37 |
| 2 | 0.47 | 2.12 | 0.04 | 2.63 |
| 3 | 0.37 | 2.73 | 0.28 | 3.55 |
| 4 | 0.13 | 7.87 | 0.10 | 10.42 |
| 5 | 0.12 | 8.26 | 0.09 | 11.11 |
| 6 | 0.08 | 12.0 | 0.06 | 16.40 |
| 7 | 0.07 | 14.7 | 0.05 | 20 |
| 8 | 0.06 | 16.4 | 0.04 | 23.2 |
| 9 | 0.05 | 18.5 | 0.04 | 23.2 |
| 10 | 0.05 | 20.4 | 0.04 | 27.8 |
| 11 | 0.05 | 21.8 | 0.03 | 32.2 |
| 12 | 0.04 | 23.8 | 0.03 | 35.72 |

TABLE 4: Time period and frequency of different mode shapes of the building

| Mode Shape No. | Shear wall ratio (%) | | | |
|---|---|---|---|---|
| | 1.5 | | 2.0 | |
| | Time Period | Frequency | Time Period | Frequency |
| 1 | 0.33 | 3.00 | 0.33 | 3.00 |
| 2 | 0.32 | 3.09 | 0.32 | 3.09 |
| 3 | 0.30 | 3.38 | 0.30 | 3.38 |
| 4 | 0.08 | 13.1 | 0.08 | 13.1 |
| 5 | 0.07 | 14.1 | 0.07 | 14.1 |
| 6 | 0.06 | 17.2 | 0.06 | 17.2 |
| 7 | 0.03 | 28.6 | 0.03 | 28.6 |
| 8 | 0.03 | 29.4 | 0.03 | 29.4 |
| 9 | 0.03 | 38.5 | 0.03 | 38.5 |
| 10 | 0.02 | 40 | 0.02 | 40 |
| 11 | 0.02 | 40 | 0.02 | 40 |
| 12 | 0.02 | 40 | 0.02 | 40 |

## VI. Conclusions

1. In time history analysis it is observed that the building with 0.5% shear wall ratio has maximum displacements whereas minimum at buildings with 2% shear wall ratio.
2. In Response spectrum analysis story drift is highly influenced by the increasing of shear wall ratio in the Buildings.
3. It is observed from response Spectrum analysis, the story drift is decreasing with increase in Shear wall ratio from 0.5% to 2%.
4. The results indicate that at least 1.0% shear wall ratio should be provided in the design of RC buildings to control the drift.
5. Results shown that 1.5% of shear wall area is significiant compared to 2.0% shear wall area, because almost it is equal results.

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