Seismic Vibration Control of High Rise Building with Shear Wall using ETABS

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***Abstract*— This work is concerned with the vibration control of the high rise building with shear wall by considering seismic force. According to is 1893(part -1):2002 code is used to analyses the structures by time history method. To use the different load combinations by IS1893 (part-1):2002. In this study to prepare the U shapes of building in ETABS- 2017 software. RCC model, shear wall, damper model and shear wall and damper may have varied seismic response performances. All the models are analysed for the seismic zone of the buildings- zone III of medium soil as per IS 1893-2002 (part 1). The results are tabulated In-terms of lateral displacement, story displacement, natural period time and base shear.**

***Keywords*— Shear walls, Time history method and ETABS.**

I. INTRODUCTION

Multi-Storey RC Buildings are capable of withstanding both vertical loads and horizontal loads. If the building is constructed without shear wall, then the size of the column (Vertical member) and beam (Horizontal members) are fairly larger in section this may leads to lot of overcrowd at the joint portion makes the difficulty in handing vibration to the concrete at the time of execution and displacement is quite large, causing enormous forces in the members. From the standpoint of economy and lateral deflection control, a shear wall may become necessary. Shear walls with adequate design and construction will have both stiffness and strength of the section to with stand the forces. It's a stiff vertical diaphragm used in construction works to carry lateral stresses. In tall structures susceptible to lateral wind force and seismic stresses, shear walls are extremely critical. In contrast to wind design, the most significant attribute of a shear wall for seismic design is that it should be ductile under reversible and repeated over loads.

II. LITERATURE REVIEW OF STRUCTURE WITH SHEAR WALL

Parmod Sharan, Balwan et al (2016): The purpose of this research is to investigate the control of seismic vibrations using a modified framed shear wall. The renovation of susceptible buildings is a key issue in earthquake-prone areas. A number of treatments have recently been developed to strengthen and repair the structures in these areas. However, because of the vacation of structures, inhabitants are disturbed by these strengthening and rehabilitation measures. Under reversed dynamic loading, a new strengthening approach for outer shear walls is discussed in this paper.

D. Karishma and Asst. Prof. A. Satya Sunitha et al [10] (2019): In this paper the earthquake vibration control using framed shear walls. The present work attempts to study the technique of shear wall. This study deals with the method of analysis and design ofa shear wall for G+5 buildings located in Zone-. The scope behind this work is to learn necessity of a shear wall in these modern days under the dead load, seismic load, live load (u.d.l) acting on the structure.

Kiran Tidke, Rahul G.R.Gandheet (2016): The purpose of this work is to investigate the analysis of the structure with and without shear wall by considering seismic forces. The goal of this project is to investigate the impact of seismic stress on the installation of shear walls in buildings in various locations. Five distinct models were used to investigate the effectiveness of shear walls. The first model is a bare frame structural system, whereas the remaining four models have differing shear wall layouts. In SAP2000 software, the response spectrum and time history approach are utilised for analysis by considering the structure situated in zone-II condition. Some parameters, such as base shear, storey drift, and structural displacement, are determined by analysis.

Khushbo K. Soni, and Dr. Prakash S. Pajga et al (2015): The goal of this project is to investigate the design of multi- story standard rcc buildings with and without shear walls. In this study, a static analysis method was used to simulate12 storey, 15 storey, and 18 storey buildings with and without shear walls for earthquake zone III. The analysis is done with E-TABv9.74 software. The goal of this research is to compare building seismic performance in terms of displacement, storey drift, base shear, cost, and carpet area. Buildings with shear walls are less expensive than those without.

III. OBJECTIVES

The goal of this research was to look at seismic vibration management of a high-rise structure with a shear wall using the ETABS-2017 programme, taking into account the building's U shape and zone III. The study aims to achieve the following goals:

- To perform time history analysis on irregular U shaped concrete framed structure using barkot earthquake data (1999) in ETABS software.
- To perform the seismic analysis of the multi- storeyed building and determining the time period, base shear, storey displacement and storey drift for considered zone III building.

- To carryout seismic analysis by introducing both shears wall, as a combined effect in the considered structure and study the response parameters.
- To conduct comparative study on conventional RCC structures, conventional RCC structures with shear wall.

LOCATION OF SHEAR WALLS(SW) A BUILDING

a. SW at center
b. SW at core and parallel side
c. SW at corner
d. SW at periphery

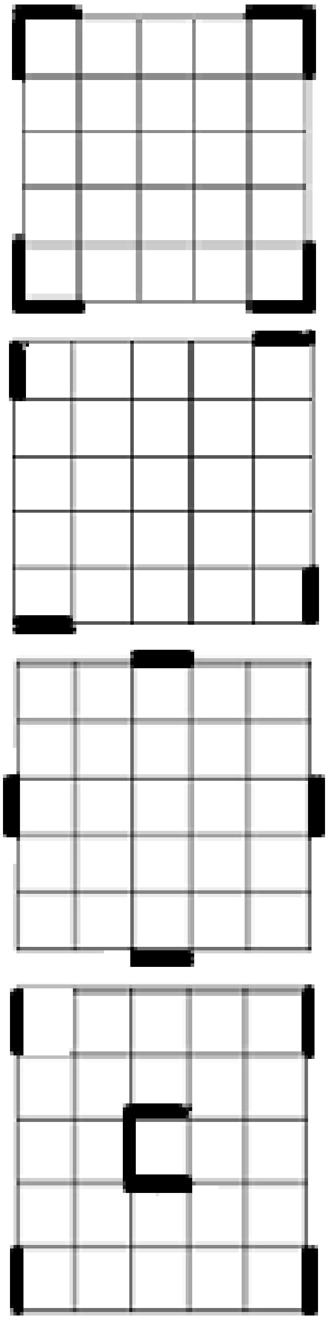

Figure-1: shows different location of shear wall in model

TYPES OF SHEAR WALL (SW):

1. Reinforced Concrete SW
2. Plywood SW
3. Midply SW
4. RC hollow block masonry wall
5. Steel plate SW

ADVANTAGES

1. Shear walls are simple to construct since wall reinforcement detailing is straightforward and hence simple to execute on site.
2. Shear walls(SW) helps in avoiding the damage caused due to the earthquake to the structural and non-structural members this may leads the save the money and efficiencyof the building gets increases.

3.Shear wall architectural features Most RC buildings with shear walls contain columns, which are used to support gravity loads (i.e., those due to self-weight and contents of building).

FUNCTION OF SHEAR WALL

The two function of the shear wall are strength and stiffness.

- The shear wall performing as a sufficient lateral resisting capacity to the earthquake (especially horizontal earthquake forces). Also it transvers the load from one element to other very easily.
- The main purpose of a shear wall is to resist lateral loads in buildings (specially high-rise buildings) that are caused by earthquakes or wind. Shear walls support gravity loads in addition to lateral loads.

IV. METHOD AND METHODLOGY

For this present investigation, 10 storey RC building base frame, shear wall similarly four such models are constructed in ETABS software. For this study, shear wall is placed exactly at the middle of the structure and the floor to floor height is considered 3meter. Support base properties are f i x e d. Column size 450mmX450mm and beam size 350X450mm, Shear wall thickness is 230mm.Slab thickness is considered as 200mm. M30 grade concrete and Fe 500 steel is used as major material grades. Frame carries wall load of 12KN/m only. Loads on Slab are considered as DL=1KN/m2 and LL=2KN/m2. ETABS takes self-weight by ETABS default.

LOAD COMBINATION:

The load combinations are defined as per the code is 1893-2002.The different load combinations are as follows.

1. 1.5 (DL+LL)
2. (DL+LL+EQX)
3. 1.2 (DL+LL+EQY)
4. 1.2 (DL+LL-EQX)
5. 1.2 (DL+LL-EQY)
6. 1.5 (DL+EQX)
7. 1.5 (DL+EQY)
8. 1.5 (DL-EQX)

9. 1.5 (DL-EQY)
10. 0.9DL+1.5EQX
11. 0.9DL+1.5EQY
12. 0.9DL-1.5EQX
13. 0.9DL-1.5EQY

TIME HISTORY ANALYSIS

The seismic response of the structure with FVD at corner location is determined using fast non-linear analysis (FNA). This is the most quick and accurate technique of analysis when compared to the direct integral of time history, and it is the method of choice for the ETABS software. FNA was used to investigate quasi behavior of the structure in order to determine how structural components deformed beyond their yield point. Each TH record is first specified as a file- based time history (TH) function, and as a loading, and finally applied to both model. After that, the model are described TH records.

Procedure:

- The design earthquakes is represented by a seismic database. In this research, I looked at the Barkot region in
- east Asia, India, in 1999, using the main website Strong Motion Center.
- A mathematical formulation of the structure is created, which typically includes a lumped mass at each storey.
- The model is accelerated at the base of structure using the digitized recording of that same.
- The complete record of lumped mass acceleration, velocity, and displacement at each interval.
- The intended model is examined using time history analysis in this study.

V. MODELLING OF STRUCTURE AND ANALYSIS

BUILDING MODELLING:

In this modelling, the dimension of the building is 32.3088mx21.336m, the total height of the building is 30m.The modelling is considered as U shape of the building which is considered as zone and the ordinary RC moment resisting frame building is considered and type soil is considered, this modelling number of bays in X direction is and number of bays in Y direction is. The analysis is worked in ETABS-2017. In this modelling, the total number of storeys is 10 storeys is taken. The plan, 3D view, rendered view as shown in figure.

BUILDING DESCRIPTION

The building used in this study is 10 storied. All building models have same floor plan.

The data is taken for the analysis is as follows:

Grade of concrete: M30

Grade of steel: Fe500

Beam size up to 10 storey: 350×450 mm

Column size up to 10 storey: 450×450 mm

Slab thickness:200mm

Storey height: 3m

Shear wall thickness: 230mm

SEISMIC LOADS

IS: 1893:2002 must be followed while designing seismic structures. The structure is in earthquake zone III. The analysis and design parameters are listed below (as per IS: 11893:2002). (Part I).

Zone: III

Zone factor: 0.16(Refer Table 2)

Importance factor (IF): 1.0 (Refer Table 6)

Response reduction Factor: 3.0(Refer Table 7)

Soil1Type: Medium

Structure Type: RC Frame Structure

MODEL1.Conventional RCC Building:

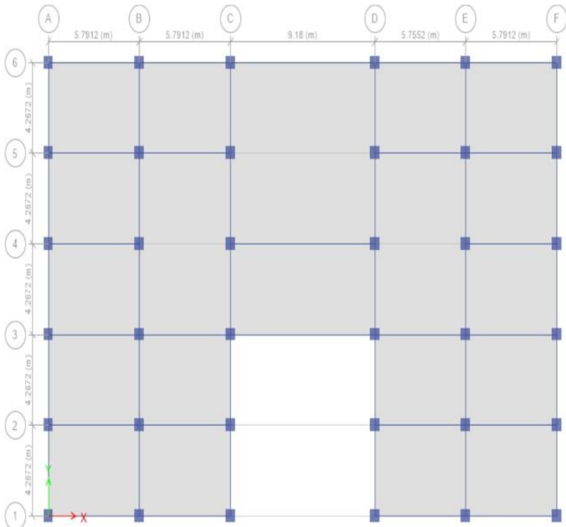

Figure-02: Plan for G+9 Storey conventional RCCbuilding

MODEL2: Conventional RCC Building with shearwall

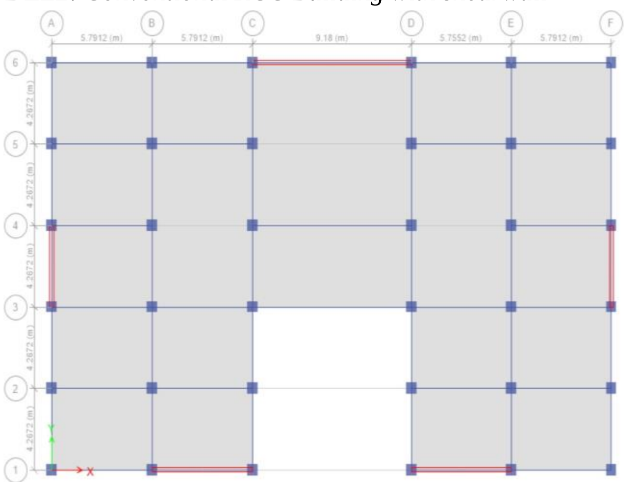

Figure-03: Plan for G+9 storey building with shear wall

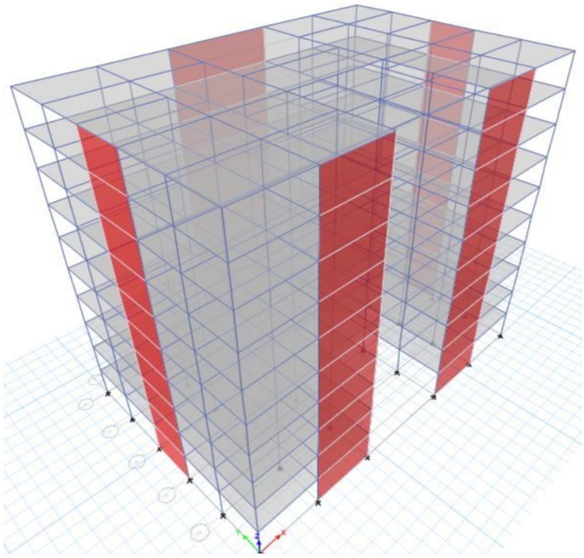

Figure-04: 3D view for building with shear wall

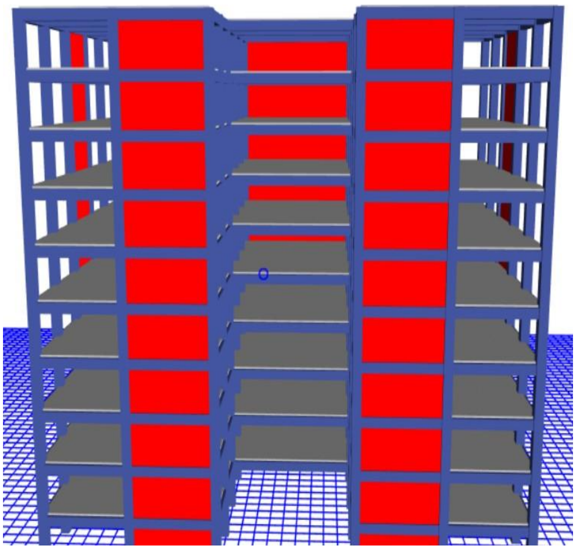

Figure-05: Rendered view for building with Shear wall

VI. RESULT AND DISCUSSION

The findings of the analysis done on the desired model will be discussed in this chapter. Time histroy analysis was used in this study.

A comparison of the behaviour of typical standard RCC buildings with buildings with shear walls has been attempted. The behaviour of each model was recorded in this study, and the findings were tabulated and graphed for several factors such as natural time period, baseshear, storey displacement, and storey drift.

NATURAL PERIOD TIME

Time taken by the wave to complete one cycle is called its time period. The naturl period periods obtained forthe different models using ETABS 2017 are given in the below tables.Time periods obtained in the time histroy analysis aredue to barkot earthquake.

Table-1: Time periods for different models for G+9 storey building

mode	Time Period in sec	
	Conventional RCC	Shear wall
1	1.85	0.924
2	1.557	0.644
3	1.47	0.553
4	0.589	0.245
5	0.5	0.145
6	0.47	0.13
7	0.324	0.118
8	0.279	0.079
9	0.263	0.079
10	0.213	0.073
11	0.187	0.065
12	0.176	0.063

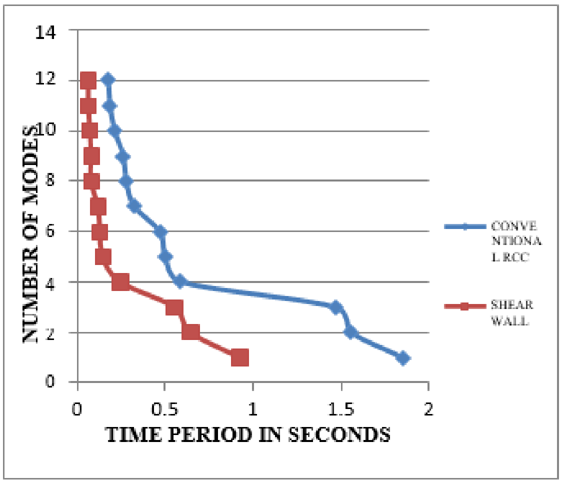

Figure-06: Time periods for different models for G+9 storey building

From fig 6.1 shows that the maximum time period of conventional RCC is 1.85sec, building with Shear wall is 0.924sec, building with damper is 0.86sec, and building with Shear wall and Damper is 0.718sec. The comparision of time periods for building with shear wall model shows lower value than compared to conventional RCC model.

BASE SHEAR

The base shear obtained from time histroy analysis for considered models are shown in below tables. The base shear are the function of the mass, stiffness, height and the natural period of the building structure.

Table-2: Base shear for different models for G+9 storey building

TYPE OF MODEL	**X -direction**
	KN
Conventional RCC	1349.493
Shear wall	4284.1595

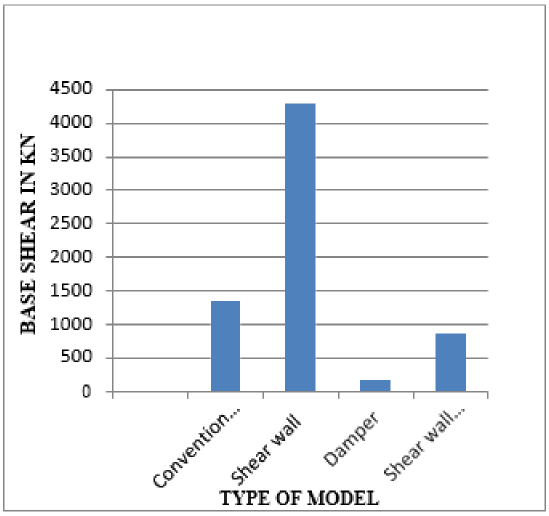

Figure-07: Base shear for different models for G+9 storey building

The time history response of 10 storey building models in terms of base shear is plotted in fig. 6.3 which shows that conventional RCC building has minimum base shear is 1349.493KN a n d maximum base shear is building with shear wall is 4284.1595KN. From the above table it is clear that the base shear of the building is directly proportional to the stiffness of the building. As the stiffness of the building increases the base shear of the building also increases. The building with shearwall having the more stiffness, that is the base shear of building with shear wall are more than compared to conventional RCC building.

STOREY DISPLACEMENT:

The storey displacement is obtained from the time history analysis for 10 storey building in X direction are listed in the table below. The tables to shows lateral displacements of G+9 storeyed conventional RCC building, building with shear wall, fig 6.3 to 6.9 indicates the plot of lateral displacements versus storey number.

Table-3: Storey displacement for different models for G+9 storey building

TYPE OF MODEL	X direction
	mm
CONVENTIONAL RCC	42.594
SHEAR WALL	21.143

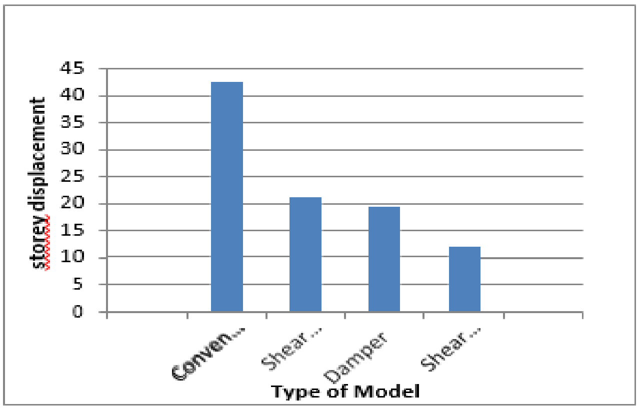

Figure-08: Maximum story displacement for all the models

Lateral displacement of the building at the top levels due to barKot earthquake for time history analysis. Top of the building shows the maximum displacement. From the figure it is observed that there is a reduction in lateral displacement at top of the building when the shear wall and fluid viscous dampers are connected in the building. The top roof level displacement is reducing from 42.594mm to 11.986mm at the top of the reduction. Hence we can provide the shear wall and viscous dampers in the building model.

STORY DRIFT:

The time history examination of a ten-story building in the X direction yields story drift. The table shows the Storey drift for the U shape of the building models derived through analysis. Details regarding the Storey drifts are well explained in IS 1893 of part-1:2002 article 27.11.1. and the factor of safety is considered 1.0.

Table-4: Maximum storey drift on different models for G+9 storey building

TYPE OF MODEL	X -direction
	mm
Conventional RCC	2.975
Shear wall	0.215

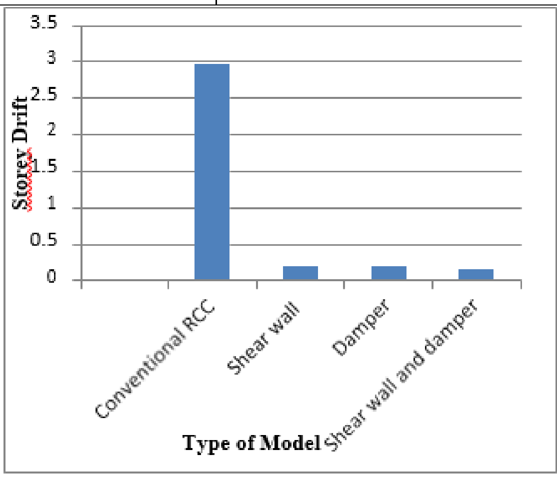

Figure-09: Maximum story drift for different models

For the loading combination 0.9DL-1.5EQX for time histroy method the storey drift is maximum for conventional RCC model compared to other model. Conventional RCC model has maximum value of 2.975mm where as for shear wall model at same storey drift is 0.215 that is the drift is reduced.

VII. CONCLUSIONS

This study is discussed on the seismic behaviour of building of ten storey situated in the seismic zone III of Indian medium soil, associated with different damping materials. The time history analysis is performed for barkot earthquake data which was occurred in 1999.the performance of the building is studied for different seismic responses like time period, lateral displacement, shear wall and combination of both for ten storeys.

1. Considering the maximum modal period in RCC building is 1.85sec.The damper and shear wall model decreases the modal period to 0.924sec .Hence there is a reduction of 89.6%.
2. Base shear for the G+9 storey building with shear wall is increased up to 4284.16KN compared to the bare frame building the base shear is 1349.49KN.This increase in base shear is due to increase in the seismic weight of the building.
3. Considering the maximum displacement in RCC building is 42.594mm in X-direction. The damper and shear wall model decreases the displacement to 21.143mm.Hence there is a reduction of 78.54%.
4. Considering the maximum storey drift in RCC building is 2.975mm in X-direction. The shear wall model decreases the displacement to 0.215mm .Hence there is a reduction of 94.68%.
5. Finally by looking in to all the results of natural time period, base shear, storey displacement and storey drift values we can conclude that the shear wall model is better when compared with conventional RCC building other model. Hence in this project shear wall model is better and passes all the required criteria.

From the results of the study it can be concluded that the shear walls more effective in controlling the structure with respect to seismic causes and seismic response of the structure increases.

VIII. SCOPE OF FUTURE STUDY

The further study can be undertaken in the following areas:

1. In the present study the work is carried out on zone III for medium soil, further the study may also be undertaken by providing different zones and different oil conditions.
2. In this study fixed base is considered for the structure; further study may also be undertaken by considering different kinds of supports.
3. The study may further carried out for different energy dissipation devices.
4. The study can be extended to various types of analysis such as response spectrum, push over analysis.
5. In the present work the fluid viscous dampers are located in corner and location of the shear wall at the centre of the building further study may be carried out to placing the dampers and shear wall in different location of the structures.

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