Study and Dynamic Effect of G+20 Building By Using Tune Mass Damper and Shear Wall For Different Seismic Zone By Using ETABS

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Abstract- The main task of structural engineers is to determine a structure's behavior in the presence of horizontal forces. Tall structures need to be strong enough to resist horizontal pressures brought on by tremors and wind. Shear walls are utilized to enhance the structure's rigidity to counteract horizontal forces. A device called a tuned mass damper is fastened to a structure and is made up of a mass, a spring, and a damper. Its purpose is to reduce the dynamic response of the structure. Response Spectrum Analysis will look at the employment of tuned mass dampers and shear walls in different places in a G+20 multi-story residential building. In a multi-story structure with G+20, base shear and the maximum allowable displacement are examined in this work. Seismic zones established by IS 1893 in India, Etabs 2018, a popular FEM integrated software, is used for the study and modelling of the complete structure. This project uses type II (medium soil) soil to do a dynamic analysis for an unsymmetrical construction layout in four zones. The findings indicate that the structure with tuned mass damper and shear walls (i.e., model 3) will exhibit better results in terms of all seismic parameters when compared to the structures without shear walls (i.e., model 1) and with shear walls (i.e., model 2).

Keyword: Bare frame, shear wall, tunable mass damper, ETABS, high-rise building.

1.INTRODUCTION

Because of the fast-growing industrialization and population boom of the 21st century, there is an increasing need for building construction, which presents an intense challenge for engineers to analyze, create, and design new types of structures, particularly in seismic zones. These natural catastrophes will be extremely difficult for civilization to handle and will have a significant impact. Therefore, engineers must build seismic-resistant buildings in this zone to counteract the seismic power and minimize its impact as much as possible in order to deal with this. Although no construction can be completely earthquake resistant—as we all know—by creating it, the power of the seismic forces may be reduced, minimizing the harm to people.

These days, high-rise structures, commonly referred to as skyscrapers, are highly sought after because of their many advantages, which include the capacity to maximize space while taking up little land. They're also really lovely. These buildings are very challenging to design, and building them requires engineers to overcome several challenges. Although a number of factors are taken into account during the design process, the main goal of this project is to use a shear wall with damper to create a 21-story structure and compare the results to a standard building of the same height that has both a shear wall and a damper. The building design made use of the following structural element, which will be covered in greater depth later. The components that are utilized in this project are

- Shear wall
- tune mass damper

1.1 Objectives of Study:

The following goals have guided the work that has been done:

1. A 21-story structure was modeled and its seismic load assessed in ETABS.

2. To ascertain the behavior of a construction having a shear wall.

3. Shear wall and tuned mass damper analysis of the structure.

4. For each of the aforementioned three scenarios, a comparative analysis of base shear, storey displacement, fundamental natural period, frequency, and storey drift has been conducted for distinct seismic zones.

1.2 Shear wall:

A shear wall is a structural element used to resist lateral forces, such as those caused by wind or seismic activity. Typically made of reinforced concrete or masonry, shear walls are designed to provide stability and strength to a building, preventing excessive swaying and ensuring it can withstand various loads.

They are often located in strategic positions within a building, such as near stairwells or elevator shafts, to maximize their effectiveness. Proper design and placement of shear walls are crucial for maintaining the overall safety and integrity of the structure.

1.3 Tune mass damper

Spring, mass and damper are the components of a tuned mass damper (TMD), a passive control system that is fastened to a structure to lessen the dynamic response of the structure. Steam is released from the structure by the damper's inertia force. It is a commonly used vibration management technique in mechanical engineering systems. Because the method is quick and easy, Recently, a number of hypotheses have been put out to lessen vibration in civil engineering projects. The intrinsic frequency of the secondary mass damper is often matched to that of the primary structure to give optimal response. The TMD will resonate out of phase with the structural motion when that frequency of the structure is activated. The relative motion that is created between them causes the excess energy in the structure to be transformed into secondary mass and ultimately discharged

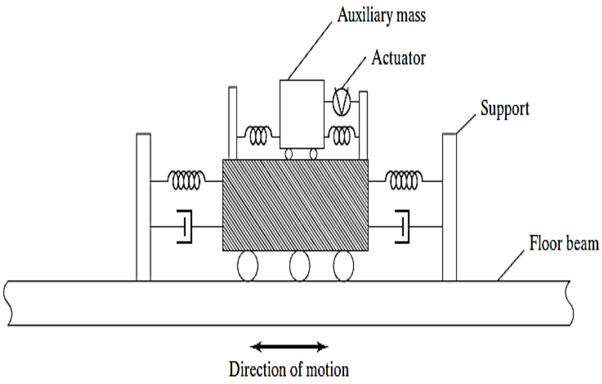


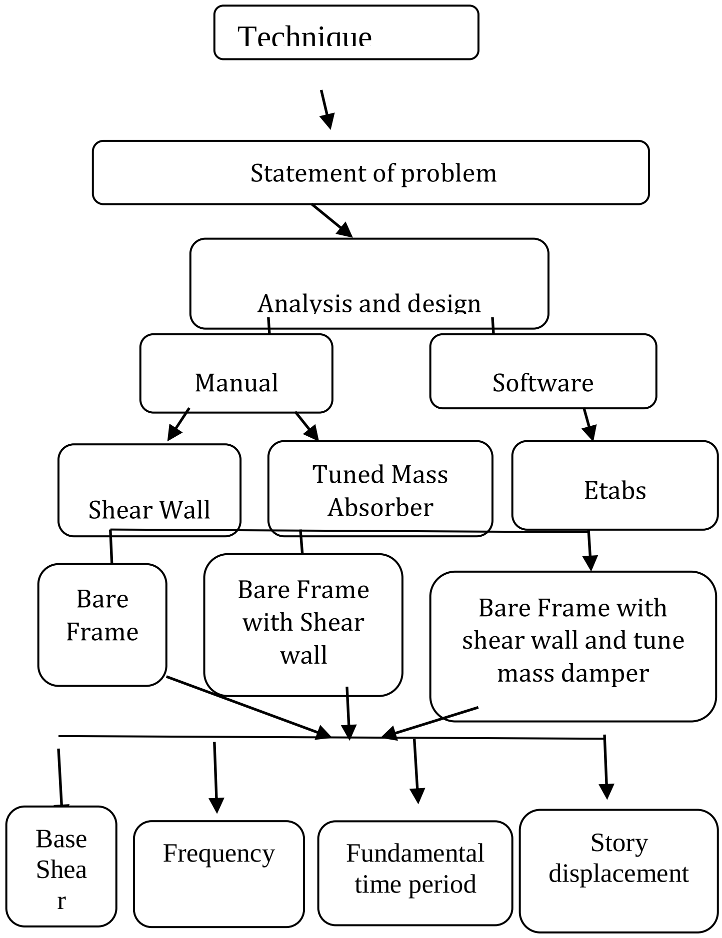
Fig. 1 configuration of an active tuned mass damper.

2. METHODOLOGY

Methods of analysis:

Numerous research techniques exist, all with differing levels of precision. The kind of loads exerted externally, the way the structure behaves, or the materials used in the structure, and the kind of structural model that is applied, all of which can be used to categorize the research procedure. Utilizing external action and behavioral framework can help further categorize the research.

- The push over analysis,
- the corresponding static method procedure,
- the linear dynamic analysis,
- the response spectrum approach,
- the elastic time history approach,
- the nonlinear static analysis,



Building Properties and specification: In the context of designing and analyzing a G+20 building (a structure with ground plus 20 floors), it is essential to outline the structural properties and specifications that define its design, safety, and performance. Below is an overview of the common building properties and specifications for a high-rise structure in terms of materials, dimensions, loading considerations, and seismic compliance.

2.1 Building Height and Layout

Total Number of Floors: Ground floor + 20 floors

- Height of Each Floor typically, 3.0 to 3.5 meters per floor, making the total height of the building approximately 60-70 meters.

- Building Footprint: Depends on the architectural design, generally ranging from 600 to 1200 square meters per floor.

- Use: Residential, commercial, or mixed-use.

3. BUILDING PROPERTIES &SPECIFICATION

Table 1: properties and specification of members.

S.NO.	Specification		Size
1	Size of plane (X and Y)		12.070m x 10.110m,
2	height of Floor to floor (m)		3.00m
3	Total height of the (G+20) building		63.000m
4	Types of Soil		Medium
5	Beam Size		0.300m x 0.500m
6	Column Size		0.500m x 0.600m
7	Thickness of wall		0.2000m
8	Slab Thickness		0.1500m
9	Concrete and steel grade		M25,Fe500
10	Types of soil (as per IS1893(part 1): 2002		Type II Medium rocky soil
11	Response Reduction Factor (R)		5.00
12	Factor		1.200
13	Seismic Zone Factor		0.100, z16.00,.24.00,.36.00 (Zone II,III,IV and V)
14	Summation of load		By IS:1893 (part 1) : 2016
115	Stair	lift	0.1500m
		Tread	0.2300m
		Wide	1.5m
		Stringer	0.150m
116	Load Applied	Dead Load	Calculated as per Self Weight
		Live Load	3 KN/m^2
		Seismic Load	As per IS 1893 (part 1) : 2002
		Floor Finish	KN/m^2

3.1 Structural System

A structural system refers to the arrangement of various structural elements in a building or structure that work together to support loads and ensure stability. The choice of a structural system significantly influences the performance, safety, and aesthetics of the building. Here are some common types of structural systems.

Foundation:

Type: Raft foundation or pile foundation, depending on soil conditions.

Depth: Generally, between 2 to 3 meters below the ground level for raft foundations and deeper for piles.

Columns: RCC (Reinforced Cement Concrete) columns designed to support axial loads and resist bending.

Column Sizes: Vary based on structural load, but typically 450mm x 600mm to 600mm x 900mm for a high-rise.

Beams: RCC beams spanning between columns, supporting floors.

Beam Sizes: Generally, 230mm x 450mm or larger depending on span and load.

4. PLAN

4.1 Plan View of Building

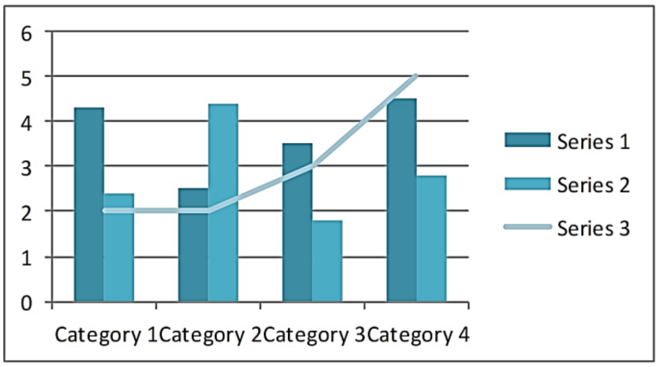


Fig. 2 Model (1) G+20 Residential building model's plan view without a shear wall

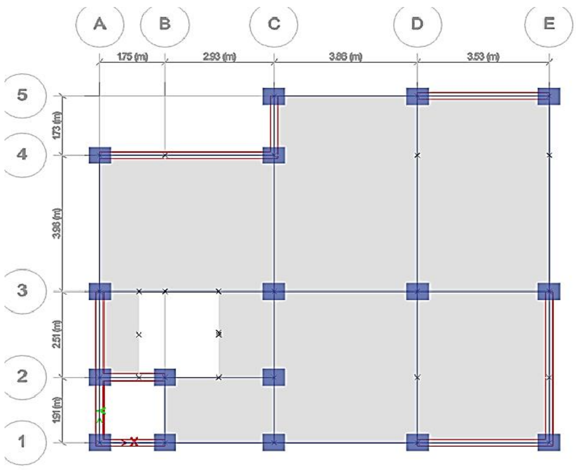


Fig. 3 Model (2) G+ 20 Residential construction models with shear walls in plan view

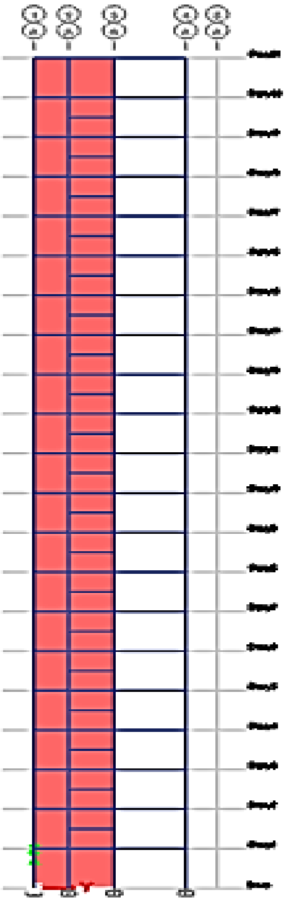


Fig.4 G+20 Residential Building Model: Left Elevation View with Shear Wall

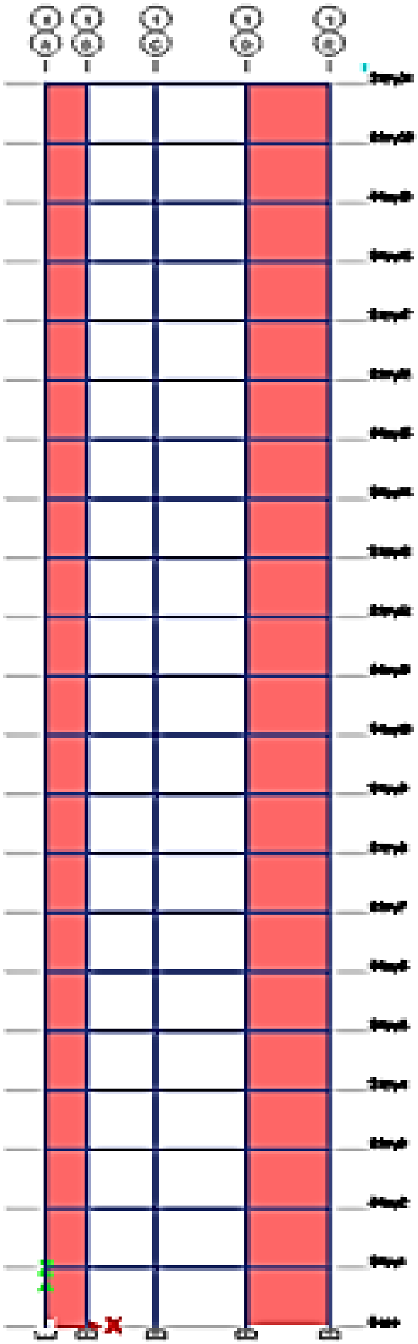


Fig. 5 G+ 20 Shear Wall Residential Structure

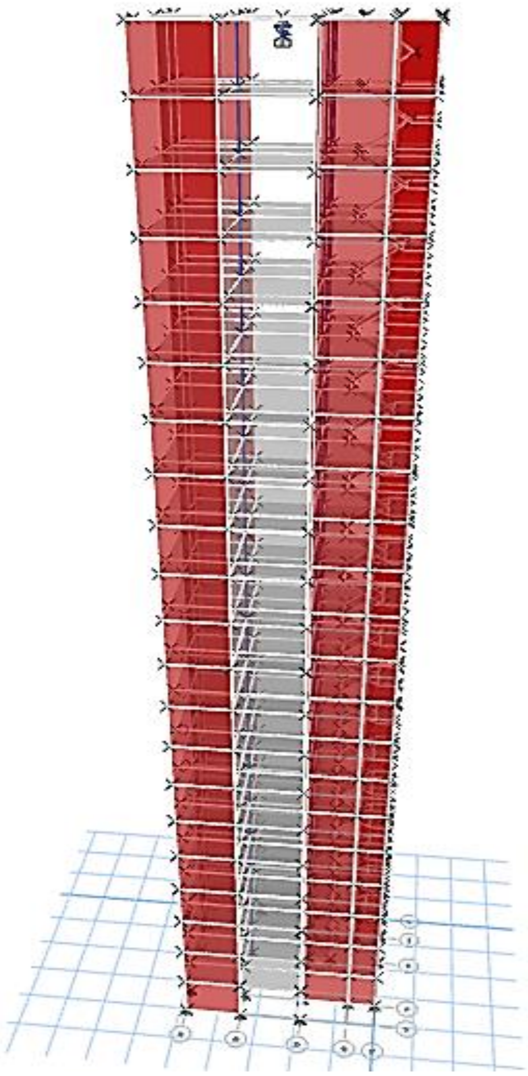


Fig. 6 An isometric view of the residential building G+ 20.

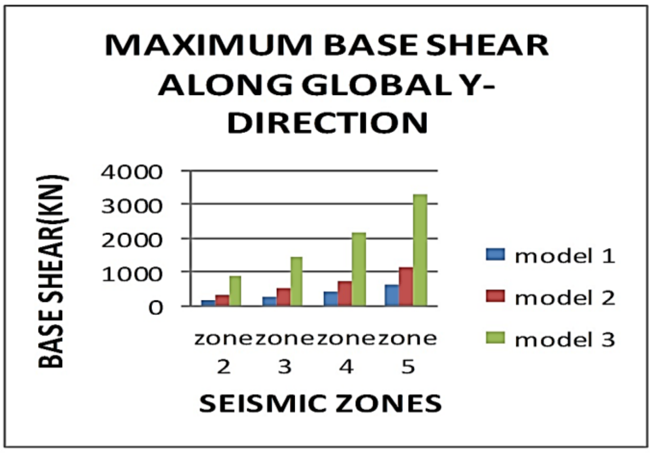


Fig. 7 Universal X-Axis Maximum Base Shear.

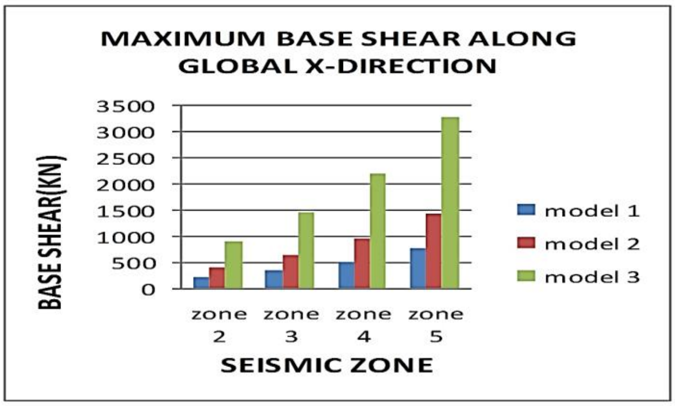


Fig. 8 Base shear for different seismic zone.

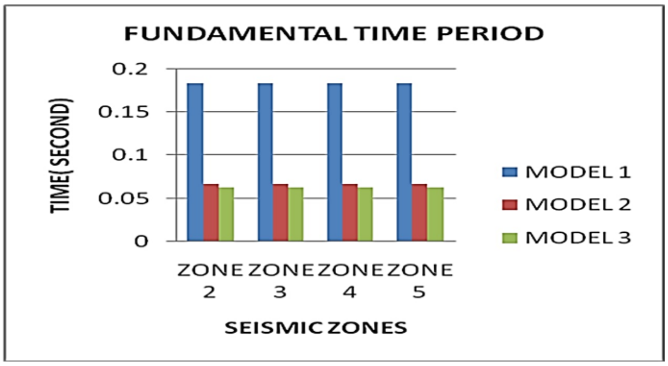


Fig. 9 Time for different seismic zone

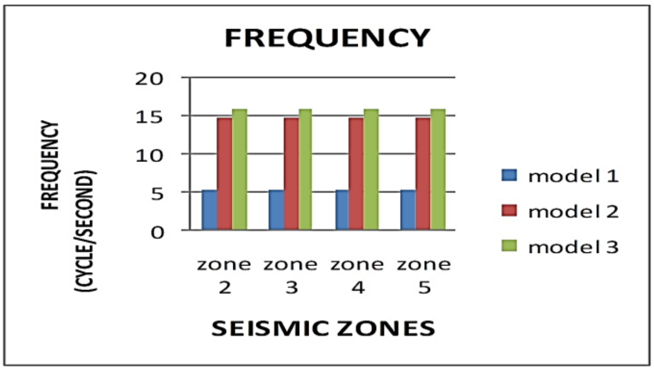


Fig. 10 Frequency for different seismic zone.

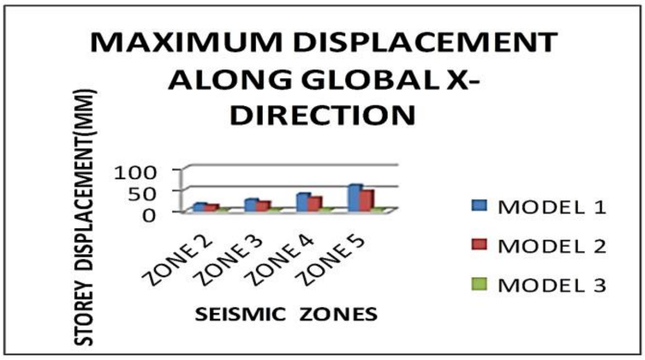


Fig. 11 Story Displacement for different seismic zone.

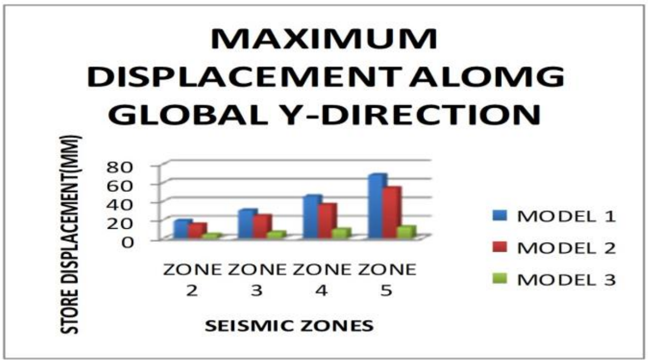


Fig. 12 Maximum Story Shift along the Y-axis.

5. Description of the Model:
A Model without absorber and shear wall, Model (1)

B. The shearing wall approach, model (2)
C. shear walls and absorber model: Model (3):

6. RESULT

1. Because it draws greater lateral stresses than a shear wall without a damper, the base shear of a shear wall with a damper is much higher than that of the other variants, although the base shear of a frame is lower because the structure weighs less.(in figures 7 and 8).

2. The building's time period, as reported in IS 1893:2016 (Part-1), is 1.67 s without infills. This time period does not coincide with any of the time periods shown in Fig. 9, indicating that the structure is safe from resonance effects. As seen in Figure 9.

3. Figures 11 and 12 show the viewpoint from above. It was found that the building's storey displacement decreases with decreasing building height. Because it counters more forces than other types, the frame has a larger storey displacement; the shear wall with damper has the shortest displacement.

7. CONCLUSION

The maximum displacement values in seismic zone V are greater than those in seismic zones II, III, IV, and V for all scenarios (models 1, 2, and 3). This implies that creating a structure with uniform stiffness could reduce displacement.

In terms of maximum displacement and base shear, the building with shear walls and a tuned mass damper (i.e., model 3) produced better results, confirming the notion that buildings with uniform stiffness produce better results.

As to IS 1893:2016 (Part-1), the building's time period of 1.67 s does not align with any of the time periods depicted in Fig. 9, signifying that the structure is safe from resonance effects.

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