INTERNATIONAL JOURNAL OF TECHNO-ENGINEERING
IJTE

ISSN: 2057-5688

PERFORMANCE BASED ANALYSIS OF STEEL DAMPERS AS TUNED MASSDAMPING IN RCC HIGH RISE BUILDING

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Abstract: An earthquake is a tremor of the earth's surface usually triggered by the release of underground stress along fault lines. The earthquake imposes several types of dynamic loads. The greatest dynamic load is the inertia load caused by the response of the concrete mass to ground accelerations. The behaviour of the structure depends on the manner in which the structure absorbs the energy transmitted to it by an earthquake and the maximum amount of motion or energy the structure can sustain. The need for exploring various control devices which help in controlling the seismic response of buildings has come due to the damage and collapse of numerous concrete structures during recent earthquakes. Tuned mass dampers have been widely used for vibration control in civil engineering systems. In recent years, Tuned Mass Dampers theory has been adopted to reduce vibrations of tall buildings and other civil engineering structures. Dynamic absorbers and tuned mass dampers are the realizations of tuned absorbers and tuned dampers for structural vibration control applications. The Primary objectives of undertaking the present study is to study the seismic response of a reinforced cement concrete framed ten storied building in Zone IV with the help of ETABS using non-linear time history analysis.

Keywords: High Raised RCC Buildings, Tuned Mass Damping System, Dynamic analysis, Damper

I. INTRODUCTION

In recent years, high-thrust, flexible buildings with low damping capacity have become very popular. Buildings shake during seismic excitement, which becomes painful for people. So, we will take special strategies to mitigate earthquakes. Dampers are one of the primary technologies for reducing seismic excitation. From recent research, TMD is a good effective seismic damper used in hyper-upward RC structures. In the case of TMD, an attractive option is to reduce excessive ground vibrations. The TMD consists of a secondary block with closely matched springs and damping elements, featuring frequency-based deceleration that will increase damping within the primary figure. The TMD is attached to a structure to reduce the dynamic response of the model [1]. The frequency of the damper is set to a specific structural frequency so that when that frequency is raised, the damper will resonate out of phase with the structural motion. The block is usually attached to the building via a spring damper machine, and energy is dissipated through the damper as relative motion develops between the block and the form. The selection of a TMD as a vibration processing tool is subject to various factors, including performance, compactness, weight, capital cost, operating cost, retrofitting and protection needs. There are three main styles of temporomandibular counteracting mass damper, pendulum, flexion and spring-modulated mass damper, as shown in Figure 1.

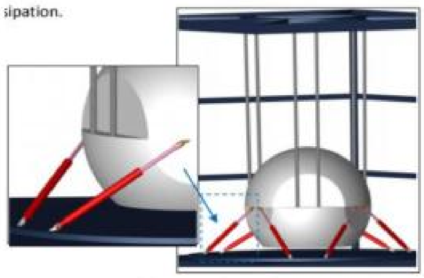


Fig.1 Pendulum TMD

In recent years, dump trucks have been widely used to reduce vibration from high-rise structures and different civil engineering systems. Tuned mass dampers have been widely employed to incorporate vibrations into mechanical engineering designs. The Tuned Mass Dampers surround Tuned Dampers and Dynamic Dampers for structural vibration handling applications. Various machines have inertia, flexibility, and loss factors: mass, spring, and damper (or fabric damping) for linear applications and their opposite rotating numbers for rotating applications. Based on the application, these machines range in size from a few ounces (grams) to multiple mortars. Additional configurations, including pendulum dampers/dampers and solution liquid dampers/absorbers, are also designed for vibration mutation packages [2].

Tuned mass dampers are attached to the form to reduce the dynamic response of the form. The mass is usually connected to the construction by a spring damping mechanism. The power is dissipated through the damper as relative motion is created between the mass and the form. The damper frequency is combined with a selected structural frequency so that when this frequency is met, the damper will resonate with the structural activity outside the section. Generally, a significant 5% damping can be considered for structures, and an improvement within the damping ratio causes low pressure or velocity.

Tuned mass damper structures are widely used to reduce vibrations caused by pedestrians or trains such as wind and traffic. Standard systems such as narrow bridges, chimneys, and tall, narrow buildings have low humidity levels and can therefore be subject to unacceptable vibrations. The tuned mass dampers motif manipulates results similar to damper growth. Depending on the mass ratio, tuning frequency, and damping functionality, the amplitude reduction can be substantial, reaching about 10 to 20% without the figure of tuned mass dampers. Essentially, the hardness and damping ratio are selected according to unique criteria. Here, a multi-story building with a rooftop tuned mass machine is erected [3].

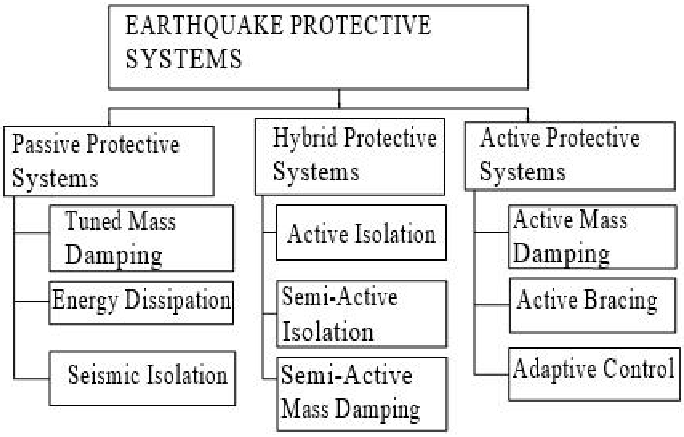


Fig.2 General diagram of earthquake protective system

Location of Tuned Mass Dampers (TMD)

TMD work by connecting large mass blocks with structural L members (along the floor) via springs (Fig. 3). The device is configured so that when the floor shakes at a resonant frequency (which will be due to the dance, for example), it produces massive block and spring-like motion. By saving energy, the movement of tuned mass dampers, in turn, reduces the amplitude of floor vibrations.

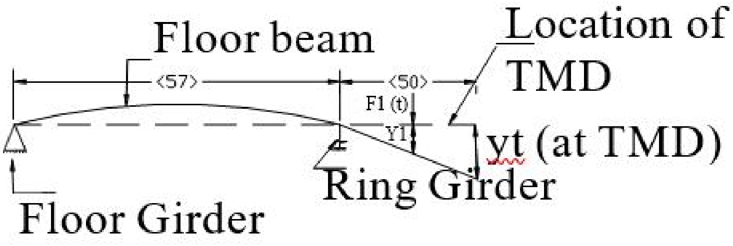


Fig.3 Floor refractions in first mode shape

where,

Ff(t) = idealized periodic forcing function on dance floor

Yt = deflection of tip of floor in first mode

Yf = deflection of floor under forcing function.

The damping device (dashpot) is usually connected parallel to the spring between the mass block and the floor, which increases the efficiency of the tuned mass dampers many times and draws a small amount of mechanical power from the device. -Like heat.

Because each tuned mass damper is "tuned" to a specific resonant frequency, it is essential to install custom-tuned mass dampers for each excited ground frequency. Tuned mass dampers are most practical when the ground dimensions are optimal. Because they rely primarily on ground vibrations to operate, they do not need to be mounted on anything near a table.

Tuned mass dampers were considered the most accessible and efficient damping system to install on the deck because they no longer required clamping on a nearby desktop item. They were especially suitable for terraces because the damping had a floor frequency per ballroom, which reduced the specific number of tuned mass dampers, and tuned mass dampers could be applied to areas where the floor-length The widths were the most significant (photo). , Maximize your performance.

II. LITERATURE SURVEY

Much research has been done on specific control devices for tuned mass dumping for multi-story buildings. The key to evaluation is to develop a basic understanding of tuned mass dumping and integrate it into the system.

Den Hartog [4]. The TMD concept was first proposed in 1909 with the help of Frahm to reduce the rolling motion of ships and the vibration of the ship's hull. A theory for TMD is later presented in a paper using Ormondroyd, and the most reliable tuning and damping parameters are discussed in detail in Dan Hartog's book on mechanical vibrations [8]. Early theory adapted to the SDOF device subject to the excitement of the sinusoidal force. Numerous researchers have investigated the expansion of the idea of dampening SDOF systems.

Hrovatet et al. [5]. Active manipulation devices operate with the help of an external power supply. Therefore, they are more environmentally friendly than passive control devices. However, in the context of structural control against earthquakes, problems including inadequate control force capacity and excessive power requirements with the help of modern technology are inevitable and must be overcome. Recently, a new control method semi-functional manipulation device, which combines the high- quality features of passive and functional management tools, can be attractive due to its low power demand and inherent stability. Earlier documents relating to SATMDs may also be from 1983. Supply SATMD, a TMD with controllable damping time. Other things being equal, the behavior of SATMD-equipped structures is significantly better than TMD's. SATMD management design relies very little on relevant parameters (such as mass ratio, frequency ratio, etc.), so there are more options to decide on them.

Clark et al. [6]. Clark proposed the idea of multiple mass-tuned dampers (MTMD) with a correction method. The first mode response of the form with TMD can be significantly reduced according to the required frequency of the structure, but in fashion, even the best modal response can be slightly suppressed or perhaps increased. To control the frequency range associated with TMDs, multiple TMDs can be used in a specific way, each according to a unique dominant frequency. Then did some research on double-tuned mass on MTMD delivery. Damper (DTMD) includes two charges attached to the proposed form (Setareh 1994). In this example, two different loading conditions were considered: harmonic excitation and random 0- impact white noise stimulation, and the performance of DTMDs in reducing response was examined. The analytical results show that DTMDs are more efficient over a full range of total mass ratios than single conventional bulk TMDs, but only slightly higher than TMDs over the actual range of mass ratios (0.01-0.05).

Allen J et al [7]. Numerous inactive TMDs reduce the mobility of the building caused by the earthquake. This article discusses the technique of designing multiple tuned mass dampers to reduce the response of the building. This technique is based entirely on Dan Hartog's work, extending from a degree of independence to a few stages of independence. The 1940 El Centro earthquake-triggered simple linear mathematical models and significantly reduced motion using design techniques.

K. C. S. Kwok et al [8]. Performance of tuned mass dampers under wind load The overall performance of each passive and active tuned mass damper (TMD) structure can only be assessed through parametric studies, which is the scene of numerous studies. Some experimental validation of TMD theory has been obtained. However, the results of these experiments are usually compared with those obtained through parametric studies, especially those involved in energetic control. Despite strict design limitations, effectively installed many passive and energy efficient large-scale damping structures in high-rise buildings and other systems to reduce the dynamic response caused by wind and earthquakes.

T.Shimazu et al. [9].“A study of the real impact of mass damping systems applied to buildings. ” In this work, the current country of large-scale buffer structure implementation is clarified; the results of these systems are mainly recorded in real houses against both wind and earthquake. The results are based on the natural life span of houses equipped with an extensive damping system, the relative weight of the mass to the weight of the building, the degree of air pressure, and the level of seismic ground movement.

III. THEORETICAL BACKGROUND

Nonlinear Dynamic Evaluation Approach Used in Gift Studies Computational information of dynamic analysis and idealization of mass and damping of the form under discussion.

The proposed nonlinear evaluation approach applies to the static and dynamic nonlinear evaluation of structures. Since nonlinear static diagnostics of frames is only a case of dynamic analysis and does not use damping or welding forces and applies as static background forces concentrated in each region with lateral forces, unbalanced Information on the calculation of forces and the state of the elements of a person's body.

The dynamic version representing a building has mode shapes equal to the model's freedom limits. Mode shapes are characterized by orthogonality, which means that no mode shape can be created as a combination of others. However, the distortion of any dynamic version can be attributed to the sum of its mode shapes. As can be explained, each is propagated by an element of scale. Each mode form has an herbal frequency of vibration. The shapes and frequencies of the methods are determined by sorting the eigenvalues.

The dynamic version that represents the building has the same range of mood shapes as the wide range of model freedom. Mode shapes have orthogonality features, which means that no given mode shape can be created as a mixture of others, however the deformation of any dynamic version as a whole of its mood shapes. As can be stated, each is multiplied by a scale component. Each mode form has an herbal frequency of vibration. The shapes and frequencies of the methods are determined by sorting the eigenvalues. The general response to a given response spectrum is obtained with the help of a statistical combination of a default range of modal reactions. The number of methods required to judge the design strengths competently is a feature of the dynamic features of the building. Generally, six to ten ways on each path are considered sufficient for smooth houses. Since each mass responds to earthquakes in two ways, it is essential to consider the practical values of the modal mass.

Tuned Mass Damper Theory for SDOF Systems

figure 4 Displays an SDOF device with large m, acceptable hardness, and sticky damping C subject to both external forces and ground motion. A tuned mass damper with mass md and stiffness kdand viscous damping cd is connected to the primary mass. The different measures of migration are ug, absolutely ground movement; u, relative motion between core mass and floor; And relative migration between ud, damper, and mass number one. Considering that the machine is subject to both external forces and ground stimuli, there are equations of motion.

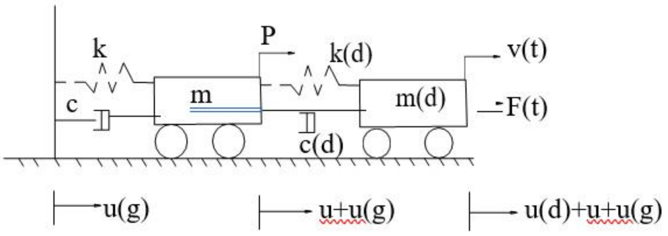


Fig.4 SDOF – TMD system

$$m_d\ddot{x}_d + c_d\dot{x}_d + k_dx_d + m_d\ddot{x} = -m_da_g$$
$$m\ddot{x} + c\dot{x} + kx - c_d\dot{x}_d - k_dx_d = -ma_g + p$$

Where a_g is the absolute velocity of the floor and p is the loading force applied to the number one mass. It's easy to paint first with the answer described in complex features. Enthusiasm is considered to be continuous with frequency $\bar{\omega}$. Enthusiasm is expressed

$$a_g = \hat{g}e^{i\bar{\omega}}$$

$$p = \hat{p}e^{i\bar{\omega}}$$

where $\hat{g}$ and $\hat{p}$ are actual measures. The reply is taken as

$$x = \bar{x}e^{i\bar{\omega}}$$
$$x_d = \bar{x}_de^{i\bar{\omega}}$$

The key due to episodic excitation (both p and u_g) is uttered in polar form:

$$\bar{x} = \frac{p}{k}H_1 e^{i\delta_1} - \frac{gm}{k}H_2 e^{i\delta_2}$$

$$x_d = \frac{\ddot{p}}{k}H_3 e^{-i\delta_3} - \frac{\ddot{g}m}{k}H_4 e^{i\delta_4}$$

Where H factors describe the amplitude of the pseudo-static reaction and are the section angles between the reaction and the excitation. The different phrases of H and δ are explained in it.

$$H_1 = \frac{\sqrt{[f^2 - \rho^2]^2 + [2\xi_d \rho f]^2}}{|D_1|}$$

$$H_2 = \frac{\sqrt{[(1+\bar{m})f^2 - \rho^2]^2 + [2\xi_d \rho f(1+\bar{m})]^2}}{|D_1|}$$

$$H_3 = \frac{\rho^2}{|D_1|}$$

$$H_4 = \frac{\sqrt{1 + [2\xi_d \rho]^2}}{|D_1|}$$

IV. METHODOLOGY

The framed form was analysed by dynamic analysis and terminology, recording the displacement intensity at critical locations. After that, a suitable TMD device is designed. TMD can weigh from 3% to 5% of the total building weight. First, TMD was analysed one by one, and its natural frequency was obtained. By designing the TMD on the top of the building in this way, the shape was analysed through dynamic analysis and the term, compared to results obtained without the TMD to show the application of observation to the displacement in the relevant places.

The approaches of dynamic examination are as given below:

1. **Response Range Assessment**: This method is applied to systems where modes other than the core significantly affect the form response. In this technique, the response of a multi-degree of freedom device is expressed as a superposition of the modal response, with each modal reaction judged by spectral analysis of the individual DF systems combined to calculate the complete response. The technique used is often used in conjunction with the reaction spectrum.

2. **Pushover Study**: Pushover study of any form is a nonlinear static diagnosis under perpetual vertical mass and a gradual increase in literal load. Equivalent static masses

properly form the forces created by earthquakes. The analysis leads to failure, which allows it to determine the capacity of the falling load and elasticity. The total displacement of the roof in a structure and a plot of base share is achieved with the help of premature failure and weak point analysis.

3. **Flexible Time Record Analysis**: Seismically weak building design may be subject to an inflexible motion for the duration of the movement. The rigid time log analysis of a building under strong seismic motion reveals areas of weakness and demand for

flexibility in the structure. It is the very balanced technique obtainable for estimating the performance of buildings.

Rectangular plan

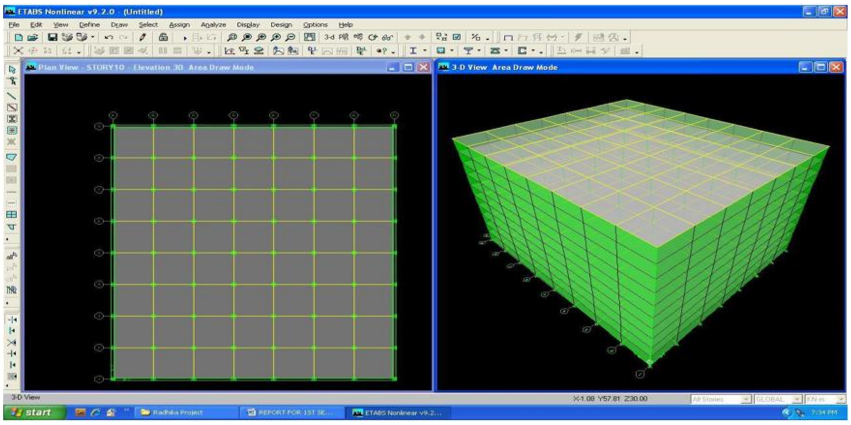


Fig.5: Balanced structure Scheme without TMD

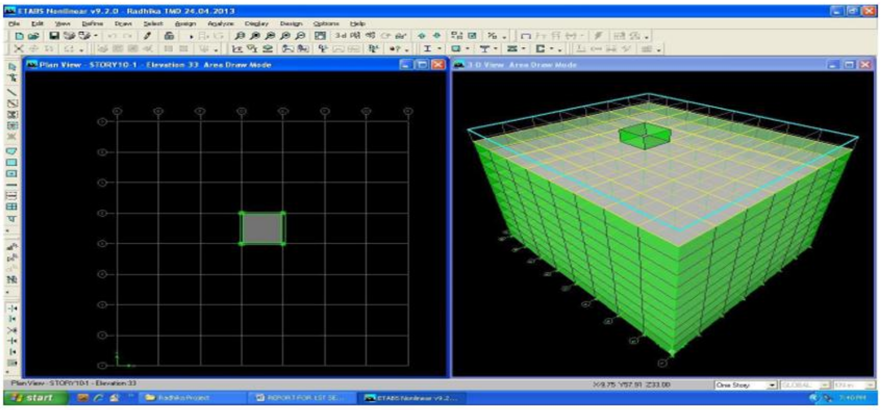


Fig.6 Balanced structure Scheme with TMD

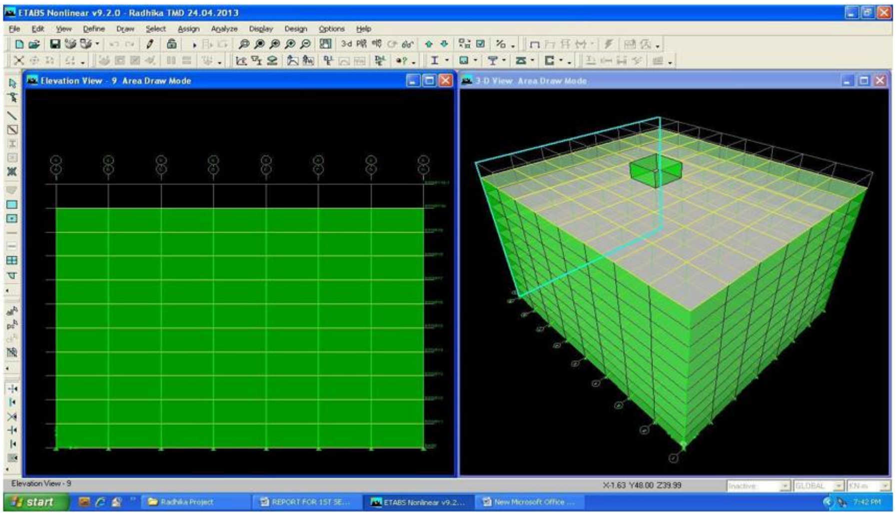


Fig.7 Displays ridge of symmetrical structure

L- Shape Building

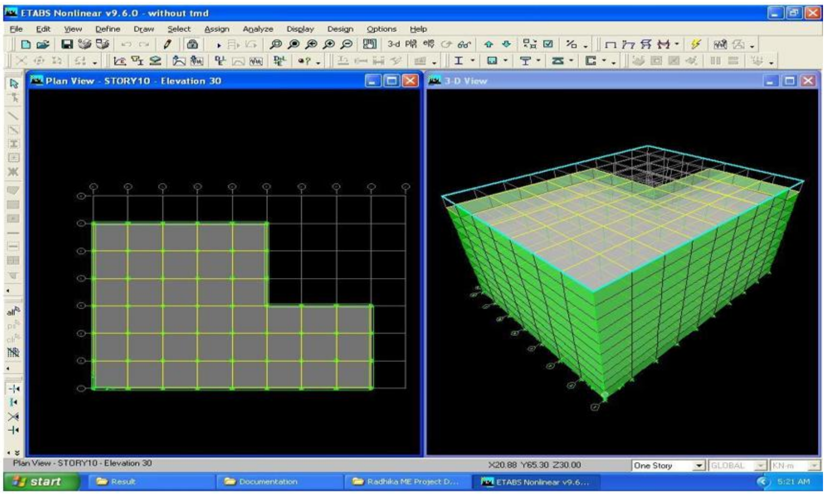


Fig.8 Unsymmetrical structure Scheme without TMD

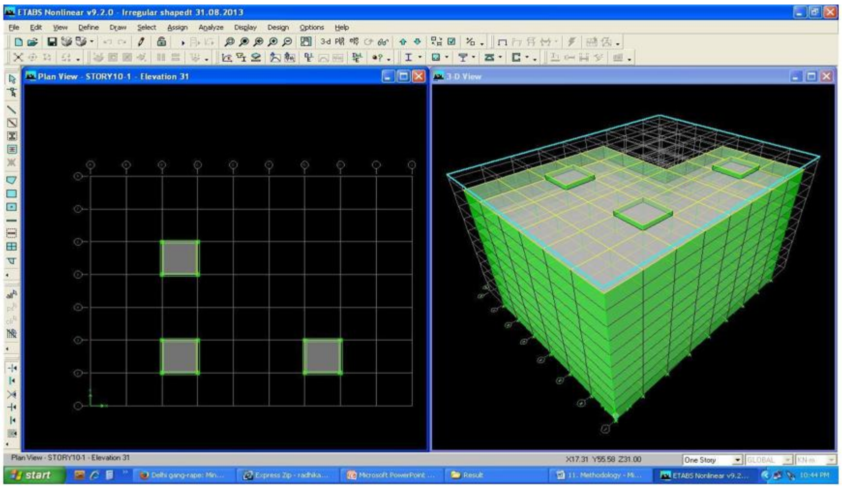


Fig.9 Unsymmetrical structure Scheme with TMD.

V. RESULTS AND DISCUSSION

The Building Description

At present, note the two enclosed replicas R.C. With ten proofs, one with a rectangular floor plan and the other with an L-shaped floor plan. The tuned mass damper is located in the middle of the network in the airplane

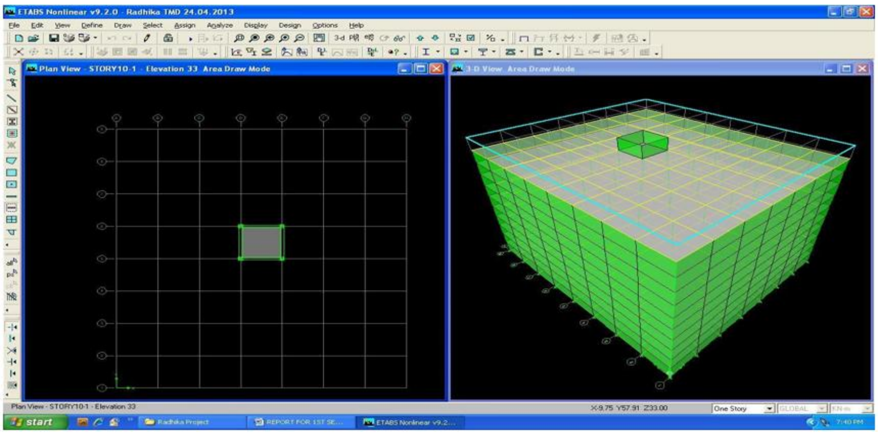


Fig.10 Schedule indicating the TMD positioned at highest floor for symmetrical division

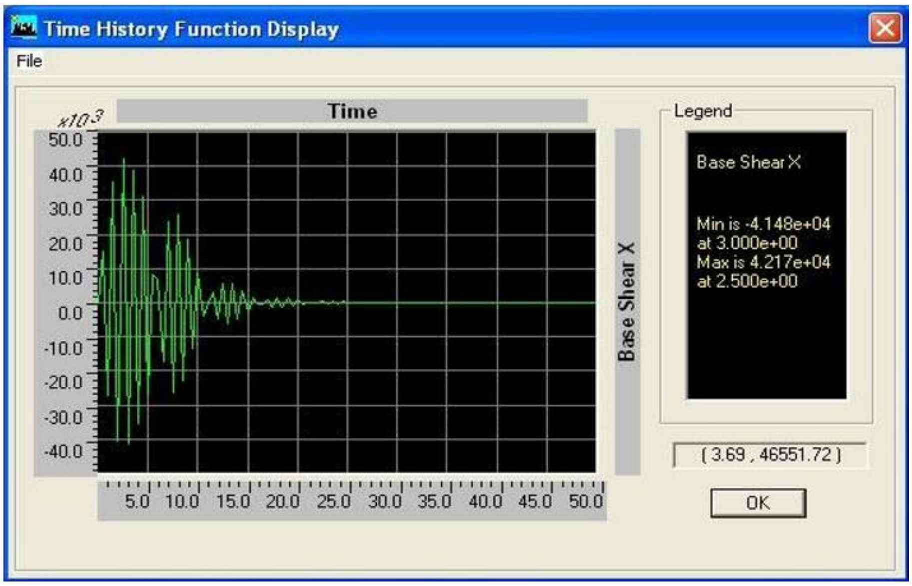
Case I: Without using the TMD &With TMD: Base Shear x:VsTime Period

Table. No 5. 1: Time Vs Base shear in X − direction (without & *with TMD*).

Without using TMD	With using TMD

Time Period	Base shear x	Time Period	Base shear x
0.00000	0	0.00000	0
0.50000	15056	0.50000	14936.57
1.00000	-26986.2	1.00000	-23050.4
1.50000	35406	1.50000	21344.96
2.00000	-40340.9	2.00000	-12778.7
2.50000	42167.01	2.50000	2807.279
3.00000	-41478.7	3.00000	4347.54
3.50000	38967.85	3.50000	-6604.74
4.00000	-35329	4.00000	4039.611
4.50000	31190.24	4.50000	1333.758
5.00000	-27069.3	5.00000	-6678.43
5.50000	8296.232	5.50000	-5127.19
6.00000	6695.808	6.00000	13080.64
6.50000	-17395.6	6.50000	-13591.1
7.00000	23807.02	7.00000	8215.011
7.50000	-26365.9	7.50000	-906.35
8.00000	25781.64	8.00000	-5082.22
8.50000	-22892	8.50000	7814.519
9.00000	18547.01	9.00000	-6811.59
9.50000	-13522.5	9.50000	3218.207

10.00000	8464.324	10.00000	895.1803
10.50000	-3860.05	10.50000	-3722.28
11.00000	32.46118	11.00000	4427.447
11.50000	2849.366	11.50000	-3197.95
12.00000	-4747.63	12.00000	940.3099
12.50000	5726.712	12.50000	1209.04
13.00000	-5921.82	13.00000	-2397.29
13.50000	5508.691	13.50000	2353.852
14.00000	-4677.01	14.00000	-1368.6
14.50000	3609.048	14.50000	45.54885
15.00000	-2464.3	15.00000	1007.399
15.50000	1370.041	15.50000	-1422.72
16.00000	-417.238	16.00000	1171.196
16.50000	-339.03	16.50000	-500.665
17.00000	875.9167	17.00000	-225.735
17.50000	-1196.98	17.50000	702.0137
18.00000	1325.32	18.00000	-790.175
18.50000	-1296.53	18.50000	539.2925

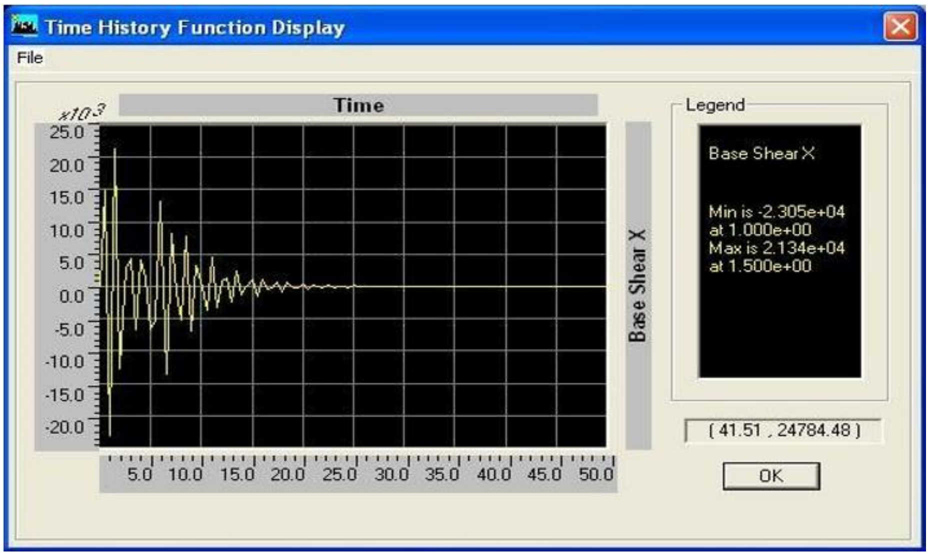


Base Shear X

Min is -4.148e+04
at 3.000e+00
Max is 4.217e+04
at 2.500e+00

(3.69 , 46551.72)

Fig.11 The Graph displaying among Time Vs Base shear X (Without TMD)



Base Shear X

Min is -2.305e+04
at 1.000e+00
Max is 2.134e+04
at 1.500e+00

(41.51 , 24784.48)

Fig. 12 The above graph provided the Time Vs. Base shear X (With TMD)

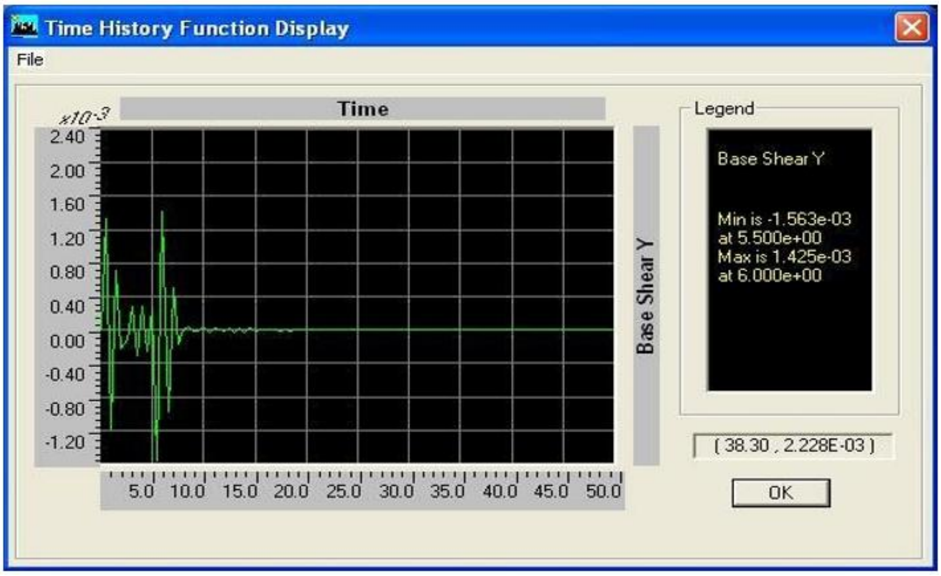
Case II: Without TMD &With TMD: isTime Period Vs. Base Shear y

Table. **No 5**. **2**: TimeVs Base shear in Y − direction (without & *with TMD*).

Without TMD		With TMD	
Time Period	Base shear y	Time Period	Base shear y
0.00000	0	0.00000	0

0.50000	0.00133	0.50000	4.73E-05
1.00000	-0.00118	1.00000	1.45E-04
1.50000	7.15E-04	1.50000	-1.01E-04
2.00000	-2.28E-04	2.00000	4.88E-05
2.50000	-1.13E-04	2.50000	-3.52E-05
3.00000	2.74E-04	3.00000	9.61E-06
3.50000	-3.09E-04	3.50000	0
4.00000	2.88E-04	4.00000	1.22E-05
4.50000	-2.56E-04	4.50000	-2.96E-05
5.00000	2.37E-04	5.00000	4.54E-05
5.50000	-0.00156	5.50000	-1.03E-04
6.00000	0.00142	6.00000	-8.95E-05
6.50000	-9.73E-04	6.50000	5.25E-05
7.00000	4.98E-04	7.00000	-1.14E-05
7.50000	-1.64E-04	7.50000	6.45E-06
8.00000	6.92E-06	8.00000	1.60E-05
8.50000	2.94E-05	8.50000	-2.80E-05
9.00000	-1.13E-05	9.00000	2.07E-05
9.50000	-1.55E-05	9.50000	-9.19E-06
10.00000	2.95E-05	10.00000	-2.62E-06
10.50000	-2.72E-05	10.50000	1.22E-05

11.00000	1.39E-05	11.00000	-1.47E-05
11.50000	2.63E-06	11.50000	1.02E-05
12.00000	-1.69E-05	12.00000	-2.77E-06
12.50000	2.60E-05	12.50000	-3.96E-06
13.00000	-2.95E-05	13.00000	7.76E-06
13.50000	2.84E-05	13.50000	-7.67E-06
14.00000	-2.43E-05	14.00000	4.45E-06
14.50000	1.86E-05	14.50000	0
15.00000	-1.25E-05	15.00000	-3.28E-06
15.50000	6.84E-06	15.50000	4.63E-06
16.00000	-2.00E-06	16.00000	-3.84E-06
16.50000	-1.76E-06	16.50000	1.68E-06
17.00000	4.39E-06	17.00000	0
17.50000	-5.94E-06	17.50000	-2.28E-06
18.00000	6.55E-06	18.00000	2.60E-06
18.50000	-6.40E-06	18.50000	-1.81E-06



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Base Shear Y

Min is -1.563e-03
at 5.500e+00
Max is 1.425e-03
at 6.000e+00

( 38.30 , 2.228E-03 )
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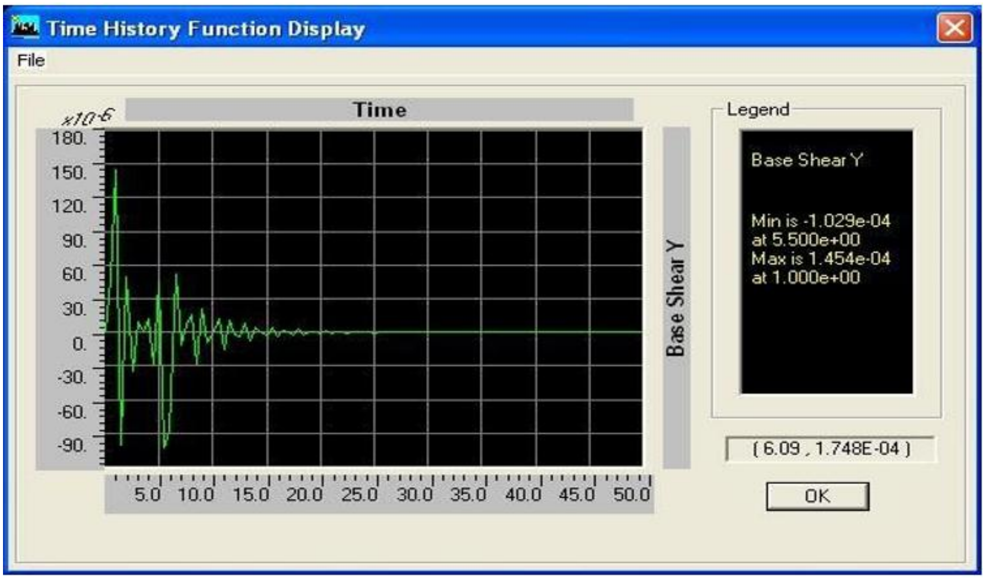
Fig.13 The above Graph Displaying among Time Vs. Base shear y (Without TMD)



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Base Shear Y

Min is -1.029e-04
at 5.500e+00
Max is 1.454e-04
at 1.000e+00

( 6.09 , 1.748E-04 )
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Fig.14 The Graph above displays a comparison between Time Vs. Base shear y (With TMD)

VI. CONCLSUION

Based on the results obtained from the ETABS package according to IS: 1893: 2002, With 5% structural damping, the following conclusions are drawn. For symmetrical construction, it can add the use of tuned mass dampers in the form of metal dampers with the help of 51% vibration amplitudes. Similarly, for asymmetrical buildings, the use of metal dampers can reduce the cost of vibration amplification by 49%. Also, for parallel buildings, the base share load is reduced by 56% using metal dampers. For asymmetrical buildings, the base share rate is raised to 42% use of metal dampers.

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