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STUDY OF DYNAMIC RESPONSE OF STRUCTURES USING ANTI-VIBRATION PADS

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Abstract – Excessive structural response resultant due to forced vibration needs to be controlled to prevent system from excessive stresses. Presently, passive way of increasing stiffness and damping to system is accepted for implementation in real field includes bracings, base isolation and damper devices to control structural response. This paper aims towards assessing effectiveness of anti-vibration pads in structural response control.

Index terms - damped vibration, undamped vibration, and seismic force.

I. INTRODUCTION

Anti vibration structures without bracings and other dampers the usage of anti-vibration pads are much more effective. So technically, the usage of dampers can be reduced if the anti - vibration pads absorb the vibration to a greater extent. With the help of a small steel skeleton prototype, this project analysis and gives a brief detail on the rate of percentage of control of vibration through anti-vibration pads.

II. OBJECTIVE

This project aims to study the dynamic response of the steel frame structures and to reduce the vibration of the steel by using anti-vibration pads without bracings. The project has a wide variety of usage in major earthquake zones. Since the usage of anti-vibration pads helps in reducing the vibration level, it can be used as a component in construction (footing).

III. CHARECTERISTICS OF ANTI VIBRATION PADS

The anti-vibration pads are being made from high quality elastomeric rubber compounds and the vibration absorbing materials like springs and rubber that are able to absorb the vertical and horizontal vibrations. Anti-vibration pads design is capable of isolating and absorbing rotational vibration. The design of anti-vibration pads is such that there is no direct metal-to-metal path for vibrations to travel. The vibrations are only partially transmitted beyond the Anti-vibration pads. Anti-vibration pads can greatly control, absorb and isolate the harmful and annoying vibrations.

System	Damping ratio(ξ)
Metals	< 0.01
Auto Shock absorbers	= 0.30
Rubber	= 0.05
Large Buildings during Earthquake	0.01 to 0.05
Prestressed Concrete Structures	0.02 to 0.05
Reinforced Concrete structures	0.04 to 0.07

IV.DESIGN CONSIDERATION

Construction Type	Damping Ratio(ξ)		
	Min	Mean	Max
Tall Buildings (h ≥100m)	0.010	0.015	0.020
Reinforced Concrete Steel	0.007	0.010	0.013
Buildings (h ~50m)	0.020	0.025	0.030
Reinforced Concrete Steel	0.015	0.020	0.025

The damping ratio (ξ-zeta) of the rubber is 0.05 and for steel is 0.0025. The damping ratio of rubber is high. By using the rubber material like anti vibration pads we can reduce the damping force easily. The given vibration is forced vibration and it requires one coordinate to define the system, so it is a single degree of freedom. All vertical and rotational motions are ignored. Dynamic problem is time-varying in nature.

So loading and its response varies with respect to time. Undammed vibrations are given before inserting the anti vibration pads. After adding the damping material like anti vibration pads it will become the damped vibration. Piezoelectric accelerometer is used. It has almost zero damping and operated up to the frequency ratio of 0.06.

V.WORKING MODEL

The steel frame is fitted with the plywood, the bottom of the metal sheet is welded with the springs. Magnetic coil is used to create a magnetic field in order to produce dynamic loading and it is winded with copper wire. The coil is hanged above the rod. The voltage regulator is connected with the magnetic coil to regulate the magnetic field in order reduce or increase the magnetic field. The regulator is connected with the Zener diode to maintain the voltage fluctuation. The metal sheet is vibrated with the help of rod immersed on the sheet and the vibration is created by the theory of magnetic field. The vibration is created in the metal sheet forms waves (like P waves and S waves) which is transfer to the plywood and the steel frame gets vibrate. The vibration is measured in the accelerometer which gives graph between the acceleration and time. Getting the results for the various voltages

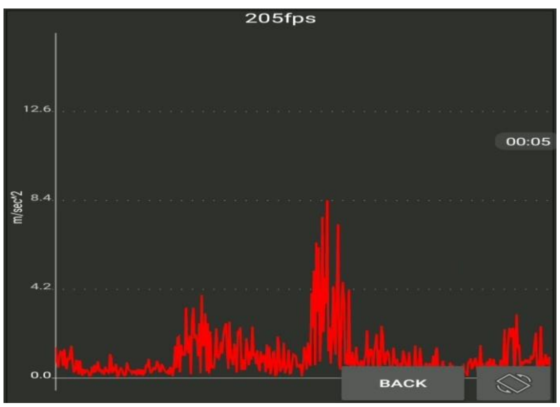

Figure.1 Simple harmonic motion for 240v

The displacement of the structure is calculated as

$$d = \frac{1}{2} \times at^2$$

a= acceleration of the structure obtained from the Graph

t = time frequency

According to the Newton's law of motion

Seismic Force (F) = m × a

m = total mass of the structures

a = acceleration of the structure obtained

From the graph

The stiffness of the steel frame is calculated as

$$\text{Stiffness} = \frac{Seismic force}{displacement}$$

Natural frequency is the number of cycles per unit Time. When no external force acts on the system after giving it an initial displacement, the body vibrates. These vibrations are called free vibrations and their frequency is called natural frequency.

$$\text{Natural frequency } (\omega) = \sqrt{\frac{k}{m}}$$

The vibration generated by the system having no damping element is known as undamped vibration.

$$\text{Undammed frequency } (\omega) = \frac{2\pi}{f}$$

After adding the damping material like anti vibration pads it will become the damped vibration

Voltage (volts)	Without anti vibration pads	With anti-vibration pads	Reduction in percentage
240	370	233	62.97
228	344	176	51.16
220	203	141	69.45
215	190	132	69.47
190	185	110	59.45

Table.3 Results for Seismic force

$$\text{Damped frequency} = \omega\sqrt{1 - \xi^2}$$

By using the anti-vibration pads, the acceleration is reduced around 60% in the foundation level without bracings. The anti-vibration pads isolate the vibration and reduce its harm.

The seismic force acting on the structure is reduced around 63%. The seismic force is reduced after placing the damper and it gives adequate strength and support to the structure. Vibration pads are easily place able under the foundation and it doesn't need fittings and connections. Isolating the vibration will reduce the cause and damage. Can save more lives during the earthquake. For large scale, anti-vibration pads are recommended to be placed under the foundation to avoid damages

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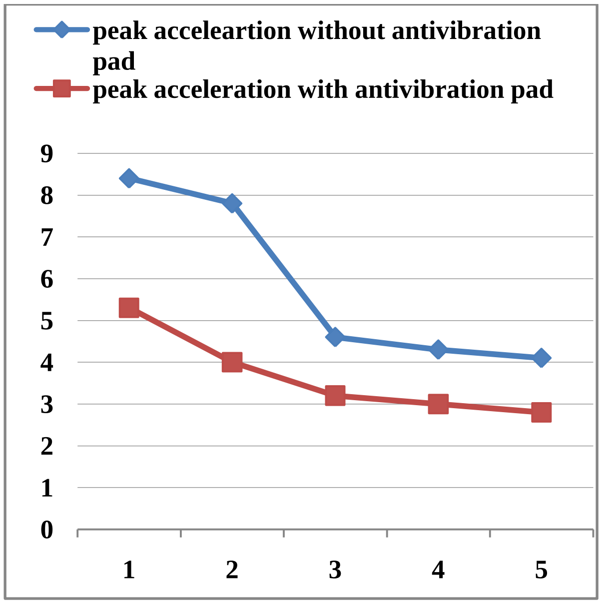

Figure.2. Peak acceleration with and without anti-vibration pads for various voltages

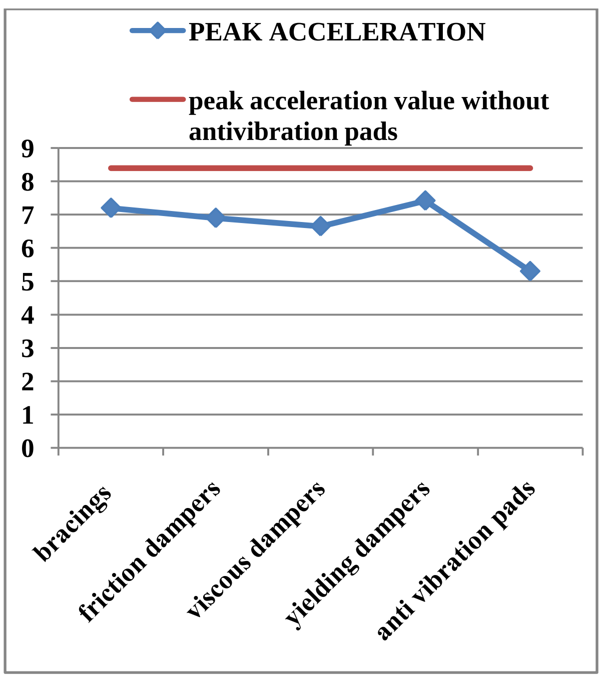

Figure3 Peak acceleration graph for various dampers

VI.CONCLUSION

The anti-vibration pads on the whole, have basic property of absorbing vibration. But using it in for only automobiles have put it in a deep backward application of them.

By using it in a construction field has variety of applications, which ensure the safety of many buildings and lives of people.

By this project we give a conclusion that the 63 % of acceleration got reduced, 62.5 % of displacement and 65% of seismic force.

So by applying this as a footing part of the building it can reduce the vibration to greater level.

Our project being done in a small scale can only estimate the seismic load for a smaller scale say (up to 2magnitude). Even though the magnitude level is smaller this can be extended to a larger level of usage. Large anti vibration pads can be used for a real construction field, where the usage gets varied.

We can provide safe and healthy atmosphere to human lives.

REFERENCE

[1] Arkava.et al. (2013) "Frequencies and Damping Ratios of a High Rise Building Based on Microtremor Measurement" International journal on 13^{th} World conference on Earthquake Engineering paper no 48.

[2] Papagiannopoulos G.A. *et al.* (2013**)**, **"**seismic inelastic design of steel structures by spectrum analysis and equivalent damping International journal on the Acoustical Society of America Vol. 33, Number 11.

[3] Jan Tippner *et al.* (2013), "Acoustics of wood" International Journal on Innovative Research in Science Engineering and Technology.

[4] Imad H.Mualla *et al.* (2014), "Dampers for Earthquake Vibration Control" International journal on World conference on Earthquake Engineering Vol. 3, issue 2.

[5] Caughev T.K. *et al.* (1961), "Effect of Damping on the Natural Frequencies of Linear Dynamic Systems" International journal on the Acoustical Society of America Vol. 33, Number 11.

As per IS13920:1993 the Seismic Force on the structure was analyzed

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