iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** XII **Month of publication:** December 2022

DOI: https://doi.org/10.22214/ijraset.2022.47852

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue XII Dec 2022- Available at www.ijraset.com

Earthquake Vibration Control of Multi Storey Building Using Base Isolation System: A Review

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Abstract: ***Earthquake, any sudden shaking of the ground caused by the passage of seismic waves through Earth's rocks. Major earthquake in recent years have highlighted the big concern of modern seismic design concept for the resilience of building. The overall goals of this thesis aim to design structural vibration control using smart material and devices and to elucidate the factors determining their robustness, feasibility, and adaptability for earthquake -resistant and resilient building. SAP2000 is a tool used for creating and analysing structural models. It offers many features across a single, customizable user interface, allowing engineers working on transportation, industrial, public works, or other facilities to generate complex models and run comprehensive tests. Earthquakes shake the ground surface, can cause buildings to collapse, disrupt transport and services, and can cause fires. They can trigger landslides and tsunami. Earthquakes occur mainly as a result of plate tectonics, which involves blocks of the Earth moving about the Earth's surface.***
Keywords: Isolation System, Earthquake Vibration, Analysis of method, Lead rubber bearing.

I. INTRODUCTION

An earthquake is what happens when two blocks of the earth suddenly slip past one another. The surface where they slip is called the fault or fault plane.

A. Types of Earthquakes

1) *Main Shock:* - In seismology, the mainshock is the largest earthquake in a sequence, sometimes preceded by one or more foreshocks, and almost always followed by many aftershocks.
2) *Fore Shock:* - A relatively small earthquake heralding the arrival of a much larger one.
3) *Slow:* - A slow earthquake is a discontinuous, earthquake-like event that releases energy over a period of hours to months, rather than the seconds to minutes.
4) *Super Shear:* In seismology, a super shear earthquake is an earthquake in which the propagation of the rupture along the fault surface occurs at seeds in excess of the Occurrence.

B. Techniques

1) Shear walls, cross braces, diaphragms moment-resisting frames, are central to reinforcing a building. Shear walls are a useful building technology that can help transfer earthquake forces. Made of multiple panels, these walls help a building keep its shape during movement.
2) *Base Isolation:* There is four types of bearing system.

a) Laminated rubber bearing
b) High damping rubber bearing.
c) Lead rubber bearing.
d) Friction pendulum system bearing.

A base isolation system is a method of seismic protection where the structure (superstructure) is separated from the base (foundation or substructure). By separating the structure from its base the amount of energy that is transferred to the superstructure during an earthquake is reduced significantly.

These base isolation systems often tend to include one or more type of bearing to support the weight of the structure. Some examples of these components are; elastomeric pads, sliding plates or inverted pendulums. All of these components can provide some level of energy dissipation, but typically only in the form of hysteretic damping. Hysteretic damping has certain limitations in terms of energy absorption and can excite higher modes in some cases.

Fig.1 Isolation system and Lead rubber bearing

LRB(Lead Rubber Bearing)

During the earthquake, the un-isolated building will vibrate back and forth in varying directions due to the inertial forces and result in deformation and damages of the building. In contrast, the base isolated building will also displace but remains its original shapes and avoid damages - that is because the lead rubber bearing effectively dissipates the inertial force upon the building, extends the building's period of vibration and decrease the acceleration of the building.

The lead plug will slide with laminated rubber during earthquake but convert this energy of movement to heat so that it efficiently reduces the inertial force upon the building, which slow the vibration of the building. Meanwhile, the rubber part will preserve its original shape due to high elasticity.

II. LITRETURE REVIEW

1) Sanjaya Kumar Patrao - Analysis Each type of energy dissipation device acts primarily to dissipate energy, its mechanism for doing so leads to distinctly different hysteretic behaviour, and thus performance of structure to which it is attached. The basic characteristics of the device in terms of its displacement or velocity dependence must be considered in the analysis and design procedure. The introduction of energy dissipation devices within the structural framing of a building introduces a number of analysis and design issues that must be considered by the structural engineer but which are not directly addressed in code-based documents.
2) S.D.Darshale – Investigated about the response of the base isolated structure .There is so Base isolation is one of the types of energy dissipation system. It is a passive system of energy control. Isolator basically isolates the superstructure and foundation and it partially reflects and partially absorb the part of the energy. Due to the introduction of lead rubber isolator, the horizontal movement of the building increases i.e., Fundamental natural time period increases and horizontal stiffness of building decreases. The inner story drift after introduction of isolator is reduced up to certain level. G+14 regular RCC building is taken into the study for comparison of rigid base and base isolated structure. The fundamental natural time period of the structure is approximately 1.7 where in for isolated structure is 4.3sec. As the natural time period increases the energy dissipation also increases and response reduces. Due to isolation inner story drift, base shear acceleration is reduced.
3) Tian Xue and Ming, (2008) - Proposed the seismic isolation with laminated rubber bearing isolators in frame shear wall structure. The Isolated structure and the non-isolated structure were compared.
   The result showed that base isolation method can reduce the displacement and base shear of structure. The connection of isolation bearing without top fixing plate is safe, while the cost of isolation bearing is largely decreased.
4) Ribakov and Iskhakov, (2008) -Studied base isolation systems in public buildings using variable friction dampers for reducing displacements at the base isolators level. Design of base isolation systems and selection of their properties usually depend on dynamic characteristics of the isolated building. It was obtained by non-destructive impulse testing of the structure before its protection. Alternatively, vibration machine testing, micro-seismic blast method or waiting regime procedure may be used for designing base isolation. The friction dampers can be reduced the big displacements.
5) Su Myat and Kyaw, (2014) - Compared seismic response of storey drifts, storey shears, storey moments, point displacements and storey accelerations study at fifteen-storey reinforced concrete building using viscous dampers and viscoelastic dampers. ETABS v 9.7.1 software was used for analysed and design of structure. Viscous dampers were most effective in reducing seismic response of the structure. Viscous dampers reduce storey drifts and displacement at 50%.

6) Dhawade, (2014) - Studied the effect of base isolation in a G+14 storied frame structure for the seismic effect with fixed base and of an isolated structure. The (G+14) storied frame structure was designed with base isolation using the ETAB software. High Damping Rubber Bearing (HDRB) was used as an isolator, had high flexibility and energy absorbing capacity. Storey overturning moment and storey shear were reduced in base isolated building when compared to fixed base building.

7) Farzad Hatami (2015) - Presented about seismic base isolation and soil structure interaction. A case study has been selected with ten storeys building with base isolator. Actual structure designed according to IBC2009. A model was prepared to study the effects of soil structure present around the building premises. Nonlinear dynamic time history analysis has been performed by simulating two past recorded earthquakes i.e.,Loma Prieta and north ridges for the soil structure interaction effect. Three different soil model for the different time period, base shear and other parameter were found out on isolated building with each of soil model. The result showed that there was hardly any change in response of structure if the underlying soil was hard or stiff but there is considerable change if the soil beneath was soft or medium hard. Also, the time period of structure gets reduced in soft soil.

8) Niranjan et al., (2016) - Studied the effect of base isolation in irregularly planned buildings. A G+14 storey RC building with regular and irregular plan having dimension 31×35m located in zone 5 with hard soil condition was considered. Four models were considered, out of which two models were regular and two irregulars. Mode period increases in High Damped Rubber Bearing when compared with fixed base building both in regular and irregular plan building. Irregular planned buildings mode period is less when compared with regular plan building.

9) Farzad hatami - Presented a paper on seismic base isolation and soil structure interaction. A case study has been selected for that a ten-story base isolator actual structure designed according to IBC-2009 was selected. A model was prepared for given effects of soil structure present around the building premises. Nonlinear dynamic time history analysis has been performed with two past recorded earthquakes I.e., Loma Prieto and north ridges for the soil structure interaction effect. Three different soil model for the different time period, base shear and other parameter are found out on isolated building with each of soil. The result showed that there was hardly any change in response of structure if the underlying soil was hard or stiff but there is considerable change if the soil beneath was soft or medium hard. Also, the time period of structure gets influenced due to soil type model.

III. METHODOLOGY

A Flow chart is produced as the overarching research methodology for this project (see Fig.2).

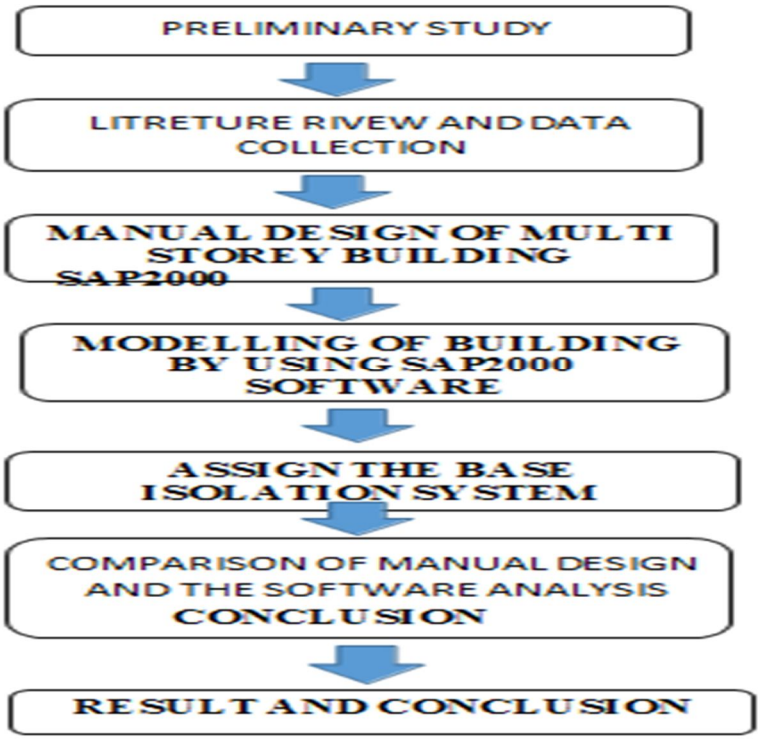

Fig -2: SCHEMATIC DIAGRAM OF METHODOLOGY

IV. CONCLUSION

1) The study displays the distribution of base isolation system using various combinations of lead and rubber. The use of sections subjected to circumstantial loading is to be implemented and concluded utilizing CSi bridge software.

2) The manual design method is discussed in the various above work. Finally, the manual design and software analysis results are compared

3) Comparing the manual results with those of software analysis, it is observed that the manual results are less than those of analysis with software.

4) The structure is analysed using SAP2000 software. It is particularly good in analysing the structure. The outcomes produced by this software are quite precise.

V. ACKNOWLEDGMENT

Firstly, we are profoundly grateful to Prof. Manoj. U. Deosarkar for him expert guidance and continuous encouragement throughout to see that this project rights its target since its commencement to present. I would like to thanks Prof. Lt. Col. Sanjay Karodpati Head of Civil Engineering Department of Dr.D.Y.Patil School of Engineering Lohegaon,Pune and Prof. Uzma Shaikh Project Coordinator whose invaluable guidance supported us in this project.

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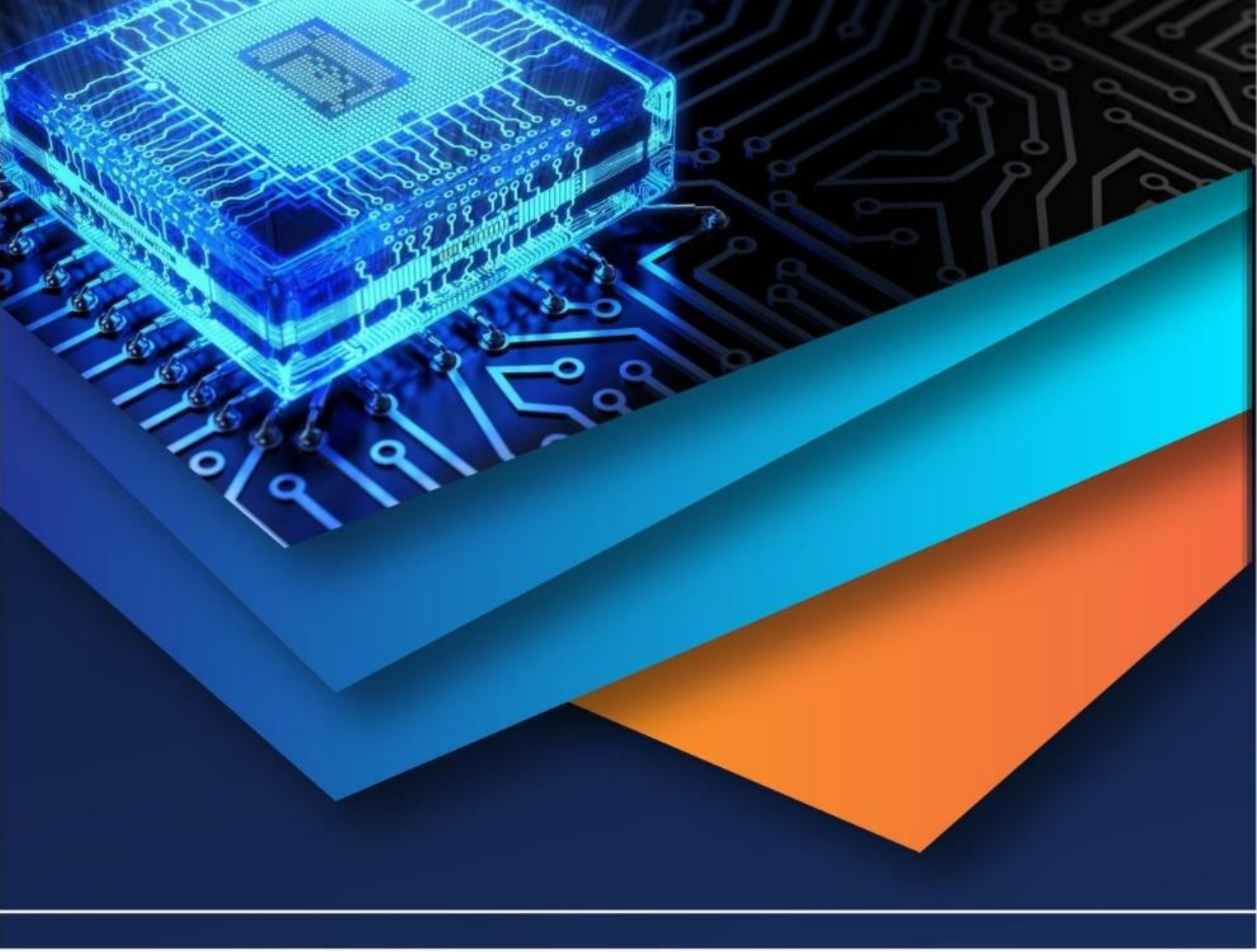

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