Analysis and Seismic Response Reduction of Building Using Base Isolation Technique

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Abstract: *Modeling and analysis of fixed base and base isolated buildings by using E-TABS software and study the effects of earthquake ground motions on these models and study the effectiveness of lead rubber bearing used as base isolation system and carry out comparison between fixed base and base isolated building on the basis of their dynamic properties like maximum shear force, maximum bending moment, base shear, storey drift and storey acceleration. In this manner it could be possible to decide the effectiveness of this base isolation system, giving advices for future possible applications.*

***Key Words*: Base isolation, Regular and Irregular Shape of Building, Earthquake, Lateral Forces etc.**

1.INTRODUCTION

Conventional seismic design attempts to make buildings that do not collapse under strong earthquake shaking, but may sustain damage to non-structural elements and to some structural members in the building. Non-structural components may consist of furniture, equipment, partitions, curtain wall systems, piping, electrical equipment and many other items. There are mainly three main categories: architectural components, mechanical and electrical equipments, and building contents. This may render the building non-functional after the earthquake, which may be problematic in some structures, like hospitals, which need to remain functional during the earthquake. Non-structural components are sensitive to large floor accelerations, velocities, and displacements. When a building is subjected to an earthquake ground motion, the building induces motion, resulting in floor accelerations higher than the ground acceleration. Hence, it is present need and also a duty of civil engineers to innovate earthquake resisting design approach to reduce such type of structural damages. Special techniques are required to design buildings such that they remain practically undamaged even in a severe earthquake. There are two basic technologies used to protect buildings from damaging earthquake effects. These are base isolation devices and seismic dampers. The idea behind base isolation is to detach (isolate) the building from the ground in such a way that earthquake motions are not transmitted up through the building, or at least greatly reduced.

1.1 GENERAL

This study deals with a new type of base isolation application. The work includes design of 10,15,20-storey reinforced concrete symmetrical plan and unsymmetrical plan building in accordance with IS 1893:2002 provisions; one with fixed base and other is base isolated. By analyzing the fixed base buildings, we get maximum reactions under each column. For these maximum values lead-rubber bearings (LRBs) are designed in order to isolate the superstructure from substructure. Time history analysis is carried out by taking elcentro earthquake ground motion records.

2. Concept

An earthquake is the result of a sudden release of energy in the Earth's crust that creates seismic waves. This results in enormous seismic vibrations that travel through bedrock. As the energy of the earthquake travels in waves through the ground, certain frequencies of vibration retain more energy than others depending on the mechanical properties of the surrounding soil. Every building has a fundamental frequency (usually between 5 and 0.833 Hertz) that often falls within the range of seismic frequencies. During a seismic event floor accelerations and inter-storey drifts are caused in a structure. The basic dilemma in providing superior seismic resistance of a building is the difficulty in minimizing inter-storey drift and floor accelerations simultaneously. Large inter-storey drifts also causes damage to non-structural components. Inter-storey drifts can be minimized by stiffening the structure, but this leads to amplification of the ground motion, which leads to high floor acceleration, causing damage to structural components. Inter-storey drifts can be minimized by stiffening the structure, but this leads to amplification of the ground motion, which leads to high floor acceleration, causing damage to structural components. Making the system more flexible can reduce floor acceleration, but this leads to large inter-storey drifts. The only practical way of reducing inter-storey drift and floor acceleration simultaneously is to use base isolation, which provides the necessary flexibility, with the displacements concentrated at the isolation level. Figure1. Shows the general configuration of a base isolated building.

It primarily comprises of an isolation bearing installed between the foundation and the superstructure equipped with an energy damping device. Many isolation device provides energy damping on themselves and eliminates the need of any passive damping device.

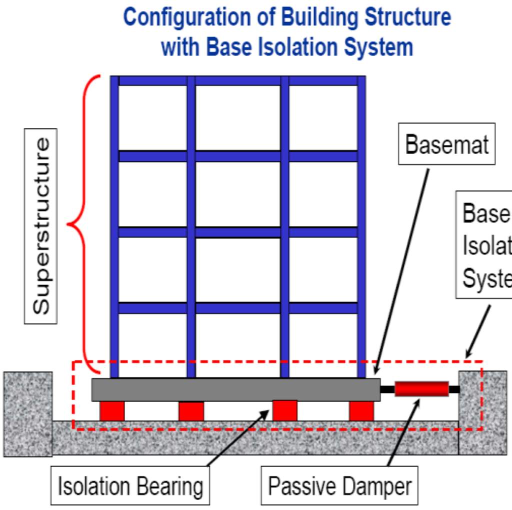

Fig-1: Building structure with Base Isolation system

2.1 ISOLATION DEVICES USE

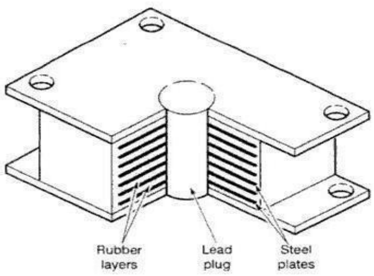

Fig -1: **Lead Rubber Bearings**

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3. CONCLUSIONS

This study presents both theoretical investigation and modeling for building subjected to earthquake induced load with fixed base and with base-isolation method using rubber bearing. The aim of this work is to contribute to the efficient design of base-isolated structure subjected to seismic ground motion.

4.LITERATURE REVIEW

Hamid Reza Tabatabaiefar, Ali Massumi (2010) As the Iranian seismic code does not address the soil–structure interaction (SSI) explicitly; the effects of SSI on RC-MRFs are studied using the direct method in this paper. Four types of structures on three types of soils, with and without the soil interaction, are modeled and subjected to different earthquake records. The results led to a criterion indicating that considering SSI in seismic design, for buildings higher than three and seven stories on soil with (shear wave velocity) Vs<175m/s and175<Vs<375 m/s, respectively, is essential. A simplified procedure has been presented, on the basis that lateral displacement increments could be applied to the fixed base models using simple factors.

Eduardo Kausel (2010) Soil–structure interaction is an interdisciplinary field of endeavor which lies at the intersection of soil and structural mechanics, soil and structural dynamics, earthquake engineering, geophysics and geo-mechanics, material science, computational and numerical methods, and diverse other technical disciplines. Its origins trace back to the late 19th century, evolved and matured gradually in the ensuing decades and during the first half of the 20th century, and progressed rapidly in the second half stimulated mainly by the needs of the nuclear power and offshore industries, by the debut of powerful computers and simulation tools such as finite elements, and by the needs for improvements in seismic safety. The pages that follow provide a concise review of some of the leading developments that paved the way for the state of the art as it is known today. Inasmuch as static foundation stiffness is also widely used in engineering analyses and code formulas for SSI effects, this work includes a brief survey of such static solutions.

J. Yang, J.B. Li, G. Lin (2006) indicate that direct integration of the ground acceleration data provided for seismic soil–structure interaction analysis often causes unrealistic drifts in the derived displacement. The drifts may have a significant effect on large-scale interaction analysis in which the displacement excitation is required as an input. This paper proposes a simple approach to integration of the acceleration to acquire a realistic displacement–time series. In this approach, the acceleration data is firstly baseline corrected in the time domain using the least-square curve fitting technique, and then processed in the frequency domain using a windowed filter to further remove the components that cause long-period oscillations in the derived displacement. The feasibility of the proposed approach is assessed using several examples and comparisons are made between the results obtained using the proposed scheme and those using other complicated procedures.

H.Yoshioka; J.C. Ramallo; and B.F.Spencer Jr. (2002) states in this paper that one of the most successful means of protecting structures against severe seismic events is base isolation. However, optimal design of base isolation systems depends on the magnitude of the design level earthquake that is considered. The features of isolation system designed for an El Centro-type earthquake typically will not be optimal for a Northridge-type earthquake and vice versa. To be effective during a wide range of seismic events, an isolation system must be adaptable. To demonstrate the efficacy of recently proposed „„smart"" base isolation paradigms, this paper presents the results of an experimental study of a particular adaptable, or smart, base isolation system that employs magneto rheological ~MR! dampers. The experimental structure, constructed and tested at the Structural Dynamics and Control/Earthquake Engineering Laboratory at the Univ. of Notre Dame, is a base-isolated two-degree-of freedom building model subjected to simulated ground motion. A sponge-type MR damper is installed between the base and the ground to provide controllable damping for the system. The effectiveness of the proposed smart base isolation system is demonstrated for both far-field and near-field earthquake excitations.

A. B. M. Saiful Islam1*, M. Jameel1, M. A. Uddin1 and Syed Ishtiaq Ahmad (2011) observes in this work that seismic base isolation is now a days moving towards a very efficient tool in seismic design of structure. Increasing flexibility of structure is well achieved by the insertion of these additional elements between upper structure and foundation as they absorb larger part of seismic energy. However in Bangladesh, this research is still young for building structures. Therefore, this is a burning question to design isolation device in context of Bangladesh. Effort has been made in this study to establish an innovative simplified design procedure for isolators incorporated in multi-storey building structures. Isolation systems namely lead rubber bearing (LRB) and high damping rubber bearing (HDRB) have been selected for the present schoolwork. Numerical formulation and limiting criteria for design of each element have been engendered. The suitability to incorporate isolation device for seismic control has been sight seen in details. The study reveals simplified design procedures for LRB and HDRB for multi-storey buildings in Bangladesh. The detail design progression has been proposed to be included in Bangladesh National Building Code (BNBC).

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