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A Review Paper on Base Isolated High Rise Building

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Abstract

Earthquake is a natural disaster by which many structures are damage and collapsed due to improper designs against seismic motion. Many earthquake resistant designs are well established by various researchers. As base isolation system using lead rubber bearing (LRB) is widely used base isolation system, the work under consideration is the brief review of the RCC structure with isolated base resting on LRB. Conventional seismic design practices helps in reducing forces for designs below the elastic level. A well designed structure should be efficient and able to survive an earthquake without collapse. However, the base isolation seismic design protects the structure to function without any damage even after major earthquakes with a negligible increase in capital cost. The introduction of base isolation reduces the storey shear, acceleration and increases the time period, storey displacement and storey drift which induces flexibility in the structure. The energy is dissipated into the foundation. The study of base isolation along with seismic analysis is aimed to be carried out by using response spectrum analysis in SAP 2000. An overall comparison of G+10 with isolator and without isolator will be studied. The G+ 10 storey building has been simulated in SAP 2000 with isolated base. The rubber isolator is used to work as a damping device which is expected to improve seismic response. The expected results will be more stable structure with base isolation technique.

Keywords- Damping, Lead rubber isolator, Seismic Response, SAP 2000Storey drift, displacements

I. INTRODUCTION

BASE ISOLATION

The modern global trend is to design the seismic resistant structure. The engineers are innovating new methods and striving constantly to achieve more safe and economic design. The base isolator is the common method which connects the base structure with the top super structure. The rubber isolation bearings can modify the fundamental frequency of the structure and this reduces the seismic response and provides the damping. The market has different type of isolators. Many countries use HDRBs i.e. High Damping Rubber Bearings. The chemistry is 30% rubber and rest fillers like silica, carbon and oil. The vulcanization process is used to get required rubber.

RCC frame structure

Base isolation frame structure

The seismic behaviour and fundamental period relation is shown in the Fig 1, 2. The seismic isolation rule can be deduced from this. The cardinal idea is to allow the movement of the base structure with minimum transmission to the super structure. To achieve this base isolation is developed by using spacers like rubber isolators. The isolators have ample of elasticity to absorb the horizontal energy produced by the earthquake. The attempt is to reduce the fundamental frequency between 1 Hz to 10 Hz. This separates out the structure in x and z directions. The earthquake forces are dominant in horizontal direction. High Damping Rubber Bearings used in many buildings in the real world have been found to be success in safeguarding the structures. HDRBs can provide 10% damping and reduce the fundamental resonant frequency. The effectiveness of the base isolation can be studied for sure. The seismic safe structure is designed to neutralize the horizontal forces. Seismic base isolation is a safe system which can passively withstand the earthquake motions. The earthquakes can be disastrous and risky for the life.

II. Literature Review

HSIANG-CHUAN TSA et al.(1989)[1] The base isolation is a novel method for safe design. The shake table is used in this paper to evaluate the seismic behavior of a structure with isolated base. The stiffness of the isolated system is very low. This controls the response of the super structure. The higher mode contribution is reduced. The rubber bearing is used for the base isolation. The first mode becomes more powerful. This method can save buildings with natural frequency from 1 Hz to 10 Hz. The higher mode response is not significant.

IunioIervolinoet. al (2010)[2]In the paper, the main issues related to code-based record selection were briefly presented with reference to EC8 and Italian code. It is difficult to apply provisions of the code. The software is developed to include the structural input for the analysis. This will help the designers to chose the specific code based input.

Roberto Villaverde et al. (2018)[3] This paper is based design simulation of a 13 storey building with a stand alone roof to improve the seismic response. A laminated rubber bearing isolates column and roof. This behaves like a damper. This method is effective and can be used in buildings of medium height.

HalukSucuoglu et al (2011)[4] In this paper the generalized force vector is calculated for each storey by response spectrum. The inter-storey drift at top level is determined using spectrum analysis. The GPA is constituted by N pushover analysis. This terminates in final result. This requires lesser hardware resources.

Di Sarnoet. al (2011) [5]This paper describes the dynamic analysis on a big size irregular multilevel building. The high damping rubbers (HDRB) are provided for the base isolation. Linear and Non Linear Dynamic analysis is performed. The storey and inter-storey drifts were recorded.

W.-L. He1 et.al (2011)[6] In this paper, a simple analytical pulse model has been proposed for long-period velocity pulses observed in near-field ground motions. The Pulse Analysis is used to study the seismic behavior. The ground motion can be successfully simulated. The results show that passive dampers close to the fundamental period of the building when force impulses are of longer duration. This has been established that the pulse model can replicate the actual ground movements with dominant pulsating behavior.

. **A. Masroor et al (2012)[7]**Structural impact of base isolated structures to moat walls was investigated**.**The impact model can simulate real life deformation of the building under seismic effects.

The moat wall is consideredflexible. The backfill is replaced by damp elastic foundation. The conclusion was that impact between base level to the moat has two phases . The contact acceleration is based on material and the geometry. The numerical model was confirmed by experimental results. The superstructure response is reduced by 7%. Because of half alterations in parameters. Contact accelerations can increase response at all level.

A.Masroor (2018) et. al[8]The paper is based on base-isolation effect along sliding and elastomeric dampers. The multilevel building is simulated which has irregular plan. Pushover analysis is used to analyze the masonry structure with Italian code. The pre-defined load pattern is applied to the structure and increased slowly and the real deformed shape is calculated.

Alessandro GALASCO1 et. al (2018) [9] In this paper NLSP(Non-Linear Static Procedure is used to analyze the structural behavior of the structures. The doubts about rigid frame analysis are raised. The novel algorithm is developed and supported by the case study.

T.T. Soong a et al (2018) [10]An attempt has been made in this to discuss the active structural design. The technology is developing fast. The software tools are being generated to find the best fitting solution in terms of strength and cost. The structural behavior is complex. The new devices have to be generated to improve the strength of the structure.

T.Y. Yang et al. (2019) [11] This paper describes Lead-rubber bearing (LRB) as a well developed and implemented isolation technology. However, the design challenges is preventing LRBs from buckling during strong earthquake shaking. Tough the component behavior of LRB under combined axial and shear loads are well established by many researchers, the seismic performance of base-isolated buildings with LRBs was not examined systematically. An attempt using the robust finite element model of the LRB considering the axial and shear coupling, was used to examine the seismic performances of two prototype buildings, each with different LRB geometric properties, structural periods, and axial loads. The results of nonlinear dynamic analyses show that the axial and shear coupling response of the LRB play an important role in the safety of base-isolated buildings. A simple amplification factor of 2.5 is proposed to increase the axial capacity of the LRB when the shear deformation reaches the maximum total displacement. The results show that such a simple amplification factor can produce low probability of failure of LRB buildings during strong earthquake shaking.

Shen-Haw Ju et al. (2020) [12] This paper studies the seismic and micro vibrations of the high-tech factory with and without lead rubber bearings (LRBs) using the three-dimensional (3D) finite element analysis. The soil-structure interaction is included using the p-y, t-z, and Q-z nonlinear soil springs, while the time-history analysis is performed under seismic, wind, or moving crane loads. For a normal design of LRBs, the high-tech factory with LRBs can decrease the seismic base shear efficiently but will have a much larger wind-induced vibration than that without LRBs, especially for the reinforced concrete level. Because micro-vibration is a major concern for high-tech factories, one should use LRBs with a large initial stiffness to resist wind loads, and use a small final LRB stiffness to reduce the seismic load of high-tech factories.

III. Research Methodology

On the basis of the literature review the motivation is to study the seismic performance of base-isolated buildings with LRBs. The objective of project work is to compare fixed base RC Frame structure and base isolated RC Frame structure by using Response spectrum analysis. The response spectrum analysis is carried out as per the provisions contained in UBC 97 for response spectrum and design of Lead Rubber bearing using SAP2000. A G+7storey RC bare frame is selected to study the effect of base isolation using Lead core rubber bearing. The following assumptions are made for the analysis of base-isolated building: The superstructure is elastic at all time, the non-linear behaviour is restricted in isolators only. Effect of infilled walls on stiffness of the structure is negligible. These are considered in computation of mass only.

IV. CONCLUSIONS

From the literature review and the analysis results of various researchers, it is observed that base isolation reduces the overall seismic response of building in comparison to fixed base building for given model. The comparison of models show that the natural time period of vibration increases more than double for isolated building. Time period affects the earthquake response of the structure, as the time period increases the base shear and acceleration values found to be reducing. Introduction of seismic base isolation system at base level of building shows low base shear values and makes the building to behave like a rigid body structure. The results shows that the base isolator is reducing the overall effect of earthquake forces on given RCC building. By introducing lead rubber bearing as base isolation system it increases the structures stability against earthquake and reduces reinforcement hence make structure economical. As the damage to the base isolated structure will be less as compared to fixed base structure, structure can be immediately occupied after the actual earthquake. Further for any important machinery installed in structure, due to the presence of the isolators, it is safer and suffers less damage than fixed base building.

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