Dynamic Analysis of RCC Buildings with Lead Rubber Base Isolater

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Abstract:- For the development of better design approach to protect the structures from earthquake damage, base isolation, to reduce the seismic energy impacting on the structure has represented a change of paradigm since it came into the fore. Base isolation technique is most suitable for high rise building, the concept of base isolation is simple, it modifies the response of the building so that the ground can move below the structure without transmitting this motion into the building, seeing the growth of such technology it became necessary to asses the general and seismic response of such structure. The present study focuses on the comparative performance of two frames of different material properties consisting base isolator, which is performed under seismic condition. The base isolation system that is utilized is composed of Rubber isolators. To reach the understanding of this fixed-base and base isolated structure the seismic analysis have performed on two types of structure and the responses are calculated considering different seismic zone. Thus, this paper aimed to compare the responses of simple rcc structure and steel structure due to Indian loadings and seismic zone variations additionally the structures are analyzed and compared using elcentro earthquake data for assement of responses like interstorey drifts, displacement and base shear.

Key Words— *Base isolation, Lead rubber bearing, Seismic isolation,*

1. INTRODUCTION

Base isolation is a technique develop to prevent or minimize damage to building during an earthquake. It has been used in New-Zealand as well as India, Japan, Italy and the USA. Base isolation technology can make medium rise masonry or reinforced concrete structures capable of withstanding earthquake, protecting them and their occupants from major damage or injury. The most capable and widely used isolators for medium rise building are lead rubber isolators. It is cost effective also when compared to other isolators. Thus, topic of this thesis is base isolation. Base isolation is a proven technology for the seismic design of structures. The system reduces the likelihood of structural and non-structural damage to a building subjected to seismic forces. As a result of the use of base isolation, lives and property have been saved. Base isolation technology is used primarily in critical facilities such as hospitals, museums, and emergency response centers, where the benefits of protecting the structure and its property from seismic damage far exceed the cost of implementing the system.

1.1. Need for the study.

To check and analyze how isolators improves the performance of the structure and give comparison of, lead rubber isolator is most suitable for which type of structure under seismic condition The need of this thesis is to offer a relative understanding of the seismic performance enhancements that a typical 8-story steel and RCC building can achieve through the implementation of base isolation technology. To reach this understanding, the structures of a fixed-base RCC and a base-isolated RCC building of similar size and layout are designed, their seismic performance is compared.

To a greater extent, this study demonstrates the responses of the structures under different seismic zones implementing base isolation on tall, flexible, and non-critical structures. As a result of this thesis, building owners and construction industry professionals can recognize the benefits of implementing base isolation on a wider range of projects, thereby creating the potential for a significant increase in the technology's use.

1.2. Objective and scope

This study analyzes a fixed-base and a base-isolated 8-story steel and rcc structure as well for an elcentro earthquake data. Lead rubber bearings are used for the isolation system in the base-isolated structure. The seismic performance of each structure is analyzed and compared for earthquake zone ii and v. 8 ground motions are scaled to each seismic demand level to perform nonlinear time history analyses on both structures. The resulting interstory drifts and displacement values are used to determine the levels of structural and non-structural damage inflicted on each building. In above study the lead rubber isolator is considered and above study will give an idea about how the placement of isolator will affect the response of the structures with different material properties. Therefore the different material properties are also considered for better comparison and result. The concept of base isolation is quite simple.

2. MODELLING

Structure with fixed based and with base isolator of material property RCC are modelled using the software SAP2000. For designing a new structure, connection details and support conditions shall be made as close to the computational models as possible. For an existing structure evaluation, structures shall be modelled as close to the actual as-built structural conditions as possible.

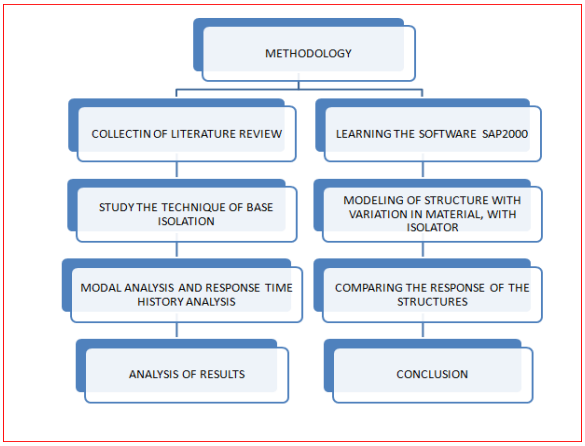
The correct choice of modelling and analysis tools/methods depend on:

a) Importance of the structure

b) Purpose of structural analysis

c) Required level of response accuracy.

Based on this, the models are prepared. It carries a building of 24m height.



Structural details of (G +8) building:

Beam:- A RCC beam of rectangular shape is considered having the dimension as 0.23*0.5meters. The grade of concrete used is M-30.

Column:- RCC columns are used of 0.3*0.4 meters and of M-30 grade.

Slab thickness is taken as 140meters. In this way total 2 models are created having different parameters i.e. RCC fixed based model and RCC model with isolator in zone 5.

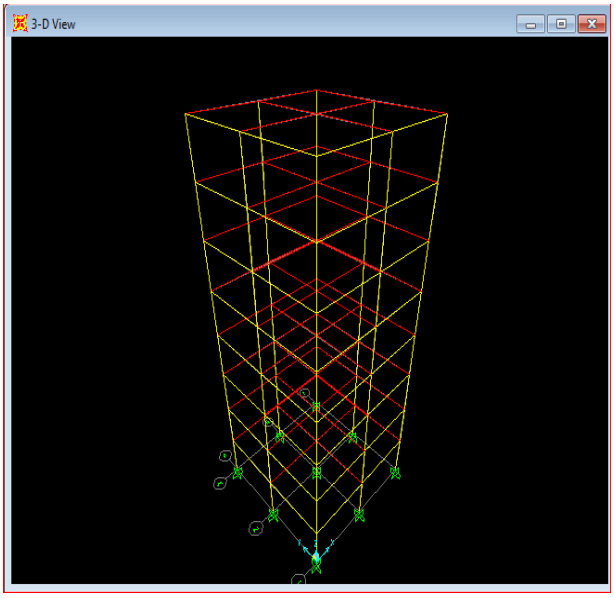


Fig 1 -RCC FIXED BASED STRUCTURE

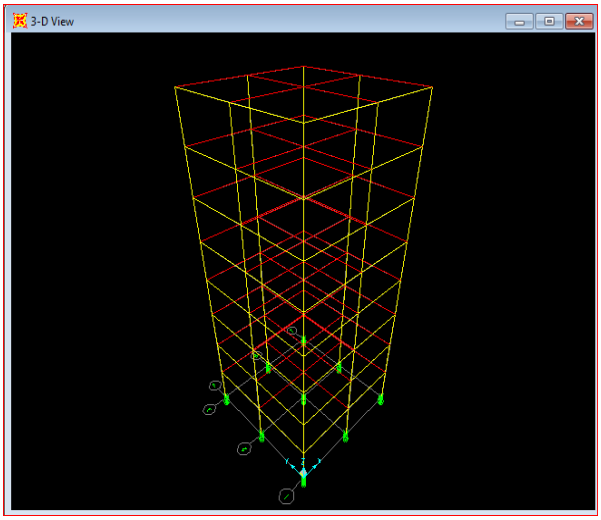


Fig 2 - RCC STRUCTURE WITH BASE ISOLATOR

During this we took previous data of The 1940 El Centro earthquake (or 1940 Imperial Valley earthquake) occurred at 21:35 Pacific Standard Time on May 18 (05:35 UTC on May 19) in the Imperial Valley in southeastern Southern California near the international border of the United States and Mexico. It had a moment magnitude of 6.9 and a maximum perceived intensity of X (Extreme) on the Mercalli intensity scale. It was the first major earthquake to be recorded by a strong-motion seismograph located next to a fault rupture. Thus, we took this earth quake data.

Material properties

Different types of materials are used for bridge structural members such as concrete, steel etc. The material properties that are usually used for an elastic analysis are: modulus of elasticity, shear modulus, Poisson's ratio, and the coefficient of thermal expansion, the mass density and the weight density. One should pay attention to the units used for material properties. For linear elastic materials, stresses are linearly proportional to strain($\sigma = E\epsilon$) as described by Hooke's Law. The Hooke's Law is applicable for both homogeneous and isotropic materials. For a simple linear spring, the constitutive law is given as: $Fs = k\xi$ where ζ is the relative extension or compression of the spring, while Fs and k represent the force in the spring and the spring stiffness, respectively Concrete grade of M30 and steel reinforcement Fe415 is used.

3. ANALYSIS

The following are the general steps to be defined for analyzing a structure using SAP2000.

- Geometry (input nodes coordinate, define members and connections)

- Boundary Conditions/ Joint Restraints (fixed, free, roller, pin or partially restrained with a specified spring constant).

• Material Property (Elastic Modulus, Poisson's Ratio, Shear Modulus, damping data, thermal properties and time-dependent properties such as Creep and shrinkage)

• Loads and Load cases

• Stress-strain relationship

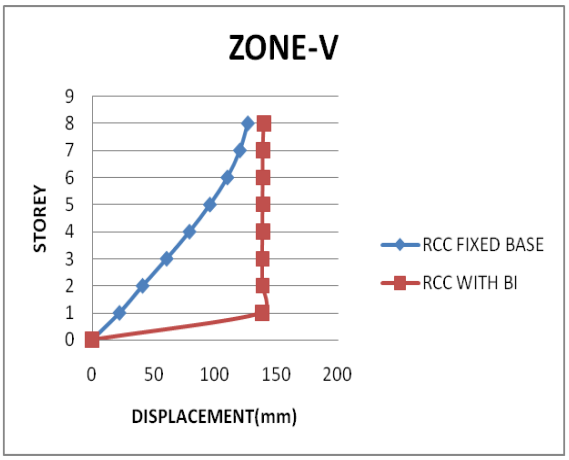
• Perform analysis of the model based on analysis cases.

• For above study total 8 models of RCC situated in different earthquake zones are considered.

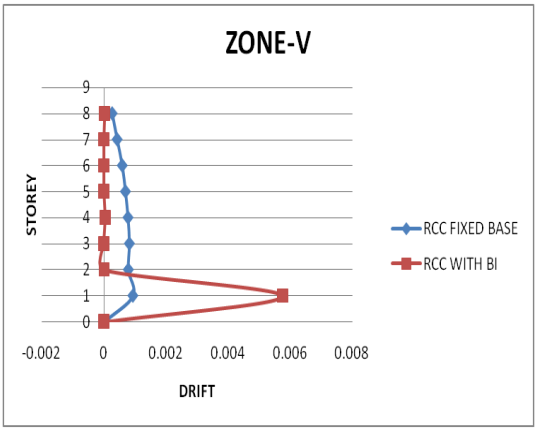
4. RESULT ANALYSIS

storey	Drift of RCC FIXED BASED(mm)	Drift of RCC WITH BI system(mm)
	ZONE-V	ZONE-V
8	0.000288	3.13E-05
7	0.000446	3.71E-06
6	0.000621	4.71E-06
5	0.000751	5.67E-06
4	0.000792	5.67E-06
3	0.000811	-9.58E-07
2	0.000783	0.000016375
1	0.000929	0.005753792

The following are the Fix base vs BI system graph between Displacement vs storey in Zone V.



The following are the Fix base vs BI system graph between Drift vs storey in Zone V.



The RCC displacement with fixed base is 10.4 % less than RCC with BI system which again shows the effectiveness of BI systems.

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