Base Isolation Method for Earthquake Resistant Buildings

Dibyashree Lohani#1, Sanyog Kumar Upadhay*1, Surya Bikram Dahal*2,Shristi Adhikari*3, Geetika Shrestha*

Department of Civil Engineering, Nepal Engineering College, Nepal

#1dibyashreel@nec.edu.np,

**1upadhyaysanyog79@gmail.com*

**2surya.bikram139@gmail.com,*

**3geetstha483224@gmail.com*

**4angelcreesty@gmail.com*

Dibyashree Lohani *received her Msc in structural Engineering in 2010 from Institute of Engineering, Pulchowk, Nepal. Currently she is an Associate Professor at Nepal Engineering College and is engaged in teaching for last 14 years. She has experienced in different building projects and Middle Marsyangdi hydroelectric project of Nepal. She has published articles in national and international journals.*

Sanyog kumar Upadhay *is studying Bachelor in Civil engineering in Nepal Engineering College under the affiliation of Pokhara University. He had participated in different research program, in and out the country such as Hultprize regional in Mumbai. He had conducted different college and national level research programs before.*

BikramDahal *is studying Bachelor in Civil engineering in Nepal Engineering College under the affiliation of Pokhara University. He had done different research activities such as base isolation, bamboo reinforcement method and different other researches. He had also participated in Hultprize regional in Mumbai.*

Shristi Adhikari *is studying Bachelor in Civil engineering in Nepal Engineering college under the affiliation of Pokhara University. She is also a research enthusiast and an idea generator. She had participated in different research program, in and out the country such as Hultprize regional in Mumbai, Locus etc.*

Geetika Shrestha *is studying Bachelor in Architecture in Nepal Engineering College under the affiliation of Pokhara University. She had also participated in Hultprize regional in Mumbai and different research programs. She is also good in model making and graphics designing.*

ABSTRACT

The field of engineering is as dynamic as the world we live in and so is the requirement of innovation in construction industry. One such innovation is base isolation method. From the result of the study, base isolation method is found to be highly optimistic for the safety of structures.

We met with different engineers regarding structure engineering and earthquake engineering. Through their recommendation, we visited National Society of Earthquake Technology (NSET) and Earthquake Safety Solution (ESS) which gave us chance to meet with Daniell King and Harry Toward who were researching in Nepal about base isolation method. We visited a village named Sankhu ward No.4 near Nepal Engineering College. We asked people how feasible this project can be. Many people showed positive responses towards it. Then we went to Sankhu Municipality for the collection of secondary data. So especially in developing countries like Nepal, this project will give a lot of benefit. Further it is expected to give better results than other resistive methods.

I. INTRODUCTION:

Massive destruction of houses, buildings and property in the recent earthquakes in Nepal has led property buyers to question if the structures being bought for residential or commercial purpose by them are quake proof [1]. Base isolation, a means of protecting a structure from earthquake forces. Simply it is a collection of structural elements which decouples a structure from its substructure resting on a shaking ground thus protects buildings integrity and reduces the overall impact of blast on structures.

Base isolation is one of the most powerful tools of passive structural vibration control technologies. It is meant to enable a building to survive a potentially devastating impact through a simple initial design [2]. It helps to modify the seismic sustainability considerably. It consists of isolation units which refer to the basic element of base isolation system which are used to provide the decoupling effect to a building [4]. As earthquake load is not controllable and it is not practical to design a structure for an indefinite seismic demand, we can modify the demand on structure by reducing the motion being transfer to structure from foundation. Base isolation is also useful for retrofitting important buildings. Increasing the ductility or elastic strength of the building is the most conventional method of handling seismic demand which is the main significance of our study [4].

A. Purpose of study:

To modify the building such that the ground below is capable of moving without transmitting minimum or no motion to the structure above and implementing the base isolation method in newly forming houses or buildings.

II. FIELD OBSERVATION AND DATA ANALYSIS:

We visited a village name Sankhu ward No.4 near Nepal Engineering College. We asked people how feasible our project is by explaining it and got positive responses towards our project. And we collected data through Sankhu Municipality which is given below:

Table 1: Sankhu Municipality [6]

						Public Property destructed		No of houses made after earthquake		No. of houses made after earthquake	
S.N.	No of completely destructed houses	No. of partially Destructed Houses	Total	Death	Victims	Completely	partially	By the government fund	By own fund	constructing phase	un-built
1.	646	3	651	11	15	1	8	9	53	54	533
2.	498	1	500	18	59	2	8	11	38	52	398
3.	617	0	619	9	9	2	7	17	46	68	486
4.	586	6	592	4	0	-	4	14	38	56	484
5.	554	1	555	1	0	2	7	14	39	51	451
6.	299	2	299	10	6	-	3	6	23	35	235
7.	439	144	553	0	4	-	5	17	36	59	441

After observing the data, we concluded that there was a great chance for construction of many buildings. So, to be safe from destruction caused due to earthquake implementation of base isolation method is the one.

Then, we designed a prototype of the building using sun board as roof and bricks, plywood as the base, and other materials as isolator. We made the base by fixing four helical springs in between using two plates, and fixed the isolated base with the designed structure. Then we consider a normal house as next prototype. A brief discussion about foundation used, types of isolators used and types of truss are presented in the section below.

A. Foundation used:

For the foundation, we used shallow foundation which was founded near the finished group, generally where the footing depth is less than the width of the footing which is usually less than 3m. They can sometimes be called as spread footing. They include pads or isolated footings.

B. Types of isolators used:

There are different kinds of isolators that can be used in making buildings. They are discussed below: [3]

a) Spring bearing

b) Lead Rubber bearing

c) Elastometer bearing

The main mechanism of the isolator is to damp the vibration caused due to the earthquake. So, the devices that have such mechanism can be used between two plates either lead plate or tectonic plate and a cylindrical lead is used inside the bearing which help in fixing of isolator and the plates [5].

C. Type of truss:

It can be applicable for both types of truss that were mainly used i.e. pitched truss and parallel chord truss. Pitched truss is a common truss that is characterized by its triangular shape. It is most often for roof formation. And the parallel chord truss or a flat truss gets its name from its parallel top and bottom chords. It is often used for floor construction [3].

D. Model overview:

The isolators were placed at the end of column. Isolators from 12 to 60 inches in diameter with capacitance of up to tons are manufactured. Custom dimensions are available for special applications. They are of height 25.4 cm.

The properties of spring are calculated and the data obtained is below:

Density $=7850 kg/m^3$ *Young's modulus* $=2*10^7$ *pa*
Poisson's ratio $=0.3$ *Stiffness* $=64680 N/m$

III. ANALYSIS AND DISCUSSION:

Talking about the analysis of the project, if we can implement in the society then the cost required for making an earthquake resistant building will be less than double brick methods, raft method and RCC method.

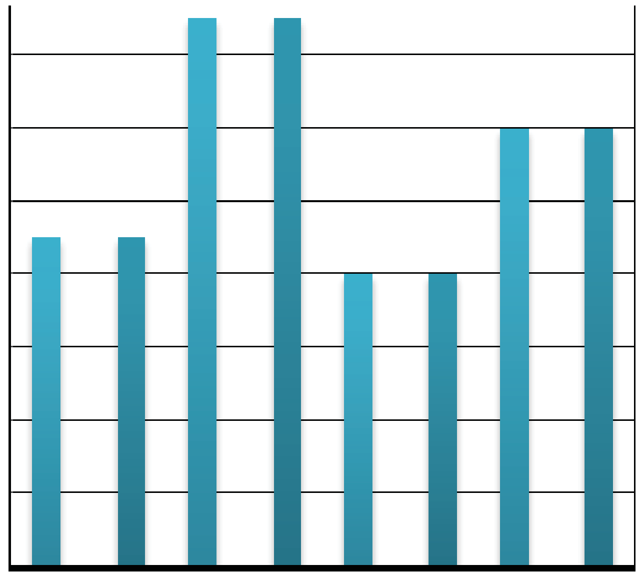

Fig 1: Cost estimation at the base (in million)

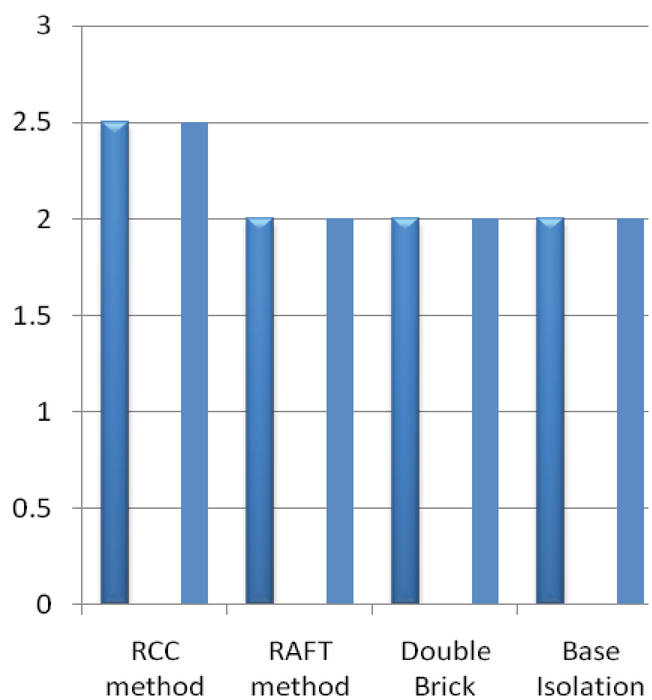

Fig 2: Cost estimation for the structure (in million)

Now the cost comparison between a normal house and isolated house for one storey is given below:

Table 2: Government norms for Municipality [6]

SN	Materials	For normal house	For isolated house
1.	Pebble, sand & stones	3,10,000	3,20,000
2.	Cement and bricks	6,30,000	6,40,000
3.	Rod and plumbing	5,10,000	4,70,000
4.	Wood and pipes	1,70,000	1,70,000
5.	Paint	1,00,000	1,00,000
6.	Marbles	80,000	80,000
7.	Electricity materials	60,000	60,000
8.	Map & Municipality charges	50,000	60,000
9.	Wage for construction	5,80,000	6,00,000
10	Isolators	------	1,76,000
	Total cost:	24,80,000	26,76,000

IV. APPLICATIONS:

Advantages:

1. It takes limited time rather than that of normal buildings.
2. It is cheaper than other resistant methods.
3. When used in normal building, it reduces the seismic frequency of earthquakes by 50 Hz.
4. Along with the increase in life time of building, it saves the life of people and properties
5. It also saves from GSA blast loads.
6. Its reliability is very high than others.
7. It also helps in increasing bearing capacity of soil.

Disadvantages:

1. It is not suitable for structure resting on soft soils but can be used together with soil stabilization method for making soft soil harder.
2. It can't be applied for building more than sixteen storeys.

V. CONCLUSION AND RECOMMENDATION:

This project is highly optimistic to achieve the primary goals of enhancing the earthquake resistant house which will protect the lives and property too. This project is fully confident in improving the safety of structures. And, if simple changes in base cause a great save in life and property then that would probably be the matter of concentration of all.

REFERENCES:

1. *Buckle (1986), Development and application of base isolation and passive energy dissipation*
2. *Skinner, WH Robinson (1993), An introduction to the seismic isolation*
3. *Tylor (1992), Performance of elastomers in isolation bearing*
4. *Clough & Penzien, Dynamics of Structures*
5. *Mario P., Structural Dynamics: Theory and Computation*
6. *Government of Nepal, Government norms for Municipality,*