Academic Science

**International Journal of Electronics, Electrical and Computational System**
**IJEECS**
**ISSN 2348-117X**
**Volume 6, Issue 8**
**August 2017**

# Seismic Base Isolation of Multi-Storey Building

[#1] **Sindhala Raju**
[#1]PG Student of Structural Engineering, Department of Civil Engineering, RGM College of Engineering and Technology, Nandyal, Andhra Pradesh, India.
**Dr. Chenna Rajaram**[#2]
[#2]Assistant Professor, Department of Civil Engineering, RGM College of Engineering and Technology, Nandyal. Andhra Pradesh, India.

**ABSTACT:**

*Seismic base isolation is a technique that has been reducing the damaging effects and structural collapse during an earthquake. The main purpose of this work is to make comparison between the fixed base building and various base isolation buildings. The various isolation systems such as friction isolators, rubber isolators, triple concave (T/C) friction isolators. It's subjected to strong ground motion such as "Lumjung (Nepal-2015) ground motion" to achieve an optimal design of the base isolation system and to make compare response of the building such as Acceleration, Base Shear, Time Period and Frequency for a 5-storied reinforced concrete regular building with and without base isolation by considering the Time History Analysis. For this purpose a history analysis is performed using a software SAP 2000 and to study the variation of base isolation building.*

***Keywords: Seismic Base Isolation, Displacement response, Time Period, Base Shear, Time History Analysis and SAP 2000***

## 1. INTRODUCTION

The concept of base isolation is a simple structure design method and it is helpful to important structures from strong ground motion. The function of base isolation method to protect structures not in favor of damage from earthquake. Base isolators are the most effective seismic method to reduce the vibrations transmitted from ground to the structure. The aim of the base isolator in seismic loading is to isolate the structure from horizontal components of the earthquake ground movement; whereas vertical movements are transmitted to the structure rather unchanged.

### 1.1 SEISMIC BASE ISOLATION

Seismic base isolation is a state of art method in which the structure is divided from the base by introducing a suspension device between the base and main structured. Seismic base isolation is the most effective method to reduce the vibrations transmitted from ground to the structure. The aim of the base isolator is under the seismic lading is to isolate the structure from the horizontal ground movement of the earthquake and to reduce vibrations and displacements. The behavior of structure with and without base isolator as shown in below figure 1.1.

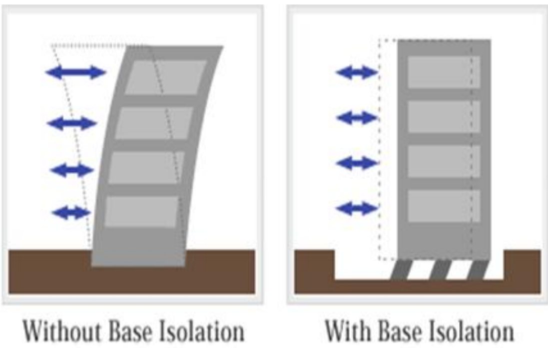


Fig 1.1: without and with base isolation

To achieve such vibrations, seismic devices known as isolators are intentionally installed in exact locations of the structures, allowing them to act upon accurately during an earthquake

1.2 BASIC CONCEPT OF BASE ISOLATION

The basic concept of base isolation is to protect the structure from damage caused due to seismic forces by introducing a support of isolating the structure from ground motion. In such way, the structure is isolated from its foundations. Due to seismic forces, there will be movement in ground and this ground movement tends to damage to the structure. So, the concept literal to isolate the structure from the ground. So, that we can control the movement of building. To using seismic base isolation devices, such as friction isolator, rubber isolator and T/C friction isolators reduce the response of the structure

1.3 TYPES OF SEISMIC BASE ISOLATORS

The most common use of seismic base isolators in building is

- Friction isolator (FI),
- Rubber isolator (RI), and
- Triple Concave (T/C) friction isolator

Friction isolator is one type of elastomeric behavior isolator and its works on the principle of simple pendulum. These are the especially designed seismic base isolators. This type of base isolators consist of the thin layer of high damping rubber and steel plates built in alternative layers. It increases the natural time period of oscillation by causing the structure and also possess a reentering capacity.

Rubber isolator is the mostly common used isolator and it’s have two end plates and many thin rubber shims interblended with the rubber. This isolator is made up of either natural rubber (or) Neoprene and its developed as in the 1970s. At the end of seismic earthquake, if a building has not returned to its place, the isolator slowly come back their original positions. It might be take few months, but its back to original place.

T/C friction isolator has a element object and it has a two end plates i.e. main concave and sliding concave. It also works on the principle of simple pendulum. It also possesses the reentering capacity.

## 2. MATHEMATICAL MODELLING

In the present work, a five storey RC frame building situated in zone V is taken for the purpose of study. It consists of 7 bays of 5 m each in X-direction and 7 bays of 4 m each in Y-direction. The total height of the building is 21 m.

Building Section Properties:

Plot area = 35 x 35 $m^2$
Thickness of the slab = 150 mm
Beam size = 250 mm x 500 mm
Column size = 500 mm x 500 mm
Thickness of wall = 150 mm
Each storey height = 3500 mm

Assumed Dead Load Intensities:

Roof finishes = 1 $kN/mm^2$
Floor finishes = 1 $kN/mm^2$

Live Load Intensities:

Roof = 1.5 $kN/mm^2$
Floor = 3 $kN/mm^2$

Material Properties:

Characteristic strength of concrete, $f_{ck}$ = 25 $MP_a$
Yield strength for steel, $f_y$ = 415 $MP_a$
Modulus of Elasticity of steel, $E_s$ = 200000 $MP_a$
Modulus of Elasticity of concrete $E_c$ = 250000 $MP_a$
The stress – strain relationship is used, as per IS 456:2000

Seismic Data Required For Analysis:

This seismic data is based on as per IS 1893:2000 (Part – 1)

International Journal of Electronics, Electrical and Computational System
IJEECS
ISSN 2348-117X
Volume 6, Issue 8
August 2017

Type of structure = RCC
Seismic zone = Zone – V
Zone factor (Z) = 0.36
Response reduction factor (R) = 5
Impact factor (I) = 1.5
Type of soil = Hard soil (or) Rock
Load combinations = 1. 1.5(D.L + L.L)
2. 1.2(D.L + L.L ±E.L)
Plot area = 35 x 35 $m^2$
Total height of building = 21 m
Total width of the building = 35 m

Time period $T_a = \frac{0.0\ *h}{\sqrt{D}} = \frac{0.0\ *2}{\sqrt{3}}$

$T_a = 0.319$ Sec

Base Shear $V_B = A_u \times W$

Where W = Total weight of building = 63623.015

Where $A_u = \frac{\left(\frac{S_a}{g}\right)Z}{2}$

$\left(\frac{S_a}{g}\right) = (0.10 \le T_a \le 0.55)$

$\left(\frac{S_a}{g}\right) = \frac{1}{T_a} = 3.130$

$A_u = 0.169$

Base Shear $V_u = 10753.56$ kN

## 2.1 STRUCTURAL MODEL

The building is modelled and designed as per IS 456:2000 in SAP 2000 v17. Structural responses are compared using Time History Analysis. The scope of the study restricts to the analysis of a moment resisting frame with fixed base and base isolated conditions using Time History Analysis.

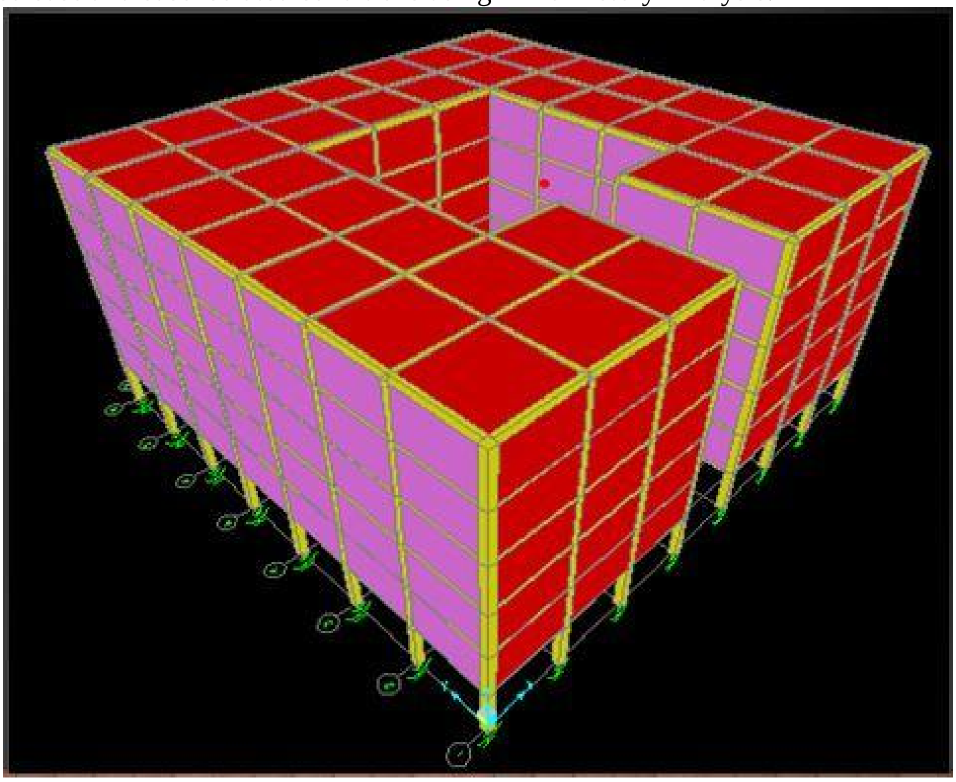

Fig 2.1: 3Dimensional view of isolation building

### 2.2 SELECTION OF EARTHQUAKE RECORD

The original earthquake records as shown in below figures. In this case two types earthquake records used. They are LUMJUNG (NEPAL-2015). The suggested earthquake records and other empirical values used the time history analyses are summarize in Table 2.1

Table 2.1: Earthquake Ground Motion Parameters

| Earthquake | Date | Epicenter | $M_W$ | PGA | Duration |
|---|---|---|---|---|---|
| Lumjung Earthquake Record | 25/04/2015 | Municipality office | 7.8 | 1.00 g | 2.20 min |

### LUMJUNG GROUND MOTION RECORD (NEPAL - 2015)

It was the worst natural disaster, and the ground motion recorded in Lumjung valley was of high frequency, with a magnitude 7.8 $M_W$ and a max Mercalli Intensity of IX (Violent).

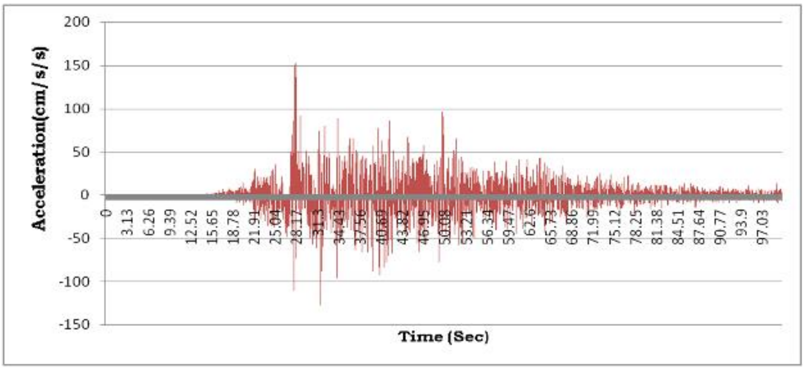


Fig 2.2: Lumjung Earthquake Ground Motion Record

### 3. ANALYSIS AND RESULTS

Time history analysis is carried out by structural models is analyzed in SAP 2000. For time history analysis, is done by Lumjung earthquake ground motion record. In this study, the comparison of fixed and base isolated building is done and analysis results are given in following tables.

### 3.1 BASE SHEAR (kN)

Table 3.1: Max BASE SHEAR (kN) at different types of buildings

| IS 1893:2002 (PART-1) | SAP 2000 software | | | |
|---|---|---|---|---|
| | Fixed isolator | Friction isolator | Rubber isolator | T/C friction isolator |
| 10753.6 | 15873.00 | 4656.62 | 4783.5 | 3833.87 |

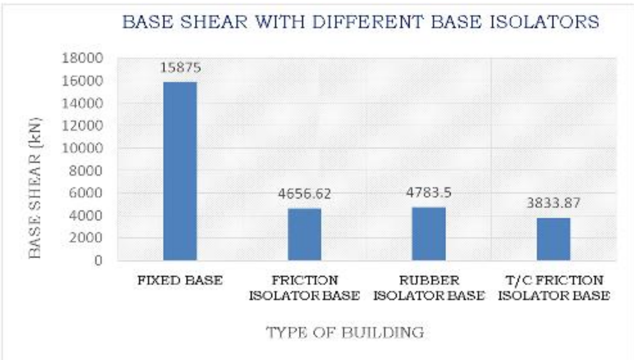


Figure 3.1: Max Base shear (kN) at Different Types of Buildings

### 3.2 DISPLACEMENT (mm)

Avg. Displacement of building with and without isolator for Lumjung earthquake

Table 3.2: Displacement (mm)

| Storey no | Fixed base Building | Friction isolator Building | Rubber isolator Building | T/c friction isolator Building |
|---|---|---|---|---|
| 5 | 689.6 | 31.72 | 33.69 | 31.73 |
| 4 | 682.3 | 31.67 | 33.63 | 31.67 |
| 3 | 674.7 | 31.61 | 33.57 | 31.61 |
| 2 | 665.4 | 31.51 | 33.47 | 31.52 |
| 1 | 656.2 | 31.44 | 33.39 | 31.44 |
| GROUND | 638.6 | 31.18 | 33.11 | 31.28 |

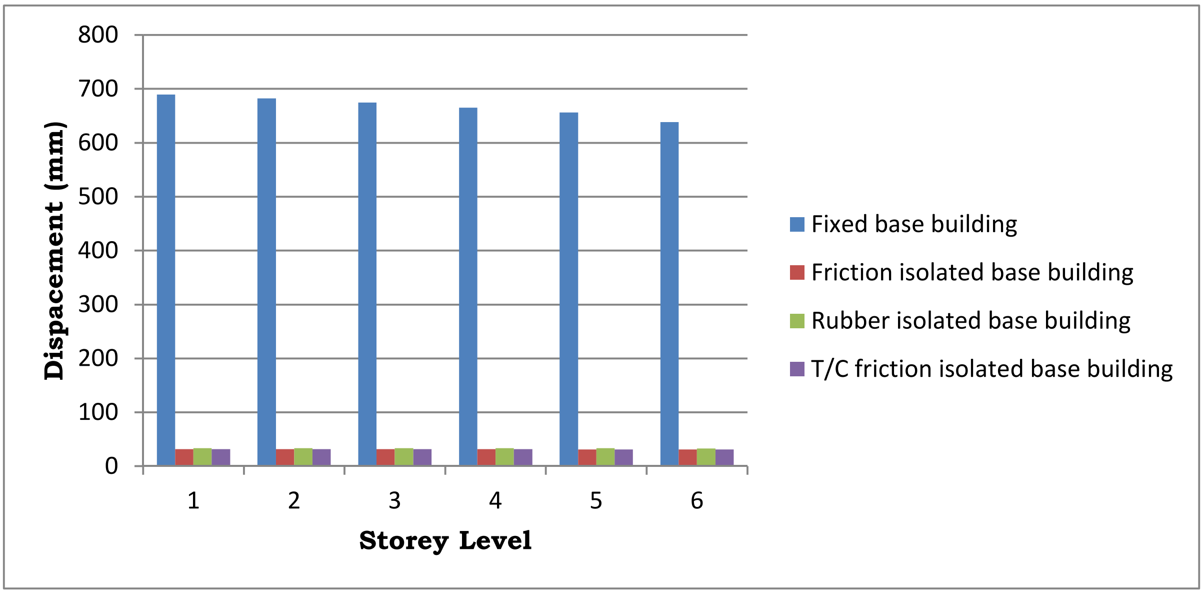


Figure 3.2: Max Displacement at different types of base isolated buildings (Lumjung earthquake)

### 3.3 FREQUENCY (Cyc/sec)

Table 3.3: Frequency values at different types base isolated buildings

| Modes | Fixed base building | Friction isolated base building | Rubber isolated base building | T/C friction isolated base building |
|---|---|---|---|---|
| 1 | 4.07 | 0.9965 | 0.985 | 0.0663 |
| 2 | 4.123 | 1.022 | 1.008 | 0.225 |
| 3 | 4.28 | 1.434 | 1.434 | 1.941 |
| 4 | 6.33 | 1.463 | 1.449 | 1.967 |
| 5 | 18.55 | 1.466 | 1.455 | 1.969 |
| 6 | 22.88 | 1.469 | 1.459 | 1.985 |
| 7 | 23.81 | 1.469 | 1.469 | 1.987 |
| 8 | 24.74 | 1.47 | 1.47 | 1.987 |
| 9 | 25.925 | 1.473 | 1.471 | 1.998 |
| 10 | 27.388 | 1.475 | 1.472 | 2 |
| 11 | 28.32 | 1.475 | 1.475 | 2 |
| 12 | 28.86 | 1.478 | 1.475 | 2.01 |

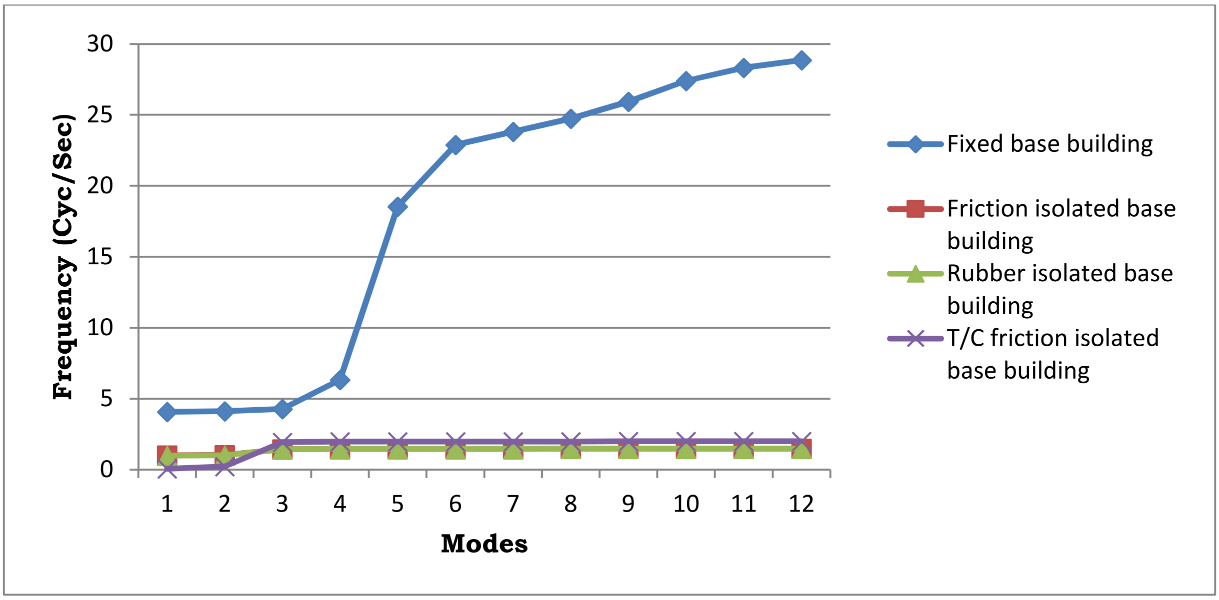


Figure 3.3: Frequency at different types of base isolated buildings

## 4. CONCLUSION

- The result of study shows that the structure response can be reduced by using base isolation system.
- The base isolation reduces the base shear when compared to without base isolation building.
- A base isolation building, displacement is less, when compared to without base isolation building. For fixed base building displacements vary significantly from bottom to top storey. But for base isolation building displacements are nearly same from bottom to top.
- Compared to fixed base building frequency is very less in base isolated buildings. So base isolation method is more sufficient method for seismic regions

## 5. REFFERENCE

[1]. Pankaj Agarwal & Manish Shrikhande, *Earthquake Resistant Design of Structures*, PHI Learning, New Delhi, 2010.

[2]. Design of seismic isolated structures from theory to practice by Farzad Naeim and James M. Kelly, Canada 1999.

[3]. Peng Hsiang Charng, ‘ Base Isolation For Multi storey Building Structures’, Ph.D Thesis, Dept. of Civil Engineering, University of Canterbury, Newzealand Dec 1998.

[4]. T. subramani, J. Jothi, M. Kavitha, an *“Earthquake Analysis Of Structure By Base Isolation Technique In SAP 2000”*

[5]. A.N Lin and H.W Shenton, *“Seismic Performance of Fixed–Base and Base–Isolated Steel Frames*”, ASCE, Vol.118, May, 1992.