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Seismic Performance of RC Structure with and Without Base Isolation System-A Review

Shamsuddin khan[1], Rayees Ali khan[2], Chhavi Gupta[3]

[1]*PG student, Department of Civil Engineering, Sharda University,*
[2] *PG student, Department of Civil Engineering, Sharda University,*
[3]*Assistant Professor, Department of Civil Engineering, Sharda University*

Abstract*— This research paper explores the seismic performance of reinforcement concrete structure with and without base isolation system. Earthquake is one of the utmost unpredictable natural inversions among all the natural disasters. The people who are living in prone areas they suffered acute disaster, significant loss of human life and their poverty during seismic ground motion. Many researchers have been experimented a several research to get the better solutions to diminish earthquake damage. Base isolation strategy is one of the biggest inventions to withstand or mitigate the structural damage under a strong ground motion. The seismic parameters are discussed such as base shear, lateral displacement, storey drift, time period, and frequency and results have been carried out by using various engineering softwares. The seismic analysis has been performed by Dynamic Analysis, and Pushover Analysis. It is observed that, base isolation system increases the stability of the structure and make structure economical.

***Keywords*— Earthquake, Base isolation, Natural Disaster, Mitigate Damage, seismic parameters**

I. INTRODUCTION

An earthquake is one of the utmost perilous natural hazards, which render to structure extreme damage especially prone areas, large scale loses of human life, and their poverty. Base isolation proves to protect serious inversion from the seismic forces [1]. Seismic isolations are successfully adopted for all vulnerability irregular and asymmetric structures to decrease dynamic loading when subjected into the structure [2]. The fundamental notion of base isolation is to withstand the structure from the extreme damage under a strong ground motion at the base. In addition to, it makes the structure more flexible during an earthquake which provides less damage of the structure [3-4]. Base isolation is also called as 'seismic base isolation' or 'base isolation system'. It is one of the biggest inventions and widely used globallyto defend or diminish the structure under an earthquake forces and mitigate the human life and their poverty [5-6]. The main aim of base isolation, when the structure with the fixed based support is stimulated by the seismic ground motion and allows ground motion transfer to the structure and therefore, structure may fails as opposed to base isolation decoupled the structure from the ground and hence reducestransfer ground motion to the structure and reduce the damage [7-8]. The application of flexible base isolation system can be extended natural period of a structure which is dominated period range under a strong ground motion and mitigate the response of the acceleration into the super structure [9]. Base isolation transfers fundamental lateral period, mitigate the energy in damping, diminish the lateral forces, and decrement collapse of structure. Seismic isolation allows stress-free support of the bulging in order to (a) it can rotate in all the direction, (b) deform in all direction, and (c) take horizontal forces [10]. Seismic isolation and energy mitigating are increased time period and the damping ratio of the structure which set up away from the ground [11]. When subjected to earthquake base isolation structure exists in the elastic stage and the non-linear behaviour is limited in seismic isolation devices [12]. Base isolation systems are utmost attentive when structure exist on stiff soil condition and structure with low-rise buildings. In addition to, rigid structures are especially well-performed with base isolation [13]. It is observed that, Indian construction practices are lacking to the application of base isolation in building construction sites [14]. At this moment, it is investigated that in India seismic isolation used a very few buildings. Seismic isolation Strategy has been arrived in India after the 1993 Killari (Maharastra) earthquake. Hereafter, Bhuj (Gujrat) Earthquake in 2001, the four (4) storeys Bhuj hospital building has been built with seismic isolation strategy [15]. Base isolation systems increment the seismic response of buildings such as inter-storey drift, shear forces, and floor accelerations are decreased as compare to fixed based structural system [16]. In one stage, initiatory designs and cost estimates have been uplifted for the fixed base and the isolated structure acted same behaviour measure and it is observed that 6% less expensive the solation design [23].

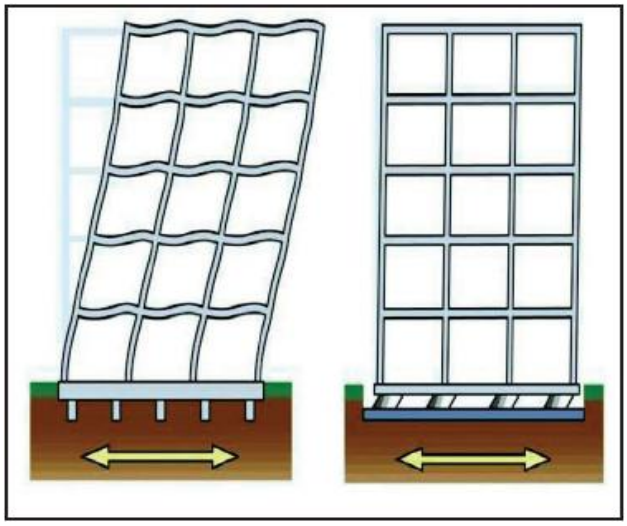

Figure 1. Behaviour of building with and without Seismic Isolation [6].

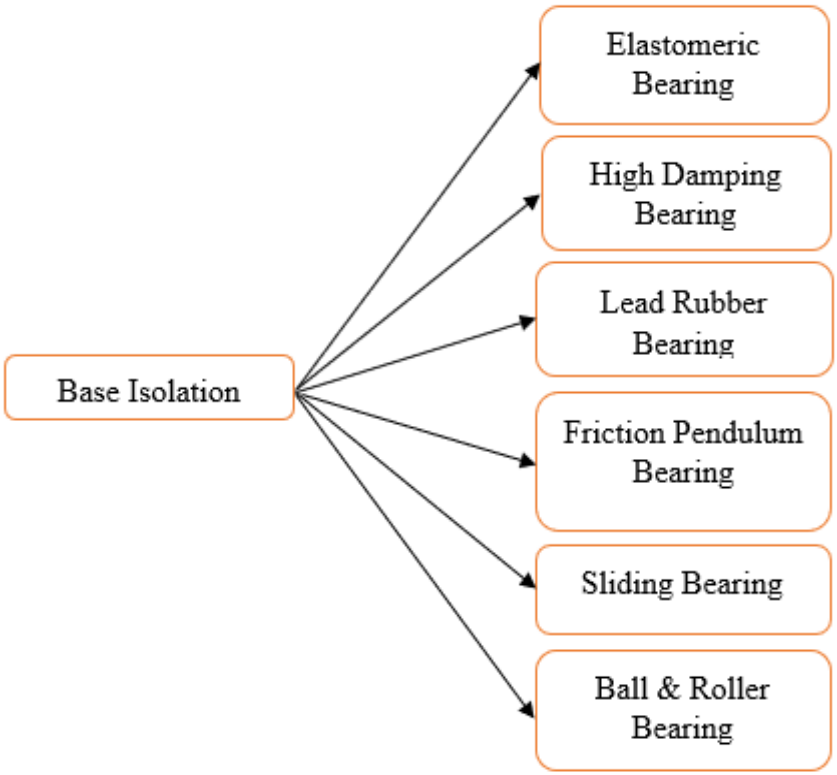

Figure 2. Various Types of Base Isolation Devices

2. LITERATURE REVIEW

2.1 Base Shear:

By use of base isolation system base shear reduce up to 45% as compared to the fixed base building [1]. The Base Isolators are found to better seismic control devices for structure and the base shear decreased about 64.53% for 5 stories building and around 85.98% for 15 stories Building [17].The building with isolated base manifests less base shear which around 43% diminish in X-direction and about 21% decrease in Y-direction as compared to the fixed base structure [10].The base shear reduced significantly by using a diverse type of seismic isolation namely friction isolation, rubber isolation, and T/C friction isolation than that of fixed base building. In addition to, Triple Concave (T/C) friction isolation elicits lower base shear (Figure 3) than others [18].

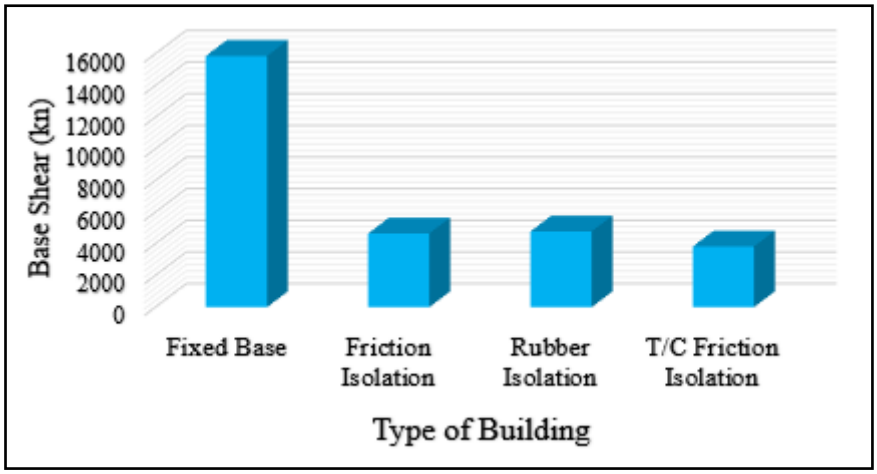

Figure 3. Max Base shear (KN) at Different Types of Buildings [18].

The base shear diminished by 45 percent by the using base isolated buildings (R2, IR1, IR2) as compared to the fixed based buildings (R2, IR1, IR2) [24]. The base shear decreased up to 70% in X-direction by use of HDRB & it decremented up to 94% by the use of FPS. Also, in Y-direction, it diminished by 71% in HDRB & in FPS it declined 85% [19]. From figure 4 it is observed that, the rubber bearing and friction pendulum induced significantly less base shear than others and their response is quite similar to each other. In addition to, friction pendulum and rubber bearing are efficient devices against earthquake [11].

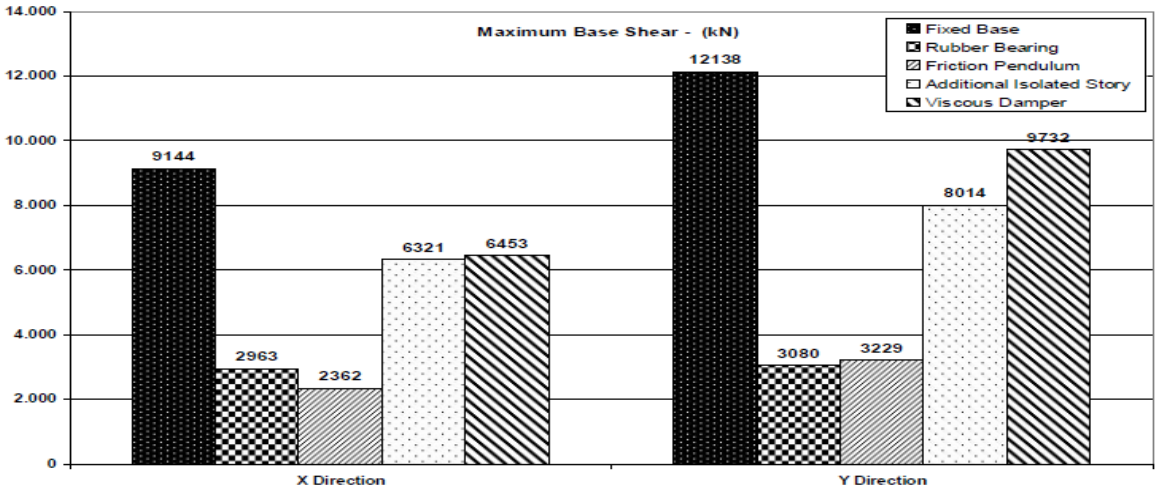

Figure 4. Maximum Base Shear in both X & Y directions [11].

2.2 Storey Displacement

Storey displacement is the lateral displacement of the storey relative to the base. In a time history analysis for EI Centro, the lateral displacement decreased around 35% at the top storey in 10 storeys with the fixed base structure, whereas the lateral displacement diminished approximately 36% in 10 storeys mass irregular structures [1]. It is noticed that, base isolation building induces maximum displacement at the top floor 32.4 mm as compared to fixed base induces 18.5 mm and base isolation makes the structure flexible under an earthquake [13]. For fixed building, the lateral displacements vary significantly from bottom to the top story of the structure over against base isolation building lateral displacement are nearly the same from bottom to top of the entire structure [18]. From the figure 5, it is observed that the storey displacement at the bottom storey is zero with fixed base building as opposed to with base isolation building induced amount of displacement at the bottom storey. Furthermore, as increase height of the storey also increases storey displacement and base isolation experiences higher displacement than that of fixed base building [17].

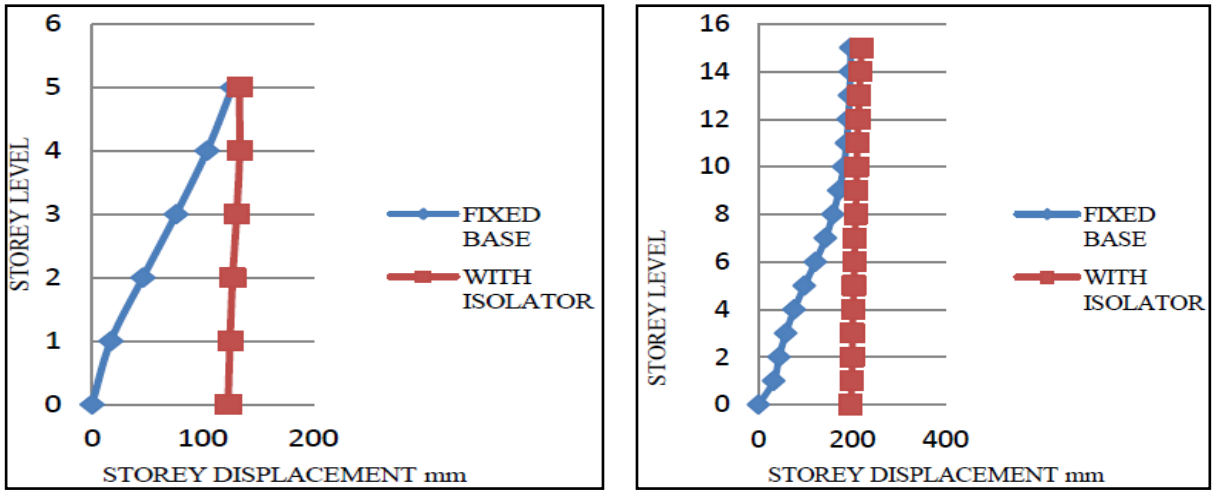

Figure 5. Storey Displacement In 5 & 15 Storeys Building [17].

From the figure 6, it is seen that the response of storey displacement with fixed base, Friction Pendulum System (FPS), and High-Density Rubber Bearing (HDRB) structures respectively. The storey displacement with fixed base building induces less than others and zero displacements at the bottom, whereas FPS& HDRB produce higher displacement than the conventional building which makes the structure quite flexible against seismic forces [19]. The storey displacement is very ignorable far field under seismic consideration as compared to the near field seismic motion in the ground both in X and Y directions [24].

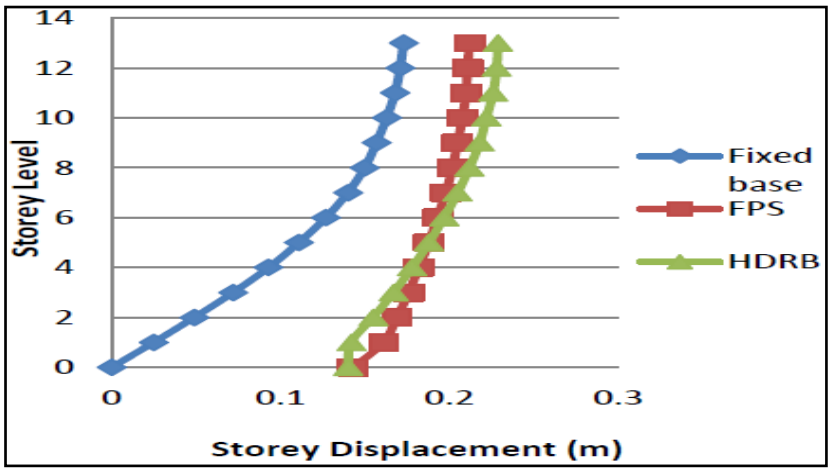

Figure 6. Storey Displacement with diverse Isolation & Fixed Base Structures ([19).

2.3 Story Drift

Thestorey drift is reduced such as 13%, 13%, and 15% at the height of 9 m of the structure for HDRB, LDRB, and LRB of the structure respectively and provides safe the structure [1]. Seismic isolation decrements the storey drift of the structure under an earthquake force as compared to the conventional base building [6 & 15]. By using seismic isolation, the storey drift reduces as the height of the storey increases which makes the building safer than that of fixed based against seismic forces [20]. Storey drift are significantly decreased both of rubber bearing and friction pendulum structures as compared to the other configurations [11]. It is noticed that the storey drift significantly diminished about 70-80% over against for near field earthquake decline only about 28% [12]. From the figure 7, it is observed that in storey 1 base isolation induced higher storey drift than that of fixed based structure, thereafter gradually reduce from storey 2 to storey 5 as compared to the conventional building and hence reduce the damage [13].

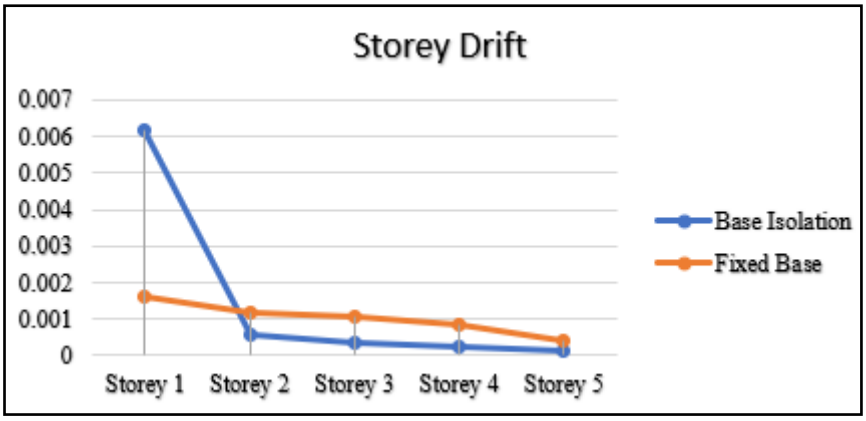

Figure 7. Variation of Storey Drift with Base Isoaltion & Fixed Base [13].

Fixed base building induced utmost storey drift than Friction Pendulum System (FPS) and High-Density Rubber Bearing (HDRB). Moreover, FPS induced minimal storey drift (Figure 8) than others which elicit more potential against earthquake [19]. The storey drift is reduced about 81.42% for 5 stories building and also diminished about 61.79% for 15 stories building [17]. The storey drift is very ignorable far field under seismic consideration as compared to the near field seismic motion in the ground both in X and Y directions [24].

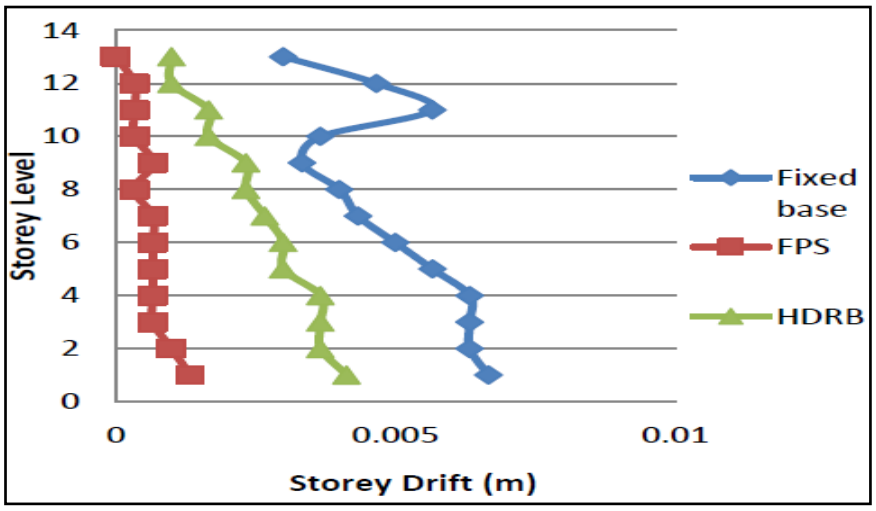

Figure 8. Variation of Storey Drift with a Diverse Base Isoaltion & Fixed Base [19].

2.4 Time Period

Seismic performances of the structure are reduced after using seismic isolation. Time period is increasing with base isolated structure which reduce the earthquake forces and transmit less forces to the superstructure. Variation of time period shows (Figure 9) fixed based and base isolated structure [4]. The principal goal of seismic isolation is shifted and improving time period under an earthquake and it observed that 36.5% time period increased with 1st modal as compared to fixed base [13].Seismic isolation building using High Density Rubber Bearing (HDRB) and Friction Pendulum System (FPS) induced utmost time period than fixed base building both in X and Y direction [19 & 21] . By using base isolation, the structure time period increments 2 times than that of fixed based structure and owing to improve the time period induce less seismic forces [22]. The reaction time of building is incremented when improve the modal period of the structure during seismic forces [20].

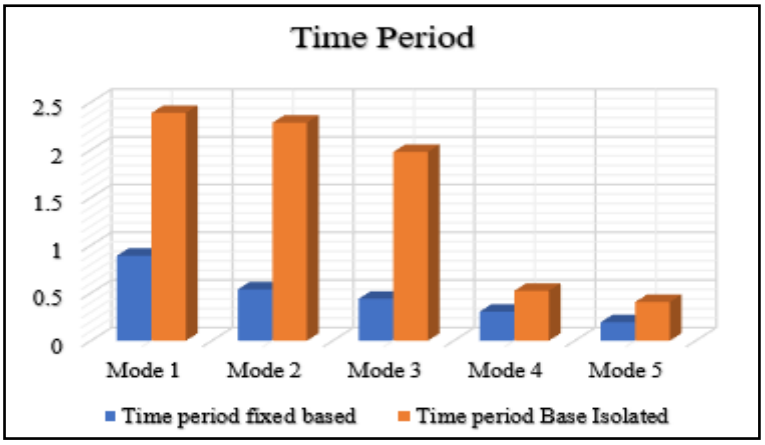

Figure 9. Variation of Time Period Fixed Based & Base Isolated [4].

Lead Rubber Bearing (LRB)and High Damping Rubber Bearing (HDRB) gives the utmost time period as compared to fixed base, x-bracing (B-X), and v-bracing (B-V) shown figure 10 [6]. The base isolation response more time period as compared to base by 5.699, 6.337, 6.895, 1.64, 1.766 times for modal 1 to 5 respectively and first 3 modes were showed higher and they soak more than 95% seismic persuaded load [8].

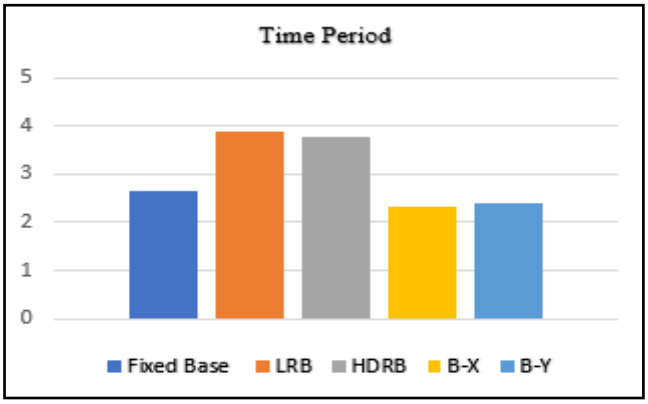

Figure 10. Time Period with Diverse Base Isolations & Fixed Based [6].

2.5 Frequency

Figure 11elicits fixed base building experienced more frequency and increases dramatically (Figure 11) as compared to base isolation systems. Therefore, seismic isolation is more potential for seismic areas [18]. When the frequency of seismic wave is considerably more, the seismic isolation structure considerably flexible and the 1st period is far from the experiences of period [25].

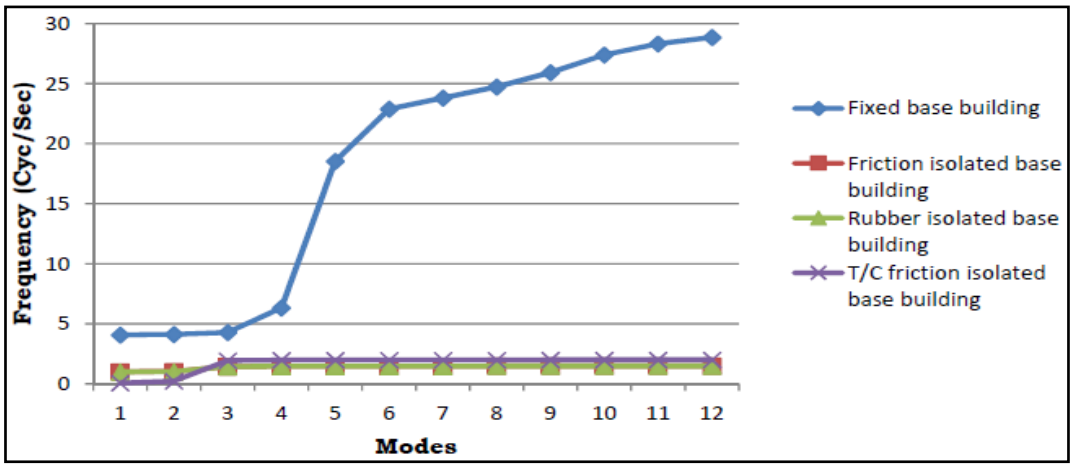

Figure 11. Variation of frequencies of Fixed Base & Base Isolated Building [18].

3. CONCLUSION

From above all the discussion, it can be accomplished about that by the use of base isolation strategy of the building the base shear significantly reduces as compared to the conventional building which provides more workable device against earthquake. In addition to, base isolation not only useful diminish base shear but also potentially decrease the storey drift and frequency of the structure which mitigates the structural damage. Furthermore, time period increases after using seismic isolation of the structure which shifts period to the structure to withstand the structure and also storey displacement increases which make the structure more flexible against earthquake. After the final analysis, it can be said that the base isolation system is the greatest strategy to save the structure from extreme seismic forces.

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