STUDY ON EFFECTIVENESS OF BASE-ISOLATION ON DIFFERENT STOREY HEIGHT FOR ASPECT RATIO

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Abstract : ***A large proportion of world's population lives under higher seismic risk region so there is a need of construction technologies which resist higher seismic forces and Base-isolation is such type of technology Base isolation system for building is introduced to decouple/isolate the superstructure of the building from potentially damaging due to earthquake motion. The main goal of this research is to find out of base isolation is to reduce the drift of the building. The present study is an attempt to understand the effectiveness of Base-isolation on different storey height for aspect ratio (H_B/L_B) of building. Four different height of building G+5 to G+20 every five incremental story has been taken. The effectiveness has been checked for aspect ratio (H_B/L_B) is 1 ($H_B=L_B$) . To avoid flexural behavior symmetrical building with Base isolation at the below the ground level in building was taken. The Building dimensions were restricted by Building aspect ratio (H_B/L_B). The response spectrum analysis of building without Base-isolation and with Base-isolation in Lead Rubber Bearing was carried out using ETABS® software. At the end, building response parameter Storey Drift was compared.***

IndexTerms – Base-isolation(LRB), Building aspect ratio, Different Storey Height, Response spectrum analysis, Storey Drift

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I. INTRODUCTION

Earthquakes are perhaps the most unpredictable and devastating of all natural disasters. They not only cause great destruction in terms of human casualties but also have a tremendous post-occurrence impact on affected areas. The overwhelming increasing population is the requirement of high rise building. A seismic isolation system is designed to separate a structure from its foundation soil at the time of an earthquake so that the size of external load on the structure is reduced by increasing the natural period of a structure through artificial means using seismic characteristics –strong short-period properties and weak long-period properties. Cases of application of such a system at general structures.

In this paper we will study about seismic behavior of different Building with Base-isolation in used Lead Rubber Bearing at aspect ratio ($H_B=L_B$), in this paper the measuring parameters for different height of building are top story drift is taken, the models are prepared and analyzed in Matrix based analytic software. To performed seismic analysis on model response spectrum method used.

To Study the different height of Building with Lead Rubber Bearing, we used the Lead Rubber Bearing at below the Ground level in building and total 8 model into this parametric study using into the 4 fixed base building model and 4 with Base-isolation building model with same aspect ratio.

II. PRESENT STUDY

To effectiveness of base isolated building is checked from G+5 to G+20 storey with every incremental five storey. Here for same aspect ratio R=1 different storey building effectiveness is checked by comparing fixed base and base isolated building. As the tendency (purpose) of base isolation is to reduce the drift of the building, so the storey drift of fixed base and base isolated building for varying storey height is compared. And the effectiveness of base isolation is decided based on storey drift parameter. Building data are same as mentioned in Building data except column sizes. Column sizes are decided by analysing and designing the model in ETABS by using response spectrum analysis.

Building Data

Grade of concrete = M 25
Beam size (m×m) = 0.4×0.5
Thickness of slab = 0.2 m
Thickness of shear wall = 0.25 m
Storey Height = 3.5 m each
Bottom storey height = 2 m
Live load = 2 kN/m^2
Dead load on slab = 1 kN/m^2
External wall load = 16.10 kN/m
Internal wall load = 8.05 kN/m
Parapet wall load = 2.3 kN/m

Table 1 Geometrical data of Buildings

No. of Story	Height of building (H_B) (m)	R=1 (H_B/L_B=1)	
		Length of building (L_B) (m)	Plan area of building (provided) (m^2)
G+5	23	23	20 X 20

G+10	40.5	40.5	40 X 40
G+15	58	58	55 X 55
G+20	75.5	75.5	75×75

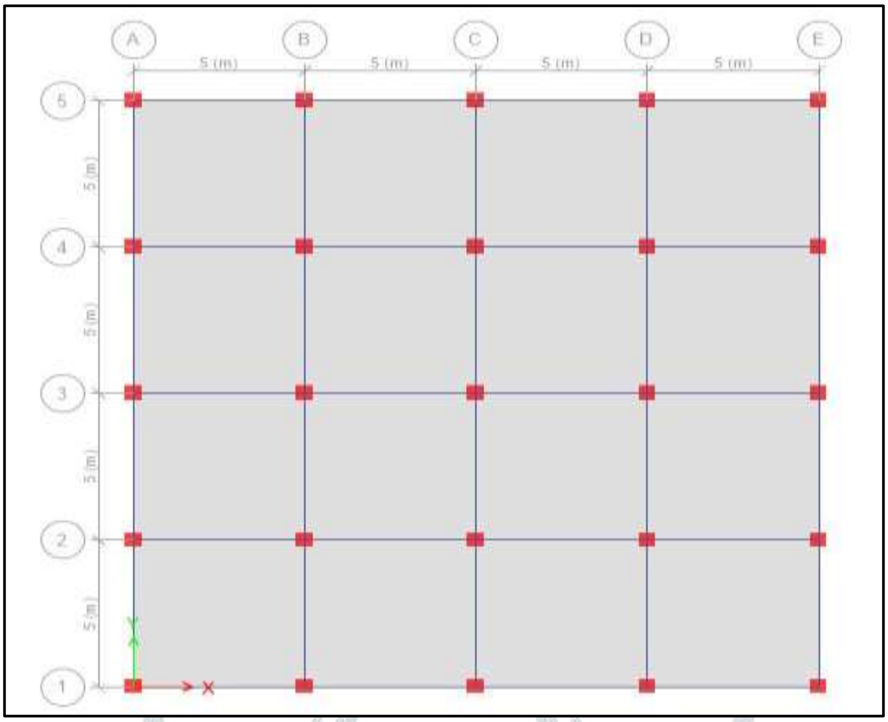

Figure 1 plan of G+5 storey building

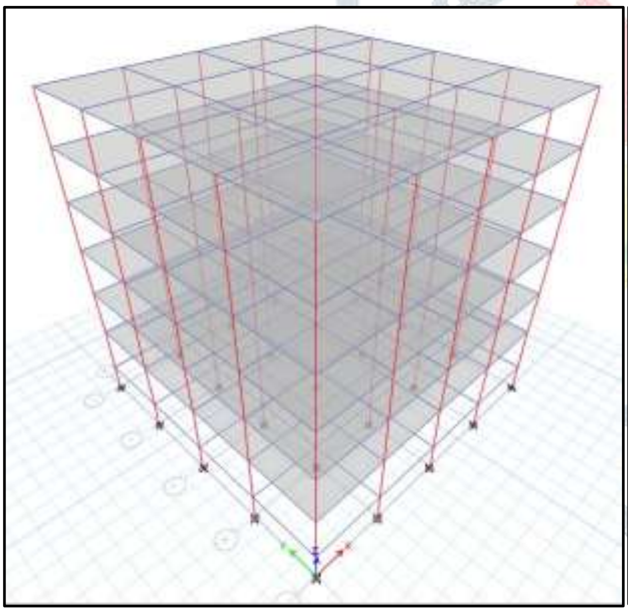

Figure 2 G+5 storey fixed base building

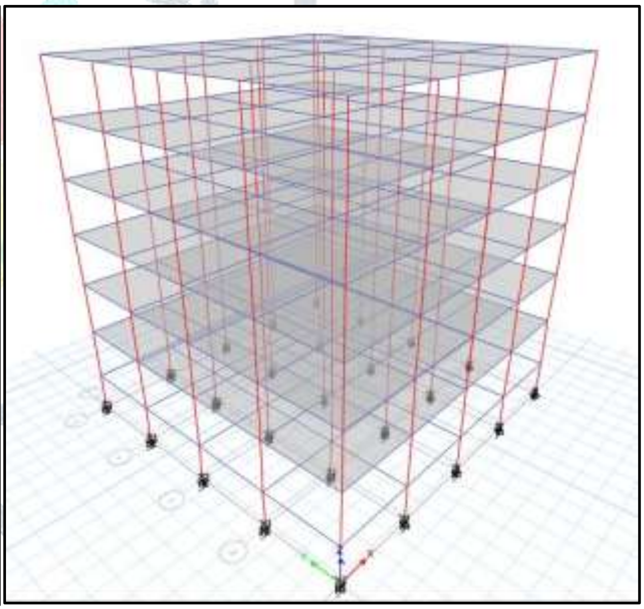

Figure 3 G+5 storey building with base-isolation

1. R=1, G+5 storey (20×20)
T_D=3 sec, P_{DL+LL} = 2315 kN, Col. Size (m)=0.4×0.4

Table 2 Properties of LRB for G+5 in ETABS

K_{eff} (kN/mm)	0.830
Q_d (kN)	32.413
K_r (kN/mm)	5.269
K_v (kN/mm)	532.203
β_{eff}	0.031
K_r^*/K_u	0.182

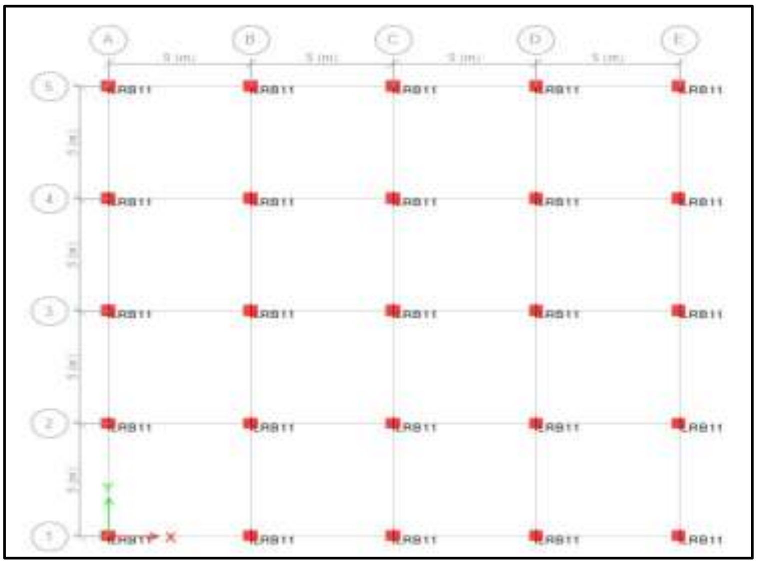

Figure 4 LRB at below ground level in G+5 storey building

2. R=1,G+10 storey (40×40)
T_D=3.5 sec, P_{DL+LL} = 4559 kN, Col.Size(m)= 0.55×0.55

Table 3 Properties of LRB for G+10 in ETABS

K_{eff} (kN/mm)	1.496
Q_d (kN)	68.167
K_r (kN/mm)	10.117
K_v (kN/mm)	649.680
β_{eff}	0.044
K_r^*/K_u	0.171

3. R=1,G+15 storey (55×55)
T_D= 4 sec, P_{DL+LL} = 6370 kN, Col.Size(m)=0.65×0.65

Table 4 Properties of LRB for G+15 in ETABS

K_{eff} (kN/mm)	2.2000
Q_d (kN)	114.5541
K_r (kN/mm)	14.8605
K_v (kN/mm)	960.8561
β_{eff}	0.0573
K_r^*/K_u	0.1713

4. R=1, G+20 storey (75×75)
T_D= 4.5 sec, P_{DL+LL} = 8597 kN, Col.Size(m)=0.75×0.75

Table 5 Properties of LRB for G+20 in ETABS

K_{eff} (kN/mm)	1.7068
Q_d (kN)	99.9800
K_r (kN/mm)	11.4051
K_v (kN/mm)	790.3525
β_{eff}	0.0702
K_r^*/K_u	0.1731

III. RESULTS

After the analysis of all models all are compared according to below parameters

Table 6 Storey Drift of G+5 building for R=1

Storey	Storey Drift		% Difference
	Fixed	BI	
Terrace	$6.78x10^{-4}$	$6.63x10^{-4}$	2.14
5^{TH}	$11.1x10^{-4}$	$10.98x10^{-4}$	1.02
4^{TH}	$14.30x10^{-4}$	$13.86x10^{-4}$	3.01
3^{RD}	$16.25x10^{-4}$	$15.48x10^{-4}$	4.70
2^{ND}	$16.95x10^{-4}$	$15.86x10^{-4}$	6.40
1^{ST}	$15.08x10^{-4}$	$13.45x10^{-4}$	10.77
GF	$5.84x10^{-4}$	-	-

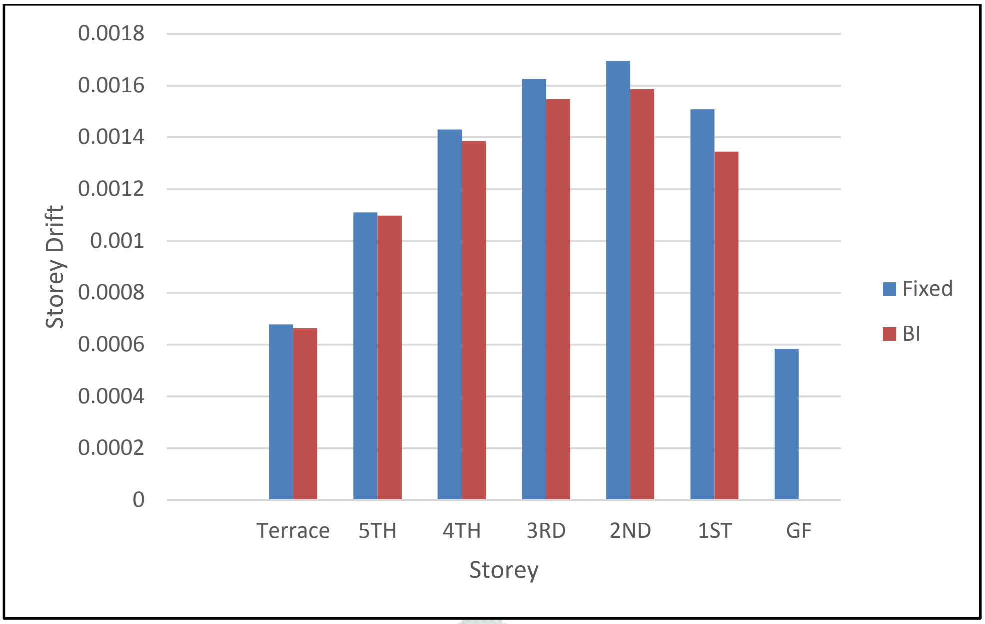

Figure 5 Storey Drift of G+5 storey building

Table 7 Storey Drift of G+10 building for R=1

Storey	Storey Drift		% Difference
	Fixed	BI	
Terrace	$8.39x10^{-4}$	$5.42x10^{-4}$	35.39
10^{TH}	$14.21x10^{-4}$	$8.86x10^{-4}$	37.62
9^{TH}	$19.39x10^{-4}$	$11.89x10^{-4}$	38.65
8^{TH}	$23.57x10^{-4}$	$14.38x10^{-4}$	38.95
7^{TH}	$26.82x10^{-4}$	$16.19x10^{-4}$	39.60
6^{TH}	$29.24x10^{-4}$	$17.57x10^{-4}$	39.90
5^{TH}	$30.95x10^{-4}$	$18.53x10^{-4}$	40.10
4^{TH}	$32.04x10^{-4}$	$19.17x10^{-4}$	40.14
3^{RD}	$32.57x10^{-4}$	$19.37x10^{-4}$	40.51
2^{ND}	$32.30x10^{-4}$	$32.18x10^{-4}$	40.60
1^{ST}	$28.42x10^{-4}$	$16.78x10^{-4}$	40.93
GF	$11.00x10^{-4}$	-	-

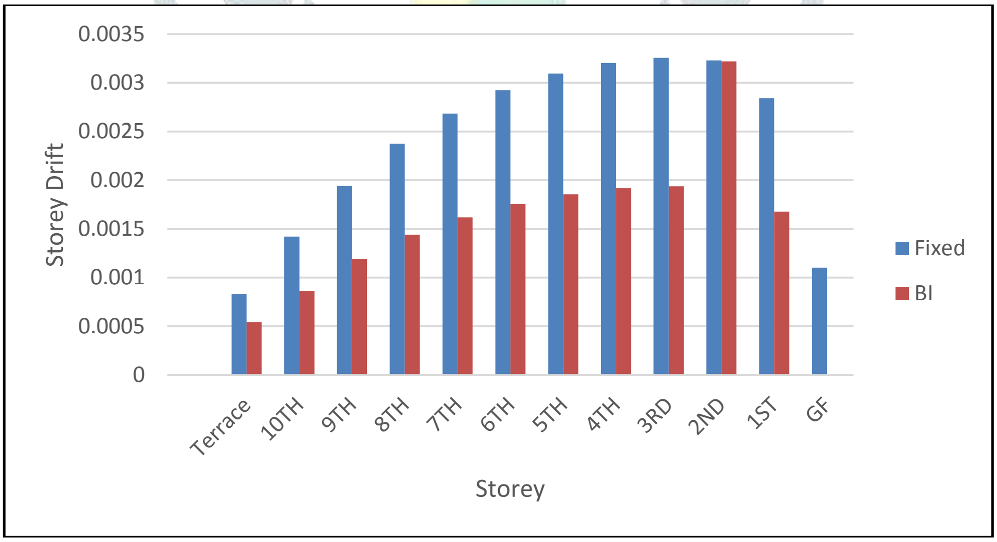

Figure 6 Storey Drift of G+10 storey building

Table 8 Storey Drift of G+10 building for R=1

Storey	Storey Drift		% Difference
	Fixed	BI	
Terrace	$8.39x10^{-4}$	$5.42x10^{-4}$	35.39
10^{TH}	$14.21x10^{-4}$	$8.86x10^{-4}$	37.62
9^{TH}	$19.39x10^{-4}$	$11.89x10^{-4}$	38.65
8^{TH}	$23.57x10^{-4}$	$14.38x10^{-4}$	38.95
7^{TH}	$26.82x10^{-4}$	$16.19x10^{-4}$	39.60
6^{TH}	$29.24x10^{-4}$	$17.57x10^{-4}$	39.90
5^{TH}	$30.95x10^{-4}$	$18.53x10^{-4}$	40.10

4TH	$32.04x10^{-4}$	$19.17x10^{-4}$	40.14
3RD	$32.57x10^{-4}$	$19.37x10^{-4}$	40.51
2ND	$32.30x10^{-4}$	$32.18x10^{-4}$	40.60
1ST	$28.42x10^{-4}$	$16.78x10^{-4}$	40.93
GF	$11.00x10^{-4}$	-	-

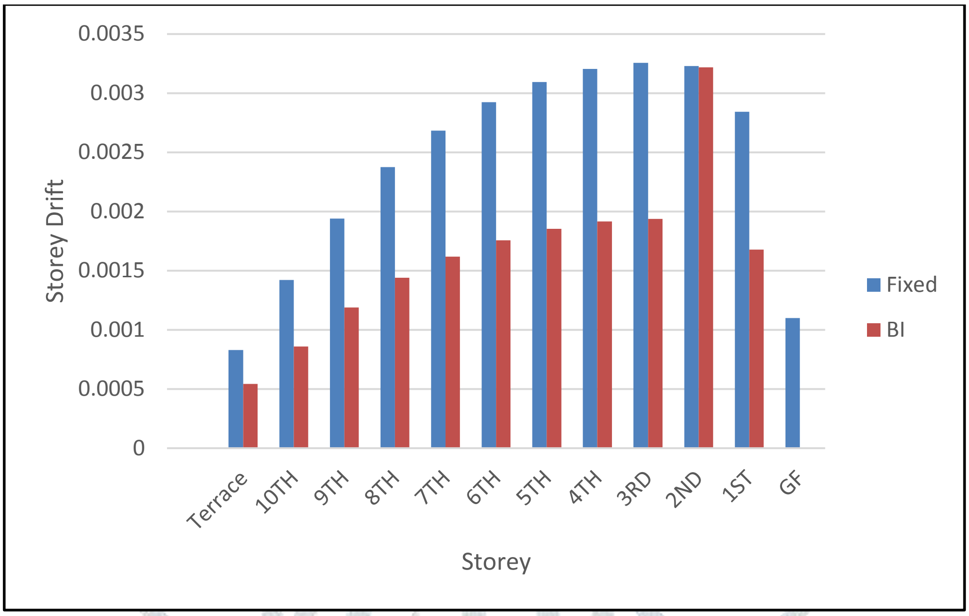

Figure 7 Storey Drift of G+10 storey building

Table 9 Storey Drift of G+15 building for R=1

Storey	Storey Drift		% Difference
	Fixed	BI	
Terrace	$7.94x10^{-4}$	$7.52x10^{-4}$	5.37
15TH	$13.14x10^{-4}$	$12.73x10^{-4}$	3.08
14TH	$18.05x10^{-4}$	$17.69x10^{-4}$	1.96
13TH	$22.34x10^{-4}$	$22.04x10^{-4}$	1.31
12TH	$26.01x10^{-4}$	$25.81x10^{-4}$	0.74
11TH	$29.11x10^{-4}$	$29.00x10^{-4}$	0.37
10TH	$31.68x10^{-4}$	$31.66x10^{-4}$	0.04
9TH	$33.76x10^{-4}$	$33.66x10^{-4}$	0.28
8TH	$35.39x10^{-4}$	$35.18x10^{-4}$	0.57
7TH	$36.63x10^{-4}$	$36.32x10^{-4}$	0.84
6TH	$37.52x10^{-4}$	$37.11x10^{-4}$	1.07
5TH	$38.10x10^{-4}$	$37.61x10^{-4}$	1.26
4TH	$38.41x10^{-4}$	$37.87x10^{-4}$	1.39
3RD	$38.45x10^{-4}$	$37.99x10^{-4}$	1.19
2ND	$37.83x10^{-4}$	$37.83x10^{-4}$	0.00
1ST	$33.28x10^{-4}$	$30.89x10^{-4}$	7.16
GF	$12.88x10^{-4}$	$7.52x10^{-4}$	-

Figure 8 Storey Drift of G+15 storey building

Table 10 Storey Drift of G+20 building for R=1

Storey	Storey Drift		% Difference
	Fixed	BI	
Terrace	$8.883x10^{-4}$	$9.6x10^{-4}$	7.47
20TH	$14.87x10^{-4}$	$15.63x10^{-4}$	4.83
19TH	$20.85x10^{-4}$	$21.59x10^{-4}$	3.41
18TH	$26.32x10^{-4}$	$27.02x10^{-4}$	2.56
17TH	$31.27x10^{-4}$	$31.90x10^{-4}$	1.97
16TH	$35.68x10^{-4}$	$36.24x10^{-4}$	1.53
15TH	$39.59x10^{-4}$	$40.07x10^{-4}$	1.19
14TH	$43.02x10^{-4}$	$43.41x10^{-4}$	0.89
13TH	$45.99x10^{-4}$	$46.31x10^{-4}$	0.68
12TH	$48.55x10^{-4}$	$48.78x10^{-4}$	0.47
11TH	$50.74x10^{-4}$	$50.87x10^{-4}$	0.24
10TH	$52.55x10^{-4}$	$52.59x10^{-4}$	0.07
9TH	$53.92x10^{-4}$	$53.98x10^{-4}$	0.10
8TH	$54.95x10^{-4}$	$55.08x10^{-4}$	0.22
7TH	$55.71x10^{-4}$	$55.90x10^{-4}$	0.34
6TH	$56.26x10^{-4}$	$56.49x10^{-4}$	0.40
5TH	$56.65x10^{-4}$	$56.86x10^{-4}$	0.37
4TH	$56.99x10^{-4}$	$57.03x10^{-4}$	0.06
3RD	$56.26x10^{-4}$	$56.90x10^{-4}$	1.11
2ND	$52.97x10^{-4}$	$55.75x10^{-4}$	4.98
1ST	$38.54x10^{-4}$	$49.35x10^{-4}$	21.90
GF	$30.56x10^{-4}$	$26.71x10^{-4}$	-

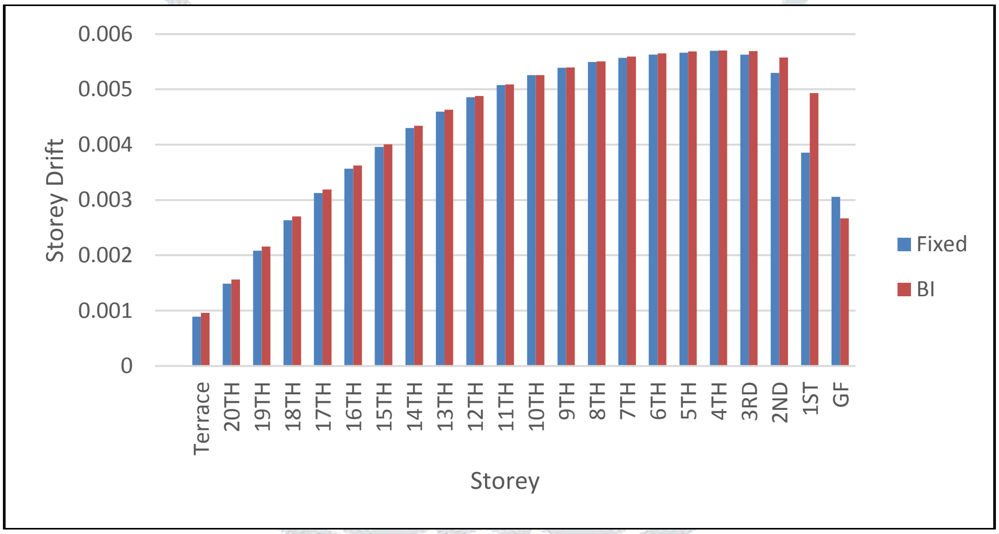

Figure 9 Storey Drift of G+20 storey building

IV. CONCLUSIONS

i) In G+5 to G+ 10 storey building storey drift is decreased at a higher rate 10 to 40%.

ii) The reduction of drift in G+15 storey building is about 4 to 9%.

iii) But in G+20 storey building storey drift is increased so, we can say that base isolation reduces its effectiveness. (3.89 sec time period of fixed base)

iv) So we can say that, the effectiveness of base isolation is maintained only up to G+15 storey building, now further study is limited to G+15 storey building.

V. ACKNOWLEDGMENT

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