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Response Spectrum Analysis of G+ 15 Story Building with and without Base Isolation System

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Abstract: ***In the study, three dimensional analytical models of G+ 15 story buildings have been generated and analysed using CSI ETABS software version 2016. The earthquake zone III in India is considered for buildings during analysis. The foundation of a building is a substructure through which the entire load of structure is transmitted to its underneath soil. Here, the analysis and design is done of G+15 story building with and without base isolation system. For the analysis in this paper, base isolation system lead rubber bearing (LRB) is used as it is most widely used as isolation system for buildings. Comparison of various parameters like story drift, story shear, story displacement, story stiffness and time period is done. The study shows that maximum story drift is observed at first story for isolated base as compared to fixed base; story displacements is observed linearly increasing with height of the building.***

Keywords: Lead Rubber Bearing (LRB), Base Isolater , ETABS 2016 Response spectrum analysis, story displacement, story shear, story stiffness.

I. INTRODUCTION

About 60% of portion of India is susceptible to damaging the structure levels of seismic hazards. The structure which do not withstand the seismic pressure might endure extensive damages, break or even collapse. In this study, the structural analysis of G+15 storyed reinforced concrete frame building with and without base isolation is done with the help of ETABS software. A response spectrum is simply a plot of the peak or steady-state response (displacement, velocity or acceleration) of a series of oscillators of varying natural frequency that are forced into motion by the same base vibration or shock. This approach permits the multiple modes of response of a building to be considered. Base isolation decouples the structure from ground motion by decreasing the fundamental frequency when compared to fix-based structure. This concept of base isolation makes the structure to remain elastic during an earthquake.

The present study is discussing that the dynamic response of the structure is provided by isolators in the base of the structure in hard soil(I) and discuss the seismic response such as story displacement, story stiffness, story drift, story force and time period. Analysis is been carried out as per the IS 1893:2002[6]. IBC 2000[11] and UBC 1997 Volume 2[12] code is used to calculate the design parameters of LRB base isolator.

A study on Design and Time History Analysis of High-Rise Building with Different Structures by M Babybai et.al.is done using ETABS software. In this paper it is found that story drift is maximum at first floor and zero at base and minimum at the top of the building.[1]

The research study on Seismic Analysis Of High Rise Buildings With Plan Irregularity by Albert Philip et.al.is done using ETABS software. In this paper it is found that Storey displacement is linearly increasing (approx. by 2%) from bottom to top for both the structures and is more for irregular structure.[2]

A research study of Comparison of analysis and design of regular and irregular configuration of multi-story building in various seismic zones and various types of soils using ETABS and STAAD by S.Mahesh et.al is done using ETABS and STAAD.

The conclusion drawn out from this paper is that Base shear value is more in the zone 5 and that in the soft soil in irregular configuration.[3]

A Study on seismic analysis of high-rise building by using software by B.P. Alone et.al. is done using STAAD pro v8i software. In this paper it is concluded that due to unsymmetrical of building geometry modes are not resisting 90 % as its satisfying in X direction successfully after carried out 300 iteration of analysis in such case cut off mode must be add in it & need to check either stiffness of building shall be increase or not.[4]

A Comparative Analysis of RCC and Steel-Concrete-Composite (B+G+ 11 Storey) Building is done by N.A.Mohite et.al. using ETABS software. The conclusion drawn out of this paper is that Still roof displacement and drift with earthquake in X and Y direction are less in Composite framed structure as to R.C.C. framed structure. This may be due to more ductility in case of Composite structure as compared to the R.C.C. which is best suited under the effect of lateral forces.[5]

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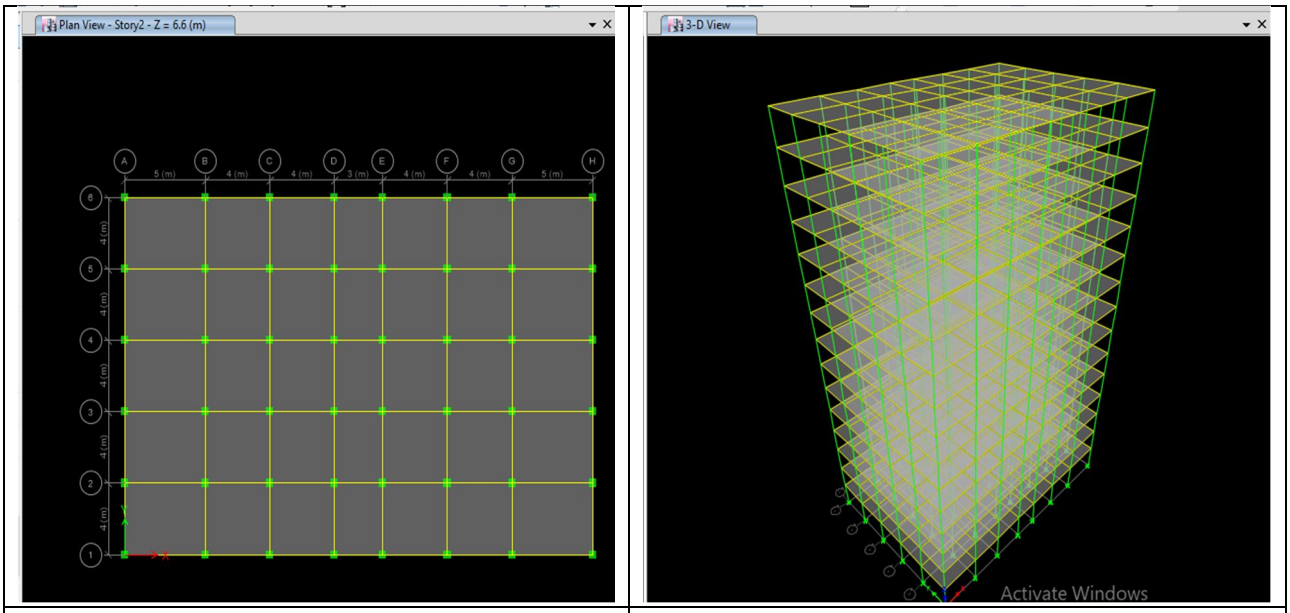
II. MODELLING AND ANALYSIS OF MULTI-STOREY BUILDING

The three-dimensional reinforced concrete structure is modelled and analysed in response spectrum analysis (RSA) using CSI ETABS version 2016 software to indicate the likely maximum seismic response of the said structure.

For the present study work, G+ 15 stories have been modeled. Material properties, section properties, base isolation characteristics[10] and loads are shown in Table 1.

Table 1 Input data

Grade of concrete	M30		Zone factor (Z)	III, 0.16
Grade of steel	Fe500		Soil Type	Hard Soil-I
Floor to floor height	3.3m		Response Reduction factor (R)	5.0
Dead Load	1.5kN/m^2		Importance factor(I)	1.0
Live Load	3 kN/m^2		Ecc. Ratio.(e)	0.05
Slab Thickness	150mm		Damping ratio	5%
Wall Thickness	230mm		Bearing Effective Stiffness	1675121.45kN/m
Column size	450mmx 450mm		Yield strength	77.314kN
Beam size	300mm x 450mm		Stiffness of LBR	15435.57kN/m



Plan | Elevation

Fig.1 Geometric of G+15 storied reinforced concrete frame model in CSI ETABS

Fig.2 Flow process adopted for analysis of the

III. RESULTS AND DISCUSSIONS

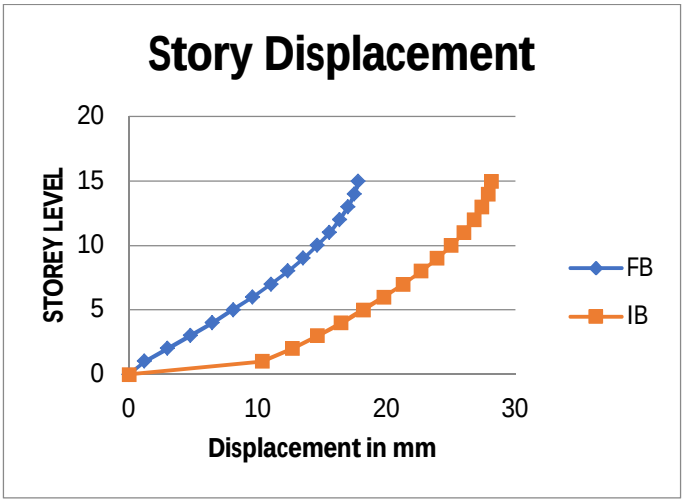
Following are the results of analysis. Comparison of parameters mentioned is tabulated in following tables.

A. Story Displacement

Table 2 demonstrates the maximum displacement of isolated base and fixed base carried out by response spectrum analysis (RSA) for fixed base(FB) and isolated base(IB). The results of isolated base model shows that at top floor as compared with the fixed base condition produces 28.181mm and 17.826mm displacement with 36.74% difference.

Table 2 Story displacement

Story	FB	IB	Difference
15	17.826	28.181	36.74
14	17.518	27.887	37.18
13	17.035	27.427	37.89
12	16.382	26.795	38.86
11	15.575	25.998	40.09
10	14.627	25.044	41.59
9	13.548	23.94	43.41
8	12.349	22.695	45.59
7	11.037	21.318	48.23
6	9.618	19.816	51.46
5	8.098	18.199	55.50
4	6.483	16.473	60.64
3	4.779	14.642	67.36
2	2.996	12.682	76.38
1	1.204	10.329	88.34
Base	0	0	0



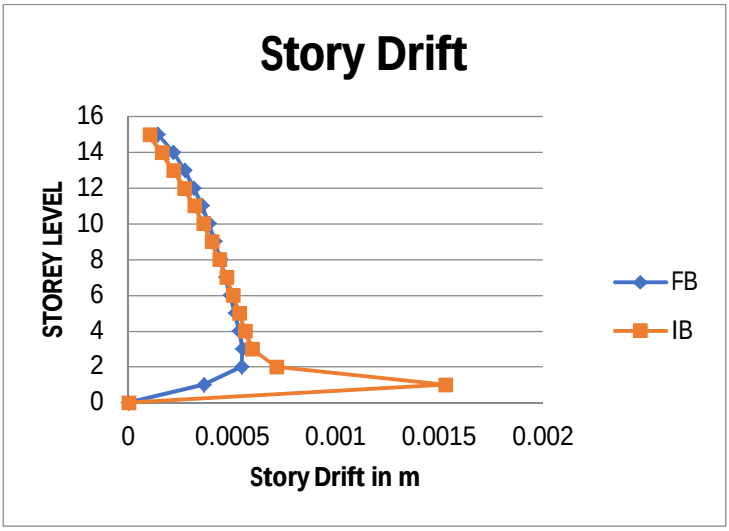
Graph 1. Story displacement

B. Story Drift

Table 3 demonstrates the maximum story drift occurs at story 1 in isolated base with a difference of 76.11% as compared to fixed base.

Table 3 Story drift

Story	FB	IB	Difference
15	0.000144	0.000102	-41.18
14	0.000218	0.000161	-35.40
13	0.000273	0.000218	-25.23
12	0.000317	0.00027	-17.41
11	0.000356	0.000318	-11.95
10	0.000389	0.000362	-7.46
9	0.000418	0.000402	-3.98
8	0.000445	0.000439	-1.37
7	0.00047	0.000474	0.84
6	0.000493	0.000505	2.38
5	0.000516	0.000535	3.55
4	0.000535	0.000563	4.97
3	0.000551	0.000598	7.86
2	0.000546	0.000714	23.53
1	0.000365	0.001528	76.11
Base	0	0	0.00



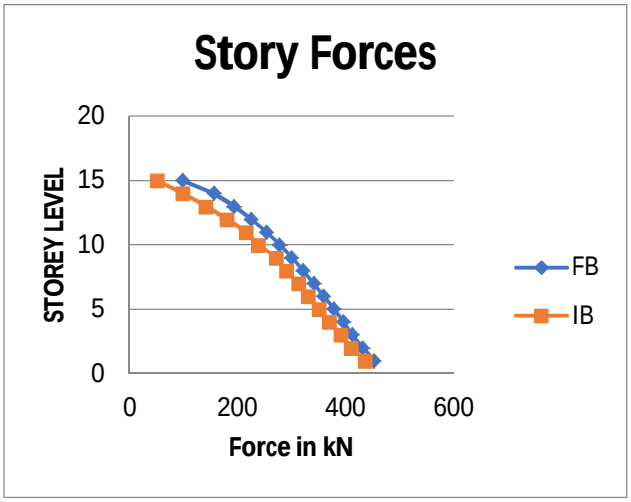
Graph 2. Story drift

C. Story Force

Table 4 demonstrates the story forces at first floor for fixed base and isolated base are 452.8151kN and 435.665kN respectively. It shows that there is 3.94% reduction in the story force of isolated base as compared to fixed base.

Table 4 Story forces

Story	FB	IB	Difference
15	98.3054	50.9353	-93.00
14	156.5172	98.7609	-58.48
13	193.6026	141.1829	-37.13
12	224.934	179.8223	-25.09
11	253.1747	215.4179	-17.53
10	277.7293	238.3384	-16.53
9	300.0012	270.9771	-10.71
8	321.059	290.6546	-10.46
7	340.7265	312.5168	-9.03
6	359.6017	330.6194	-8.77
5	378.4786	351.0761	-7.81
4	396.1188	370.0368	-7.05
3	412.2137	390.4866	-5.56
2	431.3854	410.3643	-5.12
1	452.8151	435.665	-3.94



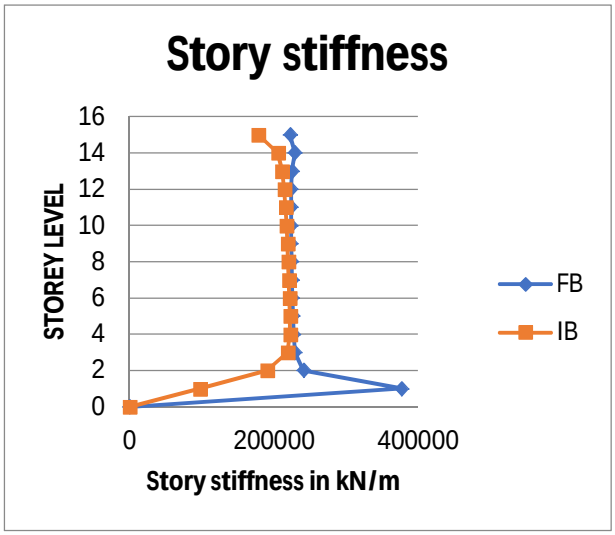
Graph 3. Story force

D. Story stiffness

Table 5 demonstrates the story stiffness. Story stiffness is more for fixed base condition as compared to isolated base.

Table 5 Story stiffness

Story	FB	IB	Difference
15	222722.02	178692.557	-24.64
14	229237.56	205866.172	-11.35
13	225428.17	211777.913	-6.45
12	224234.18	214619.633	-4.48
11	224125.14	216478.14	-3.53
10	224091.26	217855.43	-2.86
9	224292.16	218988.15	-2.42
8	224766.19	219998.805	-2.17
7	225263.56	220935.214	-1.96
6	225827.81	221805.464	-1.81
5	226661.65	222588.986	-1.83
4	227634.16	222745.303	-2.19
3	229544.73	219315.898	-4.66
2	241552.78	190600.714	-26.73
1	377622.76	97879.675	-285.80
Base	0	0	0



Graph 4. Story stiffness

E. Time Period

Time period for isolated base model is 5.154sec.and 3.942 sec. for fixed based model which is 1.31times higher than fixed base model.

Table 6. Time period

Base Type	Time period in sec.
Isolated Base	5.154 seconds
Fixed Base	3.942 seconds

IV. CONCLUSION

A. The maximum story drift is occurred at story 1 in isolated base with a difference of 76.11% as compared to fixed base.
B. The story displacement increases linearly in isolated base as compared to fixed base.
C. From seismic analysis, the story shear force was observed maximum at base (452.8151kN for fixed base and 435.665kN for isolated base).
D. The story stiffness is less in isolated base as compared to fixed base.
E. The time period in isolated base structure is 1.31times more than the fixed base structure.

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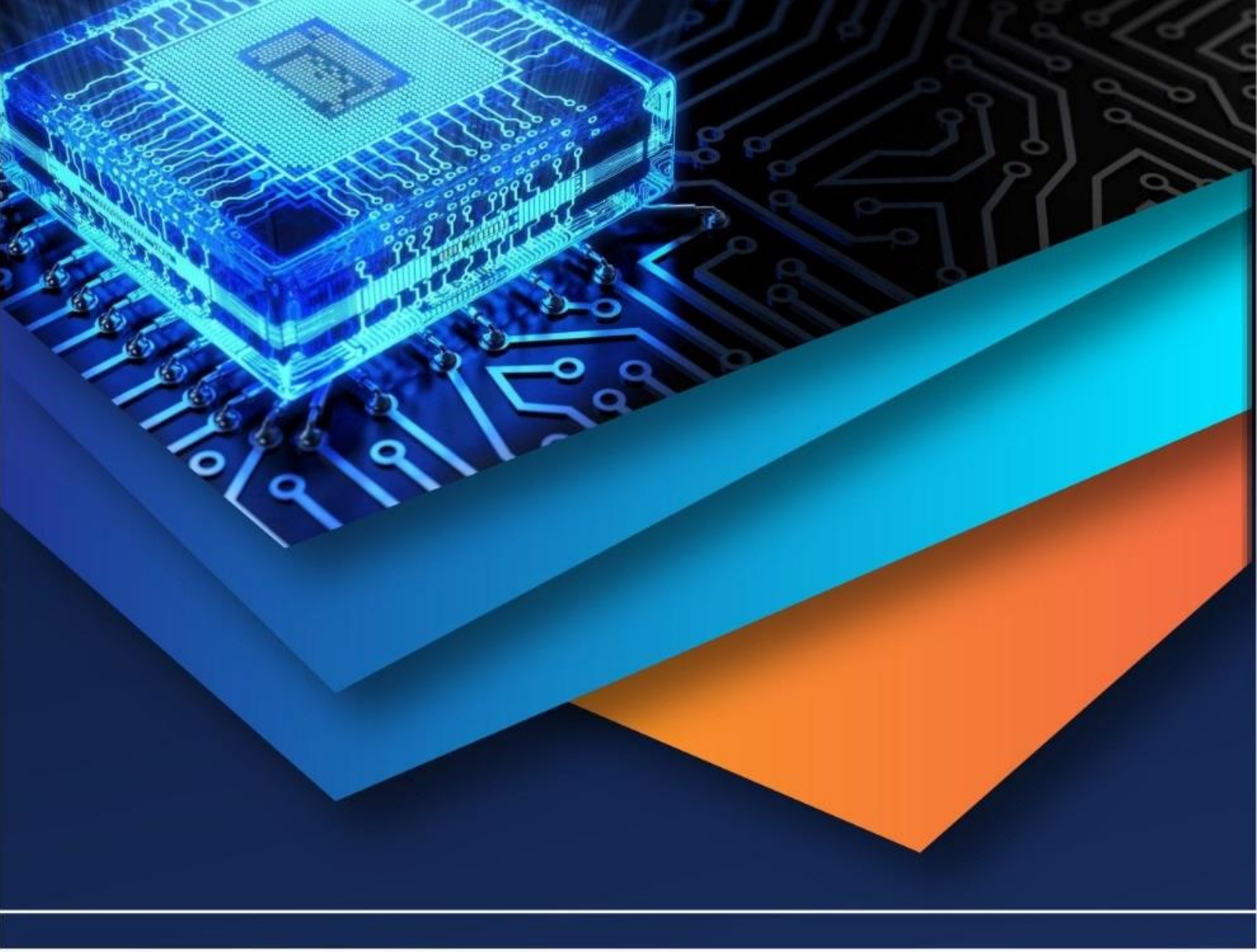

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