"SESMIC ANALYSIS OF RC MULTI STORIED BUILDING USING LEAD PLUG BEARING"

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Abstract - *The main objective of this project is to protect the buildings by designing it as earthquake resistant structure. Earthquake is one of major natural disaster in which many structures damage and collapse due to improper design against seismic motion. Earthquake also affects the economy of the nation, so essential proper measures of prevention must be developed. There are many concepts of designing a building as earthquake resistant structure; the concept used in this project is base isolation. There are many types of base isolation systems but lead rubber bearing (LRB) is used as base isolation system in this project, LRB is most widely used as isolation system for buildings*.

Key Words*: *Dynamic Analysis, lead plug bearing, seismic tremor, Linear Analysis, ETABS.

1.INTRODUCTION

In many tremors, the breakdown of structures like houses, schools, healing facilities, notable and open structures results in the across the board loss of lives and harm. Seismic tremors likewise annihilate open framework like streets, dams and extensions, and also open utilities like power and water supply establishments. Past seismic tremors demonstrate that more than 95 for every penny of the lives lost were because of the breakdown of structures that were not quake safe. In spite of the fact that there are construction laws and different controls which make it required that all structures in tremor inclined ranges in the nation must be inherent agreement with seismic tremor safe development strategies, new developments frequently disregard strict consistence to such directions and construction laws. Countless in India have been built without due thought to tremor loads. Further, the seismic tremor burdens are likewise under consistent update in progressive modifications of codes. Structures likewise break down with time and get harmed because of seismic tremor, surge, fire, impact, and so forth. Every one of these circumstances require assessment and retrofitting of existing building.

1.1 Introduction to base isolation systems

Seismic isolation also known as base isolation is an earthquake resistant design concept in which a building is decoupled from the earthquake ground motion or seismic waves. When a building is decoupled from ground motion it significantly reduces response in the structure which would have affected building if it is fixed base. Base isolation decouples the building from ground motion by decreasing the fundamental frequency when compared to fix based building. This concept of base isolation also makes to remain building elastic during an earthquake. Base isolation concept is also used in bridges, nuclear power plants and liquid storage tanks etc

The earthquake resistant structures are divided as rigid and flexible structures. In rigid structures the inter-story displacements are reduced by providing diagonal bracings, shear walls, and using composite materials. In flexible structures the excitation input is reduced with the help of using dampers and Isolators. But in rigid structures they result in large inter-storey drifts, due to which the building components and nonstructural components may get damaged even if the building is stiff during earthquake.

1.2 Lead-Plug Rubber Bearing (LRB)

LRB was first invented in 1975 in New-Zealand. The components of the LRB are lead plug, endplates, steel shims and rubber layers. The steel shims provide vertical stiffness to the LRB and layers of rubber provide lateral flexibility or horizontal stiffness. Lead core of the LRB gives extra stiffness to the isolators and it also provides damping to the system. The LRB has four functions listed below:-

- Due to its property of vertical stiffness it functions as load supporter
- Provide elasticity in horizontal direction due to the property of horizontal stiffness
- It has energy restoring capability
- As it has lead core it provides damping to the structure by deforming plastically
- It reduce ground acceleration of a structure by increasing the time period of vibration
- It can be easily installed since no separate damper is required

- It has low maintenance when compared to other types of isolators

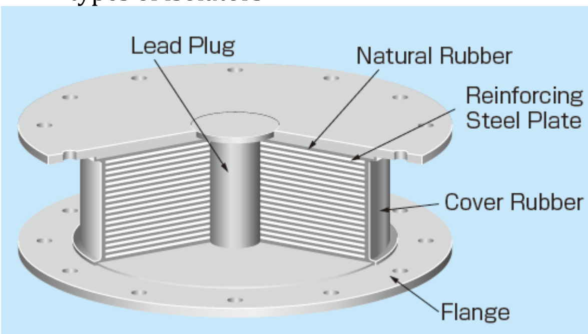

Fig -1 cross section of LRB

2. RESULTS AND DISCUSSIONS:

In this project work, the results are compared for fixed base and base isolated structure by dynamic analysis. Two methods of dynamic analysis were carried out they are Response spectrum analysis and Time history analysis. The results were compared for Story drifts, Base shear, Story shear, Point displacements and Mode shapes. Following are the four analyzed models for which the results are tabulated

2.1 ANALYSIS RESULTS

Table-1: Preliminary data.

Type of Structure	concrete
Grid data	Plan irregular geometric shape
Grid Spacing	4.5m in X-direction, 6m in Y-direction
Total dimension	36*54m
Grid Height	Uniform-3.15m
No. of Storey's	G+11
Material Properties	
Grade of steel	Fe415
Grade of concrete	M25
Poisson's ratio	0.2
Frame Section Properties	
Column	200*500
Beam	230*400interior, 230*500 exterior
Slab section Properties	
Slab	150mm
Static loads	
Self weight	Considered
Floor Finish	1KN/m^2
Live load	3 KN/m^2
Wall load	11.385KN/m^2
Earthquake load-ESA	Mass source considered

2.2 MODELS FOR ANALYSIS

Model 1: Response Spectrum Analysis with Fixed Base

Model 2: Response Spectrum Analysis with Lead Rubber Bearing

Model 3: Time History Analysis with Fixed Base

Model 4: Time History Analysis with Lead Rubber Bearing

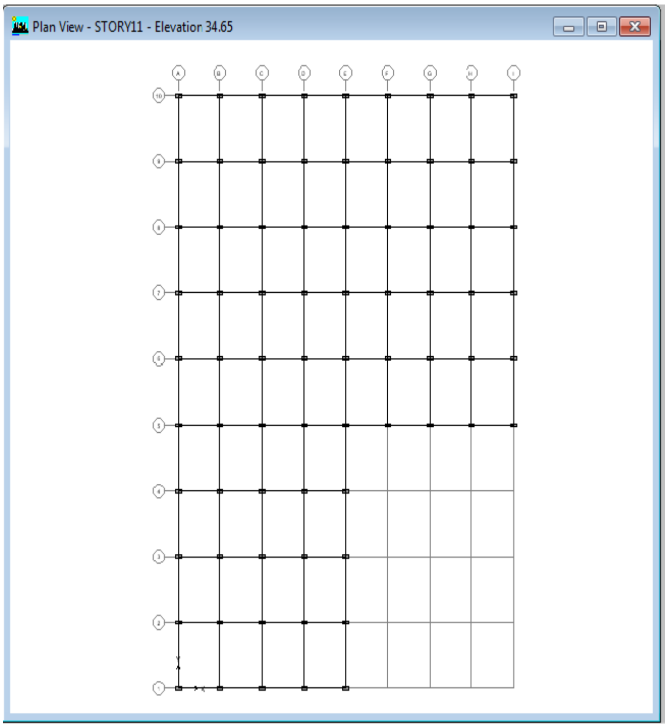

Fig- 2: Plan of building

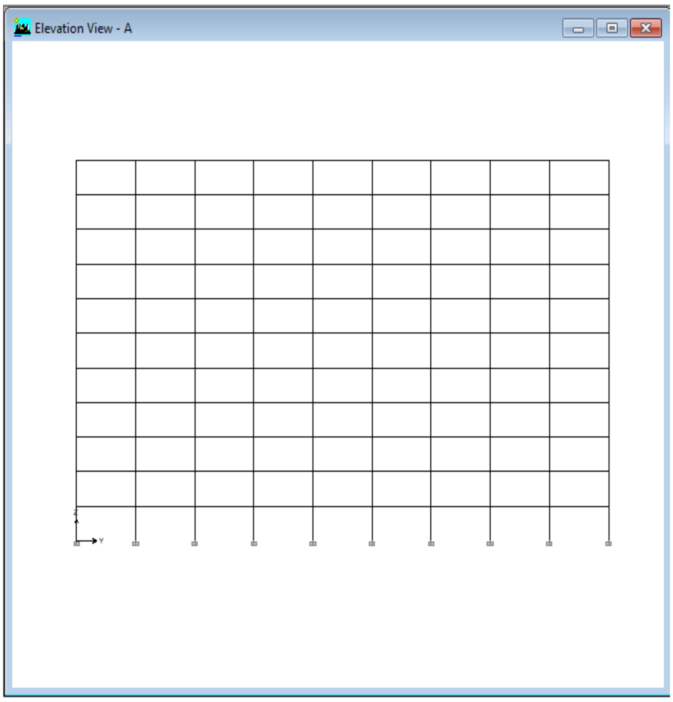

Fig-3: elevation along grid line -A

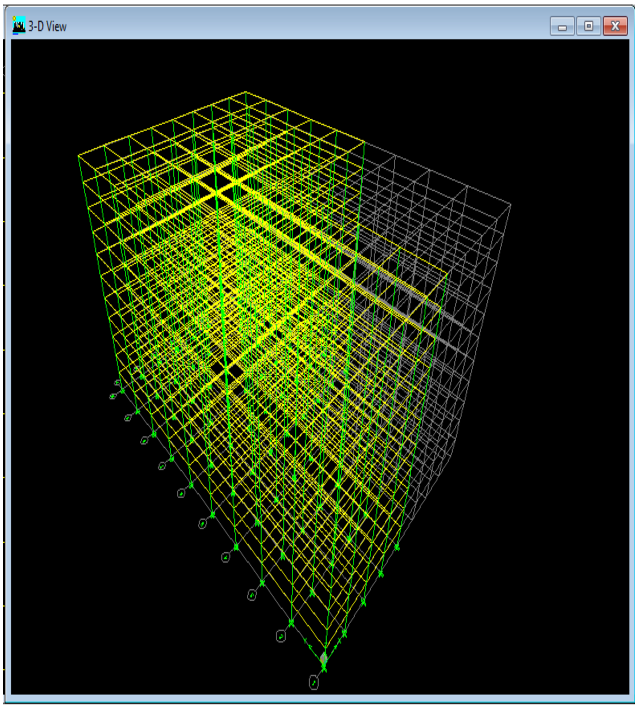

Fig-4: isometric view of model

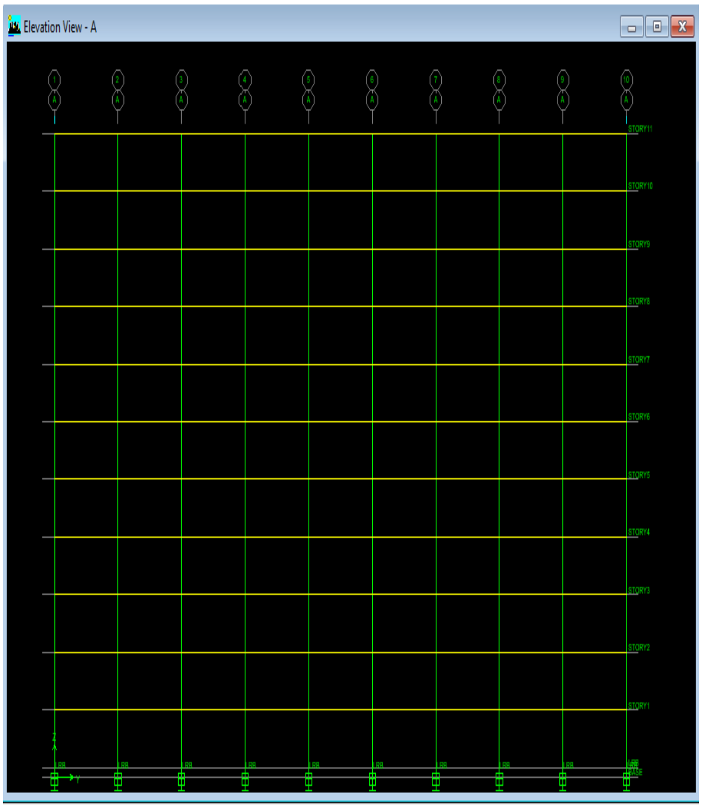

Fig-5: showing LRB above base in elevation view along YZ plane

2.3 Displacement

Table-2: Displacement of model 1 & 2

Point Displacement in m				
Type of model	Model 1		Model 2	
Story Number	U_X	U_Y	U_X	U_Y
Story 1	0.0024	0.0039	0.0188	0.021
Story 2	0.0068	0.0099	0.0238	0.0272
Story 3	0.0117	0.0158	0.0281	0.0321
Story 4	0.0165	0.0213	0.0318	0.0364
Story 5	0.021	0.0263	0.0352	0.0404
Story 6	0.025	0.0308	0.0382	0.0438
Story 7	0.0286	0.0347	0.0409	0.0468
Story 8	0.0317	0.038	0.0431	0.0493
Story 9	0.0341	0.0406	0.0449	0.0512
Story 10	0.036	0.0424	0.0463	0.0526
Story 11	0.0373	0.0436	0.0472	0.0534

Table-3:Displacement of model 3& 4.

Point Displacement in m				
Type of model	Model 3		Model 4	
Story Number	U_X	U_Y	U_X	U_Y
Story 1	0.0149	0.018	0.0503	0.054
Story 2	0.0391	0.0434	0.0609	0.0653
Story 3	0.0598	0.0639	0.0681	0.0709
Story 4	0.0758	0.0819	0.0732	0.0751
Story 5	0.0884	0.1008	0.0783	0.0773
Story 6	0.1028	0.1141	0.0838	0.088
Story 7	0.1113	0.1246	0.0917	0.0967
Story 8	0.1188	0.1434	0.0986	0.1062
Story 9	0.1257	0.1562	0.1034	0.1139
Story 10	0.1372	0.1632	0.1067	0.1203
Story 11	0.1504	0.1678	0.1089	0.1246

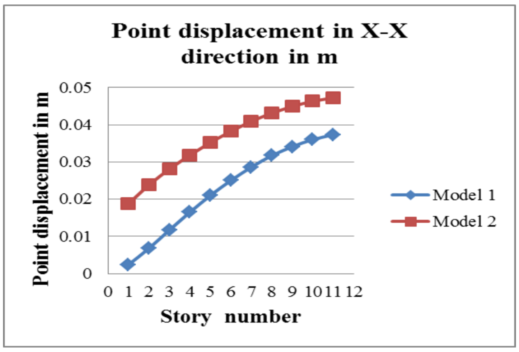

Chart-1: plotting displacement with stories

Discussion: In fig 5.4.1 it is observed that in model 2 point displacements in x-x direction are increased when compared to model 1 due to effect of lead rubber bearing. It is important that point displacements at bottom stories must be increased after providing lead rubber bearing at base. In story 1 of model 2 the point displacement in x-x direction is increased by 87% when compared to model 1, in story 6 of model 2 point displacement in x-x direction is increased by 34.55% when compared to model 1 and in story 11 of model 2 point displacement in x-x direction is increased by 20.97% when compared to model 1. From this it can be observed that lead rubber bearing increased point displacement at story 1 when compared to story 6 and 11, it can also be seen from results that efficiency of increase in point displacement in x-x direction goes on decreasing with increase in story level

2.4 Time Period

Table-4: Time period with respect to modes of structure

Mode Number	Mode direction	Type of model			
		Model 1	Model 2	Model 3	Model 4
Mode 1 in sec	Y direction	2.2002	2.886	2.2002	2.8862
Mode 2 in sec	X direction	1.6911	2.3703	1.6911	2.3708
Mode 3 in sec	Torsion	1.5942	2.2508	1.5942	2.2511

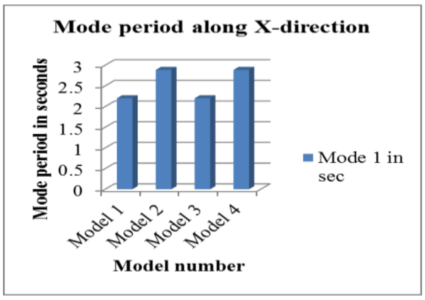

Chart-2: plotting modes with time period.

Discussion: The mode period of all four models are tabulated in table 4.5.4 below we can observe that model 2 and model 4 which are base isolated by providing lead rubber bearing at base have increase in mode period in all three modes when compared to model 1 and model 3 which are fixed base. Graphs are plotted for all three modes to compare all the models. Graphs are plotted with model number in x-axis and mode period in y-axis. Mode 1 increased by 24%, Mode 2 increased by 29% and Mode 3 increased by 30% in model 2 and model 4 (base isolated) when compared to model 1 and model 3 (fixed base).

2.5 Story Shear.

Table-5: Storey shears with respect to storey

Type of Model	Model 1		Model 2	
Story Number	V_X	V_Y	V_X	V_Y
Story 11	432.57	367.08	256.48	216.53
Story 10	803.46	663.27	505.44	422.93
Story 9	1077.24	877.14	720.61	597.5
Story 8	1283.37	1039.77	904.4	745.71
Story 7	1450.02	1167.99	1062.14	873.46
Story 6	1596.44	1281.26	1199.63	986.77
Story 5	1735.86	1386.71	1323.44	1089.31
Story 4	1874.67	1494.79	1439.55	1184.04
Story 3	2011.12	1602.19	1551.95	1274.1
Story 2	2121.38	1702.21	1662.16	1361.51
Story 1	2168.96	1760.89	1764.98	1443.3

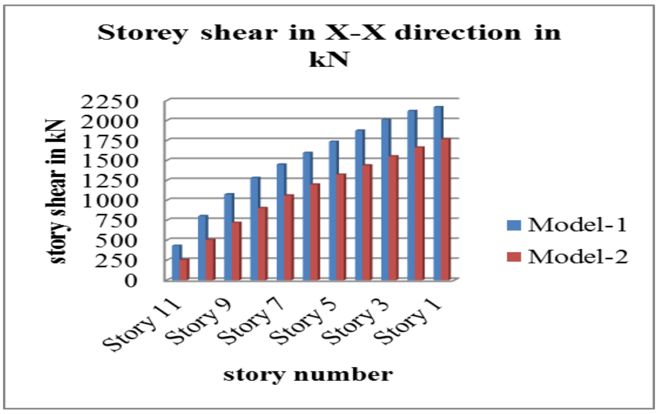

Chart-3: plotting storey shear with storey's

Discussion:

From fig 5.1.1 which are response spectrum analysis results it can be seen in model-2 (base isolated building) story shear in x-x direction were reduced significantly at each story when compared to model-1 (fixed base building). This means after the use of Lead rubber bearing as base isolator the story shear in x-x direction are reduced. The model-2 story shear in x-x direction at top story reduced by 40% when compared with model 1

3. CONCLUSIONS

Model 1 which is fixed base and Model 2 which is base isolated by providing lead rubber bearing these two models were analyzed by response spectrum analysis from these building models following conclusions can be made.

- Story shear reduced after the lead rubber bearing (LRB) is provided as base isolation system which reduces the seismic effect on building as shown in Fig 4.1.1 and Fig 4.1.2
- Base shear is also reduced after providing LRB which makes structure stable during earthquake as shown in Fig 4.2.1 and Fig 4.2.2
- Story drift are reduced in higher stories which makes structure safe against earthquake as shown in Fig 4.3.1 and Fig 4.3.2
- Point displacements are increased in every stories after providing LRB which is important to make a structure flexible during earthquake as shown in Fig 4.4.1 and Fig 4.4.2
- Mode periods are increased which increases reaction time of a structure during earthquake as shown in Fig 4.5.1, Fig 4.5.2 and Fig 4.5.3
- Finally it is concluded that after LRB is provided as base isolation system it increases the structures stability against earthquake and reduces reinforcement hence make structure economical.

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