

COMPARATIVE ANALYSIS OF IRREGULAR STRUCTURE WITH LEAD RUBBER BEARING AND FRICTION PENDULUM BEARING USED IN BASE ISOLATION STRUCTURES

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Abstract: Base isolation approach has become a critical segment to improve unwavering quality during a seismic earthquake. In now day by day's base detachment has become a relentlessly applied essential arrangement technique for structures and frameworks in significantly seismic zones in all viewpoint. The generally used separation system is Lead Rubber Bearing, Laminated Rubber Bearing and Friction Pendulum, channel Method, Pile Method and Damper part. Base separation is one of the most present day strategy and broadly acknowledged seismic insurance framework utilized in the structure in Earthquake inclined territories. The base detachment framework isolates the structures from its establishment and essentially moves it comparative with that of the super structure. The objective of this project is to comprehend the seismic exhibition of a G+10 unpredictable structure made of three distinct materials, for example, RCC, Steel and Composite with Lead Rubber Bearing (LRB) and Friction Pendulum Bearing (FPB) base isolation framework and to contrast the seismic reaction and without base isolation utilizing Response spectrum method in ETABS-2015 software. The reaction of the structure, for example, time period, base shear, story drifts and story displacements are studied and comparison is made. From this study it can also be concluded that it is better to provide isolation systems in seismic prone areas rather than providing fixed base and among two isolators used here FPB performs better than LRB for all the structures.

Keywords: - RCC, steel, Composite structures, Irregular, Response spectrum, Fixed, LRB, FPB base isolation, ETABS 2015.

I. INTRODUCTION

A. General

Earthquake are the normal calamity that happens because of the moving of plates or plate tectonics in earth's outside layer and has ended the lives of a large number of individuals all through the ages. These powers are exceptionally solid and stay for a brief length of time. In the earthquake plan of little and medium story structures, the quake power is a lot more prominent than the essential recurrence of vibration which means building goes about as an intensifier and the quickening experienced at each floor increments to the top. So the anxieties and understory floats increments in the part and the section gets harmed between the floors. At times the increasing speed makes more harm the substance and inhabitants

of the floors without making more harm to the structure. The increasing velocities can be diminished by making the structure progressively adaptable. Be that as it may, adaptability makes a few issues in the structure, for example, it makes breaks in the parcel dividers and windows may fall because of high wind power. Therefore in low to medium ascent structures the most ideal approach to accomplish adaptability is by utilizing base-seclusion technique. Consequently the use of adaptable gadgets in the flat bearing in the base of the structure lessens transmission of extreme seismic earthquake ground movements into the superstructure. In this manner to accomplish the wellbeing of structure against quake, there is a need to expand the seismic limit (obstruction) of the structure and to diminish the seismic interest (powers) on the structure. The sidelong quality and the horizontal solidness are the fundamental prerequisite of the seismic opposition. Specialists are required to choose a proper basic framework to oppose the parallel powers together with the gravity power, inside the useful and engineering imperatives. It is particularly fundamental that all the sidelong burden opposing auxiliary segments should be inflexibly associated. The seismic interest on the structure can be diminished by seismic change seclusion. The essential head of seismic separation is to adjust the reaction of the structure to allow the dispersals of vibration vitality or by base detachment. The fundamental guideline of base confinement is to lessen and control vibrations incited from seismic earthquake on any structures. The detachment framework diverts through the elements of the framework yet it doesn't ingest the vitality. In this undertaking "in addition to" formed arrangement sporadic structure is considered and here two kinds of base confinement frameworks are thought of one as, is Lead Rubber Bearing (LRB) and the other one is Friction Pendulum Bearing (FPB) base seclusion framework.

B. Base Isolation

Base isolation has become a old-style concept for structural design of buildings and bridges in high risk areas. By introducing flexible isolation system between the foundation and the structure the system will engross the shock impact effects of earthquake with the help of its flexibility. This way the seismic energy transmitted to the structure will be condensed to greater extent and the structure will remain steady for a relative period. The different types of isolators are prime factors used to introduce flexibility in the structure. Base isolation increases the elasticity of the structure and hence increases the period of the structure which is due to the isolators. By introducing base isolation in a structure increases the movement and eventually decreases the quickening in the structure as the stiffness of the structure also decreases. Generally, the isolation is placed at the base of the structure, Base isolation protects the building mechanisms of the superstructure during earthquakes.

C. Types of Base Isolators Used

1) Lead Rubber Bearing Approach: Lead Rubber Bearing or LRB may be a isolation which utilizes Heavy damping created by William Robinson, from New Zealand. Heavy damping segment utilized in vibration control progressions and containment contraptions, is seen as a big wellspring of smothering vibrations, improving a structure's seismic introduction. For withdrew structures having low bearing solidness anyway high damping, by then the "damping power" may transform into the essential pushing power at a robust tremor. The bearing is formed of versatile with a lead focus. In uniaxial test the bearing was under a full structure load. Various structures and expansions, in New Zealand and various spots, are guaranteed with lead dampers and lead and versatile heading.

The LRB having steel shims between flexible layers uses its flexibility to remain faraway from seismic waves. Through plastic mutilation, imperativeness is held from the vibrations. Its lead focus further disperses the imperativeness. The steel some portion of the LRB is treated as an elastoplastic material, the flexible as a hyperplastic material, and therefore the lead as a flexible elastic perfect model.

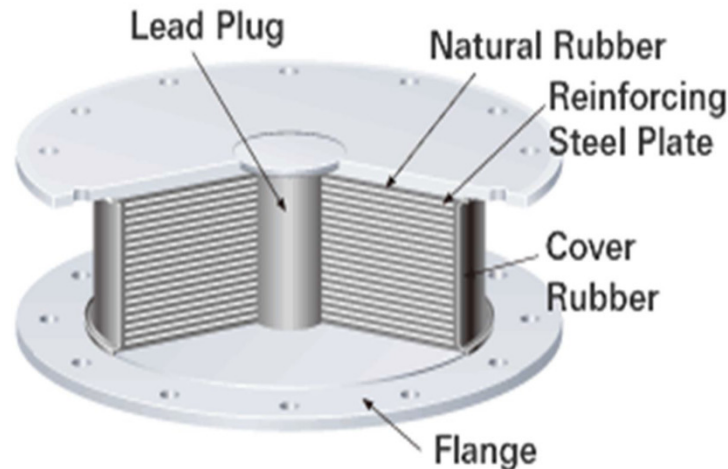


Fig.1:Lead Rubber Bearing

2) Friction Pendulum Approach:Friction Pendulum Bearing typeis one of the sort of isolation technique where the superstructure mechanism is segregated from the base foundation section using uncommonly arranged bended surfaces and heading. These permit impact under its ordinary period from the seismic scenarios. This examination presents progression of isolation framework truly showing the possibility of Friction Pendulum in the exploration office for seismic tremor designing investigation. Estimations are made of the responses of level of chance structure with and without detachment. These are then taken a gander at to no end and compelled vibrations using the quickening agents associated with the most elevated purpose. Speeding up ratio by the structure ischanging from 0.23g and 0.57g with and without separation, independently. The framework was seen as expanded by multiple times because of confinement. The seclusion framework indicated improvement in unique reaction of the model structure by diminishing the sidelong quickening and all the while expanding the damping of the system.

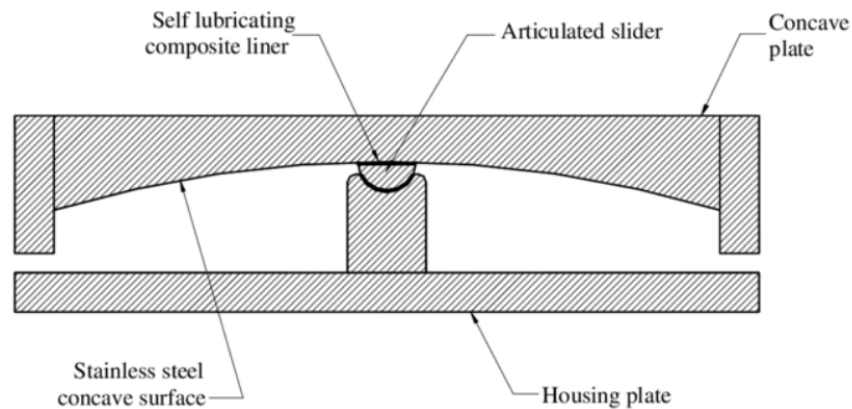


Fig.2: Friction Pendulum Bearing

D. Objectives of the Project

- 1) To study comparative analysis of Lead Rubber Bearing and Friction Pendulum Bearing Used in Base Isolation Structure
- 2) To study the behavior of structure with and without base isolation.
- 3) To study different techniques of earthquake resistance.
- 4) To study the response of the RCC, Steel and Composite structure with and without base confinement.
- 5) To know the good base isolation system for various structures.
- 6) The main objective of this project is to understand the seismic performance of a G+10 irregular building made of three different materials such as RCC, Steel and Composite with Lead Rubber Bearing (LRB) and Friction Pendulum Bearing (FPB) base isolation system
- 7) To compare the seismic response with and without base isolation utilizing Response spectrum method in ETABS-2015 software.

II. LITERATURE SURVEY

Masato Abe et al. Base-separation was more current plan idea to viably control the seismic reaction of common structures by lessening characteristic recurrence and increment damping, utilizing regularly heading made of elastic. In spite of the fact that it had applied to numerous • raised roadway spans, base detached scaffolds had not been presented to deplorable tremors. In this paper, seismic record in 1995 Kobe tremor acquired at an observed base-confined extension was broke down to examine its real seismic conduct and execution of the. The seismic exhibition base-separated extension was confirmed by quantitatively indicating the vulnerabilities related with both estimation and demonstrating.

Santi Nuraini et al. advanced nonlinear assessment in light rail travel (LRT) structures had gotten a handle on to survey the impact of seismic separation gadgets for lessening seismic interest. The evaluation utilized the utilization of two kinds of monetarily accessible heading, to be unequivocal lead flexible bearing (LRB) and breaking down pendulum structure (FPS). Six LRT structures, expected to be worked in Surabaya, were demonstrated utilizing PC helped programming SAP2000, where everything of the

three structures included three kinds of LRB and FPS set onto the dock top to empower the tons upper-fundamental to part. Nonlinear static sucker and dynamic time history assessment with seven improved ground advancement information was performed to extend improved bits of knowledge on the lead reaction of LRT structures, permitting one to completely value the extraordinariness of seismic detainments for confirming the structure against seismic activities. it's indicated that the 2 devices add up of the way to keep seismic forces, achieving facilitating of over the highest base shear occurring at the portion. Additionally, it had been conspicuous that the overall responses of LRB and FPS shows minor blunders, prescribing the 2 contraptions are tradable to be used for LRT-like structures.

N. Fallah et al. during this paper, a multi-target progress for the perfect game plan of sliding partition frameworks for covering of seismic reactions of building structures was introduced. due to the closeness of two or three parameters affecting the presentation of sliding base segregation structures, applying a comprehensive multi target improvement system is unavoidable. From this point forward, during this assessment, the acquired calculation is employed to get ideal estimations of isolator parameters; including coefficient of scouring was mass of base vessel and therefore the damping degree of the reestablishing power gadget. The reestablishing contraption, which was made out of a straight spring and an immediate gooey damper, was connected to the bottom burst so on limit the during-occasion and after-occasion sliding dislodging of the bottom pontoon. The concurrent minimization of the structure's top story evacuating and its accelerating, and additionally the bottom canal boat's development, was considered as far as possible. to satisfy as far as possible, a sensible and elitist Non-controlled Sorting Genetic Algorithm (NSGA-II) is employed to locate tons of Pareto-ideal approaches. The isolated structure was appeared as a shear-type structure having one sidelong level of chance at every story level. A ten-story building was utilized for the numerical evaluation and a get-together of seven seismic tremor records was considered for the assessment. The outcomes display that by applying the last course of action parameters obtained from the perfect qualities found by the NSGA-II approach appearing differently in reference to every individual record, the sliding isolator framework adequately covers the key seismic reactions. In like way, it's discovered that the reestablishing gadget with a perfect gooey damper may scarcely decrease the presentation of the separation framework, yet is unequivocally persuading in controlling the simplest base pontoon ejection and therefore the remaining base narrow boat dislodging.

Massimiliano Ferraioli et al. The paper manages the seismic retrofit of a substitute structure having a spot with the Hospital Center of Avellino (Italy). From the earliest starting point, the paper shows the starter appraisals, the in situ estimations and research office tests, and the seismic assessment of the energy fixed-base structures. Having thought about various procedures, base withdrawal end up being the furthermore fitting, in like way for the trustworthiness offered by the geometry of the structure to effectively make a parcel interface at the ground level. The paper displays the game plan experience, the improvement procedure, and the subtleties of the disconnection intercession. Some particular issues of base division for seismic retrofitting of different structure structures were had any kind of effect. At last, the seismic evaluation of the base-segregated structure was done. The seismic reaction was assessed through nonlinear time-history assessment, utilizing the striking Bouc-Wen model as the constitutive law of the partition course. For solid weighty assessments, a suite of typical accelerograms incredible with quickening spectra of Italian Code was first picked and sometime later applied along both even headings. The outcomes were at long last used to address a piece of the basic issues of the seismic reaction of the base-disengaged distinctive structure: unplanned torsional impacts and potential poundings during strong tremors.

Andrew S. Whittaker et al. Seismic disconnection was useful system for shielding success related atomic structures from the impacts of moderate to certified shiver shaking. In any case, seismic isolation had

been passed on in atomic structures in France and South Africa; it has not seen wide use due to restricted new structure atomic improvement in the previous 30 years and a nonappearance of rules, codes and measures for the assessment, plan and headway of detachment frameworks unequivocal to atomic structures. The financing by the United States Nuclear Regulatory Commission of an examination set out to the Lawrence Berkeley National Laboratory and MCEER/University at Buffalo upheld the synthesis of a bound to-be-passed on NUREG on seismic division. Supporting of MCEER by the National Science Foundation impelled get some information about things that give the specific motivation to another bit in ASCE Standard 4 on the seismic regulation of success related atomic work environments. The introduction needs perceived in the NUREG and ASCE 4 for seismic detachment frameworks, and superstructures and substructures are depicted in the paper. Vivacious numerical models fit for getting isolator practices under crazy loadings, which have been confirmed and embraced after ASME appears, and acknowledged in the open source code Open Sees, are presented.

Troy A. Morgan et al. Probably the hugest improvement in fundamental planning within the past 20 years has unmistakably been the advancement of execution based arrangement as techniques for selecting , proportioning, and building assistant structures to limit seismic excitations. this system was a perfect framework for structure in sight of its versatility concerning the choice of execution objectives, the depiction and propagation of both intrigue and block, and therefore the bigger treatment of defenselessness. a tremendous nature of the way of thinking is that introduction targets could also be portrayed almost like assistant execution, basic limit, budgetary examinations, and biological sensibility. This structure has the engaging component of giving an estimation of execution which will be completed by a good arrangement of system accomplices, including modelers, building owners, transitory laborers, assurance providers, capital endeavor proprietors, and open specialists. As assistant planners train their consideration on broadly described responses for the challenges displayed by maintaining and improving human headway, execution based structure will dynamically accept a central activity. This innovative method to manage arrangement demands the utilization of imaginative essential systems to realize the complex and potentially multi-target execution destinations envisioned by the varied accomplices. Given the weakness that's unavoidably present in any seismic tremor safe arrangement structure, innovative systems must not only be fit obvious response to deterministic data yet even be sufficiently solid to reply reliably to a good extent of potential data. Seismic isolation structures are undeniably fitting for execution inside an introduction based framework considering the way that: (an) energetic depictions of their direct are often made through experimentation, (b) the difference in watched lead from foreseen that was consistently low relative should normal helper parts, and (c) it'll generally be trying or maybe hard to realize an improved show objective without the utilization of seismic separation. Appeared differently in reference to standard helper structure for seismic restriction, disengagement gave an exceptional and powerful techniques for simultaneously reducing shake hurt in both distorting fragile and speeding up unstable parts. Execution based seismic arrangement of structures is at the present encountering imperative improvement thanks to results experienced in progressing shakes. Not simply has there been significant loss of human life in light of injury achieved by genuine seismic tremors, the cash related cost happening thanks to coordinate mishaps (fix of multinational , substitution of hurt substance) and winding setbacks (business aggravations, relocation costs, generation organize impedance) has moreover been imperative.

Ayman A. Seleemah et al. during this paper, the seismic responses of base-isolates sweeping and thin barrel molded liquid accumulating ground tanks were inspected. Three kinds of disconnection systems are considered. The seismic responses are differentiated and therefore the watching responses of non-bound tanks.

II. RESEARCH METHODOLOGY

The experimental model is analyzed using the software ETABS-2015. The methodology mainly discusses the method of analysis of structure and seismic investigation of fixed and base isolated structures.

A. Geometrical modeling:

The below table shows the details of the model used for the analysis and also seismic assessment is carried out as per IS 456:2000 and IS 1893 (section 1):2002 utilizing ETABS 2015 software.

Table -1 Details of the structure

Type of Frame	Special moment resisting frame
No of storey's	G +10
Storey height	3m
Height of the building	33m
No of flexural member	148
No of Compression	75
No of Slabs	64
Slab thickness	150mm
Wall thickness	230mm
Wall masonry	Brick
Steel grade	Fe345
Rebar grade	HYSD 415
Concrete grade	M25 Beam, M30 Column
Support conditions	Fixed, Base isolated

Table -2 Section Details

Structure	Column		Beam
RCC	600 * 600 mm		300*450mm
Steel	(Built up I section)		ISMB550
	Total Depth	900mm	
	Flange Width	500mm	
	Flange thickness	60mm	
	Web thickness	50mm	
Composite	600 * 600 mm (ISMB400)		ISMB350

Table -3 Seismic Data

Seismic Zone	III
Zone Factor	0.16
Soil type	Type II(Medium)
Importance factor	1.0
Response reduction factor	5.0
Damping of the structure	5%

B. Description of models

Totally 9 models is been considered for this study below describes the details of it,

1. Model 1: Response spectrum analysis of RCC structure with fixed base.

2. Model 2: Response spectrum analysis of RCC structure with LRB Isolator.
3. Model 3: Response spectrum analysis of RCC structure with FPB Isolator.
4. Model 4: Response spectrum analysis of Steel structure with fixed base.
5. Model 5: Response spectrum analysis of Steel structure with LRB Isolator.
6. Model 6: Response spectrum analysis of Steel structure with FPB Isolator.
7. Model 7: Response spectrum analysis of Composite structure with fixed base.
8. Model 8: Response spectrum analysis of Composite structure with LRB Isolator.
9. Model 9: Response spectrum analysis of Composite structure with FPB Isolator.

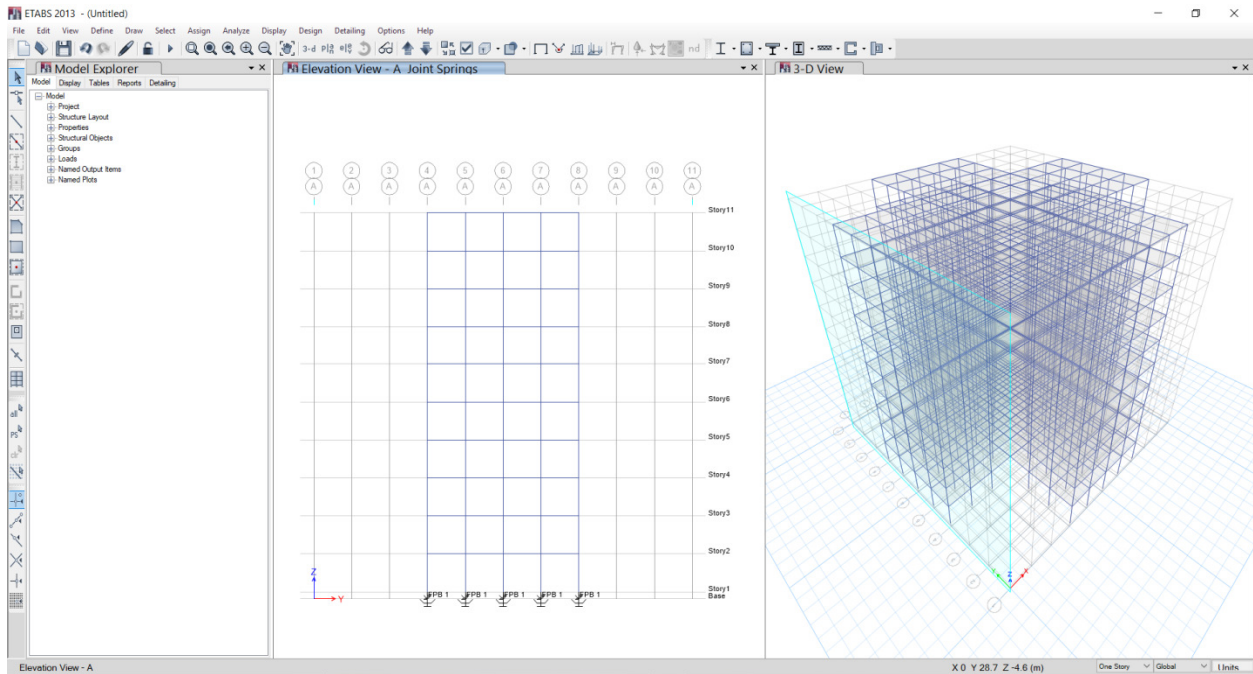


Fig.3:Elevation view of the models

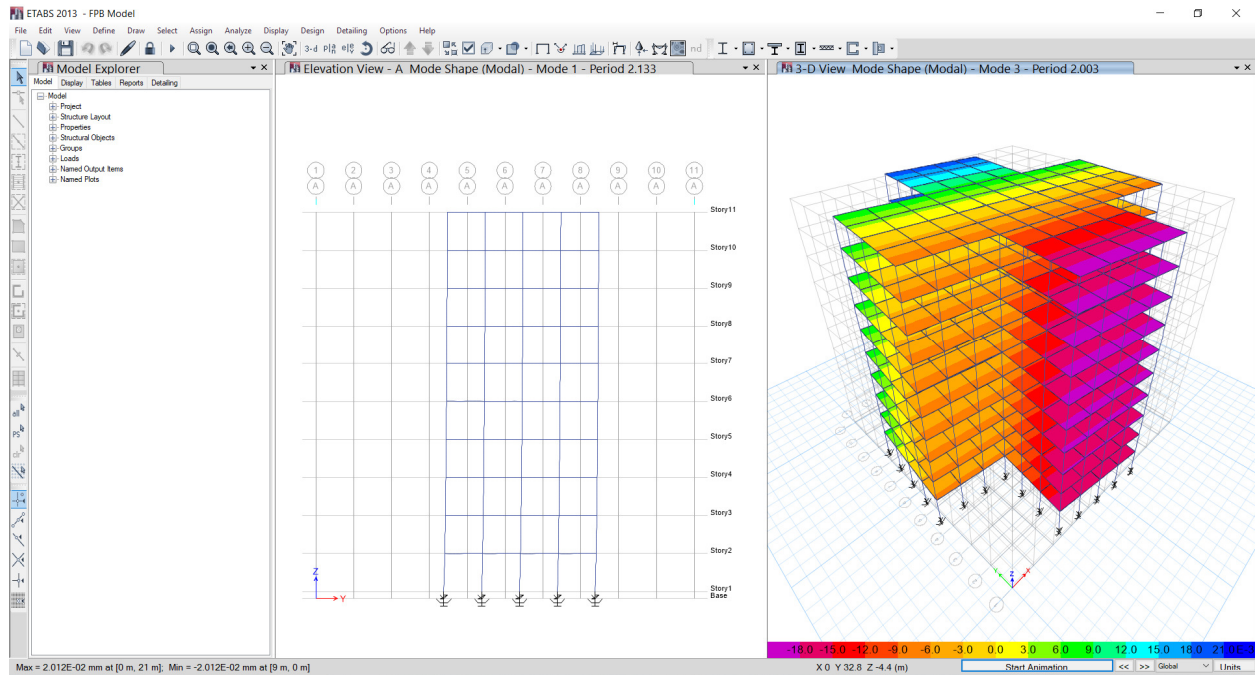


Fig.4:Model Case View

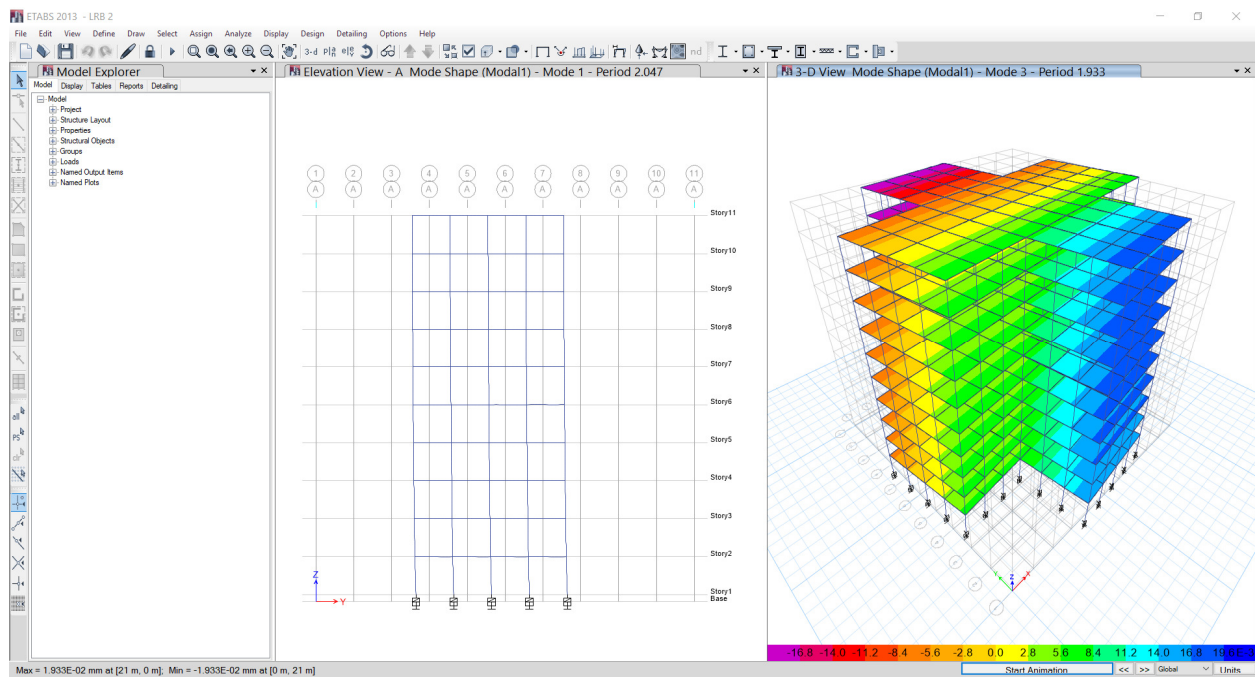


Fig.5: Model Response View

C. Modelling of LRB and FPB in ETABS 2015

Properties of FPS and LRB Isolators are modeled as spring elements (point springs) in ETABS 2015 and their properties are given as Link Properties. The properties of the contact pendulum bearing framework isolator and lead elastic bearing isolator in light of which they are enrolled underneath in table.

Table-4 Properties of Lead Rubber Bearing Isolator

U1 Linear Effective Stiffness	1500000kN/m
U2 and U3 Linear Effective Stiffness	800kN/m
U2 and U3 Non-Linear Stiffness	250kN/m
U2 and U3 Yield strength	80kN
U2 and U3 Post Yield stiffness ratio	0.1
PYSR	0.1

Table-5 Properties of Friction pendulum system isolator

U1 Linear Effective Stiffness	1500000kN/m
U1 Nonlinear Effective Stiffness	1500000kN/m
U2 and U3 Linear Effective Stiffness	750kN/m
U2 and U3 Non-Linear Stiffness	1500kN/m
U2 and U3 Friction Coefficient, Slow	0.03
U2 and U3 Friction Coefficient, Fast	0.05
U2 and U3 Rate Parameter	40
U2 Radius of Sliding Surface	2.23

D. Loads considered

Dead Load: The dead Load is considered according to Seem to be: 875 (Part-1) - 1987.

Forced Load: The Imposed Load is considered according to Seem to be: 875 (Part-2) - 1987, Live Load

Live Load for Floors: 3.0 kN/m²,

Floor Finish: 1.25 kN/m, Wall Load: 11.14 kN/m.

Seismic Load: The seismic Load is considered as per IS: 1893 (Part-1)-2002.

III. RESULTS AND DISCUSSIONS

The comparison of various parameters like displacement, Storey shear, storey drift and time period is done and tabulated from the outcomes obtained from spectrum analysis of RCC, Steel and Composite structures in fixed base and LRB and FPB base isolated base isolated conditions.

A. Storey Displacement

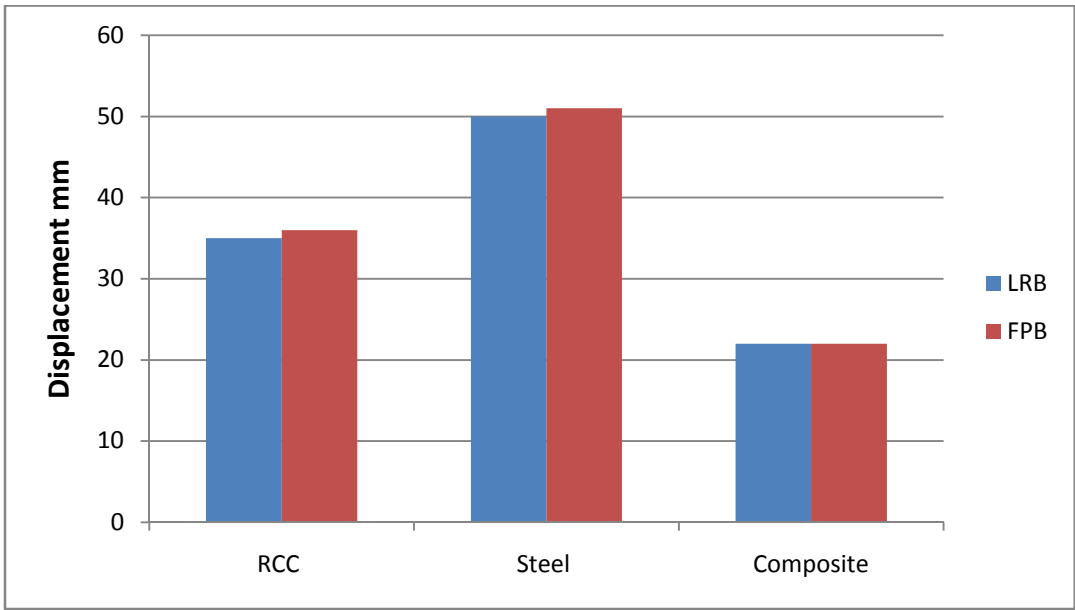


Fig.6: Displacement v/s different models

The fig.6 shows that the displacement of both the base isolated structures increases compared with that of fixed base structures. In RCC (LRB= +35%, FPB= +36%), In Steel (LRB=+50%, FPB=+51%), In Composite (LRB & FPB= +22%) increase is obtained.

B. Storey Drift

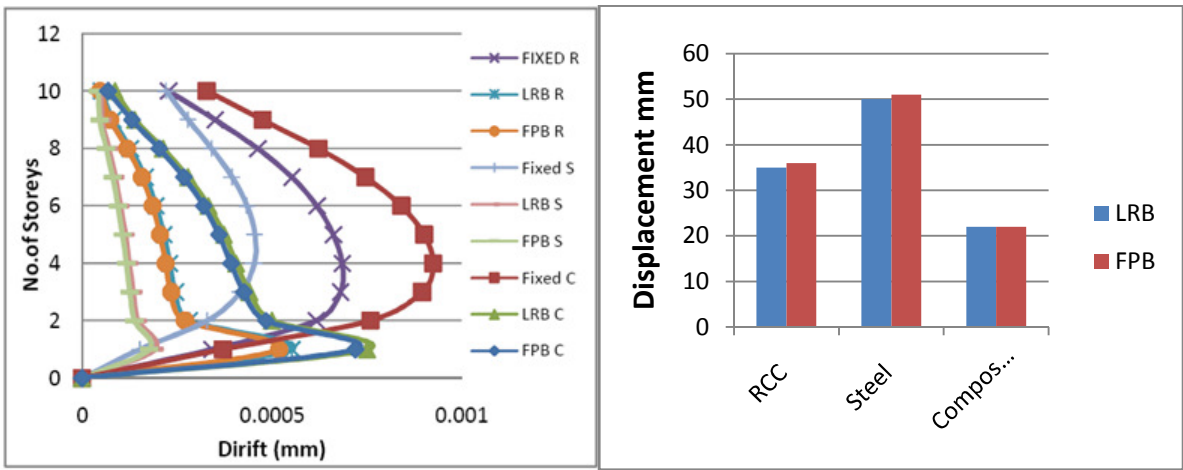


Fig.7:Storey drifts v/s different models

The Figure 7 shows that the storey drifts in both the base isolated structures decreases (except initial floor levels) with the increase in storey heights compared to that of fixed base structures. The base isolated structure produces larger drifts only in the first floor as shown in the figure. The reduction in RCC (LRB= -20%, FPB= -25%), In Steel (LRB=-58%, FPB=-62%), In Composite (LRB =-19%, FPB= -23%) is obtained.

C. Base Shear

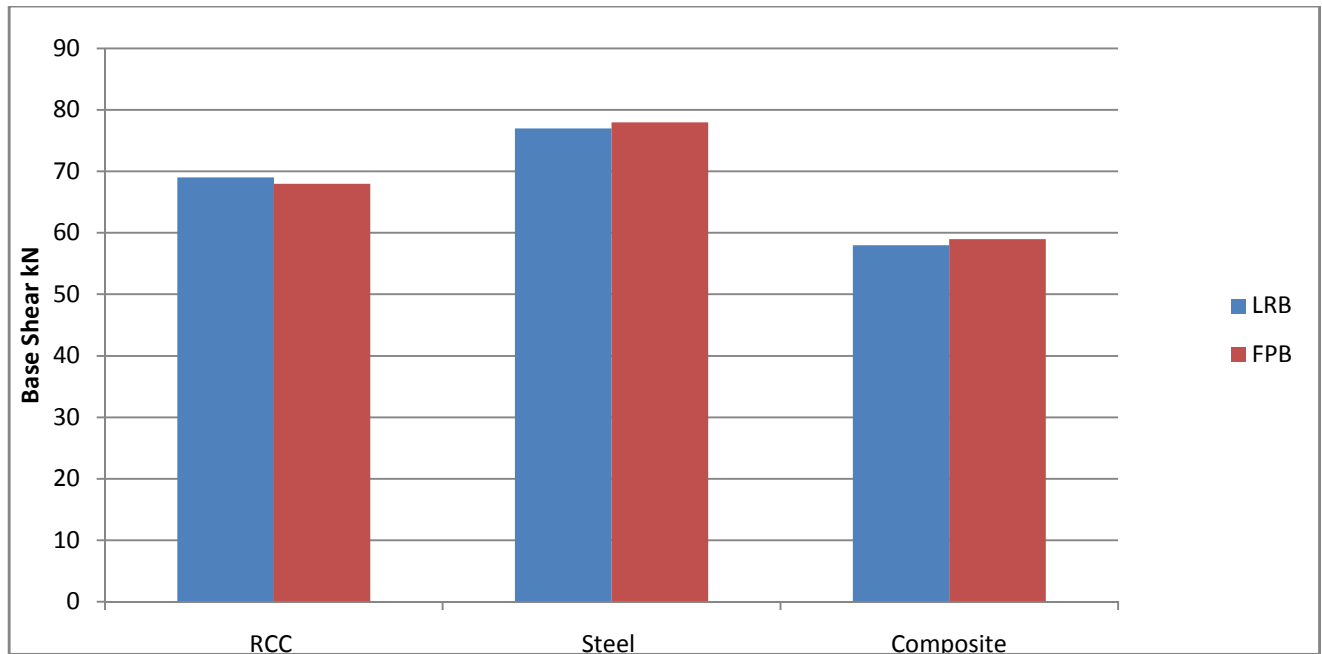


Fig.8:Storey shear v/s different models

The Figure 8 shows that the base shear reduces completely in both the base isolated structures compared with that of fixed base structure. The reduction in RCC (LRB= -69%, FPB= -68%), In Steel (LRB=-77%, FPB=-78%), In Composite (LRB =-58%, FPB=-59%) is obtained. Among two isolators FPB isolated structures shows lesser base shear than that of LRB isolated structures.

D. Time Period

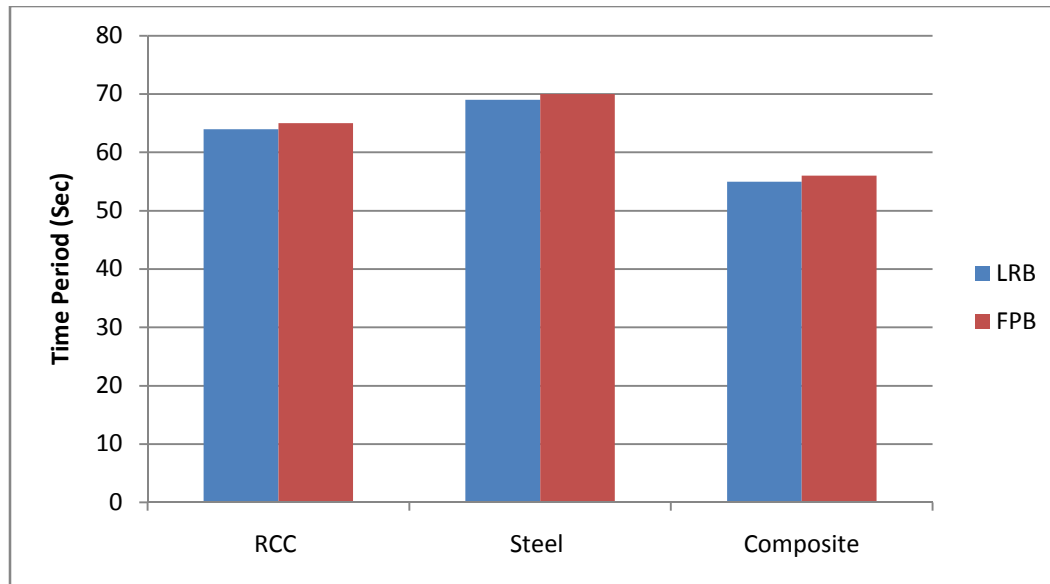


Fig.9:Time period v/s different models

The Figure 9 shows that the time span of base secluded structures increases contrasted with that of fixed base structures in all the three material properties. In RCC (LRB= +64%, FPB= +65%), In Steel (LRB=+69%, FPB=+70%), In Composite (LRB= +55% & in FPB= +56%) increase is obtained.

V. CONCLUSION

In this project an attempt is made to comprehend the adequacy of base disconnecting component for quake. Based on the investigation the accompanying ends are drawn. There is an expansion in timeframe esteem for base confined structure contrasted with that of fixed base structure. Both the disengagement framework expands the timeframe contrasted with fixed base. Be that as it may, FPB detachment framework gives additional timeframe than LRB segregation framework. Results also shows that the timeframe in the Composite structure is maximum compared to RCC and steel structure in both base disconnected also, fixed base structures. There is a tremendous lessening in the base shear for the structure with base disconnection when contrasted with fixed base structures. Both the base disengagement framework gives practically same measure of decrease in the base shear for various structures, for example, RCC, Steel and Composite. More decrease in base shear can be accomplished for steel structure when contrasted with RCC and Composite structure. The uprooting of the secluded structure increments because of an enormous increment in the adaptability of the structure. Out of two base isolation systems, it is found that the displacement in FPB isolation is more compared to that of LRB isolation system. The examination result likewise shows that the most extreme removal is happened in Composite structure when contrasted with RCC and Steel structure. From the analysis result, it is seen that lone the principal story of the base isolated structure gets more story drift value compared to fixed base structure. But in the remaining stores the drift values goes on decreasing in the base isolated structure and the drift value goes on increasing in the fixed base structure. Based on the results, it was also found that among the two isolators, FPB isolator gives better performance compared to LRB isolator for irregular medium story structures.

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