ANALYSIS OF G+9 STOREY BUILDING ANALYZED BY USING RUBBER BEARING ISOLATION SYSTEM AND FRICTION PENDULUM SYSTEM IN ALL SEISMIC ZONES

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ABSTRACT The base isolation procedure has been utilized to study the structures from the earthquake's harming impacts. Base isolation is achieved by installing isolators and energy absorbing devices under the superstructure, Seismic isolation provides not only structural safety, but also safety and security for people and properties in the building. Seismic isolation is also used for the retrofit of historic buildings. Seismic isolation and energy dissemination systems give an effective method of improving the seismic effectiveness of constructions through a typical seismic plan. Such strategies limit seismic loads by changing the inflexibility and damping of the constructions, though customary seismic design requires extra strength and flexibility to withstand seismic loads. Perhaps the main standards in the plan of tremor safe designs is the base detachment strategy. Seismic isolation systems can be modeled in various structural analysis programs using nonlinear or equivalent linear properties of isolators.

In this present study a G+9 storey building analyzed by using Rubber bearing isolation system and friction pendulum system in seismic all seismic zones namely zone II, Zone III, Zone IV and Zone V with the help of IS 1893:2016 Code in SAP 2000 Software package. The analysis is made between Rubber bearing isolation system, friction pendulum system and Fixed base building for seismic parameters like joint displacement , shear force, bending moment, building torsion, time period frequency etc. from the analytical results it was concluded that by using base isolation systems the values of base shear increased when we compared with fixed base building model. the storey shear values reduces to 35% in rubber isolation and 40% for friction pendulum models. The storey moment decreased to 25% in rubber base and 30% for friction pendulum model. The Optimum control of the parameters considered was observed when the building is damped with friction pendulum model in all the seismic zone conditions.

Key words: *Seismic isolation, Rubber bearing isolation system, friction pendulum system modeling in SAP2000, stoery drift, shear force, bending moment, building torsion.*

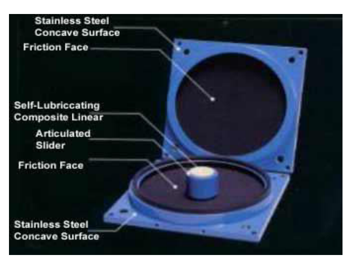
INTRODUCTION

Seismic isolation is a technique used to reduce the effects of earthquake ground shaking on structure, their components and protect them from damaging. In this technique we use some hardwires that I will describe later to reduce structures lateral movement (Drift).

Seismic isolation is one of the most important concepts for earthquake engineering which can be defined as separating or decoupling the structure from its foundation. In other words, seismic isolation is a technique developed to prevent or minimise damage to buildings during an earthquake. In this essay, the concept of base isolation will be explained by giving some examples from other engineering and sport branches. These examples are automobile suspension systems and some defence techniques in boxing. Additionally, some experiments and analytic graphs will be demonstrated to provide better understanding of the concept of base isolation.

Friction pendulum bearings

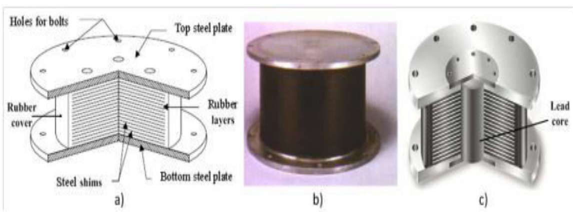
Friction pendulum systems are the most extensively used kinematic systems especially in base isolation. Pendulum system consists of a steel globe placed in two steel concave curved surface or a cylindrical member with global contact surfaces. In these parts special metals are used.



Friction pendulum bearing system

Rubber Bearings isolation

These systems also have steel laminated rubber types and steel laminated rubber types with lead nucleus, along with the ones made of rubber and neoprene. The natural and artificial rubber bearings, which were used in bridge bearings, have later been developed and have been named elastomeric bearings. These bearings, which are used as seismic isolators, are widely used. The rubber laminated isolators are formed through vulcanization of thin steel plates to rubber plates. The more developed of those are laminated rubber types with lead nucleus. Lead Laminated Rubber Bearing systems are constituted by steel/rubber laminated layers with a lead nucleus embedded in the middle, and they are highly developed seismic isolators.



Lead rubber bearing isolation

The main objectives of the present research are to study the seismic behavior of G+9 building by using IS 1893:2002 code with the help of response spectrum method in SAP2000, to study the G+9 building with different base isolation systems namely Rubber bearing isolation and friction pendulum bearing isolation in different seismic zones i.e., Zone II, Zone III, Zone IV and Zone V, to compare the results of seismic analysis of building with different base isolation systems with fixed base building in different seismic zones and hence to identify the good earthquake resistant and effective system with the help of analysis results like joint displacements, shear, bending, torsion, base shear and time period.

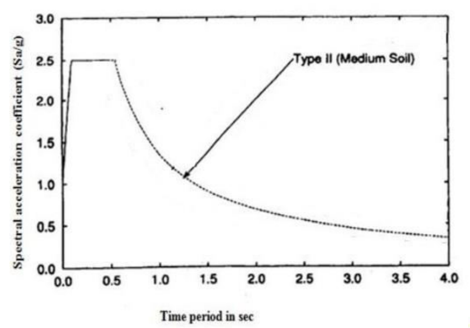
LITERATURE STUDIES

Gyawali et al. (2020), In this research, GF+4 storied regular, plan irregular and vertical irregular building models were considered for both fixed base and base isolation in SAP. Response spectrum method analysis under IS1893:2002 was The SAP analysis results were compared and validated by ETABS software. The base shear value in LRB building was reduced up to 45 to 50% as compared to fixed base building. Top storey displacement of building was increased up to 81 to 99% by using LRB.

Dr. R. S. Talikoti et al. (2014), here they took a detailed glance at the designing, working, testing as well as the suitability of base isolation design as per Indian Standards. The (G+15) RCC building was considered for the case study. It was modelled in SAP2000 software and analysed for fixed base, bracing and Isolator. Theoretical comparison was then worked out between the fixed base and the base isolated structure and the parameters such as base shear, mode period, storey displacement, storey drift and storey acceleration by using SAP2000.

METHODOLOGY USED

Response spectrum analysis is also known as linear dynamic statistical analysis method. This analysis generally done with the help of IS code for seismic analysis. The IS code used for this study is IS 1893:2016 (Part 1). The values of seismic zone factor, soil type are taken from the tables which are from this IS 1893:2016 (Part 1) code. The damping ratio is generally taken as 5% for this analysis. The response spectrum Graph for medium soil condition is shown in the below graph. The graph is plotted between the Time period and Spectral acceleration coefficient (Sa/g).



Response spectrum for medium soil type for 5% damping

In this we need to discover the size of powers finished for instance X, Y and Z and after that see the repercussions for the structure. Mix techniques combine the going with:

1. Absolute - crest esteems are included
2. Square foundation of the total of the squares (SRSS)
3. Complete quadratic blend (CQC) - a strategy that is a change on SRSS for firmly divided modes.

The output from the Response spectrum analysis is purely different from the linear dynamic analysis using the ground motions, in case of structure or building is irregular or high rise building this analysis of response is not accurate as we compared with other analysis and other method of analysis is needed, which is non linear static analysis or dynamic analysis.

In the present study I was considered a medium rise building and regular structure for the seismic loading condition for the response analysis case.

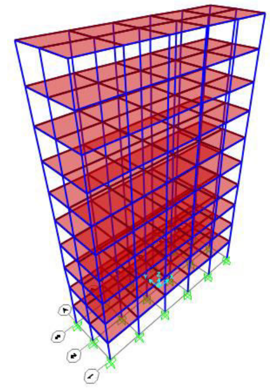
SPECIFICATIONS AND BUILDING MODELS

In the present study, analysis of G+6 multi-storied building. Three dimensional model of building is prepared in SAP 2000 Software.

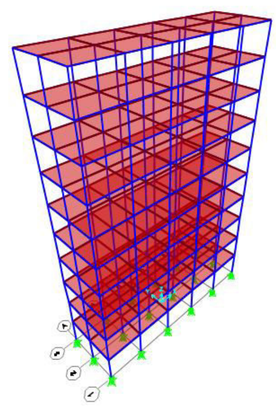
Basic parameters considered for the analysis are

1. Occupancy of the building : Residential
2. Number of stories : G+9(10 storied)
3. Total Height of building : 30 m
4. Shape of building : Rectangular
5. Geometric details
   a. Ground floor height : 3 m
   b. floor to floor height : 3 m
6. Material details
7. Concrete Grade :M30 (COLUMNS AND BEAMS)
8. Steel :HYSD 415
9. Bearing Capacity of Soil : 200 kN/m^2
10. Type Of Construction :RCC
11. Column : 0.35m × 0.35 m
12. Beams : 0.25m × 0.35 m
13. Slab thickness : 0.125 m
14. Live load : 2.5 kN/m^2(IS:875:1987)
15. Density of Reinforced concrete : 25 kN/m^3
16. Site type : II
17. Importance factor : 1.0
18. Response reduction factor : 3
19. Damping Ratio : 5%
20. Structural class : C
21. Wind design code : IS 875: 1987 (Part 3)
22. RCC design code : IS 456:2000
23. Steel design code : IS 800: 2007
24. Earthquake design code : IS 1893 : 2016

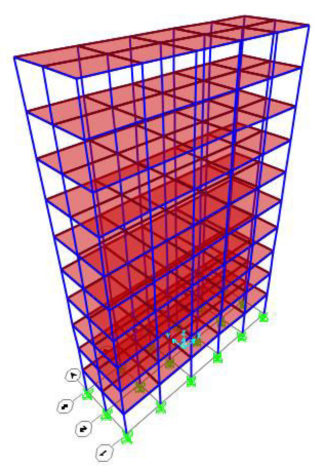
Building models in SAP 2000



Building Model with fixed supports



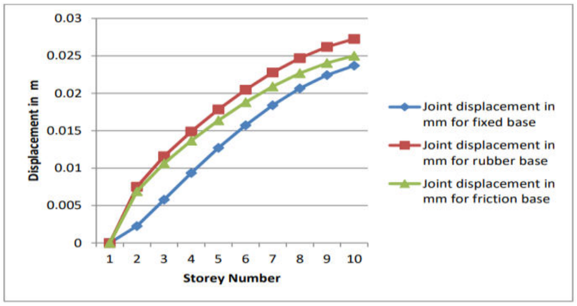
Building Model with rubber isolator at supports



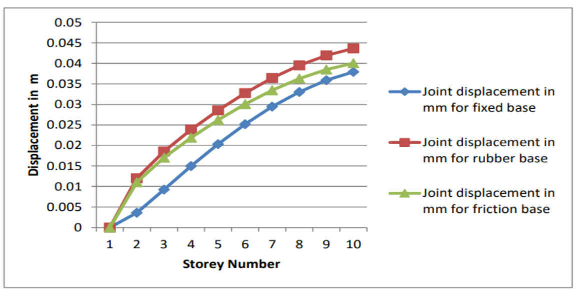
Building Model with friction isolator at supports

RESULTS AND ANALYSIS

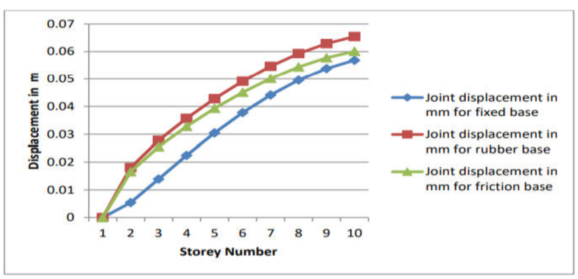
Comparison of joint displacements



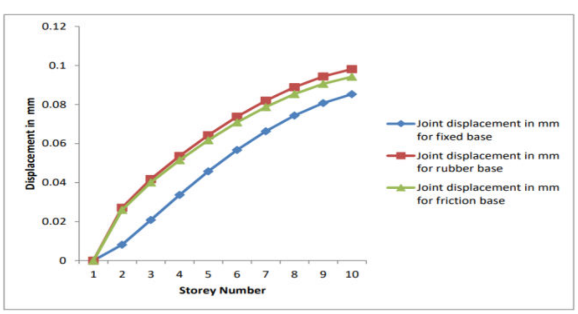
Comparison of joint displacement for different base conditions in Zone II



Comparison of joint displacement for different base conditions in Zone III

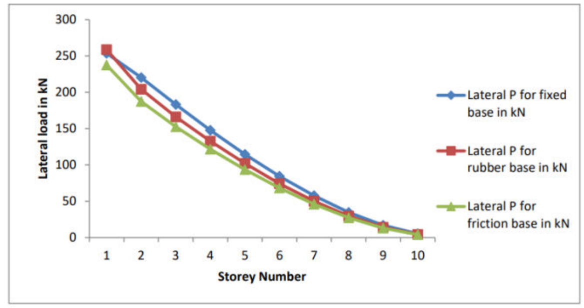


Comparison of joint displacement for different base conditions in Zone IV

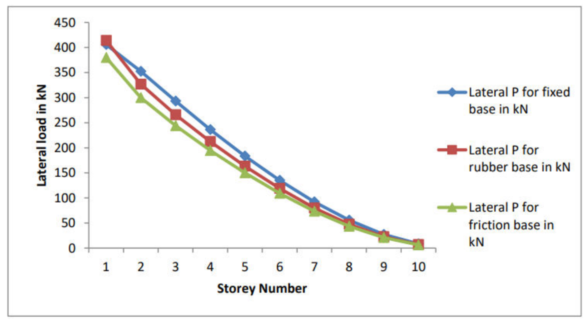


Comparison of joint displacement for different base conditions in Zone V

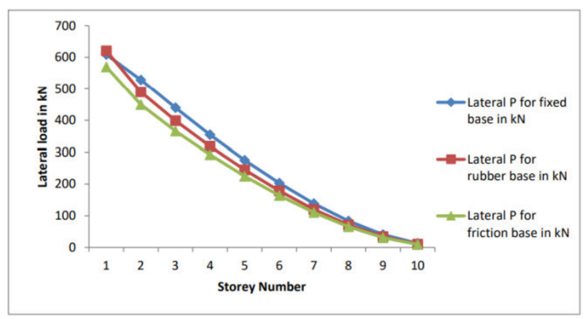
Comparison of Lateral load P



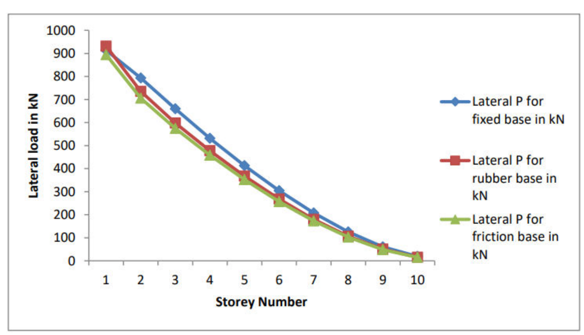
Comparison of Lateral load for different base conditions in Zone II



Comparison of Lateral load for different base conditions in Zone III

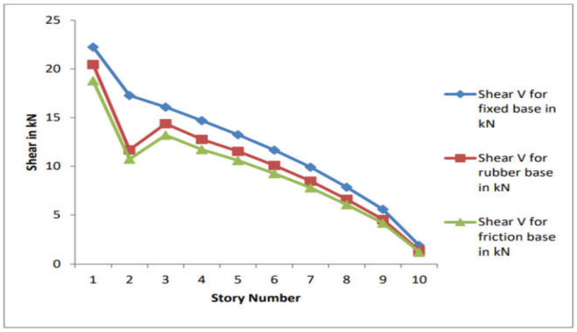


Comparison of Lateral load for different base conditions in Zone IV

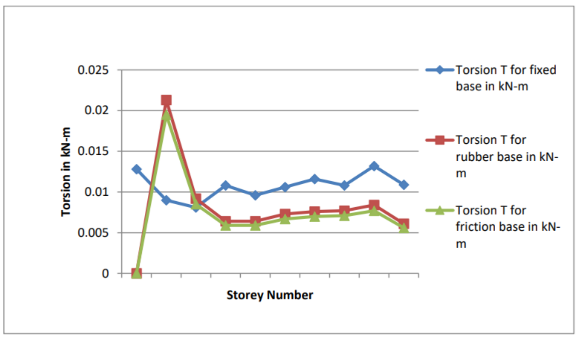


Comparison of Lateral load for different base conditions in Zone IV

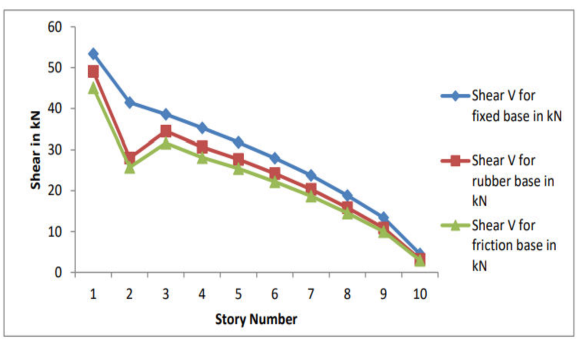
Comparison of Storey Shear



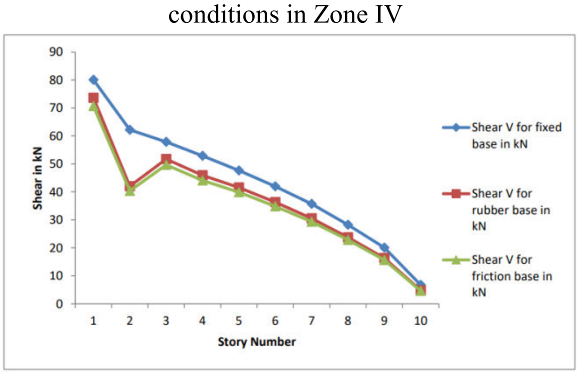
Comparison of storey shear V for different base conditions in Zone II



Comparison of storey shear V for different base conditions in Zone III

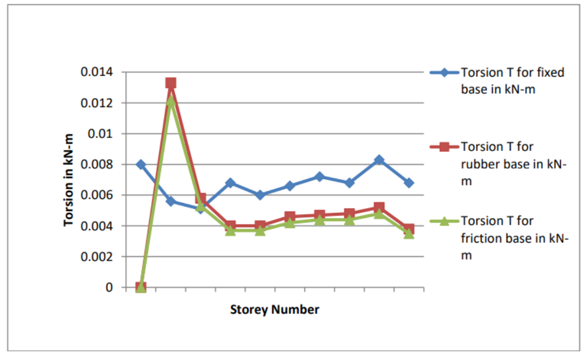


Comparison of storey shear V for different base conditions in Zone IV

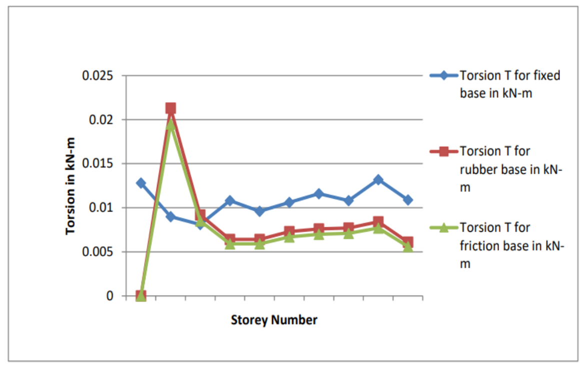


Comparison of storey shear V for different base conditions in Zone V

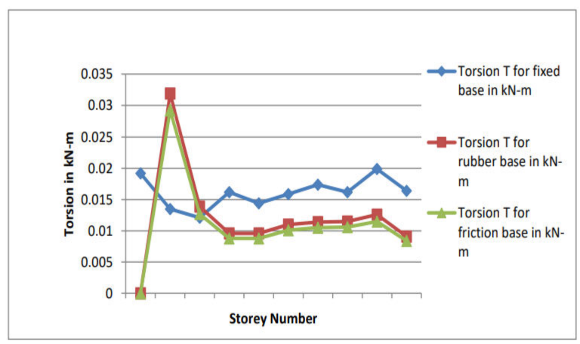
Comparison of Torsion T



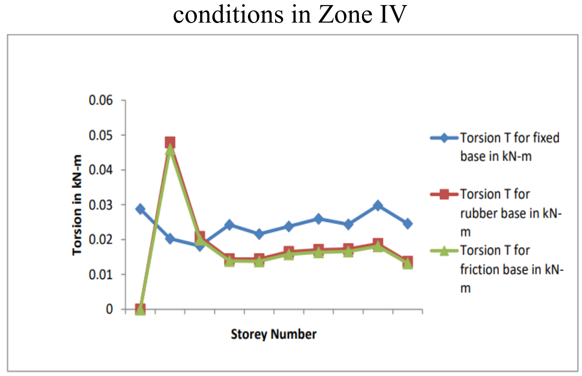
Comparison of Torsion T for different base conditions in Zone II



Comparison of Torsion T for different base conditions in Zone III

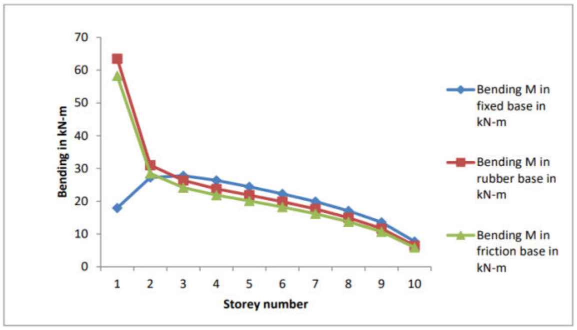


Comparison of Torsion T for different base conditions in Zone IV

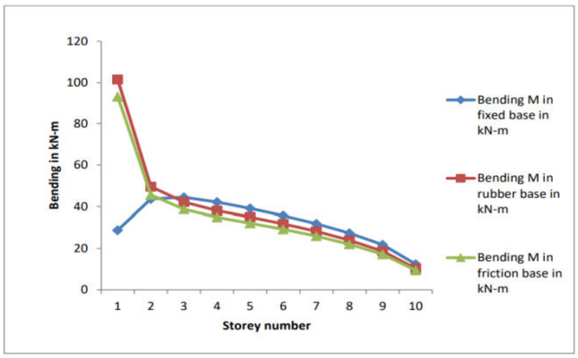


Comparison of Torsion T for different base conditions in Zone V

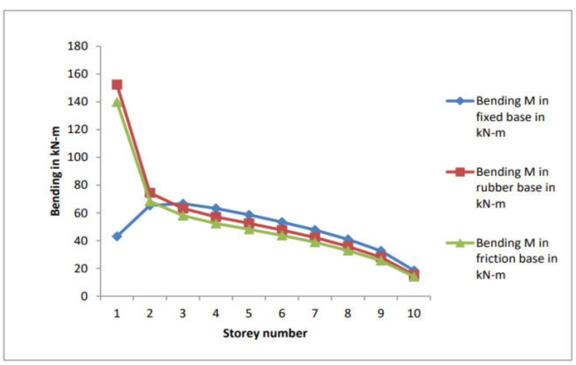
Comparison of Storey moment



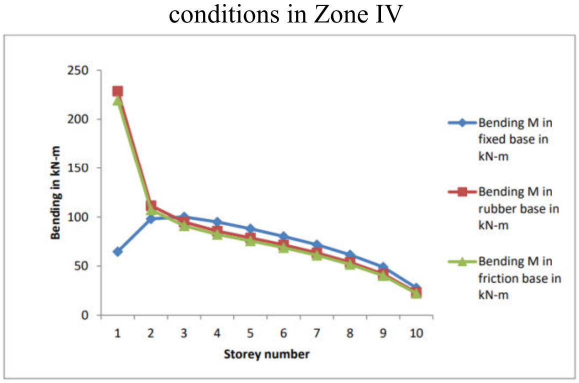
Comparison of moment M for different base conditions in Zone II



Comparison of moment M for different base conditions in Zone III

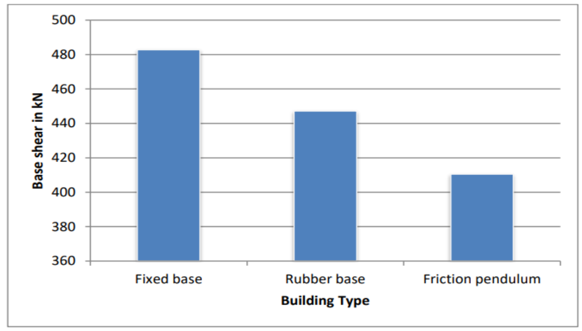


Comparison of moment M for different base conditions in Zone IV

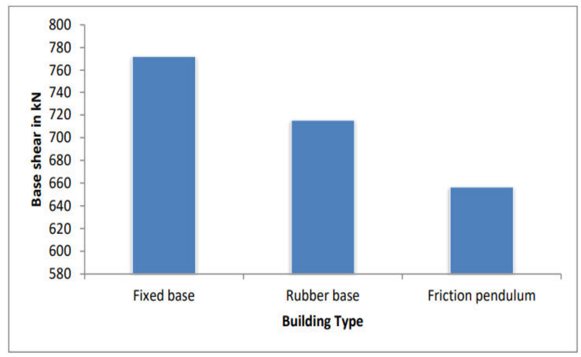


Comparison of moment M for different base conditions in Zone V

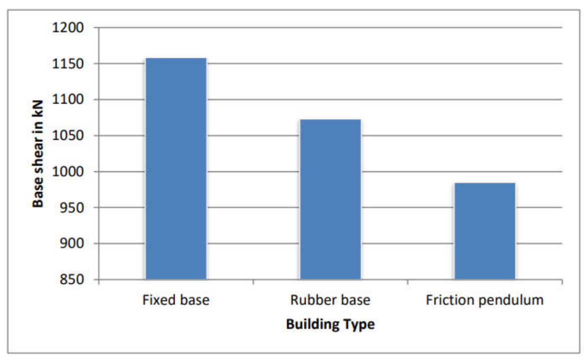
Comparison of Base shear



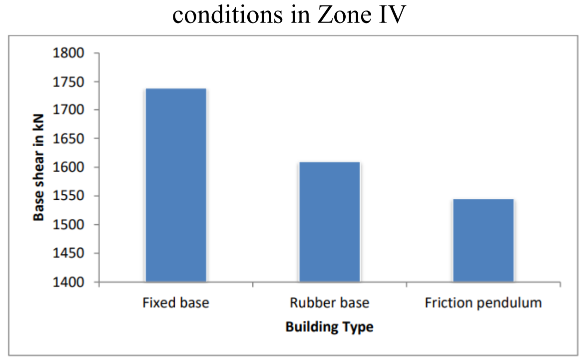
Comparison of base shear for different base conditions in Zone II



Comparison of base shear for different base conditions in Zone III



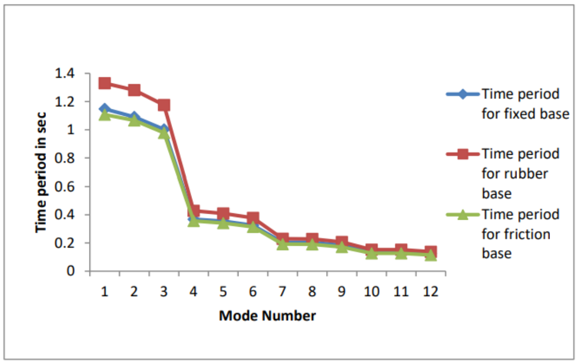
Comparison of base shear for different base conditions in Zone IV



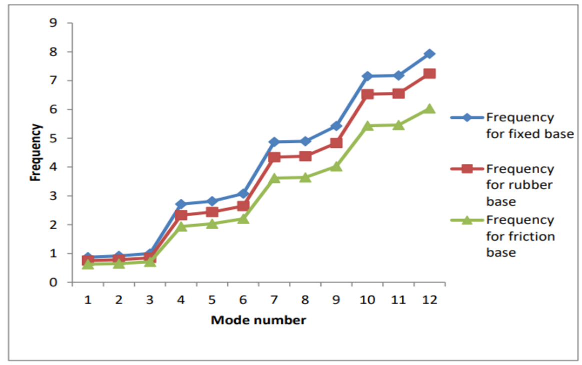
Comparison of base shear for different base conditions in Zone V

Comparison of Time period

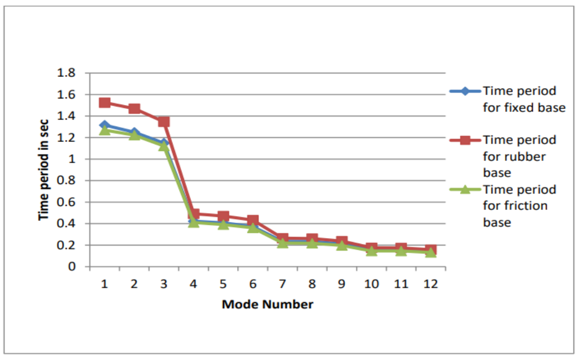
Comparison of frequency



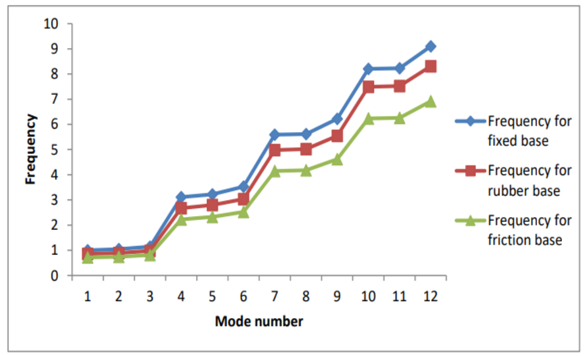
Comparison of time period for different base conditions in Zone II



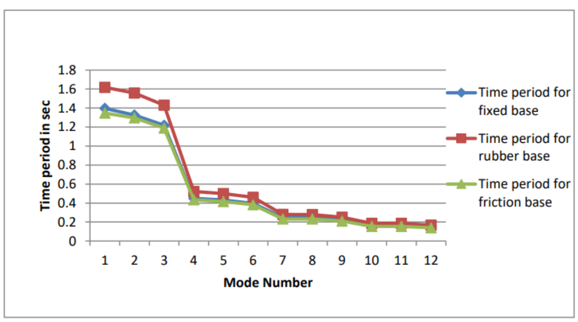
Comparison of frequency for different base conditions in Zone II



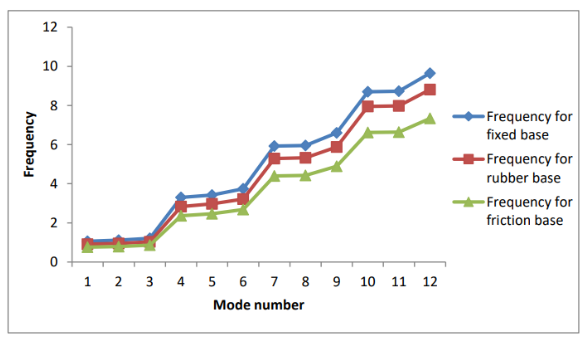
Comparison of time period for different base conditions in Zone III



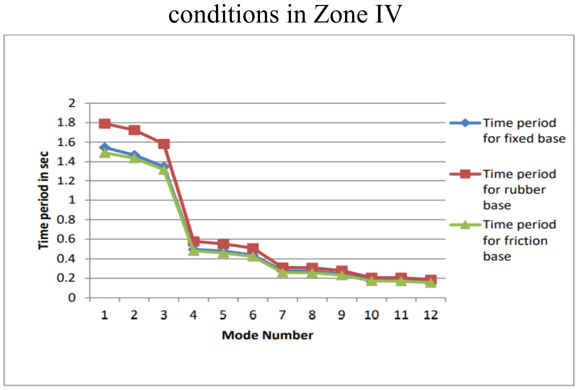
Comparison of frequency for different base conditions in Zone III



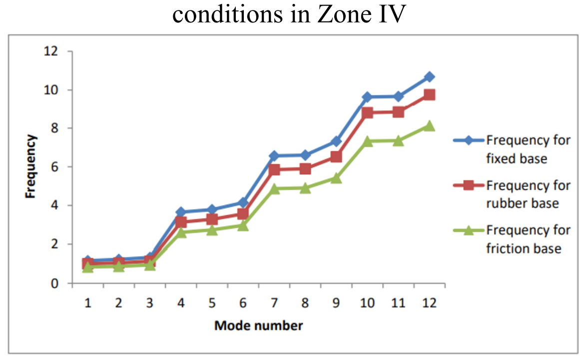
Comparison of time period for different base conditions in Zone IV



Comparison of frequency for different base conditions in Zone IV



Comparison of time period for different base conditions in Zone V



Comparison of frequency for different base conditions in Zone V

CONCLUSIONS

From analysis results it is observed that base isolation technique is very significant in order to reduce seismic response of building with isolator as compared to fixed base building and to control damages in building during seismic action. The increase or decrease of result parameters with respect to storey compared with fixed base model is discussed below.

[1]. Storey shear values are decreased when the building is damped with Lead Rubber isolation and friction pendulum isolation in all seismic zones.

[2]. By providing the rubber base isolation and friction pendulum system at the base the storey shear values are decreased by 28.57% and 34.427% respectively.

[3]. Storey Moment is decreased when the building is analyzed with Lead Rubber isolation system and friction pendulum in all seismic zones.

[4]. Storey moment values are decreased by 16.88% and 23.20% when the building is analyzed with rubber base isolation and friction pendulum isolation respectively.

[5]. Torsion values are decreased when the building is modeled with isolation systems in all seismic zones.

[6]. Reduction in storey torsion by 44.12% and 48.52% have been observed for Rubber base isolation model and friction pendulum base isolation model respectively.

[7]. By using the base isolation systems, the values of joint displacements are increased in all seismic zones by15.08% and 5.63% for rubber base model and friction pendulum model respectively.

[8]. Base isolation resulted significant decrease in storey lateral loads in all seismic zones. Storey lateral loads are decreased by 17.95% and 24.69% for rubber base model and friction pendulum model respectively.

[9]. By using isolation systems, we can reduce the usage of steel by 8.7% for rubber base isolation and 30% for friction pendulum systems as this is an important in building design.

[10]. Optimum control of the parameters considered was observed when the building is damped with Friction bearing isolation systems.

[11]. Base isolation resulted significant decrease in Base shear in all seismic zones. Base shear is decreased by 7.36% and 14.97% for rubber base model and friction pendulum model respectively.

So, from the work carried out it can be stated that Rubber base isolation system and friction pendulum is the best supplemental damping system to control seismic loading condition. Comparative study between building with rubber bearing isolation system and friction pendulum bearing isolation system in terms of result parameters suggest that the friction pendulum bearing system is most effective and optimum base isolation system to be utilized for the building type we considered for this project.

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