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Research Paper

ANALYSIS OF LEAD RUBBER BASE ISOLATION AND FRICTION PENDULUM SYSTEM OF G+12 BUILDING USING ETABS SOFTWARE

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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+12 storey building analyzed by using Rubber bearing isolation system and friction pendulum system in Zone V with the help of IS 1893:2016 Code in ETABS Software package. The comparison is made between Rubber bearing system and friction pendulum system with general building for seismic parameters like story drift, shear force, bending moment, building torsion, base shear, time period and frequency values are studied using Response spectrum analysis method.

Key words: *Seismic isolation, Rubber bearing isolation system, storey drift, shear force, bending moment, building torsion.*

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1. 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.

1.1 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.

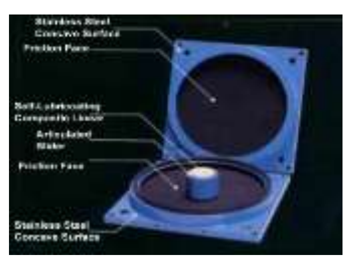

Fig 1: Friction pendulum bearing system

1.2 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.

Fig 2: 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.

2. 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 story 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.

3. 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).

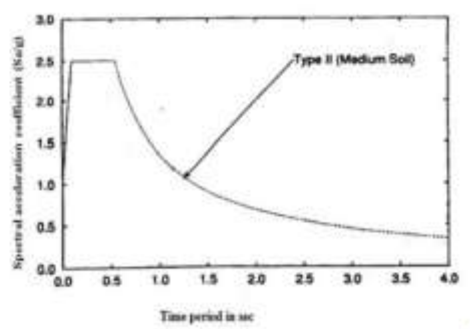

Fig 3: Response spectrum for medium soil type for 5% damping

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.

4. SPECIFICATIONS AND BUILDING MODELS

In the present study, analysis of G+12 multi-story building is carried Basic parameters considered for the analysis are

1. Utility of building : Residential building
2. Number of stories : G+12
3. Shape of building : Rectangular
4. Type of walls : Brick wall
5. Geometric details Ground floor : 3.3m
6. Floor to floor height : 3m
7. Material details Concrete Grade : M30 (COLUMNS AND BEAMS)
8. All Steel Grades : HYSD reinforcement of Grade Fe500
9. Bearing Capacity of Soil : 200 KN/m2
10. Type Of Construction : R.C.C FRAMED structure
11. Column : 0.6m X 0.6m
12. Beams : 0.46m X 0.6m
13. Slab : 0.150m
14. Live load :3kN/m2
15. Dead load :2KN/m2
16. Seismic zone :V
17. Soil type :medium
18. RCC code :IS 456-2000
19. Steel code :IS 800-2007
20. Seismic code :IS 1893:2016
21. Wind code :IS 875:2015

Isolation system properties

Rubber Base Isolation

U1- Effective stiffness -15000000

U2 –Non linear

Effective stiffness-800

Stiffness-250

Yield strength-80

Post Yield strength ratio – 0.1

U3 –Non linear

Effective stiffness-800

Stiffness-250

Yield strength-80

Post Yield strength ratio – 0.1

Friction pendulum Isolation

U1-Stiffness-15000000

U2- Non linear

Effective stiffness – 70

Stiffness – 1500

Friction cost slow – 0.03

Friction cost fast – 0.05

Rate parameter -40

Radius of sliding -2.23

U3- Non linear

Effective stiffness – 70

Stiffness – 1500

Friction cost slow – 0.03

Friction cost fast – 0.05

4.1 Building models in ETABS Software

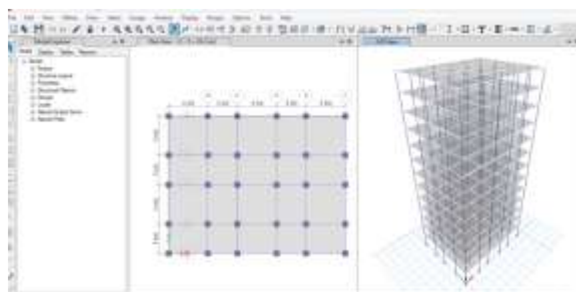

Fig 4: Building Model with fixed supports

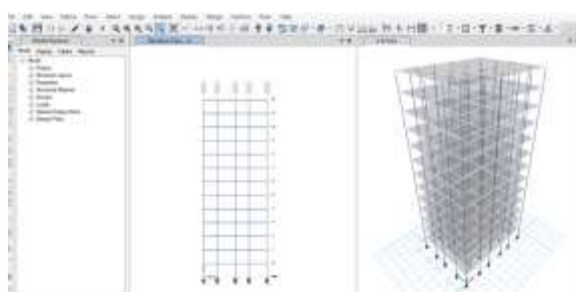

Fig 5: Building Model with rubber isolator

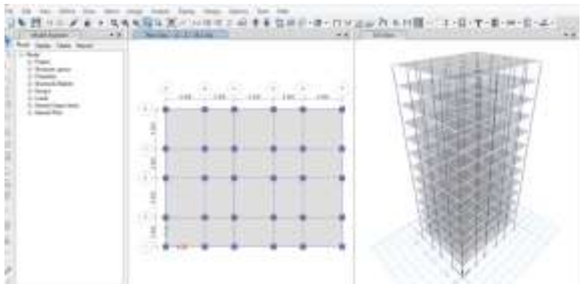

Fig 6: Building Model with friction isolator

5. RESULTS AND ANALYSIS

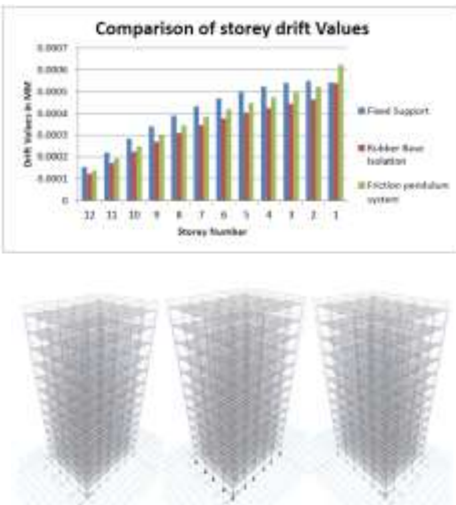

Fig 7: Comparison of storey drift Values

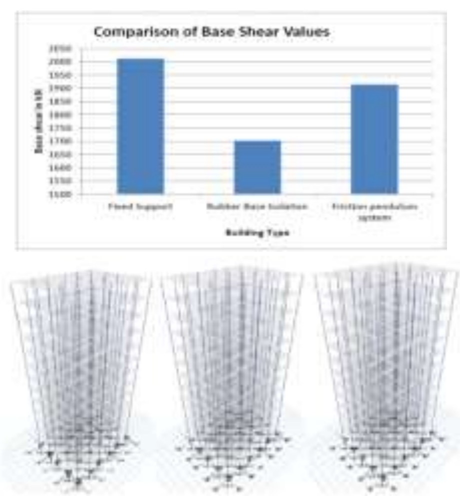

Fig 8: Comparison of Base Shear Values

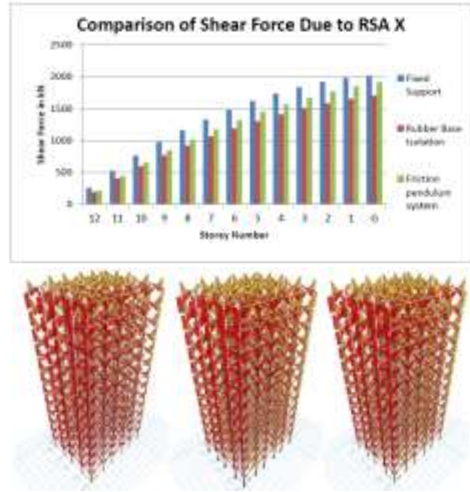

Fig 9: Comparison of shear force

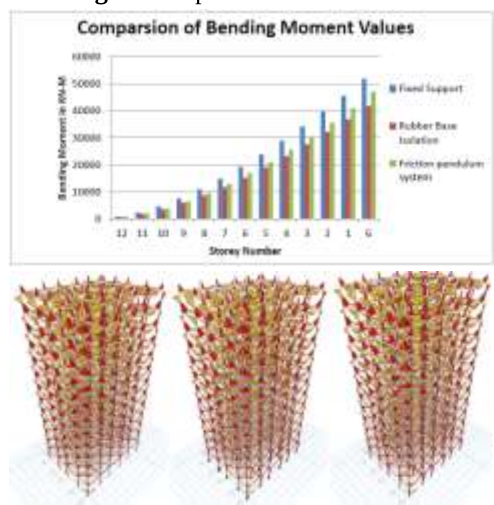

Fig 10: Comparison of Bending Moment Values

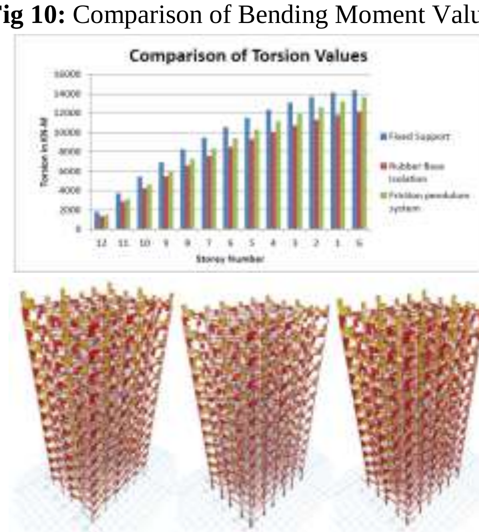

Fig 11: Comparison of Torsion Values

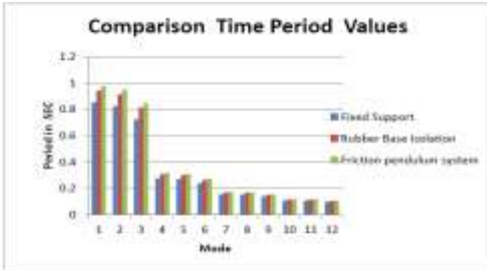

Fig 12: Comparison Time Period Values

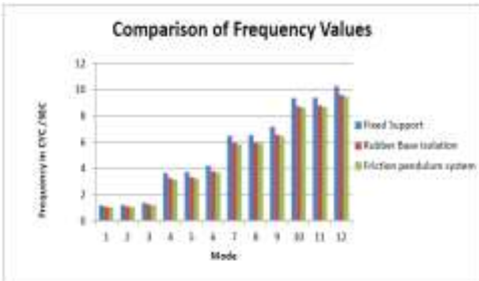

Fig 13: Comparison of Frequency Values

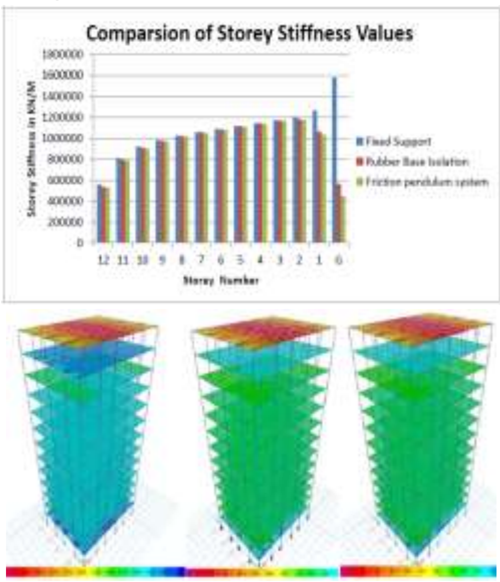

Fig 14: Comparison of Storey Stiffness Values

6. CONCLUSIONS

From this study the following conclusions were made The intensity of storey acceleration is less for both friction pendulum and rubber base isolation in zone V seismic condition. And The Storey shear decreases when the building is damped with Friction Pendulum System followed by Lead Rubber Dampers in both the directions in Zone V seismic condition. The Storey Moment decreases for both buildings in zone V when the building is damped with Lead Rubber Dampers in both directions. The values of torsion in case of Zone V decreased when the building is damped with Lead Rubber Dampers. And The Storey Drift decreased in both the zone V seismic condition when the building is damped with Lead Rubber. Optimum control of the parameters considered was observed when the building is damped with Lead Rubber Dampers. When we compared the analysis results in zone V almost the similar results are obtained for drift, shear, moment, torsion etc. So from the work carried out it can be stated that rubber base System is the best supplemental damping system.

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