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EVALUATION OF DYNAMIC RESPONSE OF RC BUILDING WITH DIFFERENT BASE ISOLATORS

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Abstract- *Earthquake, characterized by the rapid release of energy in the earth's lithosphere, poses a significant threat to buildings and infrastructure. To mitigate earthquake effects on buildings, seismic design methods such as seismic dampers and base isolation devices are used. Base isolation, in particular, is examined as a strategy to separate structures from the ground motion, thus safeguarding them from destructive consequences. This study explores the influence of different types of base isolators and their impact in minimizing seismic effects on structures and, emphasizing the advantages over the conventional structures. In the present research a numerical investigation on RC buildings with different base isolators using finite element analysis. Parameters such as storey displacement, storey shear, time period and storey drift are analyzed and compared. The findings reveal that base isolation significantly extends the structure's duration, reducing base shear values. Rubber isolators emerge as a preferred choice in terms of seismic performance*

***Key Words*: Earthquake, Base isolators, time history analysis, storey shear, storey displacement, time period.**

1. INTRODUCTION

An earthquake is the shaking of the Earth's surface caused by a rapid release of energy in the Earth's lithosphere, which generates seismic waves. It is also referred to as a quake, tremor, or temblor. Earthquakes can range in strength from those that are so little that no one can feel them to those that are powerful enough to throw things and people into the air, destroy vital infrastructure, and devastate entire cities. The number, kind, and size of earthquakes that occur in a region during a specific period of time is known as its seismic activity.

1.1 REDUCTION OF EARTHQUAKE EFFECTS ON BUILDINGS:

While the goal of conventional seismic design is to build structures that can endure strong earthquake shaking without collapsing, certain structural elements and non-structural elements (such glass facades) may sustain damage. There are two fundamental methods employed to protect structures against the damaging effects of earthquakes. These are devices for base isolation and seismic damping. Removing the structure from the ground in a way that reduces, if not totally eradicates the propagation of seismic waves through the structure is the aim of base isolation. Seismic dampers are unique equipment that are put in the structure to take in the energy offered to it by the earth motion. They work similarly to springs in cars, which absorb shocks generated by shifting roads.

1.2 BASE ISOLATION

The fundamental idea behind base isolation is to introduce a support that isolates the structure from the shaking ground to be able to protect it from the destructive consequences of an earthquake. In the strictest sense, the foundations are severed from the structure (whether it a building, a bridge, or a piece of machinery). Because the ground shakes during an earthquake, the structure sustains the majority of the damage. In other words, the idea is to keep the building stationary while separating it from the earth so that it can move. Base isolation is a design idea that has been used more frequently recently for buildings and bridges, especially for those in need to continue operating normally in the event of a big earthquake, such as hospitals, fire stations, and emergency command centers. This approach has been applied to construct many different kinds of structures, and plenty others are now being designed or built.

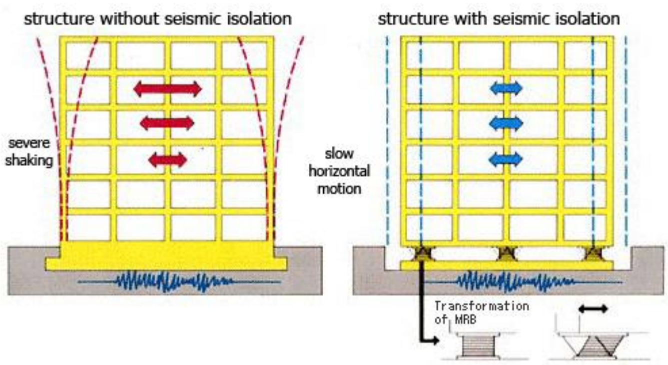

Fig 1: Deflection of a structure after and before base isolation.

1.2 ISOLATOR TYPES

- Elastomeric (Rubber) bearings
- Laminated rubber bearing
- sliding system
- Friction pendulum system (FPS)

- Rollers and Ball bearings

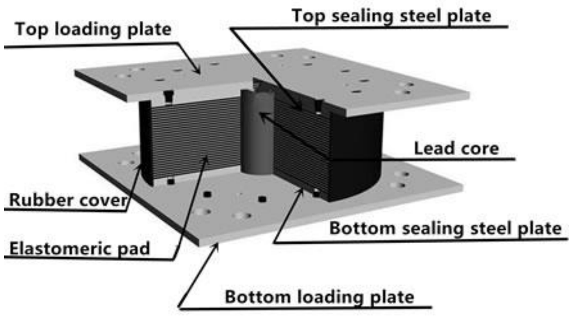

Fig 2: Lead Rubber Bearing

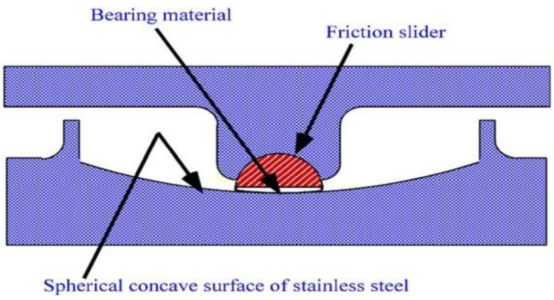

Fig 3: Depicting mechanism of Friction Pendulum System

1.3 OBJECTIVES

The main objectives of this project are:

- To perform time history analysis of 15 storey RC building provided with different base isolators.
- To compare the dynamic parameters like time period, storey shear, storey drift, storey displacement and storey stiffness when different base isolators are introduced to the conventional structure.

1.4 METHODOLOGY

Building Details

Location of the site : Chikmagalur
Plan dimensions : 35m×28m
Total number of stories: 15 (G+14)
Type of building : Residential
Structure type : Plan regular type
Height of each storey : 3m
Total height of structure: (3×14+2) = 44m

Section properties:

Wall thickness : 230mm, 200mm, 100mm
Beam sizes : 230×450mm, 300×600mm, 300×650mm
Column sizes : 450×750mm, 450×900mm

Modeling in ETABS

The analysis and design of the 'fixed base' and 'base isolated structures have been developed adopting ETABS 18.1.1. The various analysis and design features of ETABS software used in this project are:

- Time history Analysis
- Code Provisions
- IS 456-2000
- IS 875-2015 (Part 1,2,3)
- IS 1893-2016

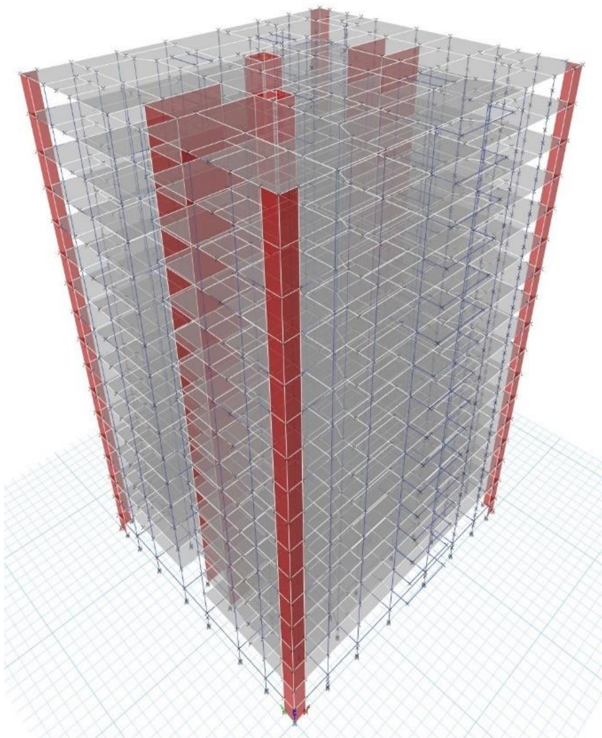

Fig 4: 3D view of the Conventional Structure

Loads
Live load = 1.5KN/m²
Super dead load = 2, 3 KN/m²
Floor finish load = 1 KN/m²
Parapet load = 5.35 KN/m²
Wall load = 12.05KN/m²

POSITION OF ISOLATORS:

1. Base isolators are placed at 0.67m above base level
2. Isolators are provided above every column.

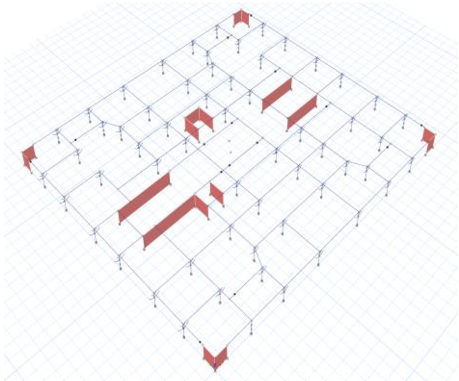

Fig 5: Structure with base isolators

Time history analysis:

Time history analysis, a key component of structural engineering, is essential to understanding how buildings and structures respond dynamically to their environment. Particularly in earthquake-prone areas, this study is essential for guaranteeing the safety and integrity of structures and is helpful in determining whether to modify the design. Fundamentally, time history analysis is an essential technique for engineers to correctly analyze and create structures that are resilient to dynamic stresses and satisfy safety criteria, hence improving the resilience and dependability of infrastructure projects.

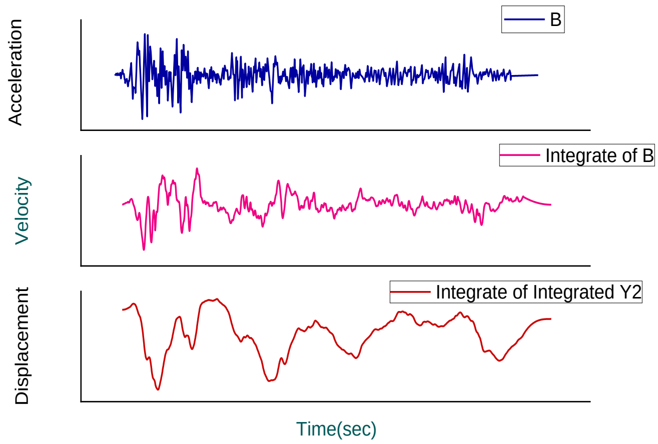

Fig 6: El - Centro ground motion data of Earthquake (N-S) 1940

1.5 RESULTS

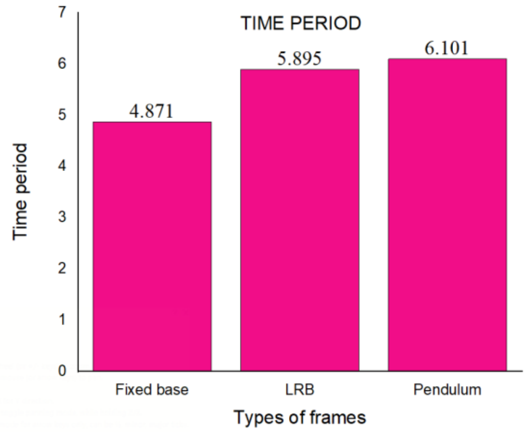

Fig 7: Fundamental time period for 3 different structures

Results obtained for the current investigation accomplished with ETABS for time period clearly shows that the time period is being magnified up to 1.3 times while going for uniformly pendulum bearing frame (T=6.101Sec.) from the fixed one (T=4.87 Sec.). This demonstrates the efficiency of seismic isolation because the spectral acceleration and base shear will likewise decrease in a proportional manner. Regarding the isolated situations, the employment of isolators with varying degrees of stiffness results in the highest magnification over time. Comparing the fundamental time periods which is obtained from modal analysis, for the 3 cases under consideration ((Results are considered for Peak acceleration level, (0.289)).

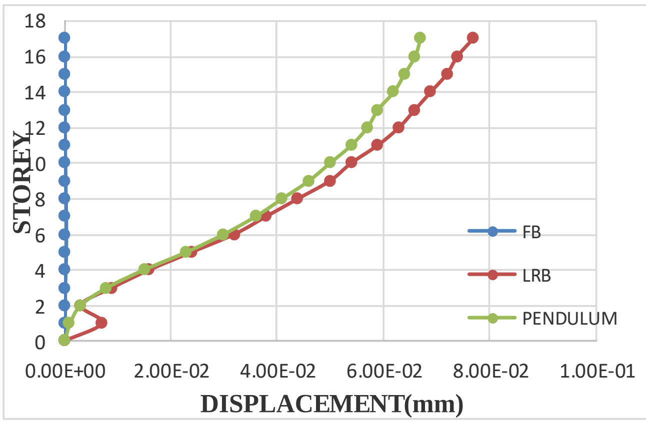

Fig 8: Displacements of the 3 different structures

The results show that absolute displacements are increased while moving from fixed to the isolated frame.

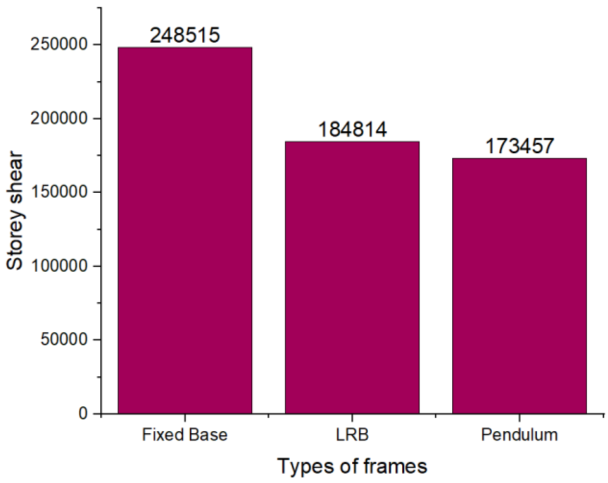

Fig 9: Base shear for 3 different structures

For total base shear show that on introduction of isolators to the fixed base frame the value of base shear is reduce up to 1.46 times of the fixed one. For isolated cases the maximum reduction in base shear is observed in case III (friction isolator with uniform stiffness) and almost equal reduction is there for both case 2-uniform rubber isolator stiffness & case 3 pendulum isolator stiffness.

CONCLUSION

Base isolation significantly extends the structure's duration and, as a result, lowers base shear. when seen in the current Study, the base shear is decreased to 1.46 times of that of the fixed one when the time period is raised up to 1.3 times.

The base shear value will decrease in accordance with the prolonged time period of the structure, and the displacement for fixed and isolated examples clearly demonstrates the reduction in case of isolated frame.

According to this study's findings and recommendations, the structure resting on rubber isolators is preferable to that resting on other isolators.

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