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International
Journal
Of Modern Engineering Research (IJMER)

Study of Structure Under Static And Dynamic Earthquake Analysis And Deformation Control With Dampers

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Abstract: *This study used both static and dynamic seismic methods to examine how structures behave when subjected to earthquake stresses, with a specific focus on the use of dampers to regulate deformation. Building and infrastructure seismic performance was crucial in earthquake-prone areas, requiring thorough analysis and reducing techniques. In an attempt to predict earthquake forces and assess structural behavior, this study used comparable static analysis techniques to examine how a structure responds to static earthquake loading. Additionally, variable-time seismic motion's impacts on the structure were represented using dynamic seismic analysis techniques, which also took the dynamic properties and earthquake appearance into consideration. In an effort to regulate structural deformations and lessen dynamic responses, the study assessed multiple kinds of dampers, such as viscous dampers, friction dampers, and tuned mass dampers. The beneficial effect of dampers in reducing structural vibrations, sway, and deformations under seismic load conditions has been examined through computational modeling and analytical research. In order to enhance building and infrastructure safety and seismic resilience, damping system conception and implementation should be better understood, as should the functioning of structures under seismic stresses. In this study consider static and dynamic analysis for irregular models. There are total four models prepared with the help of ETABS-2016. In first case use equivalent static method, for second case response spectrum, for third case time history method for analysis and a last choose that analysis concept for which maximum deformation occurred and that deformation controlled with the help of dampers.*
Keywords: *High-rise, Damper, Irregularities, Static and Dynamic Earthquake Analysis.*

I. INTRODUCTION

The sudden vibrating of the ground that marks earthquakes is caused by seismic waves that are passing through the earth's crust. Quake, tremor, and temblor are all names for earthquakes. Seismic waves are the outcome of an earthquake, which is the sudden discharge of energy from the crust of the Earth [1, 2]. Potential sources of crustal energy include mass motion, chemical processes, elastic strain, and gravity. As the only kind of energy that can be stored in the ground in sufficient amount to create substantial disturbances, the energy released owing to the elastic strain is the most important cause. In India, almost all buildings are quite modest in height (no more than four floors). The response spectrum from IS 1893 shows that low-rise buildings experience high levels of earthquake force because to their short duration. Despite this, most design engineers downplay the seriousness of the issue, putting residents at greater danger in the event of an earthquake. Damage to and loss of life in buildings constructed before the adoption of modern seismic standards is widespread [3-5].

The impact of earthquake activity on Indian construction is significant and has influenced building practices, codes, and infrastructure development. Here are some key aspects of this impact: Earthquake activity has led to the development and implementation of seismic-resistant building codes and guidelines in India. Structures in earthquake-prone areas are designed to withstand the lateral forces generated by seismic events. This includes features such as reinforced concrete frames, shear walls, and seismic dampers to enhance structural stability during earthquakes [6-8]. The susceptibility of infrastructure to earthquake damage has also prompted measures to improve resilience [9]. Bridges, roads, dams, and other critical infrastructure are designed with seismic considerations in mind. Retrofitting existing infrastructure to meet seismic standards is an ongoing challenge, particularly in older urban areas with densely populated neighborhoods.

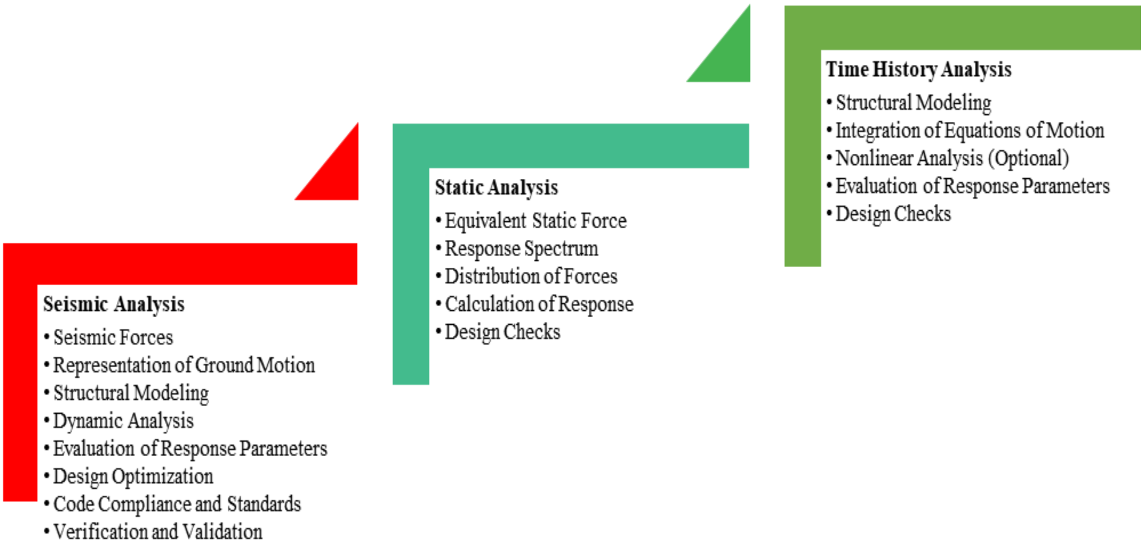


Figure 1 Flow diagram of analysis process of Structure with distinct methods

Damper

Dampers in structures are mechanical devices used to absorb, dissipate, or control energy, thereby reducing the amplitude of vibrations, oscillations, or movements induced by dynamic loads such as wind, earthquakes, or machinery [10, 11]. These are essential for enhancing the functionality, resilience, and safety of many kinds of structures, such as industrial facilities, towers, bridges, and skyscrapers. The primary purpose of dampers is to mitigate the effects of dynamic loads on structures by dissipating energy or altering the structural response [12-14]. They help reduce vibrations, sway, and deformation under external forces, thereby enhancing structural stability, comfort, and serviceability.

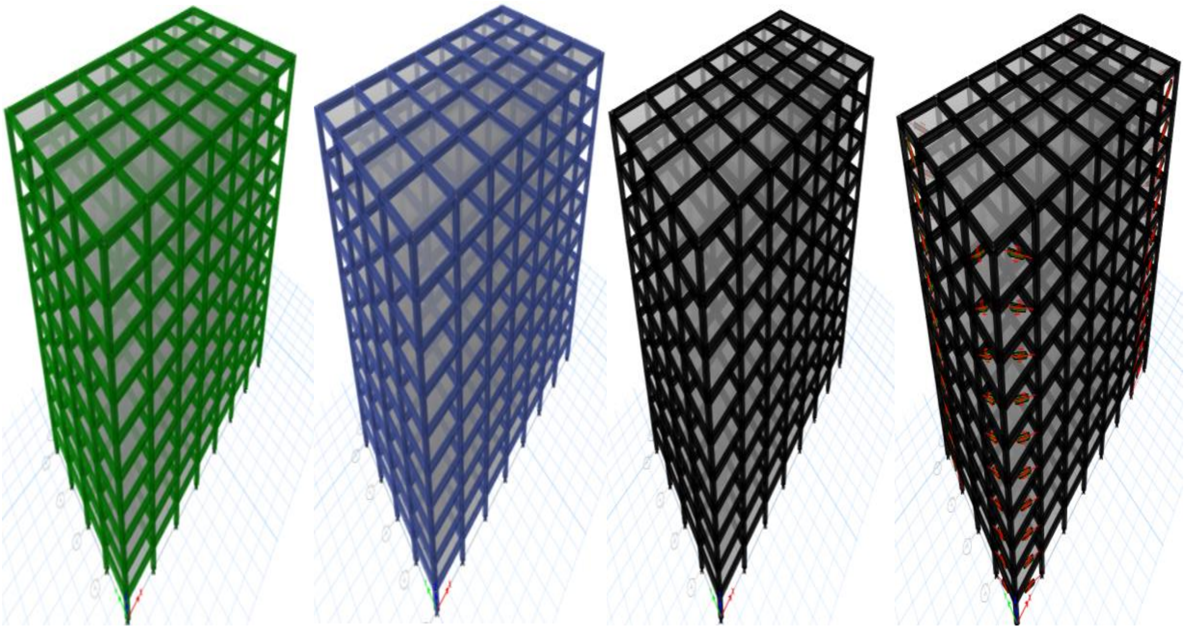
II. OBJECTIVES

- Compare the result data generated from response spectrum and time history analysis.
- Investigate structural responses to seismic forces, analyzing factors like internal forces, displacements, accelerations, and deformations.
- Contrast outcomes from static and dynamic earthquake analysis, comparing simplified estimates with time-varying ground motion considerations.
- Consider the effect of damper to control deformations and diminish dynamic responses under seismic loads.
- Offer recommendations and guidelines for implementing damping systems to mitigate seismic effects and enhance structural performance.

III. METHODOLOGY

In this section investigates both static and dynamic analyses for irregular structural models. Using ETABS-2016, four models were created. The first model employs the equivalent static method, the second model utilizes the response spectrum method, and the third model employs the time history method. Finally, the analysis concept with the maximum deformation is selected, and dampers are employed to control this deformation.

Case: 1 Bare frame with Equivalent Static Method.
Case: 2 Bare frame with Response Spectrum Method.
Case: 3 Bare frame with Time History Method.
Case: 4 Bare frame with Damper at Corners.



Case-1 Case-2 Case-3 Case-4

Figure 2 3D View of Structure in different cases

IV. RESULT AND DISCUSSION

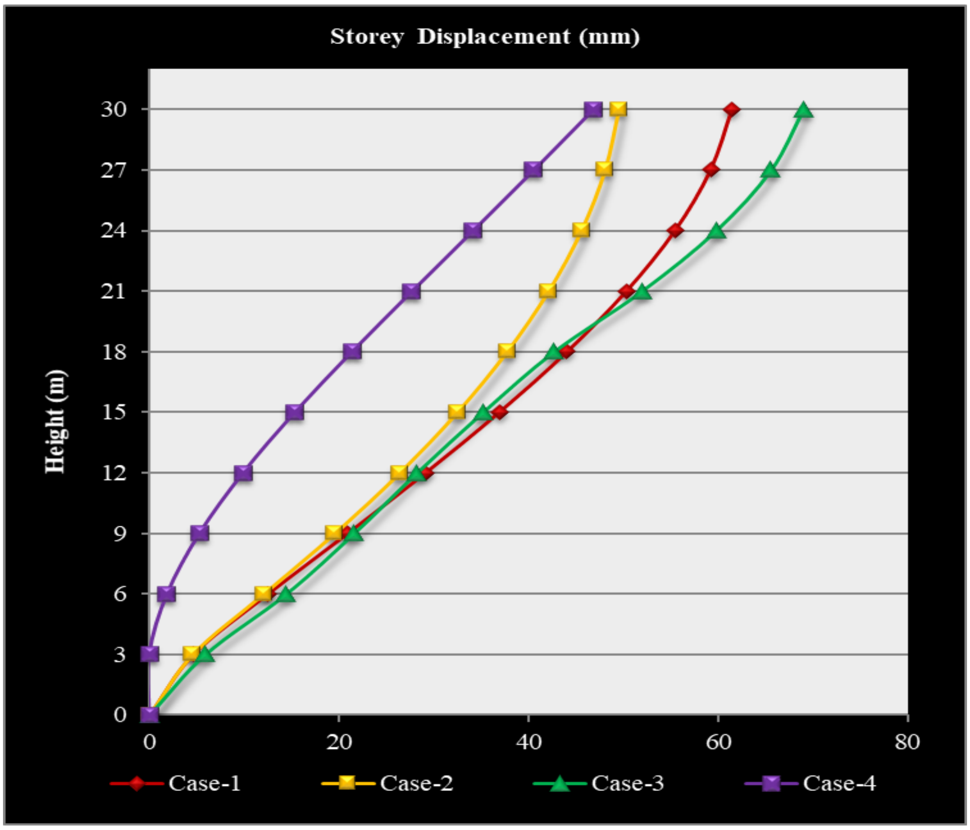


Figure 3 Comparative displacement of structure in different cases

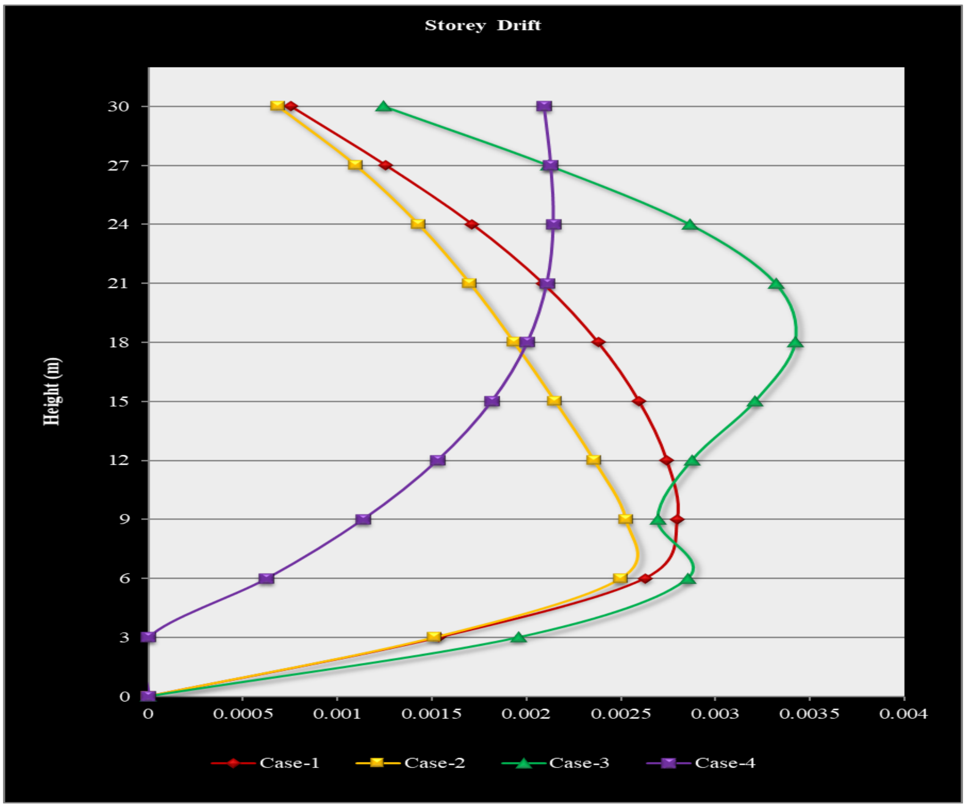


Figure 4 Comparative drift of structure in different cases

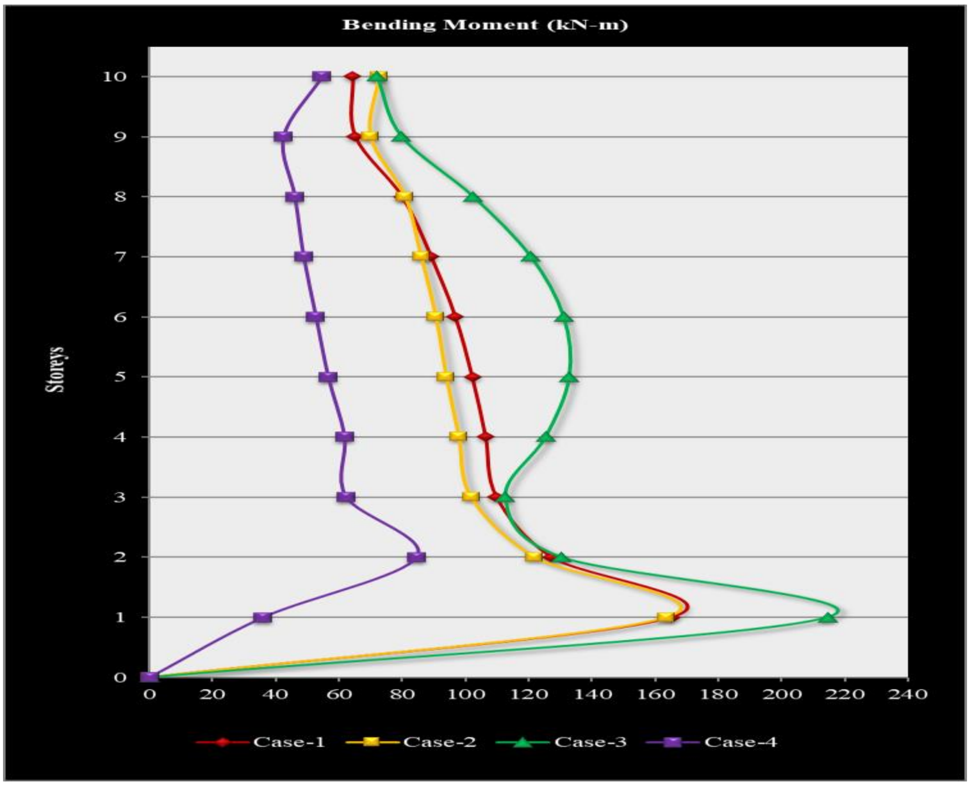


Figure 5 Comparative bending moment of structure in different cases

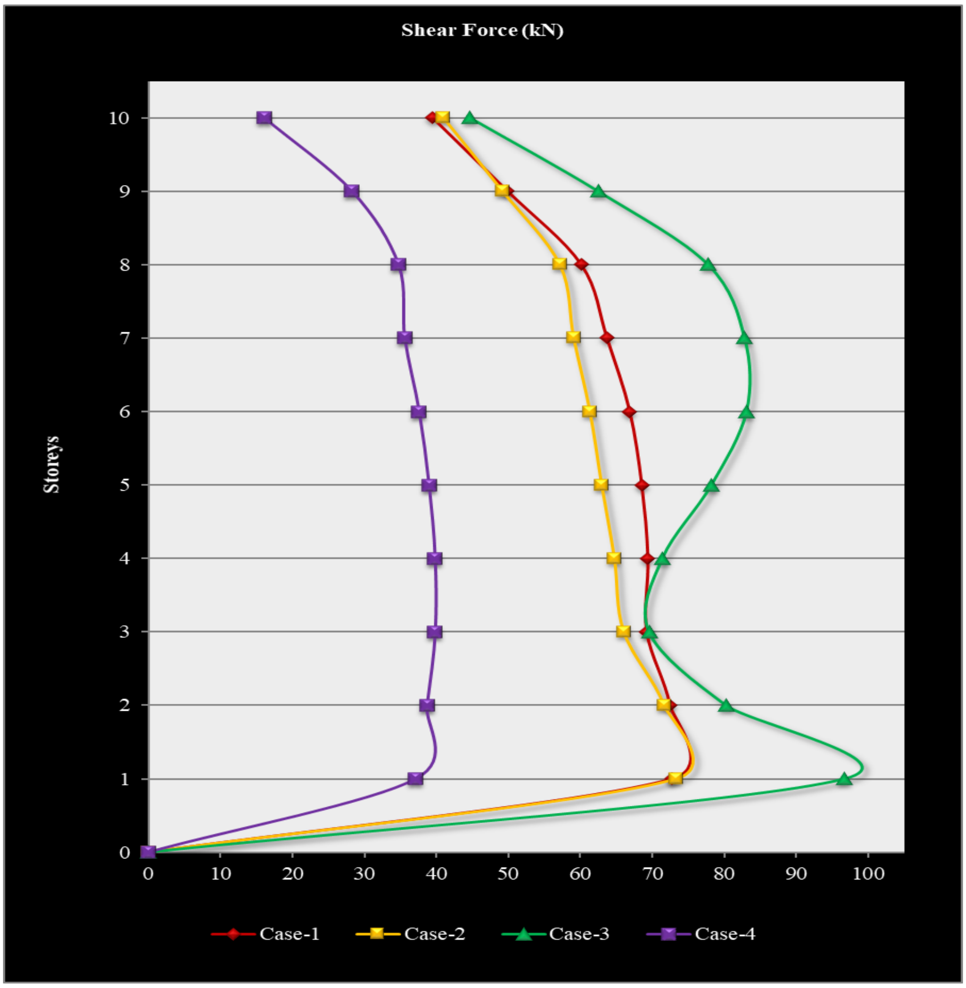


Figure 6 Comparative Shear force of structure in different cases

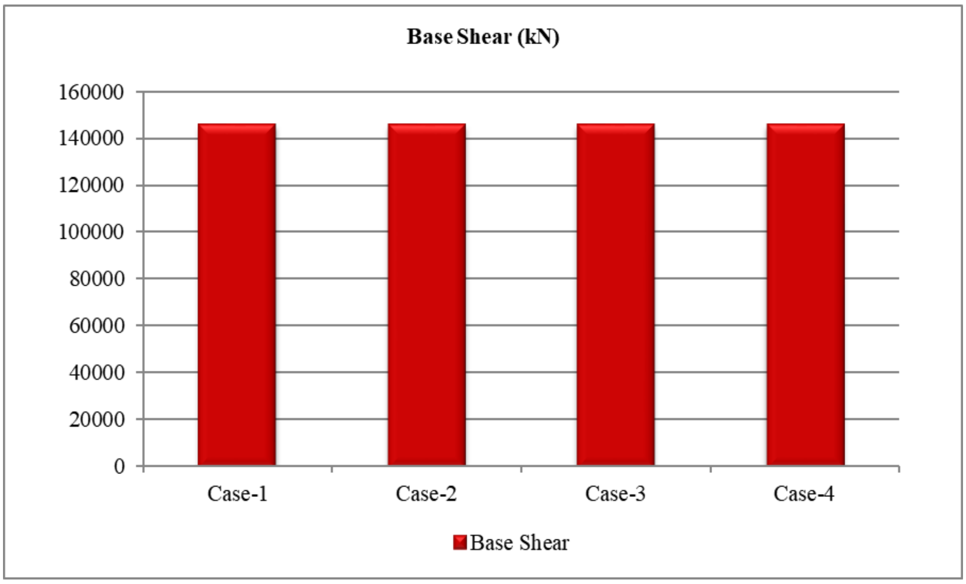


Figure 7 Comparative Base shear of structure in different cases

V. CONCLUSION

- The maximum storey displacement of a 10-floor structure varied based on the analysis method employed. Specifically, it measured 61.47mm with the equivalent static method, 49.51mm with the response spectrum method, and 68.95mm with the time history method. Introducing dampers at the corners reduced the displacement to 46.78mm. Notably, the highest displacement occurred with the time history method, indicating the significance of nonlinear dynamic analysis. Furthermore, incorporating dampers led to a notable 32.15% reduction in storey displacement.
- Similarly, the maximum storey drift showed variation with different analysis methods. It measured 0.002799 with the equivalent static method, 0.002528 with the response spectrum method and 0.003425 with the time history method. The introduction of dampers reduced the drift to 0.002143. As observed with displacement, the highest drift occurred with the time history method, with dampers contributing to a significant 37.43% reduction.
- Examining the maximum bending moment, it reached 165.30kN-m with the equivalent static method, 163.77kN-m with the response spectrum method, and 214.53kN-m with the time history method. Incorporating dampers reduced the bending moment to 84.59kN-m. Again, the time history method resulted in the highest bending moment, with dampers contributing to a notable 48.34% reduction.
- Furthermore, the maximum shear force showed variation with different analysis methods, measuring 72.74kN with the equivalent static method, 73.30kN with the response spectrum method, and 96.72kN with the time history method. Introducing dampers reduced the shear force to 39.79kN. Similar to other parameters, the time history method resulted in the highest shear force, with dampers contributing to a significant 58.86% reduction.
- The base shear remained unaffected by the method of analysis and the use of dampers, remaining unchanged in all cases.

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