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# Seismic Damage Assessment of RCC Structure Considering Infill Walls and Coupled Forces

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***Abstract:*** ***Seismic damage assessment of reinforced concrete (RC) structures is a critical aspect of structural engineering, especially in regions prone to earthquakes. These assessments ensure the safety and integrity of buildings during seismic events. Incorporating infill walls and understanding coupled forces are pivotal in accurately predicting and mitigating damage. Infill walls, although non-structural, significantly influence the dynamic behavior and overall seismic performance of RC structures. They interact with the structural frames, affecting stiffness, strength, and failure modes, which must be considered in any thorough analysis. Coupled forces, arising from the interactions between various structural and non-structural components during an earthquake, can profoundly impact a building's response to seismic loads. This introduction aims to underscore the importance of detailed seismic damage assessments, highlighting the need for advanced modeling techniques and comprehensive analyses to ensure that RC structures can withstand and perform adequately under seismic conditions. By integrating these considerations, engineers can enhance the resilience and safety of buildings, thereby reducing the risk of catastrophic failures and improving public safety during earthquakes.***

***Keywords:*** ***Infill Walls Coupled Forces Damage Index, Fiber Discretization Technique, coupled axial force, moment***

## I. INTRODUCTION

The accurate damage evaluations of structure are depending on other parameter such as, accurate modelling of frame, selection ground motion records. Masonry infill walls are widely used as partitions all over the world. Commonly masonry walls are not considered in the damage evaluation process because they are supposed to act as non-structural members or elements. Separately the infill walls are stiff and brittle but the frame is relatively flexible and ductile. The composite action of beam-column and infill walls provides additional strength and stiffness. When the frame is fully infilled, truss action is introduced. A fully infilled frame shows less inter-storey drift, although it attracts higher base shear (due to increased stiffness). A fully infilled frame yields less force in the frame elements and dissipates greater energy through infill walls. The strength and stiffness of infill walls in infilled frame buildings are ignored in the structural modelling in conventional damage evaluation practice. In this study the infill model as equivalent diagonal strut Seismic damage assessment of reinforced concrete (RC) structures is a critical aspect of structural engineering, especially in regions prone to earthquakes. These assessments ensure the safety and integrity of buildings during seismic events. Incorporating infill walls and understanding coupled forces are pivotal in accurately predicting and mitigating damage. Infill walls, although non-structural, significantly influence the dynamic behavior and overall seismic performance of RC structures. They interact with the structural frames, affecting stiffness, strength, and failure modes, which must be considered in any thorough analysis. Coupled forces, arising from the interactions between various structural and non-structural components during an earthquake, can profoundly impact a building's response to seismic loads. This introduction aims to underscore the importance of detailed seismic damage assessments, highlighting the need for advanced modeling techniques and comprehensive analyses to ensure that RC structures can withstand and perform adequately under seismic conditions. By integrating these considerations, engineers can enhance the resilience and safety of buildings, thereby reducing the risk of catastrophic failures and improving public safety during earthquakes.

## II. MODEL DEVELOPEMENT

### *A. Description of the Structure*

As example the damage analysis is performed for typical five storey reinforced concrete building. The frame building is designed according to the IS 456-2000 code. The typical storey height of frame is 3.2m used. The sectional properties of various elements obtained are based on gravity loading. The frames are analysis by considering and fiber hinge approach the computational model of the building as shown in Figure 1. for the analysis intermediate frame is considered. The frame is analyzed for various Indian ground motion records as shown in Table1

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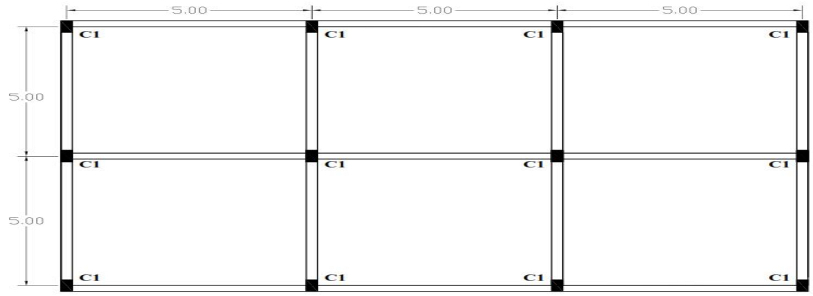


Figure 1: Plan of Symmetrical Building

The building is design for gravity loading data shown in Table 2.

Table2: Numerical Data for Infill Modeling Building

| | |
|---|---|
| Live load | 3 kN/m$^2$ |
| Floor finish | 1 kN/m$^2$ |
| Earthquake load | Indian ground motion Table.3.2.1 |
| Depth of foundation below GL | 1.5 m (consider as fixed) |
| Storey height | 3.0 m |
| Wall | 230 mm thick brick masonry walls. |
| Slab | 150 mm thick as rigid diaphragm |
| Masonry Modulus of elasticity | 550$f_m$ |
| Width of equivalent strut | 597mm |
| Strength of masonry | 7 N/mm$^2$ |
| Material Properties | Concrete- M20<br>HYSD reinforcement of grade Fe 415 |

## III. RESULTS

The hysteretic behaviour of column under different ground motions are shown in Figure 2. to 9 the hysteretic energy curve obtained from bare frame case shows more energy dissipation than the infill case. When the infill stiffness is considered in the building model the global stiffness is increased, reducing the fundamental period of the building. It affects the energy dissipation of joint. The infill's have energy dissipation characteristics that contribute to improved seismic performance which directly affects reduction in energy dissipation of joints. The detailed local and global damage index of structure are described in APPENDIX -C

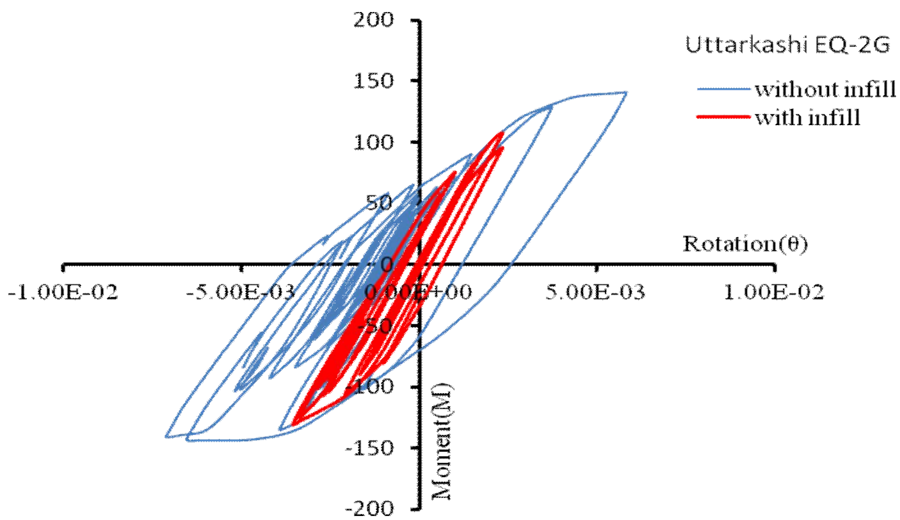


Figure 2: Hysteretic Behaviour of Bottom Storey Column Under Uttarkashi EQ

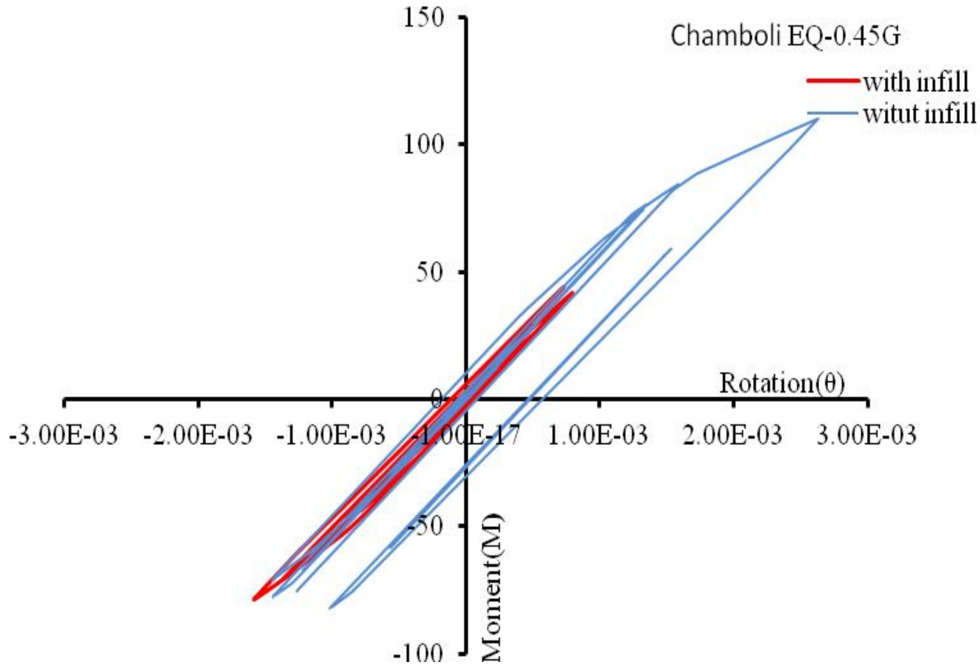


Figure 3: Hysteretic Behaviour of Bottom Storey Column under Chamboli EQ

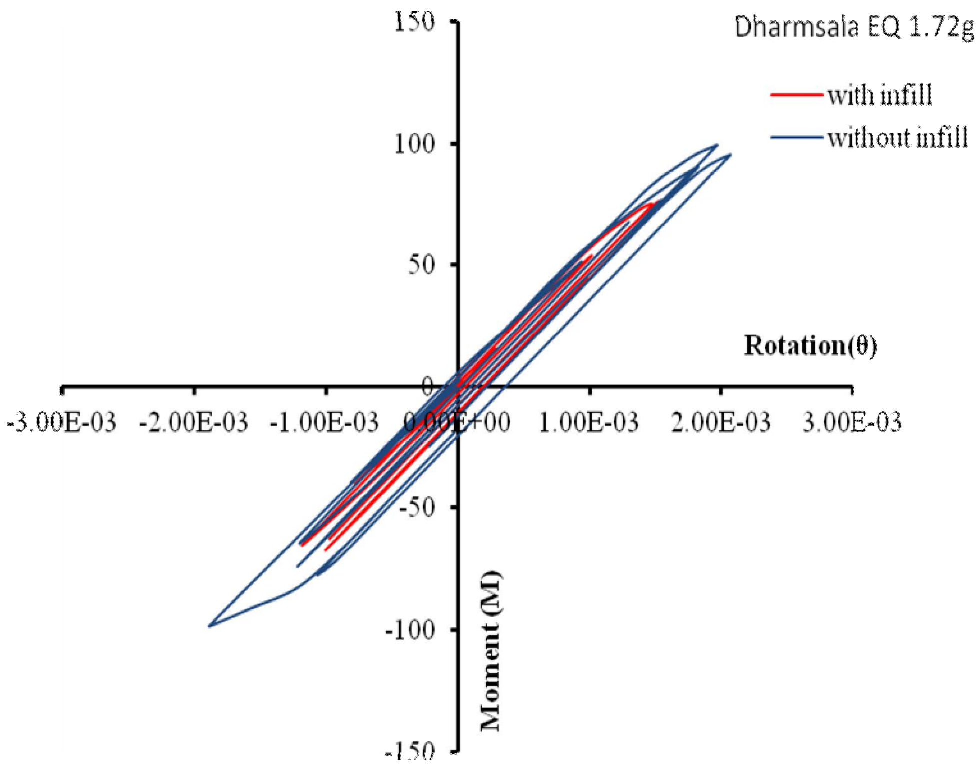


Figure 4: Hysteretic Behaviour of Bottom Storey Column under Dharmsala EQ

The damage distribution for the plastic hinges form in infill struts under different ground motions are illustrated in Figure 4.3.5.2.4 to 4.3.5.2.7.

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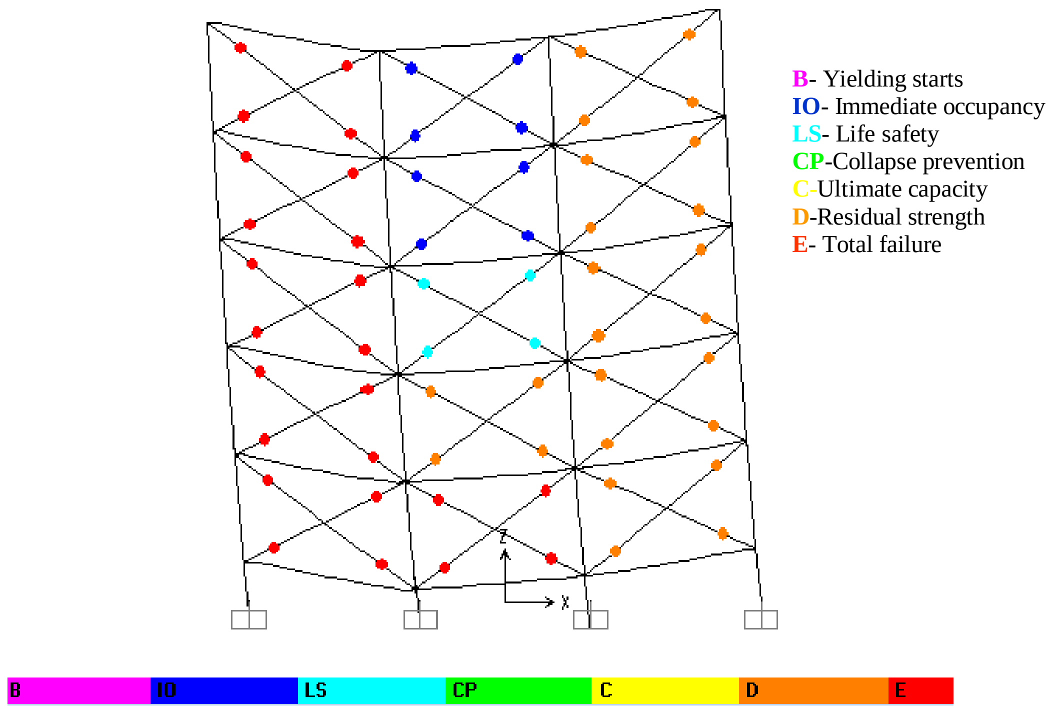


Figure 5: Hinge Formation in Infill Strut under Uttarkashi-EQ

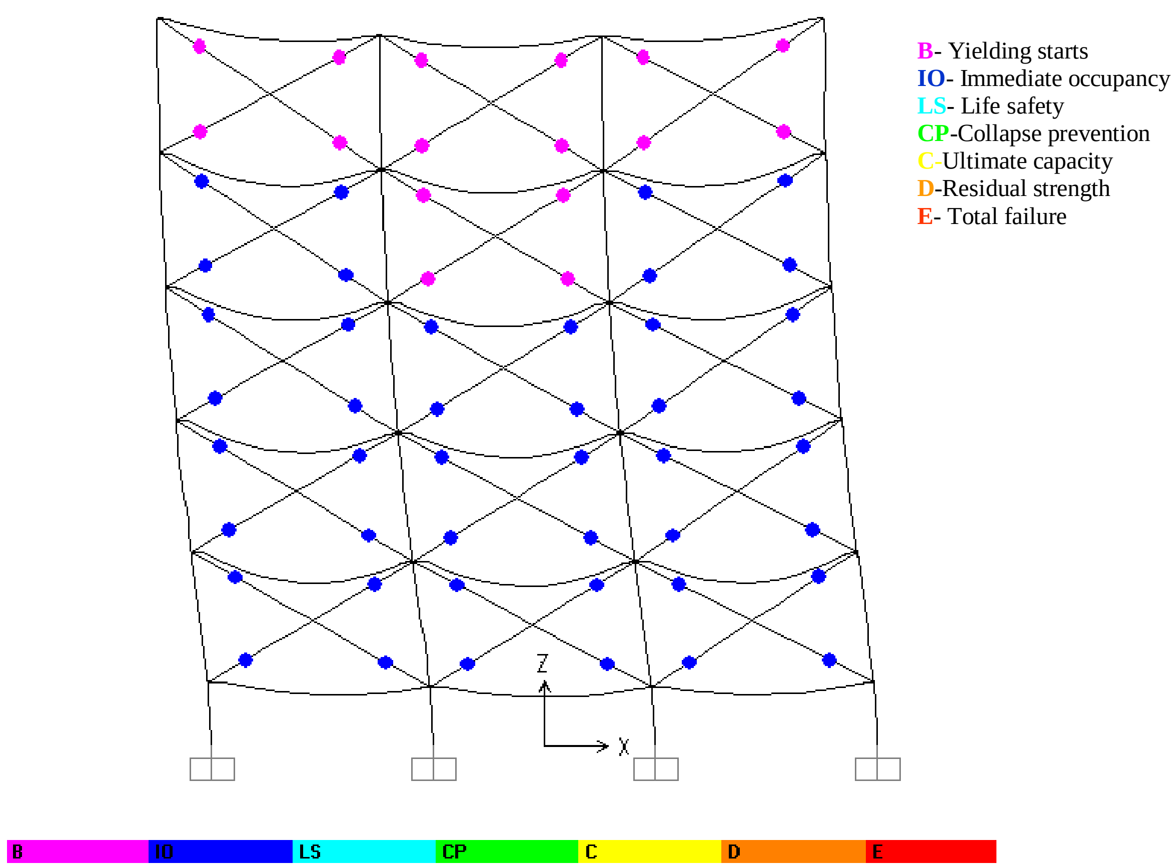


Figure 6: Hinge Formation in Infill Strut under 1.72g EQ

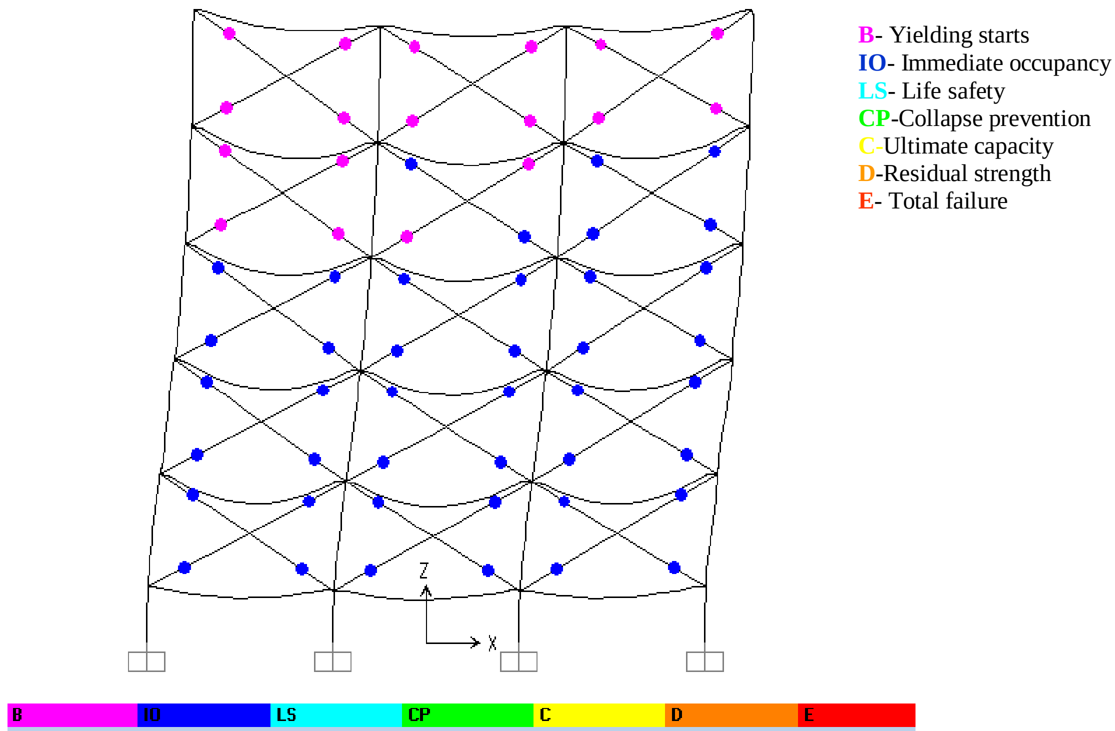


Figure 7: Hinge Formation in Infill Strut under 0.7g EQ

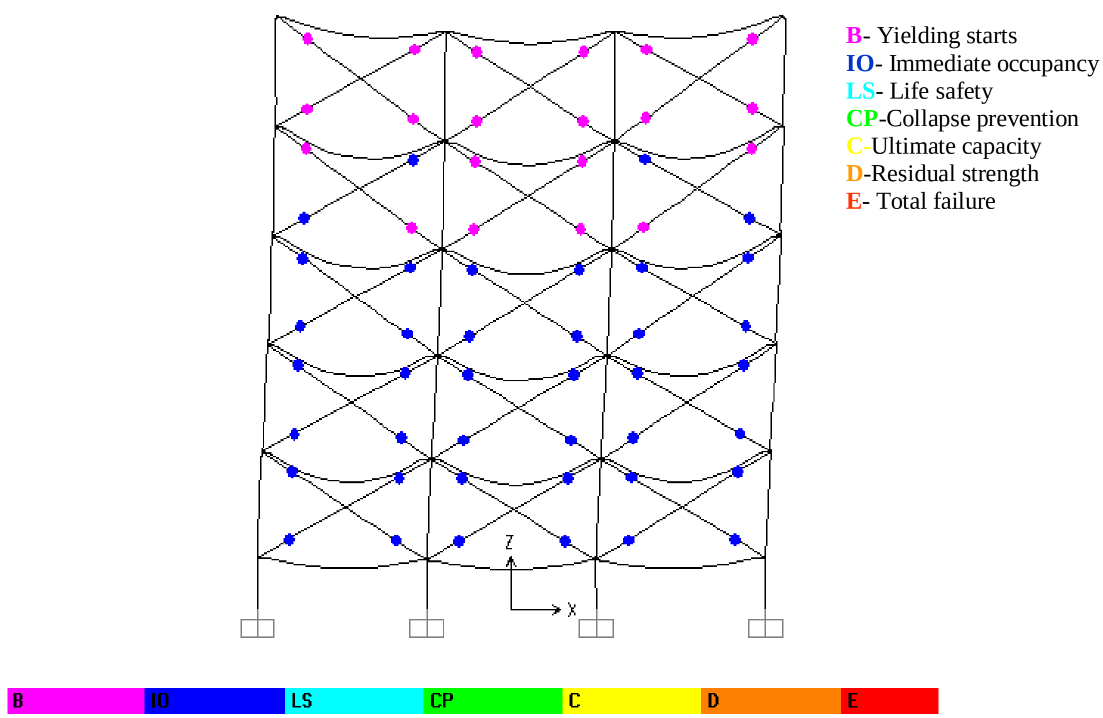


Figure 8: Hinge Formation in Infill Strut under 0.4g EQ

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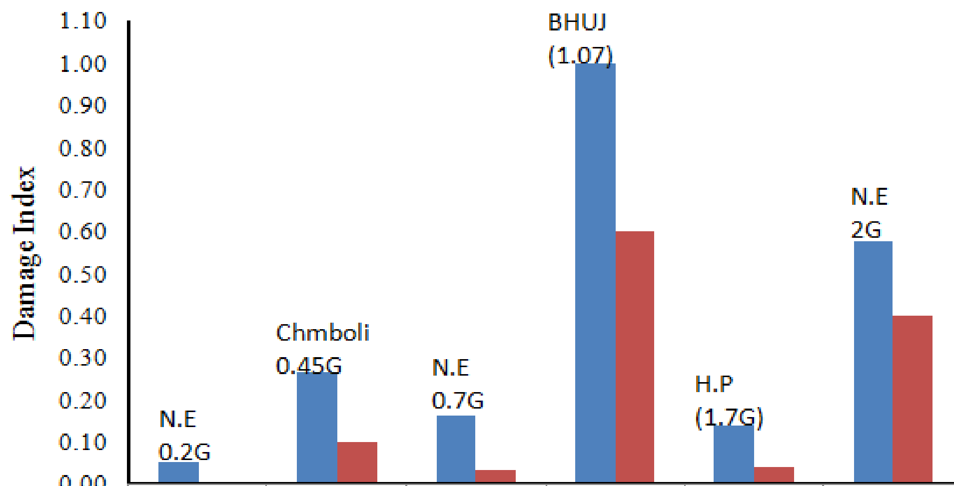
The various overall damage indices obtained from analysis under different ground motion considering infill and bare frame are as shown in Figure 4.3.5.2.8 the infill increases the stiffness and contributes energy dissipation in beams and columns. The reduction in the energy dissipation in joints directly affects local and global damage index of structure.




| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Without infill | 0.05 | 0.26 | 0.16 | 1 | 0.14 | 0.58 |
| With infill | 0 | 0.1 | 0.03 | 0.6 | 0.04 | 0.4 |

Figure 9: Comparison of Damage Index with Bare and Infill Frame

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## IV. CONCLUSION

1) Infill walls not only enhance stiffness but also facilitate energy dissipation in beams and columns.
2) This leads to a reduction in energy dissipation at joints, positively affecting the structural damage indices.
3) Infill walls play a crucial role in enhancing the seismic resilience of RC structures.

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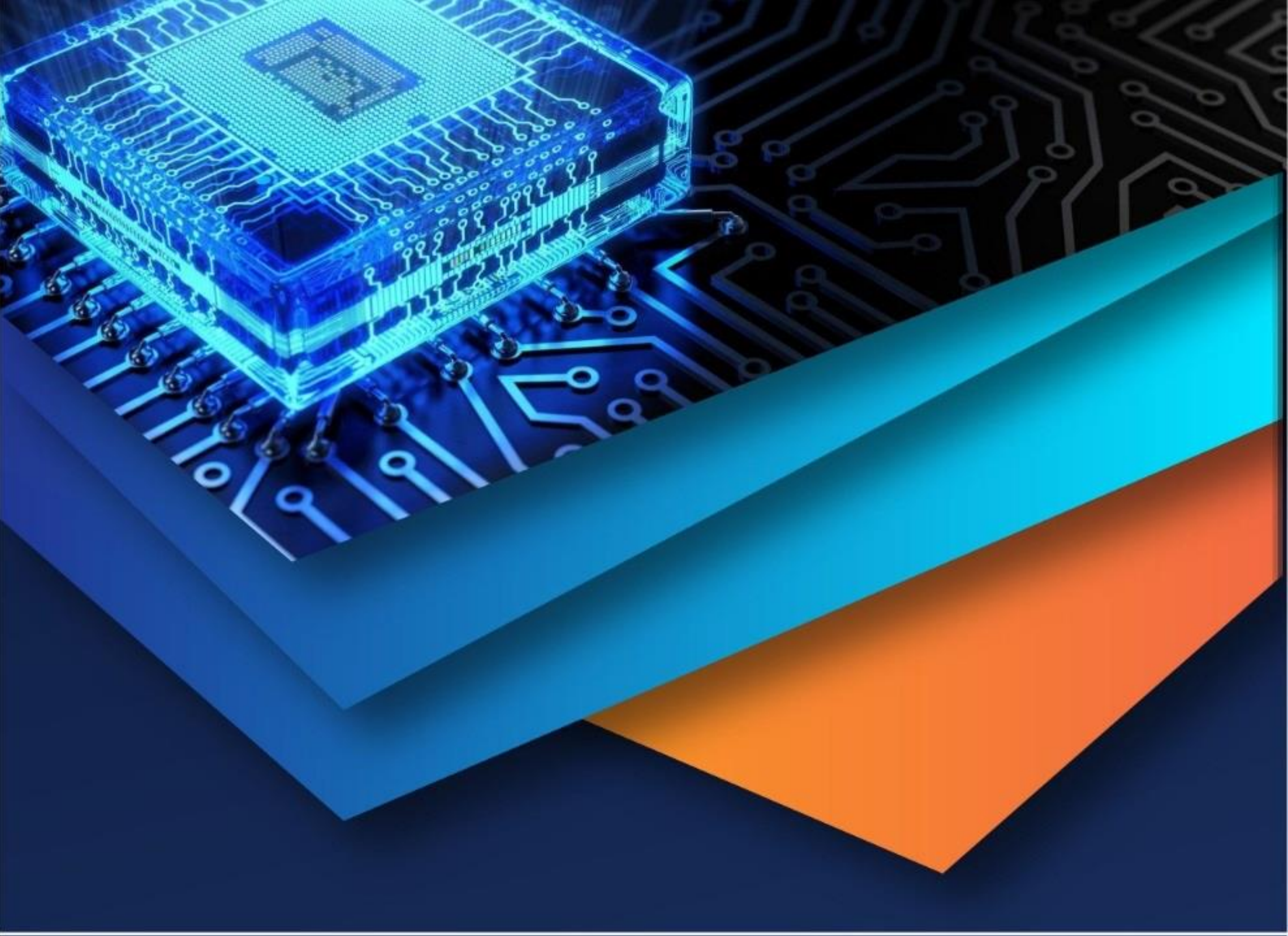

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