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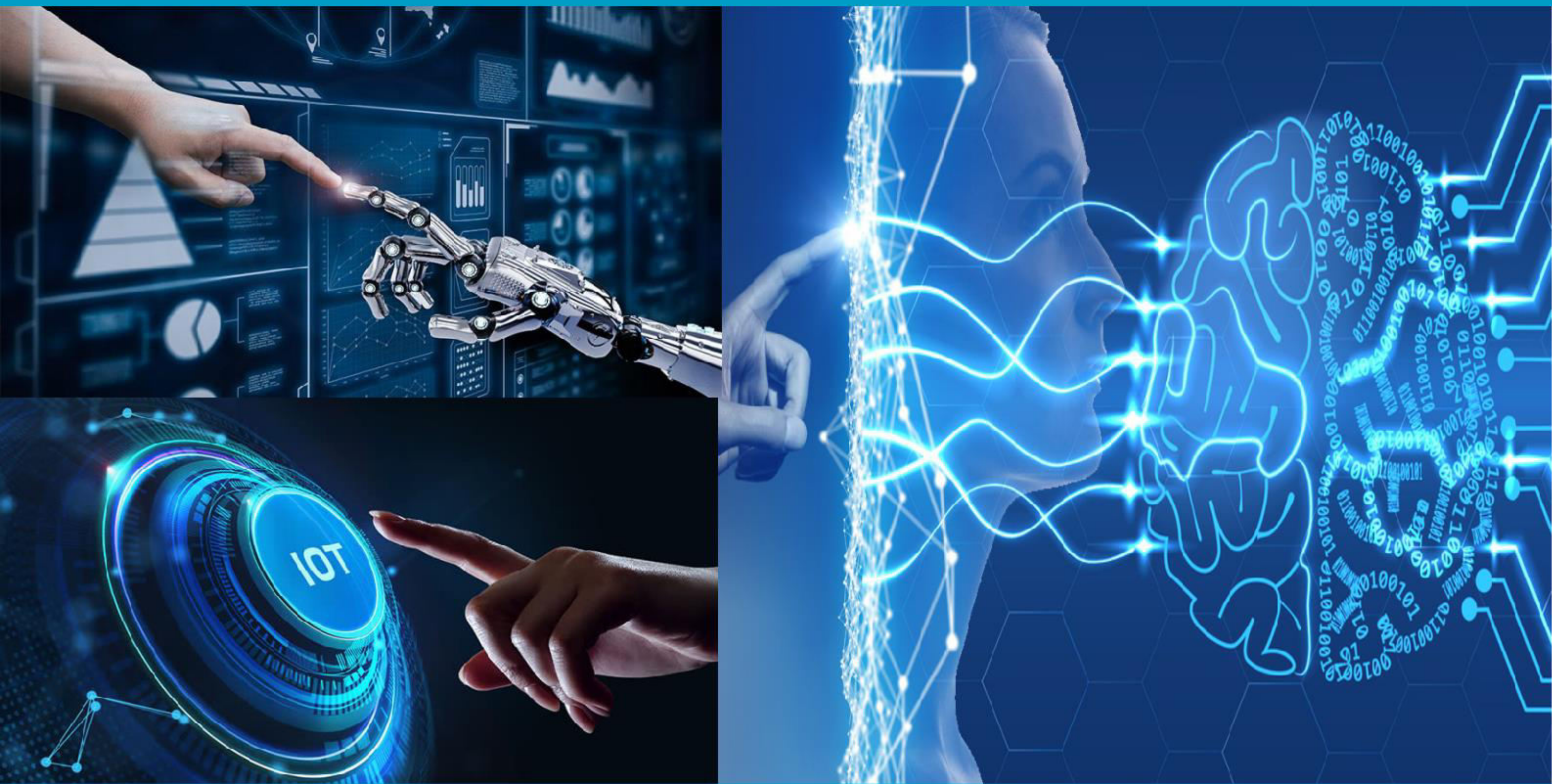

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Comparative Analysis of Structural Behavior in Seismic Prone Area III and IV

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ABSTRACT: This study evaluates the similarities and differences between the responses of the same building in Seismic Prone Areas III and IV. Drifts, bending moments, shear pressures, steel use, and column behavior are only some of the many topics covered in this investigation. The results show that there are major differences between the two seismic zones. Maximum column drifts in Seismic Zone IV were inconsistent with one another, pointing to a greater degree of lateral displacement compared to Seismic Zone III. Seismic Zone IV was found to have bending moments that were nearly 1.5 times higher than those in Seismic Zone III, indicating a greater demand on the structure. Since seismic activity was greater in Seismic Zone IV compared to Zone III, shear stresses on beams and columns were likewise much higher. Seismic Zone IV also has a higher steel-to-concrete ratio, suggesting that more robust and flexible construction is required to survive the stronger earthquakes that occur there. The research also indicated that there may be discrepancies in the way P-M-M columns communicate due to variations in how they sway or deflect. These results highlight the significance of adapting seismic design procedures to the unique features of each seismic zone. Additional design procedures and considerations are needed for the stability and safety of structures in Seismic Zone IV. Effectively addressing the problems presented by seismic activity and promoting the resilience of buildings in high-risk locations requires strict adherence to design rules, collaboration with skilled structural engineers, and thorough assessments.

KEYWORDS: shear forces, steel utilization, column behavior, Seismic Prone Area, drifts, bending moments

I. INTRODUCTION

The structure has been designed to resist all types of forces, including those caused by lateral movements and gravity. To ensure economic efficiency, the design must account for factors such as earthquakes and high winds, which generate lateral forces that create bending moments at the structure's base. In addition to lateral forces, the structure is also subject to gravitational forces resulting from its own weight, as well as any dead or live loads it may carry. To withstand these forces, the structure must be appropriately sized, reinforced, and proportioned, with an optimal beam to depth ratio. In summary, the design of the structure must consider a variety of factors to ensure its strength and stability, including resistance to lateral and gravitational forces, ideal member sizes, appropriate reinforcement, and optimal proportions.

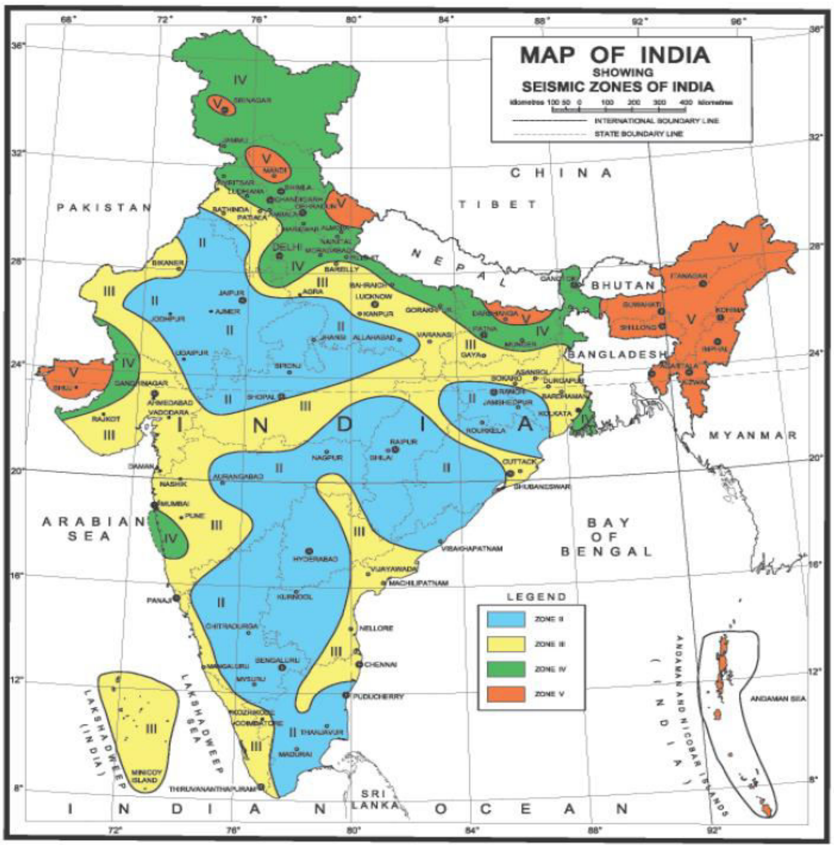
Objectives of the Study

The following are some of the goals that the research intends to accomplish:
The purpose of this study is to investigate the seismic behavior of a reinforced concrete building by means of response spectrum analysis.
In this study, the researchers compared Seismic Prone Area III and IV to one another in terms of bending moment and shear force.
It's important to evaluate the various models' findings across numerous parameters (such as Storey drift and Storey forces, or the proportion of steel that migrated from zone III to zone IV).
To get the most efficient and cost-effective setup feasible under the given conditions.

Scope of Present Study

With the assistance of the Indian seismic code IS 1893-2016 and the SAP2000 v23.1.10 software, the purpose of this study was to conduct an analysis of a G+7 reinforced concrete building located in India's Seismic Prone Area III and IV with the intention of determining the reinforcement percentage, maximum deflection, shear force, and bending moment variations. The structure will be analyzed using the Indian seismic code, and these parameters will be determined using that code.

IS 1893 (Part 1) : 2016



Based upon Survey of India Political map printed in 2002.

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Fig. 1: Map

II. METHODOLOGY

- A model and analysis of a G+7 reinforced concrete building located in seismic zone III in India were carried out.
- The modelling and analysis of a structure that is similar to others that are situated inside the Indian seismic zone 4 are components of this research.
- Modelling and analysis of the same structural element are both accomplished via the use of the method known as response spectrum analysis.
- A comparison of the results obtained by using the aforementioned models, including the amount of steel that was used, the amount of time that passed, the amount of storey displacement, and the amount of storey drift, as well as the identification of the method that is the most effective.

III. RESULTS AND DISCUSSIONS

In this section, we will go through the whole set of findings from the structure once it has been analyzed and designed.

BASE REACTIONS

TABLE: Base Reactions								
OutputCase	CaseType	StepType	GlobalFX	GlobalFY	GlobalFZ	GlobalMX	GlobalMY	GlobalMZ
Text	Text	Text	KN	KN	KN	KN-m	KN-m	KN-m
1 EQX	LinRespSpec	Max	825.663	0.0001118	0.000513	0.0018	10744.0362	3302.6531
2 EQY	LinRespSpec	Max	0.0001379	825.692	0.0005474	10704.4958	0.0072	8256.9183
3 DEAD LOAD	LinStatic		6.661E-14	-6.839E-14	17447.245	69788.9796	-174472.449	-4.476E-13
4 LIVE LOAD	LinStatic		1.926E-14	-7.522E-15	3120	12480	-31200	-1.821E-14

Fig. 2: Structure in zone III

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TABLE: Base Reactions								
OutputCase	CaseType	StepType	GlobalFX	GlobalFY	GlobalFZ	GlobalMX	GlobalMY	GlobalMZ
Text	Text	Text	KN	KN	KN	KN-m	KN-m	KN-m
1 EQX	LinRespSpec	Max	1238.495	0.0001677	0.0007694	0.0028	16116.0543	4953.9796
2 EQY	LinRespSpec	Max	0.0002068	1238.538	0.0008211	16056.7437	0.0109	12385.3775
3 DEAD LOAD	LinStatic		8.793E-14	-1.723E-13	17447.245	69788.9796	-174472.449	-1.961E-12
4 LIVE LOAD	LinStatic		1.563E-14	-3.608E-14	3120	12480	-31200	-3.961E-13

Fig. 3: Structure in zone III

Table 1: Comparison od base reactions between seismic zone III & IV

	Base reactions in Zone III	Base reactions in Zone IV
EQX, EQY	825.663.	1238.495

The seismic base responses in seismic zone IV are almost 1.5 times larger than those in seismic zone III, according to the results of an examination into an identical building situated in both Seismic Prone Area III and IV. These findings are in accordance with the findings of the investigation into the structure's performance in both Seismic Prone Area III and IV.

Drift & Deflections

seismic design, structures located in higher Seismic Prone Area often require more robust and resistant designs to withstand the increased forces generated by earthquakes. Therefore, it is not uncommon to observe significant contrasts in maximum drifts of columns between different seismic zones. Structures in higher Seismic Prone Area may experience larger drifts due to the increased seismic forces acting on them.

Joint Displacements

File View Edit Format-Filter-Sort Select Options

Units: As Noted

Filter:

Joint Text	OutputCase Text	CaseType Text	StepType Text	U1 mm	U2 mm	U3 mm	R1 Radians	R2 Radians	R3 Radians
20	108 1(DL+EQZ)	Combination	Min	-4.79E-08	-20.116157	-2.910383	-0.000265	-5.835E-11	-6.255E-12
20	109 1(DL-EQZ)	Combination	Min	-4.79E-08	-20.116157	-2.910383	-0.000265	-5.835E-11	-6.255E-12
20	112 1(DL+EQZ)	Combination	Min	-4.79E-08	-20.116111	-2.664905	-0.000263	-5.835E-11	-6.255E-12
20	113 1(DL-EQZ)	Combination	Min	-4.79E-08	-20.116111	-2.664905	-0.000263	-5.835E-11	-6.255E-12
21	104 1(DL+50%LL+EQZ)	Combination	Min	-5.78E-08	-20.115768	-3.378536	-0.000211	-3.733E-11	-6.25E-12
21	105 1(DL+50%LL-EQZ)	Combination	Min	-5.78E-08	-20.115768	-3.378536	-0.000211	-3.733E-11	-6.25E-12
24	104 1(DL+50%LL+EQZ)	Combination	Min	-4.597E-08	-20.115681	-3.260769	-0.000207	-3.664E-11	-6.473E-12
24	105 1(DL+50%LL-EQZ)	Combination	Min	-4.597E-08	-20.115681	-3.260769	-0.000207	-3.664E-11	-6.473E-12
24	108 1(DL+EQZ)	Combination	Min	-4.597E-08	-20.115681	-2.565878	-0.000207	-3.664E-11	-6.473E-12
24	109 1(DL-EQZ)	Combination	Min	-4.597E-08	-20.115681	-2.565878	-0.000207	-3.664E-11	-6.473E-12
24	112 1(DL+EQZ)	Combination	Min	-4.597E-08	-20.115681	-2.30929	-0.000207	-3.664E-11	-6.473E-12
24	113 1(DL-EQZ)	Combination	Min	-4.597E-08	-20.115681	-2.30929	-0.000207	-3.664E-11	-6.473E-12
20	104 1(DL+50%LL+EQZ)	Combination	Min	-4.79E-08	-20.115632	-3.378536	-0.000296	-5.835E-11	-6.255E-12
20	105 1(DL+50%LL-EQZ)	Combination	Min	-4.79E-08	-20.115632	-3.378536	-0.000296	-5.835E-11	-6.255E-12
21	112 1(DL+EQZ)	Combination	Min	-5.78E-08	-20.115289	-2.664905	-0.000244	-3.733E-11	-6.25E-12
21	113 1(DL-EQZ)	Combination	Min	-5.78E-08	-20.115289	-2.664905	-0.000244	-3.733E-11	-6.25E-12
21	108 1(DL+EQZ)	Combination	Min	-5.78E-08	-20.115243	-2.910383	-0.000242	-3.733E-11	-6.25E-12
21	109 1(DL-EQZ)	Combination	Min	-5.78E-08	-20.115243	-2.910383	-0.000242	-3.733E-11	-6.25E-12

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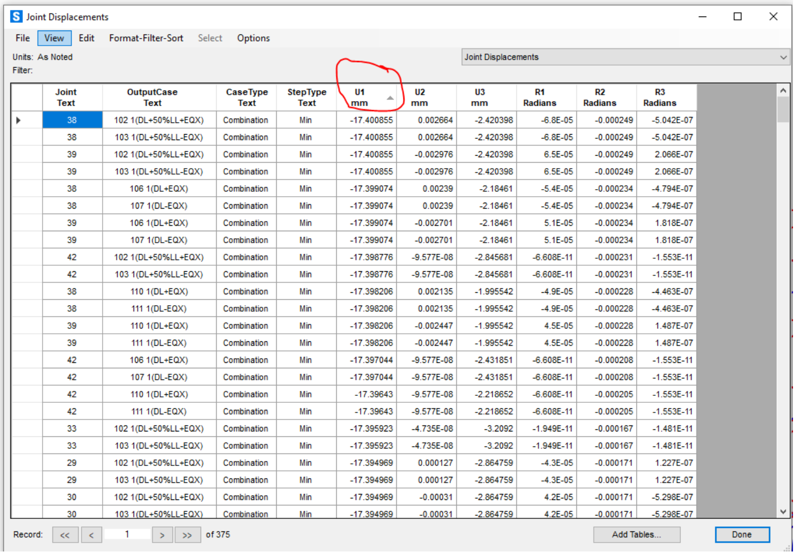
Fig.4: Structures column drift in zone III

In seismic design, column drift refers to the lateral displacement or deflection that occurs at the top of a column during an earthquake. The maximum drift of a column is an important consideration in structural design, as excessive drift can lead to structural instability and damage.

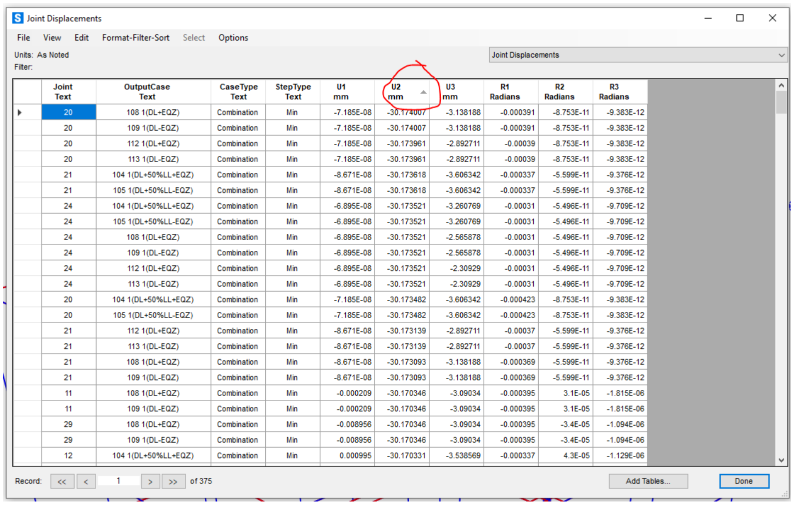
In Seismic Zone III, which typically corresponds to regions with moderate to high seismic activity, structures are designed to withstand significant seismic forces. The allowable maximum drift limits for columns in Seismic Zone III are generally more stringent compared to lower seismic zones.

The specific maximum drift limits for columns in Seismic Zone III can vary depending on the design codes and regulations followed in a particular country or region. For example, in the United States, the American Society of Civil Engineers (ASCE) 7 standard provides guidelines for seismic design. According to ASCE 7, the maximum inter-story drift limit for structures in Seismic Design Category D (which includes Seismic Zone III) is typically limited to 2-3% of the story height.



Joint Text	OutputCase Text	CaseType Text	StepType Text	U1 mm	U2 mm	U3 mm	R1 Radians	R2 Radians	R3 Radians
38	102 1(DL+50%LL+EQX)	Combination	Min	-17.400855	0.002664	-2.420398	-6.8E-05	-0.000249	-5.042E-07
38	103 1(DL+50%LL-EQX)	Combination	Min	-17.400855	0.002664	-2.420398	-6.8E-05	-0.000249	-5.042E-07
39	102 1(DL+50%LL+EQX)	Combination	Min	-17.400855	-0.002976	-2.420398	6.5E-05	-0.000249	2.066E-07
39	103 1(DL+50%LL-EQX)	Combination	Min	-17.400855	-0.002976	-2.420398	6.5E-05	-0.000249	2.066E-07
38	106 1(DL+EQX)	Combination	Min	-17.399074	0.00239	-2.18461	-5.4E-05	-0.000234	-4.794E-07
38	107 1(DL-EQX)	Combination	Min	-17.399074	0.00239	-2.18461	-5.4E-05	-0.000234	-4.794E-07
39	106 1(DL+EQX)	Combination	Min	-17.399074	-0.002701	-2.18461	5.1E-05	-0.000234	1.818E-07
39	107 1(DL-EQX)	Combination	Min	-17.399074	-0.002701	-2.18461	5.1E-05	-0.000234	1.818E-07
42	102 1(DL+50%LL+EQX)	Combination	Min	-17.398776	-9.577E-08	-2.845681	-6.608E-11	-0.000231	-1.553E-11
42	103 1(DL+50%LL-EQX)	Combination	Min	-17.398776	-9.577E-08	-2.845681	-6.608E-11	-0.000231	-1.553E-11
38	110 1(DL+EQX)	Combination	Min	-17.398206	0.002135	-1.995542	-4.9E-05	-0.000228	-4.463E-07
38	111 1(DL-EQX)	Combination	Min	-17.398206	0.002135	-1.995542	-4.9E-05	-0.000228	-4.463E-07
39	110 1(DL+EQX)	Combination	Min	-17.398206	-0.002447	-1.995542	4.5E-05	-0.000228	1.487E-07
39	111 1(DL-EQX)	Combination	Min	-17.398206	-0.002447	-1.995542	4.5E-05	-0.000228	1.487E-07
42	106 1(DL+EQX)	Combination	Min	-17.397044	-9.577E-08	-2.431851	-6.608E-11	-0.000208	-1.553E-11
42	107 1(DL-EQX)	Combination	Min	-17.397044	-9.577E-08	-2.431851	-6.608E-11	-0.000208	-1.553E-11
42	110 1(DL+EQX)	Combination	Min	-17.39643	-9.577E-08	-2.218652	-6.608E-11	-0.000205	-1.553E-11
42	111 1(DL-EQX)	Combination	Min	-17.39643	-9.577E-08	-2.218652	-6.608E-11	-0.000205	-1.553E-11
33	102 1(DL+50%LL+EQX)	Combination	Min	-17.395923	-4.735E-08	-3.2092	-1.949E-11	-0.000167	-1.481E-11
33	103 1(DL+50%LL-EQX)	Combination	Min	-17.395923	-4.735E-08	-3.2092	-1.949E-11	-0.000167	-1.481E-11
29	102 1(DL+50%LL+EQX)	Combination	Min	-17.394969	0.000127	-2.864759	-4.3E-05	-0.000171	1.227E-07
29	103 1(DL+50%LL-EQX)	Combination	Min	-17.394969	0.000127	-2.864759	-4.3E-05	-0.000171	1.227E-07
30	102 1(DL+50%LL+EQX)	Combination	Min	-17.394969	-0.00031	-2.864759	4.2E-05	-0.000171	-5.298E-07
30	103 1(DL+50%LL-EQX)	Combination	Min	-17.394969	-0.00031	-2.864759	4.2E-05	-0.000171	-5.298E-07

Fig. 5: Structure in zone III



Joint Text	OutputCase Text	CaseType Text	StepType Text	U1 mm	U2 mm	U3 mm	R1 Radians	R2 Radians	R3 Radians
20	108 1(DL+EQZ)	Combination	Min	-7.185E-08	-30.174007	-3.138188	-0.000391	-8.753E-11	-9.383E-12
20	109 1(DL-EQZ)	Combination	Min	-7.185E-08	-30.174007	-3.138188	-0.000391	-8.753E-11	-9.383E-12
20	112 1(DL+EQZ)	Combination	Min	-7.185E-08	-30.173961	-2.892711	-0.00039	-8.753E-11	-9.383E-12
20	113 1(DL-EQZ)	Combination	Min	-7.185E-08	-30.173961	-2.892711	-0.00039	-8.753E-11	-9.383E-12
21	104 1(DL+50%LL+EQZ)	Combination	Min	-8.671E-08	-30.173618	-3.606342	-0.000337	-5.599E-11	-9.376E-12
21	105 1(DL+50%LL-EQZ)	Combination	Min	-8.671E-08	-30.173618	-3.606342	-0.000337	-5.599E-11	-9.376E-12
24	104 1(DL+50%LL+EQZ)	Combination	Min	-6.895E-08	-30.173521	-3.260769	-0.00031	-5.496E-11	-9.709E-12
24	105 1(DL+50%LL-EQZ)	Combination	Min	-6.895E-08	-30.173521	-3.260769	-0.00031	-5.496E-11	-9.709E-12
24	108 1(DL+EQZ)	Combination	Min	-6.895E-08	-30.173521	-2.565878	-0.00031	-5.496E-11	-9.709E-12
24	109 1(DL-EQZ)	Combination	Min	-6.895E-08	-30.173521	-2.565878	-0.00031	-5.496E-11	-9.709E-12
24	112 1(DL+EQZ)	Combination	Min	-6.895E-08	-30.173521	-2.30929	-0.00031	-5.496E-11	-9.709E-12
24	113 1(DL-EQZ)	Combination	Min	-6.895E-08	-30.173521	-2.30929	-0.00031	-5.496E-11	-9.709E-12
20	104 1(DL+50%LL+EQZ)	Combination	Min	-7.185E-08	-30.173482	-3.606342	-0.000423	-8.753E-11	-9.383E-12
20	105 1(DL+50%LL-EQZ)	Combination	Min	-7.185E-08	-30.173482	-3.606342	-0.000423	-8.753E-11	-9.383E-12
21	112 1(DL+EQZ)	Combination	Min	-8.671E-08	-30.173139	-2.892711	-0.00037	-5.599E-11	-9.376E-12
21	113 1(DL-EQZ)	Combination	Min	-8.671E-08	-30.173139	-2.892711	-0.00037	-5.599E-11	-9.376E-12
21	108 1(DL+EQZ)	Combination	Min	-8.671E-08	-30.173093	-3.138188	-0.000369	-5.599E-11	-9.376E-12
21	109 1(DL-EQZ)	Combination	Min	-8.671E-08	-30.173093	-3.138188	-0.000369	-5.599E-11	-9.376E-12
11	108 1(DL+EQZ)	Combination	Min	-0.000209	-30.170346	-3.09034	-0.000395	3.1E-05	-1.815E-06
11	109 1(DL-EQZ)	Combination	Min	-0.000209	-30.170346	-3.09034	-0.000395	3.1E-05	-1.815E-06
29	108 1(DL+EQZ)	Combination	Min	-0.008956	-30.170346	-3.09034	-0.000395	-3.4E-05	-1.094E-06
29	109 1(DL-EQZ)	Combination	Min	-0.008956	-30.170346	-3.09034	-0.000395	-3.4E-05	-1.094E-06
12	104 1(DL+50%LL+EQZ)	Combination	Min	0.000995	-30.170331	-3.538569	-0.000337	4.3E-05	-1.129E-06

Fig. 6: Structure in zone IV

Table 2: Comparison of drift between seismic zone III & IV

	Node	Load case number	Max.Drift in Zone III	Max.Drift in Zone IV
U1 (X)	38	102	17.40	26.096
U2 (Y)	20	108	20.116	30.174

When comparing the drift between Seismic Zone III and Seismic Zone IV, it's important to consider that Seismic Prone Area are categorized based on the level of seismic activity and the potential for stronger earthquakes. Generally, higher Seismic Prone Area correspond to regions with more significant seismic forces and a higher likelihood of experiencing stronger ground shaking. In seismic design, the maximum allowable drift for columns in a structure is typically influenced by the anticipated level of seismic activity in the region. Therefore, structures located in Seismic Zone IV, which is typically associated with higher seismicity, would generally have more stringent drift requirements compared to structures in Seismic Zone III. The specific maximum drift limits for columns can vary based on design codes, regulations, and specific project requirements. These limits are established to ensure the structural integrity and safety of buildings during seismic events. To provide a more accurate and detailed comparison of drift between Seismic Zone III and Seismic Zone IV, specific information such as the design codes, structural type, and other project-specific details would be necessary. Without such information, it is challenging to provide specific values or quantitative comparisons of drift between these two seismic zones.

IV. CONCLUSIONS

In conclusion, there are notable variations between a single building in a Seismic Prone Area III and IV. It was discovered that in Seismic Prone Area III and IV, the maximum drifts of columns toward the top of the building were different. More than 1.5 times as much more bending moments were recorded in Seismic Zone IV compared to Seismic Zone III. Seismic Zone IV also had more shear stresses on beams and columns than Seismic Zone III. Seismic Zone IV was also discovered to have a higher proportion of steel in the columns and beams. It was hypothesized that the swaying or deflection of columns, which stands for communication between P-M-M columns, would vary across the two seismic zones.

These results demonstrate the profound impact that seismic activity and ground shaking have on the behavior and reaction of structures. Seismic Zone IV is home to stronger earthquakes and more careful planning is needed to assure the safety of any structures built there. The need of adapting seismic design strategies to the unique features of each seismic zone is highlighted by the variances seen in drifts, bending moments, shear pressures, steel use, and column behavior.

Seismic requirements for a certain Seismic Prone Area must be taken into account throughout the design process, thus it is essential to review the necessary design regulations, engage with skilled structural engineers, and undertake thorough assessments. Buildings in high-risk regions may be made safer and more resilient by taking into account these aspects throughout the design process to reduce vulnerability to seismic activity.

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