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Seismic Analysis of Conventional, Hexagrid and Octagrid Steel Structural Systems

Shaikh Md Yasin[1,]*, S.A. Bhalchandra[2]

Abstract

The seismic resilience of multi-story buildings in earthquake-prone regions is a critical consideration in structural engineering. This dissertation presents a comprehensive analysis of the seismic performance of proposed multi-story buildings with varying heights (G+10, G+15, and G+20) using conventional, hexagrid, and octagrid structural systems. The study utilizes the Response Spectrum Method under seismic zone V conditions to assess key parameters including storey drift, storey displacement, base shear, and overturning moment. Through nonlinear dynamic analysis, the seismic response of each structural system is evaluated, with a focus on categorizing bifurcations based on observed responses. The findings reveal significant variations in seismic performance among the different structural systems, with the hexagrid configuration demonstrating superior performance in mitigating seismic loads. The implications of these findings for seismic-resilient building design and construction practices are discussed, emphasizing the importance of adopting innovative structural systems to enhance seismic resilience and ensure the safety of built environments in earthquake-prone regions. This research contributes valuable insights to the field of structural engineering, informing stakeholders and decision-makers on effective strategies for mitigating seismic risks and creating safer built environments.

Keywords: Seismic analysis, conventional, octagrid, hexagrid, response spectrum method, multi-story buildings, comparative analysis.

INTRODUCTION

The seismic resilience of buildings in earthquake-prone regions is of paramount importance in structural engineering. With the ever-present threat of seismic events, the design and construction of multi-story buildings demand meticulous consideration of structural systems to mitigate potential damage and ensure the safety of occupants. In seismic zone V, characterized by high seismic activity, the choice of structural system plays a critical role in determining the building's ability to withstand seismic forces. This research aims to investigate and compare the seismic performance of a proposed multi-story building with varying heights, ranging from G+10 to G+20 stories, utilizing conventional, hexagrid, and octagrid structural systems. By employing the Response Spectrum Method, an established seismic analysis technique, this study assesses key parameters including storey drift, storey displacement, base shear, and overturning moment to evaluate the structural response under seismic loading conditions.

The conventional structural system, characterized by regular columns and beams, serves as a benchmark for comparison against the hexagrid and

***Author for Correspondence**
Shaikh Md Yasin
E-mail: shaikhyasin7249@gmail.com

[1]Student, Department of Applied Mechanics, Government College of Engineering, Chh.Sambhajinagar (Aurangabad), Maharashtra, India
[2]Professor, Department of Applied Mechanics, Government College of Engineering, Chh.Sambhajinagar (Aurangabad), Maharashtra, India

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octagrid systems, which represent innovative approaches to structural design. The hexagrid and octagrid systems incorporate hexagonal and octagonal grid configurations, respectively, offering potential advantages such as enhanced load distribution and improved structural integrity. Through a systematic analysis of the proposed multi-story buildings, this research endeavors to provide insights into the seismic performance of different structural systems, facilitating informed decision-making in structural design and construction practices. By illustrating the strengths and limitations of conventional and innovative structural systems, this study aims to contribute to the advancement of seismic-resistant building design methodologies.

AIM AND OBJECTIVES

The specific objectives of the research are:

- To assess the seismic performance of multi-story buildings with varying heights (G+10, G+15, G+20) under seismic zone V conditions.
- To compare the seismic response of conventional structural systems with hexagrid and octagrid systems.
- To analyze key parameters including storey drift, storey displacement, base shear, and overturning moment to evaluate structural behavior under seismic loading.

LITERATURES REVIEW

Kyoung-sun moon *et. al* [1] This paper introduces a method for determining initial member sizes for diagrid structural systems in tall buildings, offering valuable guidance for architects and engineers. It addresses architectural and constructability considerations and examines the influence of diagonal angle on diagrid behavior. Findings suggest optimal angle ranges for different building heights. A stiffness-based methodology for preliminary design sizes is proposed, showing practical usefulness compared to conventional methods. Overall, the study provides insight for integrative and efficient design decisions in the early stages of diagrid structure projects.

Khushbu Jani *et. al* [2] Recent advancements in construction technology and materials have led to the rise of high-rise buildings. The structural design of these buildings focuses on resisting lateral loads from wind or earthquakes. Different structural systems, such as shear wall cores, braced frames, framed tubes, and diagrid structures, are utilized for this purpose. Diagrid structures, with their inclined columns on the exterior surface, offer structural efficiency and flexibility in architectural planning. They typically do not require a core as lateral shear is carried by the diagonals on the building's periphery. Analysis and design of various storey diagrid steel buildings using ETABS software reveal their effectiveness in resisting lateral loads and distributing gravity loads. Diagrid systems provide flexibility in interior space and facade design.

Khushbu D. Jani *et.al* [3] This paper explores the use of diagrid structural systems in high-rise buildings, focusing on a 36-storey steel building analyzed and designed with ETABS software. Optimal diagonal column angles and their effect on lateral load resistance were investigated. Analysis and design were extended to 50, 60, 70, and 80 storey structures, revealing increasing reliance on bending mode with height. A stiffness-based approach proved useful for preliminary design. Findings indicate that diagrid columns on the periphery predominantly resist lateral loads, while internal columns bear vertical loads. The diagrid system's effectiveness in lateral load resistance stems from increased lever arm of peripheral diagonal columns.

Taranath S.D. *et.al* [4] This study examines the effectiveness of pentagrid and hexagrid bracing systems compared to no bracing in tall buildings facing standard loading conditions. Evaluating three buildings of 40, 50, and 60 stories with various structural forms, the focus is on lateral response and displacement minimization. Results suggest the pentagrid system is more efficient in resisting lateral forces compared to the hexagrid system, although it may incur slightly higher costs and require additional construction details. This research offers insights for improving vertical construction in densely populated urban areas.

Giulia Milana *et.al* [5] The diagrid structural system has emerged as a groundbreaking solution for tall buildings, offering advantages over conventional steel frames in terms of sustainability and structural performance. This study aimed to evaluate the optimal design of diagrid tall buildings compared to outrigger buildings, focusing on sustainability and structural safety. Through finite element method (FEM) nonlinear analyses, various diagrid geometries were tested and compared, shedding light on their effectiveness and resilience, even in damaged states. The findings contribute valuable insights for the continued development and utilization of diagrid systems in tall building construction, providing a preliminary assessment of their sustainability and structural performance.

Mobi Ria Mathews *et. al* [6] The construction of tall buildings has seen rapid growth globally; driven by the efficient land utilization they offer. With increasing building height, the importance of lateral load resistance systems becomes paramount, leading to the introduction of innovative structural systems like the Hexagrid system. This system, featuring hexagonal grids along the building's perimeter, efficiently counters both lateral and gravity loads through axial stress, reducing steel requirements. This paper presents a comparative analysis of different Hexagrid patterns using ETABS software, focusing on storey displacement and drift. Key findings indicate that patterns resembling the Beehive Tower perform better, with denser hexagrid layouts enhancing performance. Additionally, regular hexagons yield improved results, and models with two storeys per hexagon outperform those with four storeys.

Kiran Kamath *et.al* [7] This study aimed to evaluate the performance of diagrid structures through nonlinear static pushover analysis. Circular models with varying aspect ratios and external brace angles were analyzed. Results showed that structures with a 71° brace angle exhibited higher base shear across all aspect ratios, while those with a 59° brace angle had lower base shear. The performance of the structures was significantly influenced by the brace angle and aspect ratio. Specifically, the 59° brace angle provided higher stiffness for lower aspect ratios, while stiffness reduced with higher aspect ratios.

Draga Hasan Saputra *et. al* [8] Diagrid structures, renowned for their innovation and versatility, offer numerous advantages despite challenges like design complexity and higher construction costs. Our research, utilizing linear dynamics and spectrum response analysis in ETABS, compared diagrid systems to conventional ones. Results showcased the superior performance of diagrid structures, with significantly reduced lateral load parameters such as top storey displacement and inter-storey drift. Incorporating shear wall cores further enhanced diagrid performance, emphasizing their positive impact on structural effectiveness. Further research in this field holds promising potential for the future.

Niloufar Mashhadiali *et.al* [9] This paper introduces the Hexagrid system, a novel structural approach aimed at enhancing both the structural and architectural efficiency of tall buildings. By incorporating hexagonal grids along the building's perimeter, this system offers exceptional stability in carrying both gravity and lateral loads, functioning as a rigid shell while accommodating various structural systems. Through analysis of 50-, 80-, and 110-story buildings, the Hexagrid system demonstrates promising performance, providing desirable architecture, flexibility, and high shear mode of deflection. Overall, it stands as an innovative and efficient solution for contemporary tall building design and construction.

Saurabh Babhulkar *et.al* [10] This study investigates the seismic performance of 15-story diagrid structures with varying angles, focusing on the influence of the diagrid core. Diagrid structures, known for their efficiency and flexibility, feature diagonal members on the building's exterior, resisting horizontal loads through axial action. By analyzing prominent diagrid buildings like the Swiss Re and Hearst Tower, the study highlights the effectiveness of diagrid structures in contemporary architecture. It concludes that inclined sections at the external periphery enhance lateral load resistance compared to traditional framed structures. This innovative approach reduces concrete usage significantly, making diagrid structures more efficient than conventional ones.

SYSTEM DEVELOPMENT

In In present research, a detailed seismic analysis of proposed multi-story buildings with G+10, G+15, and G+20 stories is conducted, considering different structural systems including conventional, hexagrid, and octagrid configurations. The methodology begins with the selection of building models, ensuring they represent typical structures found in seismic zone V and adhering to local building codes. Structural system modeling is then undertaken using appropriate software to develop accurate representations of each building type and configuration. Material properties for steel are defined in accordance with relevant standards, and seismic loading conditions are applied using the Response Spectrum Method, considering prescribed spectral acceleration values for seismic zone V. Nonlinear dynamic analysis is performed for each building model, generating response spectra and evaluating structural responses under seismic excitation. Key performance indicators including storey drift, storey displacement, base shear, and overturning moment are assessed for each structural system and building height, with bifurcations categorized based on observed responses.

Comparative analysis is conducted to compare the seismic response of the different structural systems, considering factors such as effectiveness in mitigating seismic hazards and maintaining structural integrity. Sensitivity analysis is carried out to explore the influence of various parameters on seismic performance, ensuring the robustness of the findings. Documentation of all aspects of the methodology, including assumptions, input parameters, and analysis procedures, is provided to ensure transparency and reproducibility of the research outcomes (Figures 1–3 and Table 1) [11–14].

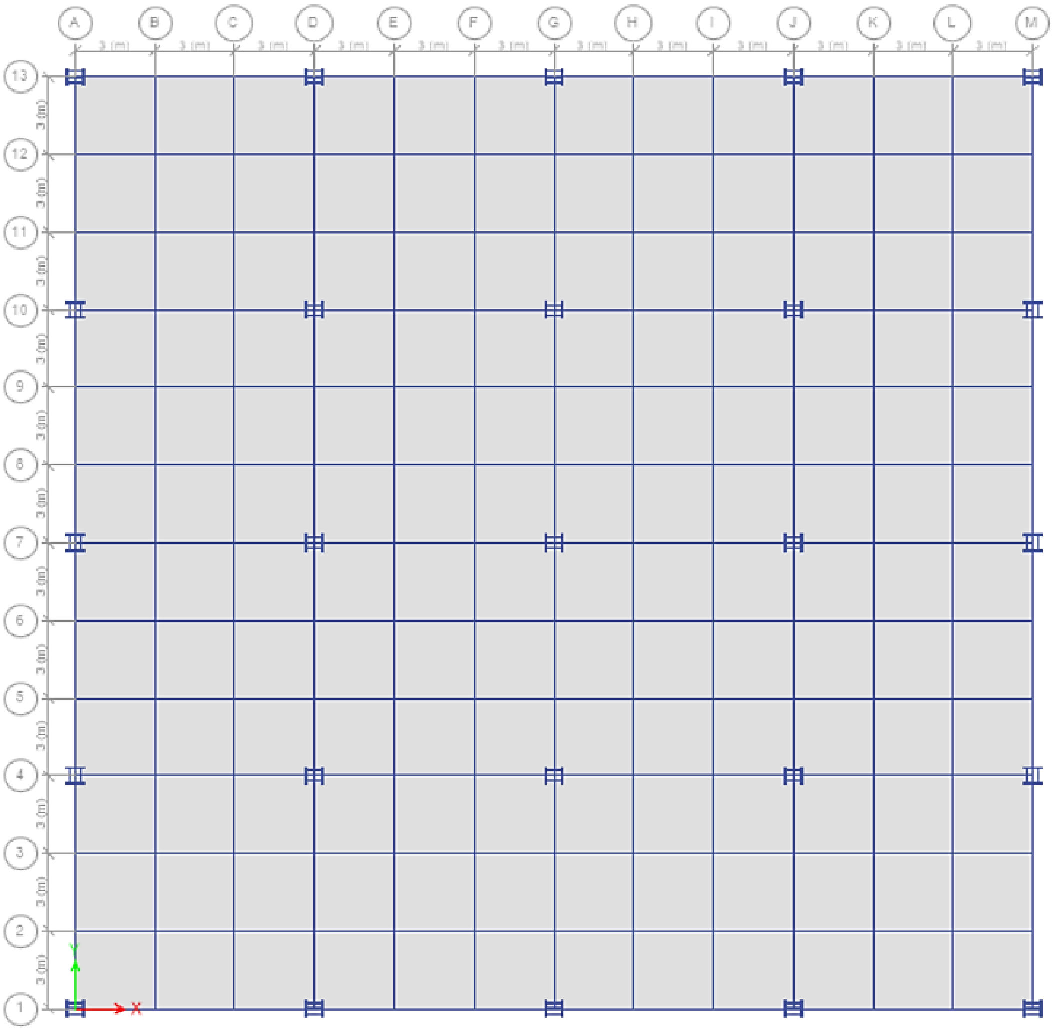

Figure 1. Plan view of the building.

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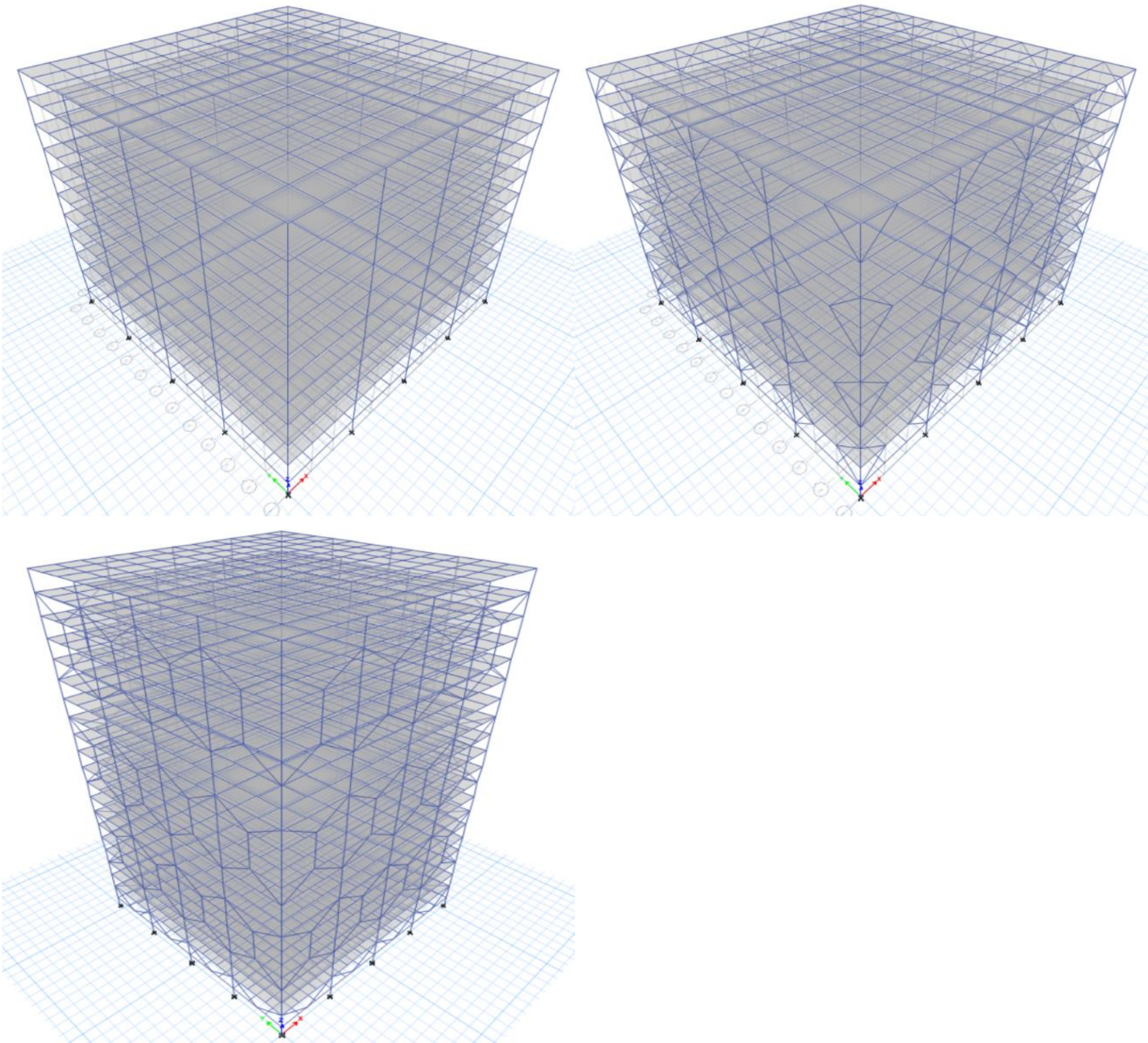

Figure 2. 3D view of the studied steel frame buildings.

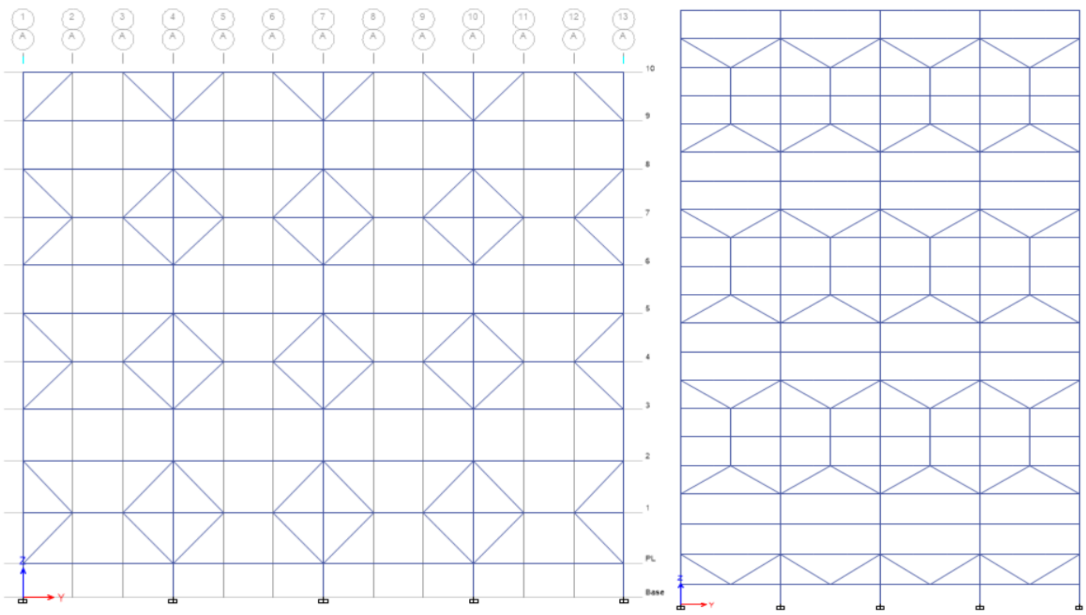

Figure 3. Elevation view of Octagrid and Hexagrid system building.

Table 1. Geometric parameters of model.

No of storeys	G+10, G+15, G+20
Length of each bay in X-direction	36 m
Length of each bay in Y-direction	36 m
Grade of steel	Fe345
Grade of concrete	M25
Column size	600 × 600 mm
Beam size	600 × 600 mm and 100 × 100 mm
Slab Thickness	130 mm
Plate thickness	25 mm
External wall thickness	230 mm
Internal wall thickness	150 mm
Bottom story height	3 m
Typical story height	3 m

RESULTS AND DISCUSSION

In present research, seismic analysis of a proposed multi-story building with G+10, G+15 and G+20 stories building with different heights using conventional, hexagrid and octagrid systems are considered. Results were obtained by using Response Spectrum Method under seismic zone V. The assessment of seismic performance involves categorizing bifurcations based on parameters such as Storey drift, Storey displacement, Base shear and Overturning moment.

Base Shear Comparison Between Conventional, Octagrid and Hexagrid Systems for Zone V

The comparison of base shear for zone V, obtained through the models, with those derived from Octagrid and Hexagrid systems, utilizing both Simplified Modal Response Spectrum Method and inelastic modeling via computer software ETABS, is presented in Tables 2–7 and illustrated in Figures 5–7.

From Tables 2–4 and 7, and Figures 4–6 one can deduce the following:

- The hexagrid system consistently results in lower maximum Base shear compared to conventional system.
- Therefore, conventional system tends to overestimate the base shear relative to Octagrid and Hexagrid system.
- The difference in base shear values between Hexagrid system and the other methods varies depending on the building height. The difference is more significant for taller buildings compared to shorter ones.

Table 2. Comparison of base shear (kN) for the studied buildings for zone V.

No of floors	Conventional	Octagrid	Hexagrid
GF	6186.3938	5150.319	3646.3246
1	6184.0312	5148.365	3644.84
2	6145.2544	5115.921	3622.0649
3	6047.1745	5033.675	3563.8904
4	5859.6662	4878.081	3453.8189
5	5417.6704	4629.24	3279.089
6	5136.5183	4273.585	3027.5199
7	4547.5066	3787.152	2683.4462
8	3774.194	3140.333	2229.2649
9	2808.8624	2331.042	1656.8205
10	1602.0965	1329.671	948.51

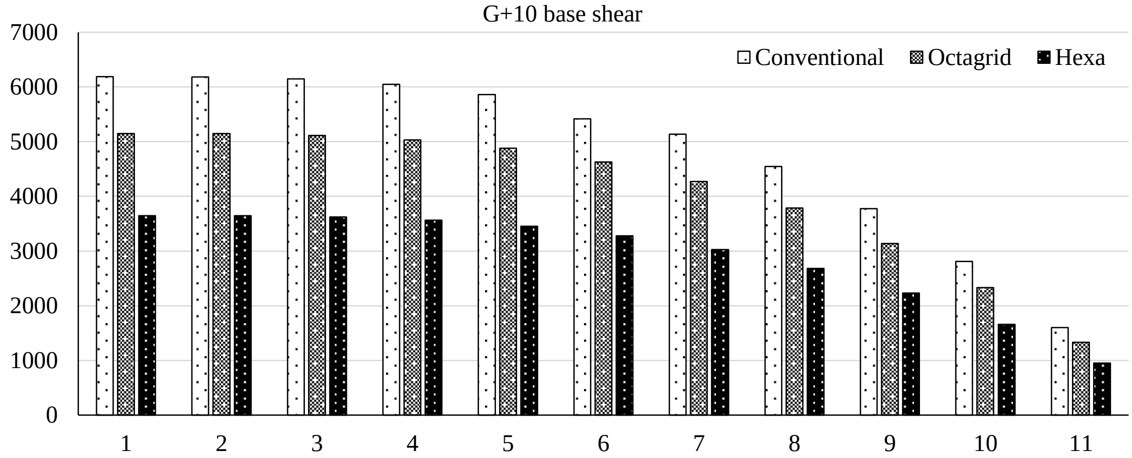

Figure 4. Comparison of Base Shear (kN) for the Studied Buildings for zone V.

Table 3. Comparison of Base Shear (kN) for the Studied Buildings for zone V.

No of floors	Conventional	Octagrid	Hexagrid
GF	6433.7698	6230.455	4452.3296
1	6432.9488	6229.653	4451.7687
2	6419.3172	6216.492	4442.4082
3	6384.7610	6183.205	4418.4851
4	6319.3872	6119.566	4373.2154
5	6214.8356	5941.512	4301.386
6	6065.4051	5874.333	4197.9104
7	5861.0277	5674.817	4056.3857
8	5589.2630	5412.362	3869.677
9	5249.2349	5084.737	3634.2187
10	4828.5034	4675.172	3342.8759
11	4311.144615	4118.908	2987.4383
12	3699.381921	3584.655	2563.7911
13	2980.481978	2882.878	2065.951
14	2139.148137	2070.364	1487.9348
15	1180.053133	1146.207	823.7592

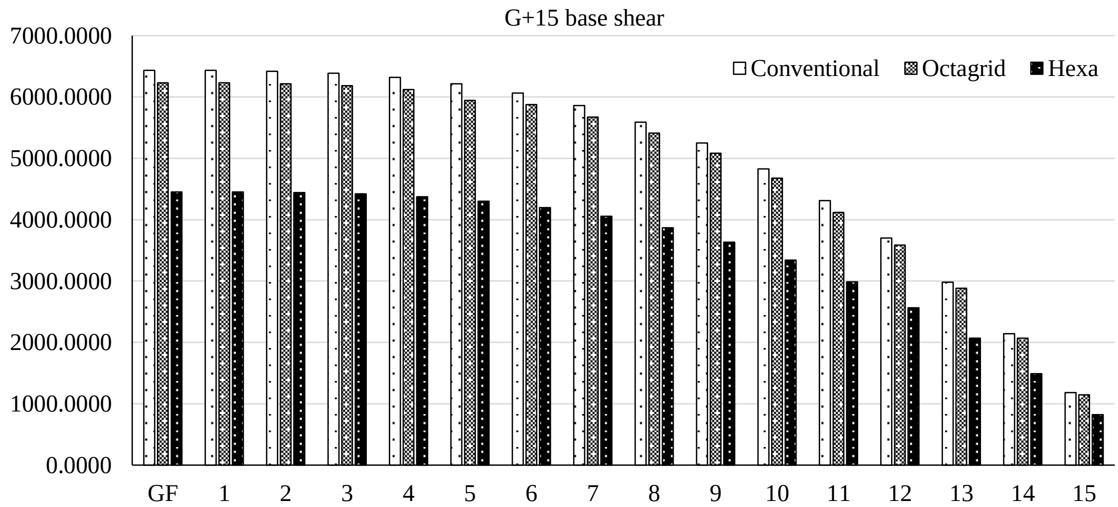

Figure 5. Comparison of Base Shear (kN) for the Studied Buildings for zone V.

Table 4. Comparison of Base Shear (kN) for the Studied Buildings for zone V

No of floors	Conventional	Octagrid	Hexagrid
GF	6247.5626	6114.908	6049.6846
1	6247.2186	6114.574	6049.3582
2	6241.5721	6109.032	6043.9104
3	6227.2904	6094.983	6029.9873
4	6199.9867	6068.404	6003.6406
5	6094.7712	6025.897	5961.8363
6	6079.033	5965.144	5901.6141
7	6009.1705	5882.052	5819.2475
8	5896.566	5771.563	5710.5841
9	5756.0009	5633.32	5573.5488
10	5580.2799	5462.266	5403.989
11	5297.8873	5251.927	5197.1263
12	5112.4015	5003.207	4950.5661
13	4811.3097	4710.928	4660.826
14	4462.7066	4368.873	4324.4239
15	4066.2038	3978.94	3937.8775
16	3561.3651	3487.399	3450.2264
17	2949.4637	2928.084	2899.3066
18	2355.615	2305.108	2281.2602
19	1640.4888	1610.581	1592.2295
20	849.6927	835.0675	828.3565

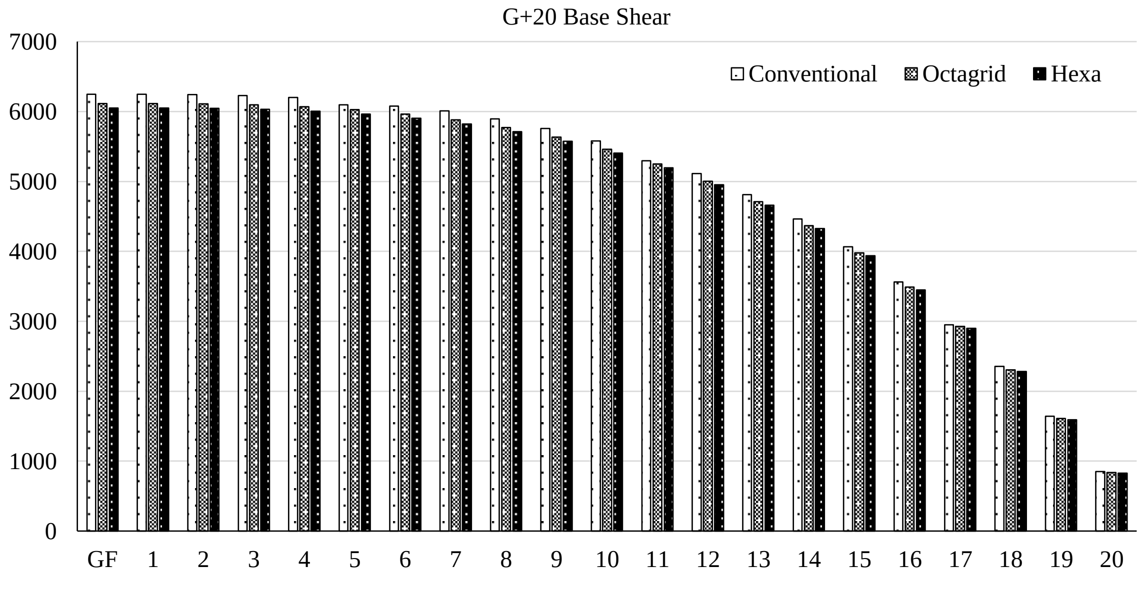

Figure 6. Comparison of Base Shear (kN) for the Studied Buildings for zone V.

Overturning Moment Comparison Between Conventional, Octagrid and Hexagrid Systems for Zone V

The comparison of Overturning moment for zone V, obtained through the models, with those derived from Octagrid and Hexagrid systems, utilizing both Simplified Modal Response Spectrum Method and inelastic modeling via computer software ETABS, is presented in Tables 5–10 and illustrated in Figures 7–9.

Table 5. Comparison of Overturning moment (kNm) for the Studied Buildings for zone V.

No of floors	Conventional	Octagrid	Hexagrid
Base	159664.874	132876.5	94151.235
GF	146673.4471	122060.8	86493.953
1	126884.5471	105586	74830.465
2	107219.733	89215.07	63239.857
3	87868.7744	73107.31	51835.408
4	70289.7759	58473.07	41473.951
5	48285.6102	44585.35	31636.684
6	38197.9786	31764.59	22554.125
7	24555.4589	20403.14	14503.786
8	13232.8768	10982.14	7815.9914
9	4806.2895	3989.011	2845.5299
10	0	0	0

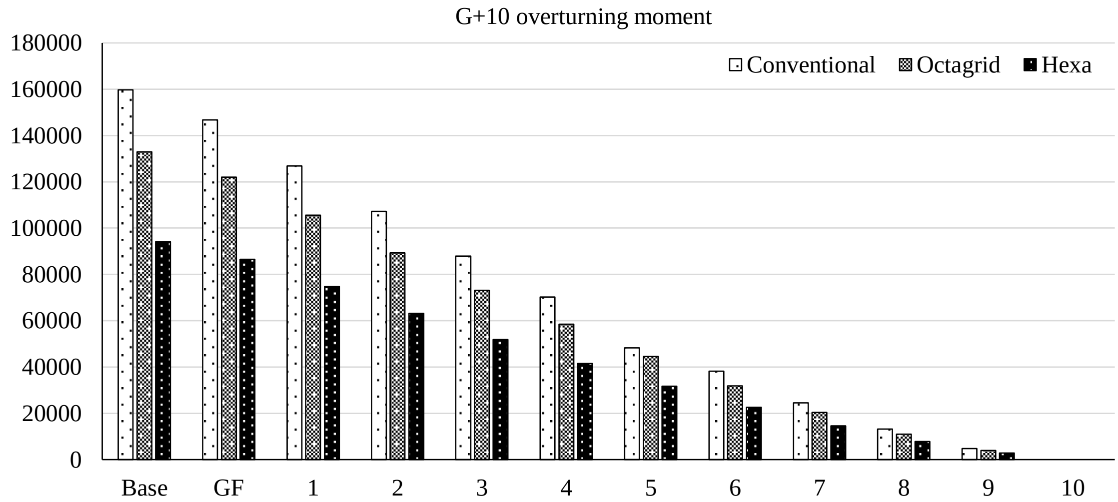

Figure 7. Comparison of Overturning moment (kNm) for the Studied Buildings for zone V.

Table 6. Comparison of Overturning moment (kNm) for the Studied Buildings for zone V.

No of floors	Conventional	Octagrid	Hexagrid
Base	238382.5485	230850.484	165064.04
GF	224871.6577	217766.529	155714.15
1	204286.2609	197831.64	141468.49
2	183744.4847	177938.865	127252.78
3	163313.2885	158152.609	113113.63
4	144355.1633	139793.91	99993.984
5	125710.6923	111549.471	87089.826
6	107514.5116	104115.974	74496.095
7	89931.46197	87091.5216	62326.938
8	73163.70475	70854.4356	50717.907
9	57416.02989	55600.224	39815.251
10	42930.54752	41574.7089	29786.623
11	29997.13824	26610.1818	20824.308
12	18899.01354	18298.3497	13132.935
13	9957.584802	9649.7149	6935.082
14	3540.152768	3438.6217	2471.2775
15	0	0	0

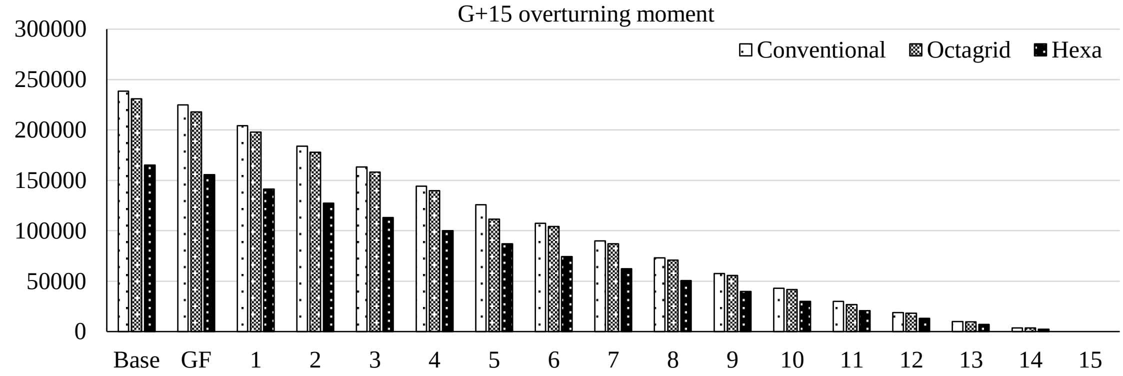

Figure 8. Comparison of Overturning moment (kNm) for the Studied Buildings for zone V.

Table 7. Comparison of Overturning moment (kNm) for the Studied Buildings for zone V.

No of floors	Conventional	Octagrid	Hexagrid
Base	303735.3286	297327.1	294188.73
GF	290615.4472	284485.8	281484.4
1	270624.3478	264919.1	262126.45
2	250651.3169	245370.2	242785.94
3	230723.9875	225866.3	223489.98
4	212124.0274	207661.1	205479.06
5	177495.5337	189583.4	187593.55
6	175370.0803	171687.9	169888.7
7	157342.5688	154041.8	152430.96
8	139652.871	136727.1	135299.21
9	122384.8681	119827.1	118578.56
10	105644.0284	103440.3	102366.6
11	82114.0904	87684.56	86775.218
12	74210.8863	72674.94	71923.52
13	59776.9574	58542.16	57941.042
14	46388.8377	45435.54	44967.77
15	34190.2264	33498.72	33154.137
16	23506.1311	23036.52	22803.458
17	13305.7931	14252.27	14105.539
18	7470.5447	7336.945	7261.7579
19	2549.0782	2505.203	2485.0695
20	0	0	0

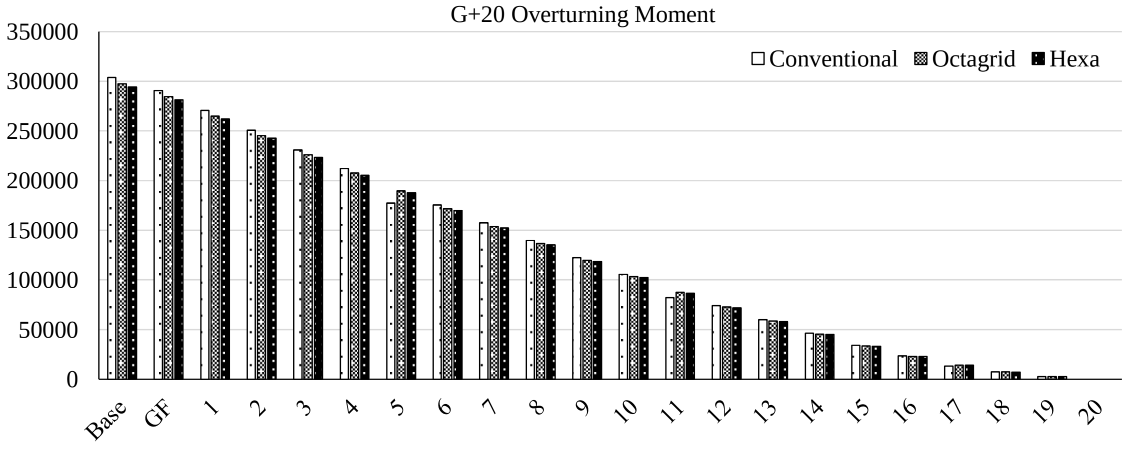

Figure 9. Comparison of Overturning moment (kNm) for the Studied Buildings for zone V.

From Tables 8–10 and Figures 8–10 one can deduce the following:

- The Across all building heights, hexagrid system consistently estimates lower overturning moments compared to both conventional and Octagrid system.
- Therefore, conventional system tends to overestimate the overturning moments relative to hexagrid and Octagrid system.
- The difference in overturning moment values between hexagrid system and the other methods varies depending on the building height. The difference is more significant for taller buildings compared to shorter ones.

Storey Displacement Comparison between Conventional, Octagrid and Hexagrid Systems for Zone V

The comparison of storey displacement for zone V, obtained through the models, with those derived from Octagrid and Hexagrid systems, utilizing both Simplified Modal Response Spectrum Method and inelastic modeling via computer software ETABS, is presented in Tables 8–11 and illustrated in Figures 10–12.

From Tables 11–13 and Figures 11–13 one can deduce the following:

- The Across all building heights, hexagrid system consistently estimates lower storey displacement compared to both conventional and Octagrid system.
- Therefore, conventional system tends to overestimate the storey displacement relative to hexagrid and Octagrid system.
- The difference in storey displacement values between hexagrid system and the other methods varies depending on the building height. The difference is more significant for taller buildings compared to shorter ones.

Table 8. Comparison of Storey Displacement (m) for the Studied Buildings for zone V.

No of floors	Conventional	Octagrid	Hexagrid
GF	1.38	1.519	2.408
1	6.42	5.554	3.434
2	13.062	10.075	9.565
3	20.189	15.911	15.261
4	26.641	20.217	16.783
5	32.751	24.439	21.062
6	38.427	29.051	25.257
7	43.406	32.288	26.464
8	47.56	35.272	29.281
9	50.813	37.877	31.821
10	53.117	39.137	32.356

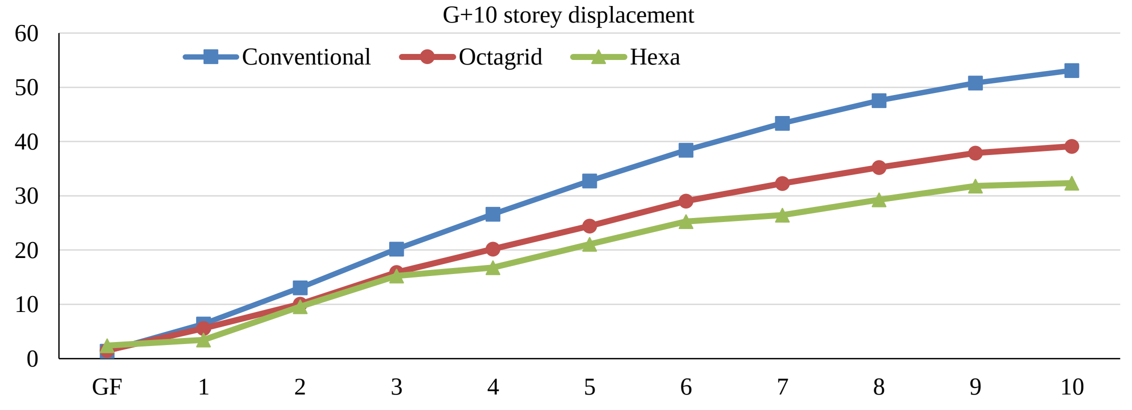

Figure 10. Comparison of Storey Displacement (m) for the Studied Buildings for zone V.

Table 9. Comparison of Storey Displacement (m) for the Studied Buildings for zone V.

No. of floors	Conventional	Octagrid	Hexagrid
GF	1.807	1.440896	2.439
1	8.429	5.257145	3.496
2	17.228	9.584558	9.754
3	26.813	15.26027	15.608
4	35.714	19.58769	17.263
5	44.49	23.92927	22.109
6	53.145	29.02485	26.969
7	61.439	33.0518	28.567
8	69.343	37.02111	32.903
9	76.818	41.45057	37.17
10	83.589	44.73959	38.548
11	89.52	47.86516	41.873
12	94.588	50.96899	45.025
13	98.727	53.00609	46
14	101.887	54.82776	47.802
15	104.138	56.40282	49.658

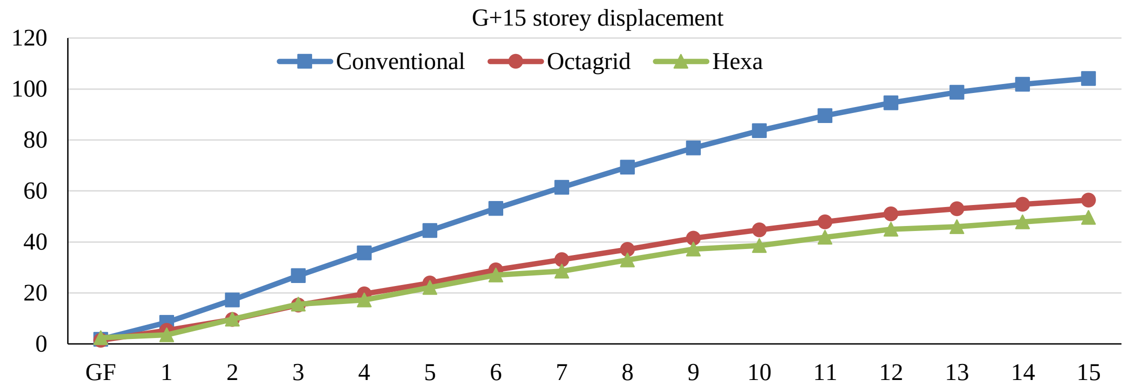

Figure 11. Comparison of Storey Displacement (m) for the Studied Buildings for zone V.

Table 10. Comparison of Storey Displacement (m) for the Studied Buildings for zone V.

No. of floors	Conventional	Octagrid	Hexagrid
GF	2.461	1.916	2.542
1	11.495	6.923	3.664
2	23.535	12.664	10.221
3	36.714	20.222	16.372
4	49.051	26.046	18.161
5	61.36	31.945	23.386
6	73.696	38.987	28.667
7	85.783	44.718	30.503
8	97.658	50.471	35.537
9	109.342	57.189	40.565
10	120.506	62.538	42.341
11	131.035	67.811	46.945
12	140.995	73.706	51.488
13	150.363	78.31	53.112
14	159.062	82.788	56.955
15	166.99	87.537	60.678
16	174.013	90.998	62.008
17	180.014	94.237	64.691
18	184.897	97.218	67.176
19	188.629	99.047	68.054
20	191.325	100.626	69.092

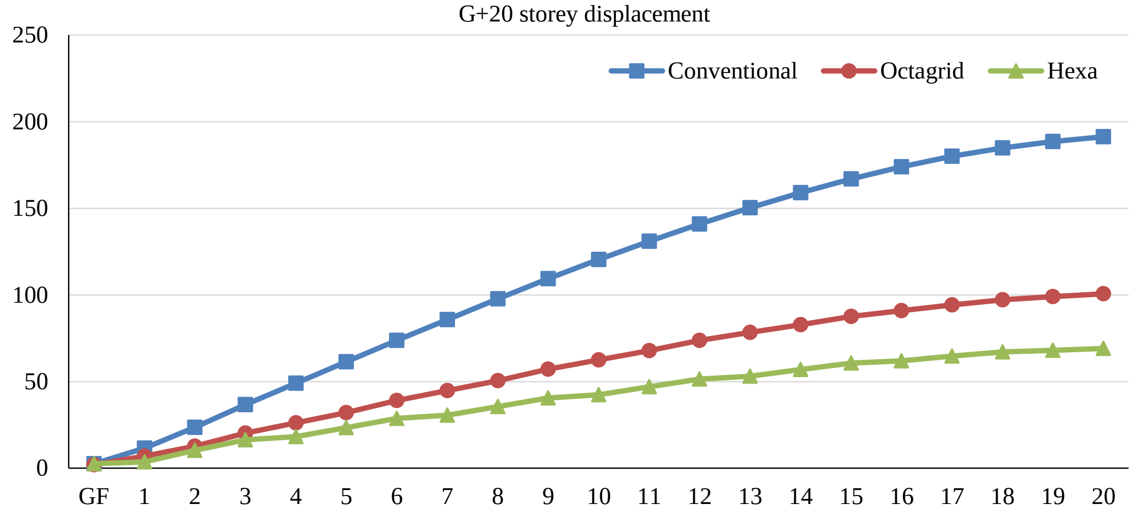

Figure 12. Comparison of Storey Displacement (m) for the Studied Buildings for zone V.

Storey Drift Comparison between Conventional, Octagrid and Hexagrid Systems for Zone V

The comparison of storey drift for zone V, obtained through the models, with those derived from Octagrid and Hexagrid systems, utilizing both Simplified Modal Response Spectrum Method and inelastic modeling via computer software ETABS, is presented in Tables 14–16 and illustrated in Figures 14–16.

Table 11. Comparison of Storey Drift (m) for the Studied Buildings for zone V.

No of Floors	Conventional	Octagrid	Hexagrid
GF	0.000657	0.000724	0.000857
1	0.00159	0.001344	0.000918
2	0.002076	0.001413	0.001916
3	0.002227	0.001824	0.00178
4	0.002151	0.001437	0.000514
5	0.002037	0.001407	0.001426
6	0.001892	0.001537	0.001412
7	0.00166	0.001086	0.000402
8	0.001384	0.000995	0.000939
9	0.001085	0.000868	0.000846
10	0.000768	0.000432	0.000193

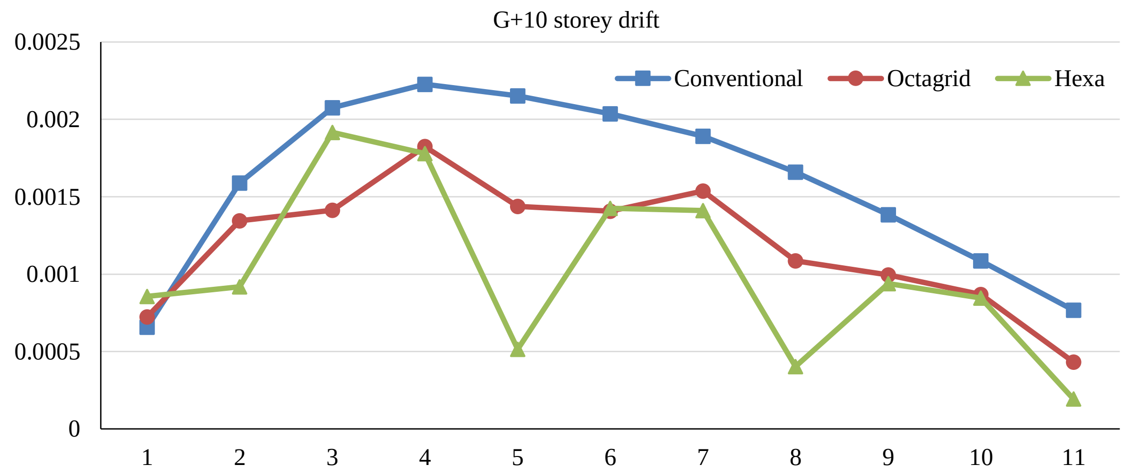

Figure 13. Comparison of Storey Drift (m) for the Studied Buildings for zone V.

Table 12. Comparison of Storey Drift (m) for the Studied Buildings for zone V.

No of floors	Conventional	Octagrid	Hexagrid
GF	0.00086	0.000686	0.000868
1	0.002089	0.001273	0.000935
2	0.00275	0.001352	0.001956
3	0.002995	0.001773	0.001829
4	0.002967	0.001444	0.000557
5	0.002926	0.001448	0.001615
6	0.002885	0.001699	0.00162
7	0.002765	0.001348	0.000532
8	0.002635	0.001324	0.001446
9	0.002491	0.001476	0.001422
10	0.002257	0.001107	0.000474
11	0.001977	0.001042	0.001108
12	0.001689	0.001035	0.00108
13	0.001379	0.000694	0.000325
14	0.001053	0.000608	0.000601
15	0.00075	0.000524	0.000618

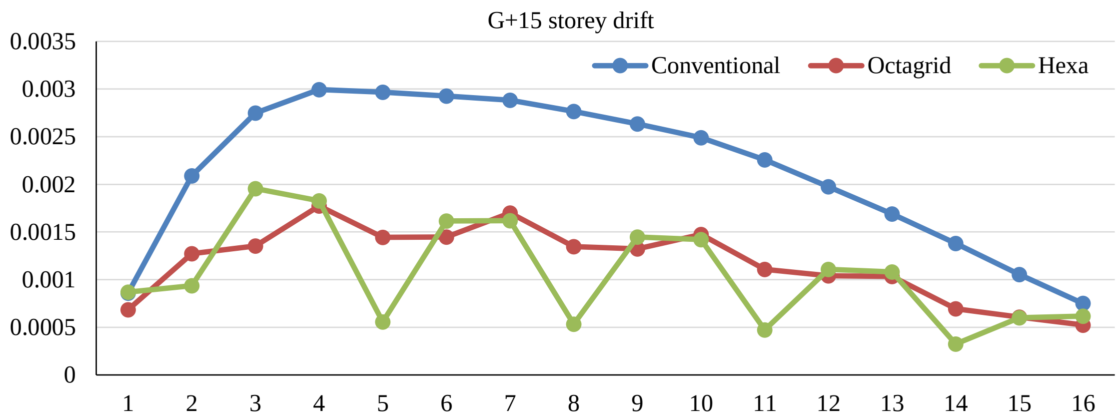

Figure 14. Comparison of Storey Drift (m) for the Studied Buildings for zone V.

Table 13. Comparison of Storey Drift (m) for the studied buildings for zone V.

No of floors	Conventional	Octagrid	Hexagrid
GF	0.001172	0.000913	0.000905
1	0.002851	0.001678	0.00098
2	0.003762	0.001794	0.002049
3	0.004118	0.002362	0.001922
4	0.004113	0.001943	0.000602
5	0.004103	0.001966	0.001742
6	0.004112	0.002347	0.00176
7	0.004029	0.001918	0.000612
8	0.003958	0.001917	0.001678
9	0.003895	0.002239	0.001676
10	0.003721	0.001797	0.000607
11	0.00351	0.001758	0.001535
12	0.00332	0.001965	0.001525
13	0.003122	0.001554	0.000541
14	0.0029	0.001493	0.001281
15	0.002643	0.001583	0.001241
16	0.002341	0.001179	0.000466
17	0.002	0.001079	0.000894
18	0.001628	0.000994	0.000861
19	0.001244	0.000639	0.000292
20	0.000899	0.000526	0.000346

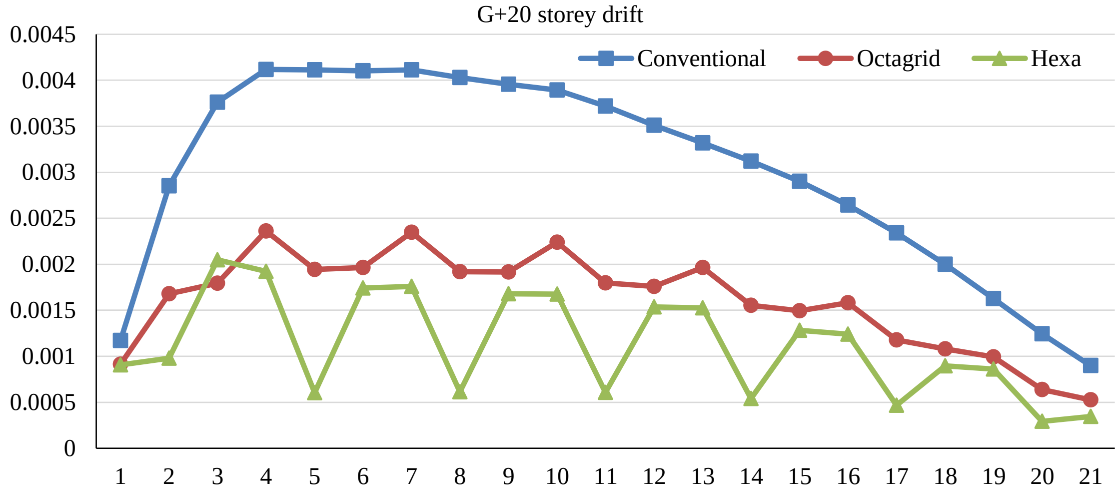

Figure 15. Comparison of Storey Drift (m) for the Studied Buildings for zone V.

From Tables 11–13 and Figures 13–15 one can deduce the following:

- The Across all building heights, hexagrid system consistently estimates lower storey drift compared to both conventional and Octagrid system.
- therefore, conventional system tends to overestimate the storey drift relative to hexagrid and Octagrid system.
- The difference in storey drift values between hexagrid system and the other methods varies depending on the building height. the difference is more significant for taller buildings compared to shorter ones.

CONCLUSIONS

An inelastic modeling via computer software ETABS is created to facilitate the seismic analysis of steel frame buildings employing the Conventional, Octagrid and Hexagrid systems for zone V. The study encompasses structural systems with variable heights, spanning from G+10, G+15 to G+20 storey buildings. Comparative analyses are conducted between the hexagrid system results and those derived from Conventional and Octagrid system. The comprehensive findings of this research yield the following conclusions.

1. The Across all building heights, Hexagrid consistently estimates lower overturning moments compared to both conventional and octagrid.
2. The difference in overturning moment values between conventional, hexagrid and octagrid methods varies depending on the building height. the difference is more significant for taller buildings compared to shorter ones.
3. The Hexagrid system consistently results in lower maximum base shear forces compared to both conventional and octagrid systems.
4. The difference in base shear values between conventional, hexagrid and octagrid methods is more significant in taller buildings than in shorter ones.
5. The difference in Storey displacement values between conventional, hexagrid and octagrid methods is more significant in taller buildings than in shorter ones.
6. The difference in storey drift values between conventional, hexagrid and octagrid methods is more significant in taller buildings than in shorter ones.
7. From study can also conclude that Hexagrid system consistently outperforms across all building heights.
8. Hexagrid system consistently yields a noteworthy reduction of 19.81% to 25.40% in base shear values compared to conventional and octagrid system. This outcome underscores the practical advantages of hexagrid system in mitigating lateral forces and lowering the seismic risk associated with multi-story buildings.

9. The observed reductions of 9.54% to 73.31% in overturning moments emphasize the enhanced seismic performance achieved through hexagrid system. Lower overturning moments signify a reduction in the torsional effects on structures, contributing to their overall stability and safety.
10. The observed reductions of 0.20% to 1.22% in storey displacement emphasize the enhanced seismic performance achieved through hexagrid system. Lower storey displacement signifies a reduction in the torsional effects on structures, contributing to their overall stability and safety.

This study demonstrates the versatility of Hexagrid System, as it consistently outperforms Conventional and octagrid systems in controlling overturning moments, base shear, storey displacement and storey drift values across a range of building heights, G+10, G+15 and G+20. This adaptability underscores its applicability in various multi-story structures.

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