



Study Of Different Story Steel Structures On Different Sloping Ground With And Without Bracing

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Abstract: Extinct earthquakes events demonstrate that, a building with irregularity is vulnerable to earthquake damages. So as it's essential to spot the seismic response of the structure even in high seismic zones to cut back the seismic damages in buildings. When constructing a steel building on sloping ground, the angle of the slope can significantly impact the design, construction, and overall feasibility of the project. Buildings situated in hilly areas more seismically vulnerable due to irregular configuration in both horizontal and vertical directions. . In present study, the structure is totally commercial building. The structure is examined for seismic zone III and soil condition is hard consider. The structure is compared the sloping ground and plain ground and also with and with-out bracing system. The different model is done on STAAD.pro software. Some model is analysis on plain ground and sloping ground with-out Bracing system and some model is analysis on plain ground and sloping ground with- Bracing System. The different slope is 10-degree, 20-degree and 30- degree is considered while analysis. The bracing is considered at outer peripherals and at Centre of core. The Models are analysis for various aspects like Story Displacement, Storey overturning moment, Storey Drift, Lateral Displacement, etc. In this research P-delta is not Consider. This help us understand detailed analysis of behaviour of building under different sloping angles and effect of earthquake on building.

Key Words: STAAD.Pro, Sloping Building, Step back, Bracing system, High rise Building

I. INTRODUCTION

In recent days the buildings with irregular configurations in both plan and elevation are common. These buildings asymmetry will suffer severely during earthquakes and undergo coupled torsion and lateral motions. A building can be designed to be earthquake proof for a rare but strong earthquake proof, but such buildings will be more expensive. The most logical approach to seismic design problem is to accept the uncertainty of the seismic phenomenon. Thus, due to growing level of heavy population the biggest reason of construction done on mountainous areas. The economic growth and rapid urbanization in hilly region has accelerated the real estate development. Due to this, population density in the hilly region has increased enormously. The adobe burnt brick; stone masonry and dressed stone masonry buildings are generally made over level ground in hilly regions. Since level land in hilly regions is very limited, there is a pressing demand to construct buildings on hill slope. Hence construction of multi-storey R.C.Frame buildings on hill slope is the only feasible choice to accommodate increasing demand of residential and commercial activities. Due to the industrial revolution, in the recent decade the growths in the cities have been onrise in incremental folds. Due to which the scarcity of plain topography land is a common problem in many cities, for this reason developers are often constructing multi-storey buildings to accommodate this rising population on sloping grounds. But with such provisions increase in self-weight and live load along with lateral earthquake forces will increase and aspect the buildings depending on many factors like strength of materials used, type of soil surface, amount of mass and stiffness of structural and non-structural members, levels of workmanship,

intensity.

II. LITERATURE REVIEW

Rahul Manoj Singh Pawar, S.B. Sohani

Rahul Manoj Singh Pawar, S.B. Sohani have concluded Buildings resting on sloping ground have less base shear compared to buildings on Plain ground. Base shear increases as slope of ground increase. Buildings resting on sloping ground have more lateral displacement compared to buildings on Plain ground. Buildings with set back step back is showing less displacement than step back model. Building is showing high value of displacement in z- direction than in X direction. The critical axial force in columns is more on plain ground than on sloping ground. The shear force and moment in columns is more on sloping ground than on plain ground. The shear force and bending moment value in beams is high in plain ground model than on sloping ground model.

VIKAS RANA

VIKAS RANA has said the performance of STEP back building during seismic excitation could prove more vulnerable than other configurations of buildings. Extreme left short column at ground level are damaged most during earthquake in case of Step back and Step back-Set back buildings. Less damage occurs in case of Set back building on at soil. Detailed study of economic cost for levelling sloping soil and other issues need to be studied. Base shear is higher for Step back-Setback building and lower for Set back building. Lateral displacement of top storey is maximum for Step back building. On sloping soil Setback-Step back building is favoured.

M. Ali and Kyoung Sun Moon (2007)

M. Ali and Kyoung Sun Moon (2007) presented a study of structural developments in tall buildings, In these structural systems and the technological driving force behind tall building developments. For the primary structural systems, a new classification-interior structures and exterior structures- are presented. While most representative structural systems for tall buildings are discussed, the emphasis in this review paper is on current trends such as outrigger systems and diagrid structures. Auxiliary damping aerodynamic and twisted forms, which directly or indirectly affect the structural performance of tall buildings, are reviewed. Finally, the future of structural developments in tall buildings is envisioned briefly.

Paul W. Richards (2009)

Paul W. Richards (2009) investigated the seismic column demands in ductile braced frames. Inductile braced frames, column seismic demands depend on the strength of ductile elements and yielding patterns that occur during earthquake loading. Column demands are investigated in buckling restrained braced frames (BRBFs), special concentrically braced frames (SBFs), and eccentrically braced frames (EBFs), with different heights (3, 9 and 18 storey) and strength levels using nonlinear time history analysis. For columns at the base of 9 and 18 storey BRBF and EBFs, axial demands observed from the analyses were 50-70

Afarani and Nicknam (2012)

Afarani and Nicknam (2012) observed the behaviour of the vertically irregular building under seismic loads by Incremental Dynamic Analysis. They have dealing with eight stories regular building having 2 bays with 4 m width in y direction has and 4 bays with 3m width in x direction with 3 m storey height is considered. They considered Dead load as 2 ton/m is distributed on beams. To avoid tensional erects, they considered symmetric building and steel moment resisting frames which are designed according to IBC 2006 and ANSI/AISC 36005.

Behruz Bagheri Azar, Mohammad Reza Bagerzadeh Karimi (2012)

Behruz Bagheri Azar, Mohammad Reza Bagerzadeh Karimi (2012) carried out a systematic examination consequence of using different kind of bracing system in tall steel structures using the software ABAQUS. The steel structures with 20, 30 and 40 oors using core bracing method with different length and configurations were studied in order to find the best suited configuration of bracing. For this purpose, various forms of bracing systems with equal amount of steel consumption were studied under earthquake loads both in static and dynamic analysis. The concept of mega -bracing and their properties as a new approach of bracing method is investigated. Lateral resistance in braced frame is provided by diagonal

members which forms the vertical truss structure together with the main beams. Using mega brace instead of common brace caused to decrease lateral displacement and shear lag which improves the structural behaviour and increases the efficiency of buildings.

F. GultanGulay et. al.

F. GultanGulay et. al. has presented the work on torsion unbalanced irregular structures for the verification of code specific design requirement of irregular structures of Turkish Earthquake Code, TEC97. Irregular structures face torsion forces in them due to the different stiffness distribution in building diaphragm. Due to the architectural requirement of the building, it is inevitable to introduce irregularity in the building and designers need to design the building to resist these severe twisting forces.

C. V. R. Murthy et al. (2004)

C. V. R. Murthy et al. (2004) studied the effects of brick masonry infills in seismic design of RC framed buildings. Non-linear pushover analysis was performed on five RC frame buildings with brick masonry infills which was modelled using equivalent braced frame methods. Infills are found to increase the strength and stiffness of the structure and reduce the drift capacity and structural damage.

S.K. Jain

S.K. Jain et. al. has emphasis on architectural (functional requirement) design of building in the present scenario in India. According to them there are so many buildings that have soft first storey. Due to the functional requirement of the first storey like parking, facility, economic functionality etc. buildings are designed with no considerations towards the stiffness of first storeys. There is soft storey due to the absence of brick infill walls which has been removed for the functional requirement. Absence of wall reduces stiffness of this first storey leading it to soft storey. They have suggested that use of Central Concrete Core method or providing additional strength to the columns are the two ways that can eliminate the effect of this soft storey.

Siddhesh Wavale, Trupti Narkhede, P J Salunke

After comparison it is observed that G+10 and G+20 structure can stand with-out Bracing but more than 20 story structure required Bracing System. In this case G+30 story structure is better performance in Bracing System. Comparison between Bracing system and with-out bracing system, if we add bracing system then stiffness of structure is increase and Because of increase stiffness, Decrease the mode of oscillation. After analysis the model, the G+30 with-out Bracing system structure is unsafe

R. S. Malik (2015)

R.S.Malik have presented a study where they compared the Staad. Pro. calculations with manual calculations. A multistory building was designed. The design included load calculation, analysis. They used Limit State method for the calculations. The IS 456 (2000) was also taken under consideration. The whole process involved first modeling, then analyzing the members due to the effect of seismic load, wind load. The height of building was 33- meters, (G+10) storied building with 3 meter as height of each floor. The overall dimensions of building were 21.30m X 14.0 m.

Ashwani Kumar (2014)

Ashwani Kumar in his studies have presented the regulations for safety against the hazards in the hill towns of India. In his paper, he raises various issues regarding the various developments in hilly towns. Also, a comparative study of existing building regulations for safety was done in his paper. His study mainly focused on the Himalayan region, only northern part of India.

Jivanya Tiwari (2014)

They presented a study on building structures and construction in hilly regions. In their research paper they took a particular building that was hotel Dalhousie. As the architecture and beauty of buildings in hilly regions looks very soothing to eyes. But it is equally difficult and challenging for an architect or an engineer to make such structures. As Himachal is one of the most beautiful and tourist attracting state. Therefore, many people come from different states. Major part consists of the design

Deependra Singh Raghuvanshi (2016)

They have presented a study on the Analysis of a multistorey building frame for lateral forces at sloping strata under the effect of seismic forces using Staad. Pro. In their study they have taken a sample building structure (G+8) building and taken three sloping angles. Dynamic analysis method is used as per IS 1893 part-1 2002. They have included four seismic zones and three soil types (medium, soft, hard). The modelling and analysis were done through Staad. Pro. As results they have done a comparison between all model they prepared with different conditions and graphically represented the data.

III. RESEARCH GAP

Various research paper compared the buildings with different seismic zones, with different climatic conditions, different land profiles but there is very less research regarding effect of slopes on the building with varying seismic zones. In this project we have compared a Building for different slopes like 0, 10, 20, 30 degree slope and vary seismic zones likes I, V.

IV. RESEARCH OBJECTIVES

The objective of this project is a Comparative study of the effect of slopes on a building in with and without bracing system . In this project, we are going to analyze multistory building in varying slopes by using software like STAAD. Pro. In this project, we are going to structurally compare the G+10 , G+20,G+30 story building with various slopes like 0, 10, 20, 30 degree and with different seismic conditions like Zone I and Zone V. And at the end we will find some results. The results include

V. BUILDING CONFIGURATIONS

1. Plan Dimension 24 m x 22.5 m
2. Story Height 3.5 m
3. Number of stories
 - i) In G+10 = 11 stories
 - ii) In G+20 = 21 stories
 - iii) In G+30 = 31 stories

The following Wind Load parameters were taken as per IS 875 (Part 3):

- Wind Speed, V_b (m/s) 47
- Terrain category 3
- Structure class C
- Risk Coefficient (k_1 factor) 1
- Topography (k_3 factor) 1

VI. LATERAL LOAD PARAMETERS

The following Earthquake Load Parameters were taken as per IS 1893:2002:

- Response reduction factor(R) 5
- Seismic zone - III
- Seismic zone factor(Z) 0.16
- Soil type - II
- Importance factor - 1
- Time period Program calculated

VII. LOAD DEFINITIONS

The following load has been considered to be acting on both the structures:

- Dead load: weight of the structure.
- Superimposed load due to finishing etc.: 1 kN/m²
- Live Load: 3 kN/m²
- Earthquake in X-direction As per IS 1893:2002
- Earthquake in Y-direction: As per IS 1893:2002
- Wind load: As per IS 875 (Part 3)

VIII. FRAME SECTIONS

Column –I section –

I100012B55020 Beam - I

section – I80012B50012
 Channel Section - ISA 125
 Slab Thickness - 120 mm

IX. STAAD PRO MODELS

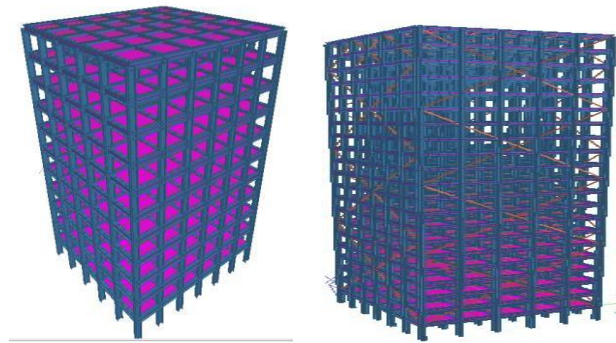


Figure 1 : STAAD Pro Models

X. RESULTS AND DISCUSSION

Response Spectrum analysis for seismic loading while linear static analysis for wind loading has been carried out for all the structures using STAAD. Pro and the results are represented in the following form:

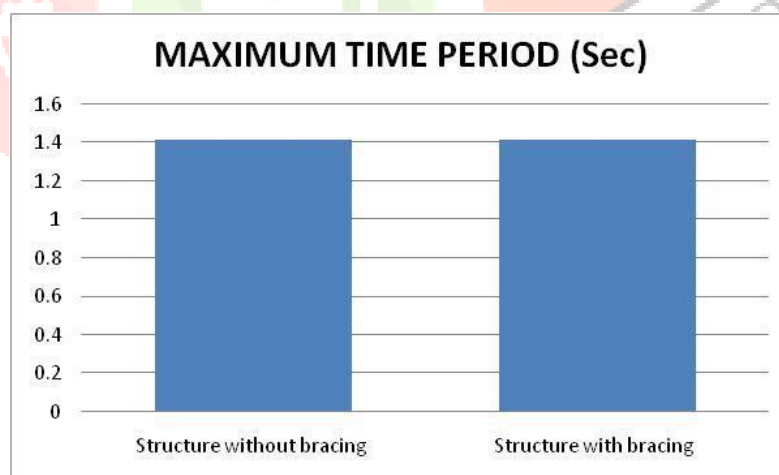
- Storey shear
- Time period

Comparative study between a building on sloping grounds with some slope having with and with bracing system. In this report structure is considered with and without any slope G+10,G+20,G+30 and analyses is done. Tabulated result and graphs are as below

G+10 Building with 0-degree slope

MAXIMUM TIME PERIOD (Second)

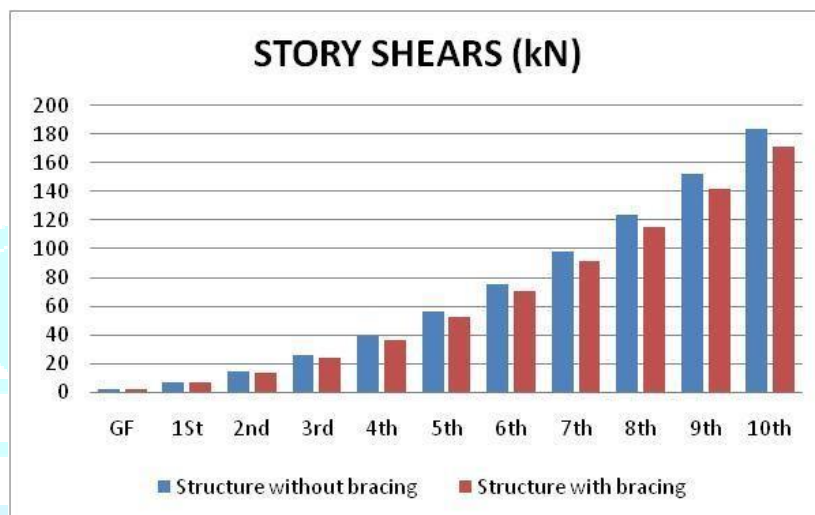
Structure Without bracing system	Structure With bracing system
1.414	1.414



Maximum Time period in sec

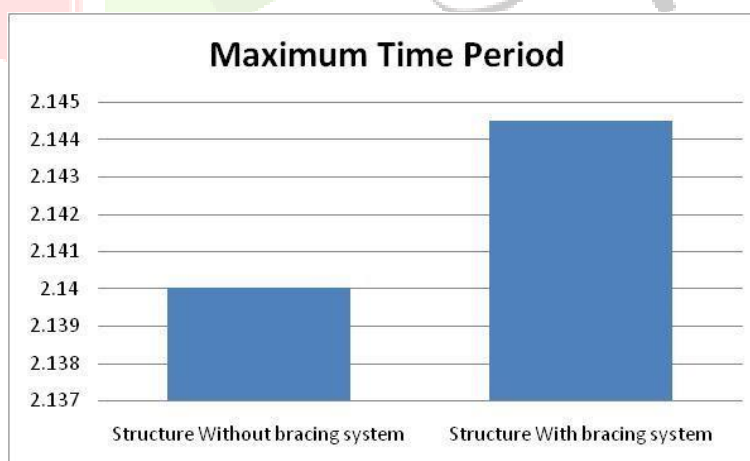
STORY SHEARS (kN)

Story	Structure Without bracing system	Structure With bracing system
GF	1.915	1.804
1St	6.812	6.323
2nd	14.654	13.602
3rd	25.462	23.635
4th	39.237	36.422
5th	55.980	51.963
6th	75.684	70.258
7th	98.366	91.307
8th	124.011	115.111
9th	152.652	141.668
10th	184.199	170.98

**Story Share in KN**

G+20 Building with 0-Degree slope
Maximum Time Period

Structure Without bracing system	Structure With bracing system
2.14	2.1445

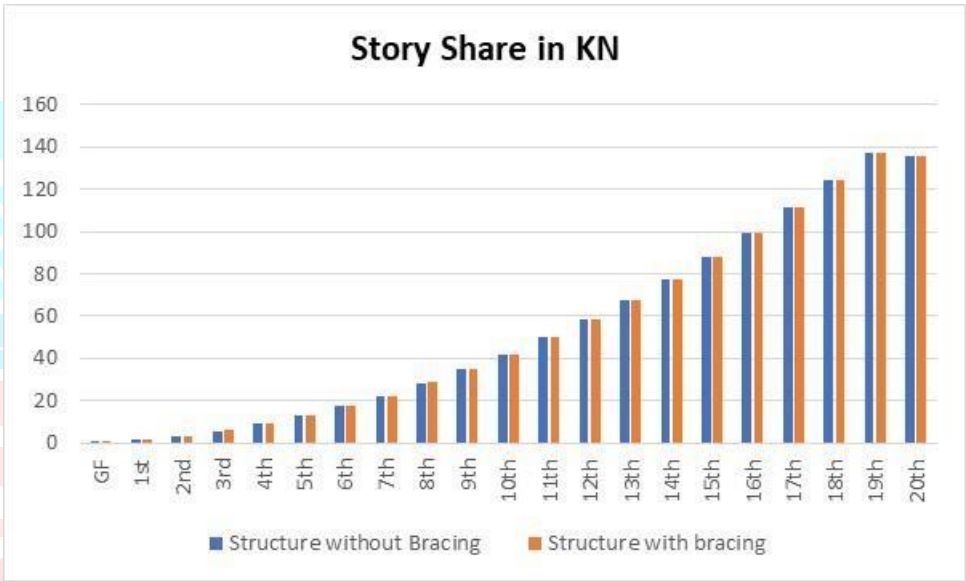


Maximum Time period in sec

Story Share in KN

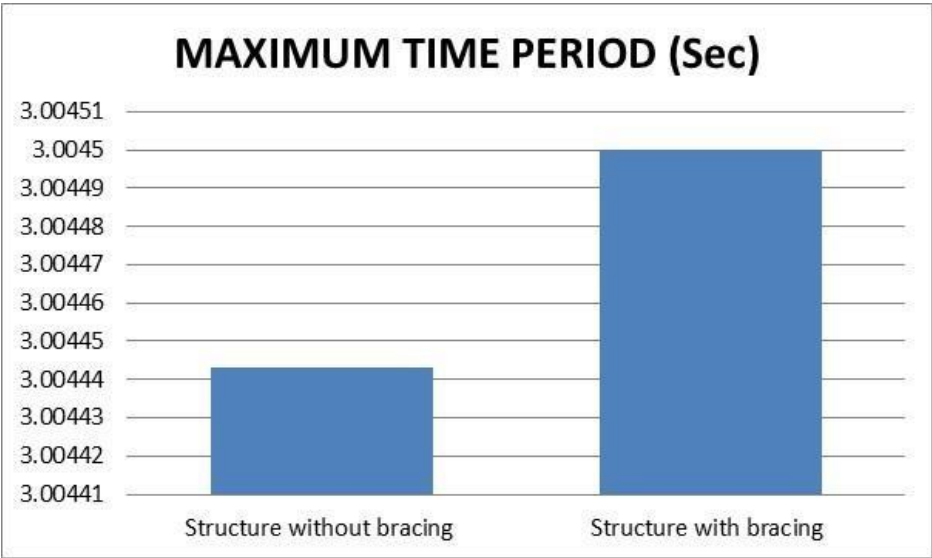
Story	Structure Without bracing system	Structure With bracing system
GF	0.437	0.437
1st	1.552	1.652
2nd	3.38	3.48

3rd	5.801	5.901
4th	8.935	8.935
5th	12.753	12.853
6th	17.243	17.343
7th	22.41	22.51
8th	28.525	28.625
9th	34.77	34.87
10th	41.964	42.0664
11th	49.785	49.885
12th	58.38	58.48
13th	67.602	67.702
14th	77.499	77.699
15th	88.073	88.173
16th	99.323	99.423
17th	111.249	111.349
18th	123.85	123.885
19th	137.128	137.228
20th	135.607	135.707



G+30 Building with 0-Degree slopeMaximum Time Period in sec

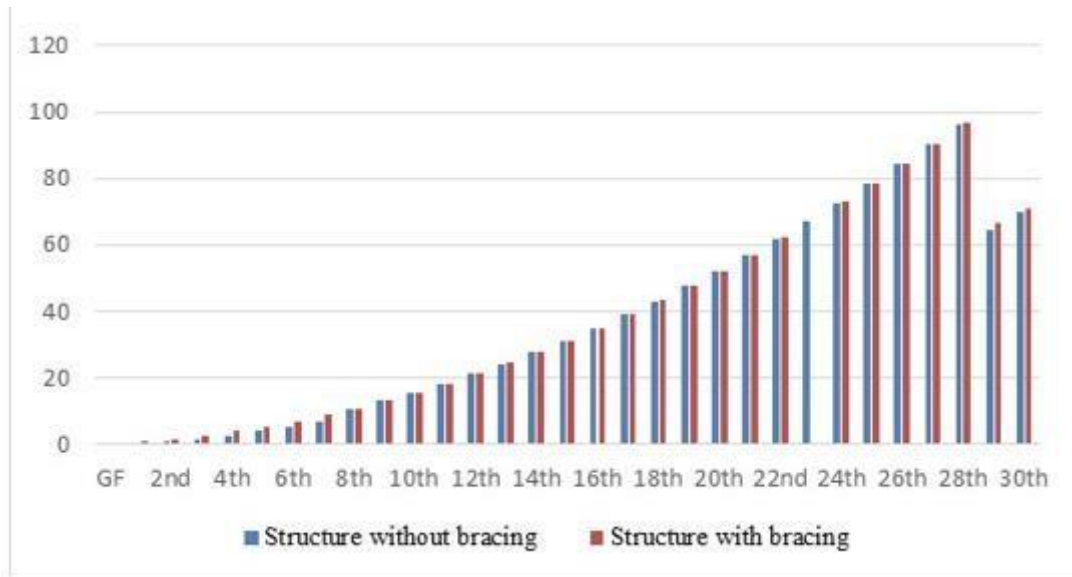
Structure Without bracing system	Structure With bracing system
3.004443	3.0045



Maximum Time period in sec

Story Share in KN

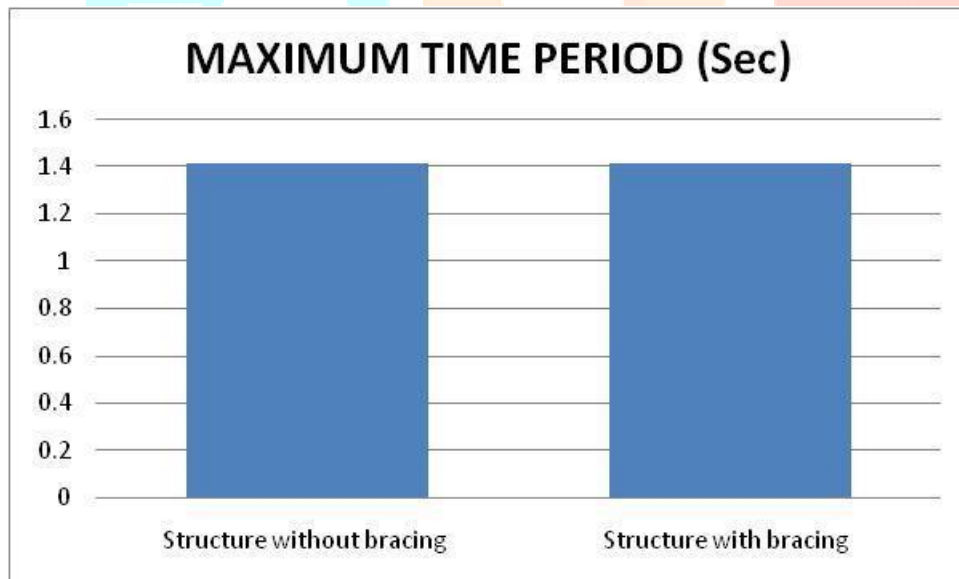
Story	Structure Without bracing system	Structure With bracing system
GF	0.138	0.49
1st	0.489	1.053
2nd	1.052	1.83
3rd	1.828	2.821
4th	2.817	4.024
5th	4.019	5.441
6th	5.434	7.071
7th	7.062	8.915
8th	10.958	10.971
9th	13.225	13.241
10th	15.69	15.79
11th	18.399	18.421
12th	21.305	21.331
13th	24.424	24.54
14th	27.757	27.791
15th	31.302	31.34
16th	35.06	35.104
17th	39.032	39.08
18th	43.216	43.269
19th	47.567	47.626
20th	52.224	52.288
21st	57.048	57.118
22nd	62.084	62.161
23rd	67.334	67.417.
24th	72.797	72.886
25th	78.472	78.569
26th	84.361	84.464
27th	90.55	90.573
28th	96.01	96.804
29th	64.69	66.694
30th	70.04	71.046



Story Share in KN

G+10 Building with 10- Degree slope**MAXIMUM TIME PERIOD (Second)**

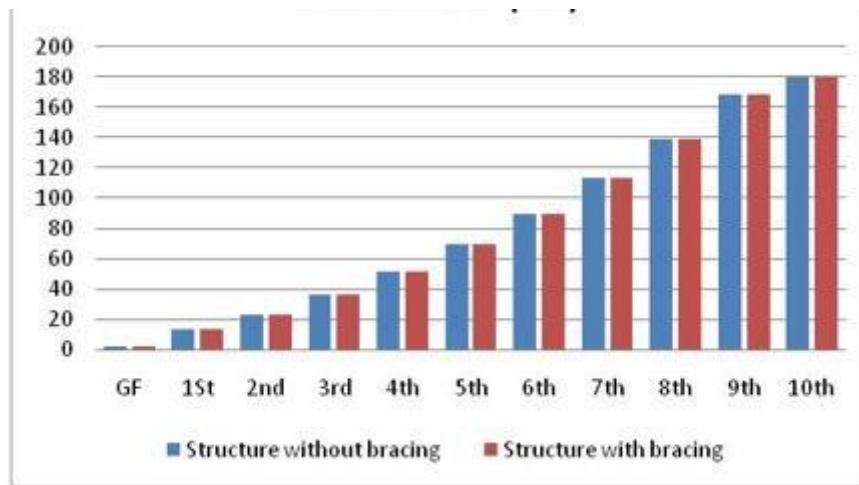
Structure Without bracing system	Structure With bracing system
1.41	1.444



Maximum Time period in sec

Story share Kn

Story	Structure Without bracing system	Structure With bracing system
Ground Floor	1.557	1.558
1St	13.374	13.392
2nd	23.239	23.271
3rd	35.811	35.861
4th	51.092	51.162
5th	69.08	69.175
6th	89.777	89.901
7th	113.182	113.338
8th	139.294	139.486
9th	168.114	168.349
10th	180.297	180.414

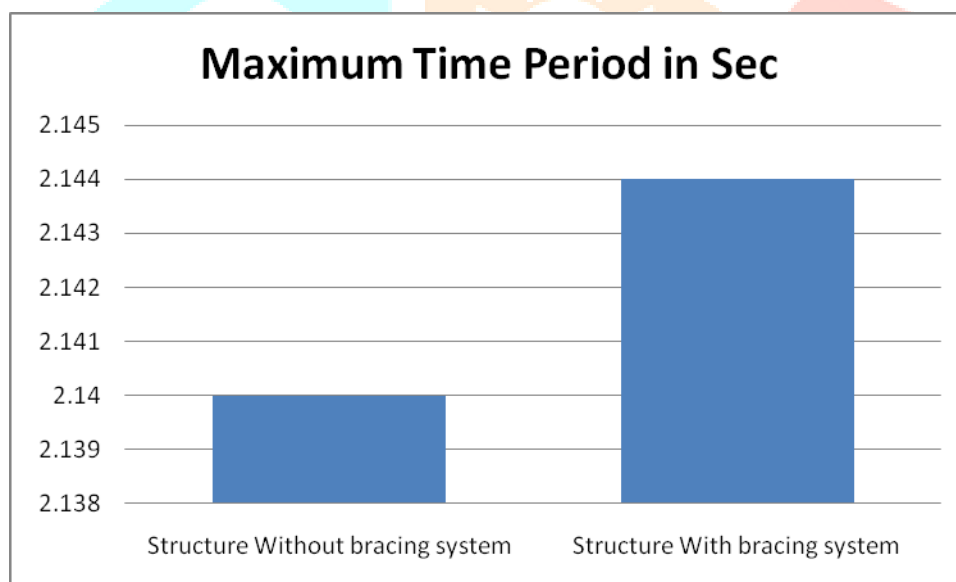


Story Share in KN

G+20 Building with 10-Degree slope

Maximum time period in sec

Structure Without bracing system	Structure With bracing system
2.14	2.1445

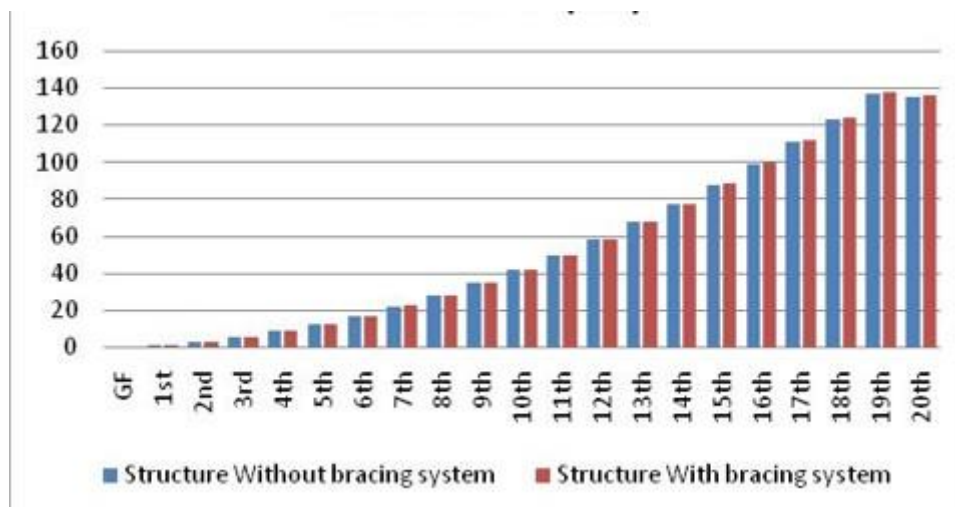


Maximum Time period in sec

Story Share in KN

Story	Structure Without bracing system	Structure With bracing system
Ground Floor	0.408	0.437
First Floor	1.545	1.554
Second floor	3.324	3.33
Third floor	5.775	5.808
Fourth Floor	8.9	8.951
Fifth Floor	12.697	12.77
Sixth Floor	17.167	17.226
Seventh Floor	22.311	22.43
Eight Floor	28.127	28.289
Ninth Floor	34.616	34.816
Tenth Floor	41.779	42.019
Eleventh Floor	49.565	49.851
Twelfth Floor	58.122	58.456
Thirteen Floor	67.303	67.69
Fourteenth Floor	77.157	77.601

Fifteen Floor	87.684	88.189
Sixteen Floor	98.884	99.453
Seventeen Floor	110.758	111.395
Eighteen Floor	123.304	124.013
Nineteen Floor	136.523	137.308
Twenty Floor	134.93	135.707

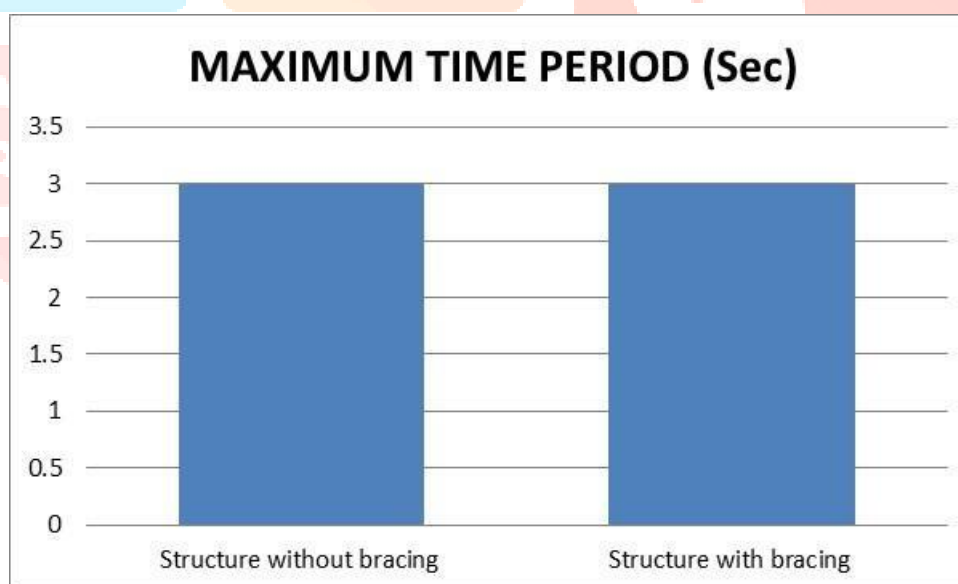


Story Share in KN

G+30 Building with 10-Degree slope

Maximum Time Period in sec

Structure Without bracing system	Structure With bracing system
3.004	3.004

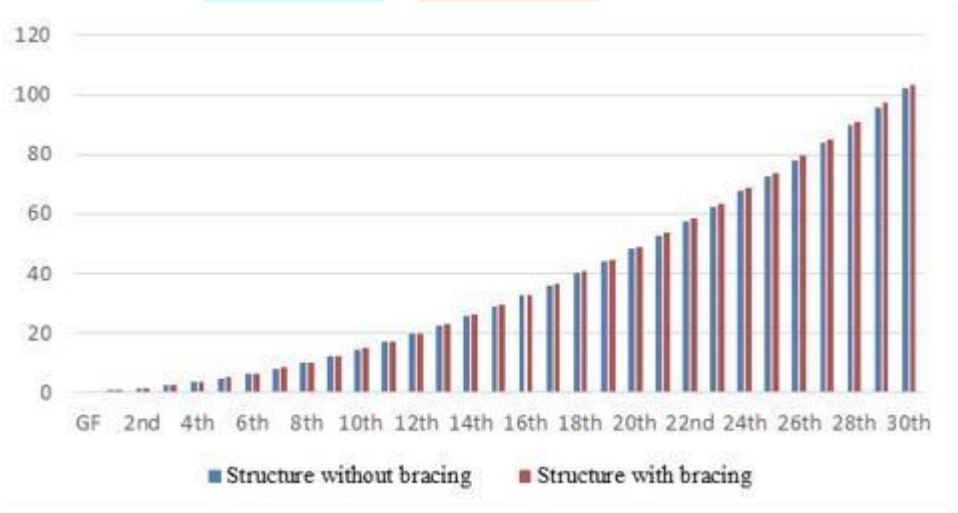


Maximum Time period in sec

Story Share Kn

Story	Structure Without bracing system	Structure With bracing system
GF	0.45	0.46
1st	0.975	0.99
2nd	1.695	1.719
3rd	2.615	2.65
4th	3.726	3.78
5th	5.038	5.111
6th	6.548	6.642
7th	8.255	8.3374

8th	10.159	10.307
9th	12.261	12.439
10th	14.546	14.757
11th	17.058	17.305
12th	19.752	20.039
13th	22.644	22.972
14th	25.733	26.107
15th	29.021	29.441
16th	32.505	32.977
17th	36.187	36.712
18th	40.066	40.648
19th	44.1	44.74
20th	48.418	49.12
21st	52.89	53.657
22nd	57.559	58.394
23rd	62.426	63.332
24th	67.491	68.74
25th	72.753	73.808
26th	78.212	79.347
27th	83.868	85.085
28th	89.635	90.935
29th	95.775	97.164
30th	102.024	103.505

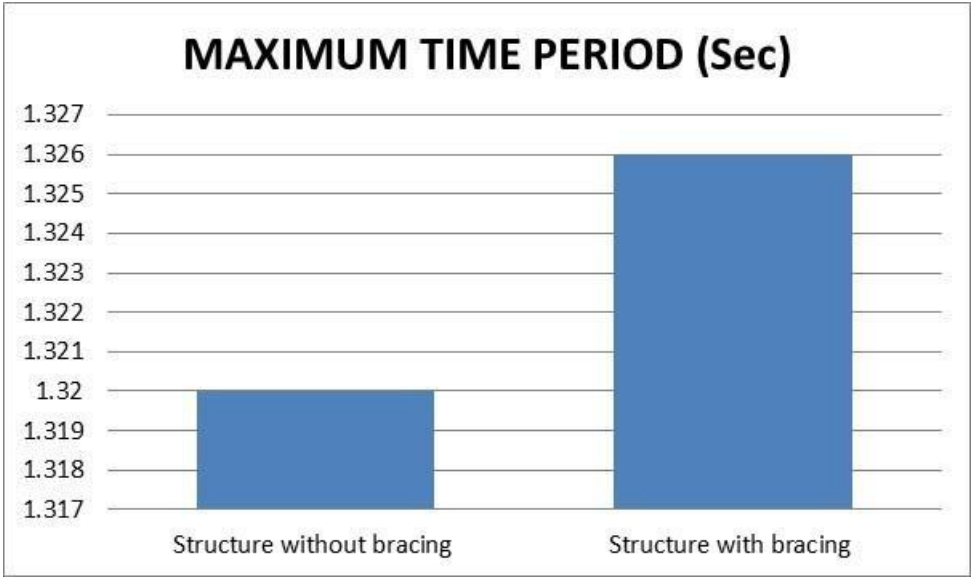


G+10 Building with 20- Degree slope

Story Share in KN

Maximum Time Period in sec

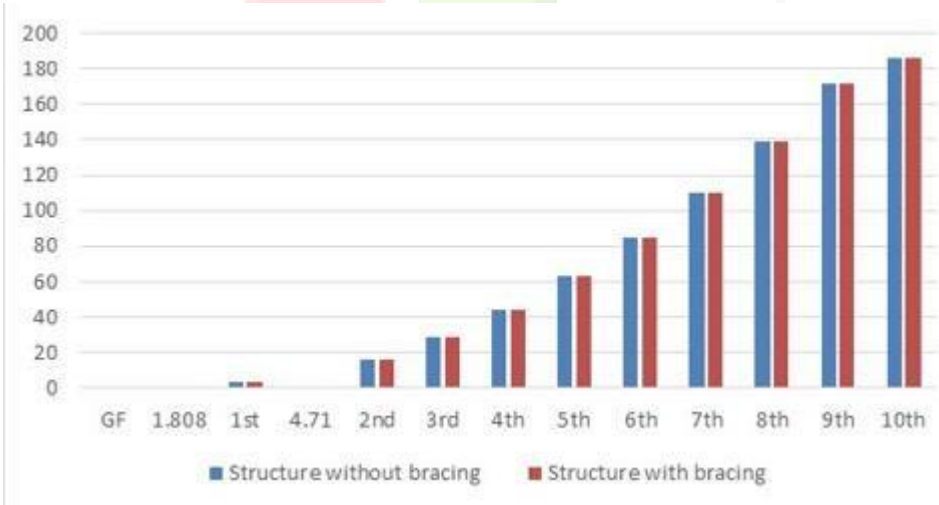
Structure Without bracing system	Structure With bracing system
1.32	1.326



Maximum Time period in sec

Story Share in Kn

Story	Structure Without bracing system	Structure With bracing system
GF	0.715	0.712
1.808	0.202	0.202
1st	3.997	3.959
4.71	0.06	0.06
2nd	16.301	16.312
3rd	28.572	28.596
4th	44.03	44.067
5th	62.817	62.87
6th	84.934	85.006
7th	110.38	110.47
8th	139.157	139.275
9th	171.261	171.407
10th	185.727	185.777

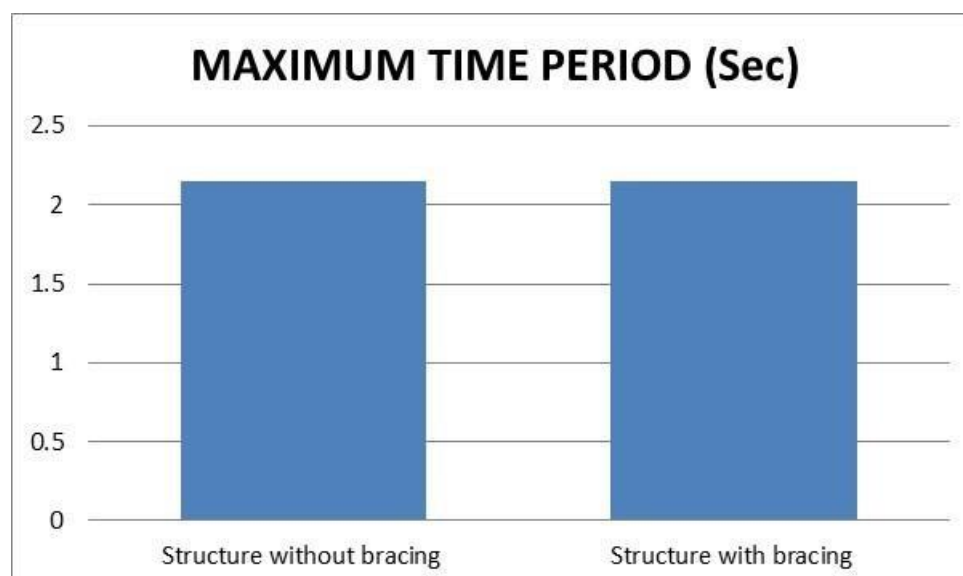


Story Share in KN

G+20 Building with 20- Degree slope

Maximum Time Period in sec

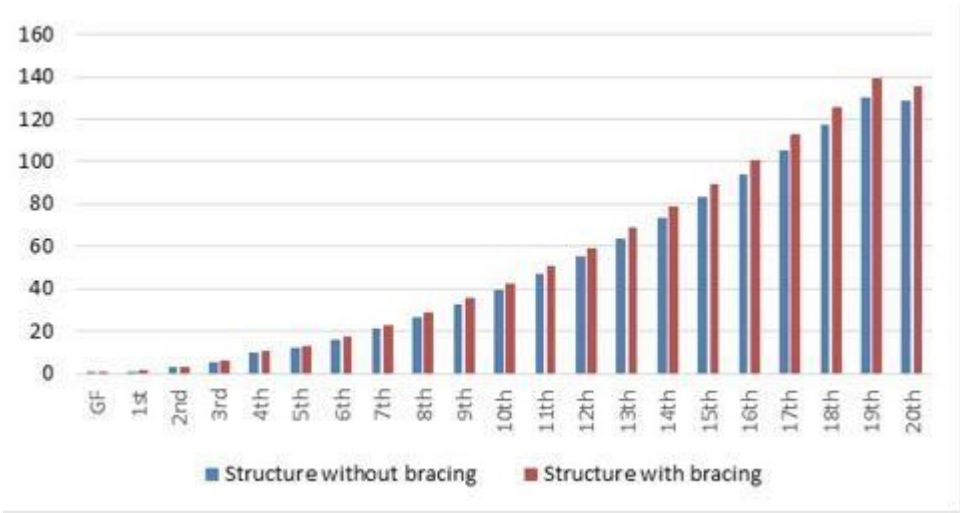
Structure Without bracing system	Structure With bracing system
2.144	2.144



Maximum Time period in sec

Story Share in kn

Story	Structure Without bracing system	Structure With bracing system
GF	0.102	0.263
1st	0.759	1.362
2nd	3.135	3.352
3rd	5.703	6.113
4th	9.952	10.624
5th	12.083	12.696
6th	16.337	17.535
7th	21.231	22.788
8th	26.766	28.729
9th	32.941	35.358
10th	39.757	42.673
11th	47.167	50.628
12th	55.31	59.366
13th	64.046	68.744
14th	73.424	78.809
15th	83.441	89.562
16th	94.1	101.001
17th	105.398	113.129
18th	117.337	125.943
19th	129.916	139.445
20th	128.476	135.698

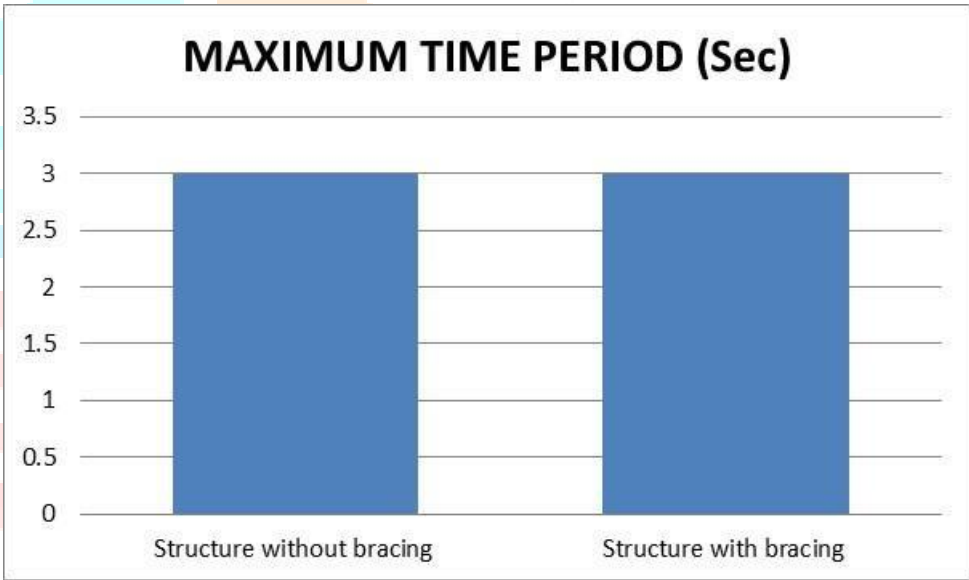


Story Share in KN

G+30 Building with 20- Degree slope

Maximum Time period in sec

Structure Without bracing system	Structure With bracing system
3.004	3.004

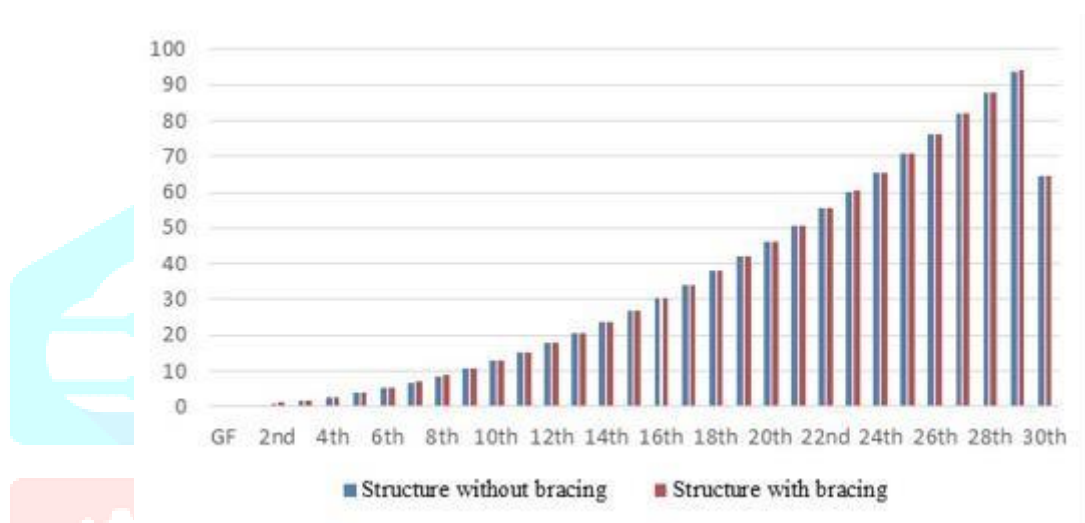


Maximum Time period in sec

Story Share in KN

Story	Structure Without bracing system	Structure With bracing system
GF	0.033	0.158
1st	0.414	0.539
2nd	1.012	1.137
3rd	1.774	1.899
4th	2.734	2.859
5th	3.9	4.025
6th	5.274	5.399
7th	6.853	6.978
8th	8.64	8.765
9th	10.634	10.759
10th	12.834	12.959
11th	15.226	15.351
12th	17.854	17.979
13th	20.674	20.799
14th	23.701	23.826

15th	26.935	27.06
16th	30.376	30.501
17th	34.023	34.148
18th	37.877	38.002
19th	41.937	42.062
20th	46.159	46.284
21st	50.679	50.804
22nd	55.359	55.484
23rd	60.247	60.372
24th	65.341	65.466
25th	70.642	70.767
26th	76.15	76.275
27th	81.864	81.989
28th	87.784	87.909
29th	93.82	93.945
30th	64.594	64.719

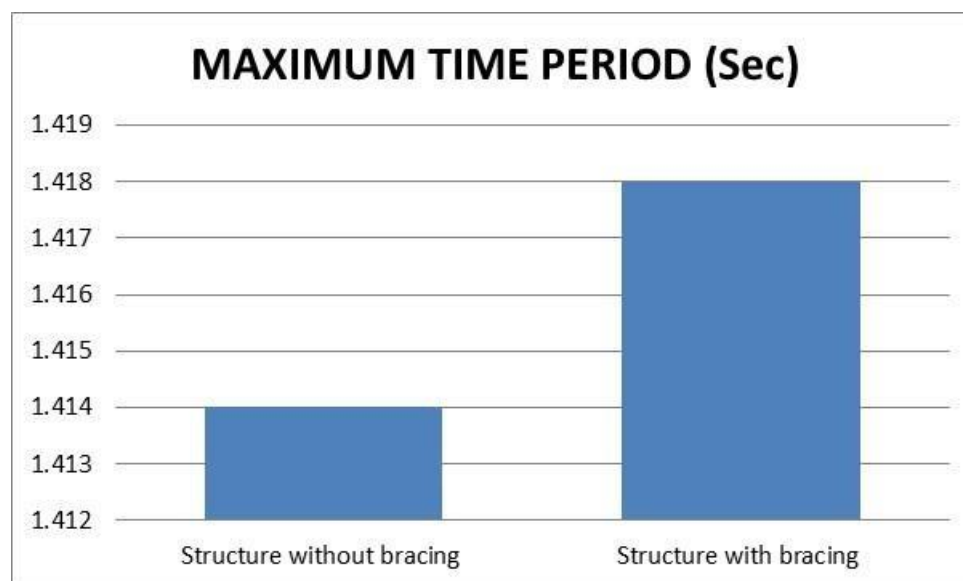


Story Share in KN

G+10 Building with 30-Degree slope

Maximum Time period in sec

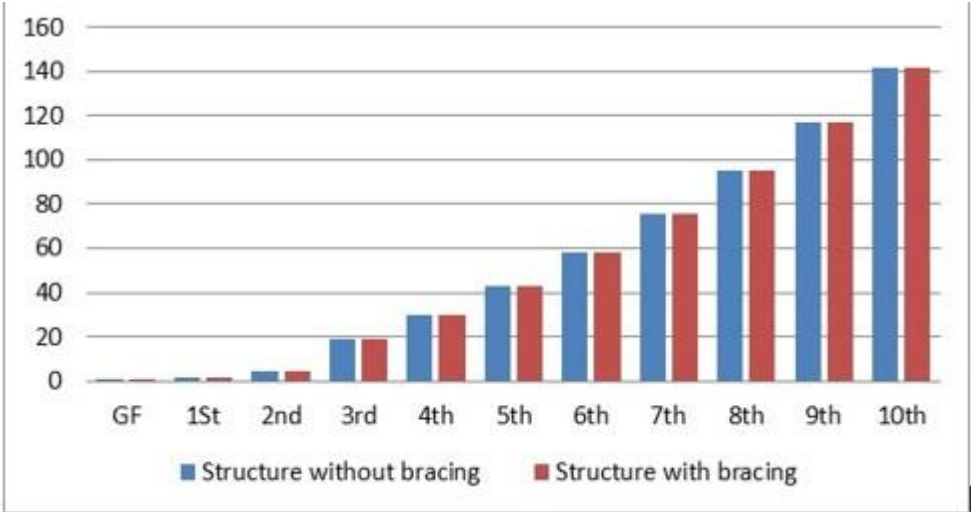
Structure Without bracing system	Structure With bracing system
1.414	1.418



Maximum Time period in sec

Story Share in KN

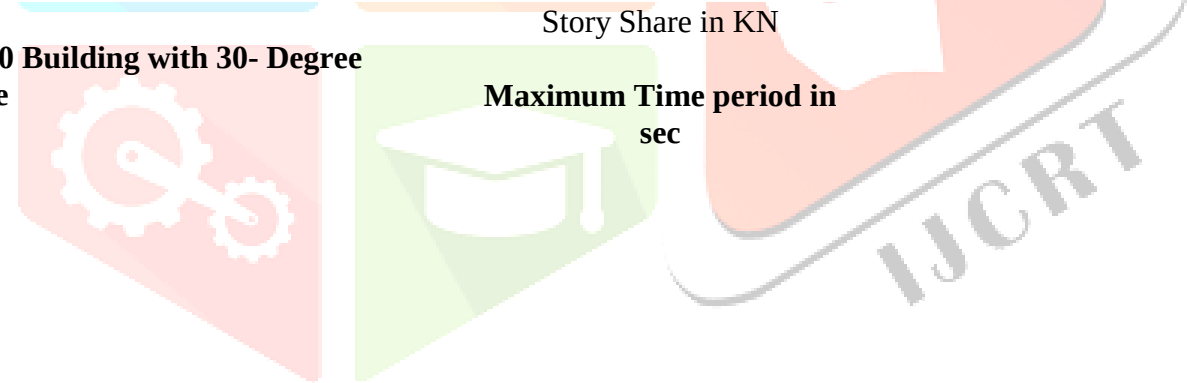
Story	Structure Without bracing system	Structure With bracing system
GF	0.217	0.217
1st	1.667	1.667
2nd	4.753	4.753
3rd	19.187	19.187
4th	30.16	30.16
5th	43.03	43.03
6th	58.179	58.179
7th	75.61	75.61
8th	95.322	95.322
9th	117.314	117.314
10th	141.586	141.586



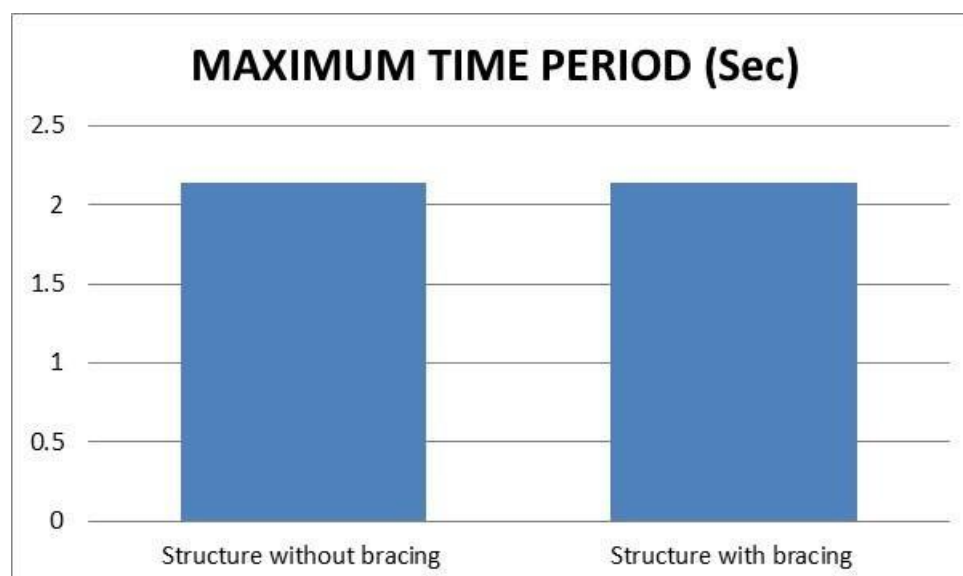
G+20 Building with 30- Degree slope

Story Share in KN

Maximum Time period in sec



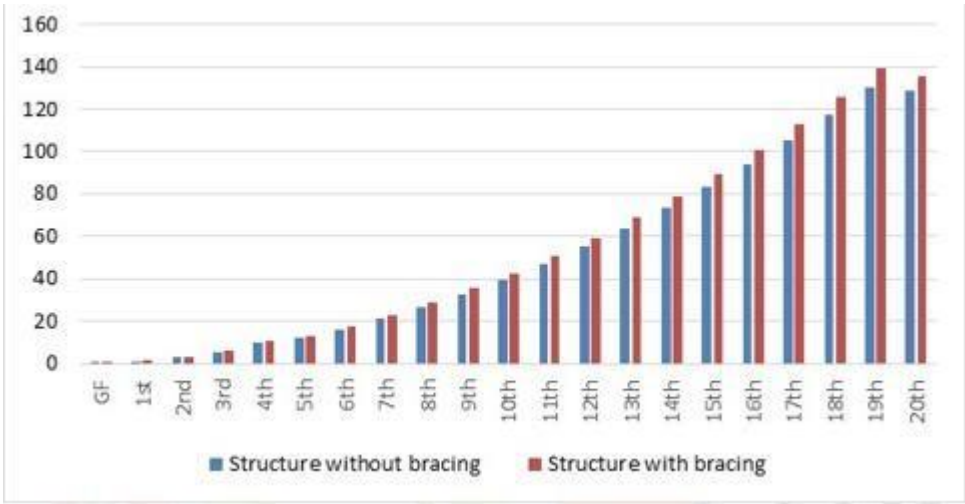
Structure Without bracing system	Structure With bracing system
2.144	2.144



Maximum Time period in sec

Story share in Kn

Story	Structure Without bracing system	Structure With bracing system
GF	0.102	0.263
1st	0.759	1.362
2nd	3.135	3.352
3rd	5.703	6.113
4th	9.952	10.624
5th	12.083	12.696
6th	16.337	17.535
7th	21.231	22.788
8th	26.766	28.729
9th	32.941	35.358
10th	39.757	42.673
11th	47.167	50.628
12th	55.31	59.366
13th	64.046	68.744
14th	73.424	78.809
15th	83.441	89.562
16th	94.1	101.001
17th	105.398	113.129
18th	117.337	125.943
19th	129.916	139.445
20th	128.476	135.698

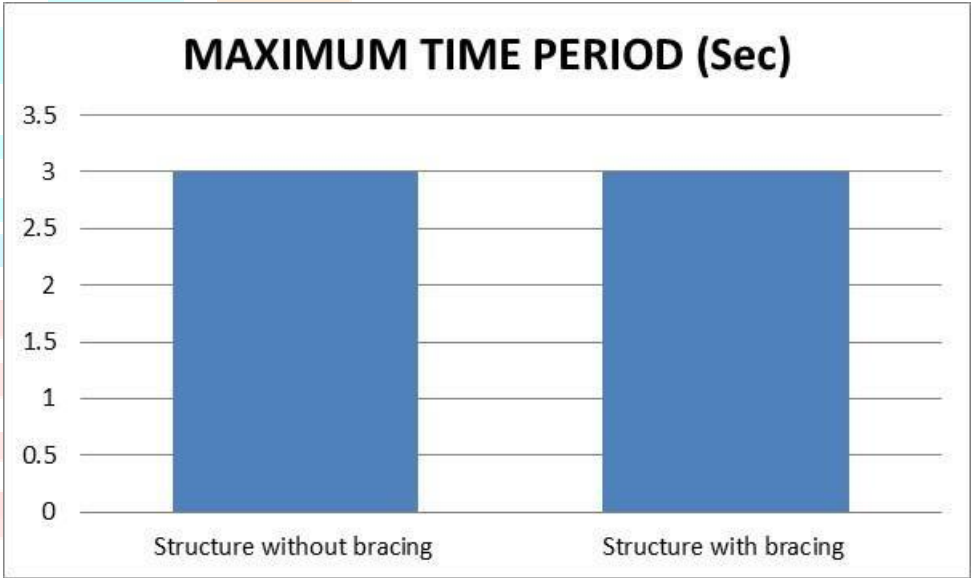


Story Share in KN

G+30 Building with 30- Degree slope

Maximum Time period in sec

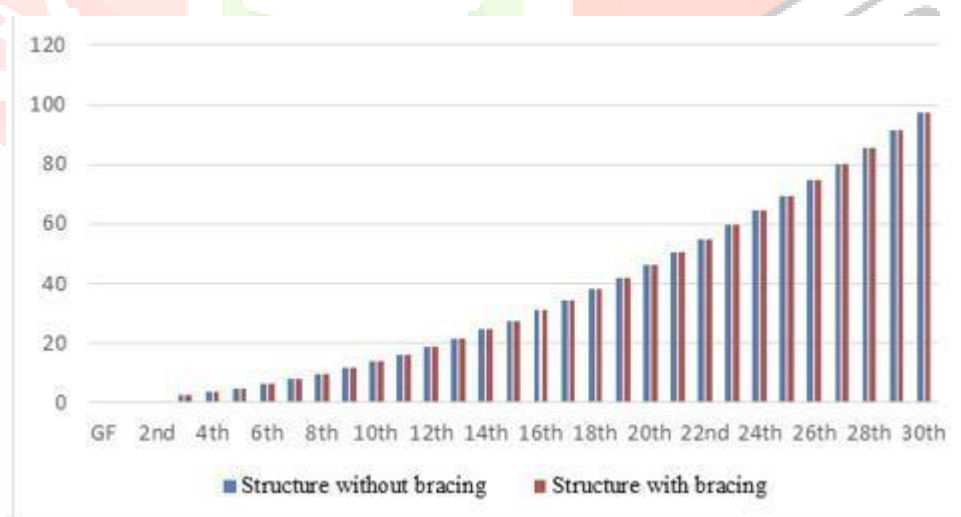
Structure Without bracing system	Structure With bracing system
3.0045	3.0045



Maximum Time period in sec

Story Share in KN

Story	Structure Without bracing system	Structure With bracing system
GF	0.019	0.019
1st	0.143	0.143
2nd	0.197	0.197
3rd	2.488	2.488
4th	3.549	3.549
5th	4.799	4.799
6th	6.236	6.236
7th	7.862	7.862
8th	9.676	9.676
9th	11.678	11.678
10th	13.855	13.855
11th	16.247	16.247
12th	18.813	18.813
13th	21.567	21.567
14th	24.51	24.51
15th	27.641	27.641
16th	30.96	30.96
17th	34.467	34.467
18th	38.162	38.162
19th	42.004	42.004
20th	46.116	46.116
21st	50.375	50.375
22nd	54.823	54.823
23rd	59.458	59.458
24th	64.282	64.282
25th	69.294	69.294
26th	74.494	74.494
27th	79.881	79.881
28th	85.374	85.374
29th	91.222	91.222
30th	97.174	97.174



Story Share in KN

XI. CONCLUSION

- For considering maximum time period for various slopes from 0 degree to 30 degree with variable structure height up to from G+10 to G+30, it is observed that, for all structure with and without bracing is nearly same, but in some structure is slightly variable.

- Story Share effects is interesting factor because from above two observation it is clear that with increasing height of building structure story displacement and base share effects keep changing but in case of maximum story share values are nearly same for all slope and all structure except few structure
- From all above observation it can concluded that structure with bracing always better solution over structure without bracing for same loading and same sectional property. Which ultimately improves structure stability, safety and serviceability.

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