Analytical Study and Comparison of Bare Frame Buildings on Sloping Ground in Y Plane

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***Abstract*: In recent years, due to increase of population density in hilly areas it is necessary to construct buildings on sloping grounds. The present study is on analysis and comparison of bare frame structure. The present project carried out to investigate the analysis and comparison of building on sloping ground with different number of storeys i.e. G+3, G+5, G+7 and G+9 in Y plane by using E tabs software and results such as storey force, storey displacement, storey stiffness and time period has been extracted. Then comparison is done for varying number of storeys in Y plane and Here, the results shows in Y plane that the storey of G+3 building has high stiffness and low displacement, storey force, time period that means it has more strength than other three buildings.**

INTRODUCTION

The term earthquake may be described as some of unstable waves generated either by natural or formatted by humans under the ground. Large strain energy released for the duration of earthquake travels as seismic waves in all directions. The buildings are usually built on flat grounds. Since the ground is leveled the constructed buildings are regular and symmetrical in both horizontal and vertical directions. Hence they tend less damage to the buildings during earthquake because in leveled ground the structures are constructed with same column height. In hilly areas due to lack of flat ground surface the construction of buildings have been started on sloping grounds. The study of earthquake resistant building on slopes becomes popular to prevent the loss of life, property during earthquake ground motion.

Normally sloping areas are rejected for the construction activities it is just because the effects of slopes on building. Sloping areas are more tends to seismic activities when it compared to even surface areas. If we go through the studies of which has been already conducted on effect of earthquakes on different parts of our country, we can easily come to a conclusion that the north eastern parts of our country are more tends to damage. Why because north eastern parts consists of mainly sloping areas. In slopingareas the locally available materials such as timber, lime, burnt brick masonry, stone masonry, bamboo and reinforced concrete etc main materials used for construction.

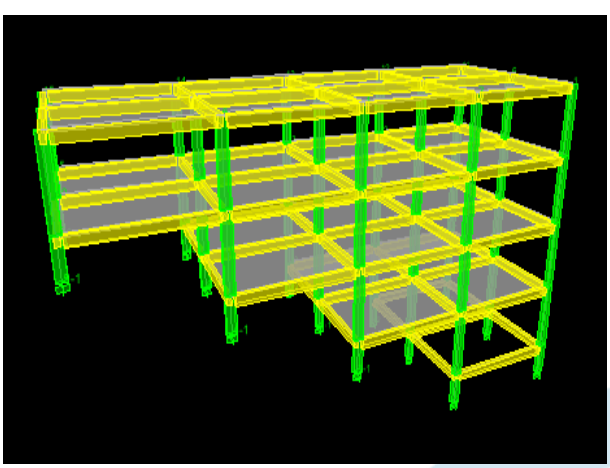
Same like, most of the buildings were situated on slopes are likely to the risk of seismic hazards which is depending upon the seismic zone in which they are located. As the intensity of slope increases the risk of damage also increases, because the ground floor or soft storey will be likely to more seismic forces.

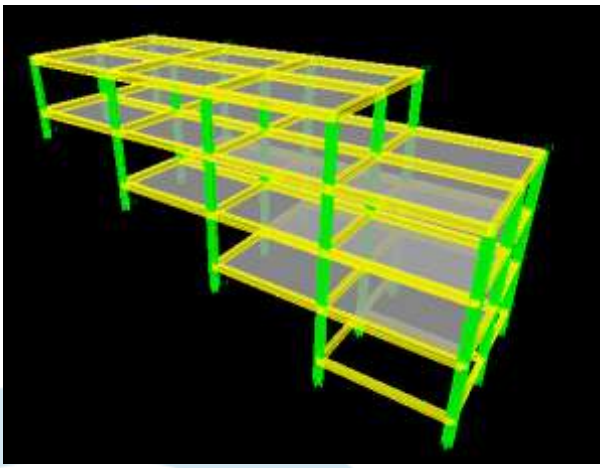
1.1 Building Configuration

Three different configurations are considered,
1) Step back

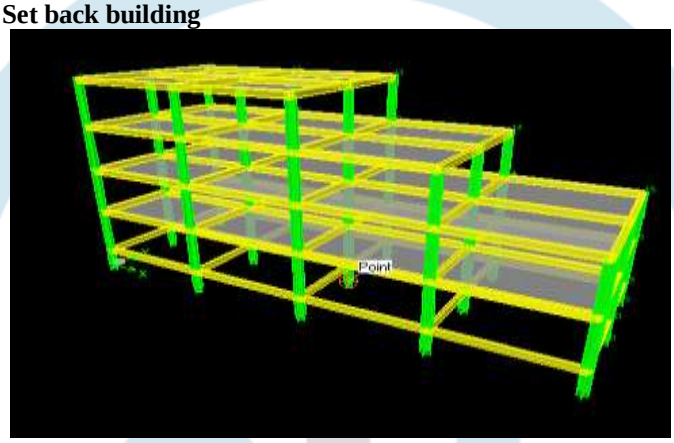
2) Step back –Set back

3) Setback.





Step back building Step back – Set back building



Set back building

Set back is nothing but the side of the building looks like having a set backs from one building to another building with some steps.

Step back buildings will be having their columns in the ground floor. So that the ground storey will be considered as soft storey.

In the combination of step back and set back building the design and architectural features are combined together and constructed.

2.0 LITERATURE REVIEW

S.D. Uttekar et.al (2016) presented A Review on Seismic Response of RC Building on Sloping Ground. Seismic analysis is the calculation of the response of a structure to earthquakes. It is part of the process of structural design, earthquake engineering or structural assessment and retrofit in regions where earthquakes are prevalent. The aim of this paper to study the response of RC structure on slopping ground. To evaluate the response of building by using linear analysis and non linear analysis.

Sripriya Arjun et.al (2016) reported A Study on Dynamic Characteristics of RC Buildings on Hill slopes. In this study, behavior of G+3 storied sloped frame building having step back set back configuration is analyzed for sinusoidal ground motion with different slope angles i.e., 16.7°, 21.8°, 26.57° and 30.96° using structural analysis tool STAAD Pro. The results were obtained in the form of top storey displacement and base shear. It is observed that short column is affected more during the earthquake. The analyses showed that for construction of the building on slopy ground the stepback setback building configuration is suitable.

Nagarjuna et.al (2015)studied byLateral stability of multistorey building on sloping ground.The structures are generally constructed on level ground; however, due to scarcity of level grounds the construction activities have been started on sloping grounds.In this study, G+ 10 storeys RCC building and the ground slope varying from 100 to 400 have been considered for the analysis. The modeling and analysis of the building has been done by using structure analysis tool ETAB, to study the effect of varying height of the column in bottom storey and the effect of shear wall at different position during the earthquake.

Sandeep Goyal (2015)investigated on Dynamic analysis of sloped buildings. The buildings situated in hilly areas are much more prone to seismic environment in comparison to the buildings that are located in flat regions. Structures on slopes differ from other buildings since they are irregular both vertically and horizontally hence torsionally coupled and are susceptible to severe damage when subjected to seismic action. In this study, behavior of two storied sloped frame having step back configuration is analyzed for sinusoidal ground motion with different slope angles.

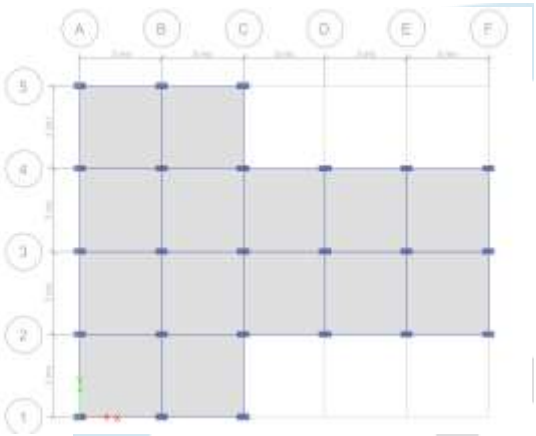
OBJECTIVES

The following objectives were taken on the basis of literature review,

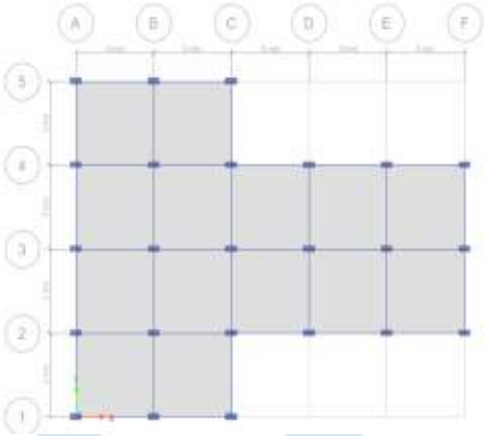
- To study the variation of storey stiffness, and time period, with respect to variation in number of storeys.
- To study the variation of base shear, storey displacement, with respect to variation in number of storeys.

MODELING DESCRIPTION

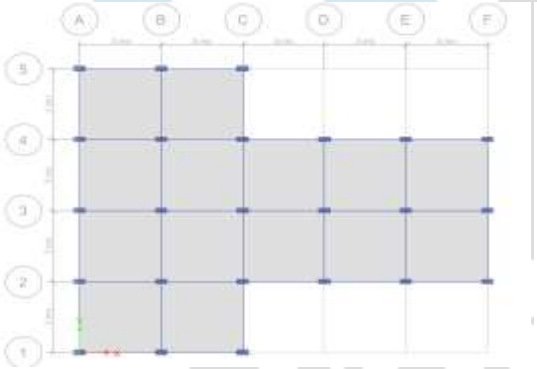
In this paper, a 5 bay by 4 bay building in Y plane with varying number of storeys models has been modeled and analysis could be done. The details of models are as follows



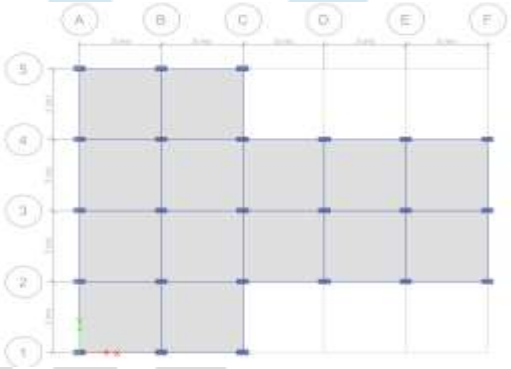
2D model of G+3



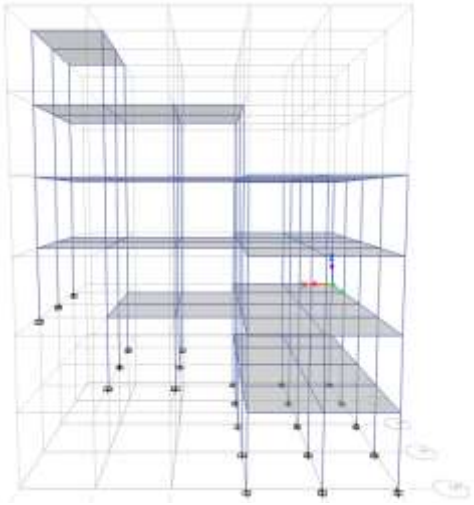
2D model of G+5



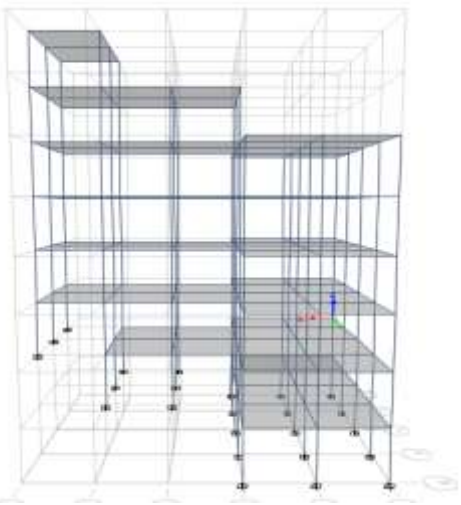
2D model of G+7



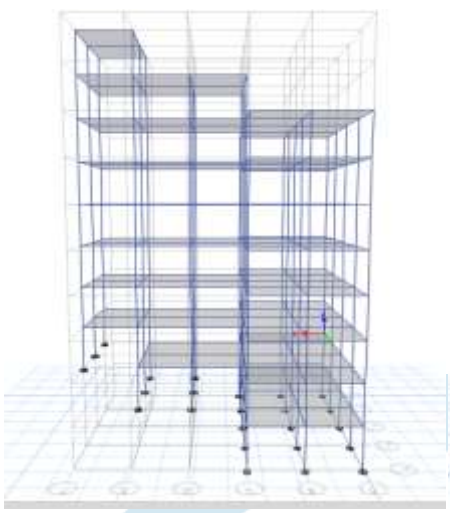
2D model of G+9



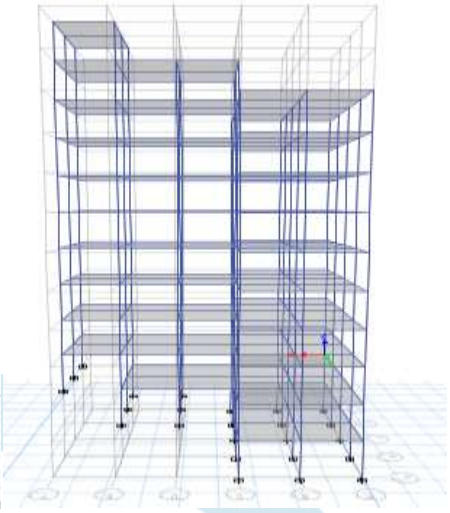
3D model of G+3



3D model of G+5



3D model of G+7



3D model of G+9

Material Properties: CONCRETE: Grade: M20 (Columns), M20 (Beams, Slabs) REINFORCEMENTS: HYSD bars of grade Fe415

Section Properties:

Beam 230X400 mm
Column 230X450 mm
Slab 150 mm thick
Storey height 3m
Load Cases:

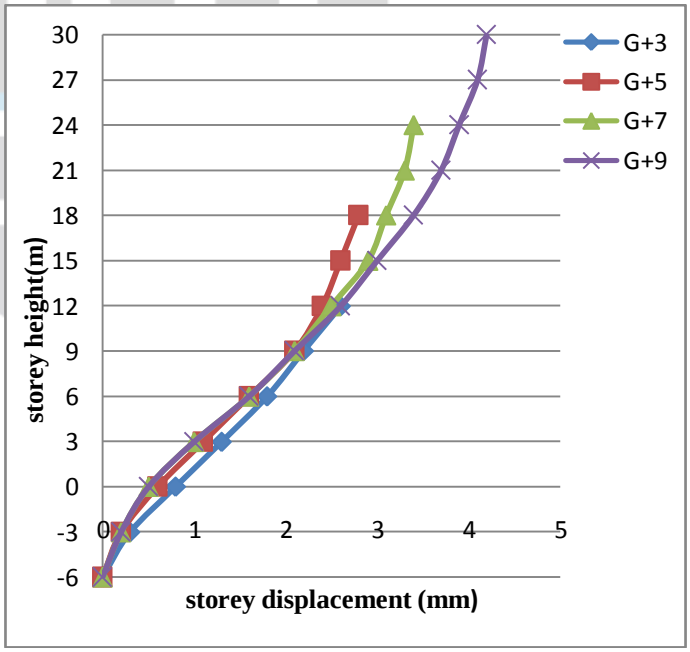
Dead load - After assigning the proper sectional properties to various members E-tabs will automatically considers the DL for the analysis.

Live load - As per IS 875-part2 Slabs have been assigned a Live load of 3kN/m^2.

RESULTS AND DISCUSSIONS
Comparison of Results with Varying Number of Storeys with Respect To Y-Plane.

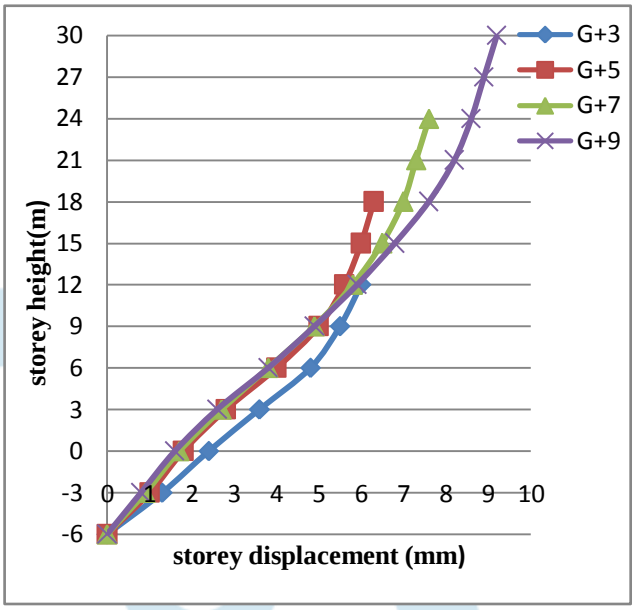
Storey displacement for RSX

Storey No	Storey Height (m)	Storey Displacement (mm)			
		G+3	G+5	G+7	G+9
9th	30				4.2
8th	27				4.1
7th	24			3.4	3.9
6th	21			3.3	3.7
5th	18		2.8	3.1	3.4
4th	15		2.6	2.9	3
TF	12	2.6	2.4	2.5	2.6
SF	9	2.2	2.1	2.1	2.1
FF	6	1.8	1.6	1.6	1.6
GF	3	1.3	1.1	1	1
BASE	0	0.8	0.6	0.5	0.5
BS1	-3	0.3	0.2	0.2	0.2
BS2	-6	0	0	0	0



Storey displacement for RSY

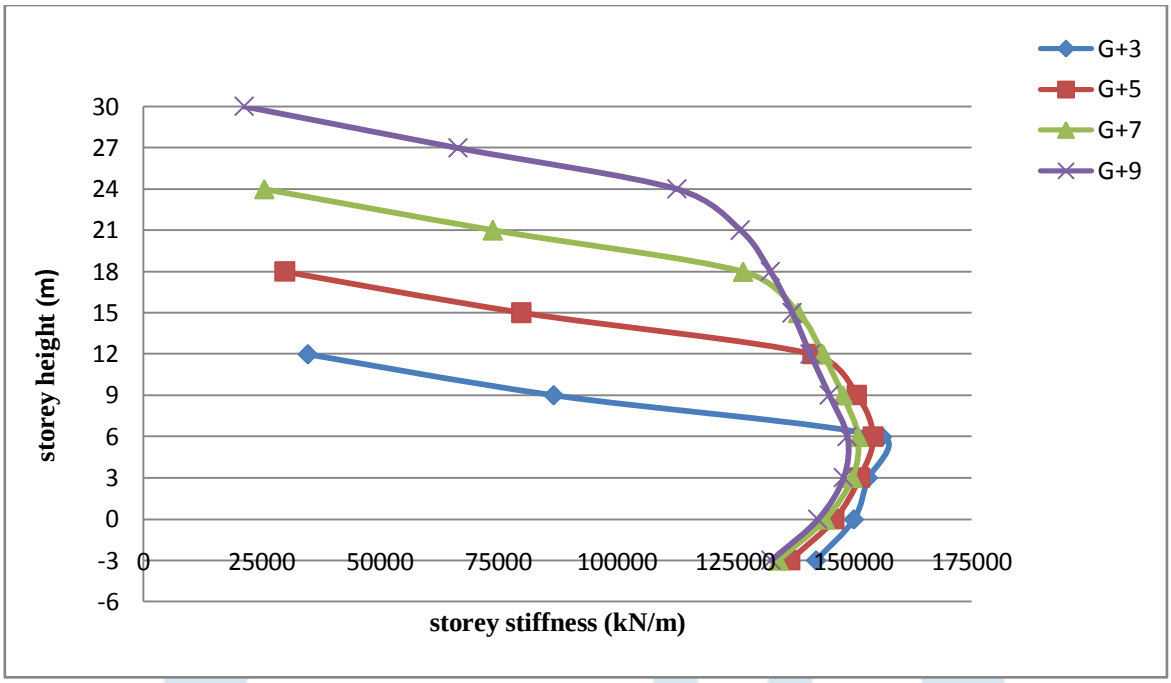
Storey No	Storey Height(m)	Storey Displacement (mm)			
		G+3	G+5	G+7	G+9
9th	30				9.2
8th	27				8.9
7th	24			7.6	8.6
6th	21			7.3	8.2
5th	18		6.3	7	7.6
4th	15		6	6.5	6.8
TF	12	6	5.6	5.8	5.9
SF	9	5.5	5	4.9	4.9
FF	6	4.8	4	3.8	3.8
GF	3	3.6	2.8	2.7	2.6
BASE	0	2.4	1.8	1.7	1.6
BS1	-3	1.3	1	0.9	0.8
BS2	-6	0	0	0	0



Discussion: From table we can notice that as the storey height increases the storey displacement values increases simultaneously. It can observe that G+9 building having more displacement than compare to G+7, G+5 and G+3 buildings.

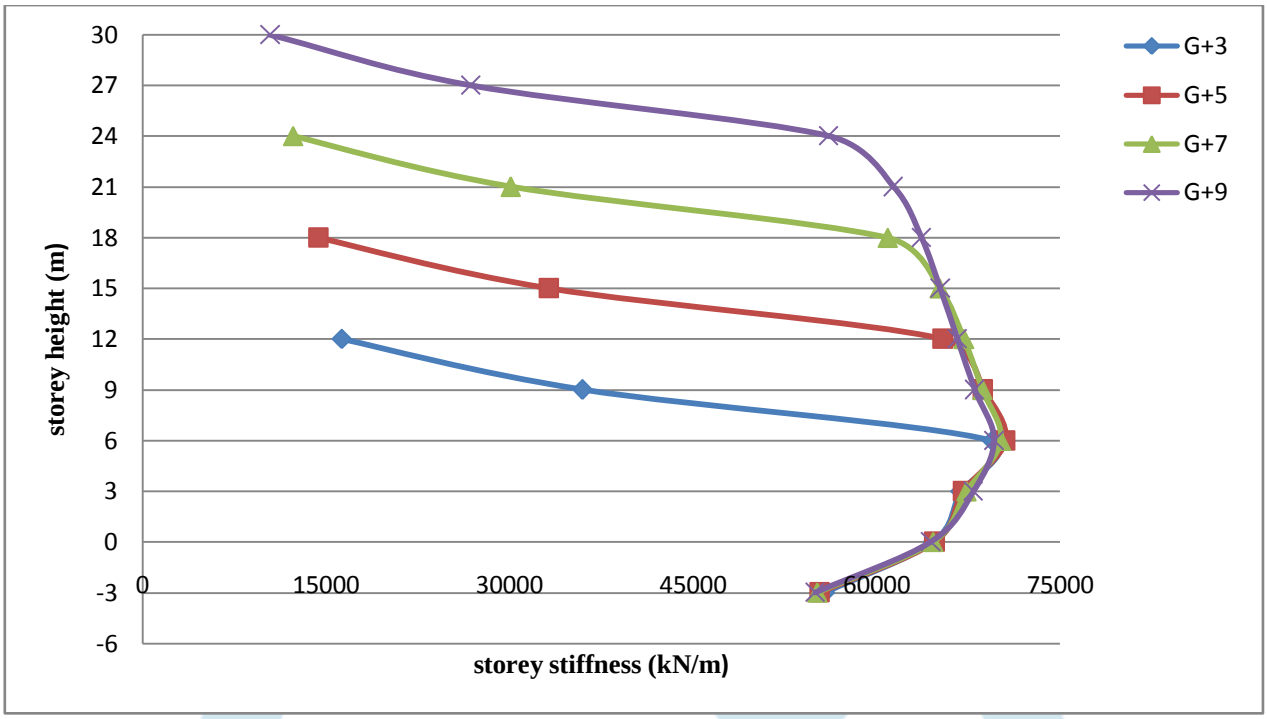
Storey stiffness for RSX

Storey	Storey Height (m)	Storey Stiffness (kN/m)			
		G+3	G+5	G+7	G+9
9th	30				21289.164
8th	27				66506.909
7th	24			25545.543	112816.347
6th	21			73769.091	126228.75
5th	18		29894.458	126779.923	132567.774
4th	15		79927.214	138352.434	137118.418
TF	12	34658.516	141524.464	143669.202	141011.764
SF	9	86713.84	150859.3	147786.346	145025.91
FF	6	156076.852	154266.744	151083.366	148822.543
GF	3	153088.435	151425.745	149895.156	147999.895
BASE	0	150111.333	146121.816	144000.898	142614.811
BS1	-3	142130.755	136666.358	134226.731	132698.962



Storey stiffness for RSY

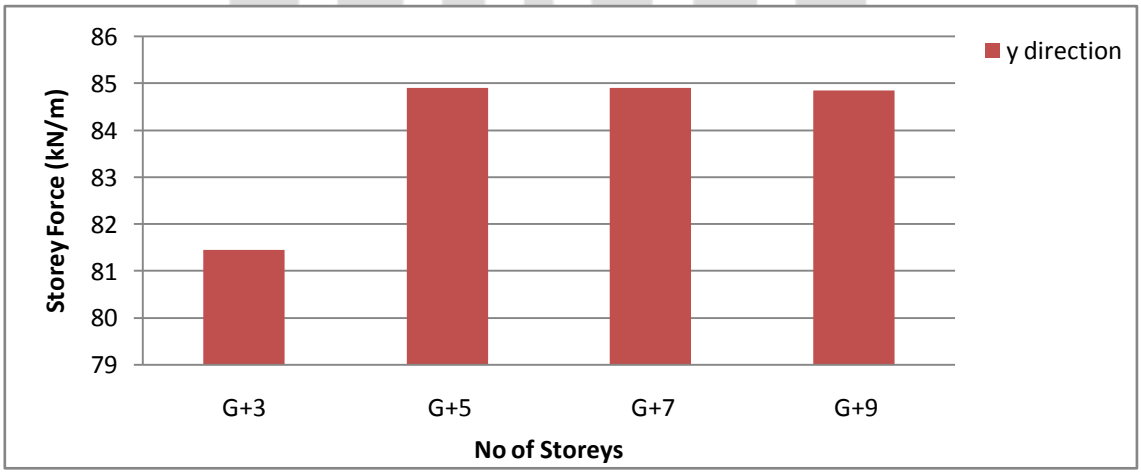
Storey	Storey Height	Storey Stiffness			
		G+3	G+5	G+7	G+9
9th	30				10452.75
8th	27				26842.331
7th	24			12288.69	56111.033
6th	21			30098.913	61390.193
5TH	18		14398.902	60898.025	63682.167
4TH	15		33254.903	65143.115	65225.279
TF	12	16297.885	65433.021	67158.171	66604.499
SF	9	35934.966	68720.145	68664.777	68011.08
FF	6	69443.256	70543.455	70151.919	69617.15
GF	3	66897.914	67099.685	67358.498	67895.665
BASE	0	64614.196	64752.526	64606.766	64435.225
BS1	-3	55776.506	55354.612	55134.703	54995.343



Discussion: For table, we conclude that the storey stiffness value increases up to 6m height and then start to decrease till 30m height. Figure it is notice that by comparing G+9 building has least stiffness value than G+7, G+5 and G+3 structures.

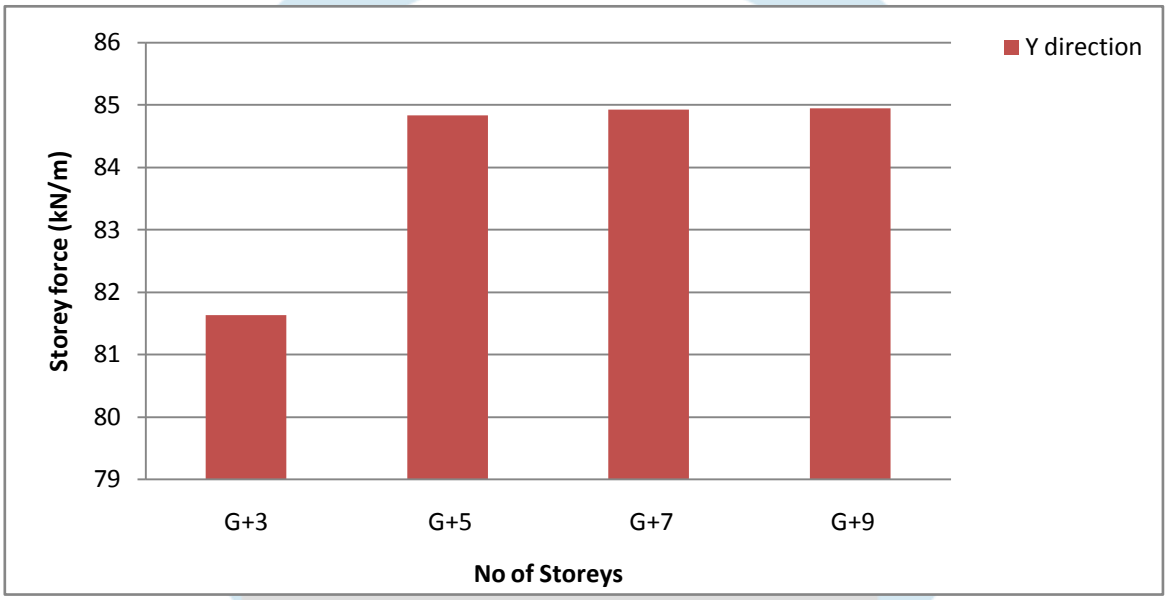
Storey forces for in RSX direction

Y plane						
Storey No	**Load Case/ Combo**	**Location**	**Storey Force (kN)**			
			G+3	**G+5**	**G+7**	**G+9**
FF	RSX Max	Bottom	81.455	84.8939	84.8903	84.8373



Storey forces for in RSY direction

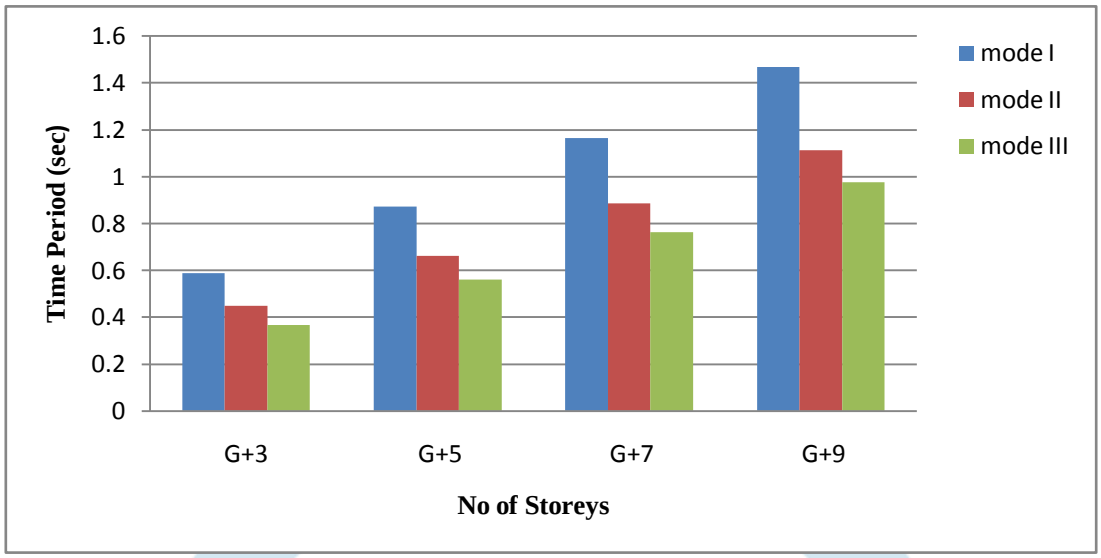
Y direction						
storey	**load case/ combo**	**location**	**value of Vy**			
			G+3	**G+5**	**G+7**	**G+9**
FF	RSY Max	Bottom	81.6275	84.8317	84.9265	84.9454



Discussion: for table it can be observe that in both Y plane and X plane when the number of storey increases then the storey forces goes on increases simultaneously.

Time period forY plane

mode	Y direction, period (sec)			
	G+3	**G+5**	**G+7**	**G+9**
1	0.587	0.87	1.163	1.466
2	0.449	0.662	0.884	1.111
3	0.367	0.559	0.763	0.975



Discussion: here the time period varies depending upon type of structure. Table it shows G+9 building has more time period as compare to other three building.

CONCLUSIONS

1. ForY plane Comparison of G+3, G+5, G+7, G+9 buildings, the building with G+9 floors gave more displacement than other 3 type of buildings in both RSX and RSY directions.
2. For both RSX and RSY direction, the storey force is high for building G+9 floors as compare to G+3, G+5 and G+7 with respect to both Y plane.
3. For Y plane gives the more time period values for G+9 structures when compare to other three buildings.
4. From Y planes, by comparing stiffness values for G+3, G+5, G+7 and G+9 structures, G+3 building has higher value of stiffness than other structures in both RSX and RSY directions.
5. Finally it is concluded that in present study for sloping ground G+3 floors has more strength due to higher value of stiffness and lower value of displacement.

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