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ANALYSIS OF SEISMIC EFFECT ON DIFFERENT ORIENTATIONS OF G+11 MULTISTOREY BUILDING

Rajashree S. Kulkarni[1], Sumitra S. Kandolkar[2]

[1]*Student, ME Structures, Goa College of Engineering, Farmagudi*
[2]*Associate Professor, Department of Civil Engineering, Goa College of Engineering, Farmagudi*

Abstract

Orientation of structure according to climatology plays a very important role in reducing the amount of carbon footprint in the environment.. This paper presents the effect of seismic load combining with vertical load on reinforced concrete structure orientated by 30⁰,45⁰,60⁰,90⁰ and 180⁰ degree keeping CG of structure same with respect to global x-z plane. A G+11 multi storey commercial building were analyzed in Staad pro v8i by orienting it in five different angles with respect to global x-z plane and observed the behavior, performance and response of structure in terms of storey drift, displacement, bending moment and shear force. Results indicated that maximum storey drift in global "x" direction is more for structure oriented by 180⁰. Maximum top nodal displacement in global "x "direction is exceeding the permissible limit in all case except for the structure oriented by 90⁰ angle. Maximum bending moment was observed for structure oriented by 90⁰ and maximum shear force for structure oriented by 180⁰. Hence it is observed that the orientation of structure is important from environmental as well as design point of view. As height of structure go on increasing these design parameter values will also go on increasing.

Keywords: *Multi-Storey Building, Orientation, Seismic Effect, Design Parameters.*

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1. INTRODUCTION

The top most priority in any building structure is to provide comfortable living space from all environmental calamities. We have to study in all possible manners to meet the above priority. The Orientation of building plays a major role on the thermal comfort of occupants [8]. To determine building orientation it is highly important to pay attention to climatic factors like solar radiation, and wind in a region [10]. Heating, ventilation and air conditioning (HVAC) systems which brought about building comfort during this hot season were estimated to account for some 65% of the total energy use in the building sector [1]. It is well established that lateral drift sustained during response to an earthquake is a major contributor to both nonstructural and structural damage [3]

Thus concern remains regarding seismic behavior, performance and response in terms of storey drift, displacement, bending moment and shear force of structure orientation. To study these effects, an analytical study was conducted on model of eleven storey five bays by five bays, moment resisting reinforced concrete frame structure. The structure considered in this work is commercial office building with plan dimensions 20mx40m and floor to floor height of 3.45m.The five different cases were analyzed in Staad pro V8i.The dead loads, live loads and seismic loads are as per Indian code.

2. METHODLOGY

Modeling of structure was done by using Staad pro V8i commercial software. The space frame of G+11 special moment resisting frame model is created. All column base are assigned as fixed base. The structure models were oriented by an angle of 30⁰,45⁰,60⁰,90⁰ and 180⁰. Seismic load combining with dead and live load was applied. The model was analysed for following load combination as per IS code.

1 1.5(DL±LL)
2 1.2(DL±LL±EQ)
3 1.5(DL±EQ)
4 0.9DL±1.5EQ

The data of structure and dimension of elements are given in table 1 and table 2. All design parameter i,e storey drift, displacement ,shear force and bending moment results analysed for worst load combination are tabulated in Table 3,Table 4,Table 5 and Table 6.

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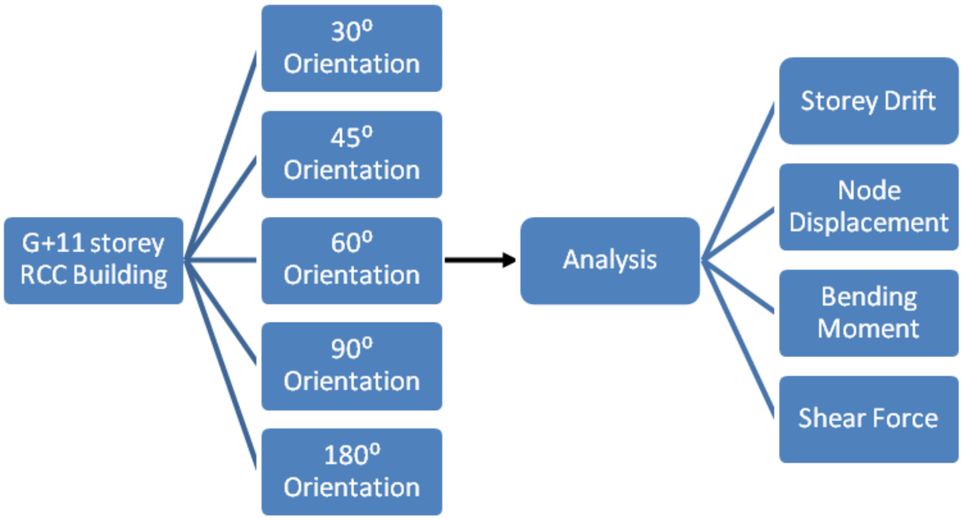

Fig 1: PROPOSED RESEARCH METHODOLOGY

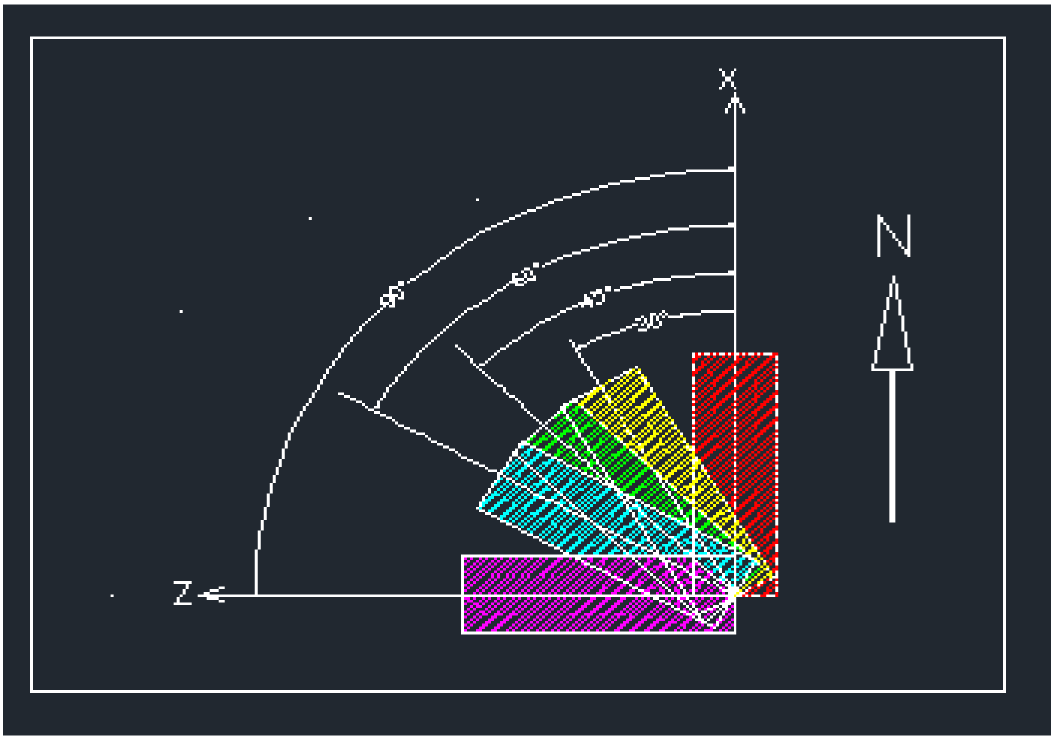

Fig 2: KEY PLAN ORIENTATION OF STRUCTURE WITH DIFFERENT ANGLES

Table 1: DATA FOR G+11 STOREY BUILDING

Geometry	Type of building	Commercial
	Height of building	41.40m
	Typical storey height	3.45m
	Width of the building	20m
	Depth of the building	40m
Materials	Grade of concrete	M40N/mm2
	Grade of Steel reinforcement	500N/mm2
	Density of infill wall material	6.5Kn/m3
Load details	Dead load	3.75Kn/m2
	Floor finish	1.0Kn/m2 and 2Kn/m2 for roof
	Wall load	4.60Kn/m

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	Live load	5Kn/m2
Seismic parameters	Zone	III
	Response reduction factor	5
	Importance factor	1
	Type of soil	Hard
	Damping ratio	5%

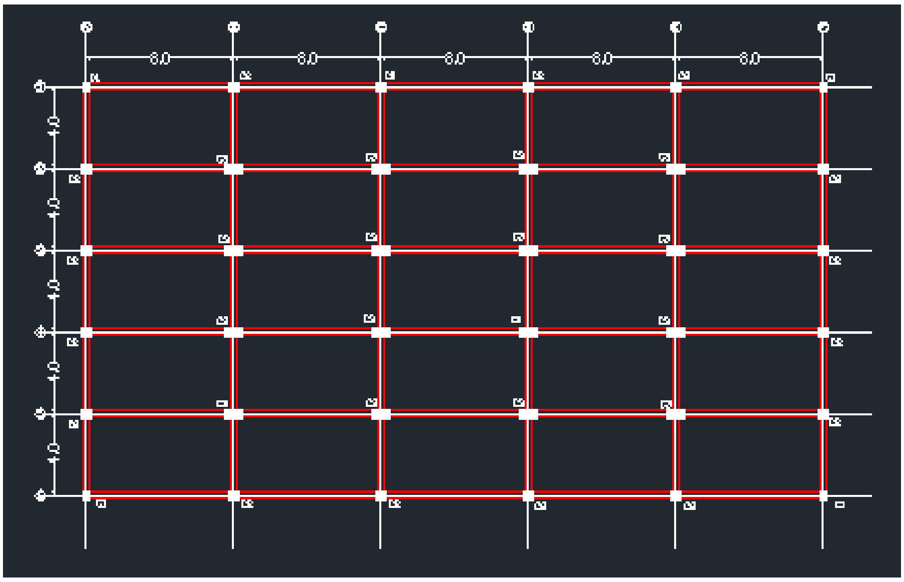

Fig 3: PLAN OF BUILDING

Table 2: SECTION PROPERTY

SL.NO	FLOOR LEVEL	COLUMN NAME			BEAM		SLAB THICKNESS (cm)
		C1 (cm)	C2 (cm)	C3 (cm)	LONG SPAN(cm)	SHORT SPAN(cm)	
1	12TH	40X40	50X40	40X40	40X40	40X40	15
2	11TH	40X40	50X40	40X40	50X30	40X40	15
3	10TH	40X40	50X40	40X40	50X30	40X40	15
4	9TH	40X40	50X40	40X40	50X30	40X40	15
5	8TH	40X40	50X40	50X40	50X30	40X40	15
6	7TH	40X40	50X40	60X40	50X30	40X40	15
7	6TH	40X40	50X40	60X40	50X30	40X40	15
8	5TH	40X40	50X40	70X40	50X30	40X40	15
9	4TH	40X40	50X40	80X40	50X30	40X40	15
10	3RD	40X40	50X40	90X40	50X30	40X40	15
11	2ND	40X40	50X40	90X40	50X30	40X40	15
12	1ST	40X40	50X40	90X40	50X30	40X40	15
13	PLINTH LEVEL	40X40	50X40	90X40	35X30	30X30	NA

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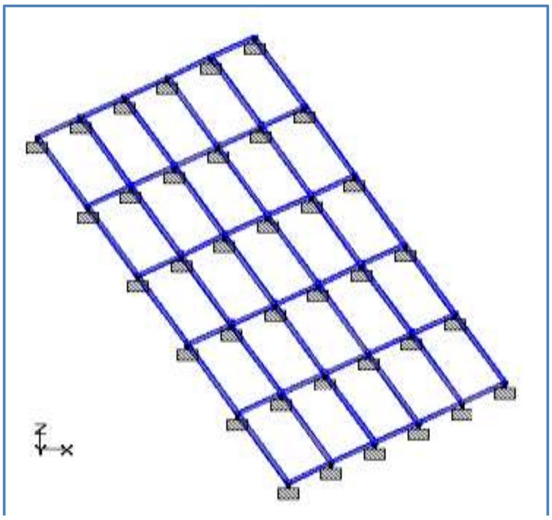

Fig 4: BUILDING ORIENTED BY 30^{o}

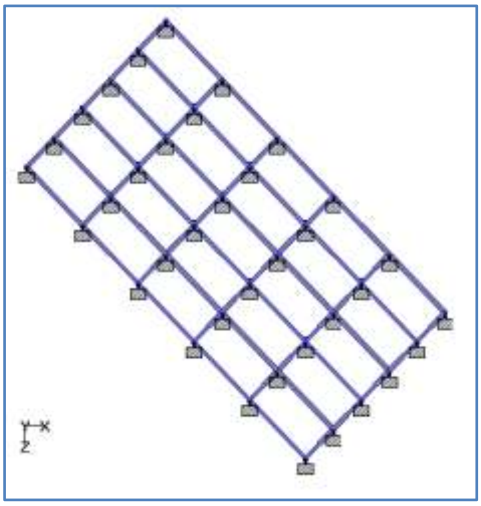

Fig 5: BUILDING ORIENTED BY 45

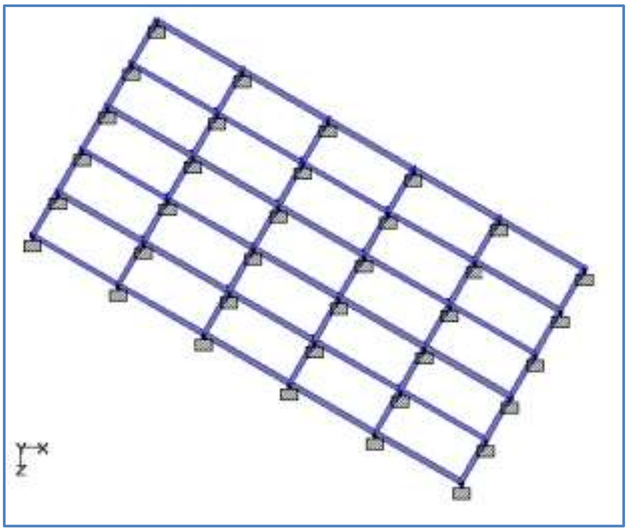

Fig 6: BUILDING ORIENTED BY 60^{o}

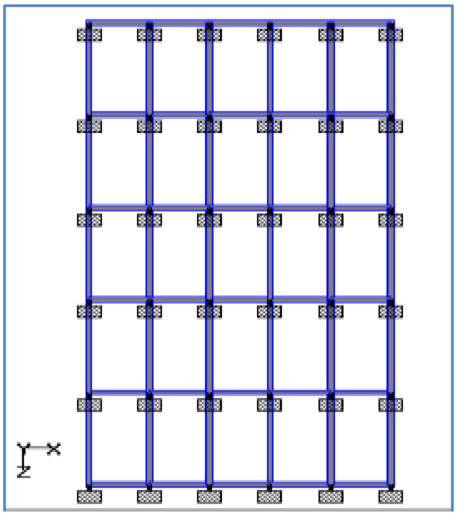

Fig 7: BUILDING ORIENTED BY 90^{o}

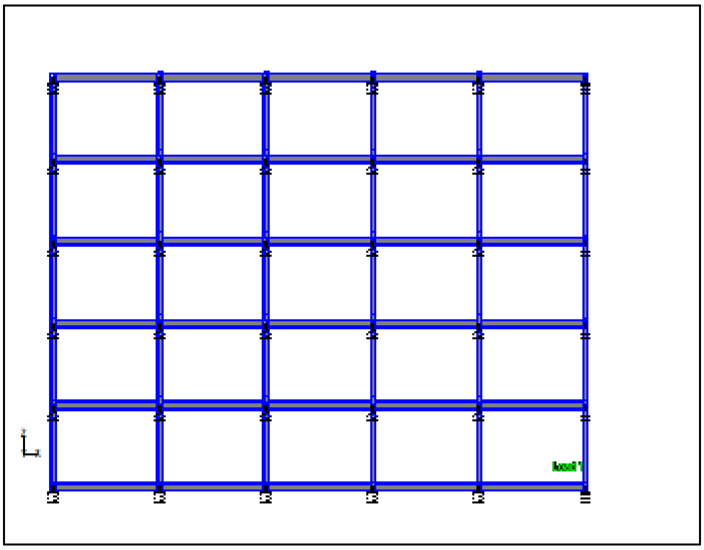

Fig 8: BUILDING ORIENTED BY 180^{o}

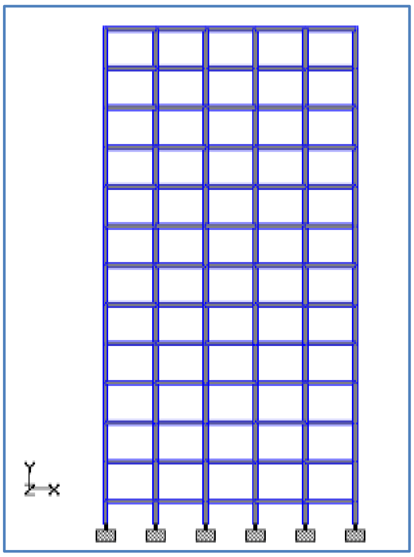

Fig 9: SCHEMATIC VIEW ELEVATION

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3. RESULTS AND DISCUSSION

The results were obtained from the software analysis performed for 5 different cases of orientation as 30°,45°,60°,90° and 180°. The results for worst load combinations are tabulated in Table Nos.3, 4, 5 and 6.

Table 3: STOREY DRIFT

Storey Height	30 Degree		45 Degree		60 Degree		90 Degree		180 Degree	
	Drift(CM)		Drift(CM)		Drift(CM)		Drift(CM)		Drift(CM)	
	X	Z	X	Z	X	Z	X	Z	X	Z
0	0.229	0.135	0.235	0.132	0.241	0.130	0.223	0.136	0.248	0.127
3.45	**0.834**	0.561	**0.863**	0.545	**0.892**	0.528	**0.807**	0.575	**0.923**	0.510
6.9	0.812	0.674	0.849	0.646	0.887	0.617	0.777	0.700	0.928	0.587
10.35	0.809	0.721	0.845	0.688	0.883	0.655	0.774	0.752	0.923	0.620
13.8	0.815	0.743	0.849	0.710	0.885	0.675	0.782	0.776	0.922	0.640
17.25	0.813	**0.750**	0.845	**0.718**	0.878	0.684	0.783	**0.782**	0.912	0.650
20.7	0.801	0.746	0.830	0.717	0.860	**0.686**	0.774	0.775	0.891	**0.655**
24.15	0.754	0.702	0.779	0.676	0.805	0.648	0.730	0.727	0.833	0.620
27.6	0.712	0.679	0.732	0.657	0.754	0.634	0.692	0.699	0.777	0.610
31.05	0.651	0.652	0.666	0.637	0.683	0.620	0.637	0.666	0.700	0.602
34.5	0.535	0.532	0.544	0.523	0.554	0.512	0.526	0.540	0.566	0.501
37.95	0.392	0.385	0.395	0.381	0.400	0.377	0.390	0.388	0.405	0.371
41.4	0.239	0.237	0.239	0.236	0.240	0.235	0.239	0.238	0.242	0.232

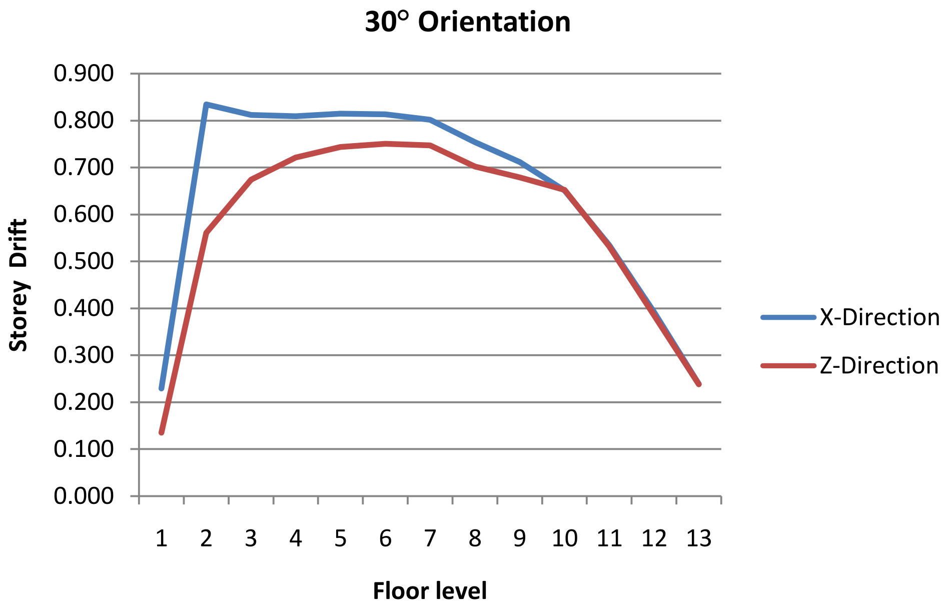

Fig 10: STOREY DRIFT FOR 30° ORIENTATION

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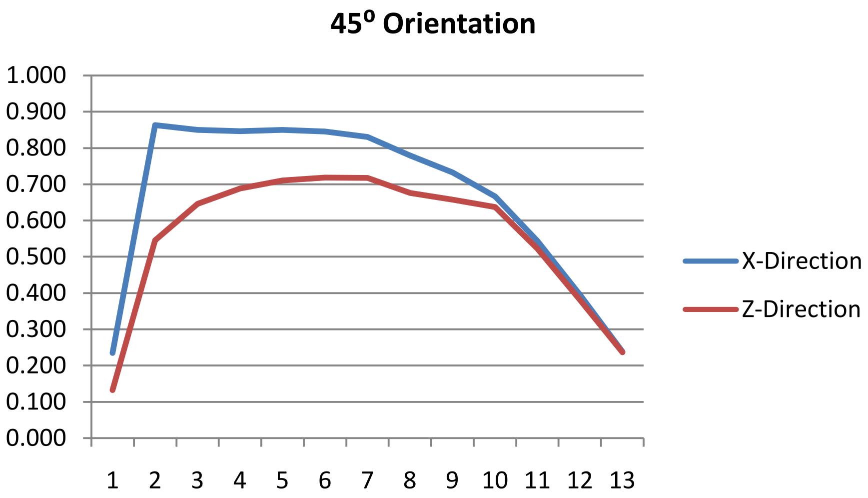

Fig 11: STOREY DRIFT FOR 45⁰ ORIENTATION

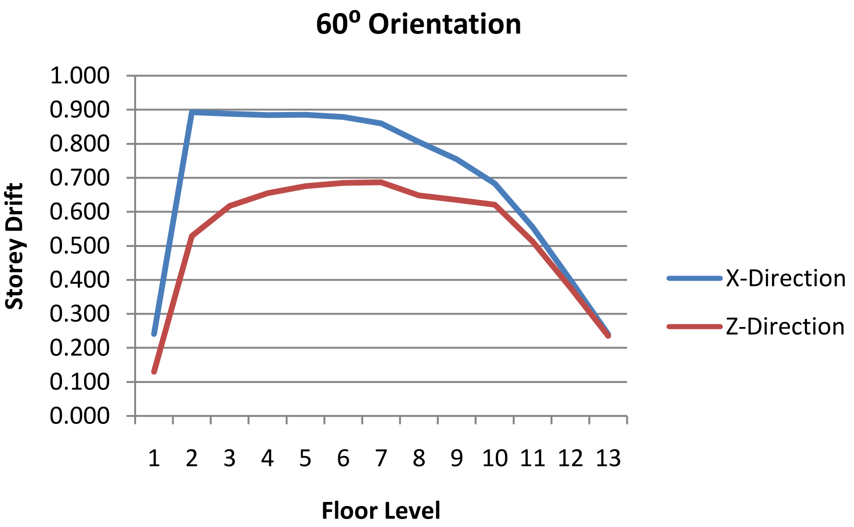

Fig 12: STOREY DRIFT FOR 60⁰ ORIENTATION

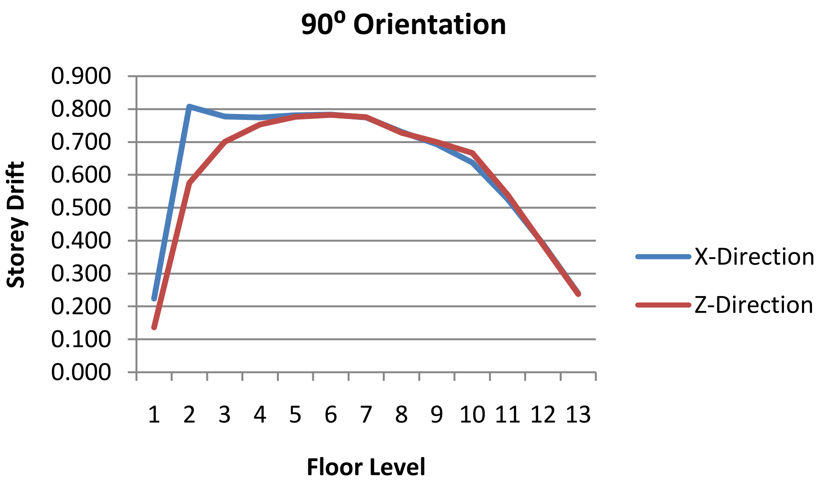

Fig 13: STOREY DRIFT FOR 90⁰ ORIENTATION

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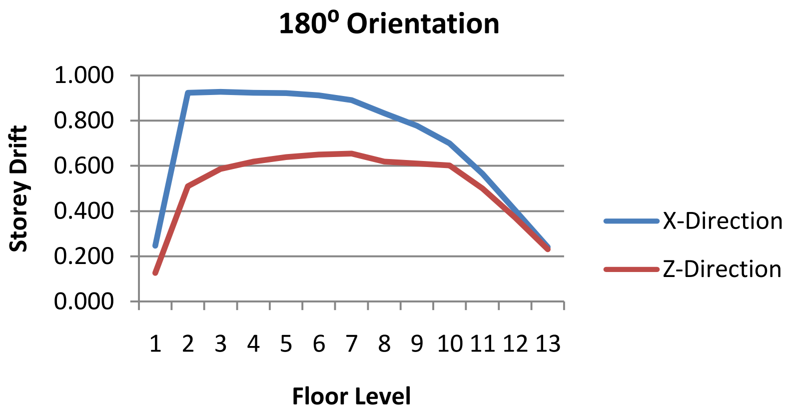

Fig 14: STOREY DRIFT FOR 90⁰ ORIENTATION

Table 3: MAXIMUM NODAL DISPLACEMENT DETAILS

SL NO.	MODEL ORIENTATION (Degree)	MAX X (mm)	MIN X (mm)	MAX Y (mm)	MIN Y (mm)	MAX Z (mm)	MIN Z (mm)
1	30	86.705	86.705	0	29.089	76.997	76.997
2	45	88.98	88.98	0	29.118	74.821	74.821
3	60	91.223	91.223	0	29.147	72.608	72.608
4	90	84.185	84.185	0	29.06	78.854	78.854
5	180	93.891	93.891	0	29.176	70.011	70.011

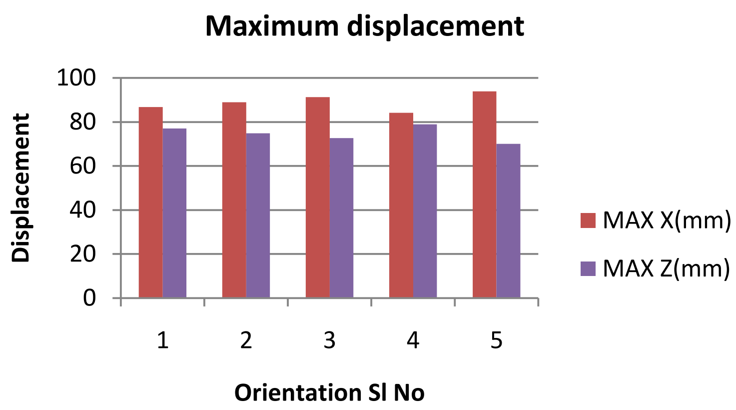

Fig 15: MAXIMUM TOP DISPLACEMENT

Table 4: MAXIMUM BEAM MOMENT DETAILS

SL.NO	MODEL ORIENTATION (Degree)	MAX M_X (KN-m)	MIN M_X (KN-m)	MAX M_Y (KN-m)	MIN M_Y (KN-m)	MAX M_Z (KN-m)	MIN M_Z (KN-m)
1	30	3.75	3.458	161.73	161.73	368.165	368.165
2	45	3.26	3.072	165.772	165.772	368.505	352.157
3	60	3.136	3.519	169.226	169.226	370.026	338.698
4	90	3.892	3.892	153.352	153.352	384.555	384.555
5	180	4.164	4.164	174.617	174.617	380.459	323.945

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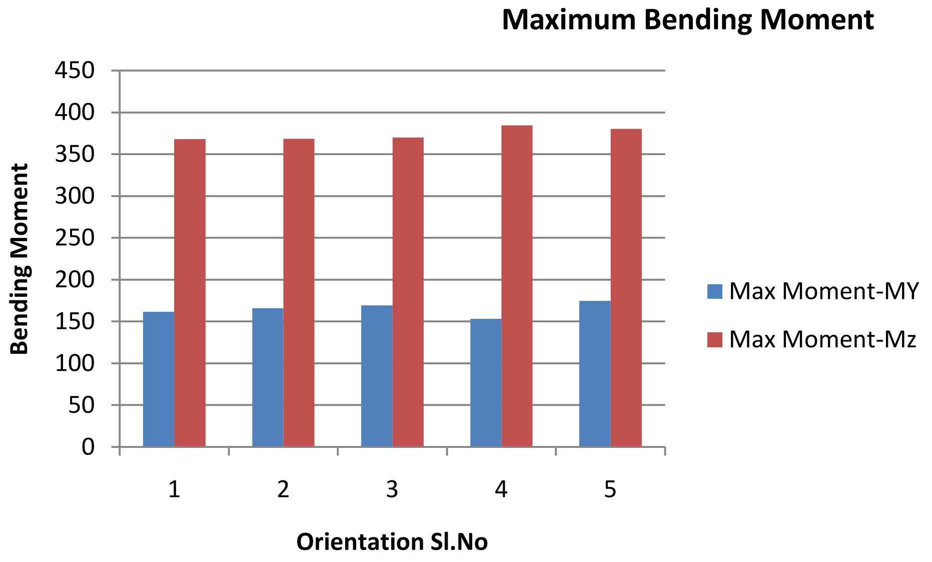

Fig 16: MAXIMUM BENDING MOMENT

Table 5: MAXIMUM SHEAR FORCE DETAILS

SL.NO	MODEL ORIENTATION (Degree)	MAX FX (KN)	MIN FX (KN)	MAX FY (KN)	MIN FY (KN)	MAX FZ (KN)	MIN FZ (KN)
1	30	7669.302	42.582	233.14	233.33	73.951	73.951
2	45	7676.939	42.059	233.887	234.101	84.539	84.541
3	60	7684.828	41.644	234.646	234.829	91.851	91.851
4	90	7661.85	43.283	232.449	232.449	65.552	65.552
5	180	7692.732	41.307	235.469	235.469	97.549	97.549

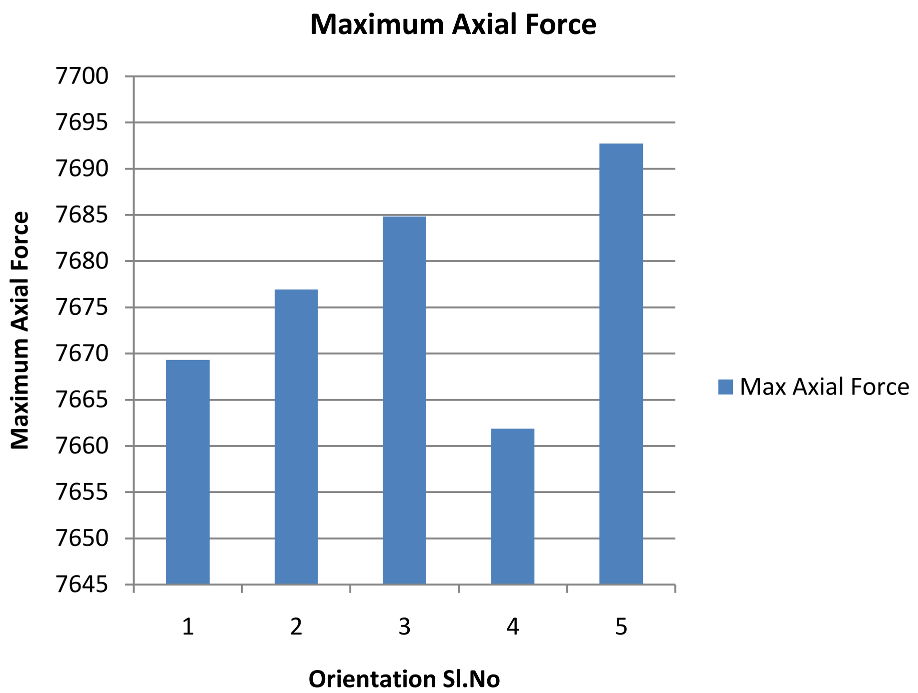

Fig 17: MAXIMUM AXIAL FORCE

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4. CONCLUSION

Study is based on structural analysis of G+11 building for different orientations. The following conclusions were made from the analysis.

1. The horizontal displacement of structure is exceeding the permissible limit in all cases except for building oriented by 90°. There is need to revise the section properties to make displacement within permissible limit.
2. Maximum bending moment is observed in structure oriented by 90°.
3. Maximum axial shear force was observed in the structure oriented by 180°.
4. Maximum storey drift was found in building with180° orientation in X direction, whereas maximum storey drift was observed for building oriented by 90° in Z direction.
5. The study indicates that the structure oriented by 90° is more suitable from design point of view.

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