International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

SEISMIC BEHAVIOUR OF MULTISTORIED BUILDING WITH OBLIQUE COLUMN AND IT'S HEIGHT OPTIMIZATION

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Abstract *- As earthquakes are one of the greatest damaging natural hazards to the building, the design and construction of tall structures which is capable of resisting the adverse effects of earth quake forces is the most important. Nowadays various construction techniques are adopted in order to increase the seismic performance of the building. Here the new method is to use the oblique columns instead of normal columns. Oblique columns are columns at an angle to the specified line. The Oblique Columns are neither parallel nor at right angles to a specified line means they are slanted or Rotated at an angle. Oblique columns are provided up to various height of the building. The analysis is carried out in ETABS16.0.2.*

Key Words: *Lateral load, Oblique column, Normal column, Earthquake force, ETABS.*

1.INTRODUCTION

The new construction method to increase the seismic performance of multi-storied buildings is the use of oblique columns instead of normal columns. Oblique column is a column which is not constructed vertical. The position, arrangement, and angle of the inclined columns are makes different types oblique columns in buildings. The angle may vary and this affects the performance of the building. It affects the lateral stiffness of the buildings. But the seismic responses may vary in each case. The seismic performance should be studied to know whether these new construction techniques adaptable or not. Because, the performance of the high-rise, mid-rise and low-rise building will be different from each other for different angles under seismic loading.

In recent years, many buildings are constructed in irregular structure system with inclined columns. It effects on the structural behaviour of the joints. The Oblique Column is the column, which neither parallel nor at right angles to a specified line means they are slanted or rotated at an angle. Since the external loads leads to shear and flexural forces on the inclined column, the performance of the building is differs from the conventional method of construction. Oblique columns are stiffer as RC frames, and therefore, the initial stiffness of the RC frames largely depends upon the stiffness of oblique column

2.SCOPE

The building models are compared by changing the soil interaction or types of soil to provide better information about the response of the system. The behavior of building for other types of irregular building can be studied

3.OBJECTIVES

- To analyze seismic performance of multi-storey symmetrical and asymmetrical structural building with oblique columns.
- To analyses seismic performance of symmetrical and asymmetrical structural building with oblique columns at various height.
- To compare the performance of multi-storey structural building with normal and oblique column.
- To optimize the height of oblique column.

4. METHODOLOGY

4.1 Modeling and model analysis

Etabs software is used for modeling and model analysis. Building configuration and loading data's for models are given. In this project the models are normal building, building symmetrical to both axis, building symmetrical to one axis and building asymmetrical to both axis. Building with oblique column up to various heights are also modeled and analyzed. Time history analysis is done

4.2 Loading consideration

- Live load : 3kN/m^2
- Floor finish : 1kN/m^2
- Seismic loading (IS : 1893 (Part I) -2002)
- Zone factor : 0.16
- Medium soil
- Response reduction factor– 3

4.3 Building configuration

Table - 4.1: Building configuration

Number of storey	G+14
Floor height	3m
Spacing between frame in X direction	8m
Spacing between frame in Z direction	8m
Grade of concrete	M30
Grade of steel	Fe500
Size of beam	350X650 mm
Size of column	750X750 mm
Size of oblique column	750x750mm
Thickness of slab	150mm
Thickness of wall	230mm
Support	Fixed
Type of building	OMRF

4.4 Models created

Table - 4.2: Models designation

DESIGNATION	DESCRITION
NB	15 storey building with normal column
BS80	15 storey building symmetrical to both axis & column inclination80^0
BS82	15 storey building symmetrical to both axis & column inclination82^0
BS85	15 storey building symmetrical to both axis & column inclination85^0
OS80	15 storey building symmetrical to one axis & column inclination80^0
OS82	15 storey building symmetrical to both axis & column inclination82^0
OS 85	15 storey building symmetrical to both axis & column inclination85^0
AS80	15 storey building asymmetrical to both axis & column inclination80^0
AS82	15 storey building asymmetrical to both axis & column inclination82^0
AS85	15 storey building asymmetrical to both axis & column inclination85^0
FH80	15 storey building with column inclination 80^0 to full height
TH80	15 storey building with column inclination 80^0 up to 2/3 height
MH80	15 storey building with column inclination 80^0 up to mid height
OH80	15 storey building with column inclination 80^0 up to 1/3 height
FH82	15 storey building with column inclination 82^0 to full height
TH82	15 storey building with column inclination 82^0 up to 2/3 height
MH82	15 storey building with column inclination 82^0 up to mid height
OH82	15 storey building with column inclination 82^0 up to 1/3 height
FH85	15 storey building with column inclination 85^0 to full height
TH85	15 storey building with column inclination 85^0 up to 2/3 height
MH85	15 storey building with column inclination 85^0 up to mid height
OH85	15 storey building with column inclination 85^0 up to 1/3 height

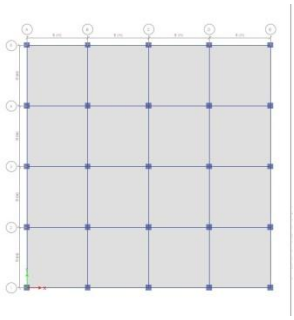

Fig-1: NB PLAN

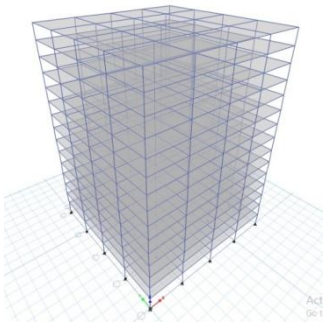

Fig-2: NB 3D

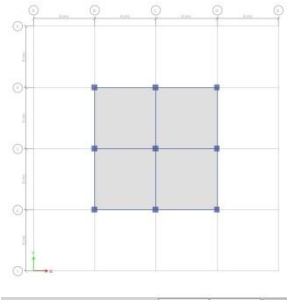

Fig -3: BS80 PLAN

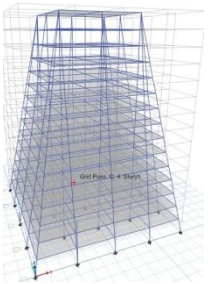

Fig -4: BS80 3D

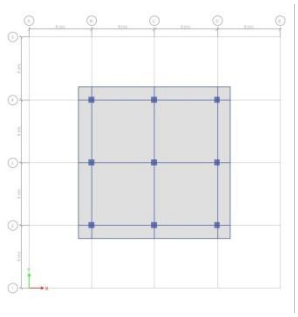

Fig -5: BS82 PLAN

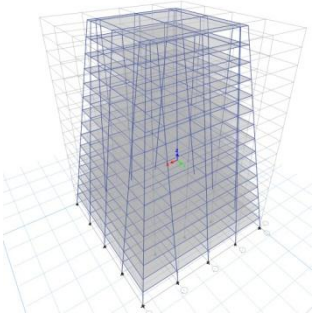

Fig -6: BS82 3D

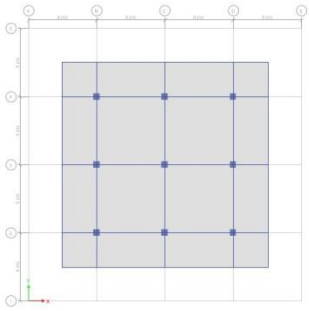

Fig -7: BS85 PLAN

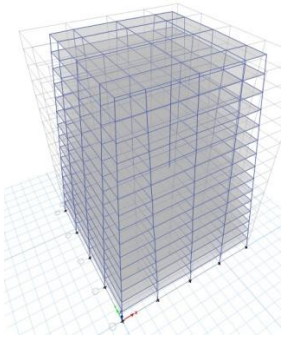

Fig -8: BS85 3D

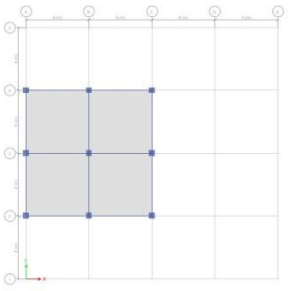

Fig -9: 0S80 PLAN

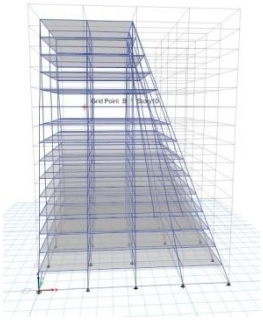

Fig -10: 0S80 3D

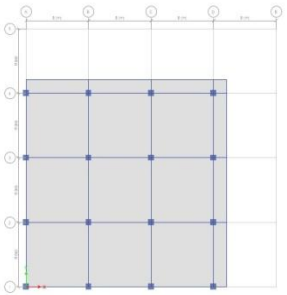

Fig -17: AS82 PLAN

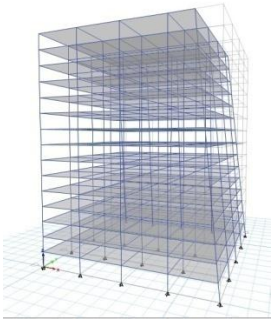

Fig -18: AS82 3D

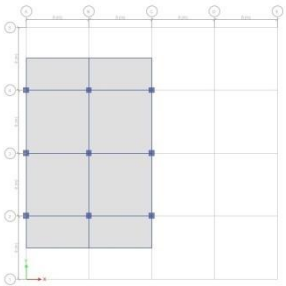

Fig -11: OS82 PLAN

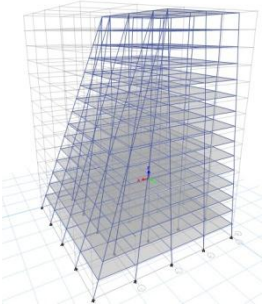

Fig -12: 0S82 3D

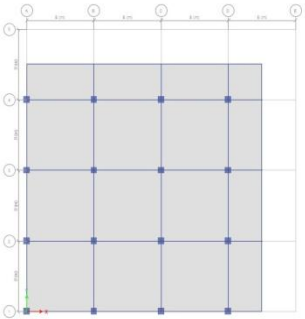

Fig -19: AS85PLAN

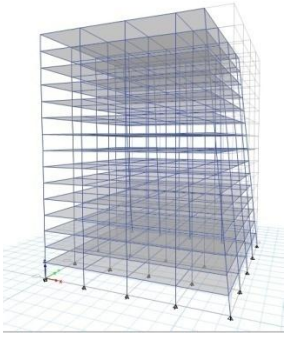

Fig -20: AS85 3D

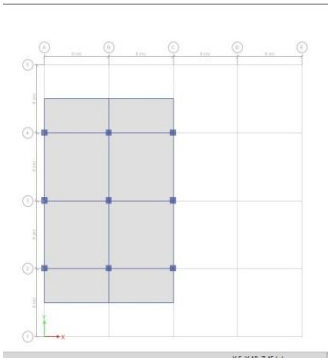

Fig -13: OS85 PLAN

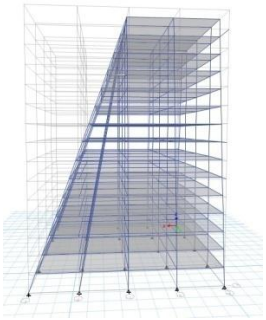

Fig -14: 0S85 3D

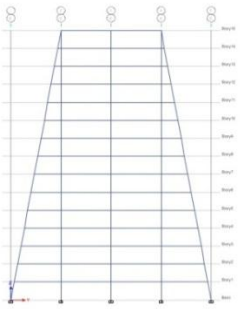

Fig -21: FH80 ELEVATION

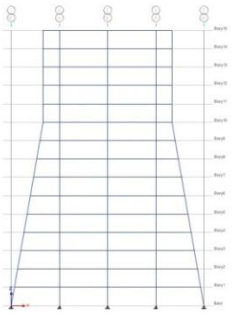

Fig -22: TH80 ELEVATION

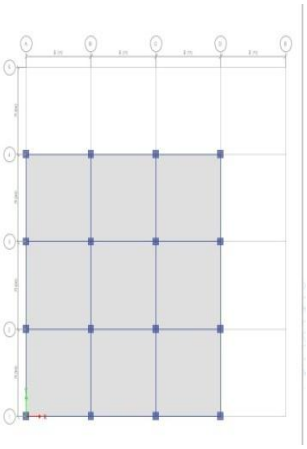

Fig -15: AS80 PLAN

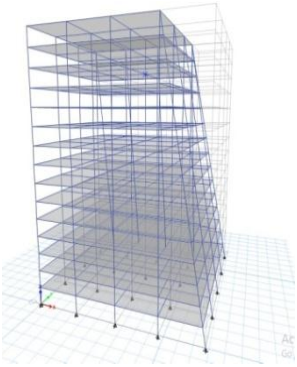

Fig -16: AS80 3D

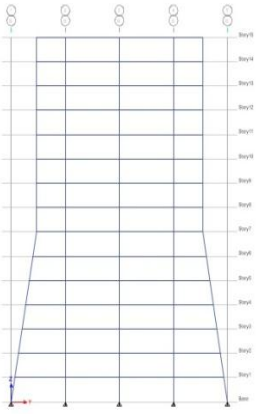

Fig - 23: MH80 ELEVATION

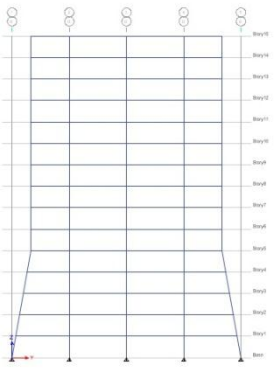

Fig -24: OH80 ELEVATION

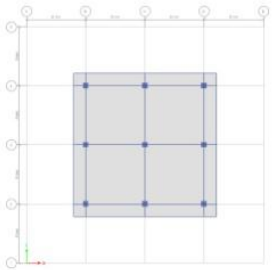

Fig -25: FH82 PLAN

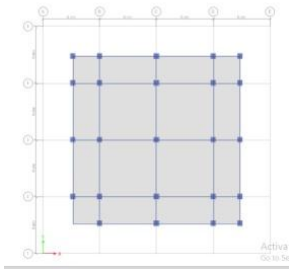

Fig -26: TH82 PLAN

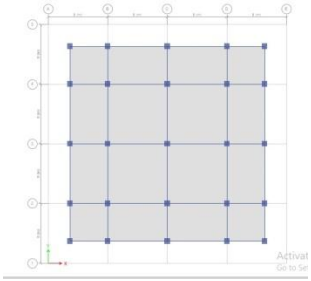

Fig -27: MH82 PLAN

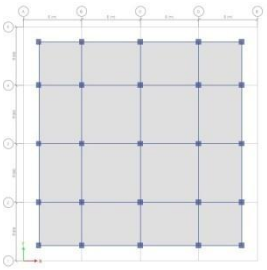

Fig -28: OH82 PLAN

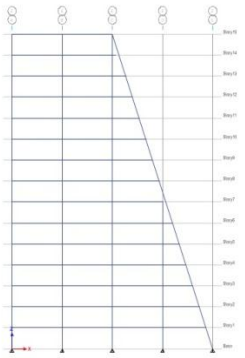

Fig -29: FH85 ELEVATION

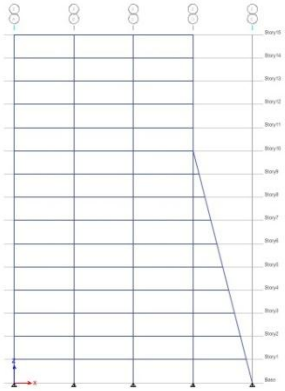

Fig -30:TH85 ELEVATION

Fig -31: MH85 ELEVATION

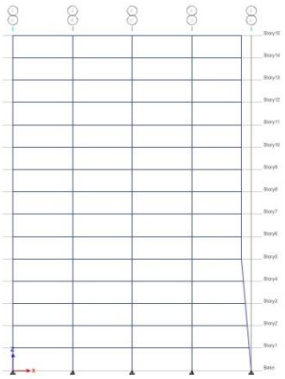

Fig -32: OH85 ELEVATION

5.RESULTS AND DISCUSSIONS

Table-1: building with column inclination 80^0

MODEL	80^0 COLUMN INCLINATION			
	Max Displacement(mm)		Max Drift(mm)	
	X	Y	X	Y
FH80	94.608	94.608	0.00491	0.00491
TH80	96.767	96.767	0.00749	0.00749
MH80	113.003	113.003	0.01117	0.01117
0H80	157.451	157.451	0.0153	0.0153

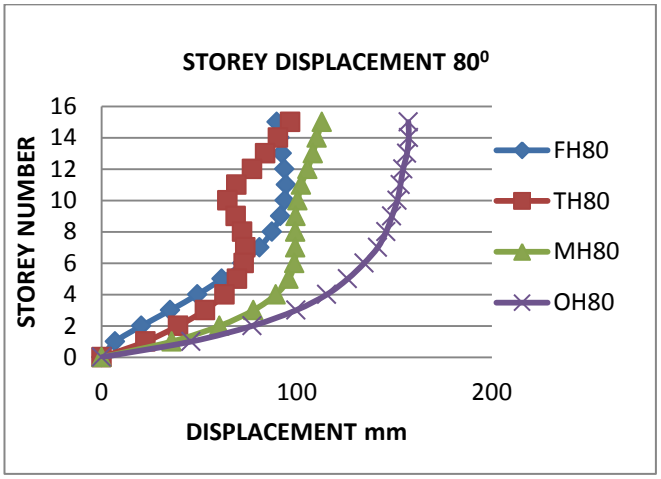

Chart- 1: Building with oblique column 80^0displacement graph

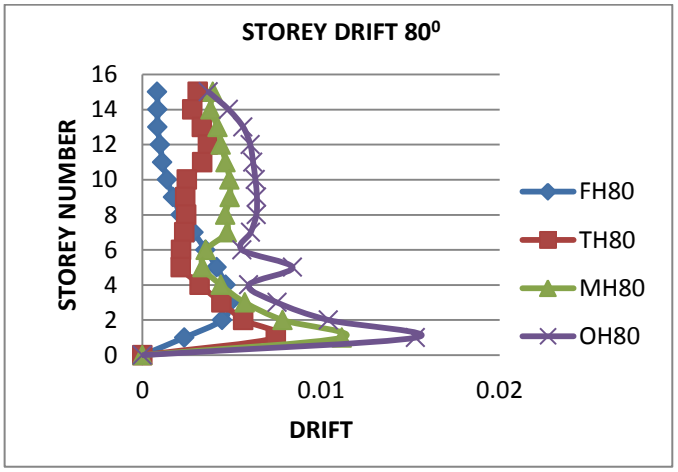

Chart- 2: Building with oblique column 80^0drift graph

Table-2: Building with column inclination 82^0

MODEL	82^0 COLUMN INCLINATION			
	Max Displacement(mm)		Max Drift(mm)	
	X	Y	X	Y
FH82	138.028	138.028	0.00851	0.00851
TH82	149.383	149.383	0.01073	0.01073
MH82	168.840	168.840	0.01410	0.01410
0H82	200.008	200.008	0.01611	0.01611

Table-3: Building with column inclination 85^0

MODEL	85^0 COLUMN INCLINATION			
	Max Displacement(mm)		Max Drift(mm)	
	X	Y	X	Y
FH85	107.404	207.20	0.05788	0.01085
TH85	112.923	207.720	0.00794	0.00846
MH85	144.302	245.901	0.00800	0.0140
0H85	282.22	260.919	0.0139	0.0147

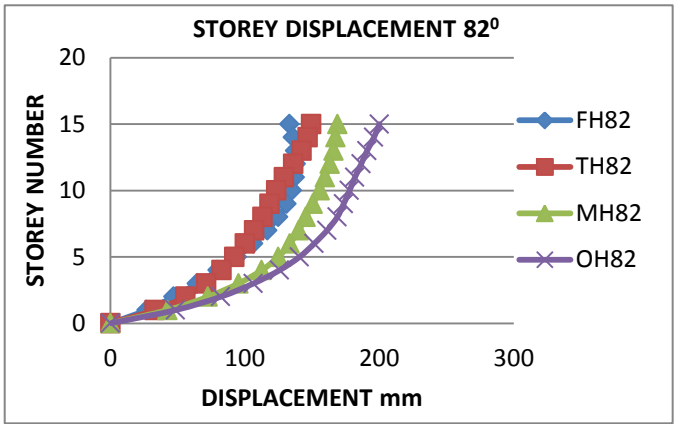

Chart- 3: Building with oblique column 82^0displacement graph

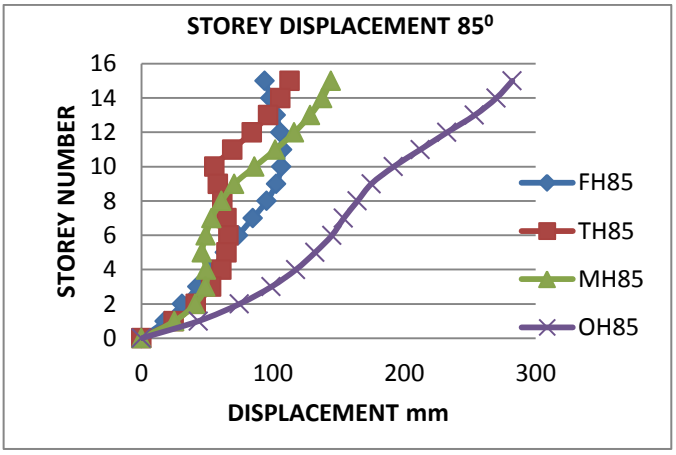

Chart- 5: Building with oblique column 85^0displacement graph

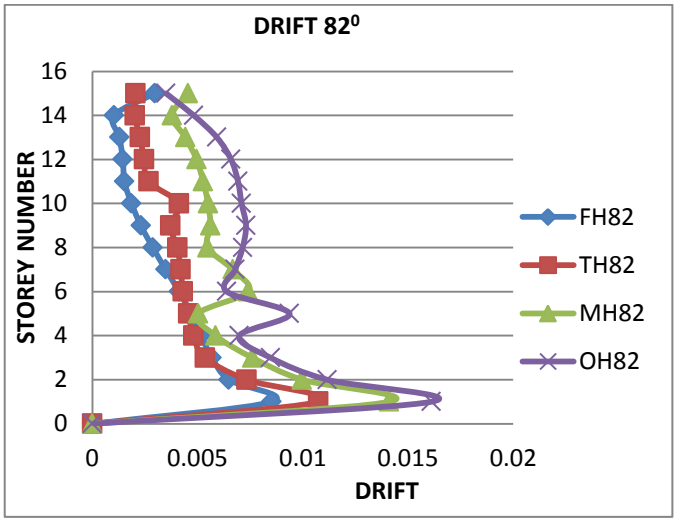

Chart- 4: Building with oblique column 82^0drift graph

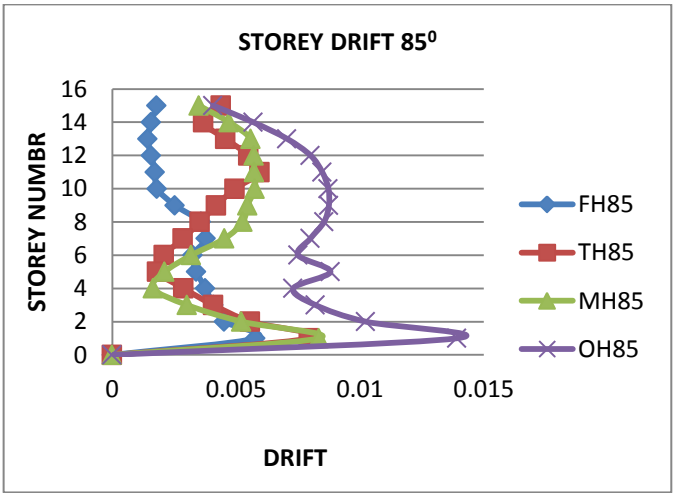

Chart- 6: Building with oblique column 85^0drift graph

Table-4: Comparison between normal building and building with oblique column at optimized height

MODEL	X-V BRACING –NB			
	Max displacement(mm)		Max drift(mm)	
	X	Y	X	Y
NB	296.478	296.478	0.1337	0.1337
FH80	94.608	94.608	0.00491	0.00491
FH82	138.028	138.028	0.00851	0.00851
FH85	107.404	207.20	0.00578	0.01085

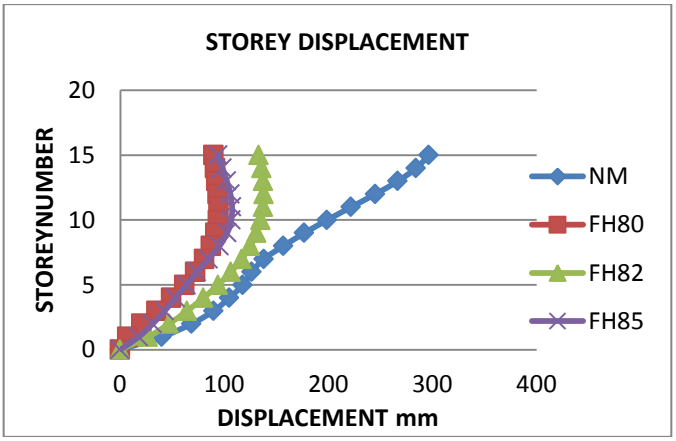

Chart- 7: Best column inclination and normal building displacement graph

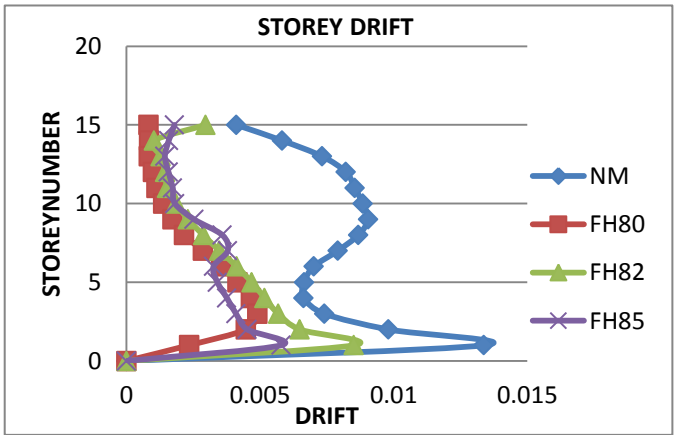

Chart- 8: Best column inclination and normal building drift graph

6. CONCLUSIONS

- The behavior of high rise building with oblique column is studied. It is studied that the oblique column system is effective in controlling drift, displacement, of the building and makes the structural form efficient under seismic loading.
- For 80^0 column inclination model symmetrical to both axis shows better performance under seismic loading.
- For 82^0 column inclination model symmetrical to both axis shows better performance under seismic loading.
- For 85^0 column inclination model symmetrical to one axis shows better performance under seismic loading.
- Model asymmetrical to both axis doesn't shows better seismic resistance with 80^0 82^0 and 85^0 column inclination.
- Model with column inclination 80^0, when the height of oblique column reduces from full height to $2/3^{rd}$ height the storey displacement and storey drift increases by 2.2% and 34% respectively.
- Model with column inclination 80^0, when the height of oblique column reduces from full height to mid height the storey displacement and storey drift increases by 16% and 56% respectively.
- Model with column inclination 80^0, when the height of oblique column reduces from full height to $1/3^{rd}$ height the storey displacement and storey drift increases by 39% and 67% respectively.
- Hence providing oblique column with column inclination 80^0 up to full height of the structure shows better control over storey displacement and storey drift.
- Model with column inclination 82^0, when the height of oblique column reduces from full height to $2/3^{rd}$ height the storey displacement and storey drift increases by 7.6% and 20% respectively.
- Model with column inclination 82^0, when the height of oblique column reduces from full height to mid height the storey displacement and storey drift increases by 18% and 39% respectively.
- Model with column inclination 82^0, when the height of oblique column reduces from full height to $1/3^{rd}$ height the storey displacement and storey drift increases by 30% and 47% respectively.
- Hence providing oblique column with column inclination 82^0 up to full height of the structure shows better control over storey displacement and storey drift.
- Model with column inclination 85^0, when the height of oblique column reduces from full height to $2/3^{rd}$ height the storey displacement and storey drift increases by 4.8% and 27% respectively. Model with column inclination 85^0, when the height of oblique column reduces from full height to mid height the storey displacement and storey drift increases by 25% and 27.6% respectively.

- Model with column inclination 85^0, when the height of oblique column reduces from full height to 1/3rd height the storey displacement and storey drift increases by 61% and 58% respectively.
- Hence providing oblique column with column inclination 85^0 up to full height of the structure shows better control over storey displacement and storey drift.
- Hence the optimum height for an oblique column is providing those up to full height of the building.
- By comparing structure with normal column and oblique column at full height shows :

  - ❖Structure with oblique column 80^0 up to full height of the structure shows 68% reduction in storey displacement and 96% reduction storey drift as compared to structure with normal column.
  - ❖Structure with oblique column 82^0 up to full height of the structure shows 53% reduction in storey displacement and 93% reduction storey drift as compared to structure with normal column.
  - ❖Structure with oblique column 85^0 up to full height of the structure shows 63% reduction in storey displacement and 95% reduction storey drift as compared to structure with normal column.

- Hence oblique column improves the performance of the building by resisting the seismic forces and reduces the effect of seismic forces of inner column .Column inclination and structural symmetry plays an important role on structural design

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