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SEISMIC ANALYSIS OF RCC TWISTED BUILDING WITH SWIMMING POOL USING ETABS

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Abstract- This project represents the structural behaviour of RCC twisted building subjected to seismic loads with private swimming pool using ETABS. In this paper various angles of twist and positions of swimming pools for RCC twisted building are analysed. The different rate of twist 1.5, 2, 2.5, 3, 3.5, 4, 4.5 and 5 degree per floor and three cases of swimming pool positions (every floor, alternate floor, specific floor) for twisted building are considered. The modelling and analysis is done using ETABS. Response spectrum method is used for analysis and the results obtained are plotted for parameters such as storey displacement, storey drift and base shear.

Index Terms- ETABS, Response spectrum method, Swimming pool, Seismic analysis, Twisted building

I. INTRODUCTION

Twisted building is the one that progressively rotates its floor plates as it gains height. The use of twisted forms for tall buildings has recently became an common architectural phenomenon. Considering swimming pools, indoor swimming pools are attractive from aesthetical point of view, the building environment is more vulnerable than most other building structures but they should also remain functional in earthquake prone areas. Indoor pools in high-rise buildings are becoming more common around the world to enhance building facilities and attract a wider set of customers. Due to this kind of combination of facilities, this requires not only knowledge of how to build a high-rise building with a unique technique or architectural design but also the knowledge about any structural engineering for a building.

The methods of earthquake analysis

Two broad approaches of earthquake analysis of multi–storied structures are

I. Static Analysis –
- Equivalent Static Method – It's linear static method. In this method formulas are developed to approximately represent behaviour of regular structures. Base shear is calculated and distributed to various floor levels. This method is not used for irregular structures.

- Pushover Analysis – It is non-linear static method. This method estimates force and displacement of structure. It identifies critical regions where inelastic deformation are expected to be high. In this method lateral load is increased along the height of building till target displacement or till building collapse. It's approximate in nature and based on static loading as it cannot represent dynamic phenomenon with accuracy. It may not detect some deformation modes in structure subjected to severe earthquake.

II. Dynamic Analysis –
- Time History Analysis – It is a non-linear dynamic method. In this method, model of building is subjected to accelerations from earthquake records that represent the expected earthquake at the base of the structure. This method is used only in particular locations where earthquake data is available with different possible time history data. Its time consuming. In time history analyses the structural response is computed at a number of subsequent time.

- Response Spectrum Method – It is a linear dynamic method. This method estimates peak values of response quantities. It can be used for any type of building and at all location.

PROBLEM STATEMENT

a. Design and analysis of RCC twisted building for 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5 degree per floor angle of twist for G+15 storey building by using ETABS.
b. To study RCC twisted building for swimming pool positions for three cases
   - On every floor
   - On alternate floor
   - On specific floor
c. To study the response such as maximum storey displacement, storey drift and base shear.

MODELLING AND ANALYSIS

Modal description-

For the study purpose a G+15 story building model has been considered

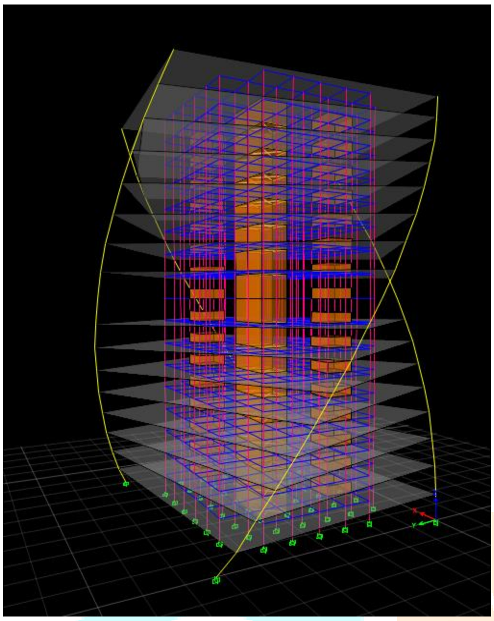

Fig 1- Isometric view of twisted building with swimming pool at every floor

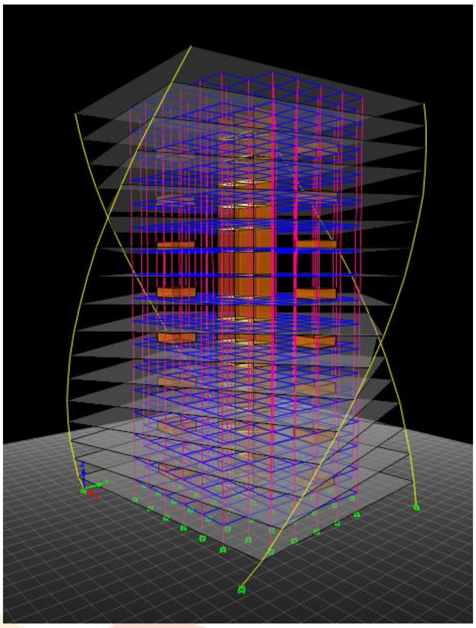

Fig 2- Isometric view of twisted building with swimming pool at alternate floor

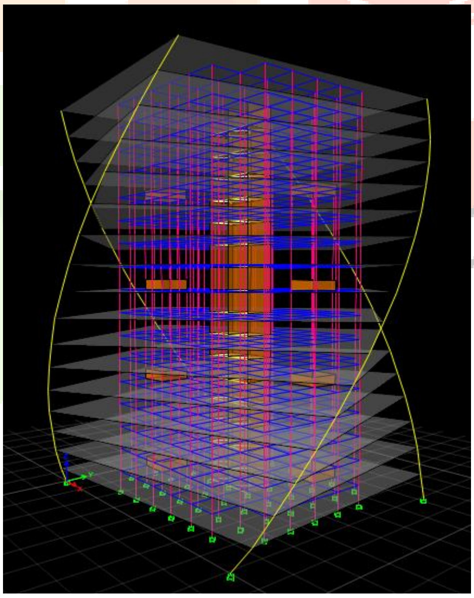

Fig 3- Isometric view of twisted building with swimming pool at specific floor

Structural properties used for the models

Particulars of item	Properties
Total Built-up Area	1458 sq.m
Number Of Storeys	G+15
Storey Height	3.7M
Swimming Pool Dimensions	4.5M X 4.5M
Depth Of Swimming Pool	1.6M
Swimming pool wall thickness	0.23M
Beam Size	0.3M X 0.8M
Column Size	1.2M X 1.2M
Slab Thickness	0.15M

Seismic parameters used in models

Particulars of item	Properties
Seismic Zone	IV
Zone Factor	0.24
Building Frame System	Ordinary Moment Resisting Frame
Response Reduction Factor	5
Importance Factor	1
Soil Type	Medium soil (Value=2)
Damping Ratio	5%

Design parameters used in model

Particulars of item	Properties
Design code for concrete	IS 456:2000
Design code for steel	IS 800:2007
Grade of concrete	M50
Grade of main reinforcement	Fe 500
Grade of secondary reinforcement	Fe 415

III. RESULTS AND DISCUSSION

Case 1- At every floor

1- Storey Displacement

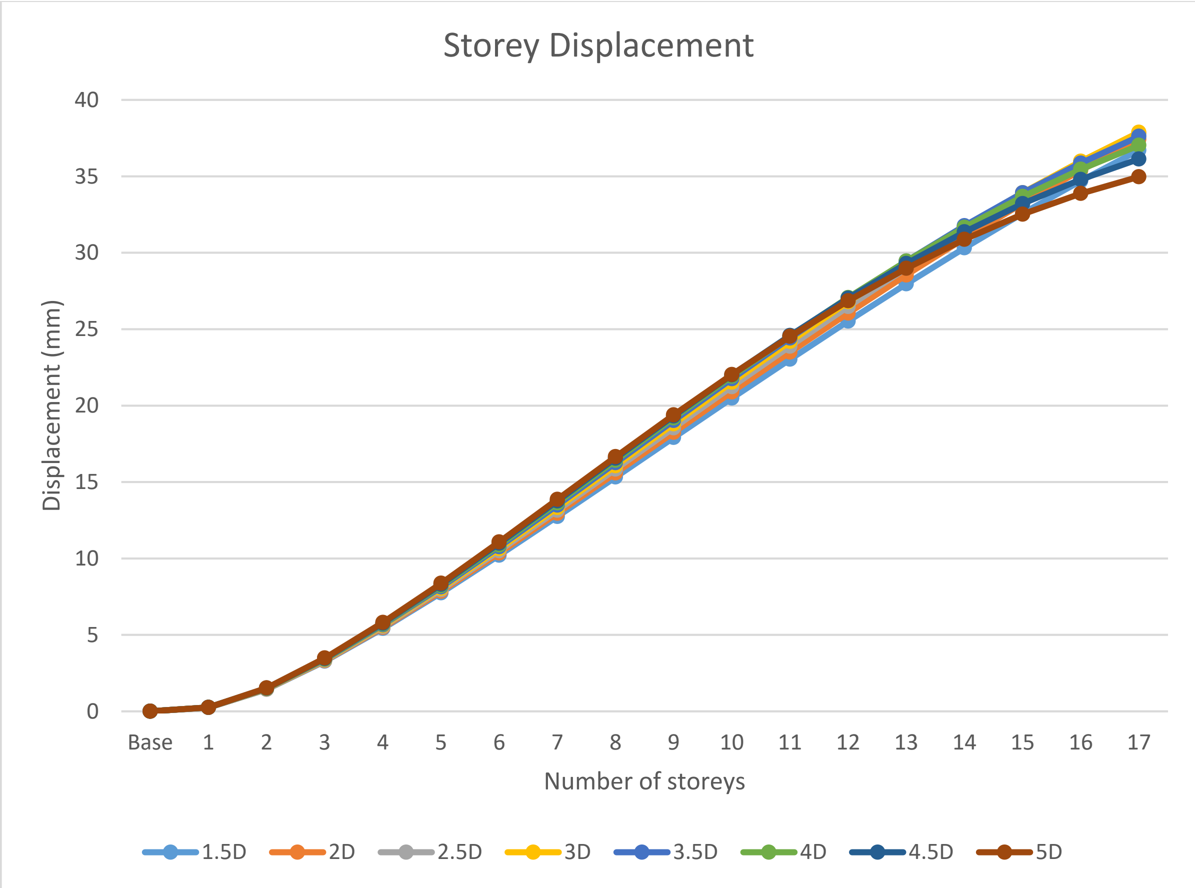

Fig 4- Storey Displacement

The figure shows the storey displacement for 1.5D, 2D, 2.5D, 3D, 3.5D, 4D, 4.5D, and 5D with swimming pool at every floor. From the analysis its observed that the storey displacement increases upto 3D and then decreases. The storey displacement is zero at the base and as the storey height increases displacement is increased by 1.8-2.6 mm. Storey 17 shows the maximum displacement for 3D (37.8801 mm) and the minimum storey displacement is for 5D (34.969 mm).

2- Storey drift

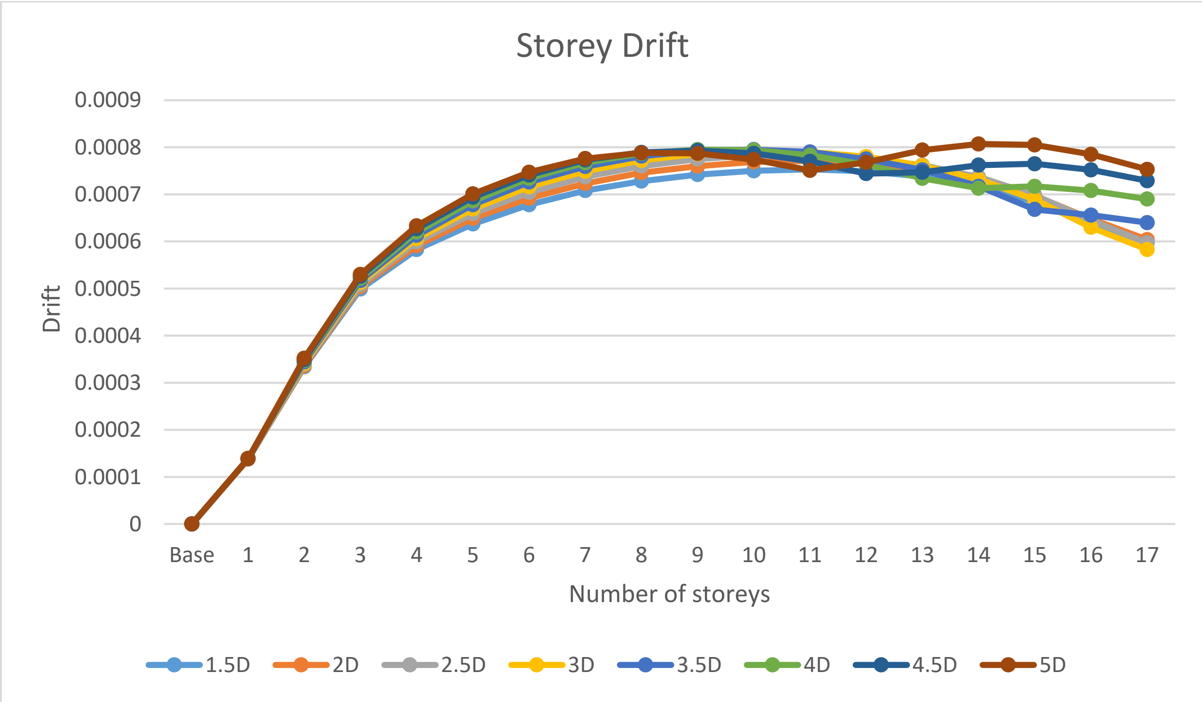

Fig 5- Storey Drift

The figure shows the storey drift for 1.5D, 2D, 2.5D, 3D, 3.5D, 4D, 4.5D, and 5D with swimming pool at every floor. From the analysis its observed that the storey drift increases as the angle of twist increases. As the storey height increases the storey drift increases upto storey 11 and then decreases. The minimum storey drift is for 1.5D (0.000753) and 5D shows the maximum storey drift (0.000807).

3- Base Shear-

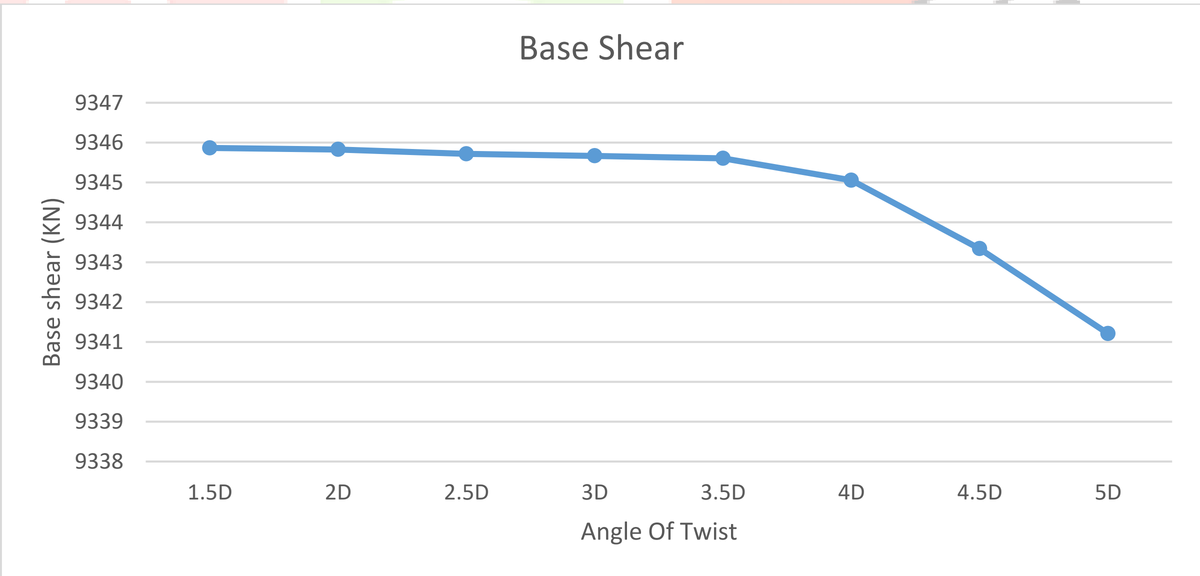

Fig 6- Base Shear

The figure shows the base shear for 1.5D, 2D, 2.5D, 3D, 3.5D, 4D, 4.5D, and 5D with swimming pool at every floor. Its observed that as the angle of twist increases the base shear decreases. From the analysis its observed that the base shear is maximum for 1.5D (9345.8661 KN).

Case 2- At alternate floors

1- Storey Displacement

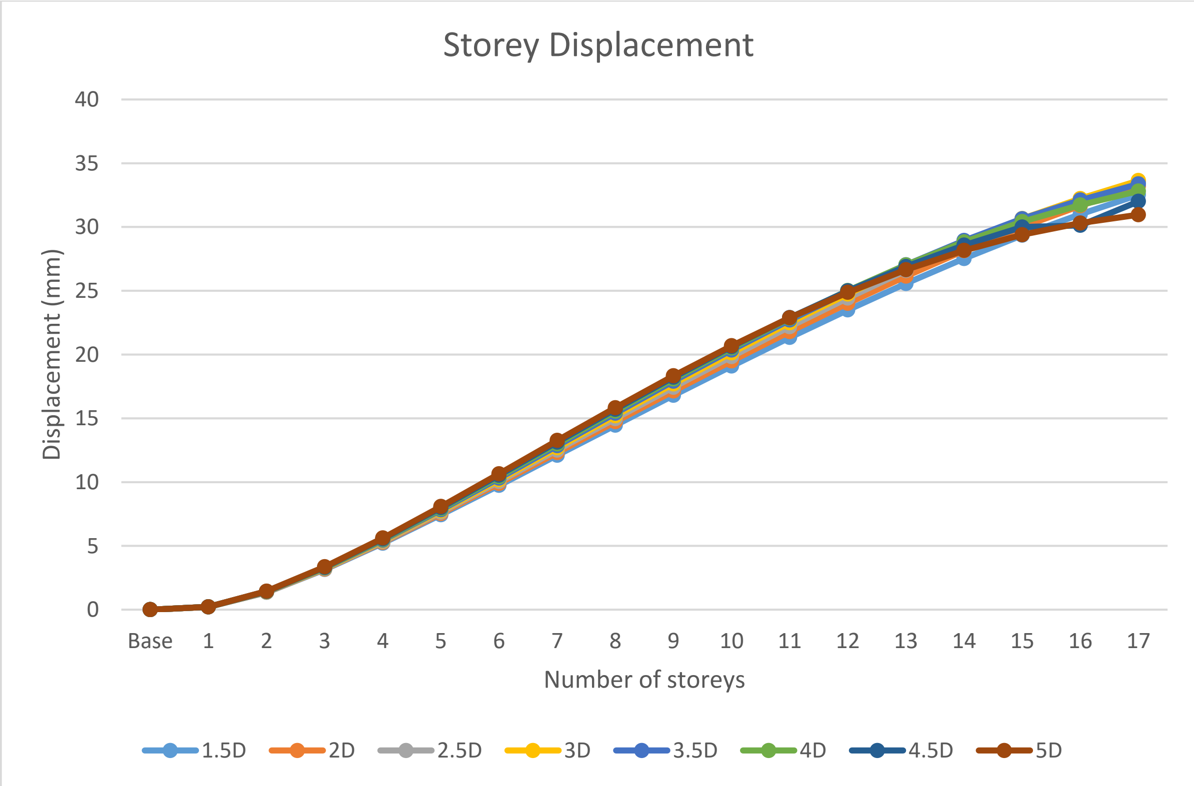

Fig 7- Storey Displacement

The figure shows the storey displacement for 1.5D, 2D, 2.5D, 3D, 3.5D, 4D, 4.5D, and 5D with swimming pool at alternate floor. From the analysis its observed that the storey displacement increases upto 3D and then decreases. The storey displacement is zero at the base and as the storey height increases displacement is increased by 1.5-2.6 mm. Storey 17 shows the maximum displacement for 3D (33.634 mm) and the minimum storey displacement is for 5D (30.963 mm).

2- Storey Drift

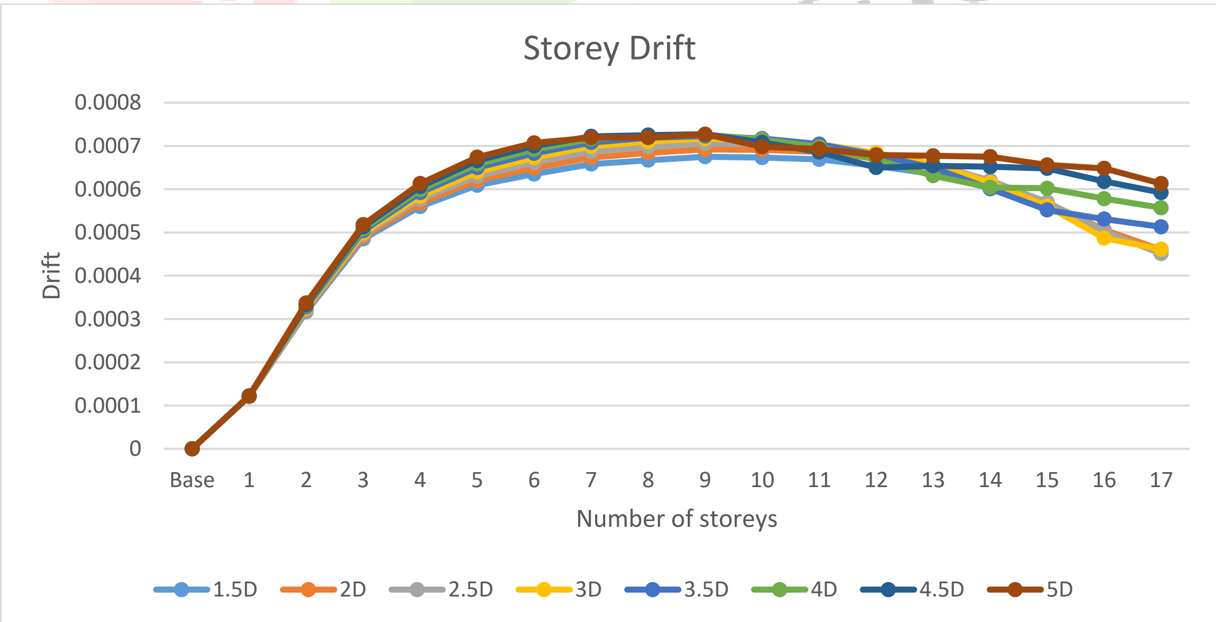

Fig 8- Storey Drift

The figure shows the storey drift for 1.5D, 2D, 2.5D, 3D, 3.5D, 4D, 4.5D, and 5D with swimming pool at alternate floor. From the analysis its observed that the storey drift increases as the angle of twist increases. As the storey height increases the storey drift increases upto storey 9 and then decreases. The minimum storey drift is for 1.5D (0.000675) and 5D shows the maximum storey drift (0.000727).

3- Base Shear

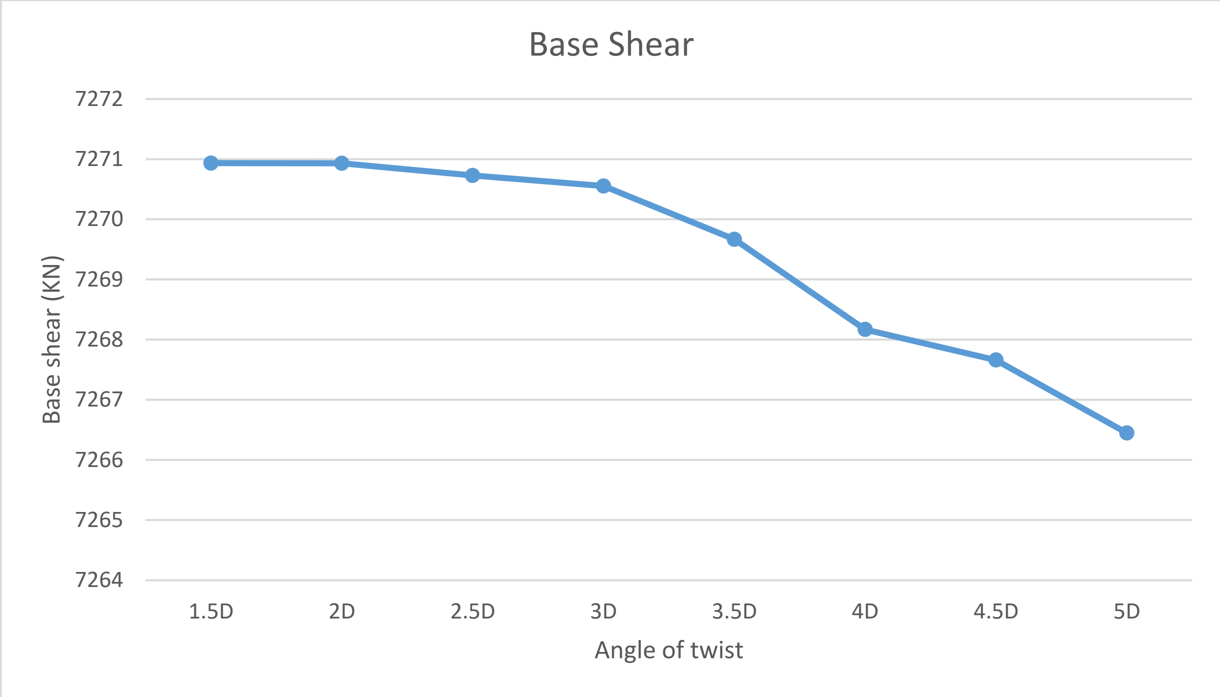

Fig 9- Base Shear

The figure shows the base shear for 1.5D, 2D, 2.5D, 3D, 3.5D, 4D, 4.5D, and 5D with swimming pool at alternate floor. Its observed that as the angle of twist increases the base shear decreases. From the analysis its observed that the base shear is maximum for 1.5D (7270.932 KN).

Case 3- At specific floor

1- Storey Displacement

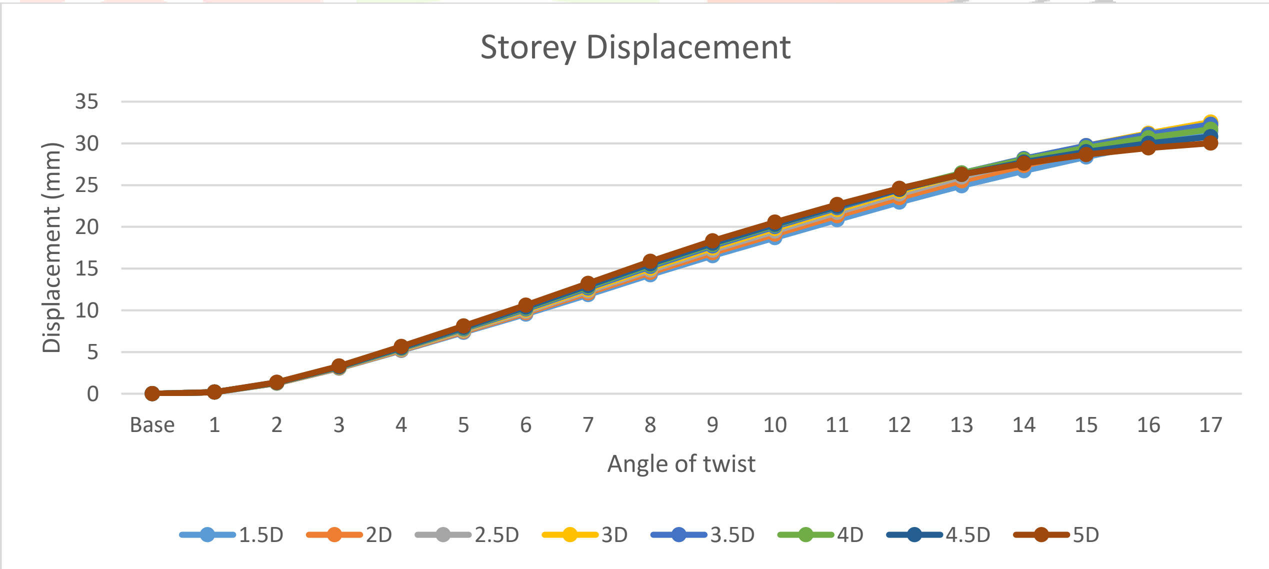

Fig 10- Storey Displacement

The figure shows the storey displacement for 1.5D, 2D, 2.5D, 3D, 3.5D, 4D, 4.5D, and 5D with swimming pool at specific floor. From the analysis its observed that the storey displacement increases upto 3D and then decreases. The storey displacement is zero at the base and as the storey height increases displacement is increased by 1.5-2.5 mm. Storey 17 shows the maximum displacement for 3D (32.548 mm) and the minimum storey displacement is for 5D (30.029 mm).

2- Storey Drift

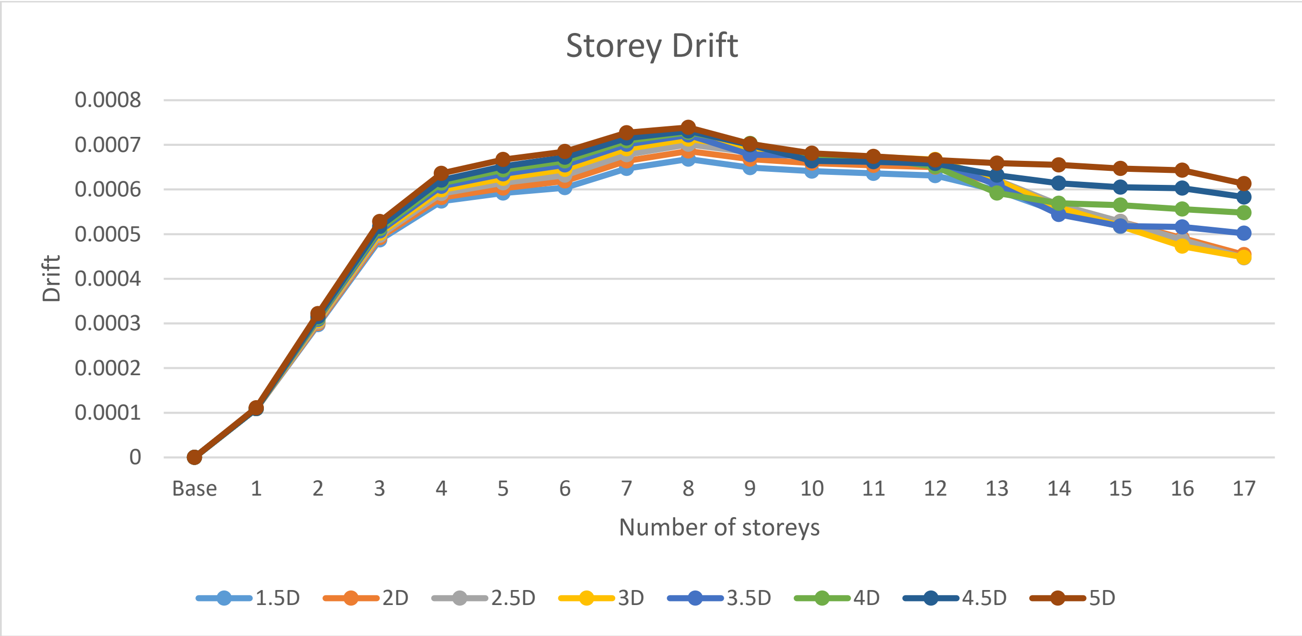

Fig 11- Storey Drift

The figure shows the storey drift for 1.5D, 2D, 2.5D, 3D, 3.5D, 4D, 4.5D, and 5D with swimming pool at specific floor. From the analysis its observed that the storey drift increases as the angle of twist increases. As the storey height increases the storey drift increases upto storey 8 and then decreases. The minimum storey drift is for 1.5D (0.000668) and 5D shows the maximum storey drift (0.000739).

3- Base Shear

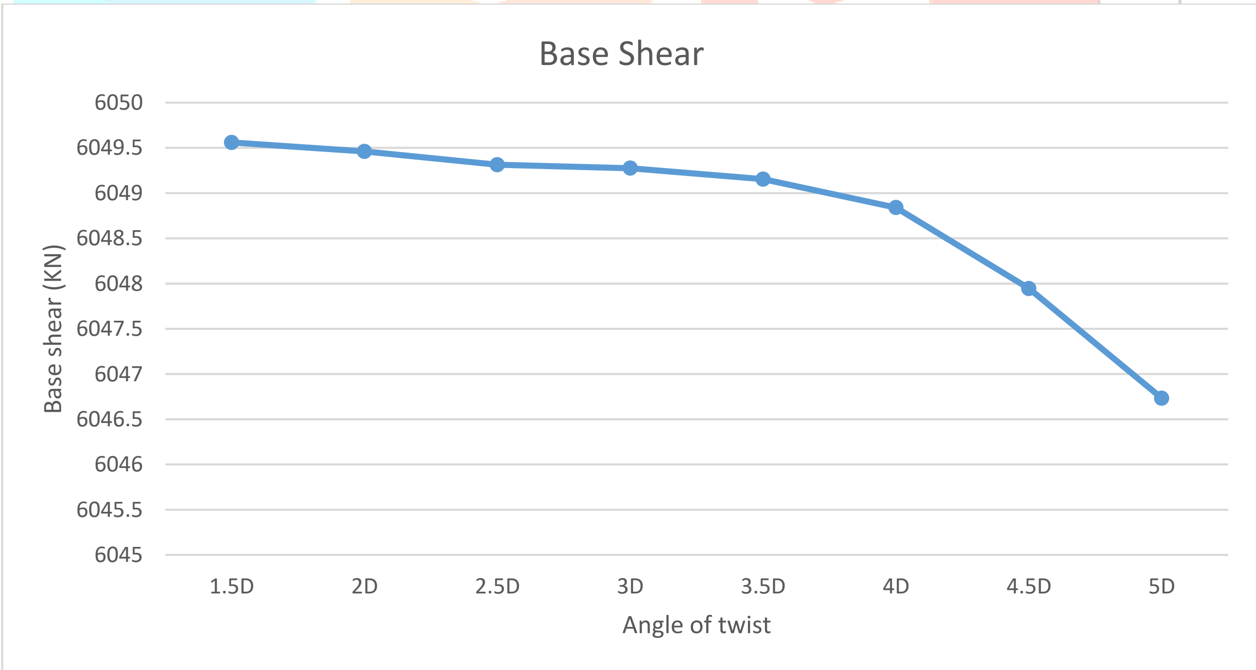

Fig 12- Base Shear

The figure shows the base shear for 1.5D, 2D, 2.5D, 3D, 3.5D, 4D, 4.5D, and 5D with swimming pool at specific floor. Its observed that as the angle of twist increases the base shear decreases. From the analysis its observed that the base shear is maximum for 1.5D (6045.559 KN).

IV. CONCLUSION

1. As the storey height increases the storey displacement is minimum at the base and then it gradually increases for swimming pool at every floor, alternate floor and specific floor of twisted building.
2. As the angle of twist increases the storey displacement is maximum upto 3D and then it decreases and 5D angle of twist shows the least displacement for all mentioned positions of swimming pools.
3. As the angle of twist increases the storey drift increases and 1.5D angle of twist shows the least storey drift.
4. As the angle of twist increases the base shear decreases and 1.5D shows the maximum base shear.

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