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"COMPARATIVE STUDY OF G+5 & G+10 REINFORCED CONCRETE STRUCTURE WITH AND WITHOUT STAIRCASE AT DIFFERENT LOCATION CONSIDERING SEISMIC EFECT BY USING SOFTWARE"

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Abstract: This Comparison study has been illustrate to the stair case in Reinforced concrete structure with and without different location with considering seismic load. Due to resisting of lateral load beam and columns comes in primary structural system.. Some other element contribute to lateral load resistance these elements fall in the category of secondary systems. Many structures were constructed in areas that are not considered seismic at the construction time or although they were located in seismic areas at that time, the earlier codes did not include seismic provisions or may have specified lower levels of seismic loads. Besides, gravity load designed structures may perform in a no-ductile manner with dangerous modes of failure. The stair offers a higher strength and stiffness influencing considerably the distribution of seismic forces. Stair could be susceptible part of the structure attract the seismic effect; in the meanwhile its stiffness could preserve the structure from collapse if it was adequately designed and built. If the stair is not well designed it can lead the structure to collapse.

Keywords: Seismic load, Staircase, Reinforced Concrete Structure, Etabs

I. INTRODUCTION

An in all over the world earthquake is a dangerous event which act quite differently and act on the weakest point in the building, cause serious damage to life and property. Analysis, design and modelling of the structure constitute the major activities in structural engineering practices. Structural analysis and design are coupled processes. In frame structure building consists of floor roof slab, supporting beams, columns and foundation. When we design the model of any building we can calculate the result and from that result we design different element of building. These element are are foundation, column, slab, RCC wall, water tank, staircase etc. Generally not modelled Stair use in a structure, althogh it is essential part of any building purpose of which is to allow the flow of traffic to be accommodated between floor levels within the building. Due to the complex modeling of the staircase, it is designed separately for non-seismic and seismic forces. Building design is the process of providing all information necessary for construction of a building which will meet its owner's requirements and also satisfy public health, welfare, and safety requirements.

Types of Stairs

- Straight flight stairs
- Quarter-turn stairs
- Half-turn stairs
- Branching stair
- Open-well with quarter turn landing
- Geometrical stair

For designing, it is classified into two types transversely and longitudinally supported.

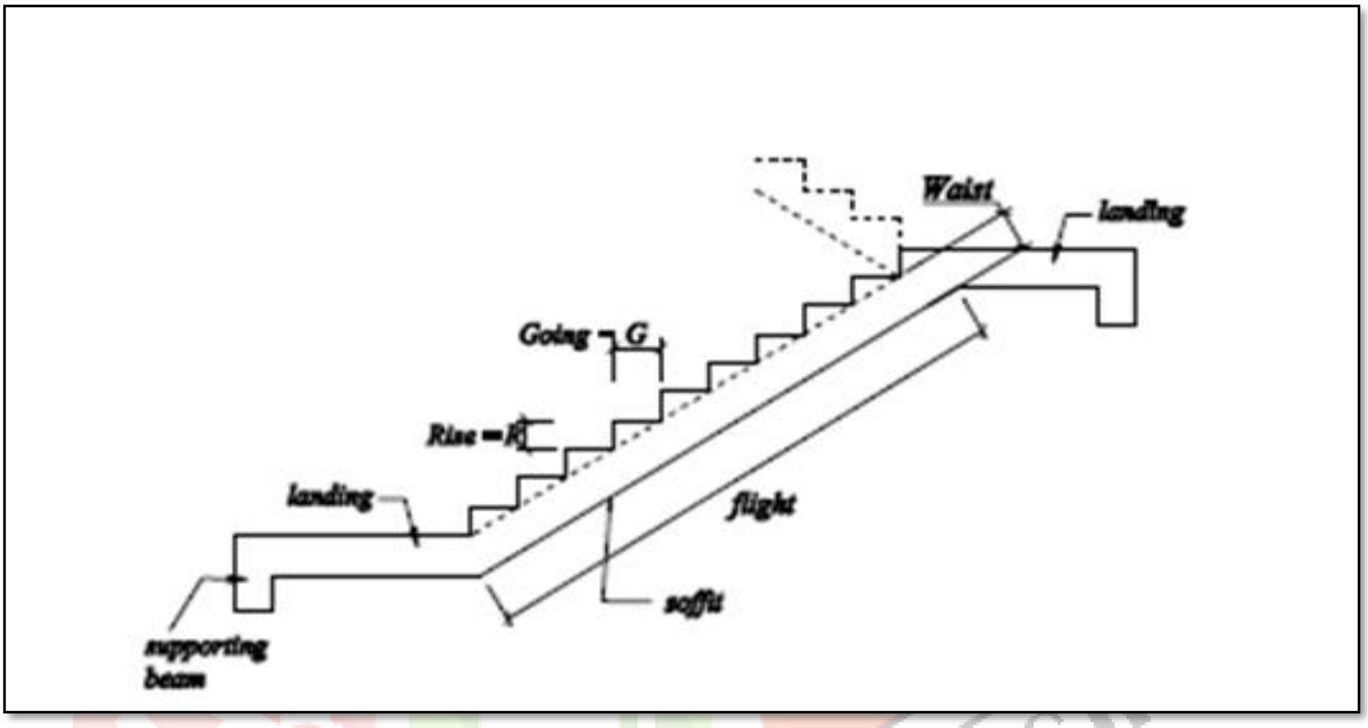
a- Transversely supported (transverse to the direction of movement) include: :

- Simply supported steps supported by two walls or beams or a combination of both.
- Steps cantilevering from a wall or a beam.
- Stairs cantilevering from a central spine beam.

b- Longitudinally supported (in the direction of movement)may be supported :

- Beams or walls at the outside edges of the landings.
- Internal beams at the ends of the flight in addition to beams or walls at the outside edges of the landings.
- Landings which are supported by beams or walls running in the longitudinal direction.
- A combination of (i) or (ii), and (iii).
- Stairs with quarter landings associated with open-well stairs

TECHNICAL TERMS:



II. PROBLEM STATEMENT

Analysis will be done by using 3-D ETABS models for different types of building configuration. The Span Length varies from 5m to 25m keeping vertical Clear height equal to 45m, c/c distance between frames varies from 3m to 5m. Different loads such as Dead Load, Live Load, and Earthquake Load will be applied on ETABS models at appropriate location as per codes used for Loading. model are analyzed by using equivalent static analysis and force coefficient method for zones III. Design is done firstly by Indian Codes (i.e. IS 456, IS 1893, IS 875). And obtained results from ETABS are compared with the help of Excel sheets and tabulated.

AIM

Reducing the damage of the structure effectively using design staircase with inclined slab and proving it as most efficient in the stability of the structure.

OBJECTIVES

The main objective of staircase during seismic performance on structure for zone III at different location in plans is considered. Performing equivalent static analysis on RC structure for different staircase location having the different structural heights.

For comparing the behavior of RC structure with modeled staircase and sans modeled staircase. At different location.

analyzing such as storey drift, storey displacement, column axial load, column bending moment, column shear force on the building. And Optimizing location of staircase is effectively in resisting seismic performance. Comparing the design results for different models on the basis ETABS results.

III. LITERATURE REVIEW

- **Xuan Xu and Weiguo [1],** have examined on Staircase evacuation modeling and its comparison with an egress drill. In that paper a study an evacuation process of a four-storey building by means of an egress drill and simulations. The evacuation in the staircase is much different from that in flat areas in the building because of some special characteristics, for example, the twisting and descending passageway; the interflow of crowds at the joint of staircase and hallway; the turning behaviour at the turning point between two flights.
- **C. Bellidoa, A. Quiroza, A. Panizoa and J.L. Torerob [2],** have examined on Performance Assessment of Pressurized Stairs in High Rise Building on this paper they said that Pressurized stair cases are an important part of the Fire Safety Strategy of high rise buildings. The results have been evaluated showing the limitations of the control system in the event of multiple doors being opened and the limitations of the pressure release dampers (as a response mechanism) if the pressure becomes unstable
- **Edoardo Cosenza, Gerardo Mario Verderame and Alessandra Zambrano [3],** have identified that the seismic performance of existing buildings and in particular on the moment resisting frame structures that could have their critical and weak points in the stair members: columns and beams or slabs. Some numerical modal linear and nonlinear push-over analyses are adopted. Some numerical modal linear and nonlinear push-over analyses are adopted. The author concluded that,
- The presence of stair yields in the transversal direction to an increase of strength and to a reduction in deformation capacity respect to the building without stair. In results need to utilize biaxial bending modeling and for the interaction of the different internal forces that governs the behavior of short columns.
- Shear failure becomes predominant in the short columns and in the reinforced concrete slabs and precedes the conventional ductile failure due to pure flexure.
- **Sang Bum Kim, Young Hack Lee, Andrew Scanlon, Heecheul Kim, and Kappyo Hong [4],** worked on experimental assessment of vibration serviceability of stair systems In this paper they investigate the serviceability performance of the steel and RC stairs. The results of pedestrian induced loading test for the evaluation of vibration are compared. He has done the experimental test in that he done laminated tread board type steel stairs and SFRC tread board type steel stairs are representative of steel stair system.
- The laminated tread board type steel stair have two laminated 1.6mm thick steel plates for a tread board, supported on 9 mm thick lateral steel plates and tread board is filled with mortar of 40mm thickness. One unit of a stair system connects a floor to a landing at mid-storey height. The setup consists of a RC shear wall and stairs. For steel stair, the system units were connected to the situ cast RC stair landing with M16 Studs Embedded in the stair landing
- **N Shyamananda Singh and S Choudhury [5],** have examined that on 'effects of staircase on the seismic performance of RCC frame building' on this paper they said that the effects of staircase on the seismic performance of the RCC frame buildings of different heights and different plans have been studied. For analysis and design, SAP 2000 version 14.0.0 has been used. Performances of both categories of the buildings have been evaluated through push over analyses and nonlinear time history analysis. Parameter such as time period of the Buildings, Effects on the landing beams and columns, Effect on inter storey drift ratio. The author concluded that,
- In the stair model, columns touching landing beam have been found to be subjected to an increase in axial force by an average of 19% and lateral moment in such columns increased on average by 32%. Shear force in landing beam increased by 36% on average. The inter storey drift ratio has been found to reduce by 33% in short direction and 23% in long direction on average and Dynamically analyzed time period got reduced by about 22.31%

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- **Pratik Deshmukh1, M.A. Banarase2 [6],** have examined that the effects of staircase on the seismic performance of the RC frame buildings of different heights and different plans have been studied. For analysis and design, ETABS v.9 has been used. Performances of both categories of the buildings have been evaluated through Response Spectrum Method. Parameter such as Storey Drift, Storey Displacement. The author concluded that,
- It has been observed that the presence of staircase tremendously influence the peak value of result of beams and columns around staircase obtained after analysis.
- In case of building modelled with staircase, the inter storey drift ratio has been found to reduce approximately by 20% in X and Y-direction, the storey displacement has been found to reduce by 30% in X and Y-direction.
- Columns supporting landing beam have been found to be subjected to an increase in axial force 19%. The lateral moment in such columns increased on average by 32%. The tensional moment in landing beam increased enormously.
- Area of steel decrease in beam supporting staircase flight at top by an average of 80% and at bottom of 13%.
- If building and there components are not design properly by considering diagonal effect of staircases, it may get fail under major earthquakes.
- **Ankit R. Shelotkar, Mayur A. Banarase [7],** have examined that the effects of staircase on the seismic performance of the RC frame buildings of different heights and plans have been studied. For analysis and design, ETABS v.9 has been

used. Performances of all categories of the buildings have been evaluated through Response Spectrum Method. Parameter such as Storey Drift, Storey Displacement. The author concluded that,

- It is observed that the Columns supporting landing beam have been found to be subjected to an increase in moment & beam supporting staircase flight has been found to be subjected to a decrease in area of steel at top.
- The presence of staircase yields in the transversal direction to an increase of strength.
- It is also observed that damage in main structures was due to interactions with stairways and in stairways due to high stiffness and corresponding high force demand, with insufficient strength due to inadequate design.

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IV. RESEARCH METHODOLOGY

- Literature Survey, conference proceedings, reference books and BIS publications.
- Study of method of analysis adopted for the analysis of multi storied building with stair and without stair model.
- As per the plan and type of building suitable structural dimensions were decided.
- Modelled in ETABS.
- Static analysis factor such seismic zone factor, site type, importance factor, time period, response reduction factor along with different loadings.
- Seismic analysis has been performed using response spectrum analysis as per IS code and governing parameters such as drift, displacement, time period, axial load, bending moment, shear, area of steel and other forces have been recorded.
- Results of with stair and without stair case modelled building were compared.
- Result of structure analysis were tabulated in the form of tables and graphs.

V. DESIGN ANALYSIS & MODELING

Structural Configuration :

Design data for all buildings

- Grade of Concrete = M30
- Grade of Steel = Fe415
- Density of Concrete = 25kN/m3
- Density of Brick = 20 kN /m3

Earthquake data for both buildings

- Seismic Zone = III
- Importance factor = 1.5
- Response reduction factor = 5 (SMRF)
- Type of soil = TYPE II (Medium)
- Damping = 5%

Structural Configuration :

Building Details for both Buildings: The structural data for both symmetrical buildings is as given:

Design data for all buildings

- Plan Dimension of building = 25 X 18 m
- No of storey in G+5 = 6
- No of storey in G+10 = 11
- Ground storey height = 3.00 m
- Intermediate storey height = 3.00 m
- Slab thickness = 150 mm
- Rise of step = 160mm
- Tread of step = 300mm
- Full brick wall = 300 mm
- Internal brick wall = 300 mm
- Parapet wall height = 1 m

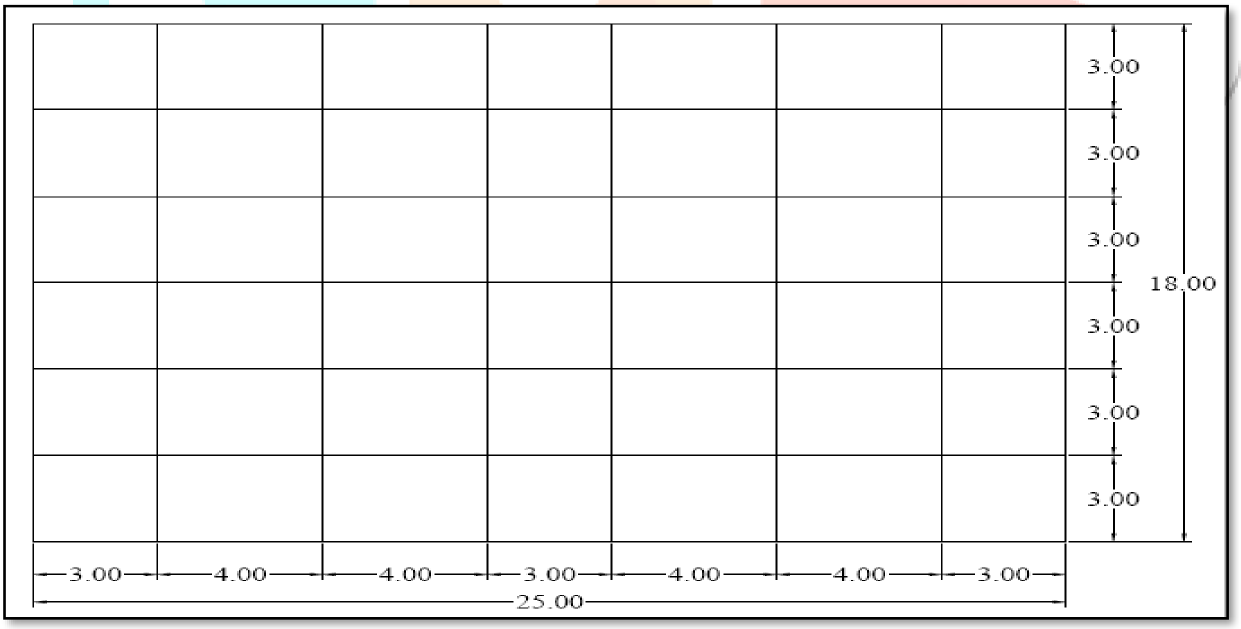
Size of Structural Elements
Table 1: Table for Size of Structural Elements
Part A – (G+5 Building). (All Dimension in mm)

Sr.No.	Model No.	Size of Beam	Size of Column	Size of Slab
1	M1 (A1)	300 X 450	300 X 350	150
2	M2 (A2)	300 X 450	300 X 350	150
3	M3 (A3)	300 X 450	300 X 350	150
4	M4 (B1)	300 X 450	300 X 350	150
5	M5 (B2)	300 X 450	300 X 350	150
6	M6 (B3)	300 X 450	300 X 350	150

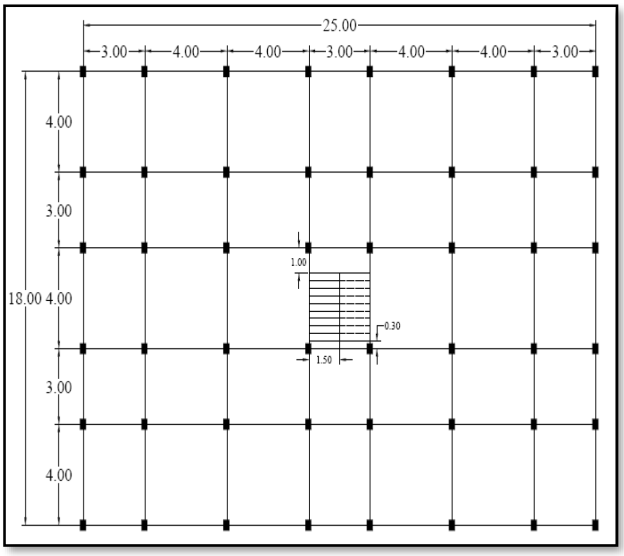
Size of Structural Elements
Table 1: Table for Size of Structural Elements
Part B – (G+10 Building). (All Dimension in mm)

Sr.No.	Model No.	Size of Beam	Size of Column	Size of Slab
1	M7 (A4)	300 X 450	300 X 750	150
2	M8 (A5)	300 X 450	300 X 750	150
3	M9 (A6)	300 X 450	300 X 750	150
4	M10 (B4)	300 X 450	300 X 750	150
5	M11(B5)	300 X 450	300 X 750	150
6	M12(B6)	300 X 450	300 X 750	150

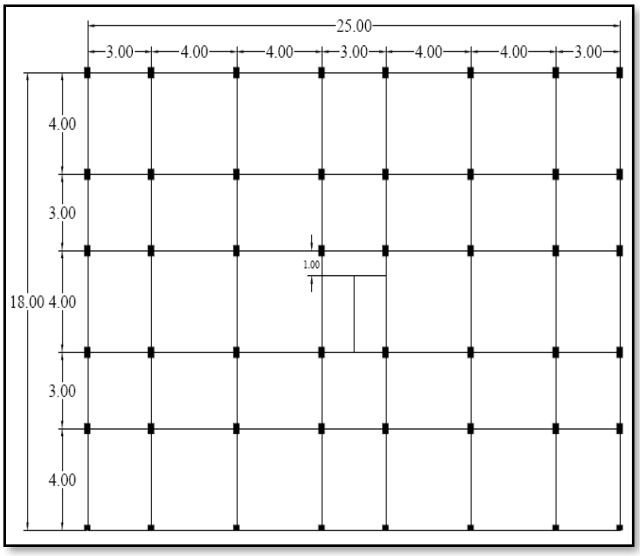
Structural elevations and plans for different location of stair case
Part A - G+5 Building (Elevation).



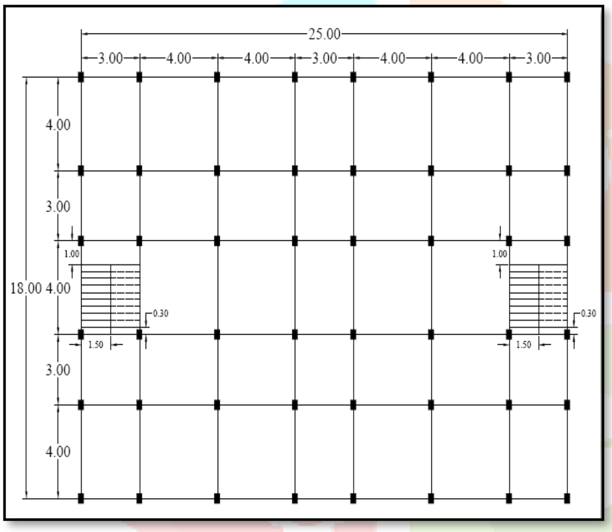
Elevation view of building (G+5)



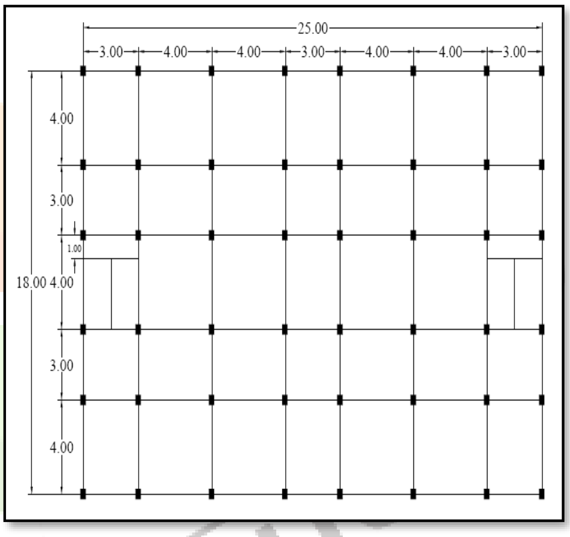
Structural plan of building with staircase at centre location (A1)



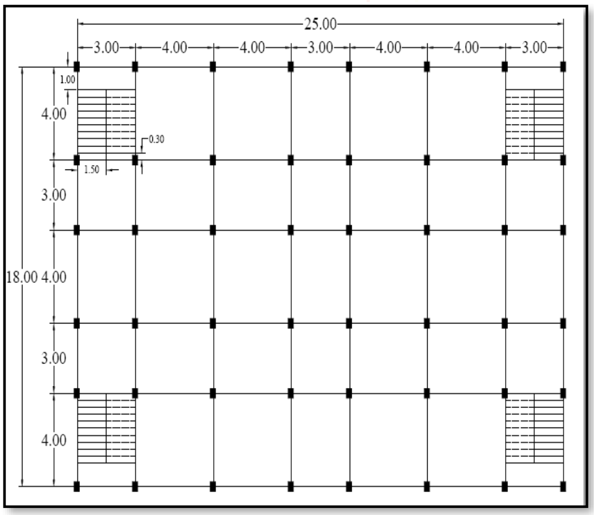
Structural plan of building without staircase at centre location (B1)



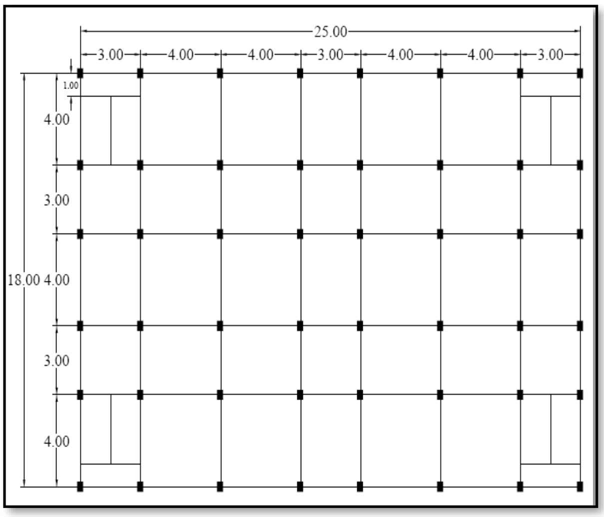
Structural plan of building with staircase at mid end location (A2)



Structural plan of building without staircase at mid end location (B2)

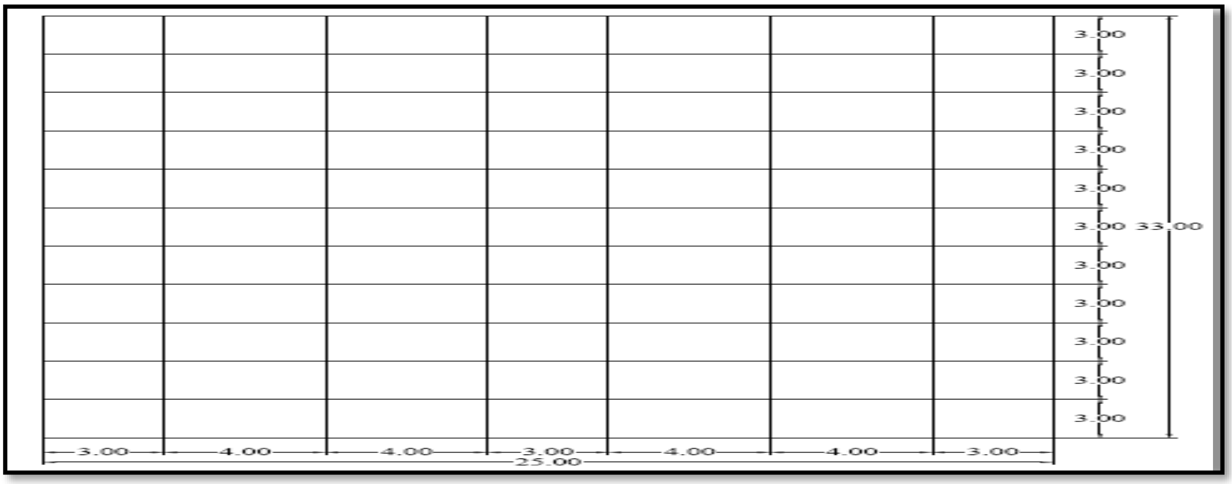


Sructural plan of building with staircase at corner location (A3)

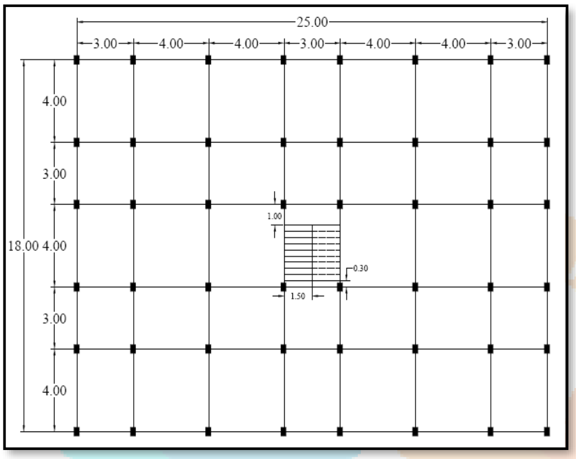


Sructural plan of building without staircase at corner location (B3)

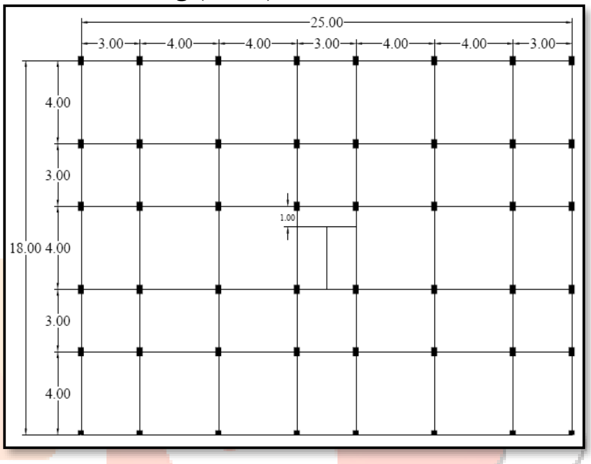
Part B - G+10 Building (Elevation)



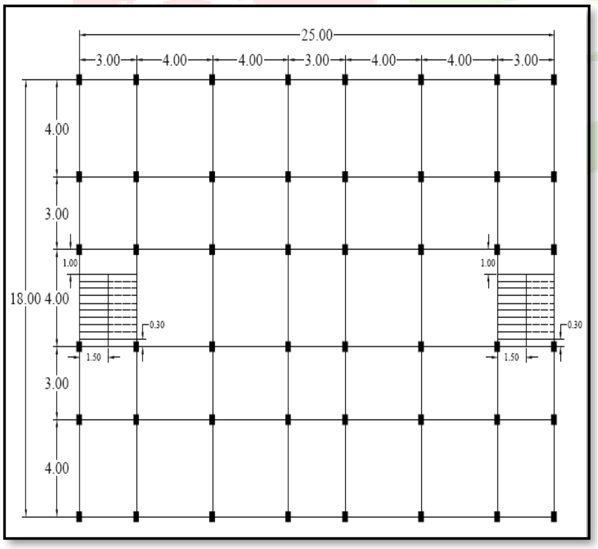
Elevation view of building (G+10)



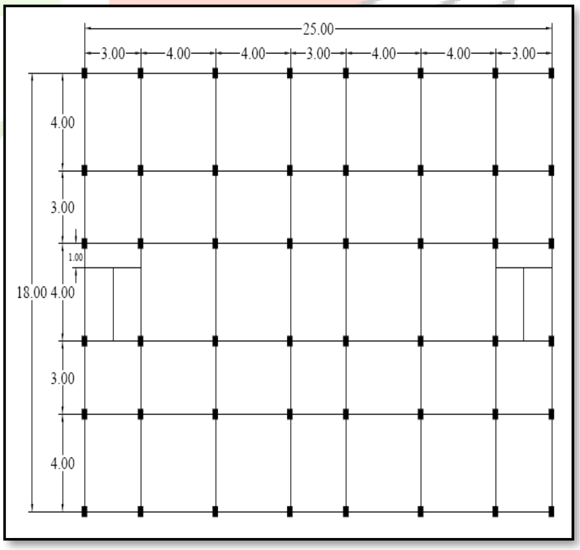
Structural plan of building with staircase at centre location (A4)



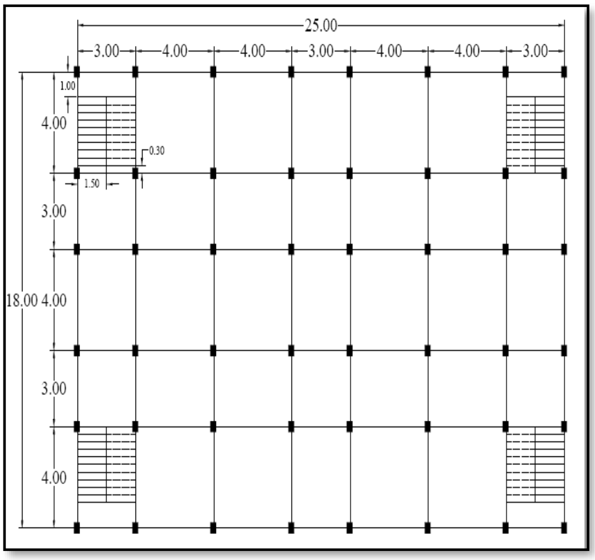
Structural plan of building without staircase at centre location (B4)



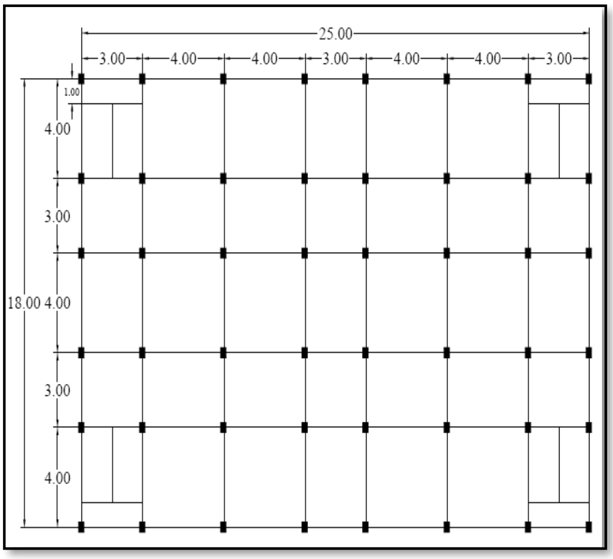
Structural plan of building with staircase at mid end location (A5)



Structural plan of building without staircase at mid end location (B5)



Structural plan of building with staircase at corner location (A6)



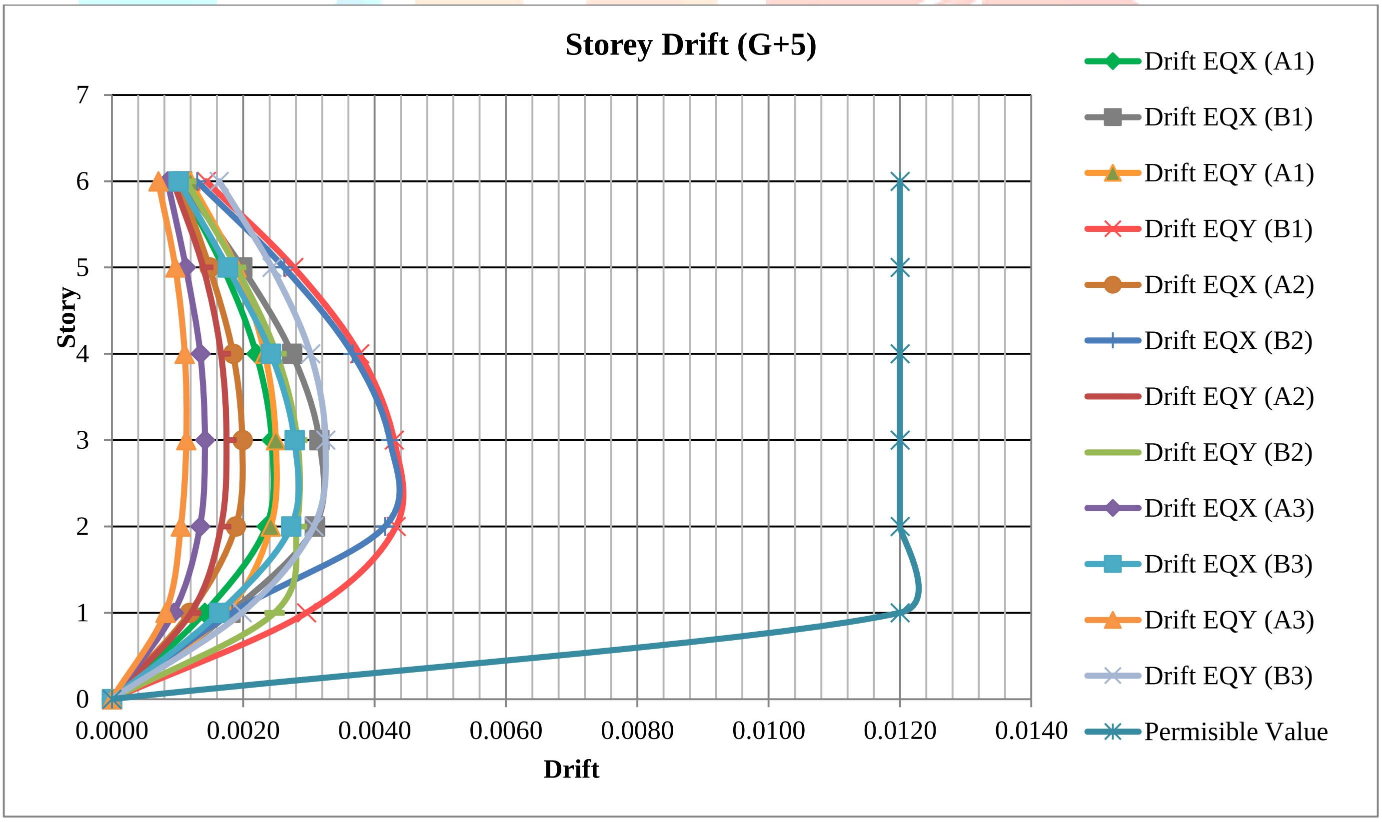
Structural plan of building without staircase at corner location (B6)

VI. RESULTS & DISCUSSION

6.3 Comparison Study of G+5 and G+10 Model

Results for building with stair case i.e. A1, A2 & A3 are compared with, without stair model i.e. B1, B2 & B3 for G+5 and G+10 model.

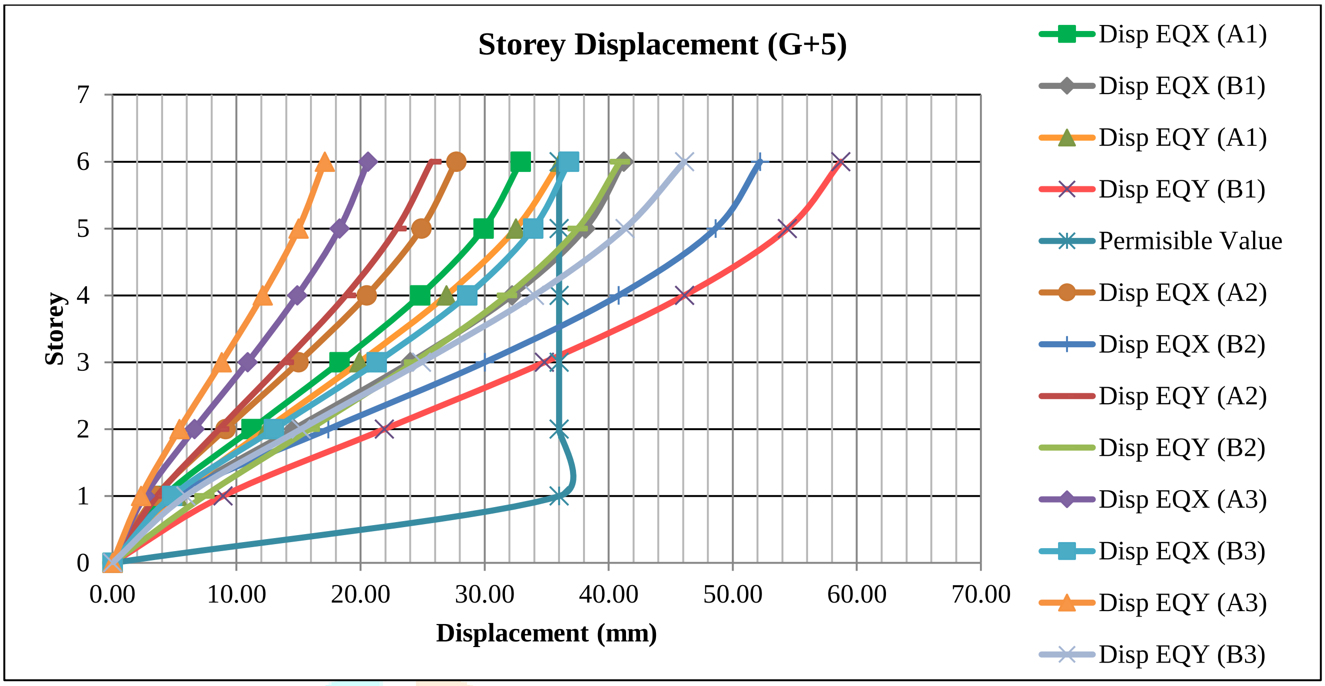
6.3.1.1 Comparison of storey drift.



Graph.6.35: Comparison of storey drift with stair and without stair model.

From Figure X-direction x-axis represents storey drift and y-axis represents storey level for G+5 building it is observed that the storey drift in X-direction for A3 is less than A2 by 29 %, A2 is less than A1 by 18% and in Y-direction for A3 is less than A2 by 35%, A2 is less than A1 by 30%.

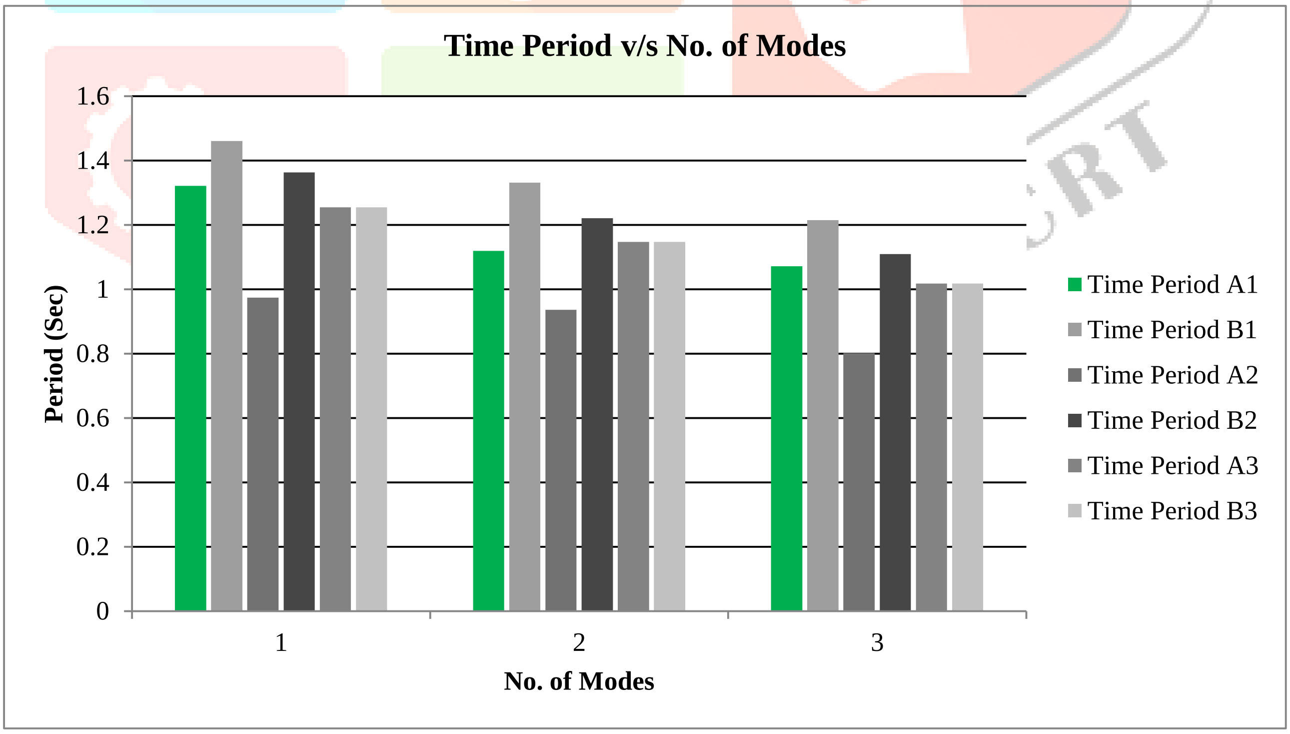
6.3.1.2 Comparison of storey displacement.



Graph.6.36: Comparison of storey displacement with stair and without stair model.

From Figure X-direction x-axis represents storey displacement and y-axis represents storey level for G+5 building it is observed that the storey drift in X-direction for A3 is less than A2 by 26 %, A2 is less than A1 by 16% and in Y-direction for A3 is less than A2 by 34%, A2 is less than A1 by 29%.

6.3.1.3 Comparison of time period.

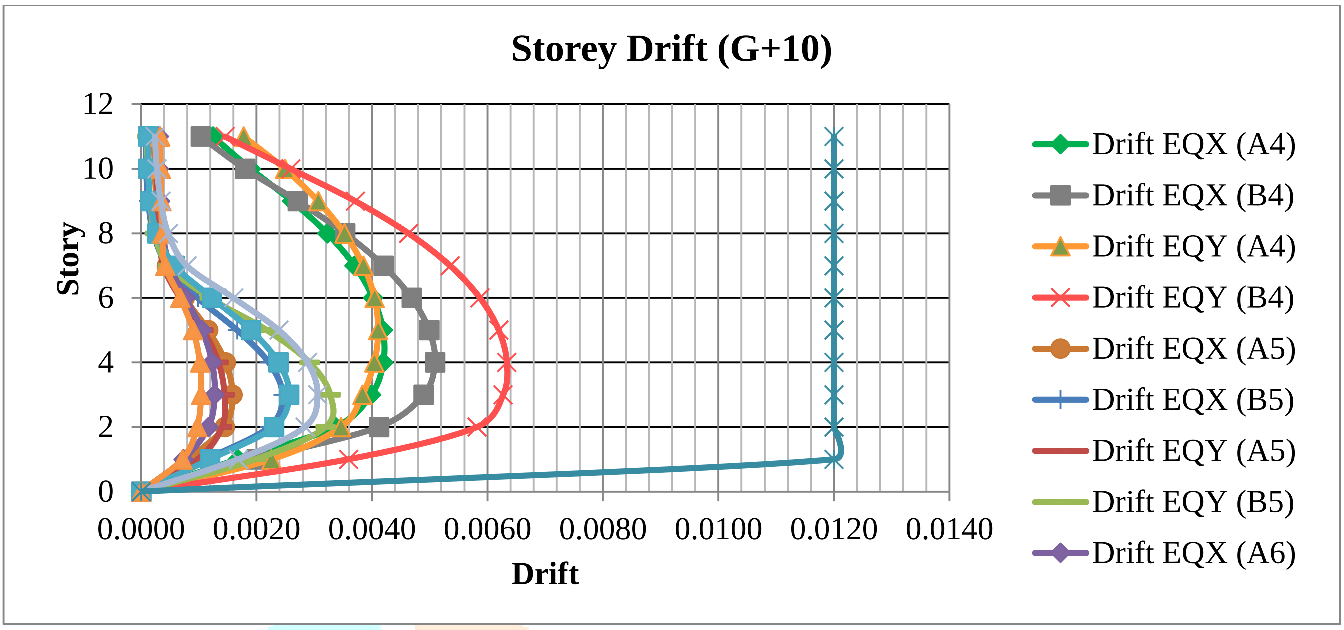


Graph.6.37:Comparison of time period with stair and without stair model.

From Figure X-direction x-axis represents modes and y-axis represents time period for G+5 building it is observed that the time period for A3 is less than A2 by 17%, A2 is less than A1 by 23%.

6.3.2 Results for building with stair case i.e. A4, A5 & A6 are compared with, without stair model i.e. B4, B5 & B6 for G+5 and G+10 model.

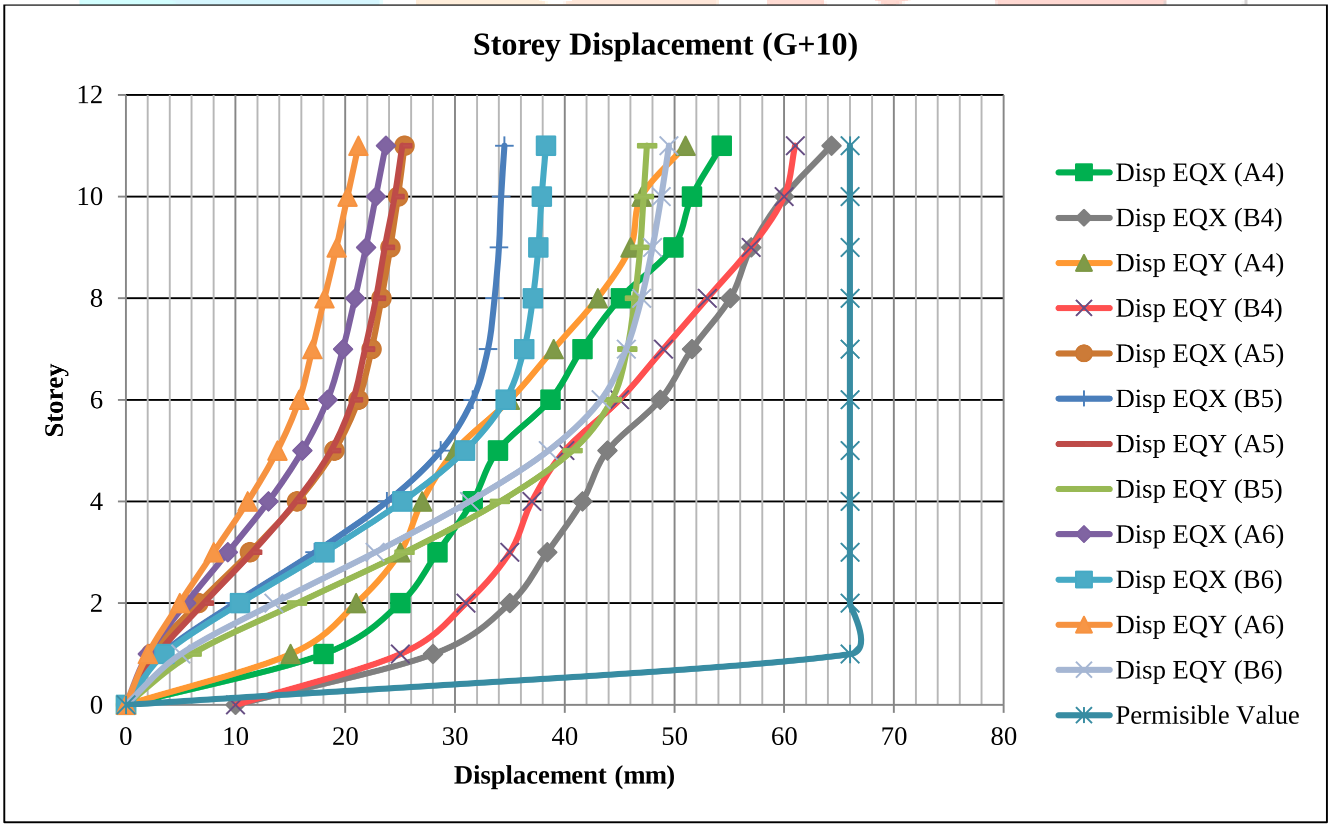
6.3.2.1 Comparison of storey drift.



Graph.6.38:Comparison of storey drift with stair and without stair model.

From Figure X-direction x-axis represents storey drift and y-axis represents storey level for G+10 building it is observed that the storey drift in X-direction for A6 is less than A5 by 20 %, A5 is less than A4 by 62% and in Y-direction for A6 is less than A5 by 28%, A5 is less than A4 by 65%.

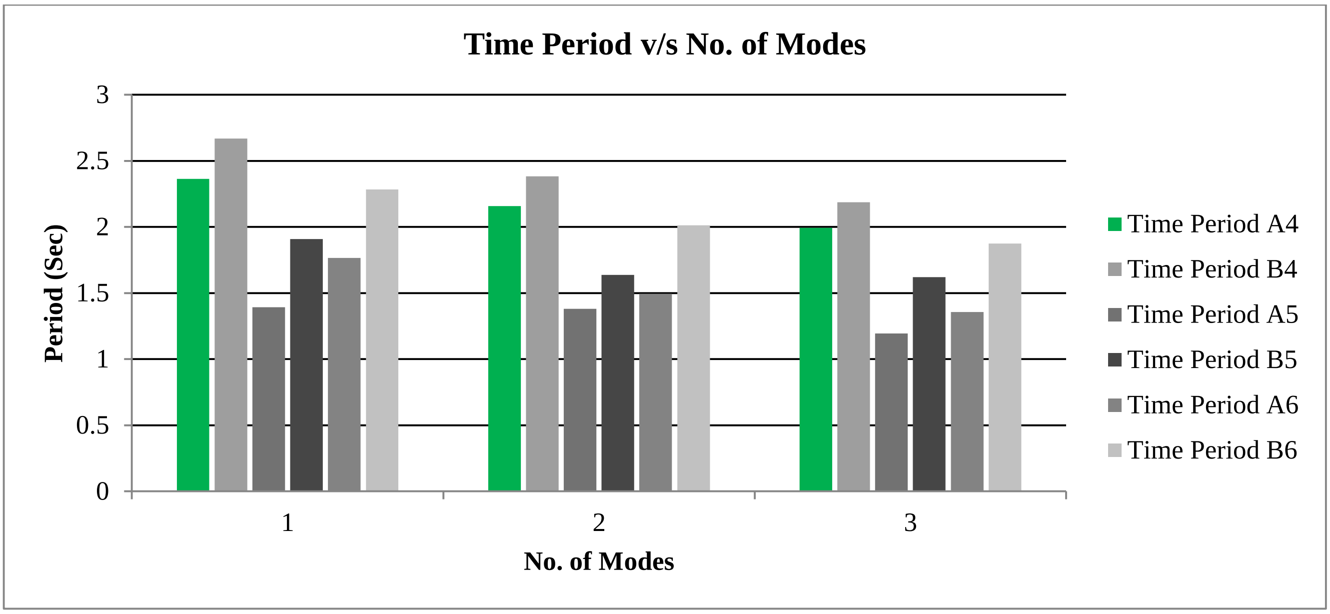
6.3.2.2 Comparison of storey displacement.



Graph.6.39:Comparison of storey displacement with stair and without stair model.

From Figure X-direction x-axis represents storey displacement and y-axis represents storey level for G+10 building it is observed that the storey drift in X-direction for A6 is less than A5 by 7%, A5 is less than A4 by 53% and in Y-direction for A6 is less than A5 by 16%, A5 is less than A4 by 51%.

6.3.2.3 Comparison of time period.



Graph.6.40:Comparison of time period with stair and without stair model.

From Figure X-direction x-axis represents modes and y-axis represents time period for G+10 building it is observed that the time period for A5 is less than A6 by 14%, A6 is less than A4 by 29%.

VII. CONCLUSION

From the study and results form design the important conclusion is, if structure and their elements are not design properly it can be serious damage & life threatening. The presences of staircase influence the peak value of result. And the peak value obtained by equivalent static method for columns around staircase. In this we have observed that when we compared all structural model under consideration, in case of model AX3 (G+5) & AX6 (G+10), as staircase is along shorter direction the shorter span will divide in two parts. Hence the values for drift, displacement, and time period is observed to be lesser as compared to other models. then it is better to provide stair case in shorter direction (Y-direction) for the model. In with stair model it is observed that, columns supporting landing beam have been found to be max axial force. The lateral moment in such columns in landing beam increases enormously, the failure of beam is resolved by not providing the area of steel at negative moment locations and by increasing the depth of beam. In absence of staircase in model it is observed that, the force drift, displacement & time period increases due to absence of inclined slab, it is necessary to considering the inclined behaviour of staircase during modeling. Because of the mid landing the column under the staircase will be act like a short column, as the short column gone through tremendous stresses and forces the beam connecting the short column is failed in the results obtained from ETAB 15. Hence the redesigning of the section is required.

VIII. FUTURE SCOPE

- The various building models which are analyses in the dissertation work can be further studied by introducing various types of staircase by changing plan and height of the building.
- Stair case +Lift+ Maven technology construction should be studied.
- When floors of building are more than 10 than one should use software to analyses the location of stair case or lift.
- Traffic on each floor should be calculated and accordingly the location of staircase or lift should be studied.
- Use the different software like SAP, STAAD, and EVACENET 50.
- Traffic on each floor should be calculated and accordingly the location of staircase or lift should be studied.

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