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Analysis of An Inclined Structure Considering Suspension Cables Using Staad.Pro

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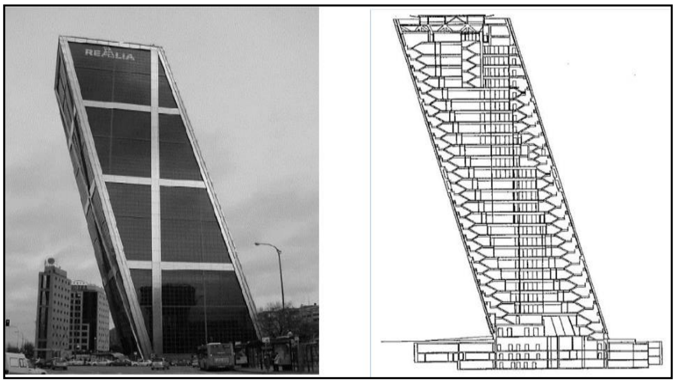
ABSTRACT

Seismic analysis is mandatory in every case of structure analysis whether it's related to any soil condition or geography. Architectures and structure engineers together have created marvels in form of unique structures whether its time from ancient Pyramids to Transamerica Pyramid in San Francisco. This structures are not always about cosmetic interests as even such structures are meant to be stable against different forces and economical aspects. High rise buildings and skyscrapers are designed with different technologies to resist heavy winds and seismic forces and such technologies include leaning at different angles, twisting shapes or creating free shapes for aerodynamics. Many inventions have helped to develop the idea of building tall buildings, the invention of the vertical elevator in 1853 by the American Elisha Graves Otis was one of the most important factors in the development of this concept. Viability of this elevator for quickly vertical movement helped people to move between stories effortlessly. Until 1870, cast iron and wood was the main materials used in construction of building where walls made of masonry had to be so thick in order to be able to carry out the load coming from floors. This system limited the height of the building because of the large weight of its components. Later, the steel frame system was invited which became as the best solution at that time as it much strong system which can tack more load of each floor and therefore the thickness of the walls could be reduced where insulation became its main function. In this investigation, the results of maximum response in terms of base shear, displacement, time history are evaluated. The aim of this research designing and analysis of cable slanted building behavior originated on different sloping angles and its behaviour during earthquake areas of zone V. The seismic analysis of G+12 storey RCC building on varying slope angles is studied and compared with the same on the flat ground. The structural analysis software STAAD Pro V8i is used to study the effect of slant on building performance during earthquake in zone V.

Keywords : Structural System, STAAD.Pro, Slant Buildings and Cable Support System

I. INTRODUCTION

Post-earthquake damages investigation in past and recent earthquakes has illustrated that the building structures are vulnerable to severe damage and/or collapse during moderate to strong ground motion. In this investigation, the results of maximum response in terms of base shear, displacement, time history are evaluated. The aim of this research designing and analysis of cable slanted building behavior originated on different sloping angles and its behaviour during earthquake areas of zone V. The seismic analysis of G+12 storey RCC building on varying slope angles is studied and compared with the same on the flat ground. The structural analysis software STAAD Pro V8i is used to study the effect of slant on building performance during earthquake in zone V. North and northeastern parts of India have large scale of hilly regions, which are categorized under seismic zone IV and V. Major seismic events during the past years in hilly areas such as Kangra, 1905 earthquake M8, Kinnaur ,1975 earthquake M6.2 , Uttarkashi uphill"s, 1991earthquake M6.6 ,Nepal/Sikkim (India) border area in 2011 earthquake M6.9 ,where there is level difference of sloping on the structure using cables andn failure is also seen in damaged buildings which is one of the vertical irregularity. In the present study differently angles of slant cable stayed building configured R.C framed building are described and studied from structural seismic safety point of view under the action of dead, live and earthquake loads. A G+12 storey RCC building responses are checked for both the building constructed on plane with soft soil. Comparison is made considering different angles of slant by using software such as STAAD. Pro on MS-excel. The static and dynamic response for the building are compared and checked for the changes in terms of shear force, bending moments and deflection in same elements at an earthquake shaking of same magnitude. In a static model for both the buildings a comparison is made between the bending moments and shear forces of the elements at same nodes in both the structures. Thereby, concluding the changes in the shear force and bending moments of same elements in structure constructed on plane and sloping ground.



(A)

(B)

Fig 1. Building with slant using cables

II. Objectives of the Study

- To analyze seismic performance of multi-storey slant structure with different degree using cables.
- Study the behavior of buildings constructed on plane ground for static load and dynamic load using analytical application STAAD.Pro.
- To compare the performance of multi-storey structural building with normal and oblique column.
- To optimize the structure stability of slant using cables with different angles.

III. Literature Survey

Yan Yu et.al (2017) in the research paper, the wind initiated reaction of an L-formed cable support glass curtain divider is dissected. To really mirror the power transmission, a finite element analysis of the curtain wall is set up to guarantee communitarian deformation among glass and link, including glass board, link, sealant, and paw association. Time-space vibration investigation of the drapery divider is done with the irregular succession of multi-hub fluctuating breeze speed time history reenacted via autoregressive straight separating strategy dependent on Kaimal wind speed range. Four breeze stream headings are determined, specifically, 0◦, 15◦, 30◦, and 45◦, to dissect the breeze prompted dynamic reaction of this design with thought of the liquid construction association impact. At last, the redirection of the glass surface is concentrated by measurable examination of removal to acquire the breeze vibration coefficient appropriate for the underlying model of useful activities, and the variety of link power is explored.

Results expressed that the greatest removal of the construction is 0.253m under 45◦ breeze bearing. The glass drapery divider shows solid honesty and distorts agreeably. The breeze prompted vibration coefficient is recommended to be 2.0 for commonsense activities, bringing about traditionalist outcomes contrasted and Chinese codes. The relocation at the corner is generally small, showing that the solidness of the two surfaces is adequately enormous. By dissecting the speed increase time history and force range, the initial not many modes are energized and the vibration of this construction is a limited band measure under fluctuating breeze load. The investigation of link pivotal force shows that the most extreme mean hub power can reach 357 kN. The conveyance of axial force on the two surfaces is very extraordinary and is fundamentally influenced by the breeze direction.

Zhifu Gu et.al (2010) A breeze loading concentrate on a cable-net supported glass wall was led using air stream tests. A comparable aeroelastic model is planned and built. Reaction of removals of the divider is estimated and investigated. To plan a glass divider under wind load, the "wind vibration factor" is assessed and talked about. Truth be told, the system of wind following up on the divider is regularly referred to as sure pressing factor as well as adverse pressing factor brought about by the stream division on the edges of the structure. Because of the timidity in the system of wind acting, two-run of the typical response cases were ordered.

Results show that because of the constraint in the component of wind activity on the divider, two common cases can be ordered, i.e., as the breeze following up on the divider straightforwardly with the positive pressing factor, and as the stream partition from the edge of the structure causing the negative tension on the divider. Thus, the reactions of the divider are very unique because of the distinction in instrument of wind activity, and the upsides of "wind-vibration factor", which are applied in designing practice, are likewise very extraordinary. The negative pressing factor, which is related with the shear layer. The dynamic reaction of the construction brought about by the negative pressing factor is more grounded than that of the positive pressing factor case. To decide the streamlined breeze stacking on an adaptable piece of a design on a structure, an air stream study might be valuable and assume a significant part.

K.Grebowski and M.Werdon (2015) the point of the article was to dissect the working of the applied extension link stays in structures, contingent upon the presented compressive power during quakes. The investigation showed that cable-stayed cantilever structures adequately move seismic powers, yet just if proper compressive power is presented on the link stays. On the off chance that the compressive power is too high, the construction turns out to be hardened,

which is very disadvantageous during tremors. Components participated in a firm way to speed up one another, which can bring about a development fiasco. On the off chance that the compressive power is lower, the structure is adaptable (given that the components of the suspended construction are joined by an adaptable joint with the remainder of the structure). Components participated in a versatile manner make specific pieces of the construction move freely and keep them from shared speed increase. It is exceptionally simple to notice it on the charts, where for the compressive power of N=2000 kN, the greatest dislodging of the cantilever is 60 mm, while for the most reduced compressive power of N=1000 kN, the greatest removal of the cantilever is 20 mm.
In view of the outcomes it very well may be reasoned that gratitude to the utilization of link remained cantilever structures in abnormal developments, we can forestall harm to structures situated in seismically dynamic zones and assurance wellbeing to individuals utilizing those structures. Information on the worth of the compressive power required for the pressure of link stays as ahead of schedule as at the phase of planning will permit previous elimination of errors and mistakes.

METHODOLOGY

Step 1 the initial step for any research is to study the history on the related subject and the same is carried in the this research where different authors research is studied from all around the globe on slanting structures whether it's a historical tower of Pisa or new structures with different slant angles.

Step 2 This step includes modelling of the structure using analytical application STAAD.Pro v8i. the modelling of the structure is done using nodes considering three different angles of slant 10°, 15° and 20°.

Case I 10° Slant Building

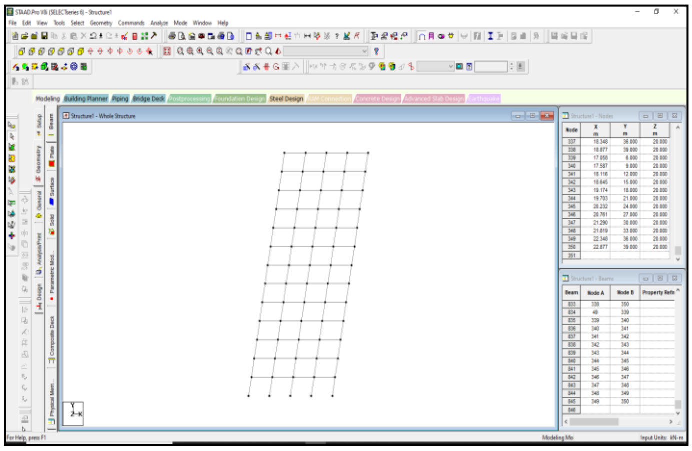


Fig 2 10° Slant Building

Case II 15° Slant Building

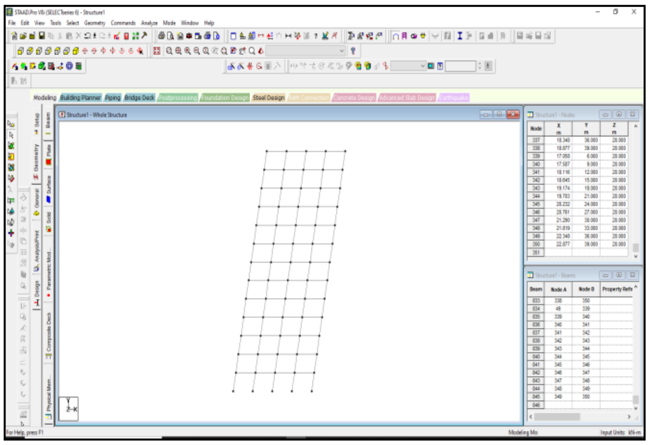


Fig 3 15° Slant Building

Case III 20° Slant Building

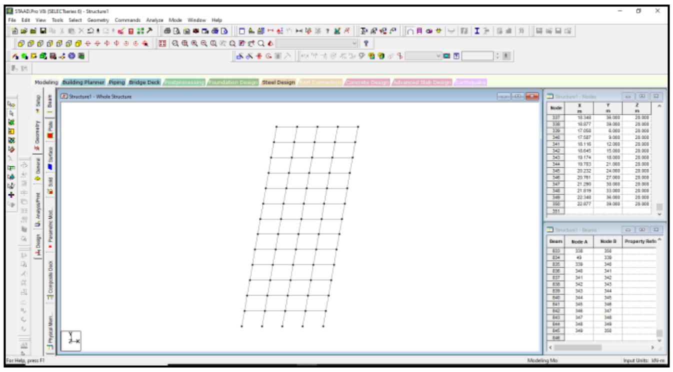


Fig 4 20° Slant Building

Step 3 Defining materials properties to the frame and section data for column and beams

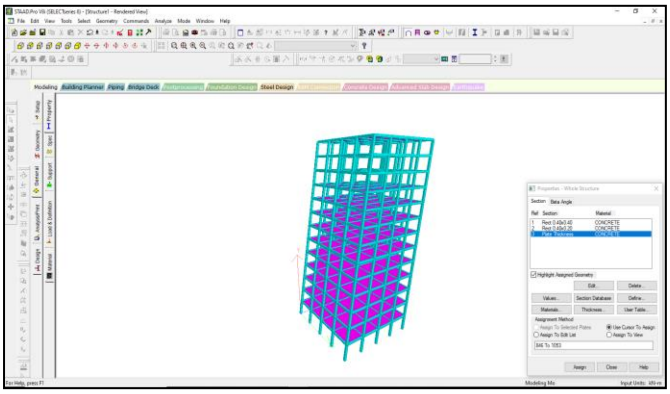
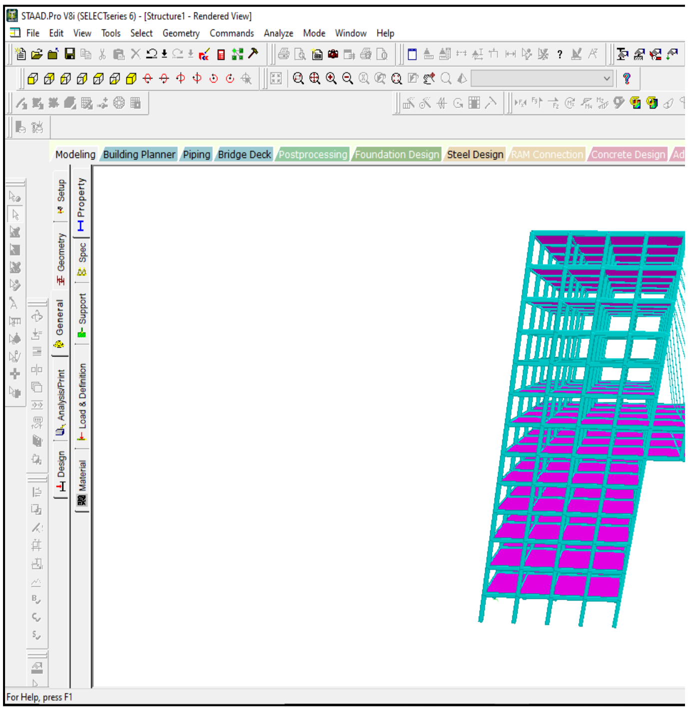
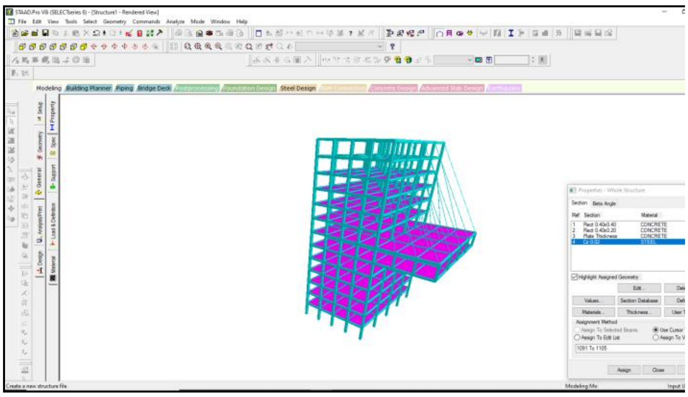


Fig 5 Defining material properties and section data

Step 4 Assigning steel cables for the slant at different angles to support extension at seventh floor.



(A)



(B)

Fig 6 Assigning Support steel cables to the extension

Step 5 Assigning Fixed Support to the bottom of the structure

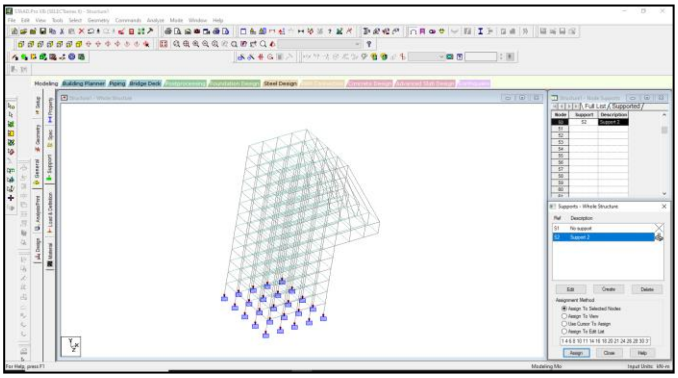


Fig 7 Assigning Fixed Support

Step 6 Assigning Loading condition dead load, live load and seismic load to the structure

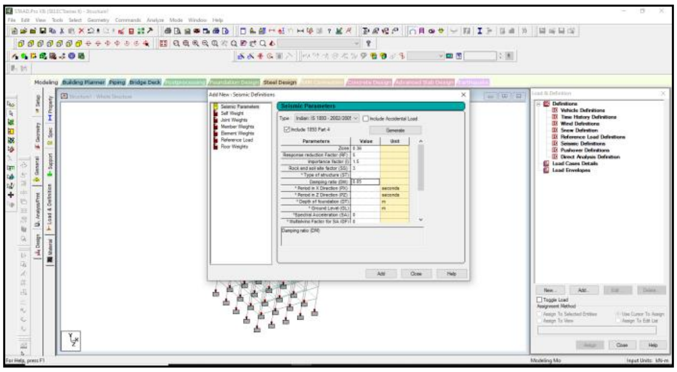
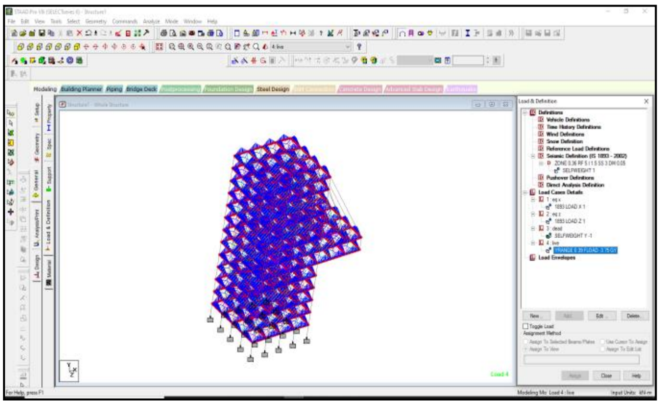
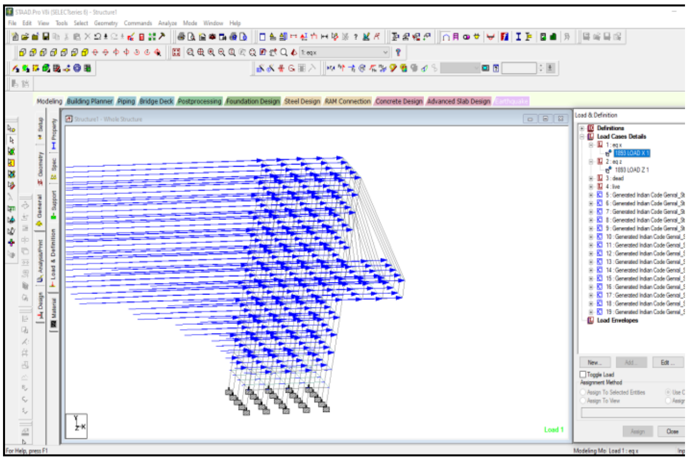


Fig 8 Assigning seismic load as per IS 1893- 2002

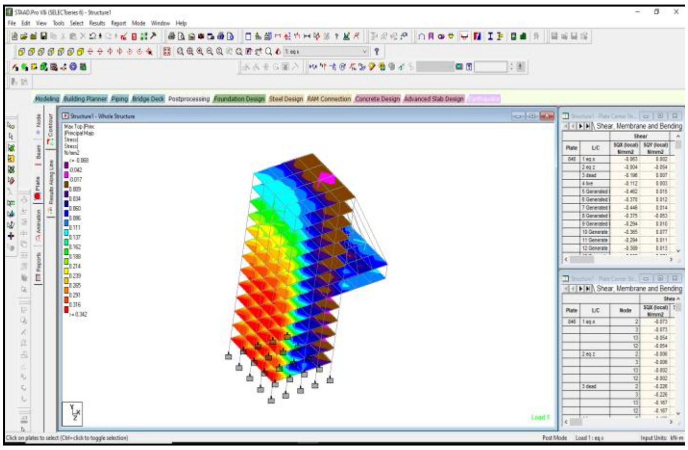
Step 7 the model is analyzed on parameters of different forces acting on the structure comparing all the three cases.



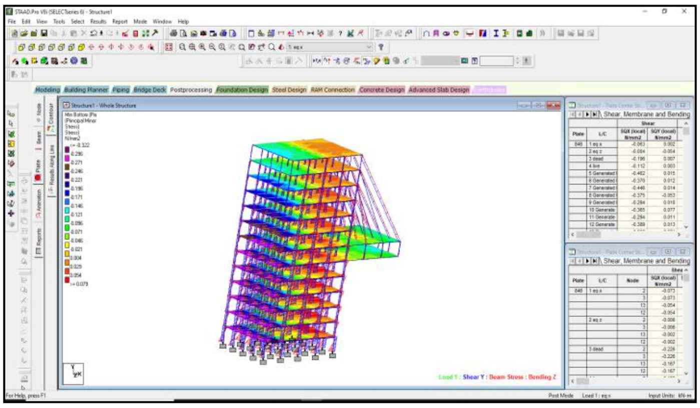
(A) Deflection



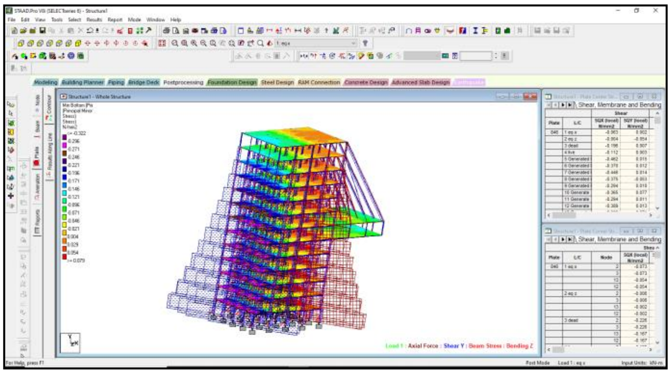
(B) Stress on Y Direction



(C) Stress analysis on every individual floor



(D) Stress Analysis –Bending Moment.



(E) Axial Force and stress analysis

Fig 9 Stress Analysis

Step 8 the results are tabulated on graphical representation using Microsoft excel.

Table 1 Parameters of Multi Storey Building

S. No	Specifications	Details
1	Type of Building	Multistorey RCC Structure with cables
2	Type of Frame	Special RC Moment Resisting Frame
3	Zones	V
4	Type of soil	Soft soil
5	Number of stories	G+12
	Spacing between frame in X direction	8m
	Spacing between	8m

	frame in Z direction	
6	Thickness of Slab	150mm
7	Floor to floor height	3m
8	Size of Column	750X750 mm
	Size of Beam	350X650 mm
	Thickness of wall	230mm
9	Materials	M30 and Fe 500
	Support	Fixed
10	Importance factor	1
11	Response Reduction Factor	5
12	Damping Percentage:	5%
13	Seismic analysis	Equivalent static load method as per IS: 1893 (Part 1):2002

ANALYSIS RESULTS:

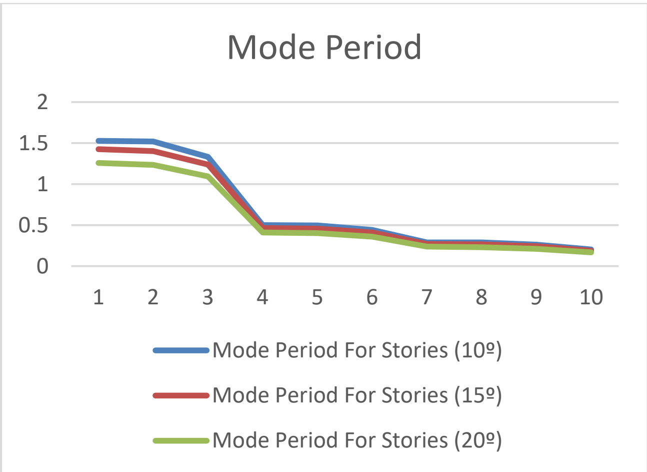


Fig 10 Mode Period

Fig 11 Base Shear

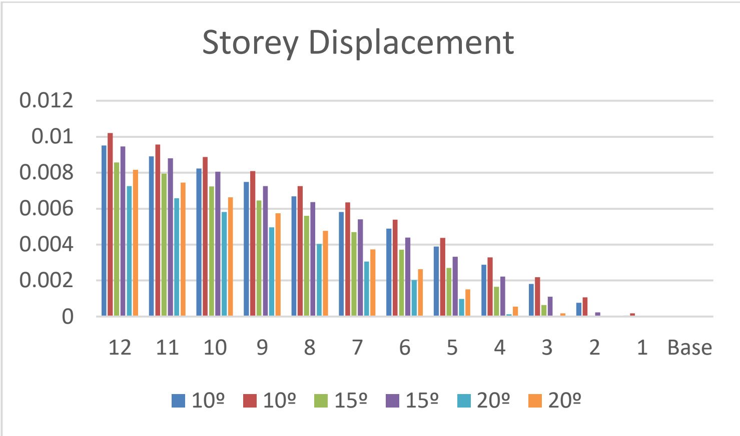


Fig 12 Storey Displacement

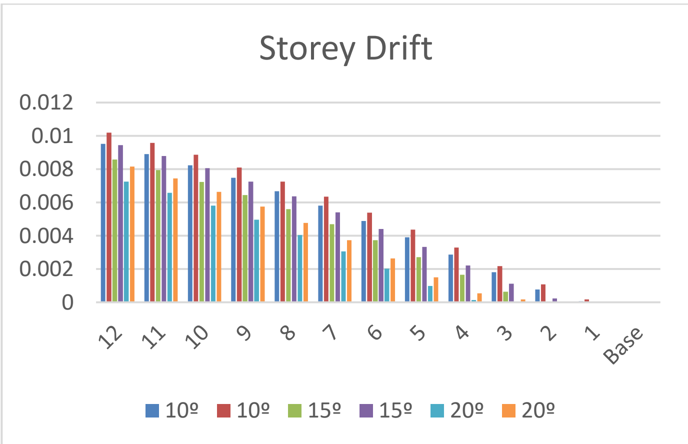


Fig 13 Storey Drift

IV. CONCLUSION

All the three buildings were analysed using STAAD.Pro v8i with the configuration as stated in chapter 3 considering three different slant degree with seismic loading condition.

1. The slants on the structure possess relatively more maximum displacement which may give to critical situations than the straight structure.
2. Mode shape for 15 storey takes maximum period at top storey as well as at bottom storey.
3. Base shear is maximum at 10º slant compared to other models.
4. Base shear is maximum in X- direction as compared to Y- direction for tilt structure.
5. Mode period decreases with increase in slant angle.
6. Storey displacement is maximum at 10º tilt at the structure
7. Displacement is maximum at top storey when compared with bottom storey in all other models along X- direction and Y-direction.
8. Storey drift is maximum at 10º slope for all models.

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