TO STUDY THE RESPONSE OF G+15 BUILDING IN ZONE –V FOR DIFFERENT SOIL CONDITIONS USING ETABS AND STAAD PRO

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Abstract: **This project mainly deals with the comparative analysis of a multi storey building structure (G+15) in Zone -Vfor different soil conditions using STAAD.Pro and ETABS software's separately. The main objective of this study is to compare building behavior in above mentioned software's to find the response of building in seismic zone –V under different soil conditions i.e hard, medium and soft.And to evaluate the performance using displacement, drift and base shearalong X and Y directions.**

Index Terms **– STAAD Pro, ETABS, Response Spectrum, Base Shear, Storey Drift, Storey Displacement.**

1. INTRODUCTION

Over the past few years, India's infrastructure system has grown up tremendously at the same time lots of research has been done in the field of construction. With prime importance of comfort and economy safety also plays major role in the design of any structure. Now a day's earthquake resistant design got main attention in design of any type of structure. Earthquake is the vibration of the surface of the Earth, resulting from the sudden release of energy in the Earth's lithosphere that creates seismic waves. Base shear, storey shear and base moment are considered.

In Beam Column System of buildings reinforced concrete frames are provided in both principal directions to resist vertical loads and the vertical loads are transmitted to vertical framing system i.e, columns and foundations. This type of system is effective in resisting both vertical & horizontal loads. The brick walls are to be regarded as filler walls only. This system is suitable for multi-storied building which is also effective in resisting horizontal loads due to earthquake.

In RC Structural wall system the lateral and gravity load-resisting system consists of reinforced concrete walls and reinforced concrete slabs. RC structural walls are the main vertical structural elements with a dual role of resisting both the gravity and lateral loads. Wall thickness varies from 140 mm to 500 mm, depending on the number of stories, building age, and thermal insulation requirements. In general, these walls are continuous throughout the building height; however, some walls are discontinued at the street front or basement level to allow for commercial or parking spaces. Usually the wall layout is symmetrical with respect to at least one axis of symmetry in the plan.

Earthquake shaking is random and time variant. But, most style codes represent the earthquake-induced inertia forces because the internal impact of such random shaking within the sort of style equivalent static lateral force. This force depends on the unstable hazard at the location of the building described by the unstable Zones. Instead, the earthquake demand is calculated by solely supported as of the chance of proof, and therefore the style of earthquake effects is termed as earthquake resistant style against the probable worth of the demand.

2. OBJECTIVES

The main objectives of this project are as follows:

1. To compare the behaviour of0buildings under seismicity.
2. To find the response of buildings in seismic zone V and under different soil zones.
3. To compare building behaviour in ETABS and in STAAD.PRO.
4. To evaluate the performance using displacement, drift and base shear.

3. LITERATURE REVIEW

Literature survey:

1. V. Ramanjaneyulu et.al, this project mainly deals with the comparative analysis of the results obtained from the design of a regular and a plan irregular (as per IS 1893) multi storey building structure when designed using STAAD.Pro and ETABS software separately. The principle objective of this project is the comparative study on design and analysis of multi-storeyed building (G+8) by STAAD.Pro and ETABS software. STAAD.Pro is one of the leading software for the design of structures. In this project they analyse the G+8 building for finding the shear forces, bending moments, deflections & reinforcement details for the structural components of building (such as Beams, columns & slabs). ETABS is also leading design software in present days used by many structural designers. Here they had also analysed the same structure using ETABS software for the design.

2. Prashanth. P et.al, STAAD.Pro and ETABS are the present day leading design softwares in the market. Many design companies use these softwares for their project design purposes. So, this project mainly deals with the comparative analysis of the results obtained from the design of a regular and a plan irregular (as per IS 1893) multi storey building structure when designed using STAAD.Pro and ETABS softwares separately. These results will also be compared with manual calculations of a sample beam and column of the same structure designed as per IS 456.

3. S .Vijaya Bhaskar Reddy et.al, Structural Analysis and design are predominant in finding out significant threats to integrity and stability of a structure. Multi storied structures, when designed, are made to fulfil basic aspects and serviceability. Since Robustness of structure depends on loads imposed, it requires attention. All the challenges faced by structural engineers were taken as opportunities to develop software's such as STAAD PRO, ETABS & SAFE, SAP etc, with ease of use.

Software such as ETABS and STAAD-pro are leading commercial software's worldwide for structural analysis. The design results using STAAD PRO and ETABS of a rectangular RCC building, for both regular and irregular plan configuration, are obtained and compared.

4. D. Ramya et.al, Structural Analysis is a branch which involves in the determination of behaviour of structures in order to predict the responses of real structures such as buildings, bridges, trusses etc. Under the improvement of expected loading & external environment during the service life of structure. The results of analysis are used to verify the structure fitness for use. Computer software's are also being used for the calculation of forces, bending moment, stress, strain & deformation or deflection for a complex structural system. The principle objective of this project is the comparative study on design and analysis of multi-storeyed building (G+10) by STAAD.Pro and ETABS software's STAAD.Pro is one of the leading softwares for the design of structures. In this project they had analysed the G+10 building for finding the shear forces, bending moments, deflections & reinforcement details for the structural components of building (such as Beams, columns & slabs) to develop the economic design. ETABS is also a leading design software in present days used by many structural designers. Here they had also analysed the same structure using ETABS software for the design. Finally we will made an attempt to define the economical section of G+10 multi-storeyed building using both STAAD.Pro and ETABS comparatively.

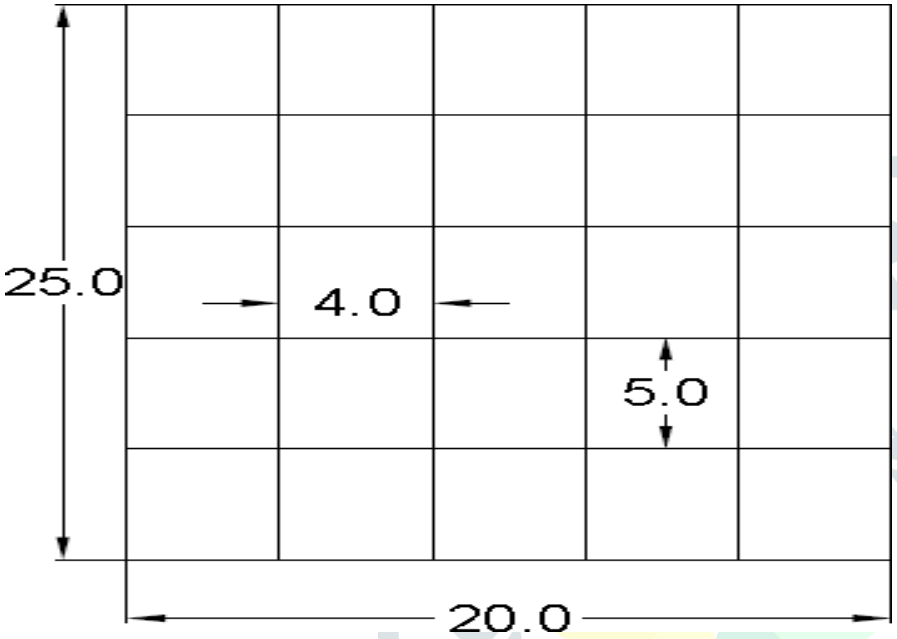
4. MODELLING AND ANALYSIS

4.1 ETABS [EXTENDED THREE DIMENSIONAL ANALYSIS OF BUILDING SYSTEMS]

ETABS is developed by an US based computers and structures Inc. Which improves the ability of the engineer to design and analyse a simplest to complex structure. ETABS is engineering software which is developed especially for building systems and is the most commonly used nowadays in the structural design companies due its ease in modelling and analysing the building structures. The software package consist of modelling tools and templates, code based load prescriptions, different methods of analysis and their solutions techniques, unique coordinate for this particular class of structure with grid like geometry.

4.2 STAAD.PRO

Staad is powerful design software licensed by Bentley. STAAD stands for Structural Analysis and Design any object which is stable under a given loading can be considered as structure. So first find the outline of the structure, whereas analysis is the estimation of what are the type of loads that acts on the beam and calculation of shear force and bending moment comes under analysis stage. Design phase is designing the type of materials and its dimensions to resist the load. This we do after the analysis. To calculate shear force diagram and bending moment diagram of a complex loading beam it takes about an hour. So when it comes into the building with several members it will take a week. Staad pro is a very powerful tool which does this job in just an hour. Staad is a best alternative for high rise buildings. Now a day's most of the high rise buildings are designed by Staad which makes a compulsion for a civil engineer to know about this software. This software can be used to design Reinforced Concrete Structure, steel Structure or bridge, truss etc. according to various country codes.



4.3 Response Spectrum Method

In this concept the multiple modes of vibration of a structure can be used. This analysis can be used in many building codes for all except for simple or complex structures. The vibration of a building is defined as the combination of many special modes that are in a vibrating string corresponding to the "harmonics". Computer aided structural analysis is used to determine these mode shapes for the structure. For every mode shape, from design spectrum responses are studied, with the help of parameters such as modal participation mass and modal frequency, and then they are combined to provide an evaluation of the total responses of the structure.

Building Details and Plan

- Number of stories = G+15
- C/C distance between columns in X-direction = 4m
- C/C distance between columns in Y-direction = 5m
- Foundation level to ground level = 3m
- Floor to floor height = 3m
- Live load on all floors = 3kN/m2
- Live Load on Roof = 1.5kN/m2
- Floor Finish = 1.5kN/m2
- Concrete = M25 and M30
- Steel = Fe415 and Fe500

- Size of column = 500X500mm
- Size of beam = 230x500mm
- Depth of slab = 150mm
- Seismic zone V = 0.36
- Soil Type = Soft, Medium and Hard

5. RESULTS AND DISCUSSION

This chapter deals with results and discussion of a G+15 storey building modelled both in ETABS and STAAD.PRO software, located in zone V and different soil conditions like soft, medium and hard

Discussions are made based on following parameters

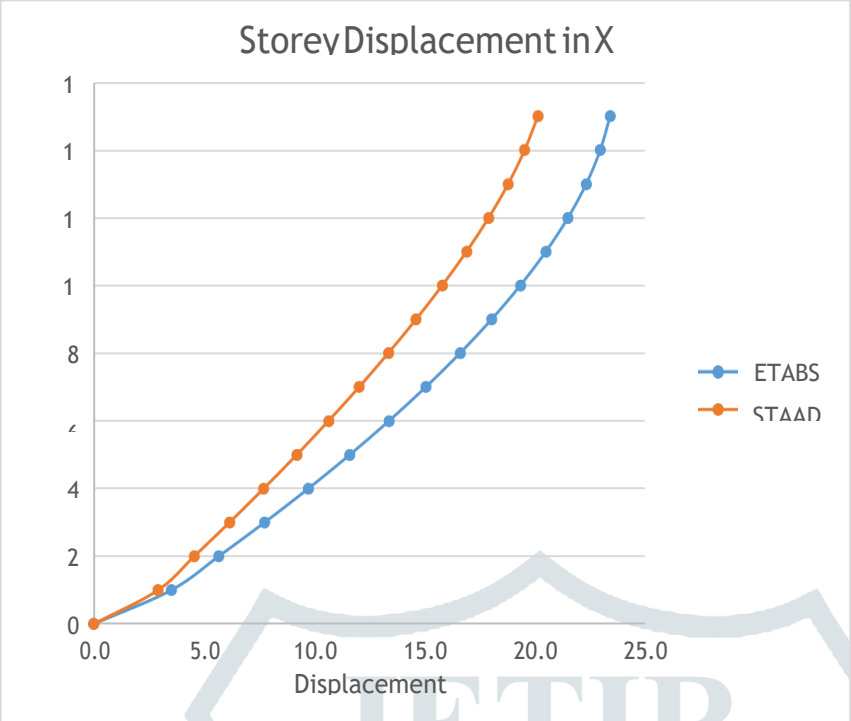
1. Storey Displacement
2. Storey drift
3. Base Shear

5.1Storey Displacement

The floor level versus displacement graph is been plotted for all six models in X and Y direction.

Table 5.1.1: Storey Displacement of Hard Soil in X Direction

Storey	ETABS	STAAD PRO
15	23.41	20.13
14	22.96	19.53
13	22.32	18.79
12	21.50	17.90
11	20.49	16.90
10	19.33	15.79
9	18.03	14.61
8	16.60	13.35
7	15.05	12.03
6	13.38	10.64
5	11.61	9.20
4	9.73	7.70
3	7.74	6.15
2	5.67	4.56
1	3.51	2.92
0	0.00	0.00



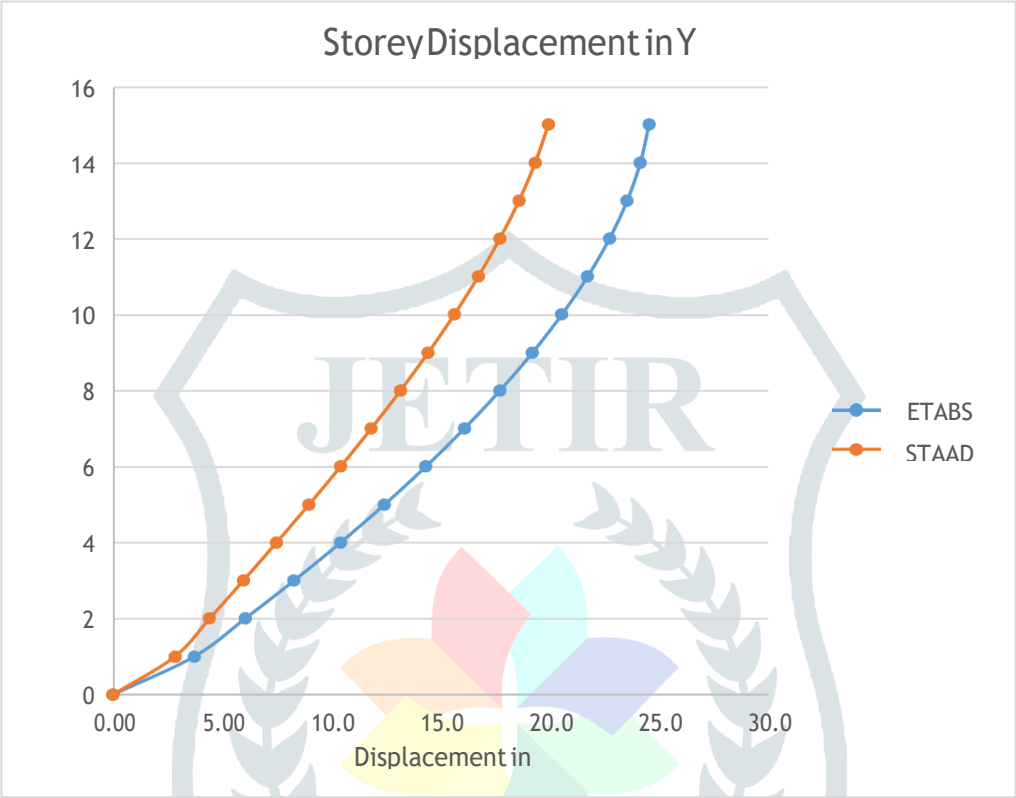
Graph 5.1.1: Storey Displacement of Hard Soil in X Direction

Storey Displacement is the total displacement of i^{th} storey with respect to ground, here it can be seen that the Storey displacement for the building model in ETABS has a higher displacement compared to the model in Staad Pro.

Table 5.1.2: Storey Displacement of Hard Soil in Y Direction

Storey	ETABS	STAAD PRO
15	24.50	19.90
14	24.10	19.30
13	23.50	18.55
12	22.69	17.68
11	21.69	16.69
10	20.51	15.59
9	19.17	14.40
8	17.69	13.14
7	16.06	11.80
6	14.30	10.40
5	12.41	8.95
4	10.40	7.47

3	8.27	5.95
2	6.04	4.41
1	3.71	2.83
0	0.00	0.00



Graph 5.1.2: Storey Displacement of Hard Soil in Y Direction

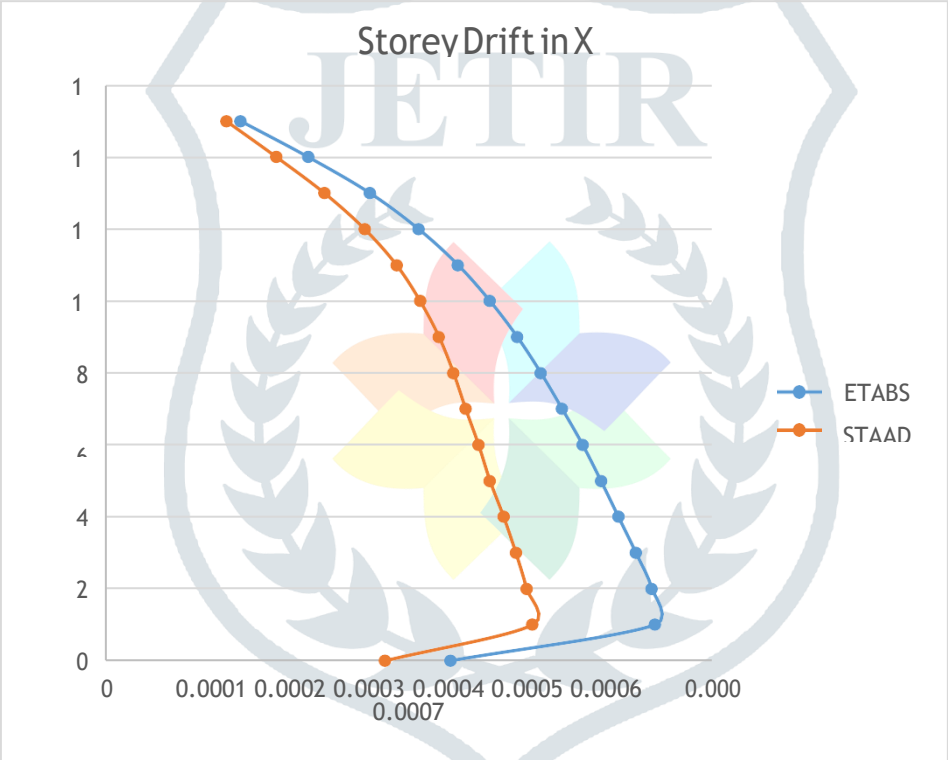
Here it can be seen that the Storey displacement for the building model in ETABS has a higher displacement compared to the model in Staad Pro.

5.2 Storey Drift

Table 5.2.1: Storey Drift of Hard Soil in X Direction

Storey	ETABS	STAAD PRO
15	0.000179	0.00016
14	0.000268	0.000226
13	0.000349	0.000289
12	0.000413	0.000342
11	0.000465	0.000384
10	0.000507	0.000415
9	0.000543	0.00044

8	0.000574	0.000459
7	0.000602	0.000475
6	0.000629	0.000492
5	0.000653	0.000507
4	0.000676	0.000525
3	0.000699	0.000541
2	0.00072	0.000555
1	0.000724	0.000563
0	0.000455	0.000369



Graph 5.2.1: Storey Drift of Hard Soil in X Direction

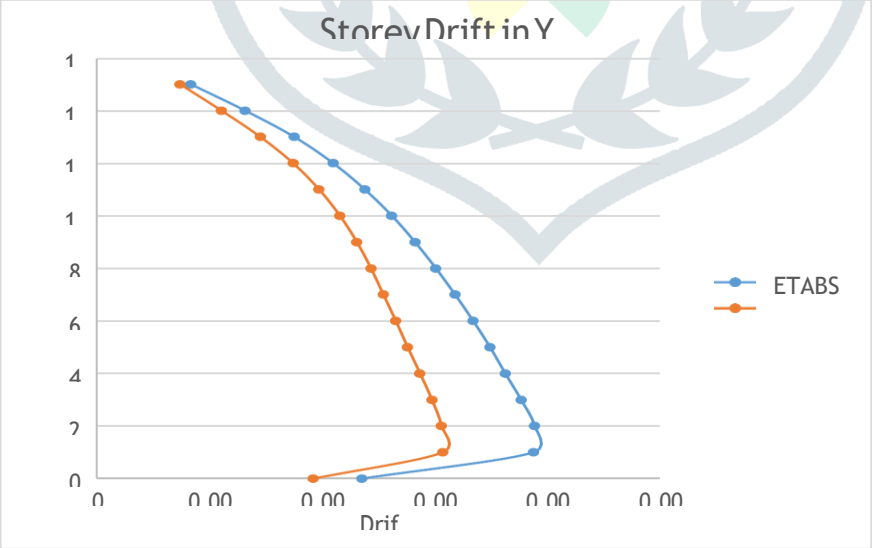
Storey Drift is defined as ratio of displacement of two consecutive floors to height of that floor. They must be so designed as to accommodate the storey drift, else they will crack, here it can be seen that the Storey drift for the building model in Staad Pro has lesser drift values compared to the model in ETABS.

Table 5.2.2: Storey Drift of Hard Soil in Y Direction

Storey	ETABS	STAAD PRO
15	0.000168	0.000149
14	0.000264	0.000222
13	0.000351	0.000291

12	0.00042	0.000349
11	0.000476	0.000395
10	0.000524	0.000432
9	0.000565	0.000462
8	0.000602	0.000487
7	0.000636	0.000509
6	0.000668	0.000531
5	0.000698	0.000552
4	0.000725	0.000574
3	0.000753	0.000595
2	0.000777	0.000612
1	0.000775	0.000614
0	0.000471	0.000385

Graph 5.2.2: Storey Drift of Hard Soil in Y Direction



Here it can be seen that the Storey drift for the building model in Staad Pro has lesser drift values compared to the model in ETABS.

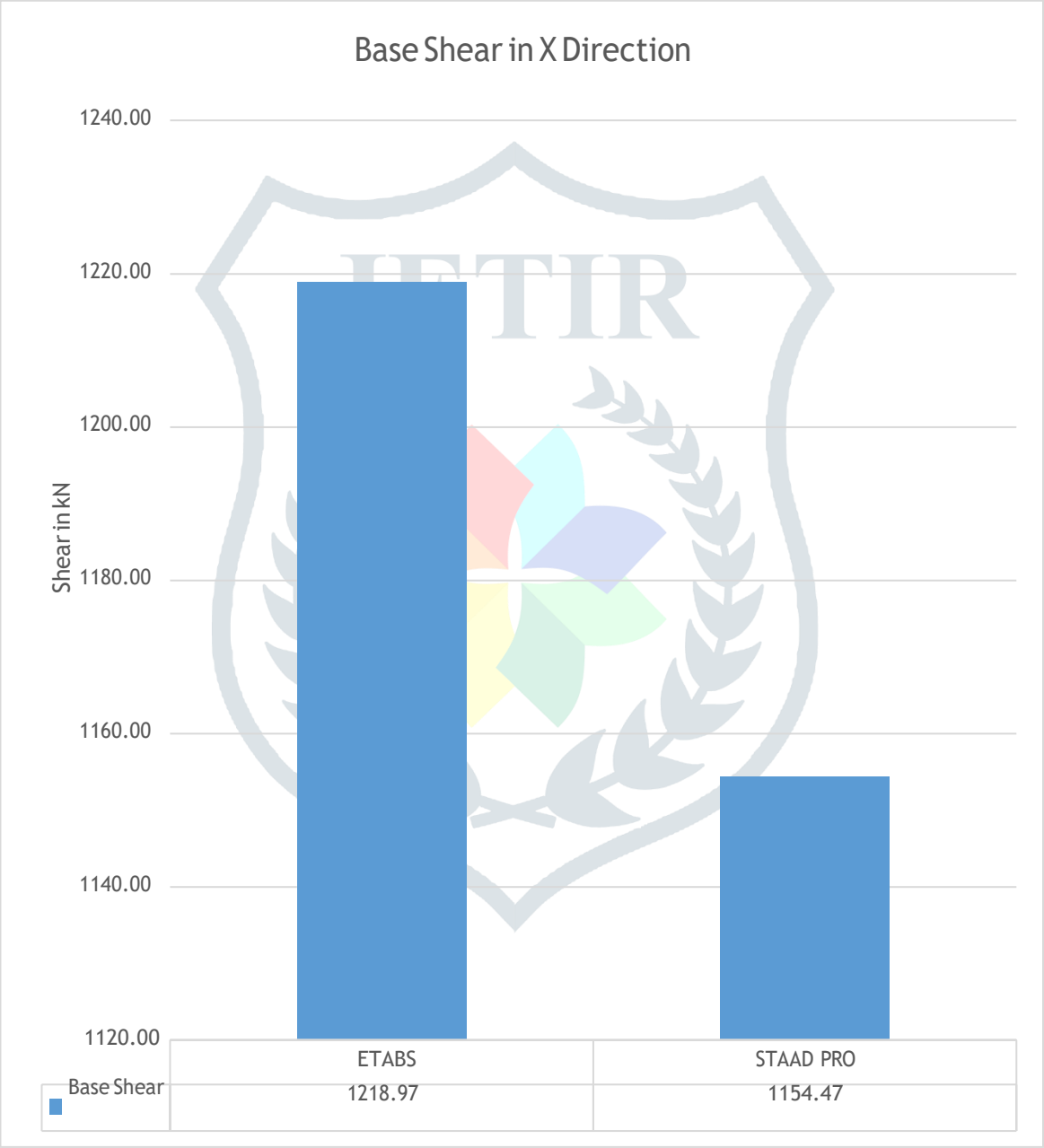
5.3 Base Shear

The Shear force at the base of the structure so obtained is been plotted for all six models in X and Y direction.

Table 5.3.1: Base Shear of Hard Soil in X Direction

	ETABS	STAAD PRO
Base Shear	1218.97	1154.47

Graph 5.3.1: Base Shear of Hard Soil in X Direction



6. CONCLUSION

In this project behaviour of the building in Hard, Medium and Soft soil beds is studied and their performance is noted. The modelling and analysis of the building in their respective soil strata is carried out in ETABS and StaadPro Software's. Response spectrum analysis is done in both the software and their corresponding behaviors and results are extracted and interpreted. Various parameters such as displacements, storey drifts and Base Shear have been grouped. Hence from the obtained results the following conclusions are made,

1. The storey displacement of the building model at hard strata has less displacement values than that of the building in medium strata it is comparatively less than the building model at soft strata.

2. The displacement values in the Etabs model is seen to be showing comparatively higher displacement vales than that of the models in the Staad Pro Software.
3. The storey drift of the building model at hard strata has less drift values than that of the building in medium strata it is comparatively less than the building model at soft strata.
4. The drift values in the Etabs model is seen to be showing comparatively higher drift vales than that of the models in the Staad Pro Software.
5. The base shear of the building model at hard strata has less base shear values than that of the building in medium strata it is comparatively less than the building model at soft strata.
6. The base shear values in the Etabs model is seen to be showing comparatively higher base shear values than that of the models in the Staad Pro Software.
7. It is to be noted that provide better results of the building model it is the Etabs with which modelling and analysis can be carried out quickly, were as in Staad Pro software results so obtained are comparatively less which result in lesser reinforcement required for the building.
8. The building model that is analysed with the hard strata give us the result with lesser values which indicates that building is more resistant to the lateral forces (earthquake force) and can withstand larger extent of force.
9. However, the building model that is analysed with the medium has comparatively stable values than that of the building at soft strata. In case of soft soil suitable foundations to checked for the SBC values before construction.

7. REFERENCES

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