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"ANALYSIS OF MULTISTOREYED STRUCTURE BY USING DESIGN SOFTWARES WITH CONSIDERATION OF LATERAL LOADS"

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ABSTRACT

Structural analysis comprises the set of physical laws and mathematics required to study and predicts the behaviour of structures. Basic investigation can be seen all the more uniquely as a technique to drive the building configuration process or demonstrate the sufficiency of a structure without a reliance on straightforwardly testing it.

To play out an exact investigation a basic specialist must decide such data as auxiliary burdens, geometry, bolster conditions, and materials properties. The after effects of such an investigation regularly incorporate help responses, stresses and removals. This data is then contrasted with criteria that show the states of disappointment. Progressed basic investigation may look at dynamic reaction, security and non-direct conduct. Right now are introducing near examination of four diversely heighted 3 dimensional structure outline considering seismic zone II utilizing three distinctive investigation instruments for example STAAD.PRO, SAP2000 and ETABS. In this paper we concluded that SAP2000 is suitable and providing linear results upto G+10 structure but as we raise the height above G+10 it is observed that ETABS is providing more precise result. Thus it is identified that ETABS is more linear for analysis of tall structures in comparison whereas STAAD.PRO shows values higher for same loading condition in comparison.

Key Words: *STAAD.PRO, SAP2000, ETABS, Structural analysis, forces, moment, displacement*.

I. INTRODUCTION

To play out a precise examination a basic specialist must decide such data as auxiliary burdens, geometry, bolster conditions, and materials properties. The after effects of such an examination commonly incorporate help responses, stresses and relocations. This data is then contrasted with criteria that demonstrate the states of disappointment. Progressed basic examination may look at dynamic reaction, steadiness and non-direct conduct.

The structural analysis is the confirmation of the effects of weights on physical structures and their portions. Structures subject to this sort of assessment fuse all that must withstand loads, for instance, structures, ranges, vehicles, furniture, dress, soil strata, prostheses and common tissue. Helper examination uses the fields of associated mechanics, materials science and associated math to process a structure's damages, inward forces, stresses, reinforce reactions, expanding rates, and adequacy. The results of the examination are used to affirm a structure's preparation for use, habitually blocking physical tests. The helper examination is, therefore, a key bit of the structure plan of structures.

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STAAD.PRO, SAP2000 and ETABS are three design software's to design and analyse any kind of structure in static and dynamic approach. Anyway these products will give distinctive plan and logical outcomes for the equivalent auxiliary arrangements, this is because of their diverse diagnostic component and the manner in which they do investigate the structure. In the event of investigation and plan of structures with geometrical inconsistencies there is substantially more need to contrast configuration after effects of various programming's with get sheltered just as conservative structures.

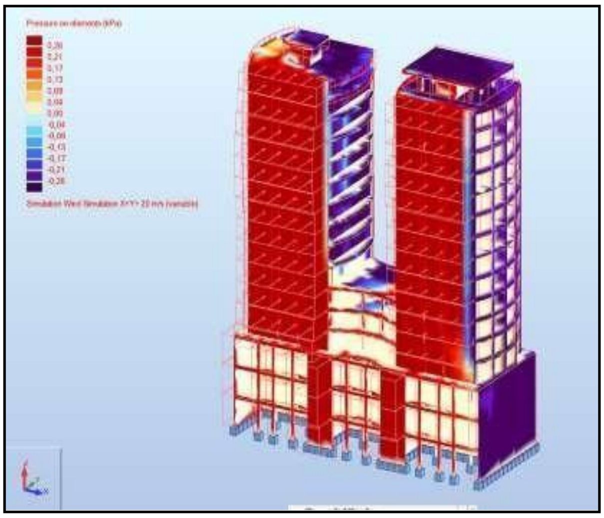

Fig. 1: Structure analysis

1.1 Aim of the Study:

The aim of this study is to determine the most suitable and approximate software to generate structural analysis result. This can help the designer to have an authentic base to select analysis tool between STAAD and ETABS before performing analysis.

1.2 Objectives of the study:

1) To carry out modeling and analysis of G+5, 10, 15 and 20 storey R.C. framed structures using STAAD-PRO, SAP2000 & ETABS
2) To Design a regular and plan irregular multistorey structure as per IS-456 & IS-1893:2016
3) To find out shear forces, bending moments and reinforcement details for the structural components of the building (beams and Columns) and compare the results.
4) To compare results of ETABS, SAP2000 and STAAD- PRO
5) To observe which software gives more accurate results.

II. LITERATURE REVIEW

Richa Agarwal et. al. (2017) [Comparison of Design Result of Multi Story Structure using ETABS and STAAD PRO Software] here the author depicted a relative plan from 5 story, 10 story, 15 story structure with different earthquake zones II, III, IV, V (as per IS code 1893 and 456-2000) of building using STAAD PRO and ETABS separately. Correlation of both programming STAAD PRO and ETABS, the plan result acquire gave the lesser region of required steel when contrasted with STAAD PRO for the bar configuration result. Correspondingly the segment configuration result likewise region of required is lesser in STAAD PRO programming as a contrast with ETABS. Subsequently, the last achieve ETABS gave a lesser territory of steel when contrasted with STAAD PRO in the two cases.

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Lelisa Nemo Nura and Jay Prakash Pandit (2019) the research paper stated that both SAP2000 and STAAD.PRO are efficient structural software. Both have helped revolutionize the system of analysis and design of structures. They have played a great role in eradicating the very tedious analysis and design procedure by hand, with very high precision as well. The purpose of this thesis is not to draw a general conclusion of which software is better than which, but a suggestion according to a predefined criteria as to when a user shall use either of the software. From the criteria set to evaluate the software a clear picture can be drawn for what purpose certain software shall be used. The main difference in the application of the software can be noticed from the past chapters as; SAP2000 doesn't have a feature for designing continuum structural elements such as slabs, shells, and shear wall. The exclusion of such important feature in SAP2000 is probably a market strategy of CSI (producer of SAP2000) as to make users buy other CSI products which specialize in those areas such as SAFE. Through long years of experience on the market, both software packages have integrated user comments in order to polish the software functionality to a better precision and applicability. Thus precision of results for simpler structures was quite similar in case of both software.

S .Vijaya Bhaskar Reddy and V.Madhu (2018) the research paper presented the detailed analysis analysis on simulation tools ETABS and STAAD PRO, which have been used for analysis and design of rectangular Plan with vertical regular and rectangular Plan with Vertical geometrically irregular multi-storey building. This study was focused on bringing out advantages of using ETABS over current practices of STAAD PRO versions to light. It was observed that ETABS was more user friendly, accurate, compatible for analysing design.

Results stated that Max reaction produced was 4572.12kN in ETABS and 4624.92kN in STAADPro due to load 1.5(Self +Dead +Live). The maximum displacement was along x- direction and its value was 106.25mm (in STAADPro.) for irregular building and 53.47mm (in ETABS) along z-direction for regular building. So, more precise results was generated by ETABS which leads to economical design of the building. The storey overturning moment decreases with increase in storey height along x- direction for EQ length load and they was more in regular building than the irregular building. The ETABS gave lesser area of steel reinforcement for irregular building as compared to regular building in case of beams and columns.

Mahmad saber and D. Gouse Peera et. al. (2015) the research paper presented a detailed description for analysis and designing of structuring using various applications STAAD.PRO and ETABS. The analysis of a rectangular plan with vertical regular and rectangular Plan with Vertical geometrically irregular multi-story building was done using static analysis method.

The conclusion stated that presentation of results from STAAD Pro and ETABS was quite different making it difficult for observations on the case of assigning loading parameters and design. ETABS gave lesser area of required steel as compared to STAAD PRO while designing beams. Similarly the column section required area of the steel similar both software's but in these case are considered in percentage 0.3% TO 0.5%. Form the design results of column; since the required steel for the column forces trendy this certain problem was less than the minimum steel limit of column (i.e., 0.85%), the amount of steel calculated by both the software's was equal. Therefore, comparison of results for this case is not possible.

III. METHODOLOGY

In this comparative study we are considering 12 cases utilizing three different analysis tool i.e. STAAD.PRO, SAP2000 and ETABS. Four different storey height is considered G+5, G+10, G+15 & G+20.

1) Step-1: Plan selected for the study is of dimension 20 x 25 m.

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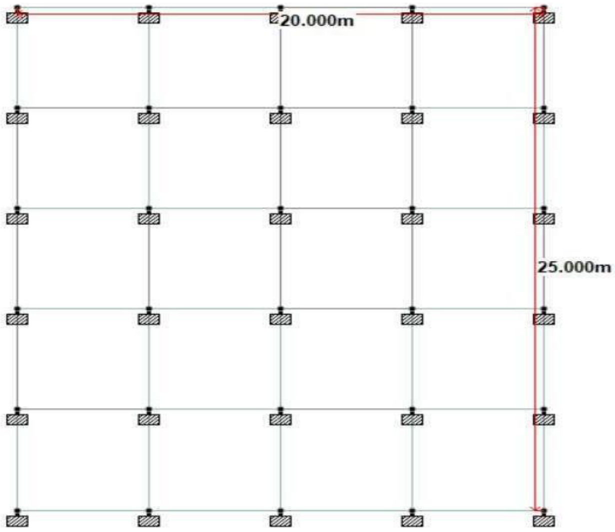

Fig. 2: Plan of geometry selected

2) Step-2: To assign sectional data and properties.
3) Step-3: Assign fixed end Condition.
4) Step-4: Assign seismic loading condition and loadcombinations.
5) Step-5: Perform Analysis to generate result sheets.
6) Step-6: Preparing Comparative Analysis results in M.S.excel.
7) Step-7: Providing conclusion as per results.

3.1 Flow Chart

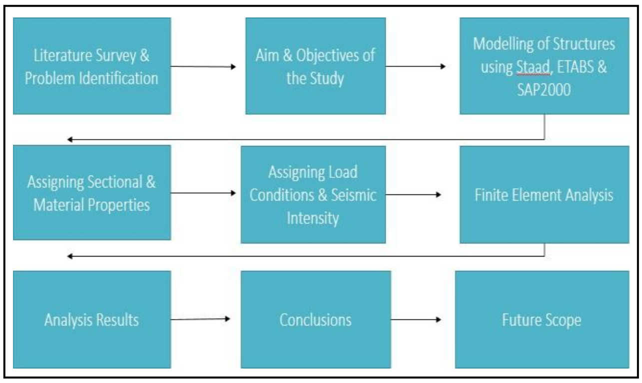

Fig. 3: Flow chart of the study

3.2 Load Calculation

Dead Load (As per I.S. 875-1):
Self-Weight: Assigned in Y Axis in downward direction.
Wall Load: Thickness x height x Density (Unit weight of the material)
Wall Load= 0.23m x 2.7m x 20kN/m^3 = 12.42 KN/m
Parapet Load: Thickness x 1m x Density (Unit weight of the material)
0.23m x 1m x 20 kN/m^3 = 4.6 KN/m
Slab Load: 0.125m x 25KN/m3 = 3.125 KN/m2 Live Load (As per I.S. 875-2):
Floor Load: Considering 5 KN/m2 as given in I.S. 875-2 for commercial buildings.
Seismic Load (As per I.S. 1893-I: 2016)
Vb = Ah x Weight of Building
Vb – base shear, Ah- Horizontal Seismic Coefficient.

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Table 1: Seismic description

Factor	Condition	Remark
Z Zone	II (Bhopal Region)	As per I.S. 1893-I:2016 Table -2
I Impotance Factor	1.5 Important Structure	Table 6
R Response Reduction	5 (S.M.R.F.)	Table 7
Soil	Medium Soil	As per CBR value <3
Damping Ratio	0.5	Damping effect

IV. RESULTS AND DISCUSSION

Case-1: G+5

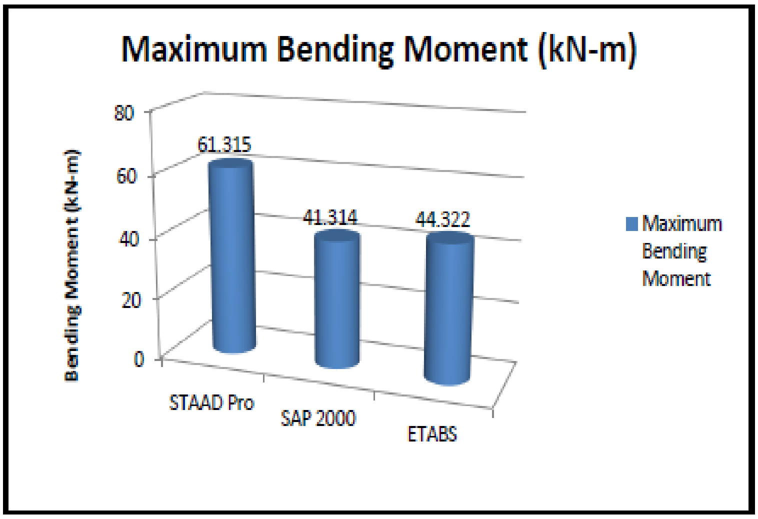

Figure 4.1: Max. Bending Moment (kN-m) for G+5 height

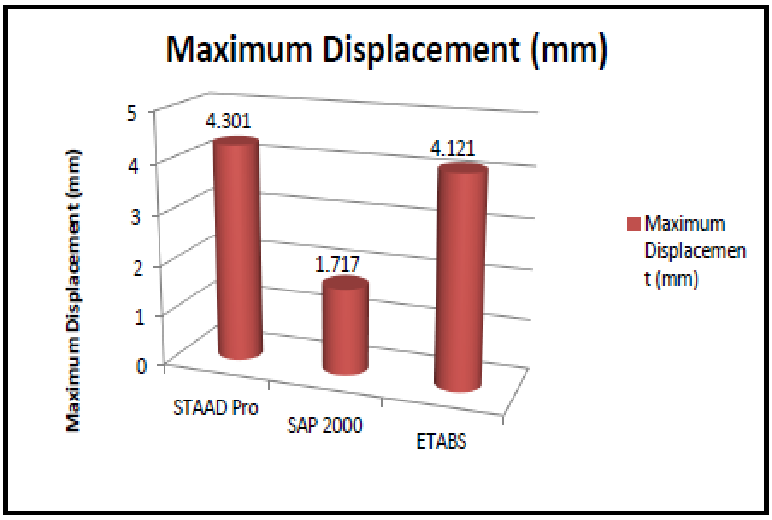

Figure 4.2: Max. Displacement (mm) for G+5 height

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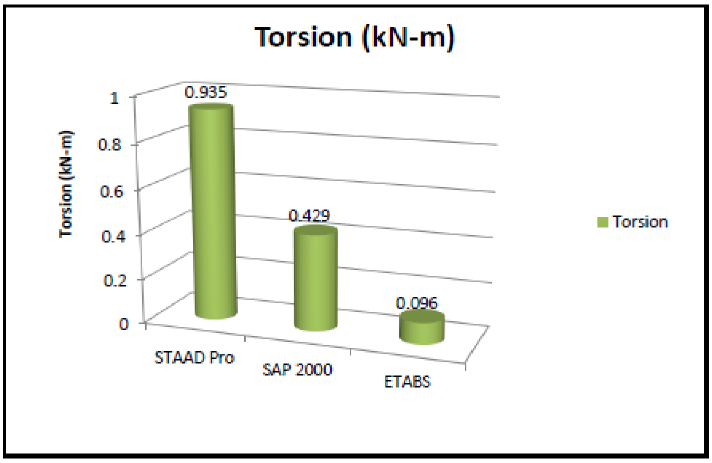

Figure 4.3: Torsion (kN-m) for G+5 height

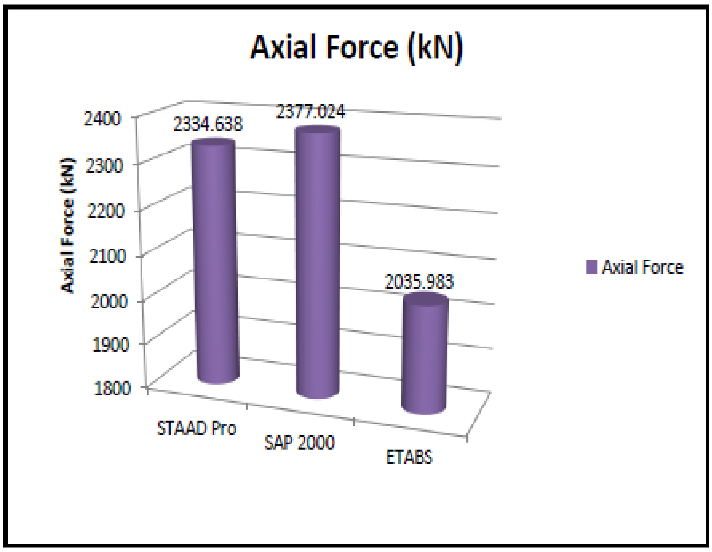

Figure 4.4: Axial Force (kN) for G+5 height

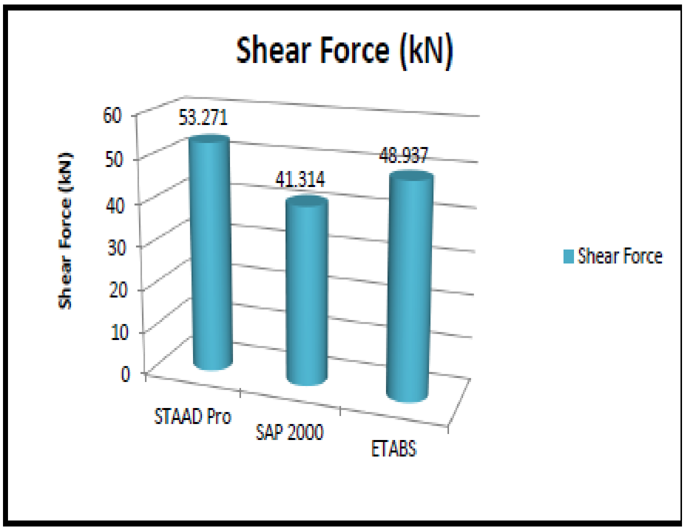

Figure 4.5: Shear Force (kN) for G+5 height

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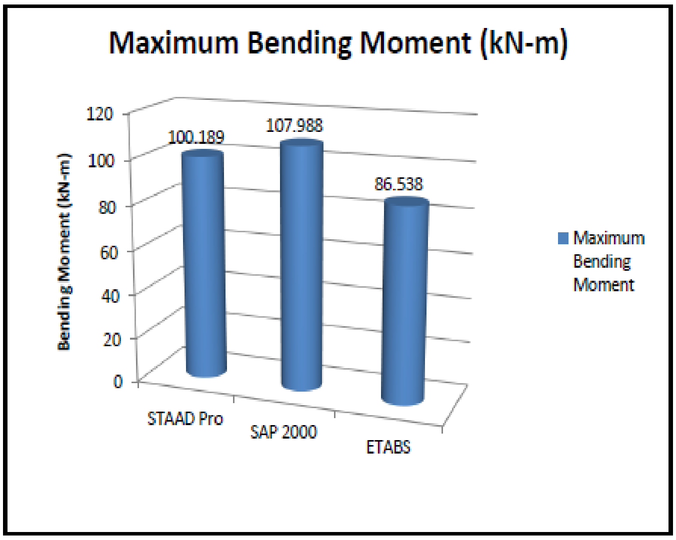

Figure 4.6: Max. Bending Moment (kN-m) for G+10 height

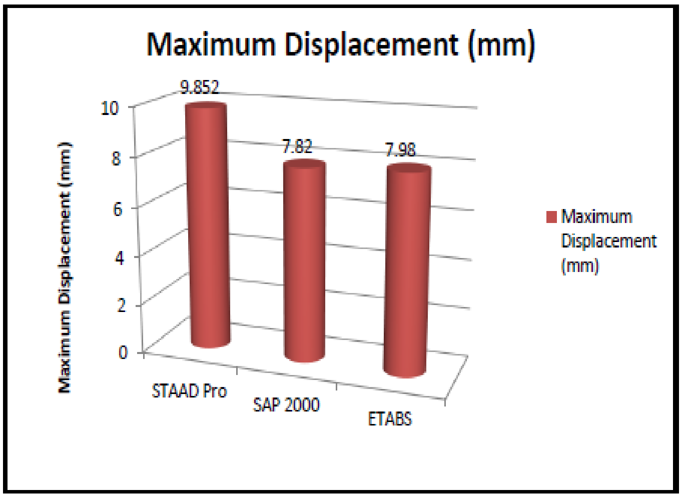

Figure 4.7: Max. Displacement (mm) for G+10 height

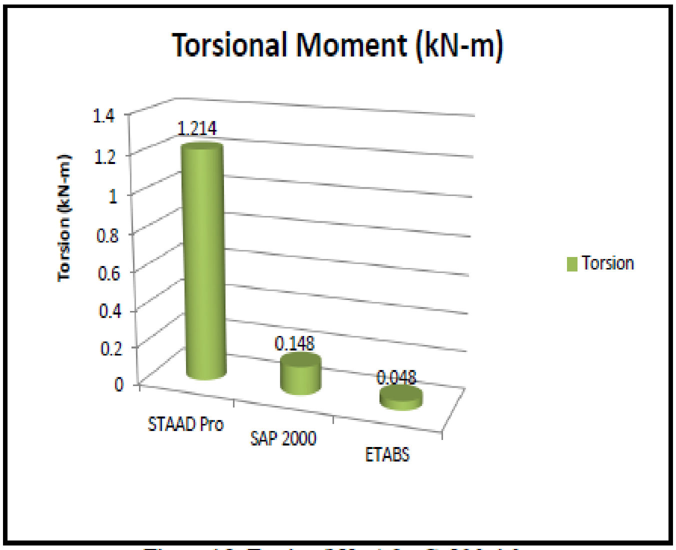

Figure 4.8: Torsion (kN-m) for G+10 height

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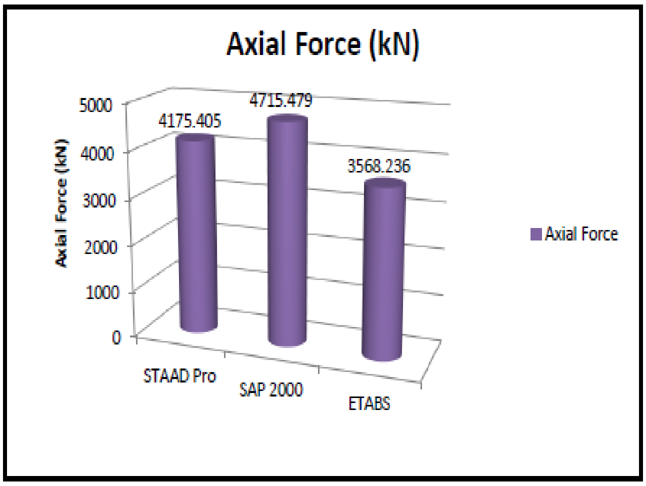

Figure 4.9: Axial Force (kN) for G+10 height

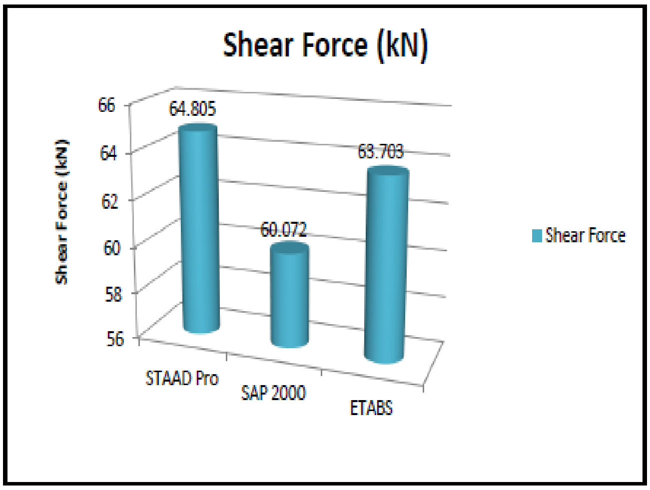

Figure 4.10: Shear Force (kN) for G+10 height

Case-3: G+15

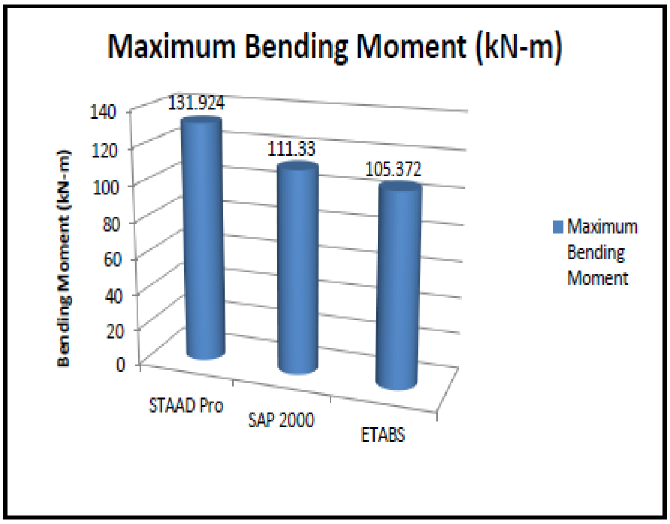

Figure 4.11: Max. Bending Moment (kN-m) for G+15 height

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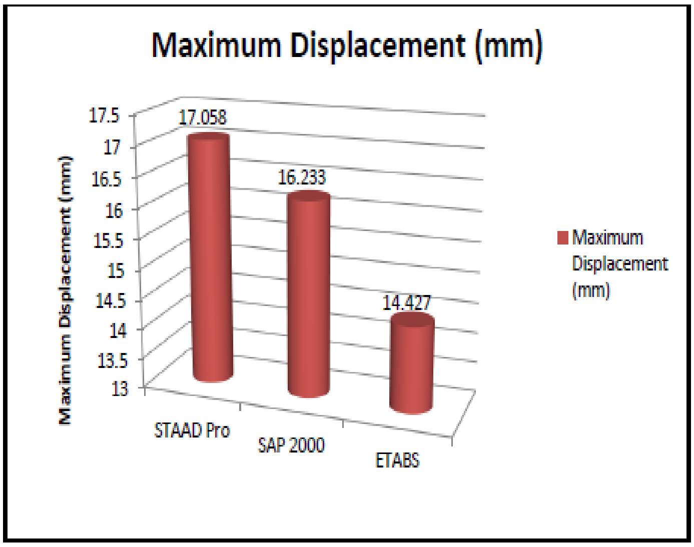

Figure 4.12: Max. Displacement (mm) for G+15 height

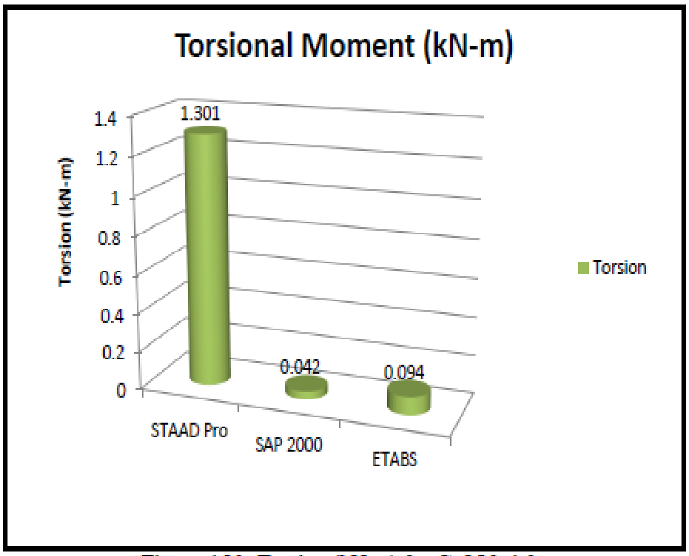

Figure 4.13: Torsion (kN-m) for G+15 height

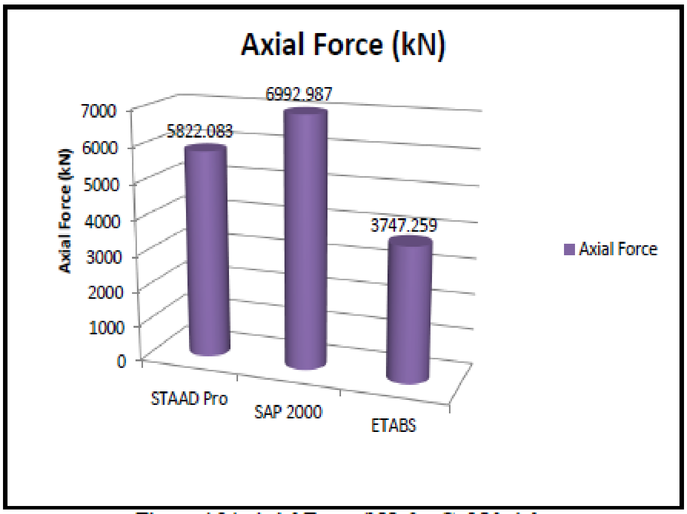

Figure 4.14: Axial Force (kN) for G+15 height

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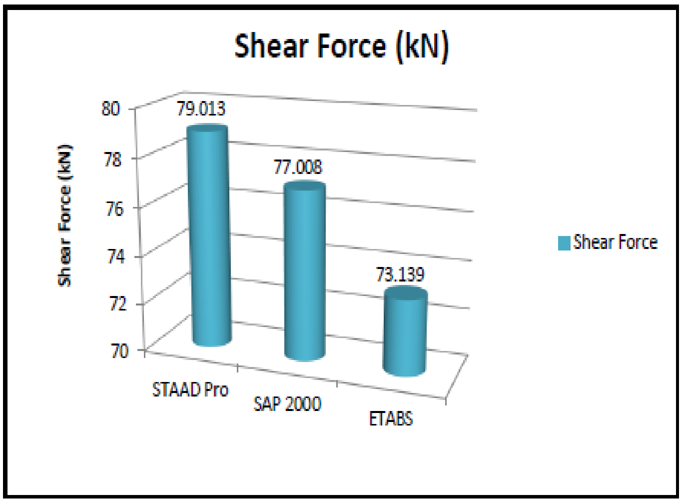

Figure 4.15: Shear Force (kN) for G+15 height

Case-4: G+20

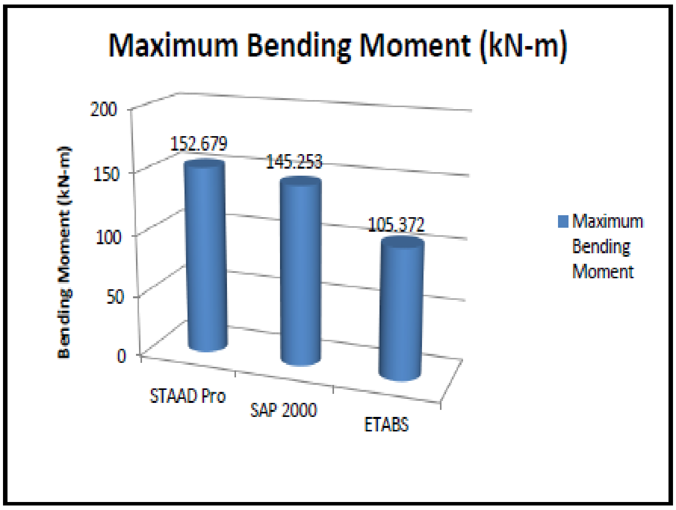

Figure 4.16: Max. Bending Moment (kN-m) for G+20 height

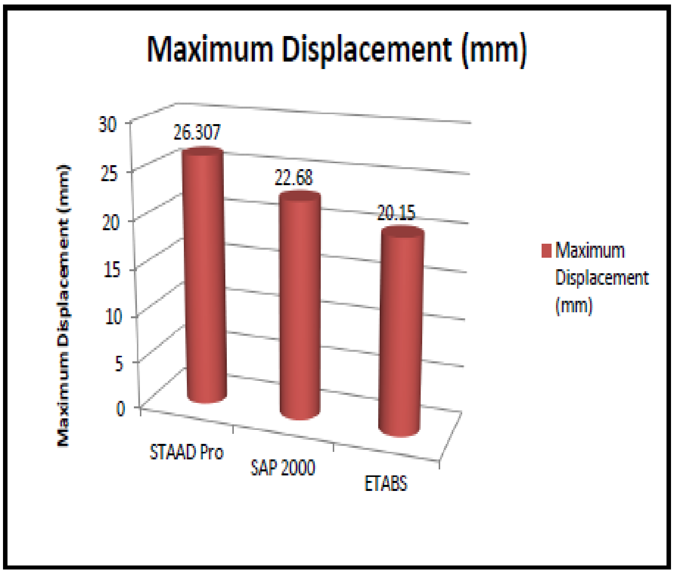

Figure 4.17: Max. Displacement (mm) for G+20 height

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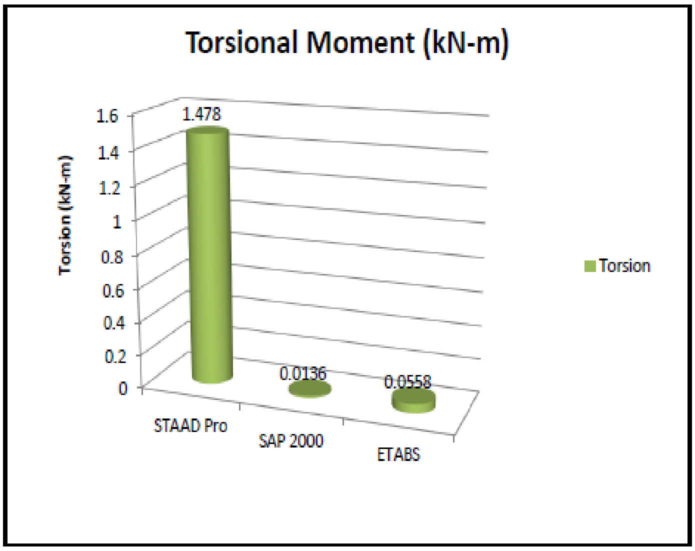

Figure 4.18: Torsion (kN-m) for G+20 height

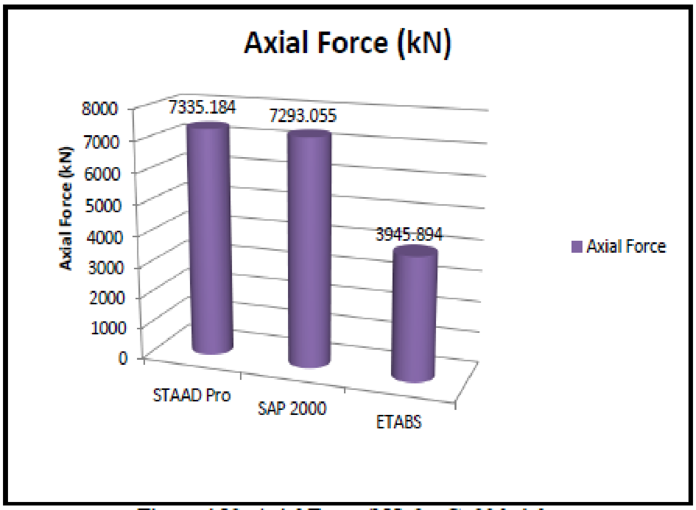

Figure 4.19: Axial Force (kN) for G+20 height

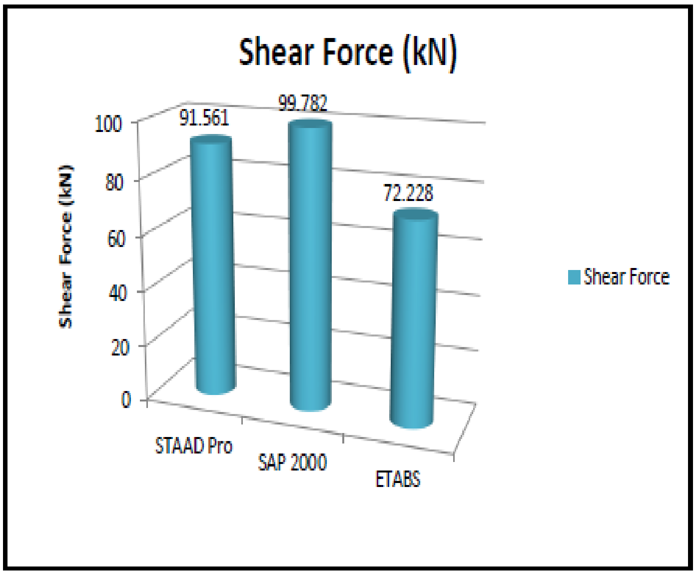

Figure 4.20: Shear Force (kN) for G+20 height

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V. Conclusion

In this study we are comparing analysis result of three different analysis tools i.e. STAAD.PRO, ETABS and SAP2000. Here for comparative analysis we have compared G+5, G+10, G+15 and G+20 storey structure considering Seismic zone II and medium soil condition.
In this study following outcomes has been observed as follows:

A. G+5 Storey

In terms of bending moment we observed a variation of 32.62 %, where STAAD value is 61.315 Kn-m, ETABS value 44.322 kN-m and SAP2000 value is 41.314 kN-m.
In terms of Forces minute variation in analysis output of all the three softwares with value STAAD 53.271kN, ETABS 48.937KN and SAP2000 41.314 KN.
In terms of deflection we observed almost similar value in STAAD and ETABS output whereas in sap2000 deflection observed is less in comparison.

B. G+10 Storey

In terms of bending moment we observed a variation of 19.86 %, where STAAD value is 100.189 KN-m, ETABS value 86.537 kN-m and SAP2000 value is 107.988 kN-m.
In terms of Forces variation in analysis output of all the three softwares with value STAAD 64.805 kN, ETABS 63.707 KN and SAP2000 60.072 KN.
In terms of deflection we observed almost similar value in STAAD and ETABS output whereas in sap2000 deflection observed is less in comparison.

C. G+15 Storey

In terms of bending moment we observed a variation of 20.12 % where STAAD value is 131.924 KN-m, ETABS value 105.372 kN-m and SAP2000 value is 111.33 kN-m.
In terms of Forces minute variation in analysis output of all the three softwares with value STAAD 79.013 kN, ETABS 73.138 KN and SAP2000 77.008 KN.
In terms of deflection we observed almost similar value in STAAD and ETABS output whereas in ETABS (14.427 mm) deflection observed is less in comparison.

D. G+20 Storey

In terms of bending moment we observed a variation of 32.40 %, where STAAD value is 152.679 KN-m, ETABS value 103.208 kN-m and SAP2000 value is 145.253 kN-m.
In terms of Forces variation in analysis output of all the three softwares with value STAAD 91.561 kN, ETABS 72.228 KN and SAP2000 99.782 KN.
In terms of deflection we observed almost similar value in STAAD and ETABS output whereas in ETABS (20.15 mm) deflection observed is less in comparison.

5.1 Future Scope

In this study seismic analysis is considered whereas in future wind pressure can be considered. In this study Indian standard provisions are considered whereas in future same can be done with Europian, American or british codal provision. In this study G+20 Tall structure is considered whereas in future more tall structure can be consider for analysis.

In this study STAAD.PRO, ETABS and SAP2000 is considered for analysis whereas in future tekla and mid as can be consider.

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