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Structural Behavior of Steel Structures on the Basis of Computer Simulation Software

Jitendra Choubisa
Jitendra Choubisa, Techno India NJR Institute of Technology, Udaipur 313001, India. Email ID: jitendra.choubisa@technonjr.org

Abstract: ***Creating a world class infrastructure that stands aesthetic and performs well structurally is not that easy. As an engineer one must have to keep in mind the applications and structural needs of a building. Talking of structures, RCC structures are quite common to work out with and on the other hand steel structures gives good weight per unit length. Steel structures are also easy to construct and helps in reducing project time. In this paper we have discussed about how structurally a model behaves in regards to its comparison among two computer simulating software viz., etabs and staad pro. Staad pro is there for long in the field of simulation and etabs is easy to workout with the interactive design and functions. We have compared here mainly three types of structures made entirely of steel sections. A Howe roof truss, a Howe bridge truss and a transmission tower. All of them were modeled in both etabs and staad pro and the results were matched. Both the software showed quite same base reaction, bending moment and shear forces. But Etabs shows slightly less bending moment, shear forces & Base reaction with more precision in the respective members as compared to StaadPro. And on the other hand etabs also shows which members is stressed or utilized fully upto its strength, by which one can use an optimized way of designing a structures.***
Keywords: StaadPro, Etabs, Tower, Truss, Howe, Simulation.

I. INTRODUCTION

Infrastructural development helps in increasing and maintaining the economy of a country and structures constructed for transportation, tele communication comes in this category. To speed up the design process and to get design results quick, we take help of software's such as etabs and staad pro. Here in this research work several steel structures are drawn, analysed and designed. The results were then compared for both etabs and staad pro. [12] All the designing were done keeping in mind the Indian standard steel code IS 800:2007 [1]. The loading considered here is only DEAD loads, because mobile towers and members like truss in our case occasionally acted upon by Live loads. As in etabs a dead load multiplier is added in start to consider the dead loads of structures and in staad pro we have added the self-weight i.e., dead load in the load settings. The geometry of structure are kept simplest [7] as we are doing a comparison between two platforms. The geometry is kept same in both the software. The geometries was selected by keeping in mind that the structures are widely used in industries and also stress distribution is simplest in this kind of structures.

A. Size and dimensions of structure

Table 1. Size and dimensions [2]

Structure	Etabs	StaadPro
TOWER	8 m x 8 m at base and 0.5 m x 0.5 m at top	
TRUSS	8.33 m Longitudinal and 10 m transverse	
HOWE TRUSS	Width of 14 m and length of 20 m with 5 bays of 4 m each	

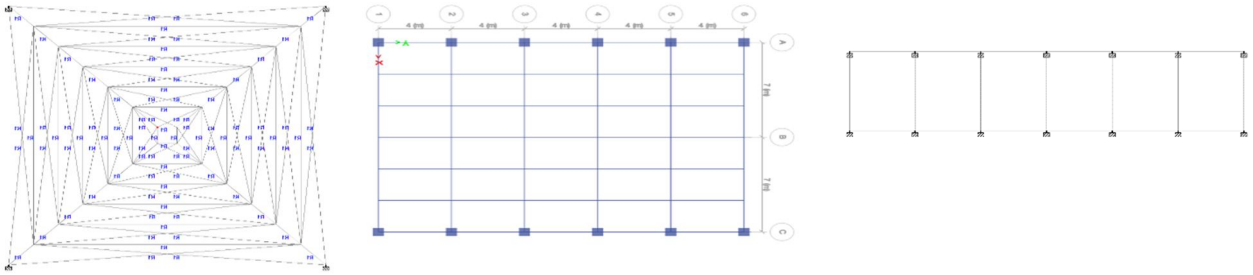


Fig.1 (a) Plan of Tower, (b) Plan of Truss & (c) Plan of Howe Truss

B. Loading Consideration: [3]

1) Loading

Table 2. Dead Load Considerations

Etabs	StaadPro
Dead Load	Dead Load
Self-Weight (By dead Load Multiplier)	Self-Weight (In setting)

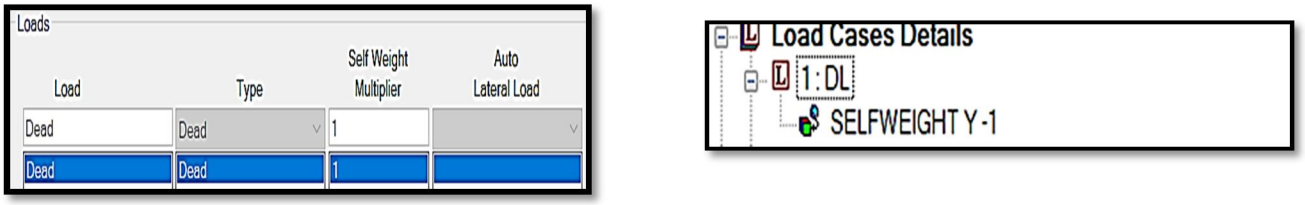


Fig.2 (a) Dead Load in etabs (b) Dead load in Staad Pro

2) Members: [2]

Table 3. Member Sizes

Structure	Etabs	StaadPro
TOWER	All elements ISA 200 X 200 X 25 mm	
TRUSS	Truss elements ISA 100 X 100 X 10 mm & Column 2 feet X 2 feet	
HOWE TRUSS	All elements ISA 100 X 100 X 12 mm	

3) Material

All material has been taken as FE 500 Grade.

4) Elevation of Building

Table 4. Elevations of Structure

Structure	**Height**
TOWER	50 m
TRUSS	10 m
HOWE TRUSS	7.5

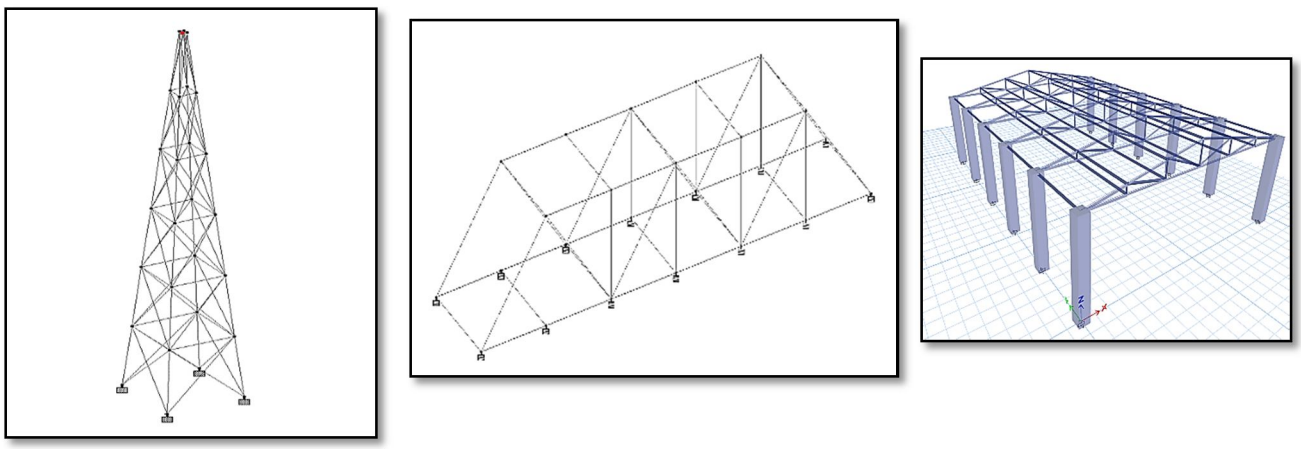


Fig.3 (a) Elevations of Tower, Truss and Howe Truss

II. LITERATURE REVIEW

1) Richa Agarwal, Prof. Archna Tiwari [4] has worked on the simulation of multistory building y using etabs and staad pro both and have compared the results graphically and numerically both. This Paper concluded that steel provided by etabs in mush lesser than StaadPro.
2) Mahmad sabeer, D. Gouse Peera [5] in their paper have studied the design results of RCC building and have concluded that area of steel reinforcement given by beam in etabs is much lesser than Staad Pro, but in StaadPro area of reinforcement is same for both etabs and StaadPro.
3) Prashanth, Anshuman, Pandey.R.K, Arpan Herbert [6] in their paper have compared a 11-story RCC building modelled in both the software's and have concluded that etabs gives lesser area of reinforcement and for columns both gives almost same area of reinforcement.
4) V. Ramanjaneyulu, Dharmesh. M, V. Chiranjeevi [7] has worked on a similar type of topic in their paper. They have modelled a multistory RCC building with different plan section (regular and irregular shapes), and they conclude that StaadPro is suitable is upto G+8 tall building only and etabs gave higher steel as compared to StaadPro.
5) Shilpa Chouhan, Rohit Sharma, Abhishek Gupta [8] in their paper has worked on steel section modelling in StaadPro and etabs both. Their main purpose was to provide a way of structural optimization and they concluded that as span increases requirement of strength of beam and angles increases in etabs as compared to StaadPro or we can say etabs requires more strength members to show desired result in comparison to StaadPro. In the study it dealed with much time bound to choose design and geometry and most effective and economical truss type. The main aim was to compare structure among staad pro and etabs in accordance with strength parameters. The software used by them were StaadPro and ETABS. The steel truss with different spans were analysed like 7m, 10m, 12m etc. The designed steel truss structures are analysed for increasing structural efficiency with different configurations.
6) Mohd Azaz, Abhay Walke, Mohd. Samir Ansari, Ashraf Ansari, Zishan Ali Khan [9] in their paper on steel trusses comparison have showed that in etabs axial forces in members are less as compared to StaadPro and the deflections showed by StaadPro is also quite more in values in comparison to etabs. This study told us about the Comparison of various parameters, which is done very nicely in form of graphs and tables. The presented paper displays the comparison graphs of axial force & displacement against loading of all the models. The objective of this paper was to find an effective structural software that can give economic truss design when needed
7) Alena Mathew, Reshma C [11] in their work on study of buckling and wind load analysis on truss elements have concluded that as span increases cost, buckling and weight also increases. They also concluded that the ratio of weight per m^2 of 6.0 m spacing to 4.5 m spacing of trusses comes in range of 1.04 to 1.2.
8) M.Indrajit, V. Senthil kumar [10] worked on the topic Standardization of Truss Profile and this paper was all about expenses due to cost and weight of the section. This paper shows us the best suitable profile of a truss member for minimization of steel in various sections like angles, tees section etc. They have used double Fink truss and Howe truss profile of various span of 15m, 20m, etc. It was analysed by considering Coimbatore as wind zone.

A. *About the Software*

Both the software are structural analysis and designing software but we need to find out which software is more user friendly and works efficiently.

STAAD was bought by Bentley whereas ETABS was bought by CSI. ETABS offers 3D object-based modelling with great visualization tools and an economic design capabilities for several types of structures.

It does have linear and nonlinear analysis engines, and it can display graphs and tables with reports and schematic drawings very nicely and easily [13].

With the help of this one can easily understand the design and analysis results. STAAD can use various methods of analysis like static analysis and also more advanced analysis methods like p-Δ analysis, non-linear analysis, Pushover analysis and many more. StaadPro can also use dynamic analysis method for analysing the building against seismic attack by using time history or response spectrum method. [15]

STAAD & ETABS both follows LSD (limit state design) [1]. Limit State is a restricted state for a structure beyond which the material cannot sustain the strain. In order to use LSD, a structure must have to pass two criteria's that is one for the ultimate design and one for the serviceability criteria.

B. Codes Used

IS 800: 2007 [1] is code of practice for general construction in steel and the provision of code is generally applicable on all the types of bolted and revit connections, it also uses steel sections of wide variety. This code provides a firm base for the design procedure and for actual loads consideration IS875: 1964 is used.

III. ANALYSIS RESULT

We analysed all the three structure in etabs and staad pro respectively, we are here placing some tables of bending moment, base reactions, shear forces of a test member.[5][6][7]

Table 5 Results of Tower

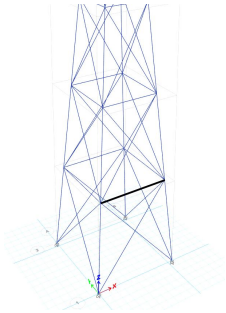
TOWER			
	Test Member		Member with Black Dark Line
S.No		Etabs	StaadPro
1	Bending Moment	-2.3120 kN-m	-2.235 kN-m
2	Shear Force	±2.4355 kN	±2.4 kN
3	Deflection	1.221 mm	3.3 mm
4	Base Reaction (at origin)	134.84 kN	135.069 kN

Table 6 Results of Howe Truss

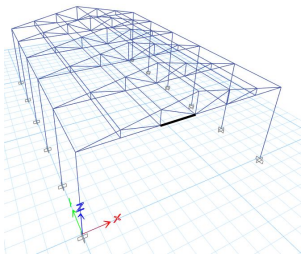
Howe Truss			
	Test Member		Member with Black Dark Line
S.No		Etabs	StaadPro
1	Bending Moment	0.0609 kN-m	0.127 kN-m
2	Shear Force	0.1764 kN	0.358 kN
3	Deflection	0.047 mm	0.111 mm
4	Base Reaction (at origin)	57.88 kN	62.778 kN

Table 7 Results of Howe Bridge Truss

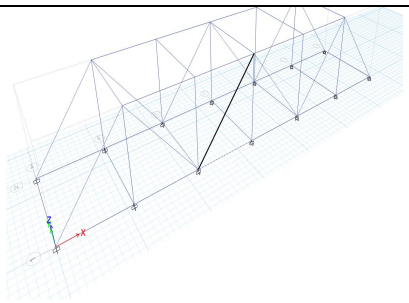
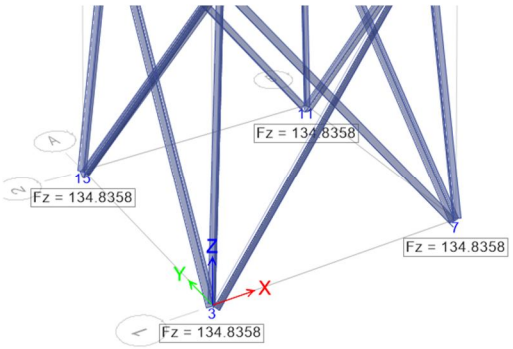
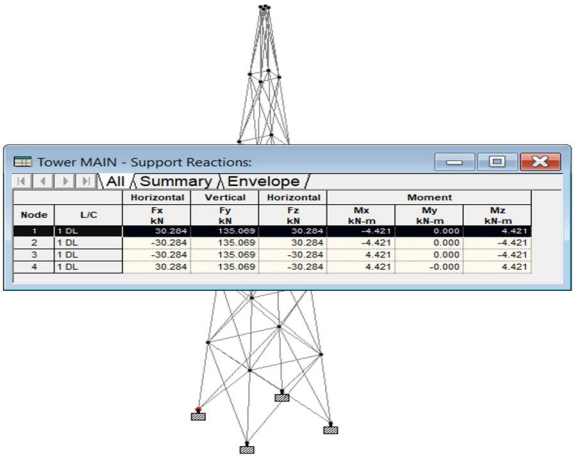
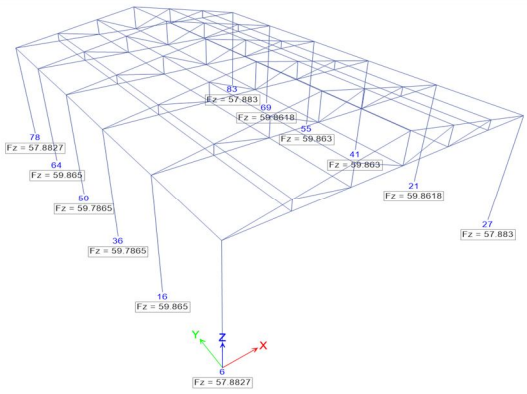
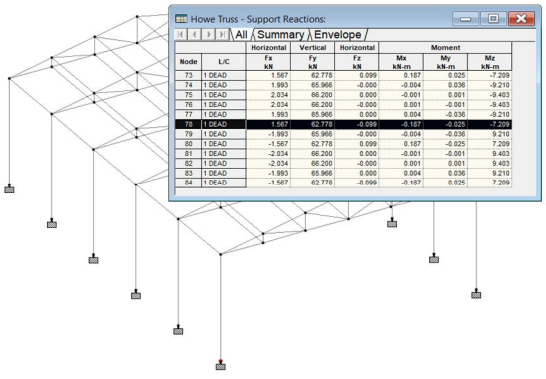
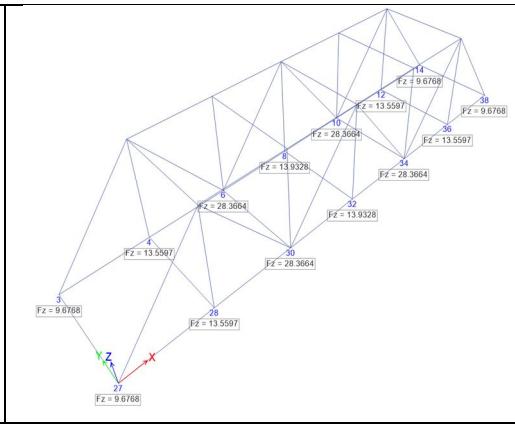
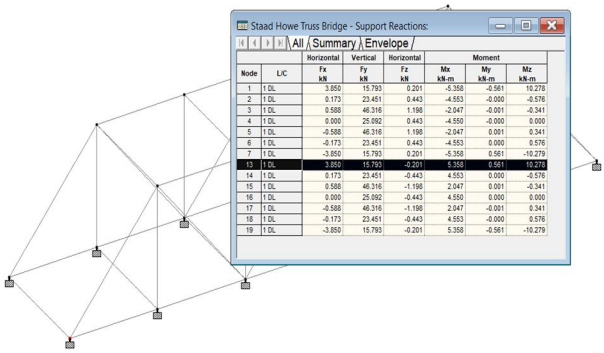
Howe Bridge Truss			
	Test Member		Member with Black Dark Line
S.No		Etabs	StaadPro
1	Bending Moment	-6.5299 kN-m	-6.53 kN-m
2	Shear Force	3.0078 kN	3.01 kN
3	Deflection	NIL	mm
4	Base Reaction (at origin)	9.68 kN	15.793 kN

Table 8 Base reaction results

Base Reaction Tables			
	Structure		
S.No		Etabs	StaadPro
1	Tower		
2	Howe Truss		

3	Howe Bridge Truss		

The above base reaction were due to Dead Load only, which is only due to self-weight of the elements. The supports were restrained in all the directions, That is, movement in X, Y, Z & moment in X, Y & Z are restricted.
The Results were collected in tables and is compared in next section.

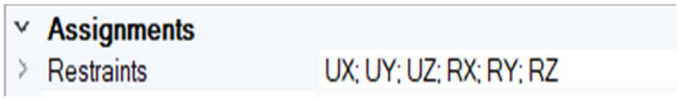
IV. COMPARISON

Bending moments, shear force and base reaction in test members are compared over each structure in both the software's, we can easily compare the various results from the above table and can conclude the following details:

Table 9 Results comparison

S.No	Member	Property	Etabs	StaadPro
1	Tower	Bending Moment	-2.3120 kN-m	-2.235 kN-m
		We can see moments doesn't vary so much in both the cases but etabs gives more of the moment in member		
		Shear Force	±2.4355 kN	±2.4 kN
		Here we can conclude that the values are same for both but etabs gives more precise values.		
		Base Reaction	134.84 kN	135.069 kN
		This shows that values were reported almost same by both the software's.		
2	Howe Truss	Bending Moment	0.0609 kN-m	0.127 kN-m
		Difference of almost 0.06 Kn-m is noticed here, Etabs a less of bending moment in comparison to StaadPro.		
		Shear Force	0.1764 kN	0.358 kN
		Here we can see that shear force in etabs is reported almost half of the shear force in staad pro.		
		Base Reaction	57.88 kN	62.778 kN
		The base reactions were reported less in etabs as compare to staad pro.		
3	Truss Bridge	Bending Moment	-6.5299 kN-m	-6.53 kN-m
		The results for Bending Moments are almost same for both the software's but Etabs shows results so much precise than StaadPro.		
		Shear Force	3.0078 kN	3.01 kN
		Here again we can conclude that shear forces by both the software's are going to be same but again we can point out that etabs shows answer more precisely.		
		Base Reaction	9.68 kN	15.793 kN
		Base reactions are different in both. We can see etabs report a less reaction that Staad Pro		
All of the above values were according to the DEAD Loads only. Etabs takes dead load of structure by using a dead load multiplier in Load Pattern definitions and in Staad pro a self-weight dead load is defined and was added onto the structure. All the supports are Fixed.				

Etabs Supports & Staad Pro Supports

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35  SUPPORTS
36    1 TO 7 13 TO 19 FIXED
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Bottom Line of the Story

For Bending Moment	For Shear Force	For Base Reaction
Bending moments are almost same, except Howe truss case, but it is not that much big, so we can conclude that both the software shows almost same bending moment of test member.	For shear force we can conclude that although both software's report the same values, but in case of Howe truss it differ by 50%.	Base reaction is reported always quite less by etabs in comparison to staad pro. This thing can help in reducing foundation reinforcement area and giving optimum design.

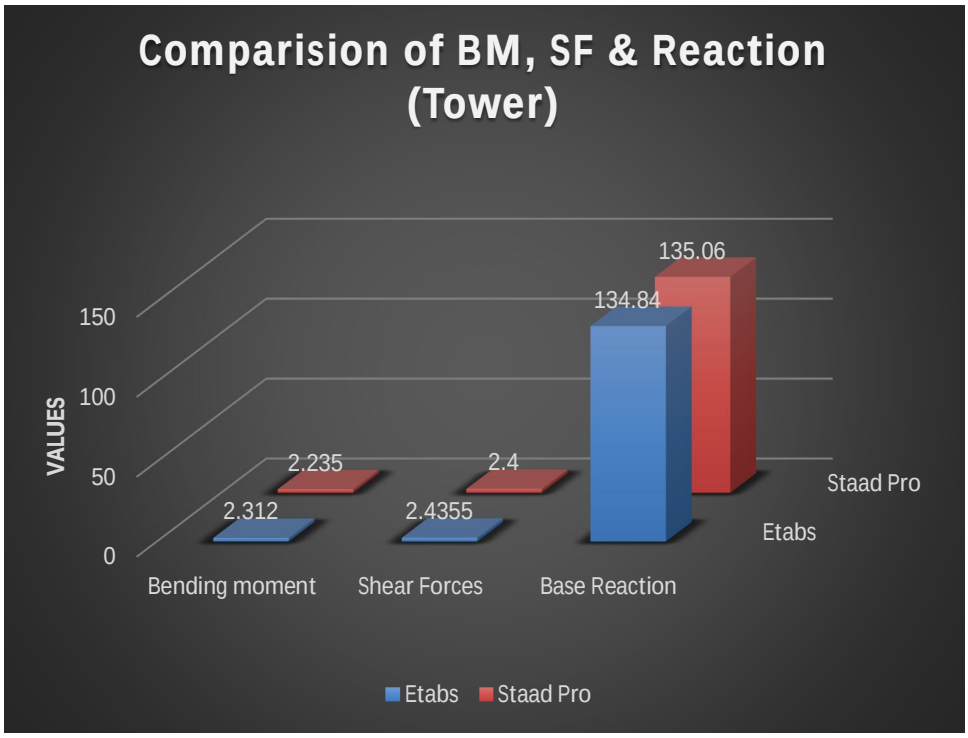

Fig.4 Graph of comparison of BM, SF & Reaction (Tower)

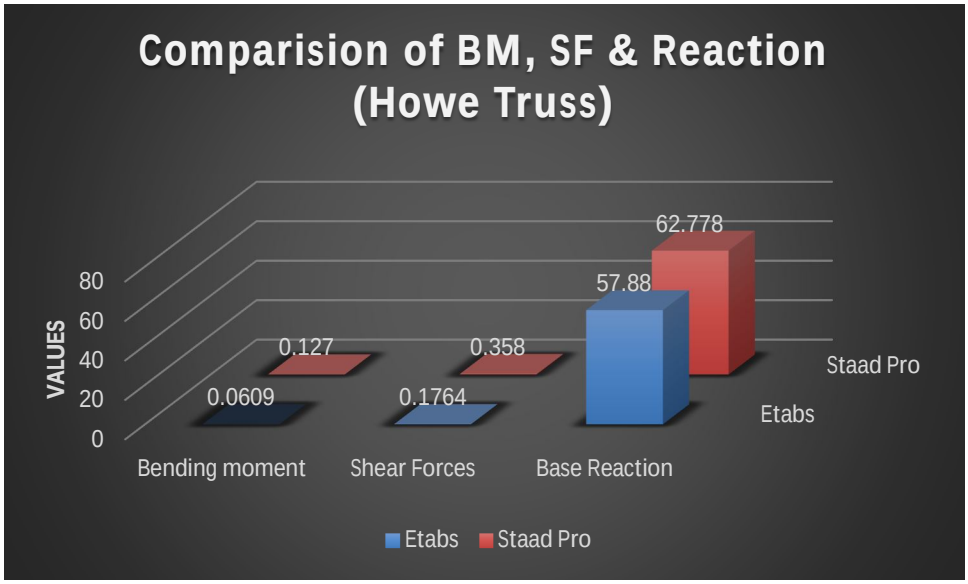

Fig.5 Graph of comparison of BM, SF & Reaction (Howe Truss)

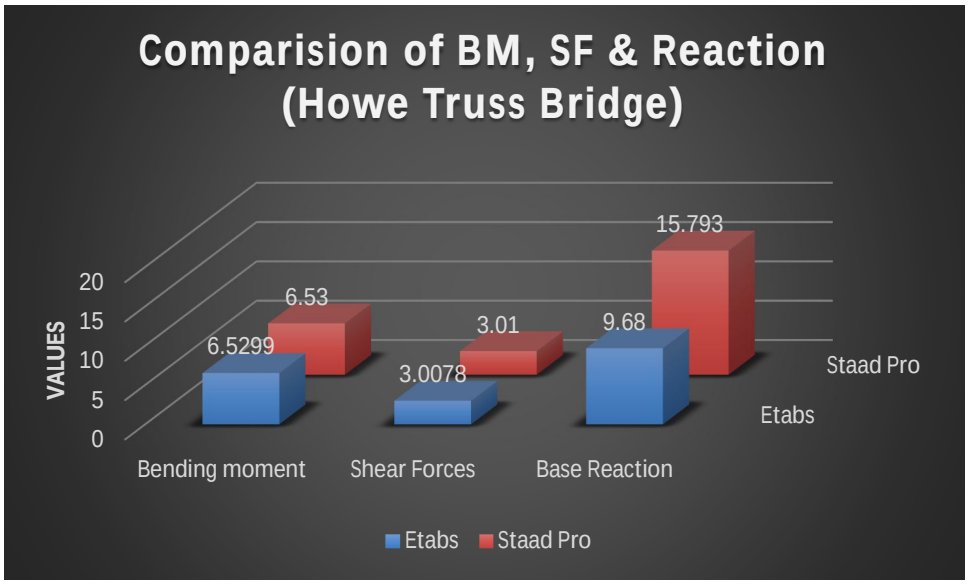

Fig.6 Graph of comparison of BM, SF & Reaction (Howe Truss Bridge)

V. CONCLUSION

As we can see both the software's are showing almost same results but etabs is leading in giving more precise results than staad pro and base reactions are also being reported less by etabs. One can use this thing in design of foundation to have a less reinforcement used in foundation. When we talk about complex projects, in which there are various number of foundations, a reduction of even 0.1 % in steel reflects a lot more in overall cost, so in this sense we can say etabs provide an economical solution for steel structures.

Apart from this Staad has introduced its new UI with the name of Connect design version. It has a very good UI and I think it'll give a tough competition to etabs in regards of User interface. The only thing now staad have to improve in order to tackle etabs in structural market is its report preparations. The bright, colourful graphs in etabs catch the attention of anybody. Also staad can provide some basic tutorials for staad like CSI Etabs do on their website and YouTube channel too.

One thing I like to mention here is that every year Bentley organizes a competition knows as Bentley Design Competition with which students from India and all over the places can take part and can come with their own unique design. On the other hand CSI Etabs is not currently anything like this. Both of the software comes with a lot of other software in package like Staad comes with

staad foundation, ram connection designs, RCDC and many more. Same as Staad, Etabs also have SAFE for foundation and slab designs, SAP for more accurate structural analysis and CSI Col especially for design and analysis of columns.

A great need of features regarding the pretension and pre-stress is needed in structural software. Right now SAFE from CSI can provide some design regarding pre-tensioning and post tensioning of slabs on the other hand Staad also has some features regarding this but it needs improvements.

At last we can conclude from this study that indeed Etabs gave less base reactions but on the whole both software's work almost same, so it depends on person to person that which software they go for, the old man STAAD or the new player Etabs.

VI. FUTURE WORK

This study was done by only considering dead loads, one can take this research a bit more forward by giving wind loads and live loads. One can also use seismic loads and can see the drift of topmost members so that one can check which software give less displacements and can help in having optimum designing. Steel structure are used widely in industrial purposes and reducing its cost by the use of a robust software can bring a lot of relaxation in cost. One can also use different types of seismic analysis method to study the behaviour of this structures in both the software.

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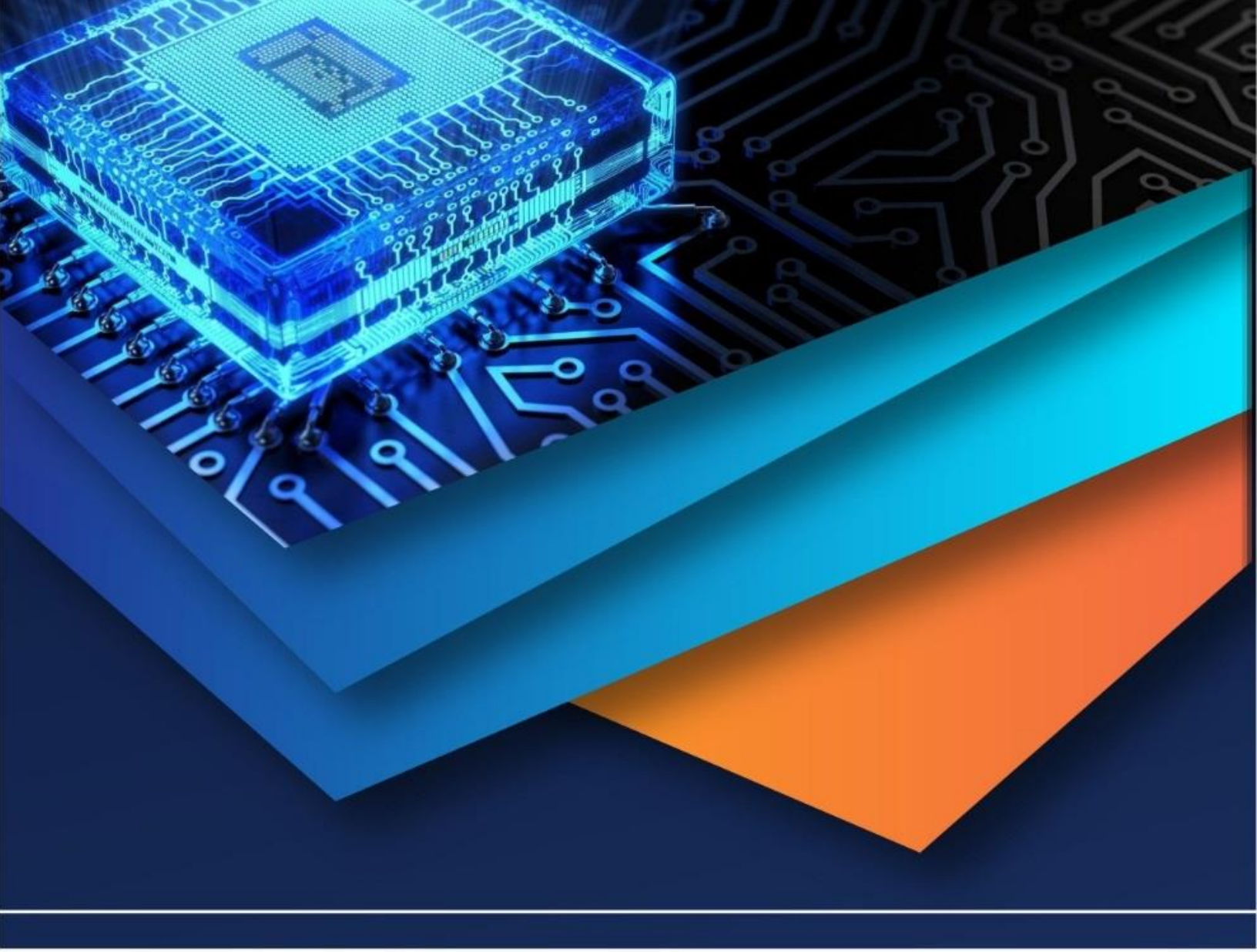

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