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COMPARATIVE STUDY OF SIMULATION TOOLS STAAD.PRO AND ETABS SOFTWARE FOR MULTI-STOREY BUILDINGS

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Abstract— The principle objective of this thesis work is to detailed study the simulation tools (ETABS 2016 and STAAD.ProV8i) for analysis and design of a multi-storied building. The design methods used in STAAD.Pro and ETABS are limit state design method as per Indian standard code. ETABS and STAAD.pro features a state-of-the-art user interface, visualization tools, influential analysis and design engines with progressive finite element and dynamic analysis abilities. From model generation, analysis and design to visualization and outcome verification, STAAD.Pro and ETABS software are the expert's choice. First, this thesis work considered a reinforced cement concrete frame in STAAD.Pro and ETABS software with the dimension of 4 bays @4.0m in x – axis and 6 bays @ 4.0m in z- axis. Where bay stands of the distance between two columns or member. The y-axis of structure consisted of height of building (G+4, G+30 floors). Each Floor has specific height as per structure criteria. In this structure all floor had 3 m height each. Design of respective structure for Wind Load, Dead Load, Live Load and seismic load for calculation of all loads prefer IS 875(part-1), IS 875(part-2), IS875(part-3), IS1893-2002 Code. Indian Standard code 875(part-3)-1987gives complete information about design of Wind load effect on building. Wind load calculation for G+4 and G+30 floors structure by STAAD.Pro and ETABS software with consideration of given wind intensities at different level of structure and design structure for wind load as per IS 875(part-3) code.

Keywords— Analysis, Design, STAAD PRO, ETABS, Residential building, gravity load, shear force, bending moment and axial force

I. INTRODUCTION

STAAD.Pro and ETABS software are user approachable software which areused in design and analysis of any structure with precise result and minimum time consumption. Generally, we design a multi-storeyed structure by manual method but time consumption in manual method is more as compare to software method. Generally, we observe that design and analysis of multi-storeyed building using STAAD.Pro and ETABS have more accurate result and less time as compare to manual method. So, in new era we use software for design and analysis of structure and software design and analysis is economic as compare to manual method. STAAD.Pro and ETABSare not two software for design and analyses of structure instead of much software are used in market as per their specification. Our thesis involves comparative analysis and design of G+4, G+30 multi-storeyed building by using trending software STAAD.Pro and ETABS.The Reason behind use of these software in our project Given below: -

1. STAAD.Pro and ETABS provide easy interface for design and analysis of multi-storeyed building
2. Accuracy of STAAD.Pro and ETABS result are more accurate as compare to manual method of Reinforced cement concrete Structure design result.
3. STAAD.Pro and ETABS have multilateral software for solving any type of design and analysis problem.
4. One of the most advantage is that STAAD.Pro and ETABS software works with Indian standard codes.
5. STAAD.Pro and ETABS software works faster than other software so these software's are more popular than other.

II. OBJECTIVE OF THE STUDY

To carry out the modelling and analysis of Reinforced cement concrete framed structure using STAAD.Pro and ETABS.

- The main objective of this study-oriented work is to comprehensive study the simulation tools for analysis and design of structure.
- Comparison of simulation tools STAAD.Pro and ETABS for vertical geometrical multi-storey building.
- To design a difficult plan of multi storey building structure as per IS code.
- To find out shear force, bending moments and deflection of multi-storey structure.
- To compare the results obtained from STAAD.Pro and ETABS for deep understanding of software.
- To observe the software gives more accurate and economical result.

III. LOAD CONSIDERATION

As per Indian standard code 875 (part-2)-1987Live load is a load which acts on a structure for fix time period. Live loads for buildings and structures are different for different condition. Live load keeps change time to time for same structure. Different type of live loads act on a building structure, some of them are given below:

- Weight of human body
- Weight of movable furniture
- Dust weight
- Vehicle load
- Movable object

IV. WIND LOAD:-

As per Indian standard code875 (part – 3) 2015 Wind load on a building structure works as a randomly applied dynamic load. Effect of wind load on structure depends on velocity of wind, air density, orientation of the structure, area of contact and shape of structure.
According to Indian standard code wind load calculations are given below: -

$$V_Z=V_b k_1 k_2 k_3$$

Where
V_Z = design wind speed at any height z in m/s;
k_1 = probability factor (risk coefficient) (see 5.3.1 IS 875 PART -3 2015);
k_2 = terrain, height and structure size factor (see 5.3.2 IS 875 PART -3 2015);
k_3 = topography factor (see 5.3.3 IS 875 PART -3 2015).

V. SEISMIC LOAD

As per Indian standard code1893 (part-1):2002Seismic load is defined as the produced dew to action of earthquake. The total design lateral force or design seismic base shear (V_B) along any principal direction shall be determined by the following expression:

$$V_B=A_h W$$

Where
Ah = Design horizontal acceleration spectrum value as per clause 6.4.2 (IS 1893 (Part -1): 2002), using the fundamental natural period Ta as per IS 1893 (Part -1): 2002 in the considered direction of vibration,

W =Seismic weight of the building as per IS 1893 (Part -1): 2002.

VI. DESIGN AND ANALYSIS WITH STAAD.PRO V8I & ETABS

STAAD.Pro and ETABS have two methods for creating the structure. These methods of creating the model are given below: -

- Using the command file
- Using the graphical model generation mode, or graphical user interface (GUI).

The command file is text file which covers the data for the structure being modelled. This file contains of simple English language like commands. This command file is automatically created behind the scenes when the structure is generated using the graphical user interface.

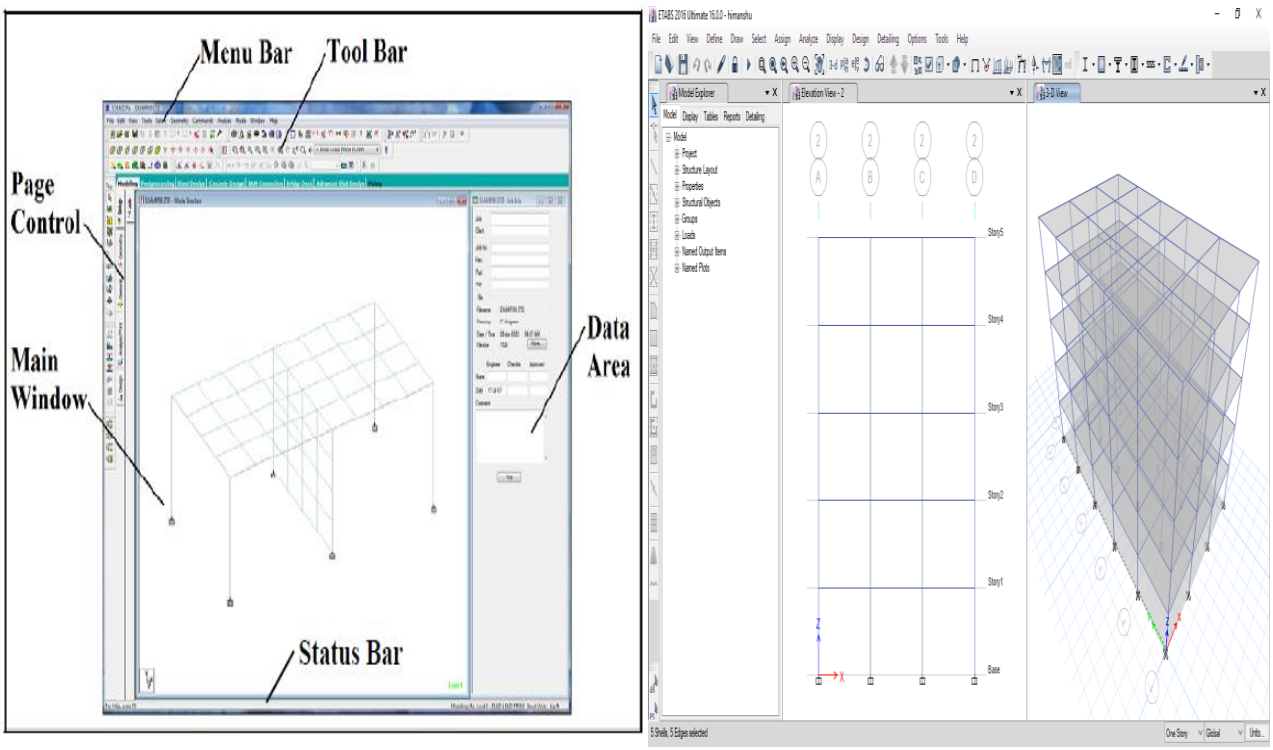

Figure 1.Graphic User Interface Screen of ETABS & STAAD.Pro

A. *DESIGN PARAMETER: -*

STAAD.Pro& ETABS software Contains many numbers of parameters which are needed to perform design as per is 13920(Ductile detailing of reinforced concrete structures subjected to seismic forces). It accepts all parameters that are needed to perform design as per Indian standard code 456-2000.

VII. ANALYSIS AND DESIGN RESULT OF G+4 RCC FRAMED BUILDING USING STAAD.PRO & ETABS

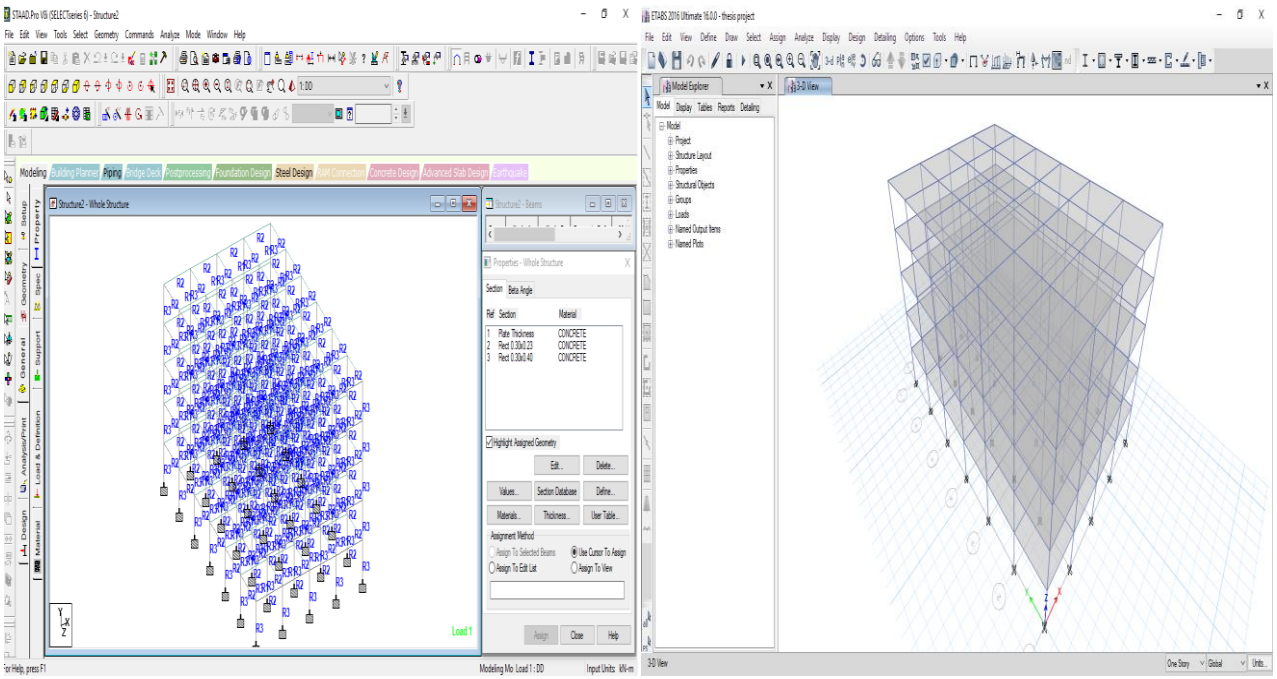

Figure 2. Isometric view of G+4 Storey Building in ETABS

All columns = 0.30 * 0.40 m
All beams = 0.30 * 0.23 m
All slabs = 0.2 m thick
Parapet = .10 m thick RCC

A. *PHYSICAL PARAMETERS OF BUILDING:*

Height = 3m + 4 storeys @ 3m = 15m

Note: 1.0m parapet being non- structural element for seismic purposes, is not considered of building frame height

Length = 6 bays @ 4.0m = 24.0m

Width = 4 bays @ 4.0 m =16.0m
Live load on the floors is 4 kN/m2
Grade of concrete and steel used:

Concrete – M 25
Steel - Fe 415

B. *LOADING ON STRUCTURE: -*
In this multi-storey building structure, we use different load case and these loads are categorizes as:

- Self -Weight of structure
- Dead load of structure
- Live load
- Wind load
- Load combinations

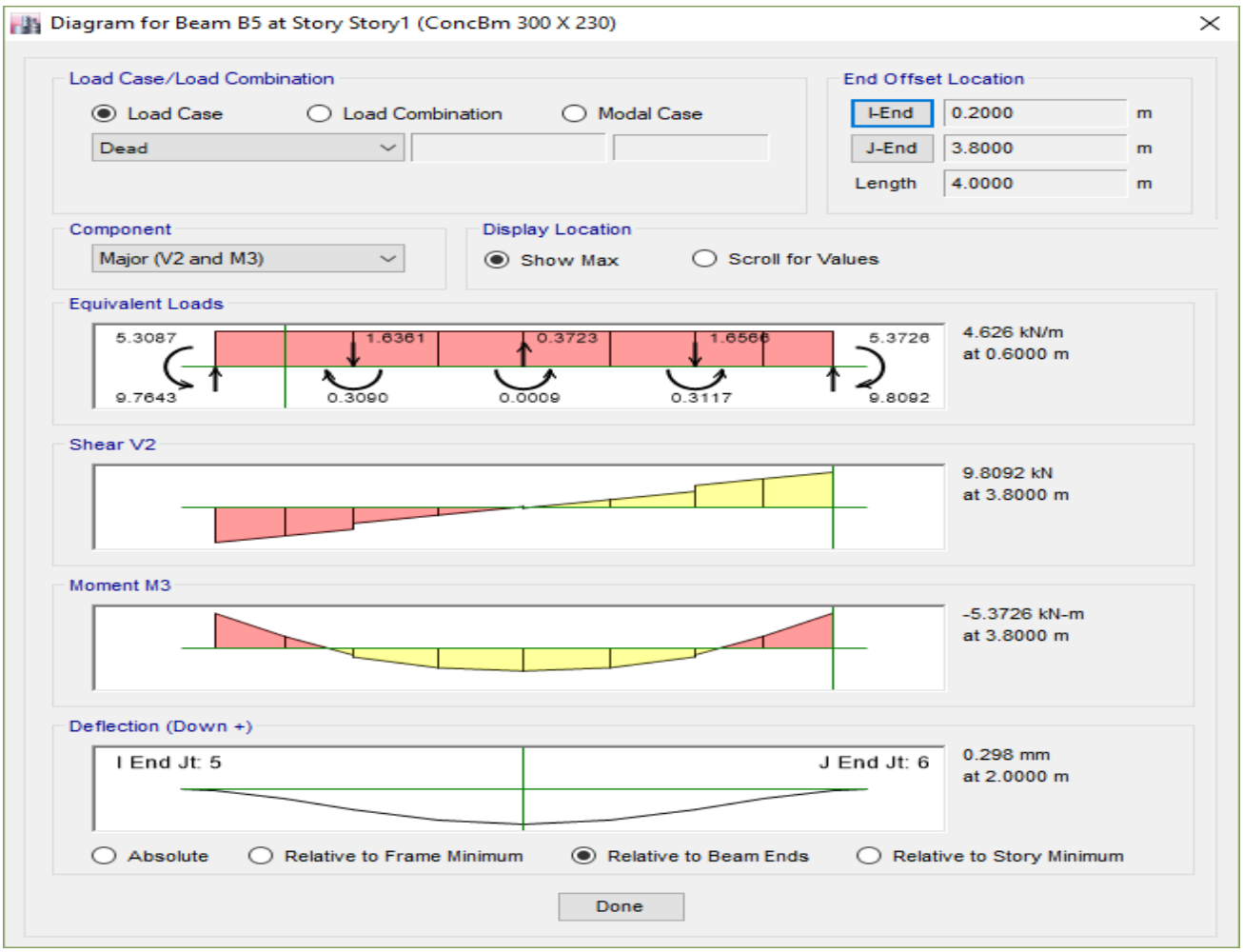

Figure 3. Design results of a beam using ETABS

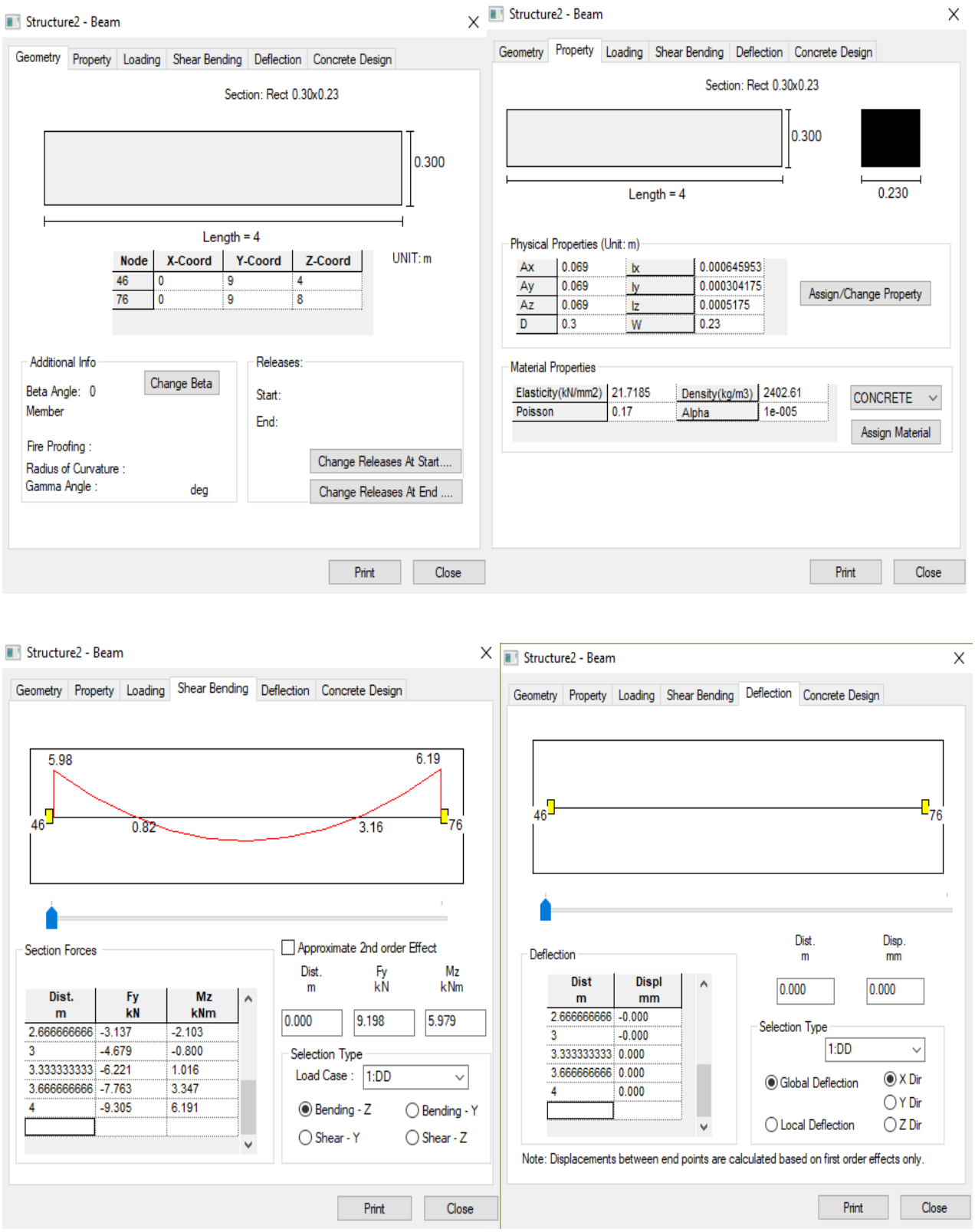

Figure 4. Design results of a beam using STAAD.Pro

VIII. ANALYSIS AND DESIGN RESULTS OF G+30 MULTI-STOREY BUILDING USING ETABS

A. *PHYSICAL PARAMETERS OF BUILDING:*

Height = 3m + 30 storeys @ 3m = 93m

Note: 1.0m parapet being non- structural element for seismic purposes, is not considered of building frame height

Length = 6 bays @ 4.0m = 24.0m

Width = 4 bays @ 4.0 m =16.0m

Live load on the floors is 4 kN/m2

All columns = 0.60 * 0.60 m

All beams = 0.30 * 0.40 m

All slabs = 0.2 m thick

Grade of concrete and steel used:

Concrete – M 25

Steel - Fe 415

B. *LOADING ON STRUCTURE: -*

In this multi-storey building structure, we use different load case and these loads are categorizes as:

- Self -Weight of structure
- Dead load of structure
- Live load
- Seismic Load
- Load combinations

TABLE NO.1: BEAM ELEMENT DETAILS TYPE: DUCTILE FRAME (SUMMARY)

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
Story15	B5	141	beam 400 x300	DCon11	3700	4000	1

TABLE NO.2: DESIGN MOMENT AND FLEXURAL REINFORCEMENT FOR MOMENT, MU3& TU

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	-57.2241		443	1	443	347
Bottom (-2 Axis)		0	347	1	0	347

TABLE NO.3: SHEAR FORCE AND REINFORCEMENT FOR SHEAR, VU2& TU

Shear Ve kN	Shear Vc kN	Shear Vs kN	Shear Vp kN	Rebar Asv /s mm²/m
76.163	48.9098	102.4173	42.2581	756.82

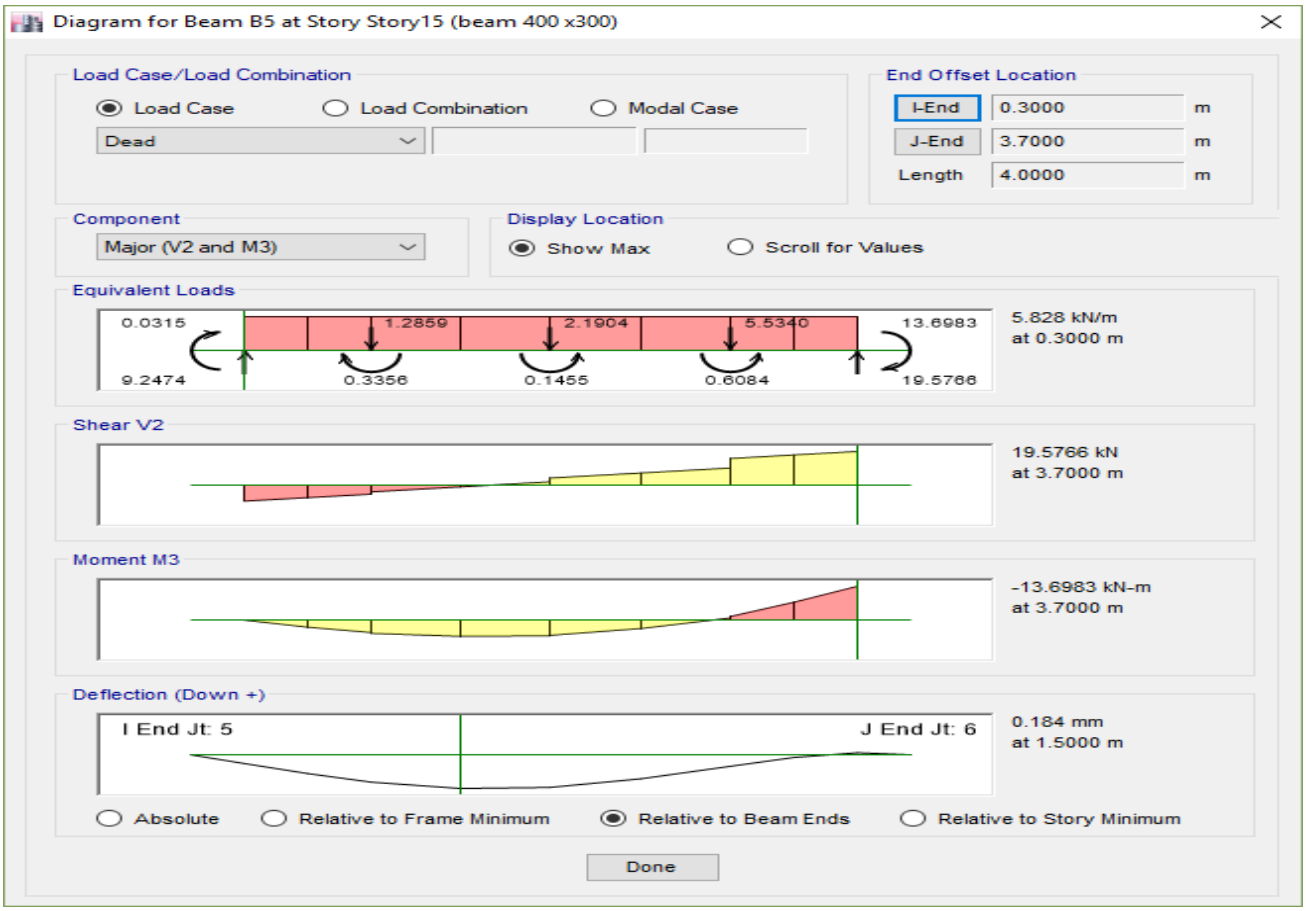

Figure 5. Design results of a beam using ETABS

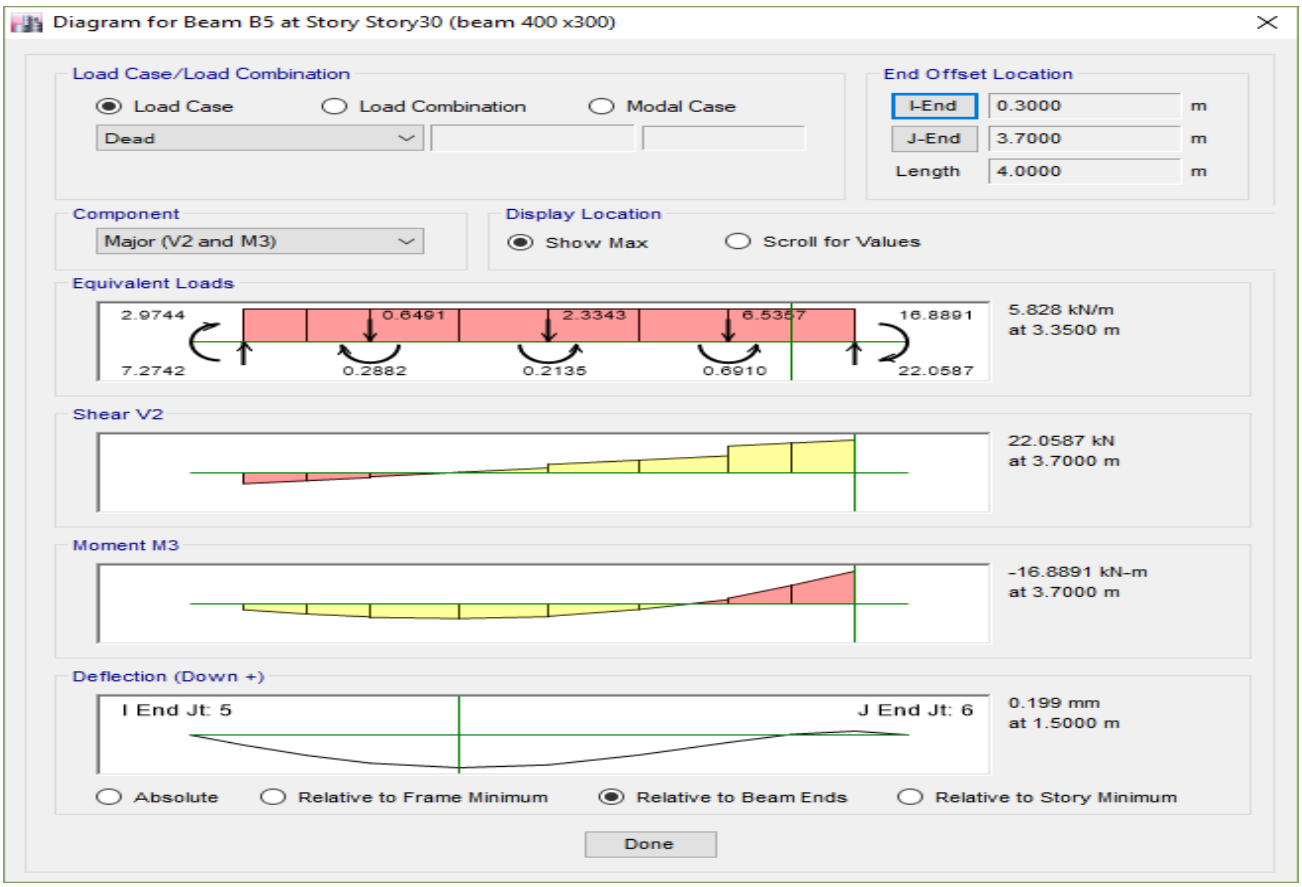

Figure 6. Design results of a beam using ETABS

IX. POST PROCESSING MODE

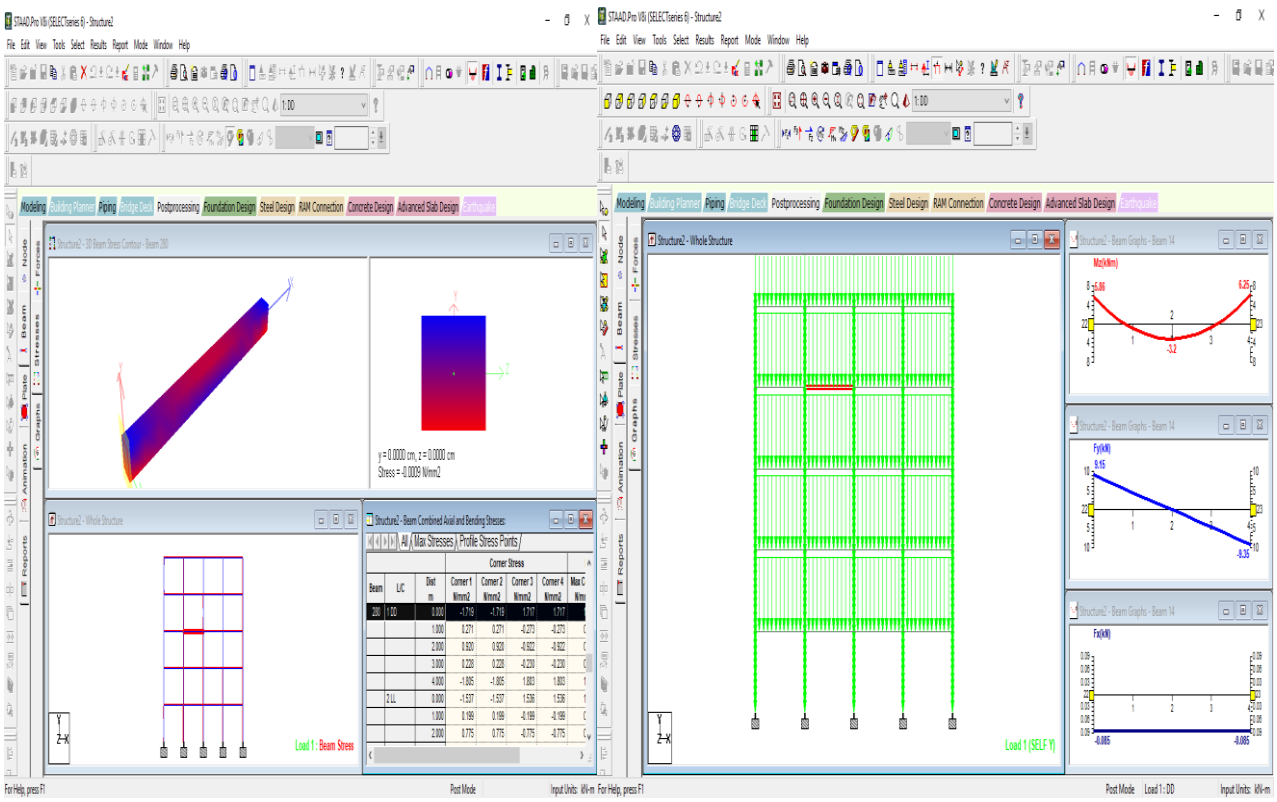

Figure 7.Post Processing Mode In Staad.pro

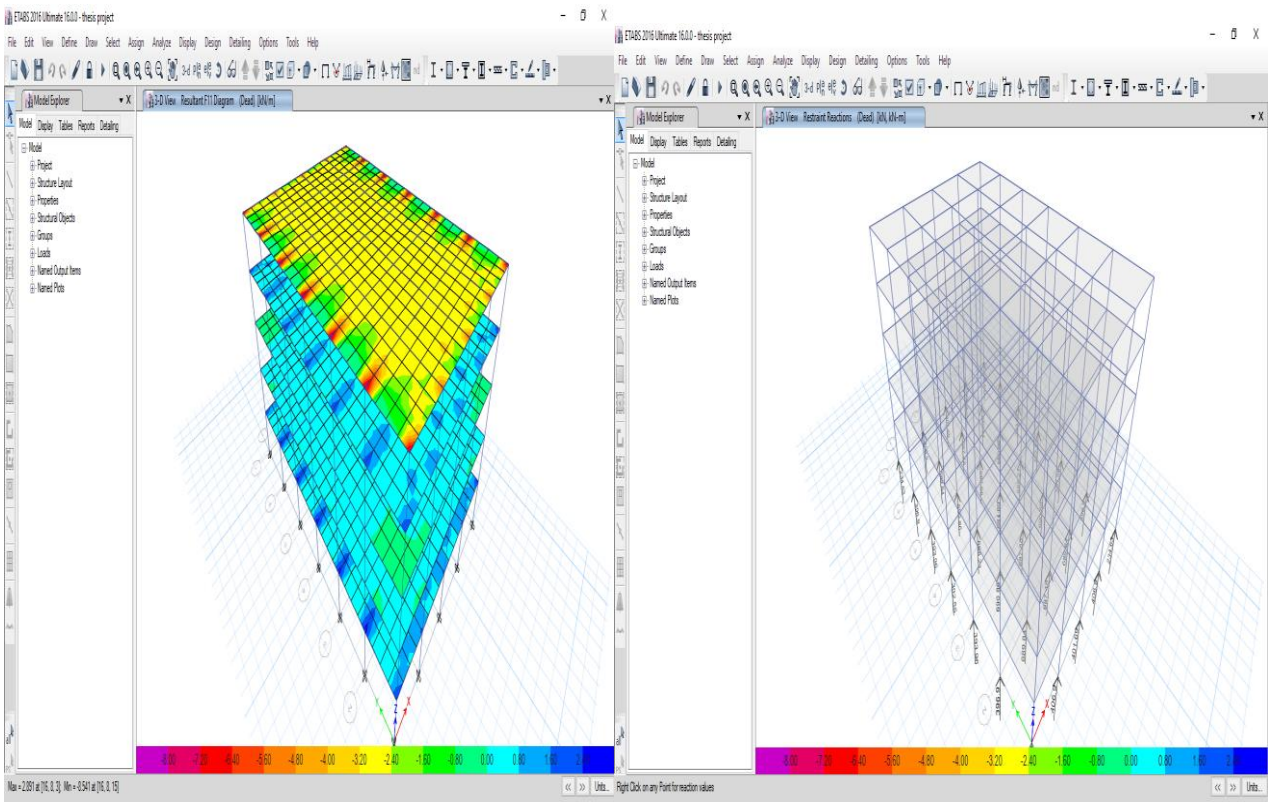

Figure 8.Post Processing Mode In ETABS

X. CONCLUSION

- For multi-storey building (more than G+25 floor) STAAD.Pro software not work properly (Hanging problem) and for same case ETABS works smoothly.
- ETABS offered smaller area of mandatory steel as compared to STAAD. PRO.
- STAAD.Pro software is more flexible to work for new users compared to the ETABS software.
- Axial forces calculated by STAAD.Pro are nearly similar to the axial forces calculated by ETABS, so may adopt the analysis values for the design purposes.
- The analysis values in both software's STAAD.Pro and ETABS are almost similar but design values are slightly different.
- Analysis and Design was completed by using ETABS and STAAD.Pro software successfully verified as per IS456:2000.
- The quantity of concrete requirement is same for the design of the multi-storied building using both STAAD and ETABS analysis.
- Units of building data can be changed any time in ETABS software and in STAAD.Pro units can be changed anytime but, some results show by its selected default unit, dimension marking value remains same in previous unit even after changing unit.
- Command or design parameters are assigned by user in STAAD.Pro and in ETABS software no need to assign, just run analysis and design by code selection.
- ETABS software provide special feature of checking all design data as per code and STAAD.Pro not provide this feature.
- Column Shape and orientation clearly mention in ETABS software and in STAAD.Pro Column assign by a point only and size and orientation not mention.
- Shear wall can be designed easily in ETABS as compare to STAAD.Pro.
- Pick up Column can be designed by ETABS software and STAAD.Pro software not design pick up column.
- Diaphragm concept can be applying for slab (for Earthquake) in ETABS Software and in STAAD.Pro we can't be apply Diaphragm concept.
- Building view limit function available in ETABS software and in STAAD.Pro software we can't view particular floor of building.
- Each element can be on or off according to requirement in ETABS.
- Main beam is not splited into two parts when secondary beam is resting on main beam and in STAAD.Pro main beam splited into parts.

Table: -4 Comparative studies of STAAD.Pro and ETABS

S.No.	Comparison Point	Software		Remarks
		ETABS	STAAD.Pro	
1	Accuracy	Results of ETABS are more accurate	Less accurate as compare to ETABS	ETABS is more accurate for both Analysis and Design.
2	Flexibility	Learners Choice	User Friendly	……
3	Time	It takes more Time.	It takes Less Time as compare to ETABS	STAAD.Pro is very fast in processing.
4	For multi-storey building (more than G+20 storey)	Working well	Not work properly	Staad.Pro hang in Design process of more than G+20 storey building.
5	Present Day Status	Most of the Structural designer uses this software in US and Dubai.	Most of the Structural designer uses this software in India.	STAAD.Pro is more preferred in India because of its flexibility and good marketing Advertisement.

REFERENCES

[1] **Sumit Sharma, Ashish Yadav, Mukesh Dubey** "Comparative study for seismic analysis of building using different software" IRJET, April 2018.
[2] **V.Ramanjaneyulu, Dharmesh.M, V. Chiranjeevi** "comparative study of multi-storey building design and analysis result using STAAD.Pro and ETABS for regular and irregular plan specification" IRJET, Jan-2018.
[3] **Dhiraj Jha, GeetPathare, Abhijeet Patil, Aditya Taware, Mr. NikkhilIngawale**"comparative study of seismic analysis by IS code method using ETABS and STAAD.Pro" IEEE, May-2018.
[4] **Prof.S. Vijaya Bhaskar Reddy, V. Madhu** "Comparative study on design and analysis results of a multi – storied Building using STAAD.Pro and ETABS software for regular and irregular building plan configuration" IJAERV, NOVEMBER-2018.
[5] **Dr. P. D. Hiwase, Miss. Aditi Joshi, Mr. Aakash Keshariya**"Comparison between manual and software approach towards design of structural members" IJES, 2018.
[6] **Ramanand Shukla, PrithwishSaha**"Comparative study of a G+10 multi-storied building using ETABS and STAAD.Pro Software" IJSRST, 2017.
[7] **Rohitkumar B R, Dyavappanavar S P, Sushmitha N J, Sunitha V, Yadwad V** "Analysis and design of Multi storey Structure Using ETABS" IRJET, May 2017.
[8] **Harsitha M N, Das B K, Chaudhary R K, Singh S, Shivhare S** "Analysis and Design of a Commercial Building. International Research Journal of Engineering and Technology" 4(6), 426–429, IRJET, Jun 2017
[9] **M Malikarjun, P V Sura Prakash** "Analysis and Design of a Multi Storied Residential Building Of (Ung-2 + G + 10) By Using Most Economical Column Method" 4(2), 151–158, IJSEAT, Feb 2016.
[10] **Kulkarni T, Kulkarni S, Algur A, &Kolhar M** "Analysis and Design of High-Rise Building Frame Using Staad Pro" 2319–2321, IRJET, Jun 2016.
[11] **Manikanta K V, Venkateswarlu D** "Comparative Study on Design Results Of A Multi-Storied Building Using Staad Pro And Etabs For Regular And Irregular Plan Configuration" 2(15), 204–215, IJRSAE, Sep 2016.
[12] **D.Ramya, A.V.S.Sai Kumar** "Comparative Study on Design and Analysis of Multistoreyed" 4(10), 125–130, IJESRT, Oct 2015.
[13] **Peera D G** "Comparison Design Result of RCC Building Using Staad and Etabs Software" 2(8), 92–97, IJIRAE, Aug 2015.
[14] **Prashanth.P, Anshuman. S, Pandey. R.K, Arpan Herbert**, "Comparison of design results of a Structure designed using STAAD and ETABS Software, " INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING, ISSN 0976 – 4399, Volume 2, No 3, 2012.
[15] **Poonam, Kumar Anil and Gupta Ashok K** "Study of Response of Structural Irregular Building Frames to Seismic Excitations," International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD), ISSN 2249-6866 Vol.2, Issue 2 (2012).
[16] **Prashanth P, Anshuman S, Pandey R K, Arpan Herbert** "Comparison of design results of a Structure designed using STAAD and ETABS Software" 2(3), 869–875. ICJSE, 2012.
[17] **Sanghanibharat k. and Paresh Girishbhai Patel** "Behaviour of Building Component in Various Zones," International Journal of Advances in Engineering Sciences, Vol. 1, Issue 1(Jan. 2011).
[18] **Hammad Salahuddin, Saqib Habib, Talha Rehman** "Comparison of design of a building using ETABS V 9.5 & STAAD PRO 2005," University of Engineering and Technology, Taxila, Pakistan.
[19] **Griffith M. C., Pinto A. V.** "Seismic Retrofit of RC Buildings - A Review and Case Study", University of Adelaide, Adelaide, Australia and European Commission, Joint Research Centre, Ispra Italy.
[20] **Bureau of Indian Standards: IS-875, part 1 (1987)**, Dead Loads on Buildings and Structures, New Delhi, India.
[21] **Bureau of Indian Standards: IS-875, part 2 (1987),** Live Loads on Buildings and Structures, New Delhi, India.
[22] **Bureau of Indian Standards: IS-875, part 3 (1987),** Wind Loads on Buildings and Structures, New Delhi, India.
[23] **Bureau of Indian Standards: IS-1893, part 1 (2002),** Criteria for Earthquake Resistant Design of Structures: Part 1 General provisions and Buildings, New Delhi, India.
[24] **Dr. V.L. Shah &Dr. S.R. Karve** - "Illustrated design of Reinforced concrete Buildings".
[25] **"STAAD Pro technical reference2004**-Getting started & tutorials" Published byR.E. I.
[26] **"STAAD Pro 2005** – Technical reference manual" Published by: R.E.I.
[27] **Civil Engineering International Journals (CEIJ),** www.civilengjournals.com.