

## Management of Multistory Building Design by Staadpro

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### ABSTRACT

Unique structures need more time for its time consuming calculations, if we use manual methods. STAAD Pro provides us quick results. It is easy to use for analyze and design any structure for more accuracy. In the STAAD Pro limit state method is use as per Indian Standard Code and Practices. We can conclude that this software can save much time and is very accurate in designs as compare to manual design and calculations. The principle objective of this project is to analyses and design a multi-storied building (3 dimensional frame) using STAAD Pro and to compare its time with manual method. Pro features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities. In this project, the designing is done by Better technique for creating Geometry, Defining the cross sections for column and beam etc, and Creating specification and supports, then the Loads are defined. After that the model is analyzed by 'run analysis'. Then reviewing Checks and Errors given by the STAAD Pro after analysis (whether beam column passed in loads or failed) results.

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### I. INTRODUCTION

The full form of STAAD is "STRUCTURAL AIDED ANALYSIS AND DESIGN"

**STAAD** or (**STAAD Pro**) is a structural analysis and design computer program originally developed by Research Engineers International at Yorba Linda, CA in 1997.

Project involves analysis and design of multi-storied using very popular designing software STAAD Pro. One can chose STAAD Pro because of its following advantages:

- Easy to use interface,
- Conformation with the Indian Standard Codes,
- Versatile nature of solving any type of problem,
- Accuracy of the solution

Construction of high rise building is basic need because of population and land scarcity. If we use conventional method of manual design of building is time consuming and more possibility of human errors. So it is necessary to use of software for getting more accurate result. STAAD Pro is structural software accepted by much civil engineering. Which can solve typical problem like wind analysis seismic analysis using various load combination to confirm various code like IS456:2000, 1893:2002, IS875:1987etc.

Structural engineers are facing the challenges of striving for most efficient and

economical design with accuracy in solution while ensuring that the final design of a building and the building must be serviceable for its intended function over its design life time. The main objective of the project is to modify the general design practice of a multi storied building with wind loads. The structural design should satisfy the criterion of ultimate strength and serviceability. A civil engineer must be familiar with planning, analysis and design of framed structures. Hence it was proposed to choose a problem, involving analysis and design of multistoried framed structure as the project work.

### The STAAD analysis and design engine:

It is a general purpose calculation engine for structural analysis and integrated Steel, Concrete, Timber and Aluminum design To start with we have solved some sample problems using STAAD Pro and checked the accuracy of the results with manual calculations. The results were to satisfaction and were accurate. In the initial phase of our project we have done calculations regarding badings on buildings and also considered seismic and wind loads. Structural analysis comprises the set of physical has and mathematics required to study and predicts the behavior of structures. Structural analysis can be viewed more abstractly as a method to drive the engineering

design process or prove the soundness of a design without a dependence on directly testing it. To perform an accurate analysis a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties. The results of such an analysis typically include support reactions, stresses and displacements. This information is then compared to criteria that indicate the conditions of failure. Advanced structural analysis may examine dynamic response, stability and non-linear behavior. The purpose of design is the achievement of an acceptable probability that structures being designed will perform satisfactorily during their intended life. With an appropriate degree of safety, they should sustain all the loads and deformations of normal construction and use and have adequate durability and adequate resistance to the effects of seismic and wind. Structure and structural elements shall normally be designed by Limit State Method. Account should be taken of accepted theories, experiment and experience and the need to design for durability. Design, including design for durability, construction and use in service should be considered as a whole. The realization of design objectives requires compliance with clearly defined standards for materials, production, workmanship and also maintenance and use of structure in service. The design of the building is dependent upon the minimum requirements as prescribed in the Indian Standard Codes. The minimum requirements pertaining to the structural safety of buildings are being covered by way of laying down minimum design loads which have to be assumed for dead loads, imposed loads, and other external loads, the structure would be required to bear.

#### **History of STAAD Pro:**

1. STAAD pro was originally developed by Research Engineers International in Yorba Linda, CA.
2. In late 2005, Research Engineers International was bought by Bentley system.

## **II. CONCEPT OF STAAD Pro and SOFTWARE'S**

### **A. CONCEPT**

STAAD Pro is one of the most widely used structural analysis and design software products worldwide. It supports over 90 international steel, concrete, timber & aluminum design codes. STADD Pro is structural software which can be used for Analysis of structural members of the structure. It's mostly used for execute the structural elements like columns, beams, walls, slabs on basis of loads moments,

shear forces, tensional effects, bending moments, deflection etc

### **B. SOFTWARES**

This project is mostly based on software and it is essential to know the details about these software's. List of software's used

- i. STAAD pro (v8i)
- ii. STAAD foundations (v8i)
- iii. AutoCAD

#### **i. 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 S.F.D and B.M.D 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's 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 carry R. C. C, steel, bridge, truss etc., according to various country codes.

**Alternatives for STAAD:** Struts, robot, sap, adds pro which gives details very clearly regarding reinforcement and manual calculations. But these software's are restricted to some designs only where as STAAD can deal with several types of structure.

**STAAD Editor:** STAAD has very great advantage to other software's i.e., STAAD editor. STAAD editor is the programming for the structure we created and loads we taken all details are presented in programming format in STAAD editor. This program can be used to analyze another structure also by just making some modifications, but this require some programming skills. So load cases created for a structure can be used for another structure using STAAD editor.

#### **Property and loading**

- a. Constant thickness as well as linearly varying thickness between nodes.
- b. New IBC 2003 code for automatic distribution of seismic load.
- c. New loading for sample application of complex loading patterns.

d. New floor load generator which automatically updates the pressure distribution if floor changes also allows for elimination of floor members and creation of floor groups.

e. Automatically reduces the live loads dubbed as live load or roof load (live) as per UBC/IBC.

f. Wind load on open lattice structure.

### ii. STAAD FOUNDATIONS (V8I)

It gives efficient foundation design and documentation using plant-specific design tools, multiple design codes including Indian codes and metric bar sizes, design optimization, and automatic drawing generation. STAAD Foundation Advanced provides you with a streamlined workflow through its integration with STAAD Pro or as a stand-alone application. You can design virtually any type of foundation, from basic to the most complex. Easily model complex or simple footings, such as plant foundations supporting vertical vessels, horizontal vessels, tanks and other footings Quickly model common foundations such as isolated, combined, strip, pile caps, and many more Simplify challenging scenarios such as vibrating machine foundation, lateral analysis of piers, or mat design using FEA Efficiently use your structural model with the foundation model through integration with STAAD Pro, including automatically synced changes in both models. This software can deal different types of foundations,

#### Shallow ( $d < b$ )

1. Isolated (Spread) Footing
2. Combined (Strip) Footing
3. Mat (Raft) Foundation

### SYMBOLS IN STAAD.PRO AND STAAD FOUNDATION V8I:

The following symbol has been used in our project and its meaning is clearly mentioned respective to it:

A	Area
A <sub>st</sub>	Area of steel
b	Breadth of beam or shorter dimension of rectangular column
D	Overall depth of beam or slab
DL	Dead load
D <sub>1</sub>	effective depth of slab or beam
D	Overall depth of beam or slab
Mu <sub>max</sub>	moment of resistance factor
f <sub>ck</sub>	characteristic compressive strength
f <sub>y</sub>	characteristic strength of steel
L <sub>d</sub>	development length
LL	live load
L <sub>x</sub>	length of shorter side of slab

L <sub>y</sub>	length of longer side of slab
B.M.	bending moment
M <sub>u</sub>	factored bending moment
M <sub>d</sub>	design moment
M <sub>f</sub>	modification factor
M <sub>x</sub>	mid span bending moment along short span
M <sub>y</sub>	mid span bending moment along longer span
M <sub>x</sub>	support bending moment along short span
M <sub>y</sub>	support bending moment along longer span
pt	percentage of steel
W	total design load
W <sub>d</sub>	factored load
T <sub>c max</sub>	maximum shear stress in concrete with shear
T <sub>x</sub>	shear stress in concrete
T <sub>v</sub>	nominal shear stress
φ	diameter of bar
P <sub>u</sub>	factored axial load
Mu <sub>lim</sub>	limiting moment of resistance of a section without compression reinforcement
Mu <sub>x</sub> , Mu <sub>y</sub>	moment about X and Y axis due to design loads maximum uniaxial moment capacity for an axial load of pu, bending moment x and Y axis respectively
A <sub>c</sub>	area of concrete&
A <sub>sc</sub>	area of longitudinal reinforcement for column

### iii. AutoCAD:

AutoCAD is powerful software licensed by auto desk. The word auto came from auto Desk Company and cad stands for computer aided design. AutoCAD is used for drawing different layouts, details, plans, elevations, sections and different sections can be shown in auto cad. It is very useful software for civil, mechanical and also electrical engineer. The importance of this software makes every engineer a compulsion to learn this software's. We used AutoCAD for drawing the plan, elevation of a residential building. We also used AutoCAD to show the reinforcement details and design details of a stair case. AutoCAD is a very easy software to learn and much user friendly for anyone to handle and can be learn quickly Learning of certain commands is required to draw in AutoCAD.

### III. ANALYSIS AND DESIGN OF BUILDING

#### A. PROCEDURE

- a. Creation of nodal points: Based on the column positioning of plan we entered the node points into the STAAD file
- b. Representation of beams and columns: By using add beam command we had drawn the beams and columns between the corresponding node points.
- c. 3D view of structure.
- d. Supports and property assigning: After the creation of structure the supports at the base of structure are specified as fixed. Also the Materials were specified and cross section of beams and columns members was assigned.
- e. 3D rendering view: After assigning the property the 3d rendering view of the structure can be shown
- f. Assigning of seismic loads: In order to assign Seismic loads firstly we have defined the seismic loads according to the code IS1893:2002 with proper floor weights. Loads are added in load case details in +X,-X, +Z,-Z directions with specified seismic factor.
- g. Assigning of wind loads: Wind loads are defined as per IS 875 PART 3 based on intensity calculated and exposure factor. Then loads are added in load case details in +X,-X, +Z,-Z directions.

#### B. DESIGN OF BUILDING

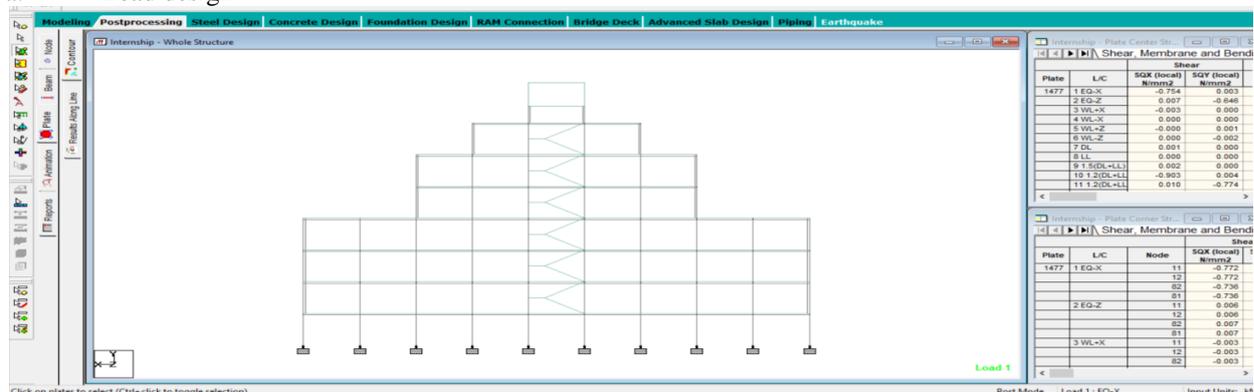
In this project RCC G+5 building is designed and analyzed

##### a. Load design

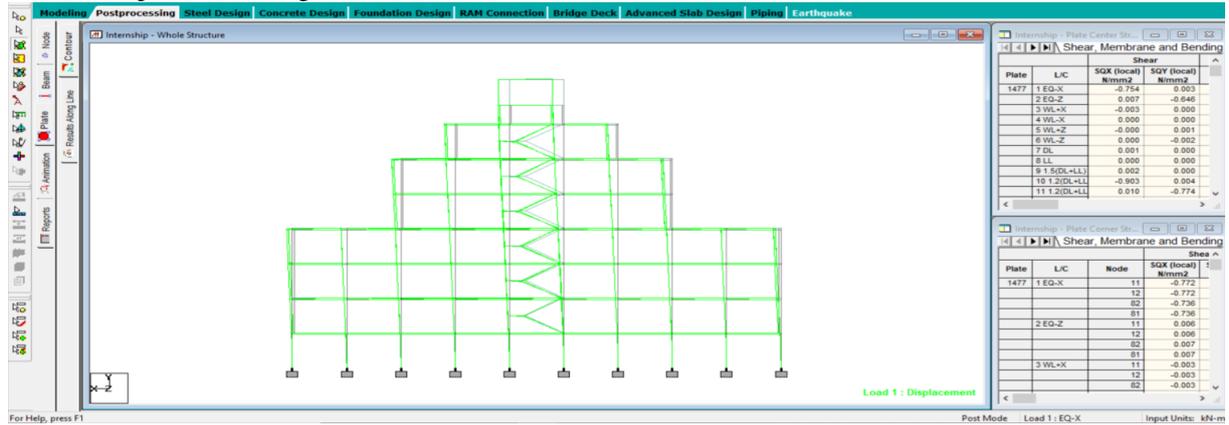
- h. Assigning of dead loads: Dead loads are calculated as per IS 875 PART 1 for external walls, internal walls, parapet wall including self-weight of structure.
- i. Assigning of live loads: Live loads are assigned for every floor as 3KN/m<sup>2</sup> based on IS 875 PART 2.
- j. Adding of load combinations: After assigning all the loads, the load combinations are given with suitable factor of safety as per IS 875 PART 5.
- k. Analysis: After the completion of all the above steps we have performed the analysis and checked for errors.
- l. Design: Finally concrete design is performed as per IS 456: 2000 by defining suitable design commands for different structural components. After the assigning of commands again we performed analysis for any errors.

##### Load combinations:

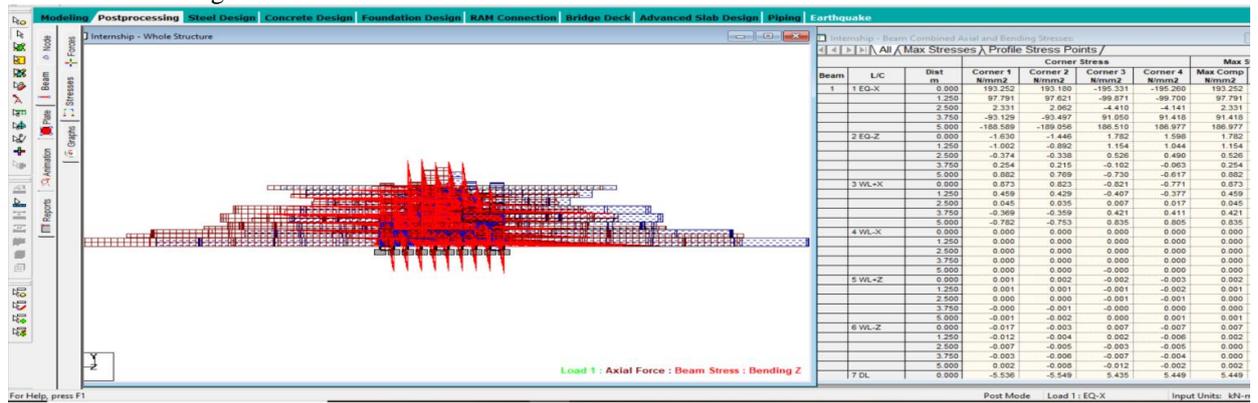
- a. DL + LL
- b. DL + WL (+X)
- c. DL + WL (-X)
- d. DL + WL (+Z)
- e. DL + WL (-Z)
- f. DL + LL + WL (+X)
- g. DL + LL + WL (-X)
- h. DL + LL + WL (+Z)
- i. DL + LL + WL (-Z)



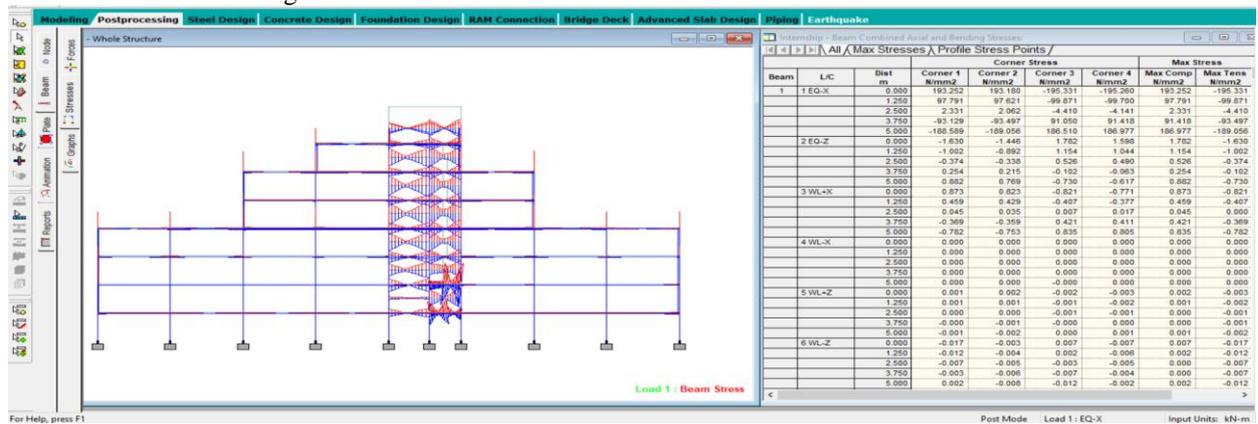
b. Displacement design



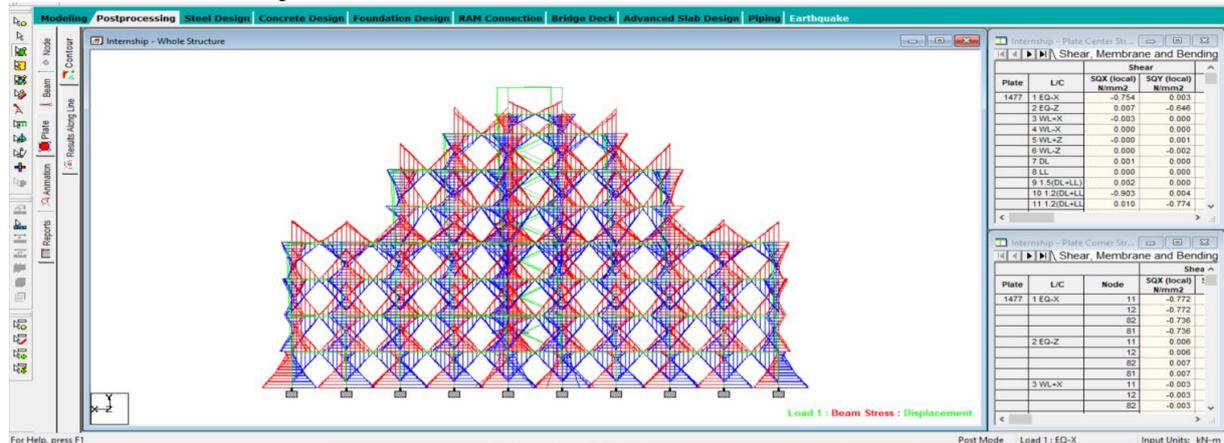
c. BMD design



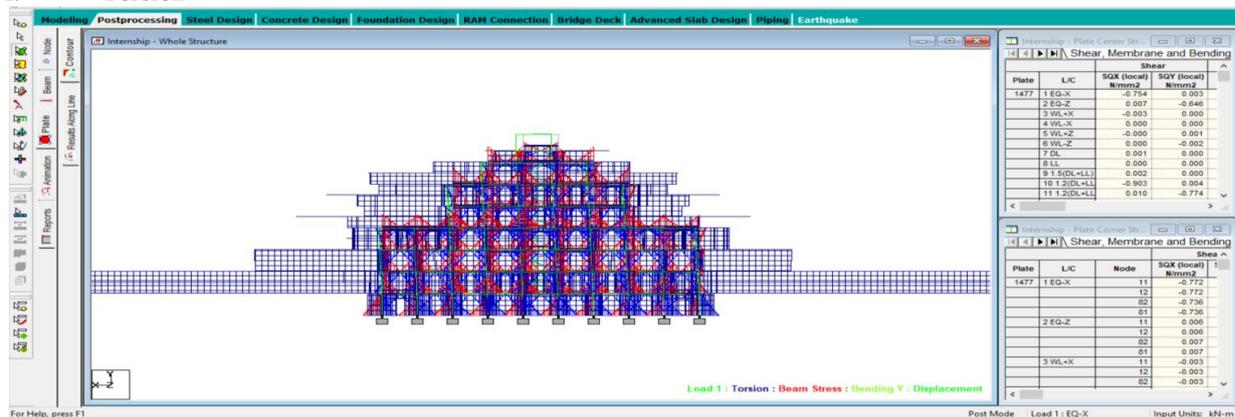
d. Beam Stress design



e. Beam Stress Displacement



f. Torsion



IV. DISCUSSION & CONCLUSION

A. CONCLUSION

For small structures Manual method has used but for Multistory Buildings STAAD Pro is economical.

Unique structures like high rise buildings, water tanks and multistory buildings need more time for calculations, if we go through manual methods but STAAD Pro gives us quick calculations with all checks and errors.

If any error rises in manual method then one have to check all the calculations from start to end but if any error rises in STAAD output then it provides us a quick check for error and it seems easy to minimize error.

STAAD also provide SMD, BMD, Tension and Displacement diagram with just one click.

STAAD allows any structure to view in 2D or 3D mode, and simply provides all material properties, loads, supports and rendered view of structure.

B. DISCUSSION

The following points are discuss from the experimental investigation,

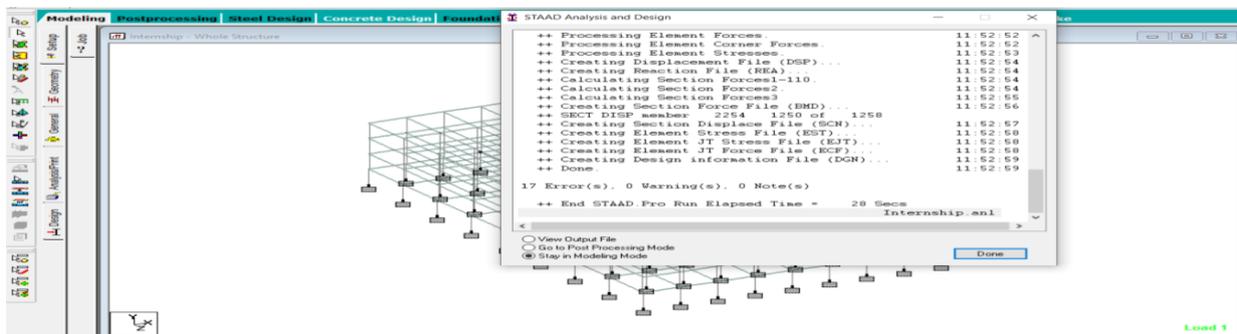
- Designing using Software's like STAAD will reduces lot of time in design work.
- Details of each and every member will be obtained using STAAD pro.
- All the List of failed beams will be obtained and also Better Section will be given by the software.
- Accuracy of structure will Improved by using STAAD.pro software.
- Short term deflection of all horizontal members will be available within 20mm.
- The structural components of the building will safe in shear and flexure.
- Amount of steel provided for the structure will be economic.
- Proposed sizes of the elements will be used in the structure.
- STAAD Pro V8i advanced software will provides us a fast, efficient, easy to use and accurate platform for analyzing and designing structures.
- Readymade models are imported to STAAD from built in wizard. Dimensions are edited as per our requirements.

k. Check will also available for the deflection of various members under the given loading combinations.

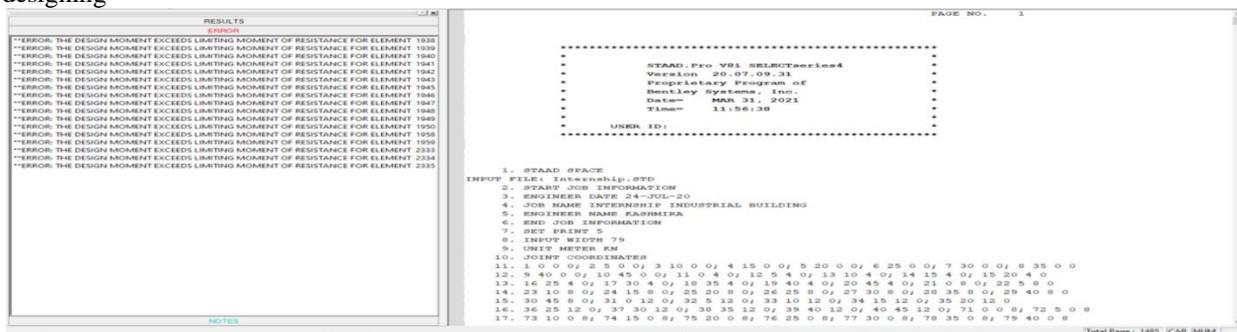
l. Also we can perform both Static analysis and Response spectrum analysis when designing for seismic.

m. Further in case of rectification it will be simple to change the values at the place where error occurred and the obtained results are generated in the output.

n. Errors are also available for design



o. Easy checks are available with numbers in STAAD Pro to analyze which errors are occurred in designing



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