A MAJOR PROJECT REPORT

ON

"SEISMIC ANALYSIS OF INTZE WATER TANK USING STAAD PRO"

Submitted to-

MADHAV INSTITUTE OF TECHNOLOGY AND SCIENCE GWALIOR

(A Govt. Aided Autonomous Institute under RGPV, Bhopal (M.P) Established in 1957)

IN PARTIAL FULFILLMENT OFTHE REQUIREMENT FOR THE AWARD OF THE DEGREE

OF

BACHELOR of TECHNOLOGY

IN

CIVIL ENGINEERING

2018-2022

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CERTIFICATE

This is the certification that the project entitled **"Seismic Analysis of Intze Water Tank using STAAD.Pro"** is being submitted by **Sneha Rajawat**in partial fulfillment for the award of the Degree of Bachelor of Engineering in Civil Engineering is are cord of the ir own work carried under my guidance and supervision.

All the information in this document has been obtained and presented in accordance with academic rules and ethical conduct. To the best of your knowledge, the matter presented in this project has not been submitted for the award of any other diploma or degree certificate.

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ACKNOWLEDGEMENT

When it comes to properly acknowledge someone's support and assistance, it may be a challenging undertaking, chiefly when the support offered is so wholehearted and unwavering.

I am eternally grateful to my renowned guide, **Dr. Abhilash Shukla**, Assistant Professor of Civil Engineering Department, MITS Gwalior.

Also, I would like to Head of Civil Engineering Department, MITS Gwalior, and all other academics and staff members of MITS Gwalior's Civil Engineering Department for their unwavering support throughout the project.

I am grateful to **Dr. R. K. Pandit**, Director of MITS Gwalior, for establishing an outstanding institutional environment and forgiving all facilities and assistance in the preparation of my dissertation.

Last but not least, I'd want to thank my supportive family for their encouragement and cooperation during this project's duration. Thank you also to all of my friends for their encouragement and support.

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List of Abbreviations

DOF.....................Degree Of Freedom

IS ....Indian Standard

THA......................Time History Analysis

K_s..........................Lateral Stiffness of Staging

K_c..........................Convective mass with a spring of stiffness, K_c.

T_i..........................Time period of impulsive mode

m_i..........................Impulsive mass of liquid

m_s..........................Mass of empty container of elevated tank and one-third mass of staging

SMRF....................Special Moment Resisting Frame

OHT...................... Over Head Tank.

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ABSTRACT

Earthquakes can be the reason of destruction by not just shaking, but also by the after consequences like landslides, floods, fires, and disturbance in communication. .Hence it's critical to take essential precautions at the same time as siting, planning & designing of structure, a good way to make sure safety. As elevated water tanks have large masses concentrated on top of slender which have supporting structures thus, putting them at a higher risk to seismic force.

Non-linear dynamic analysis is the only method to describe the actual behavior of the structure during an earthquake. Time history analysis is used to determine the seismic response of a structure under the dynamic loading of a representative earthquake.The intze tank is modeled using STAAD Pro software and uses a combination of plate and line elements. The gravity loading includes vertical and horizontal water pressure together with the self-weight of the structure. The lateral loading is in the form of seismic loading following the provisions of IS 1893. To make certain that the water tank is secure against seismic forces, it is essential to study seismic analysis to design earthquake resistance structures.

ABSTRACT IN HINDI

भूकंप न केवल झटकों से विनाश का कारण हो सकता है, बल्कि भूस्खलन, बाढ़, आग और संचार में गड़बड़ी जैसे परिणामों के बाद भी हो सकता है। . इसलिए बैठने, योजना बनाने और संरचना की डिजाइनिंग के साथ-साथ सुरक्षा सुनिश्चित करने का एक अच्छा तरीका आवश्यक सावधानी बरतना महत्वपूर्ण है। चूंकि ऊंचे पानी की टंकियों में बड़े द्रव्यमान पतले के शीर्ष पर केंद्रित होते हैं जिनकी सहायक संरचनाएं होती हैं, जिससे उन्हें भूकंपीय बल के लिए एक उच्च जोखिम में डाल दिया जाता है।

भूकंप के दौरान संरचना के वास्तविक व्यवहार का वर्णन करने के लिए गैर-रेखीय गतिशील विश्लेषण एकमात्र तरीका है। एक प्रतिनिधि भूकंप के गतिशील लोडिंग के तहत एक संरचना की भूकंपीय प्रतिक्रिया को निर्धारित करने के लिए समय इतिहास विश्लेषण का उपयोग किया जाता है। इंट्ज़ टैंक को STAAD Pro सॉफ़्टवेयर का उपयोग करके तैयार किया गया है और प्लेट और लाइन तत्वों के संयोजन का उपयोग करता है। गुरुत्वाकर्षण भार में संरचना के स्व-भार के साथ-साथ ऊर्ध्वाधर और क्षैतिज पानी का दबाव शामिल है। आईएस 1893 के प्रावधानों का पालन करते हुए पार्श्व लोडिंग भूकंपीय लोडिंग के रूप में है। यह सुनिश्चित करने के लिए कि पानी की टंकी भूकंपीय ताकतों के खिलाफ सुरक्षित है, भूकंप प्रतिरोध संरचनाओं को डिजाइन करने के लिए भूकंपीय विश्लेषण का अध्ययन करना आवश्यक है।

CHAPTER I

INTRODUCTION

1.1 General

Large liquid storage tanks are extensively used within companies to retain chemicals, petroleum products, and other liquids, as well as to store water in public water supply systems. A water tank is often used to store the water in terms of meeting daily needs. Water tanks are classified into the following categories:

Based on location-

1. Tanks resting on the ground
2. Tanks that are elevated and supported by staging
3. Underground storage tanks

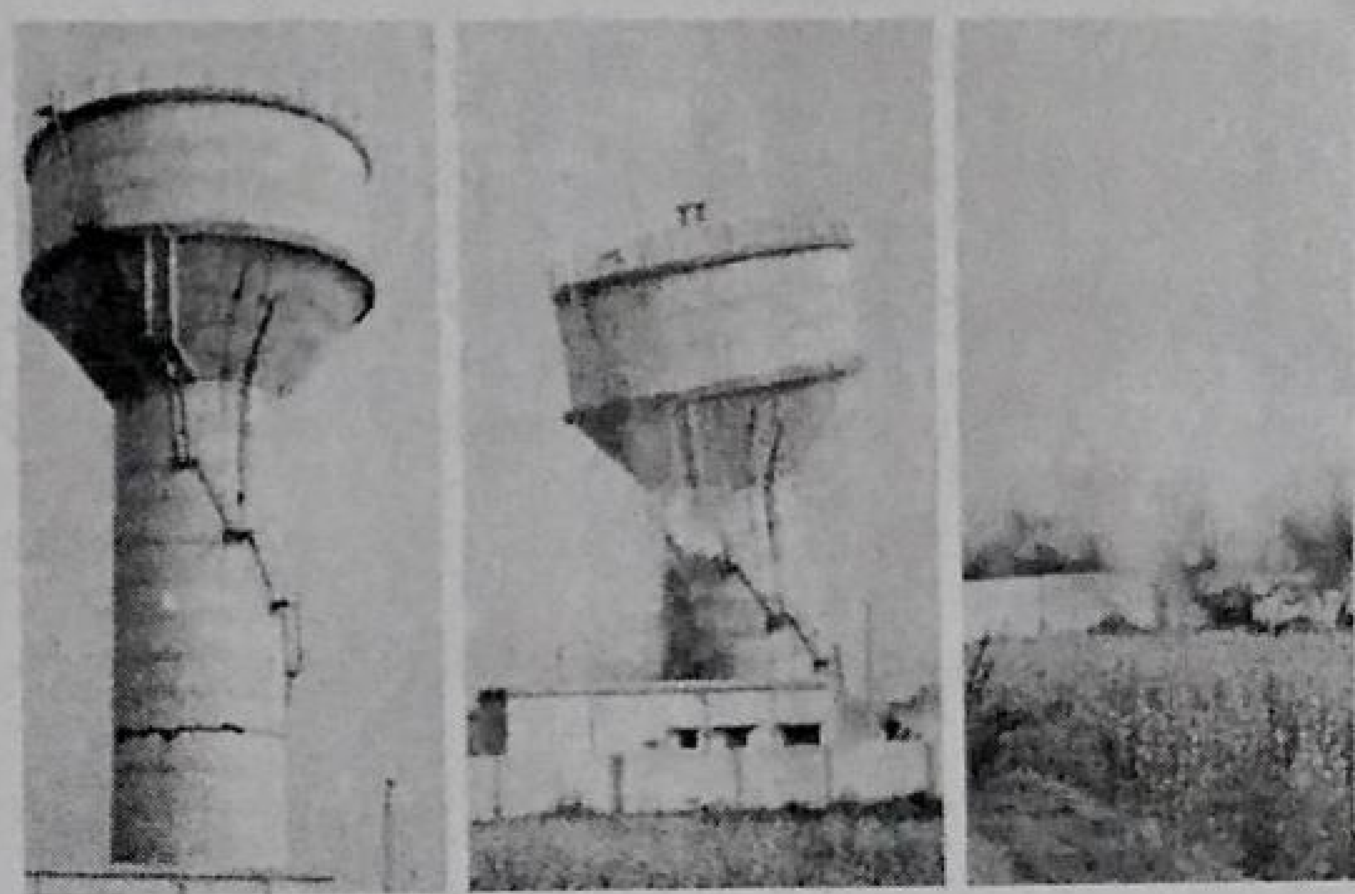

FIG 1. Failure of OHT

Based on form-

1. Circular tanks
2. Rectangular tanks
3. Spherical tanks
4. Intze tanks
5. Circular tanks with conical bottoms

Elevated water tanks are generally used in public water supply systems. As it is a crucial part of the lifeline system, it is a must that the water tanks remain functional. Because elevated water tanks contain massive masses concentrated on top of slender structures with supporting structures, they are particularly sensitive to seismic forces. During previous earthquakes, these structures had poor seismic performance. As a consequence, a non-linear time history study of an OHT is performed using STAAD Pro to mimic structure behaviour in the Gwalior region during an earthquake. There are four earthquake zones in India.. Gwalior lies in ZoneII i.e., the seismic intensity is low in this region. As per IS 1893(Part1):2002, seismic zones in India are divided as:

Seismic Zone	II	III	IV	V
Seismic intensity	Low	Moderate	Severe	Very severe
Zone factor, Z	0.10	0.16	0.24	0.36

DIFFERENT METHODS OF SEISMIC ANALYSIS

Depending on the structure's external activity and behaviour codes of practice, 4 kinds of code-compliant analyses may be carried out consistent with that vary from each other in the behavior of the structure (linear or non-linear) and the stability of forces.

1. **Linear Static Analysis**: For normal systems with constrained height, linear static evaluation or the equal static approach can be utilised. It necessitates fewer computational resources and is entirely reliant on data provided inside the code of practise.
2. **Non-linear static analysis**: Pushover analysis is a sort of non-linear static analysis that is usually referred to as Pushover analysis. It is a viable method for assessing a structure's deformation and damage pattern by analysing it when subjected to constant vertical loads and gradually increasing lateral stresses. In an earthquake, it is a mathematical model that incorporates the nonlinear load-deformation characteristics of individual components and elements of a structure that will be subjected to increasing lateral loads representing inertia forces until a target displacement is exceeded.
3. **Linear dynamic analysis:** Response spectrum analysis is another name for it. This method takes into account the building's numerous mode shapes. The peak structural reaction over the period of an earthquake is obtained directly from the seismic response in that technique; yet, this is quite accurate for structural design applications.
4. **Non-linear dynamic analysis**. Nonlinear dynamic analysis is the best technique to understand a structure's true behaviour during an earthquake. Time history analysis is used to determine the seismic response of a structure under the dynamic loading of a representative earthquake. The time history response of a structure is its response (motion or force) as a function of time, taking inertial effects and other loading sources into consideration.

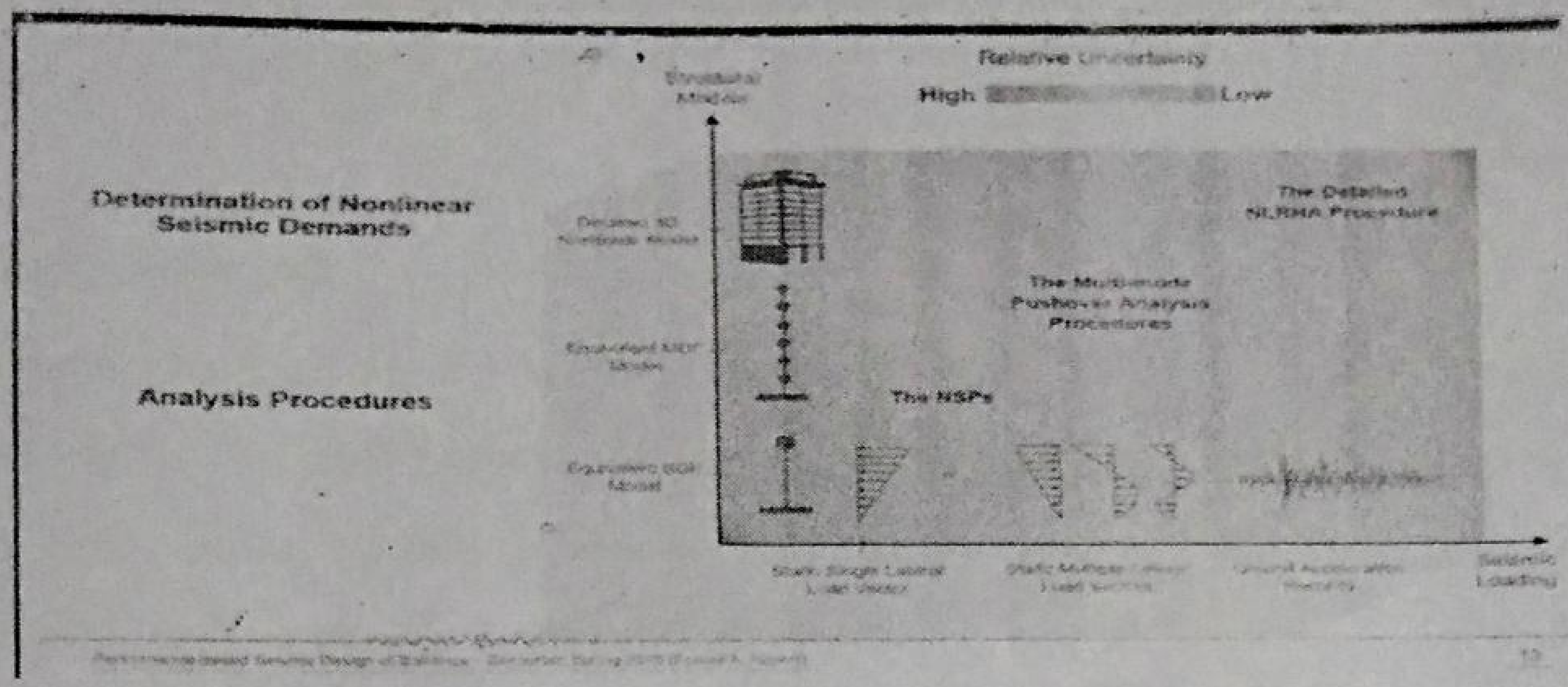

Fig.2 Different procedures of Nonlinear analysis

CHAPTER-2

OBJECTIVE

2.1 Problem Statement

The present problem being undertaken for the study is entitled, "Seismic analysis of Intze water tank using STAAD.Pro". As earthquakes can be dangerous, in terms of causing damage to infrastructure and causing economic losses. Moreover, it can be fatal for human lives as well. Hence, the structures must be safe under seismic forces.

As many earthquakes have occurred in past in India, that have caused large-scale destruction in the country by the loss of human lives and infrastructure as well. Thus, the IS code 1893 was proposed to construct an earthquake-resistant design, considering earthquake data from the history of earthquakes in India. The seismic hazard map of India was amended in 2000 (5), when the Bureau of Indian Standards adopted it (BIS). Zone III runs the length of the state and encompasses all of the districts in the Narmada and Son Valleys, with the greatest predicted intensity being VII (MSK). The vast majority of the city, which includes the capital, Bhopal, and is north and south of the Narmada-Son Valleys, is in Zone II, with a maximum anticipated intensity of VI (MSK).

Gwalior is in Zone II, which means that the region's seismic activity is modest. However, in order to the behaviour of a 150KL capacity intze tank under seismic loading, a non-linear dynamic study is carried out. Because it is an overhead tank with an 18-meter staging height, it is subject to seismic loads and damage. The major purpose is to calculate and assess the building's seismal reaction before measuring and styling it with the STAAD-Pro software suite.

• Intze tank modelling and application of various loads on STAAD-Pro, as well as load calculations owing to various loading combinations, analysis and structure design.

• STAAD Pro vs. manual seismic load calculations on the structure, both utilising the same static methodology.

• calculating the responses, shear pressures, bending moment, seismal forces, and node displacement, restricting them with appropriate features & materials, thereafter reassigning

CHAPTER 3

LITERATURE REVIEW

1. Deepak Kumar Pokkalla, Aishwarya Alok, and P.R.Maiti completed "Comparative Study of Dynamic Analysis of Rectangular Liquid Filled Containers Using Codal Provisions." The purpose of this study.is to determine how impulsive and convective liquid mass components affect the hydrodynamic pressure distribution in rectangular tanks with varying shapes. A comparison of Draft IS 1893 Part 2, ACI 350.3, and Eurocode8 was undertaken for the rectangular shaped tank. The Magnitudes of Shear and moment at the base of rectangular-shaped tanks have also been investigated using static IS 3370 IV and dynamic (Draft IS 1893 Part 2) evaluations. We need to adopt modern codes that are more dependable and accurate than the old ones, according to the study's conclusions.
2. "Study on Seismic Analysis of Intze Water Tank with Four Types of Staging Configuration" was completed by Mohammad Salman Ansari, Neeti Mishra, and Dr. Omprakash Netula. This study intends to investigate the consequences of earthquakes through seismic analysis, as well as the behaviour of various forms of staging configurations of water tank structures with varying parameters and seismic zones. STAAD Pro software was used to conduct the analysis in this study. The research used 16 models to test the performance and management of four distinct types of bracings during seismic loads. For each type of staging under each zone, the results were examined using three parameters: I shear bending, ii) deflection, and iii) shear force.
3. "Non-Linear Time History Analysis of an Elevated Water Tank" was conducted by Miss Nikita S. Gholap and Prof. M.N. Shirsath. A non-linear time history analysis was being used to examine the circular and rectangular tanks under different types of bracings in this study. The goal of this research is to identify and quantify the variations in seismic behaviour of column beam (Building) and column brace (staging) frames in the post-elastic phase. For a staging height of 20 metres, he investigates the overhead water tank with various bracing techniques. The water tank model is developed for a 150 m3 capacity, and the BHUJ earthquake is taken into account for time history analysis. The pushover curves are constructed using pushover analysis, while the pushover curves are established using pushover analysis.
4. . Kaushal Vijay Rathod and Sumit Gupta performed "A Nonlinear Time History Analysis of Ten Storey Rcc Building." They used ETABS to perform a nonlinear time history analysis

on a ten-story RCC building frame, taking the time history of the 1940 el Centro earthquake into account. The fundamental parameters of seismic analysis are the load-carrying capacity, ductility, stiffness, damping, and mass of structures. Other response parameters such as base shear, storey drift, and storey displacements are determined. The calculated storey drift is compared to the minimal storey drift criterion specified in IS 1893:2002.

5. "Water Tank Analysis Using STAAD PRO" was done by Manik Ghoshal. The study and design of an elevated circular water tank with STAAD are included in this work. V8i software is a professional version of the V8i programme. Manual load calculations are being used in the design, along with STAAD study of the entire structure. V8i (Pro) In STAAD, the design method was used. The water tank is susceptible to wind, dead load, self-weight, and hydrostatic load owing to water, and the corresponding analysis is Limit State Design. The water needs of a community of 120 families were investigated in this study. As a result, STAAD constructed an above water tank. STAAD.Pro software to meet the locality's water needs.
6. "Analysis and Design of Intze Water Tank Using STAAD Pro" was completed by Chandana Imadabathuni, Padala Sri Vardhan Goud, Nalla Ravi Kiran, and Bathula Naveen. The wind load was also taken into account in this investigation. Intze Water is constructed with a capacity of 300,000 litres and a 12 metre staging made of M30 concrete. The tank was designed both manually and with STAAD Pro, and the program's results demonstrate that the design is safe. The manual design of all the components of an elevated design has been discussed in this study work.
7. The wind evaluation of an overhead INTZE type water tank was done by Dubey.D., Dubey.S., and Bajpai Y.K. using the STAAD- Pro Software programme. They came to the conclusion that the Designed Wind Forces for Zone I were around Zone II's is 21% lower, region III's is 35–37% lower, zone IV's is 45–47% lower, zone V's is 55–57% lower, and area VI's is 71–73% lower. Also Region I's lateral displacements are set at 29 percent less than region II's, 45 to 46 percent less than region III's, 50 to 52 percent less than region IV's, 56 to 58 percent less than region V's, and 63 to 65 percent less than region VI's.

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Chapter 4

Modeling with STAAD.Pro

The most commonly employed engineering software programme for 3D is Staad.Pro v8i. Modeling, analysis, and multilateral design are all examples of multilateral design. It offers a user-friendly UI. A suite of other modelling and design software programmes, as well as visual tools, efficient analysis, and design capabilities. Building specialists all over the world chose Staad.Pro for static and dynamic research. Bridges, containment systems, embedded structures, concrete stadiums, and the fundamentals are just a few of the topics covered. Construction.

STAAD Pro is a widely used civil engineering structural application that can work on problems like wind and seismic analysis utilising various load combinations to confirm various codes like IS4562000, IS18932002, IS8751987, IS18932016, and so on. The acronym STAAD stands for "STRUCTURAL AIDED.ANALYSIS.AND.DESIGN." STAAD Pro is a popular piece of software in the construction industry because of below stated benefits:

1. Ease of use,
2. Per Indian Standard code
3. Higher efficiency and time saving
4. A wide range of problems can be worked
5. High level of precision in results

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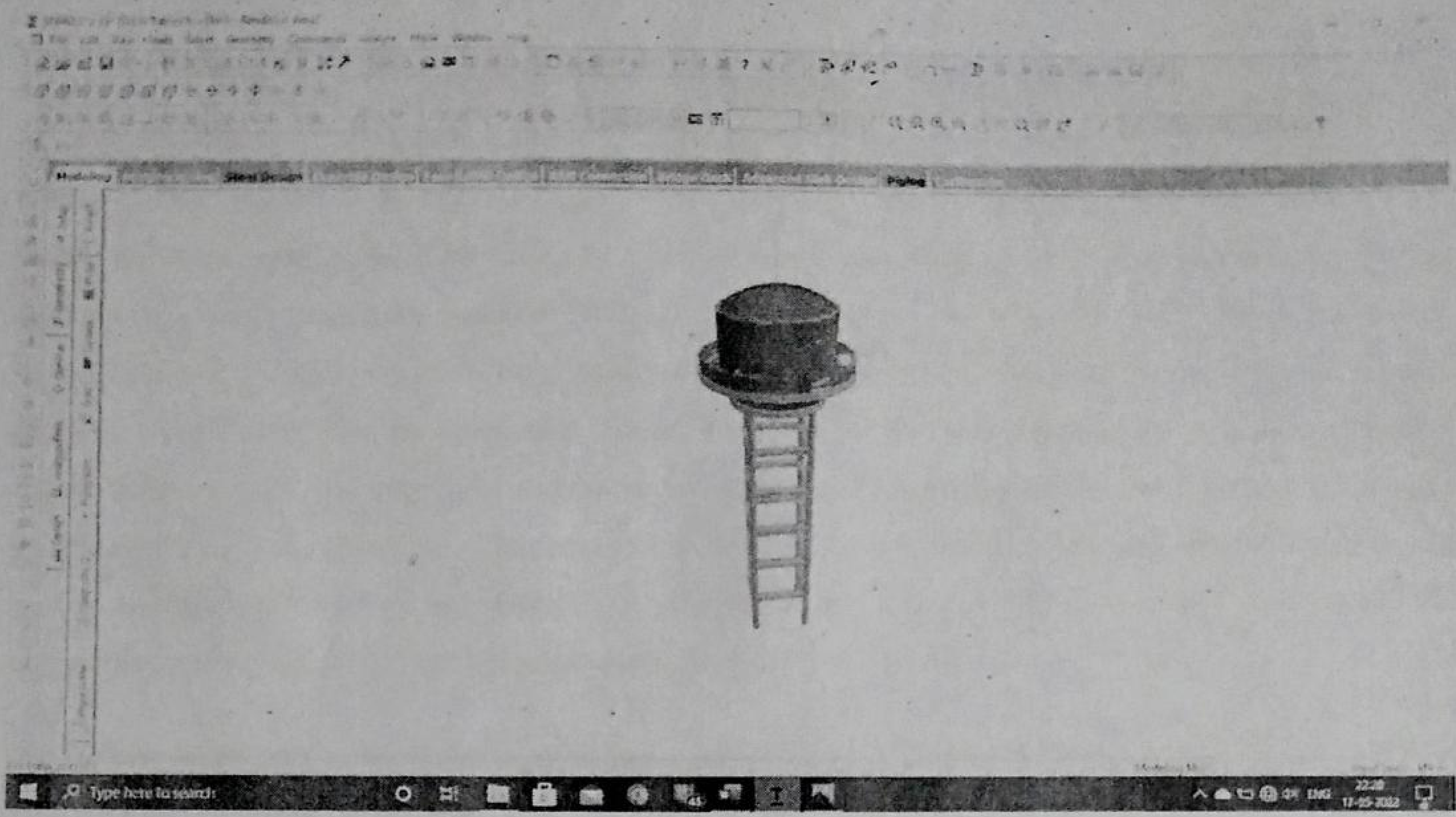


Fig. 3 3D rendered view in STAAD.Pro

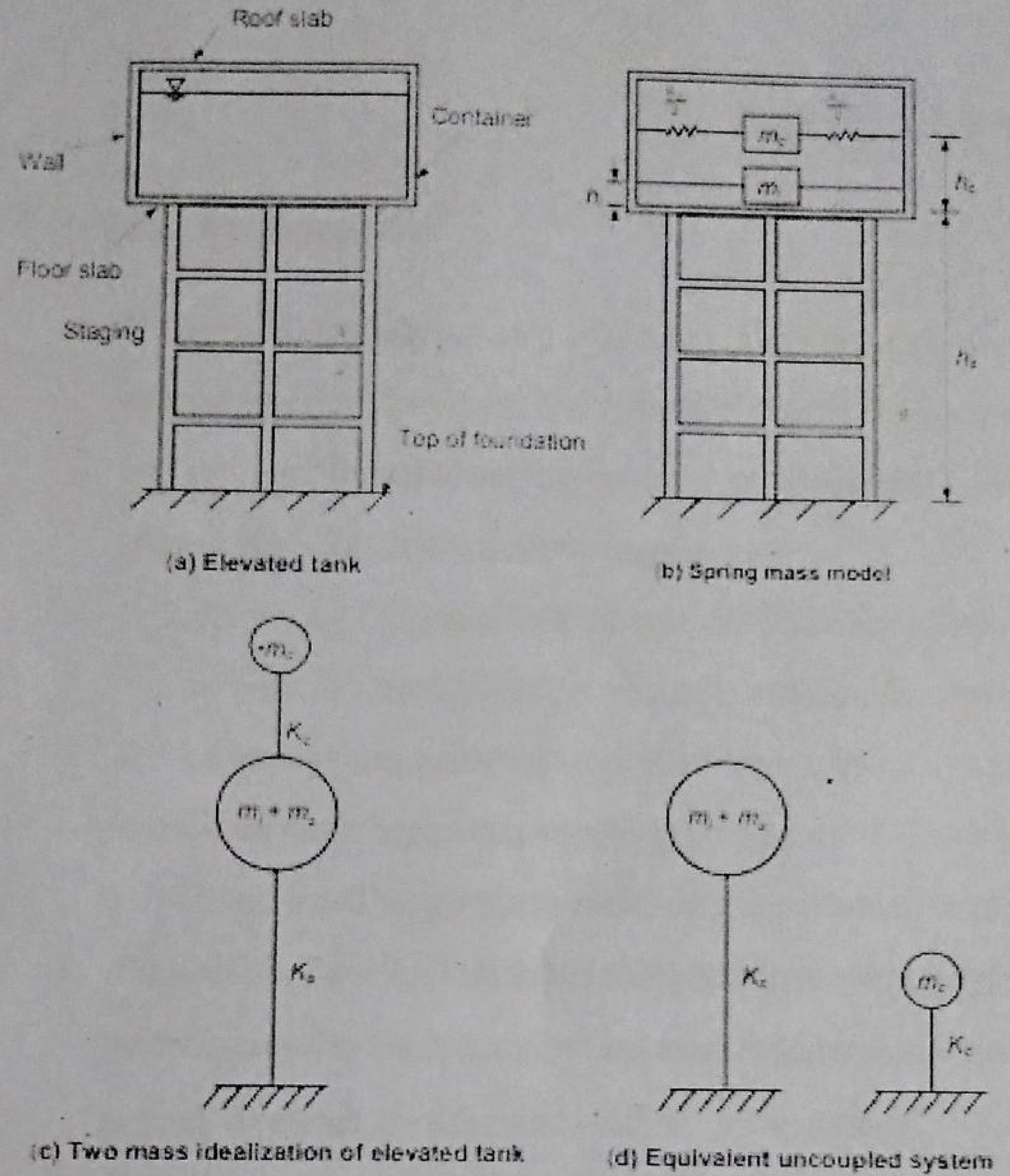
CHAPTER 5

DYNAMIC STRUCTURAL ANALYSIS

While seismic excitation occurs, the liquid within the tank exerts a hydrodynamic force on the tank walls and base, complicating the analysis. The dynamic interaction of fluid and structure is a major concern for such structures because it alters their response to transient and cyclic activation. During seismic excitation, the hydrodynamic pressure in a flexible tank may be significantly higher than in a rigid tank due to interaction effects between the flexible construction and the contained liquid. In most cases, the impulsive and convective terms of the earthquake's hydrodynamic pressure can be distinguished. The impulsive component is caused by the interaction of the tank wall with the liquid and is highly dependent on the flexibility of the wall, whereas the convective component is caused by the interaction of the tank wall with the liquid.slosh waves.

Sloshing is a dynamic load that acts on a tank's structure as a result of fluid motion with a restricted free surface within the tank. Its characteristics can vary greatly depending on the tank configuration and seismological parameters of the applied load, resulting in severely localised pressure on the tank walls on rare occasions. To evaluate hydrodynamic forces exerted during seismal activity, advanced dynamic modelling of the tank liquid system that accounts for the hydrodynamic forces imposed by the fluid on the tank wall is required. On the other hand, the availability of mechanical tank models has greatly simplified the study. Elevated tanks could theoretically be idealised by a two-mass model, as shown in Figure. The majority of elevated tanks are never completely full. As a result, a two-mass idealisation of the tank is also permissible, as opposed to the one-mass idealisation used in IS 1893:1984. Housner (1963b) proposed the 2 mass model for elevated tanks, which is widely used in most international codes today. The reaction of the two-degree of freedom system could be predicted using basic structural dynamics. However, in raised tanks, the two periods appear to be well separated. As a result, the system can be thought of as two separate single-DOF systemsFor elevated tanks, the two DOF system in Figure could be treated as two uncoupled single degrees of freedom systems, with one representing the impulsive and structural mass as an inverted pendulum with lateral stiffness equal to that of the staging, ks, and the other representing the convective mass as a spring of stiffness, Kc..

PROVISIONS



(Refer Clause 4.2.2.4)

Figure 4 – Two mass idealization for elevated tank

Where mi, mc, Kc, and other parameters of the spring-mass model are given, along with charts and empirical formulas for determining their values. The parameters of this model are determined by the tank's geometry and flexibility.

The duration of impulsive mode, Ti in seconds, is calculated as follows:

$$Ti = 2\pi\sqrt{(mi + ms)/Ks}$$

CHAPTER 6

DESCRIPTION OF INTZE TANK

Different parts of the intze tank

1. Top dome: We typically provide a 100mm to 150 mm thick dome with reinforcement along the top latitudes and longitudes. The height of the dome is usually one-fifth of its length.
2. Top ring beam: The uppermost ring beam receives meridian thrust. The beam is built to withstand the hoop stress caused by water pressure.
3. . Cylindrical walls: Cylindrical walls are especially vulnerable to hoop tension caused by water pressure. As a result, the wall is designed to withstand the tension of the hoop.
4. The bottom ring beam connects the conical slab to the cylindrical wall. The ring beam is used to dampen the horizontal component of the conical wall's response to the cylindrical wall. The generated hoop tension is intended for the bottom ring beam.
5. . Conical slab: The slab is vulnerable to hoop tension as well as meridional thrust. Ring tension is caused by fluid pressure, whereas meridional tension is caused by vertical pressure. As a result, the slab must be built in a secure manner.,
6. The bottom slab could be domed or circular. This slab is supported by the lower ring beam.
7. Bottom ring beam: The bottom ring beam must be built to withstand the loads imposed by the inclined thrust slab and the beneath dome (outward thrust). It will be installed on the columns and may be designed to withstand the bending moment and torsion.
8. Columns: The columns are designed to transmit all of the tank's stress. When designing columns, wind and earthquake loads are considered. Columns are braced at regular intervals to withstand wind and earthquake forces.

Table 2. Problem Data

CONTENT	VALUE	UNIT
Capacity	150	Kl
Dia of cylindrical portion	7	m
Radius of tank	3.5	m
Rise of top dome	1.2	m
Rise of bottom dome	0.9	m
Height of conical dome	1.1	m
Dia of bottom dome	4.8	m
Radius of bottom dome	2.4	m
Free board	0.30	m
Radius of top dome	5.7	m
Radius of bottom dome R2	3.65	m
Ht required	3.5	M
	Say	m
Height (including freeboard)H	3.8	m
Actual capacity provide	156.5	kl
SBC	8.0	$T m^2$
Depth of foundation	3.0	m

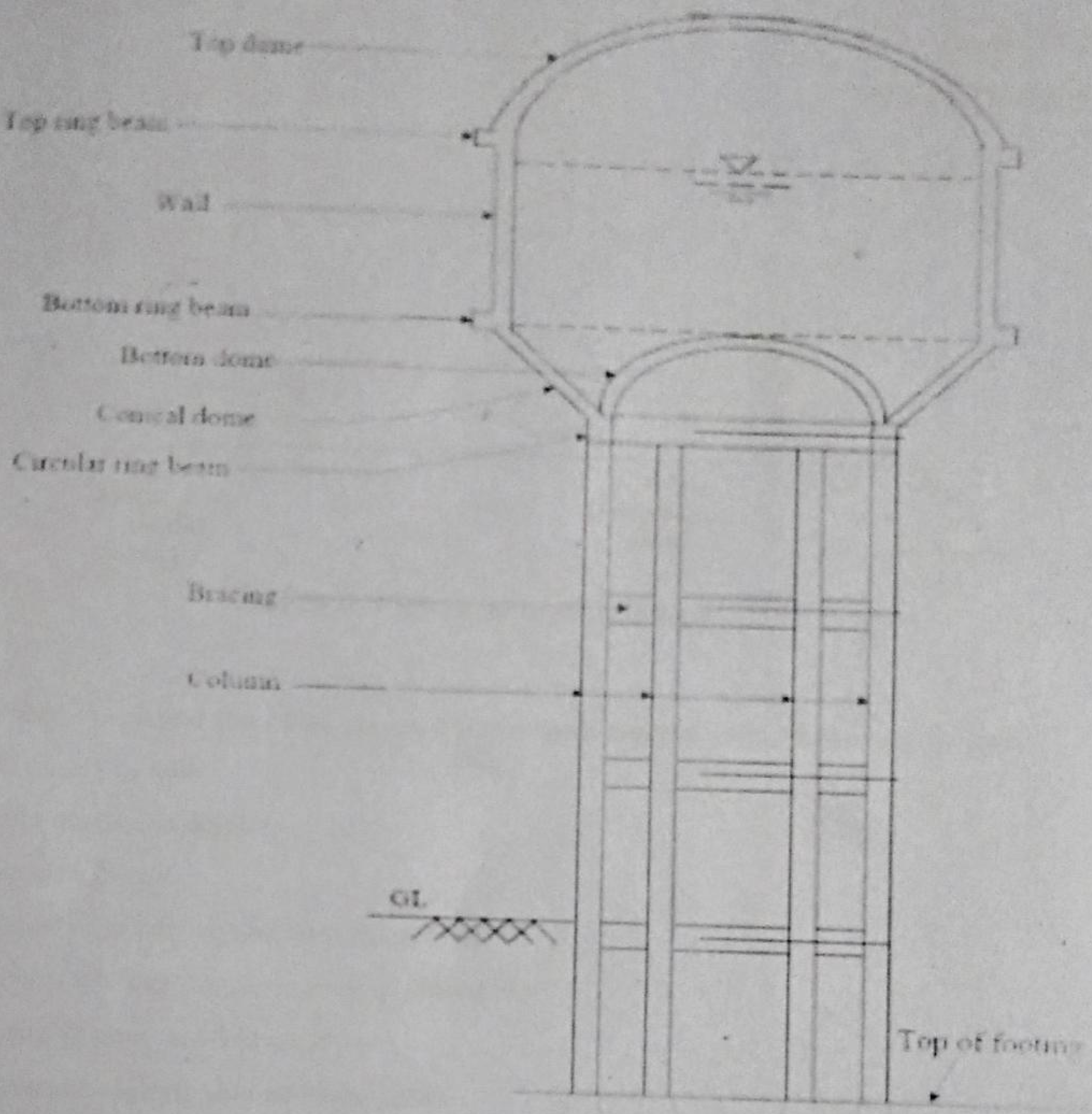


Fig .5 Elements of intze tank

CHAPTER 7

METHODOLOGY

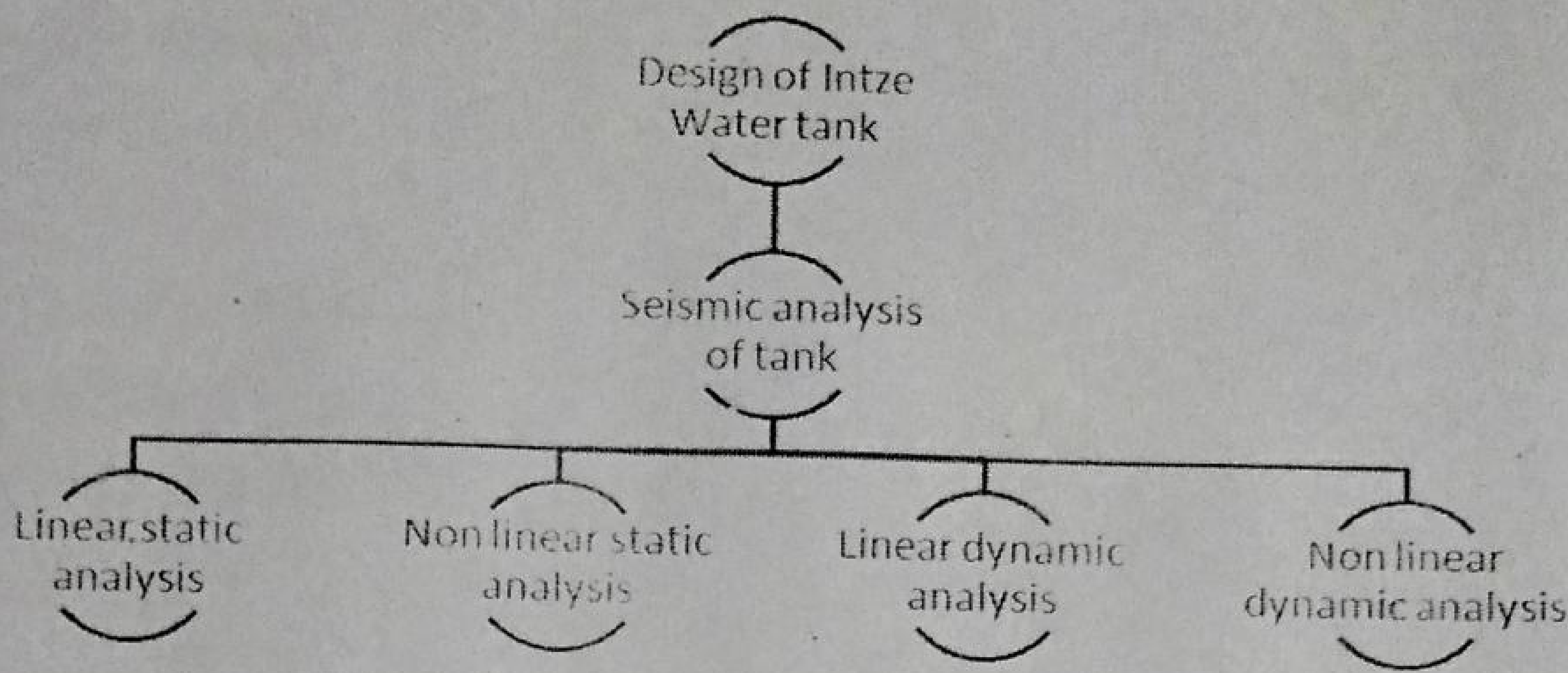


Fig 6. Figure of methodology

The feasible shape and size of an elevated water tank depend on the following factors:

1. Capacity of tank
2. The maximum depth for water.
3. Staging heights
4. Number of bearing and their frame type
5. Allowable bearing capacity of the foundation.
6. Seismic zone and Site conditions

The procedure of designing an intze tank.

1.Design of top ring beam as well as top dome

2. Designing of the cylindrical wall

3. Design of the ring beam to the conical dome

4. Design of conical and bottom spherical dome

5. Design of bottom ring beam

6. Design of supporting structure

7. Design of foundation

Design Steps

Dimensions of the water tank are below stated

Top Dome

Thickness of top dome= 100mm

Divisions along length= 10

Divisions along periphery=20

Ring beam B1

Width of ring beam= 200 mm

Depth of ring beam= 200 mm

Divisions along periphery= 20

Tank Wall

Thickness of tank wall= 200 mm

Divisions along length= 10

Divisions along periphery=20

Ring beam B2

Width of beam= 500 mm

Depth of beam= 300 mm

Divisions along periphery=20

Conical dome

Thickness of conical dome= 200 mm

Height of conical dome= 1m

Slant height= 1.556 m

Dia of mid height= 5.90 m

Divisions along periphery= 20

Bottom dome

Thickness=2oo mm

Dia of bottom Ring beam - B3= 4.8 m

Radius of bottom dome R2= 3.650 m

Bottom dome rise= 0.90 m

No. of bays along length= 10

No. of bays along periphery=20

Column

No. of columns= 4

Diameter of colum= 450 mm

Brace beam

Width of beam= 300 mm

Depth of beam= 500 mm

No. of braces= 5

Details of structure

The following table lists the seismic parameters that were used in this study:

Table 3. Seismic parameters

S.No.	Variables	Parameter
1.	Seismic Zone	II
2.	Seismic zone factor	0.10
3.	Soil Type	Medium
4.	Response Reduction Factor	4
5.	Importance factor	1.5
6.	Damping Ratio	0.05
7.	Type of tank	SMRF

Non-Linear Dynamic analysis/ Time History Analysis

In t– steps, the time-history analysis could be a stepwise technique that evaluates the loading and, as a result, the response history. The response is evaluated at each step based on the initial conditions (displacements and velocities), as well as the loading history and interval.

The time increment, or t, is used for analysis.

• The size of the output time step should be small enough to provide adequate resolution for time history analysis.

• The necessary ACCURACY is determined by the applied loading type's characteristics as well as the known and natural time period.

• The sufficiency of precision can also be tested by reducing the time step size until it is tiny enough to have no effect on the outcome. The start of a load assignment is determined by the arrival time

- Possibilities include positive, negative, and zero.Begins at time zero by default STAAD

  • For the negative time of arrival, the portion of the input that occurs before time zero is ignored.

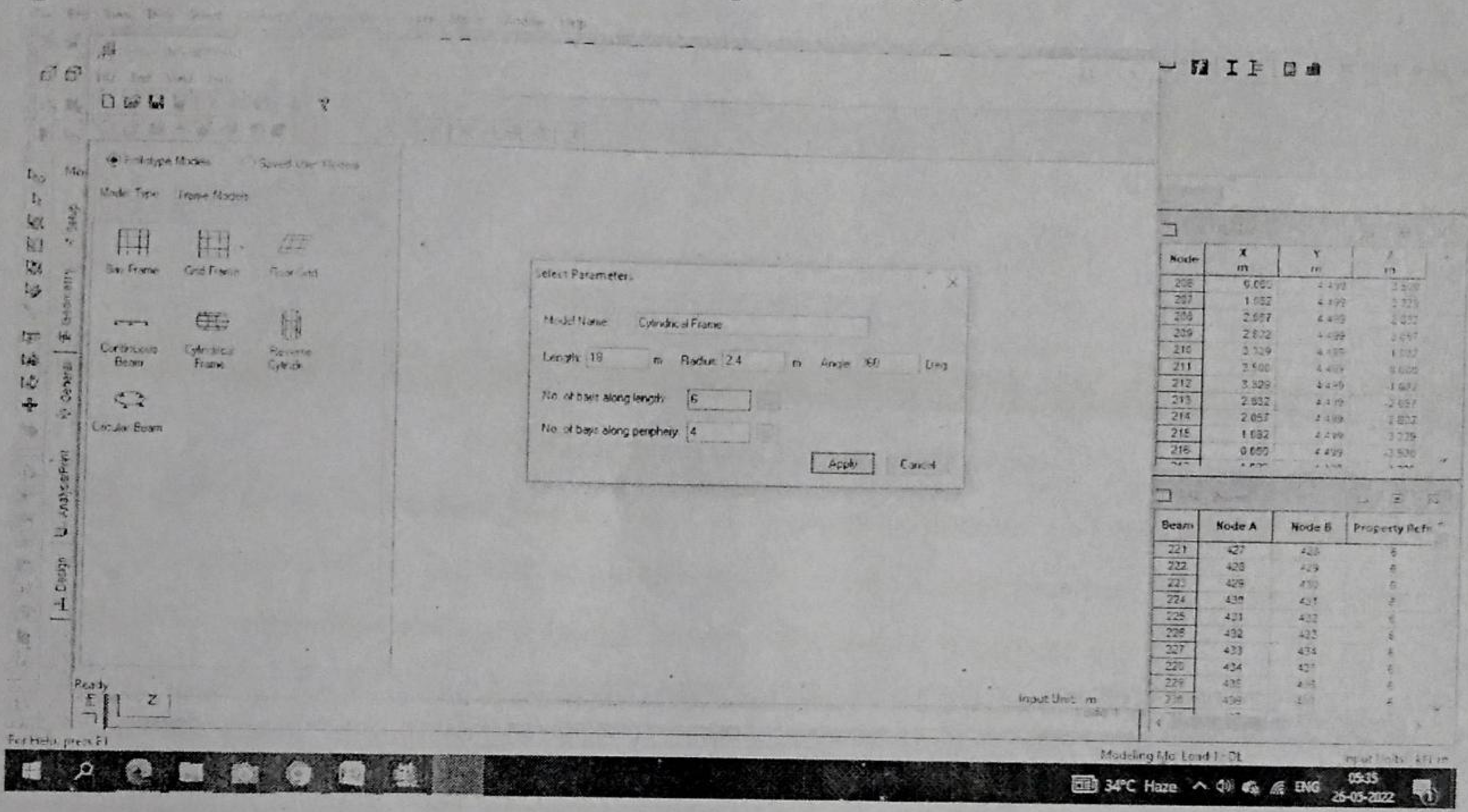
• Damping – This is used to apply a single modal damping ratio to all modes; the default value is 0.05.

• CDAMP-If a damping ratio based on the kind of material in the structure has already been determined under CONSTANT, that value can be employed immediately in the nonlinear dynamic analysis.

• MDAMP- If we need to employ a different damping ratio for each mode, we can use the MDAMP option.

- **MODELLING IN STAAD.PRO**
- **Step-1: Modeling: In order to take into account the type of structure, the Geometry and Structural Wizard tool was used.**

Fig 7. Modelling in STAAD.Pro



- **Step-2: Nodal Point Generation** According to the planning for the column's location in the building, their appropriate nodal point has been generated on that model. On that model, their appropriate nodal point was generated based on the planning for the column's location in the building.

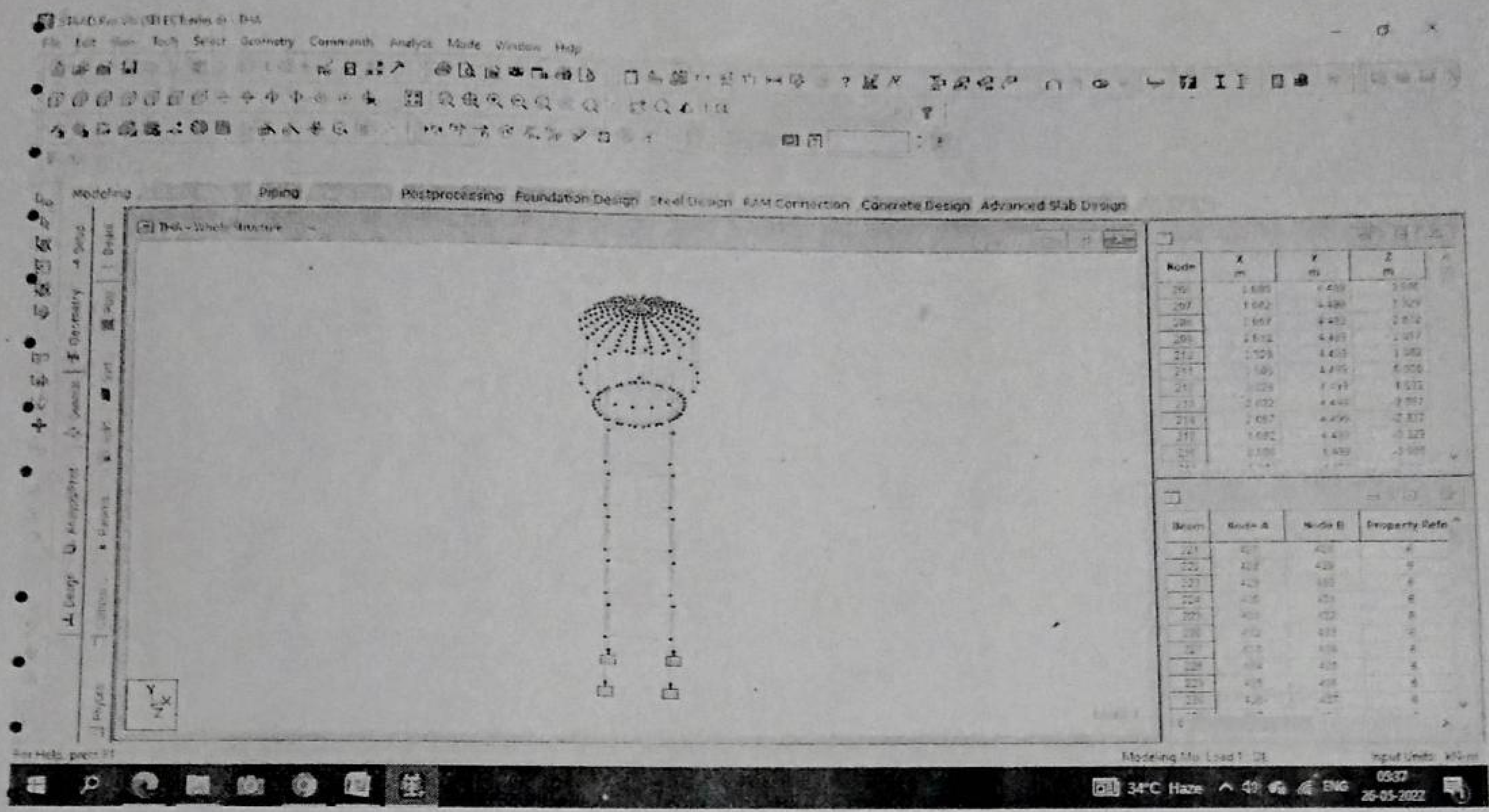


Fig 8 Generating nodal point in staad pro

- **Step-3 Property Definition:** Use the General-Property command in STAAD-Pro to define the property based on the size requirements of the individual structure. As a result, after allocating selected beams and columns, beams and columns have been created..

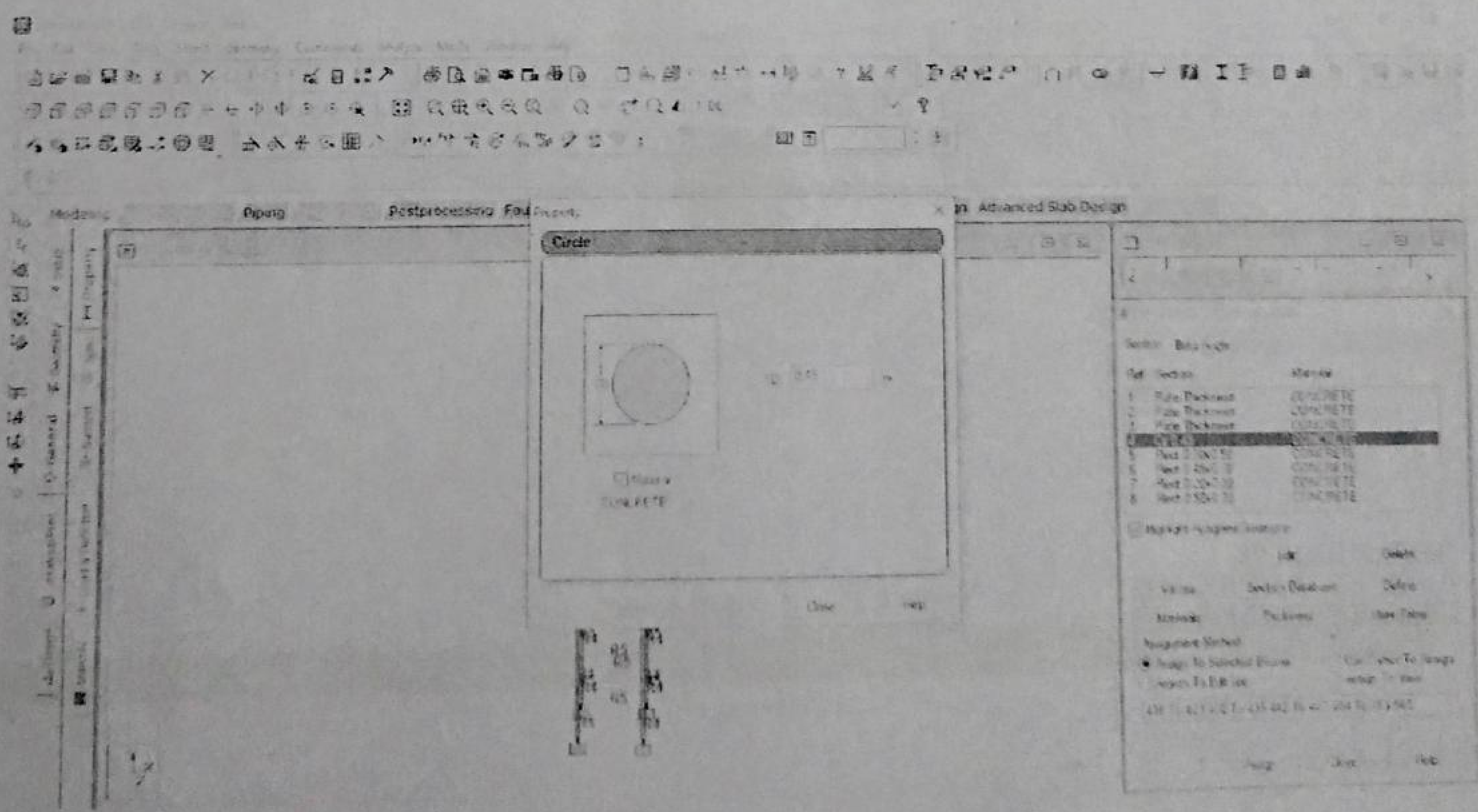


Fig 9 . Defining Properties of various element

- **Step-4: Create and Assign Support and Member Properties**: After selecting columns with the Node Cursor and assigning cross-sections based on load calculations and property definition, column definition at supports is provided as a fixed beneath each column.

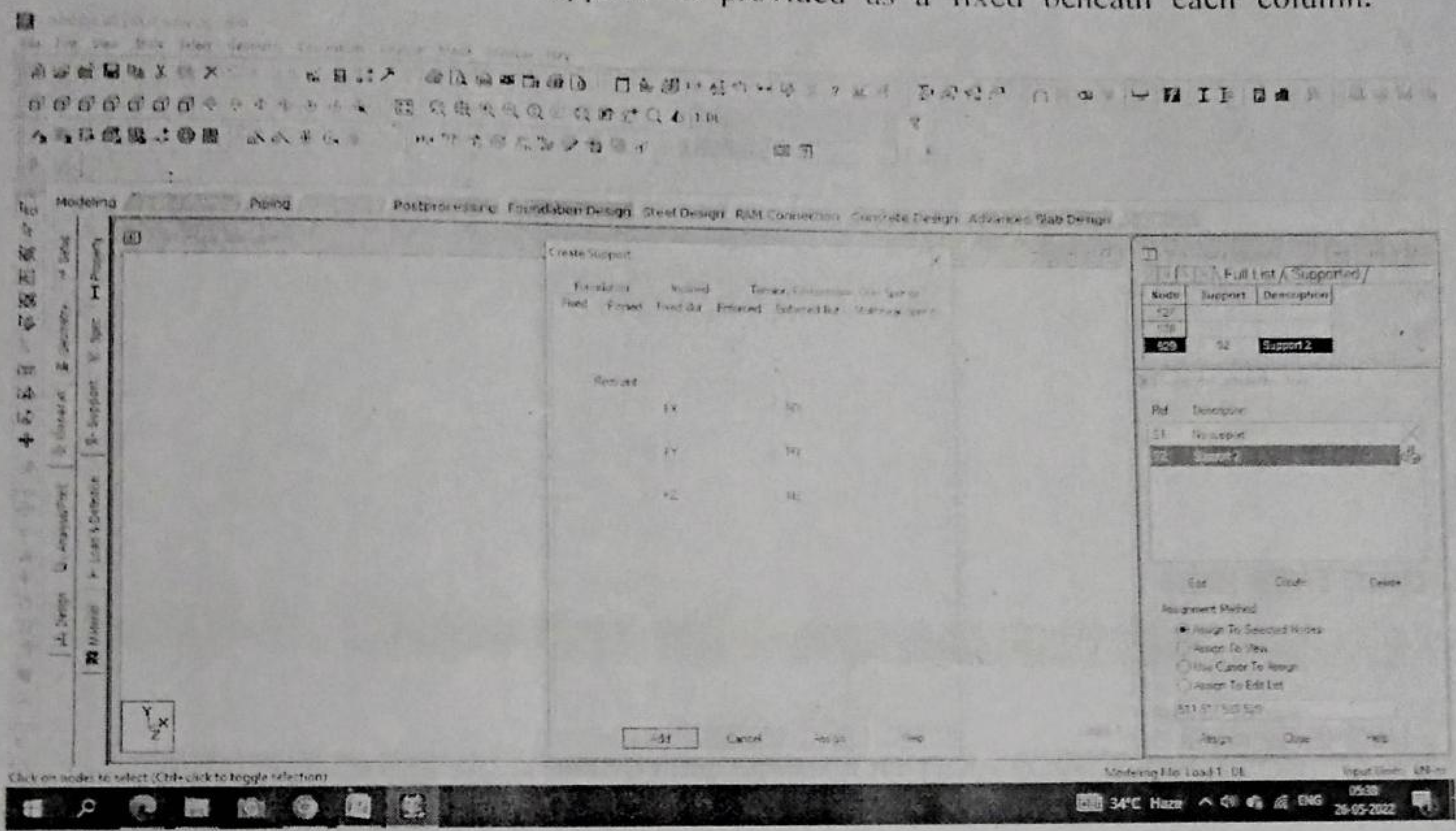


Fig 10. **Create and Assign Support and Member Properties**

- **Step-5: 3-DRendering:** After you've assigned the member property to the structure, you can use the 3-D Rendering command to see a 3-D view of it.

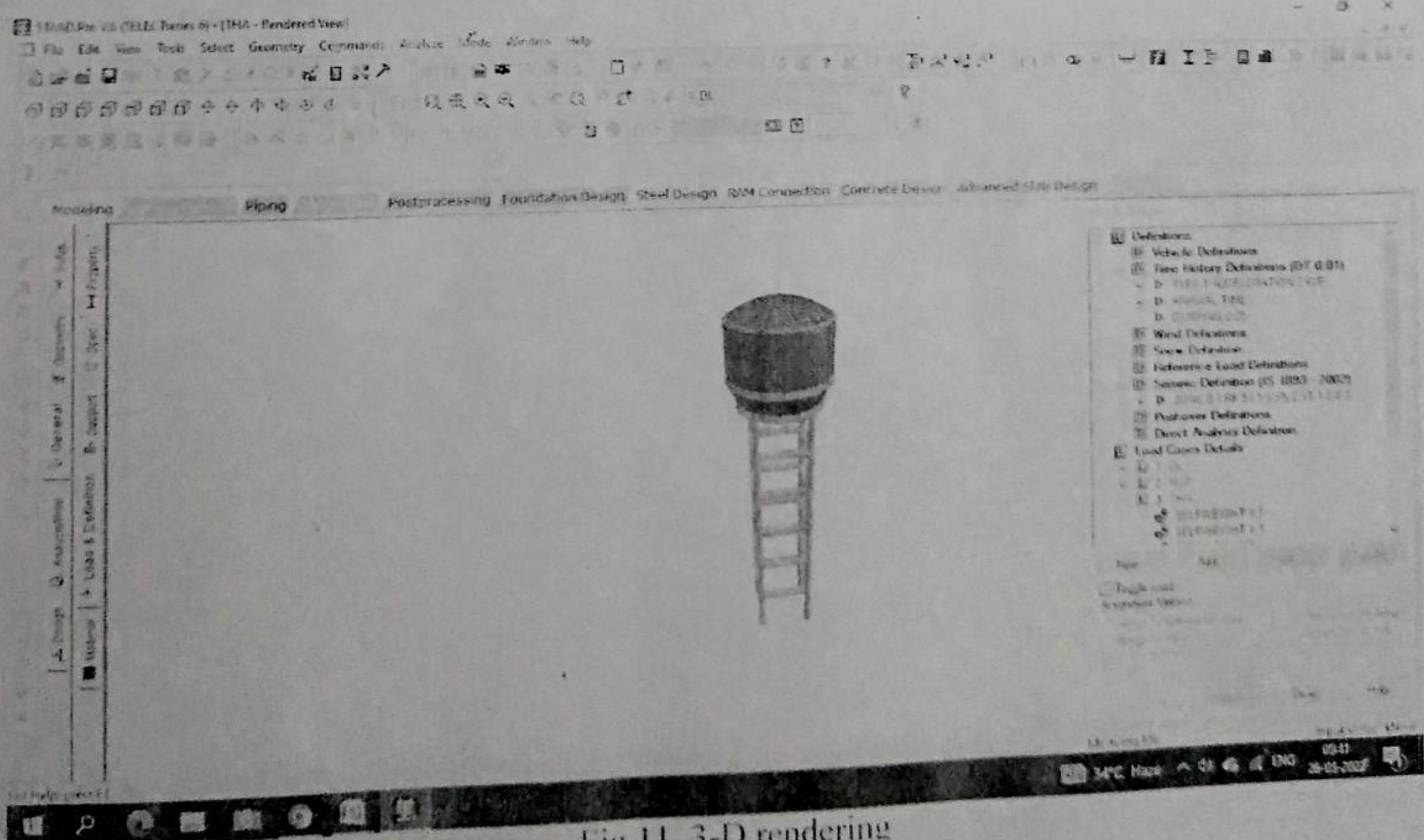


Fig 11. 3-D rendering

- **Step-6: Load Assigning:** Dead load, Hydrostatic Pressure, Earthquake loads.

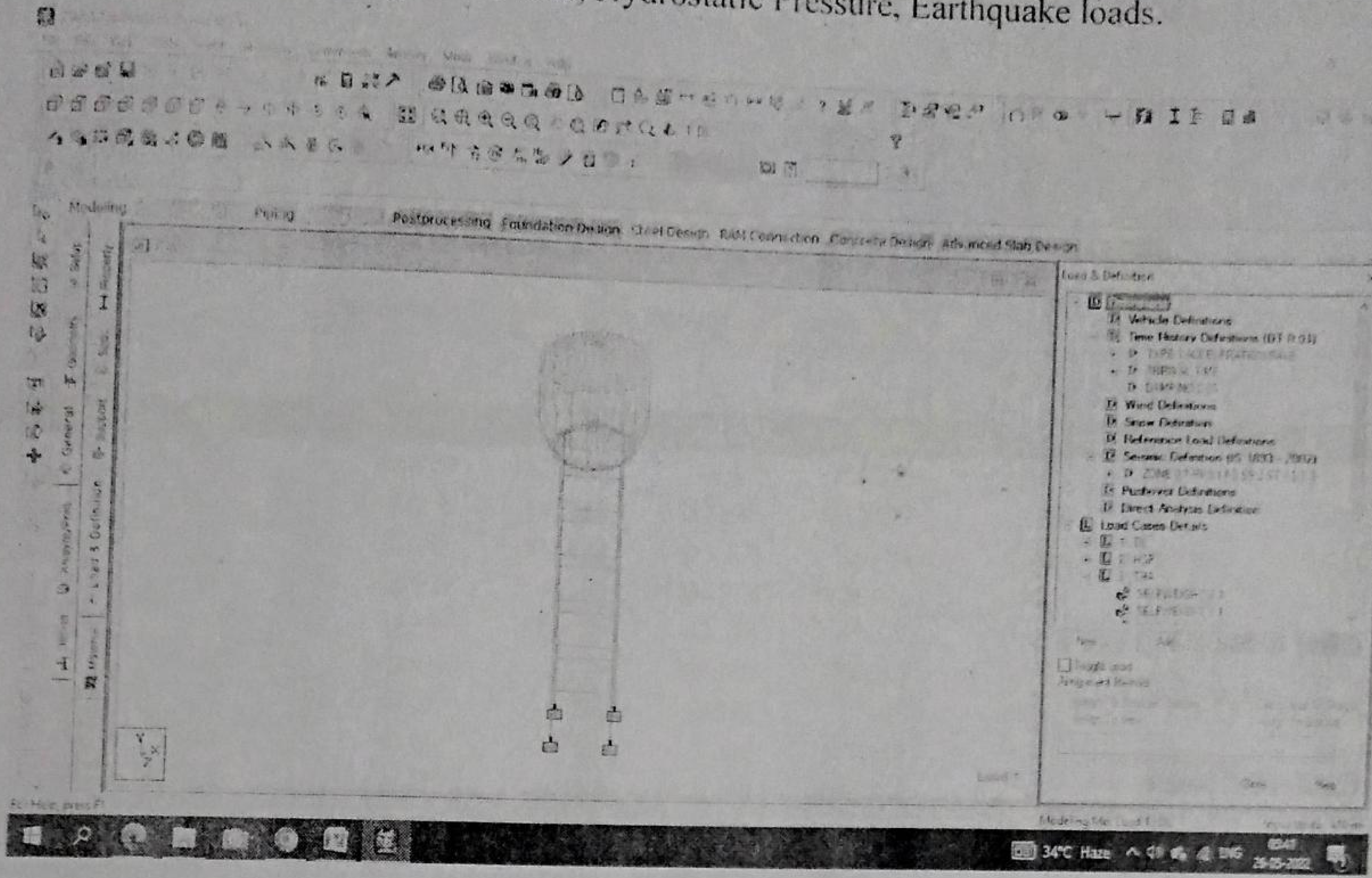


Fig 12 . Load assigning

- **Step-7: When a Time History Analysis is finished,** STAAD-Pro is utilised to generate output. The structure is then thoroughly investigated, with the Post-processing mode utilised to identify shear forces and bending moment diagrams in order to determine whether or not they are safe. Errors have also been double-checked..

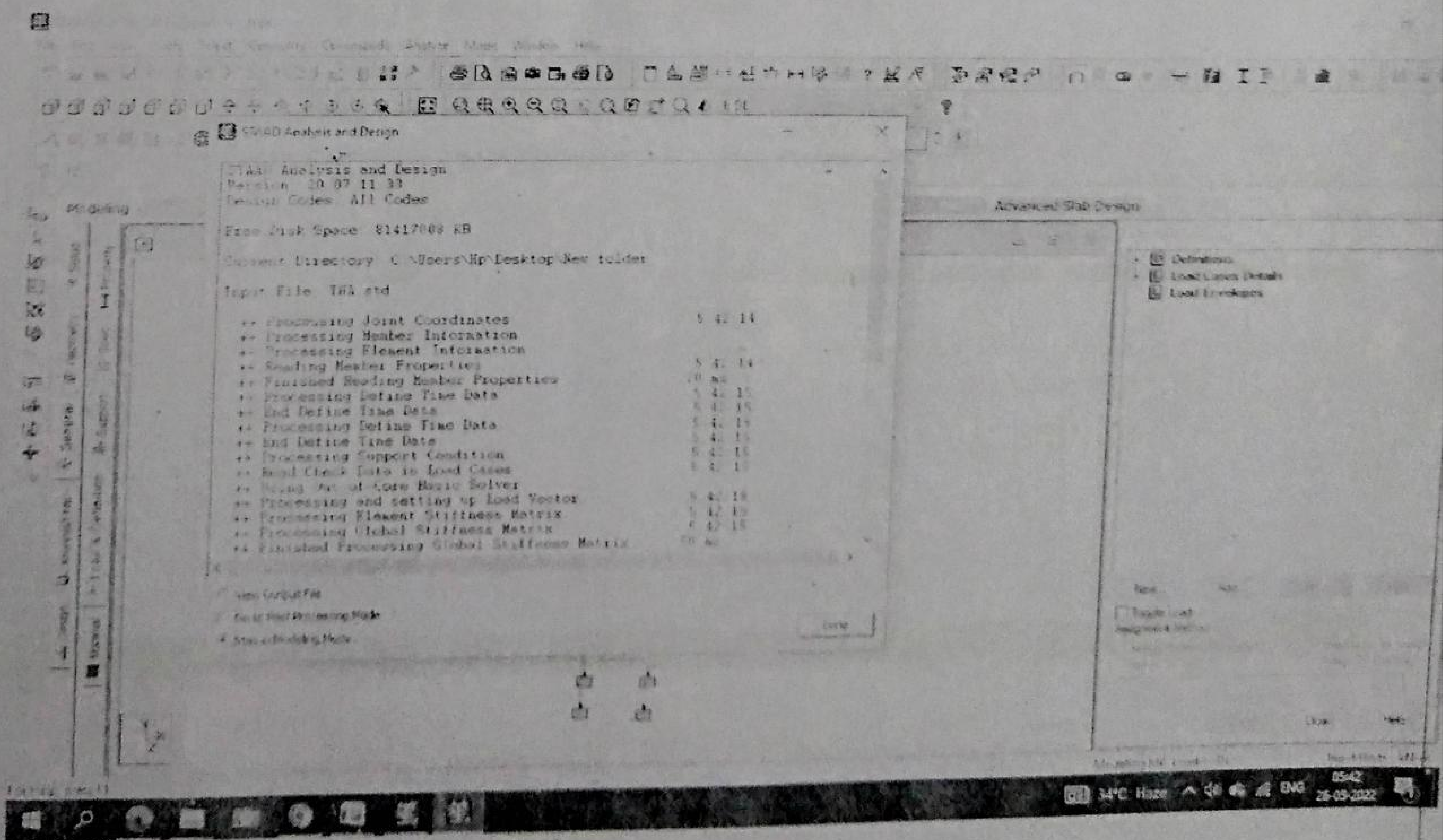


Fig 13 When a time History Analysis

RESULT

1. RESPONSE OF NODE

Table 4. Response Summary of Node

	Node	L/C	Horizontal X mm	Vertical Y mm	Horizontal Z mm	Resultant mm	Rotational rX rad	Rotational rY rad	Rotational rZ rad
Max X	296	3 THA	1213.196	68.277	1240.993	1736.827	0.020	-0.006	-0.015
Min X	419	2 HSP	-56.623	-179.584	-4.622	188.336	0.001	0.017	-0.000
Max Y	218	3 THA	1206.030	111.645	1212.205	1713.597	0.021	-0.007	-0.015
Min Y	295	2 HSP	-32.255	-182.022	-18.220	185.754	0.000	0.016	0.000
Max Z	311	3 THA	1200.892	-4.395	1255.770	1737.561	0.020	-0.006	-0.015
Min Z	211	2 HSP	2.531	-178.451	-63.330	189.372	-0.001	0.016	-0.002
Max rX	515	3 THA	352.434	13.481	355.566	500.818	0.065	0.001	-0.065
Min rX	493	2 HSP	39.922	-29.452	-10.966	50.808	-0.029	0.015	-0.019
Max rY	441	2 HSP	39.952	-172.360	9.689	177.195	0.013	0.018	-0.003
Min rY	423	3 THA	1138.073	94.752	1126.240	1603.934	0.020	-0.007	-0.015
Max rZ	497	2 HSP	-9.625	-30.058	-42.989	53.331	-0.019	0.015	0.029
Min rZ	521	3 THA	355.505	-15.737	350.829	499.713	0.064	0.001	-0.065
Max Rs	334	3 THA	1210.373	34.815	1251.689	1741.534	0.020	-0.006	-0.015

- **Response due to dead load**

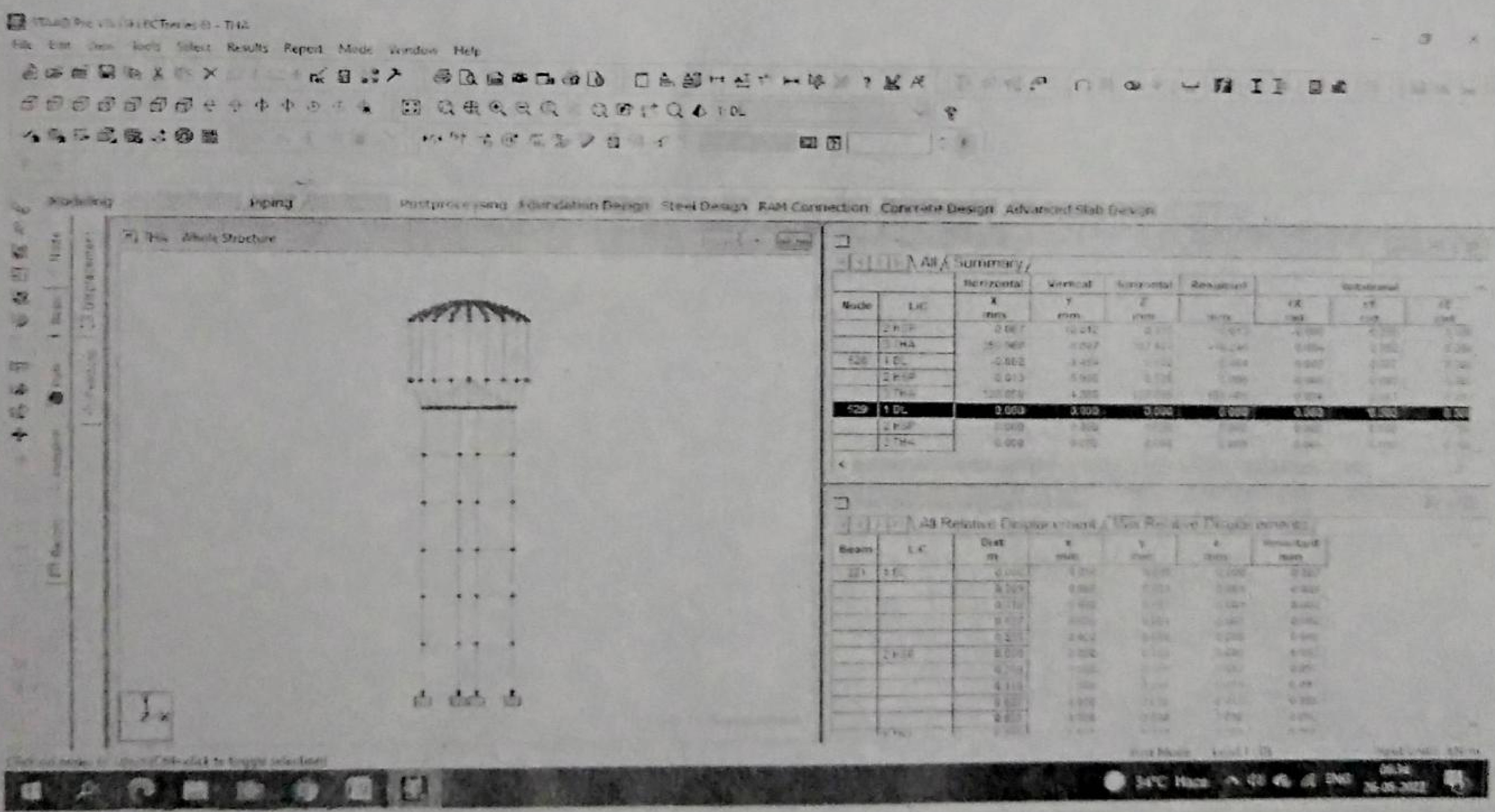


Fig 14. Response of node due to dead load

- **Response of node due to HSP**

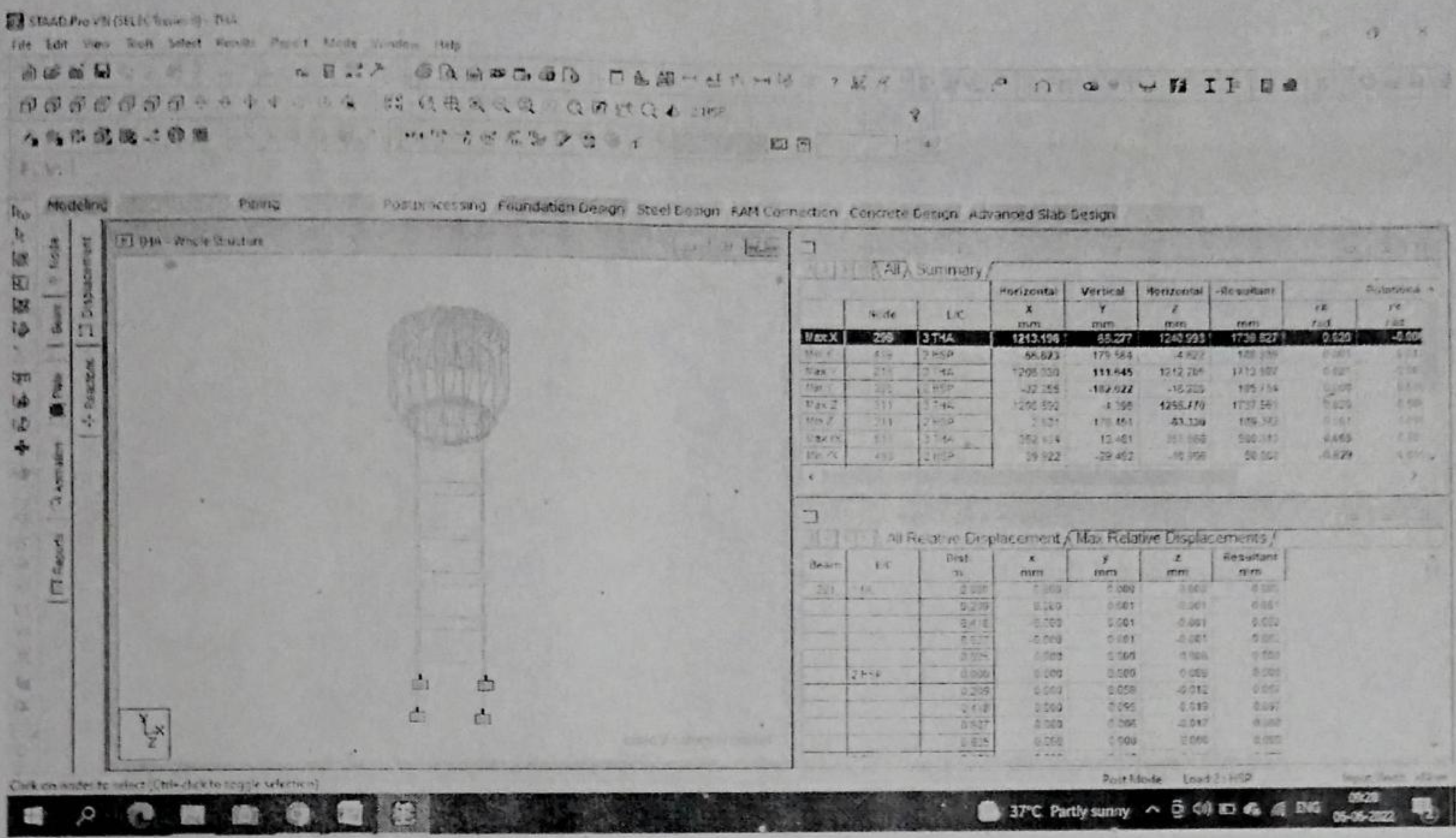


Fig 15 Response of node due to HSP

- **Response due to THA**

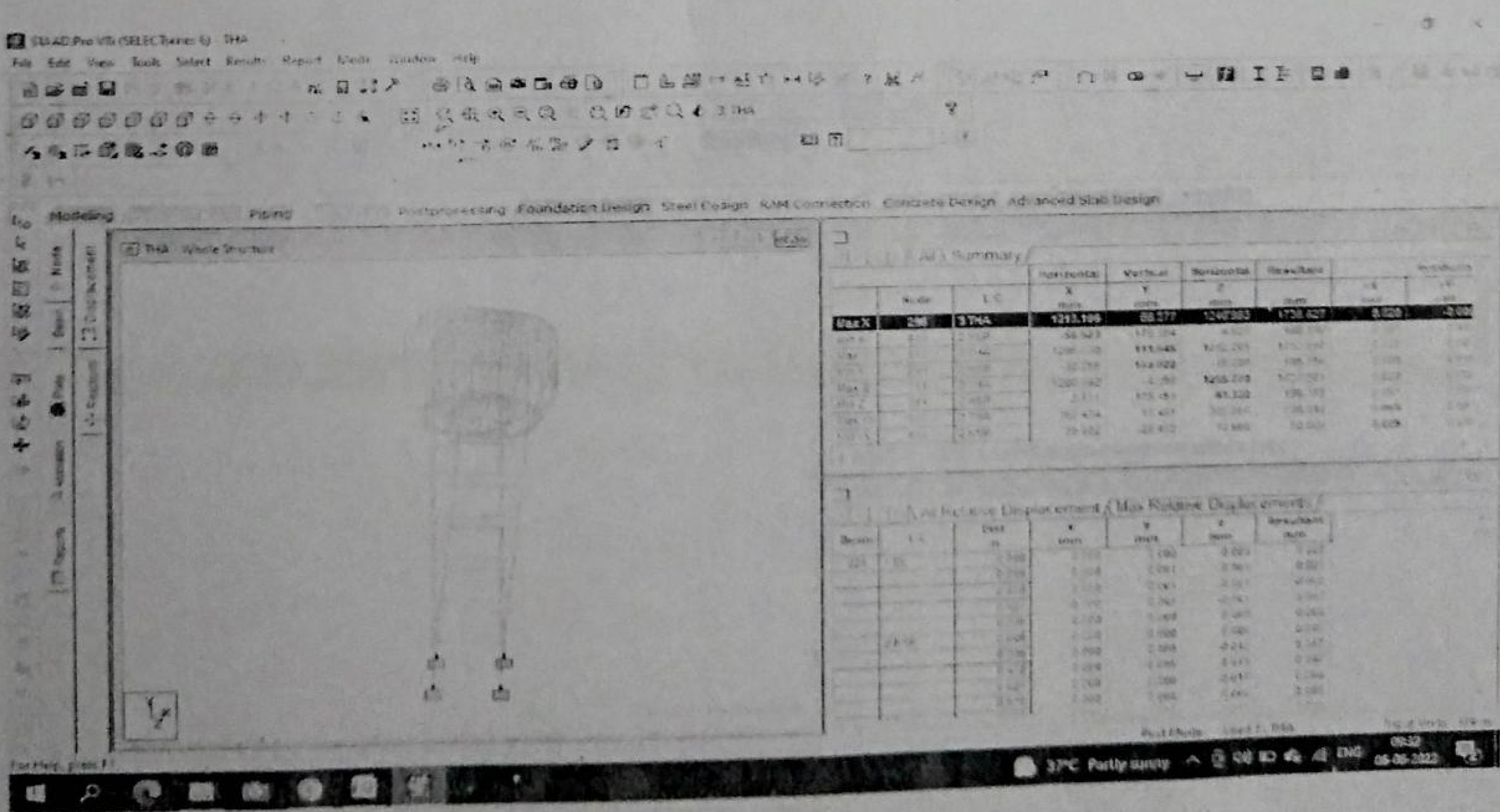


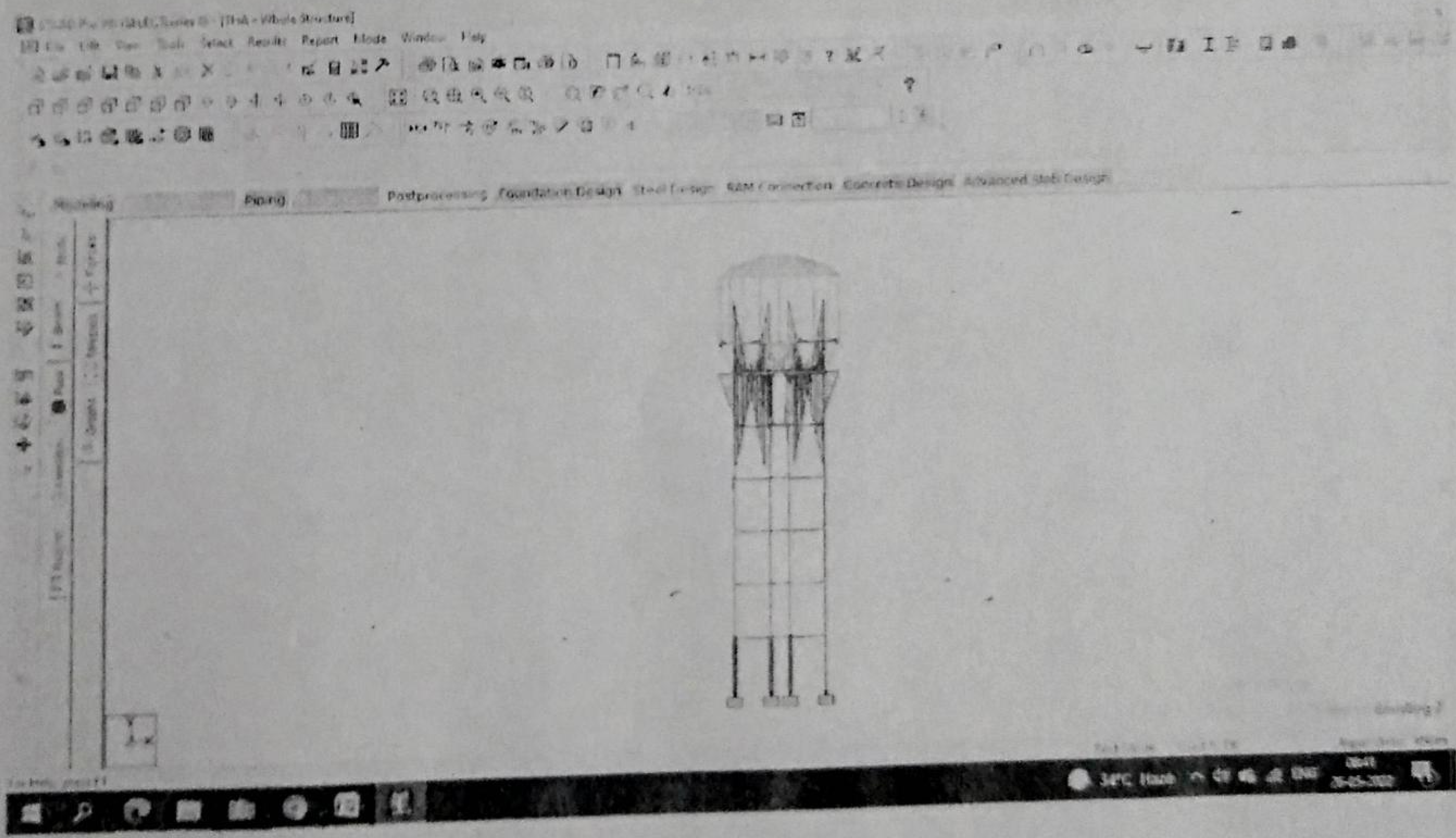
Fig 16 Displacement due to THA

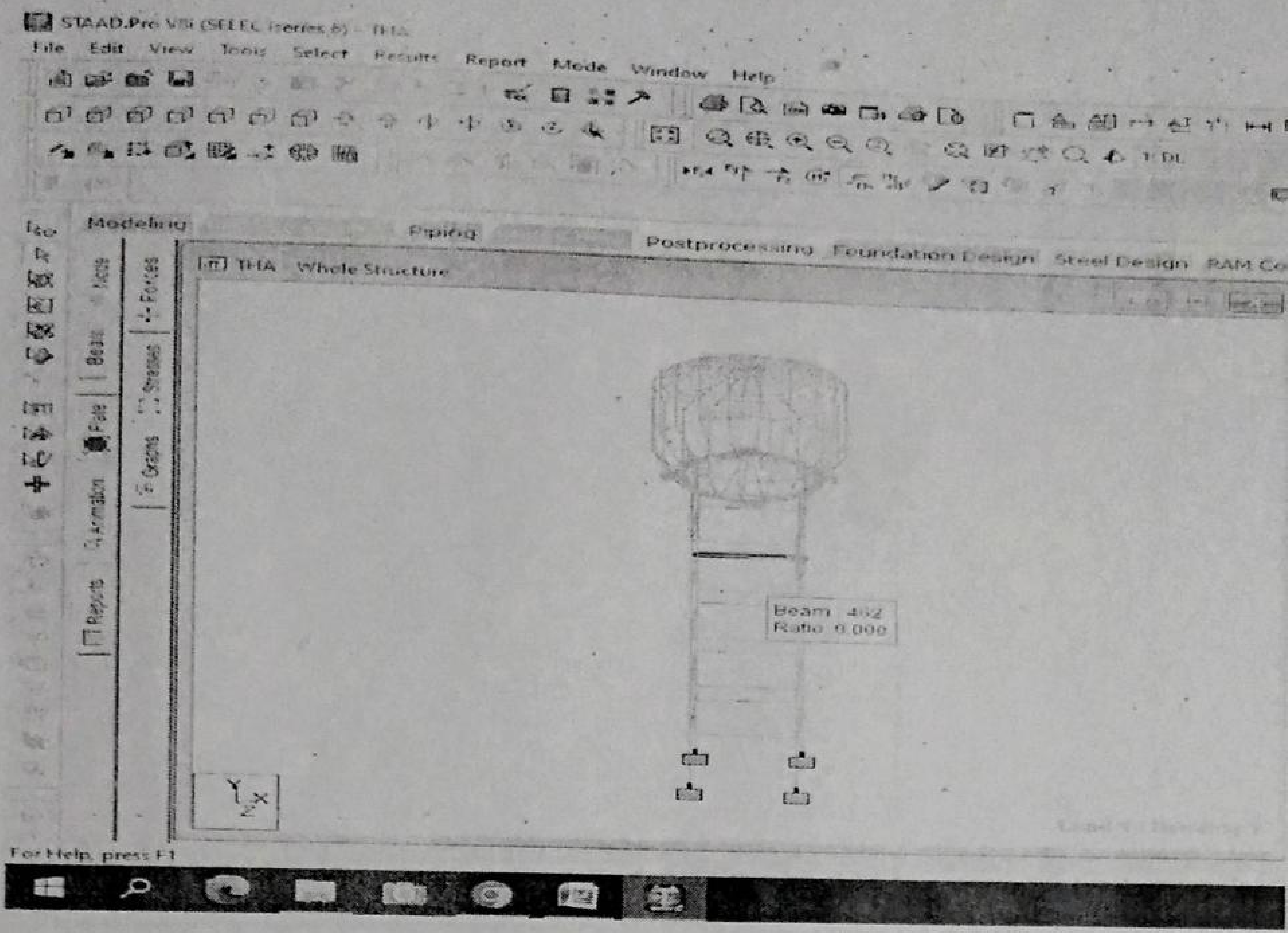
2. BEAM RESPONSE

- Table 5 Beam response summary due to Loads

	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kNm	My kNm	Mz kNm
Max Fx	447	3 THA	522	9908.369	890.762	872.486	-6.411	-533.796	552.720
Min Fx	423	3 THA	511	-11567.694	894.146	912.480	-8.275	2143.870	-2107.877
Max Fy	409	2 HSP	497	107.878	5781.981	-159.300	-764.467	-25.460	6801.378
Min Fy	224	2 HSP	430	8071.045	-3899.879	-112.524	-923.951	-750.281	-431.225
Max Fz	435	3 THA	517	-8364.140	909.836	918.113	-5.899	2160.298	-2140.177
Min Fz	418	2 HSP	502	5772.217	-39.608	-533.440	-181.911	1290.817	150.160
Max Mx	448	2 HSP	493	233.410	-1609.572	34.832	1094.044	-64.481	-4084.151
Min Mx	234	2 HSP	440	8240.400	-3712.989	-127.939	-951.673	-759.908	-320.978
Max My	435	3 THA	517	-8364.140	909.836	918.113	-5.899	2160.298	-2140.177
Min My	418	3 THA	502	-2677.620	469.671	631.509	49.325	-1487.327	1054.453
Max Mz	409	2 HSP	497	107.878	5781.981	-159.300	-764.467	-25.460	6801.378
Min Mz	409	2 HSP	431	107.878	5781.981	-159.300	-764.467	-450.791	-8636.497

- Beam response due to DL

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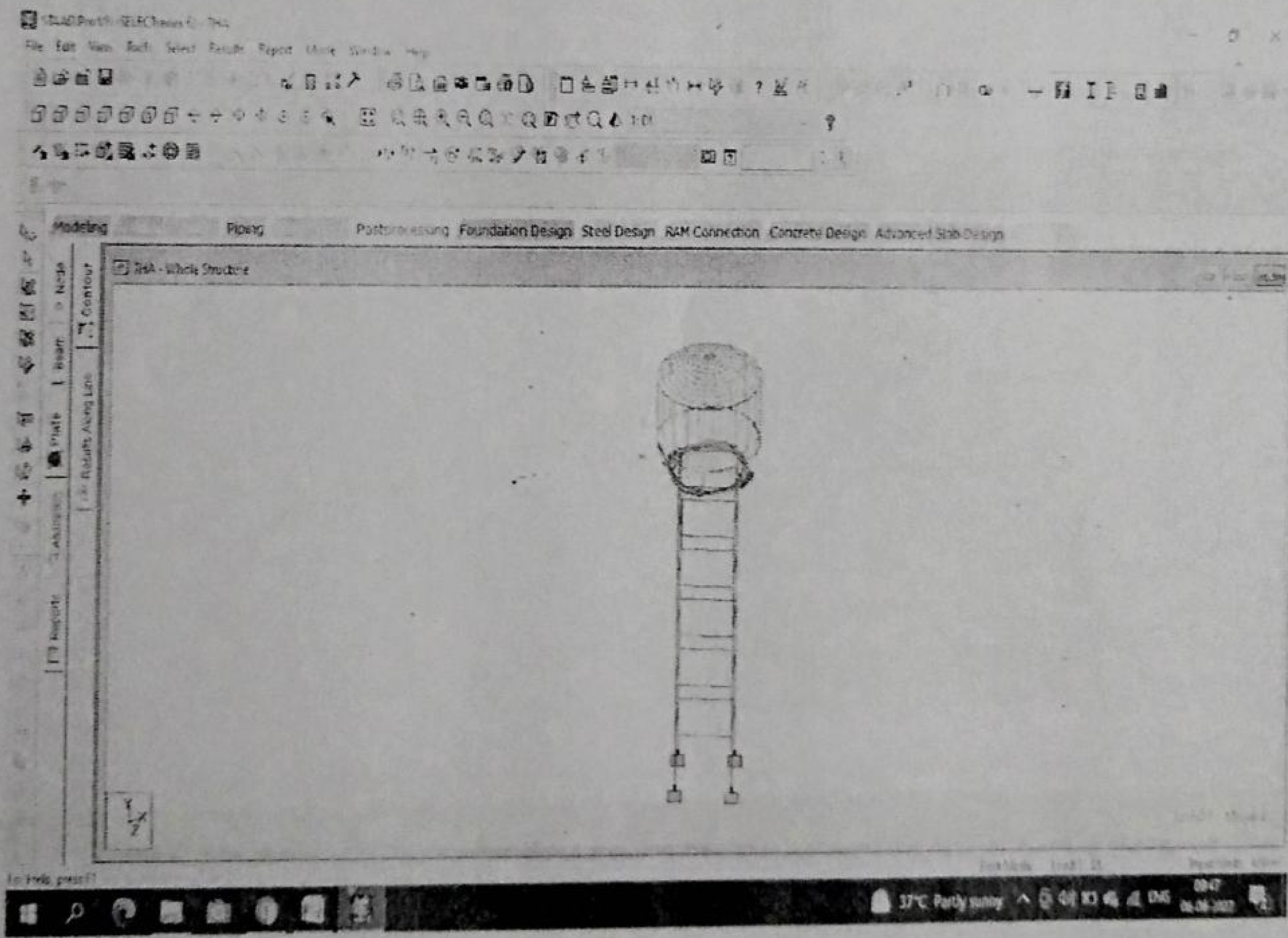
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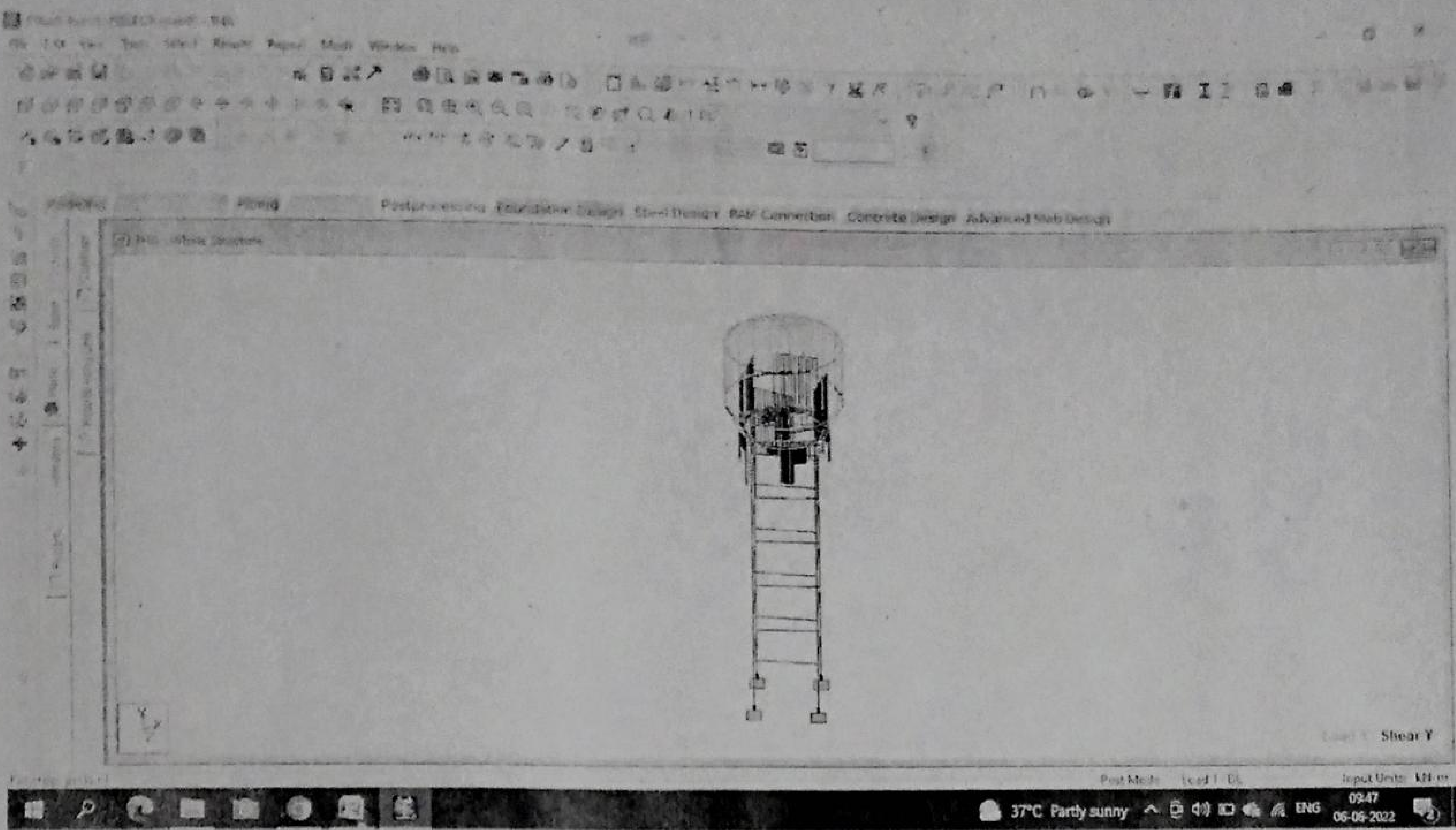
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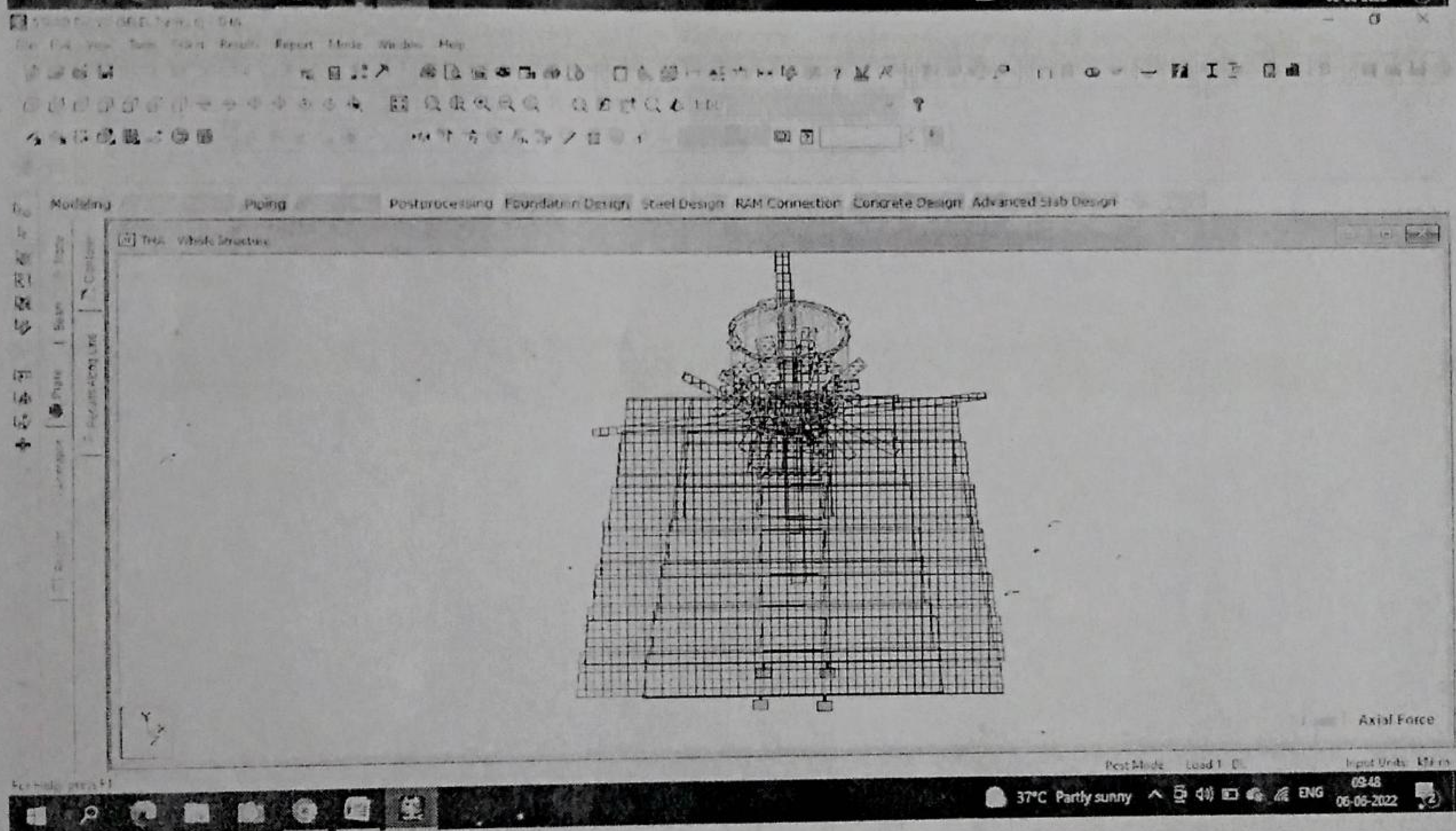
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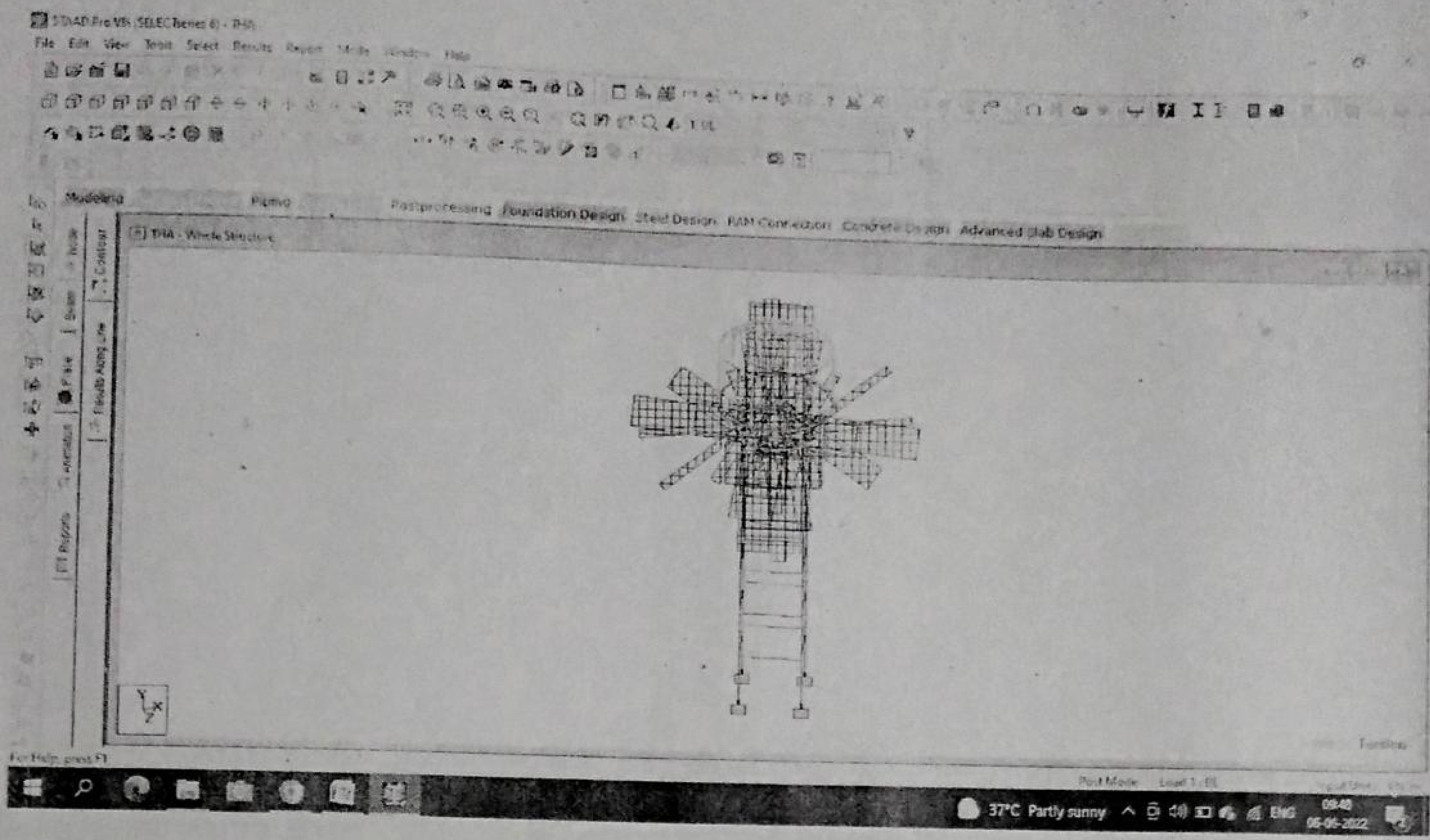


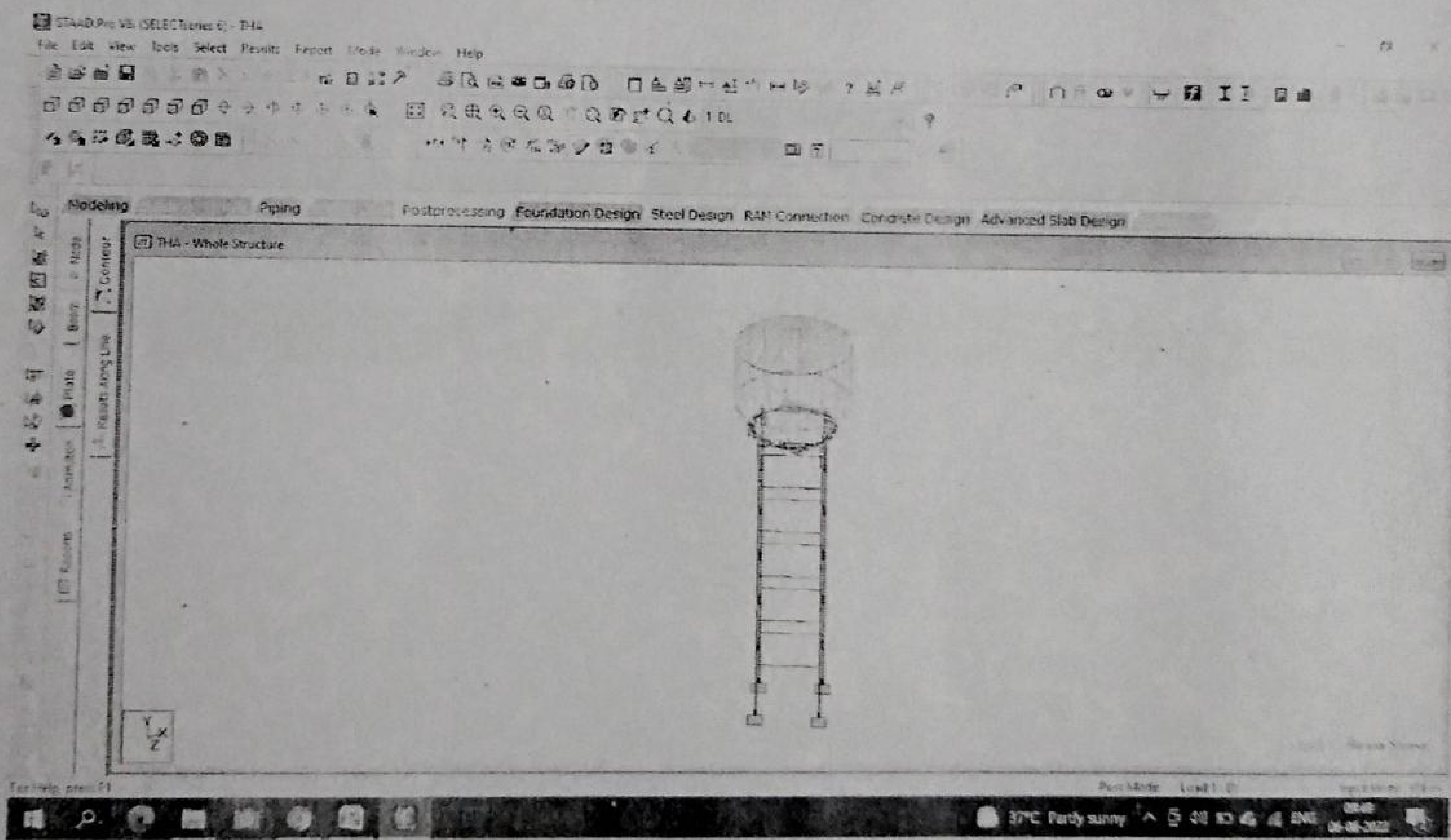
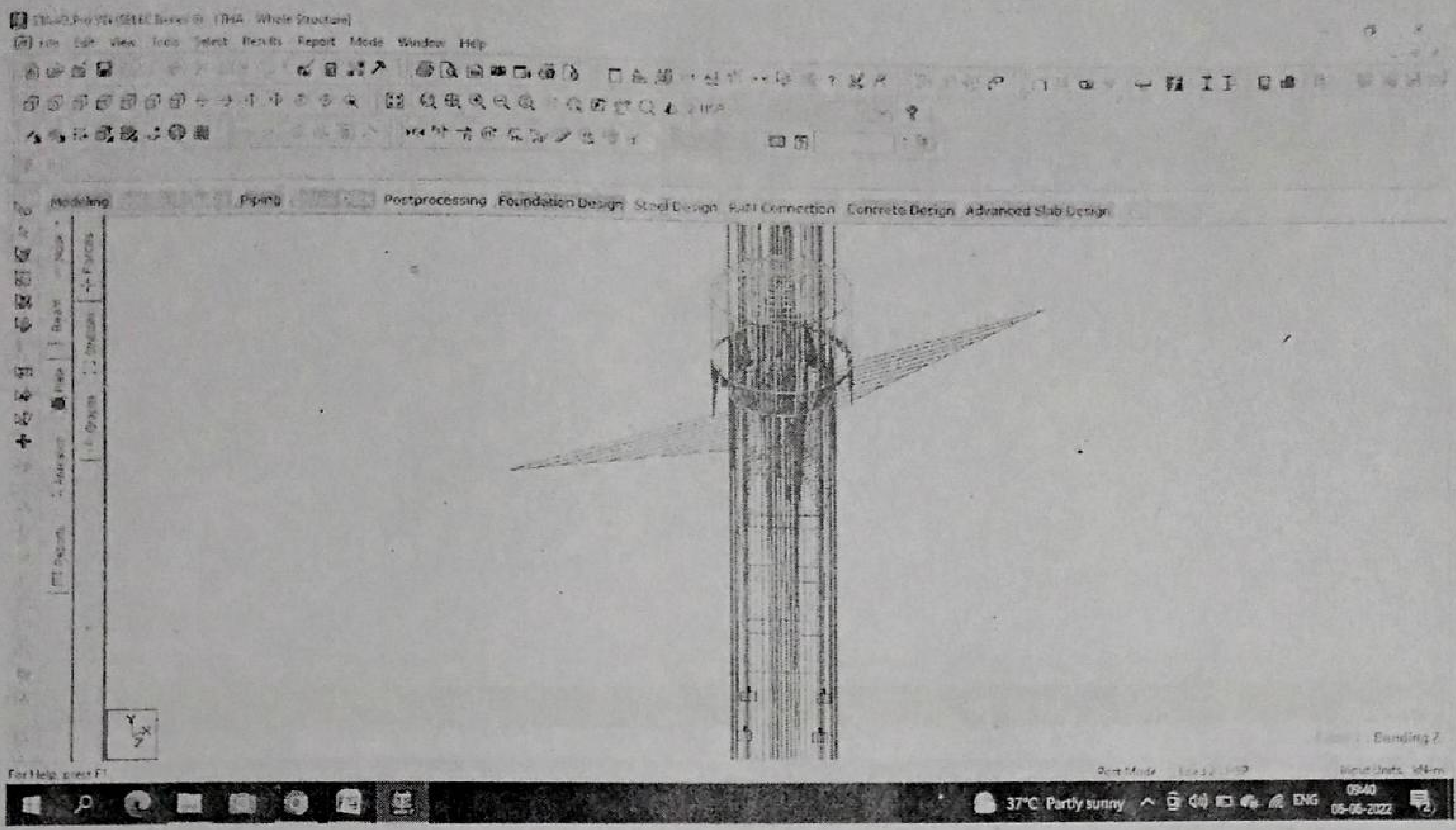
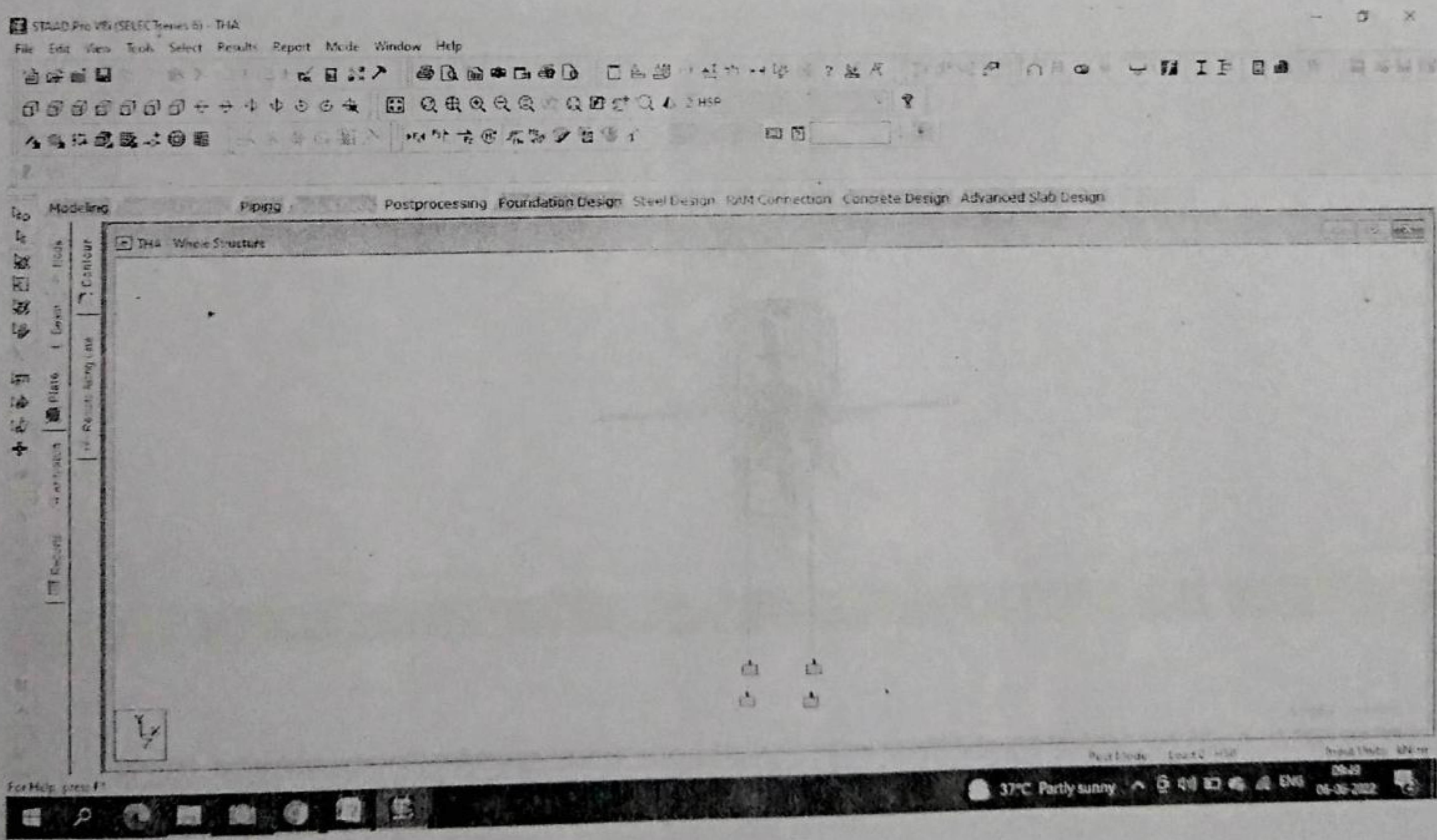
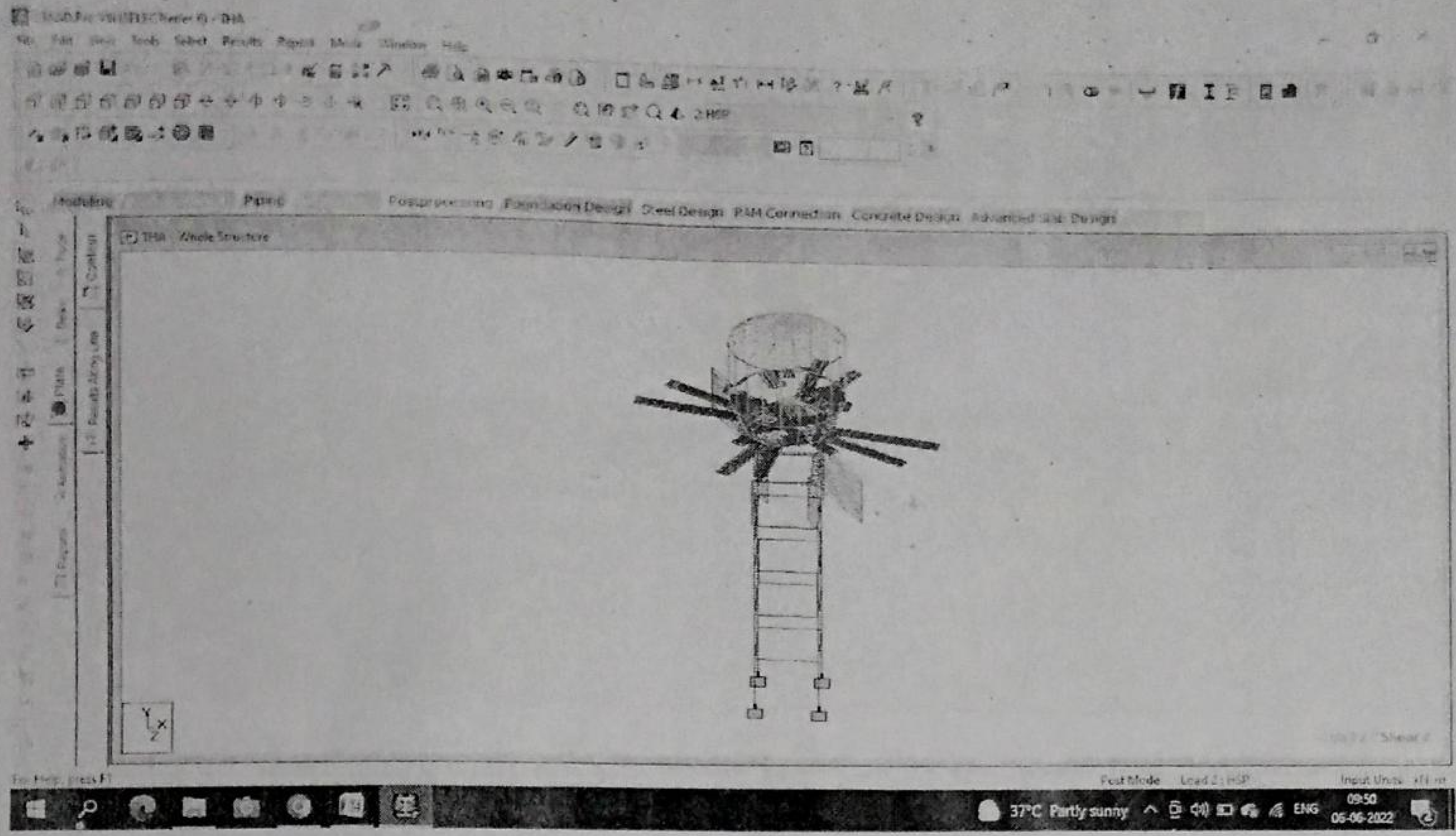


Fig 17 Response of Beam bending due to DL

- Beam response due to HSP



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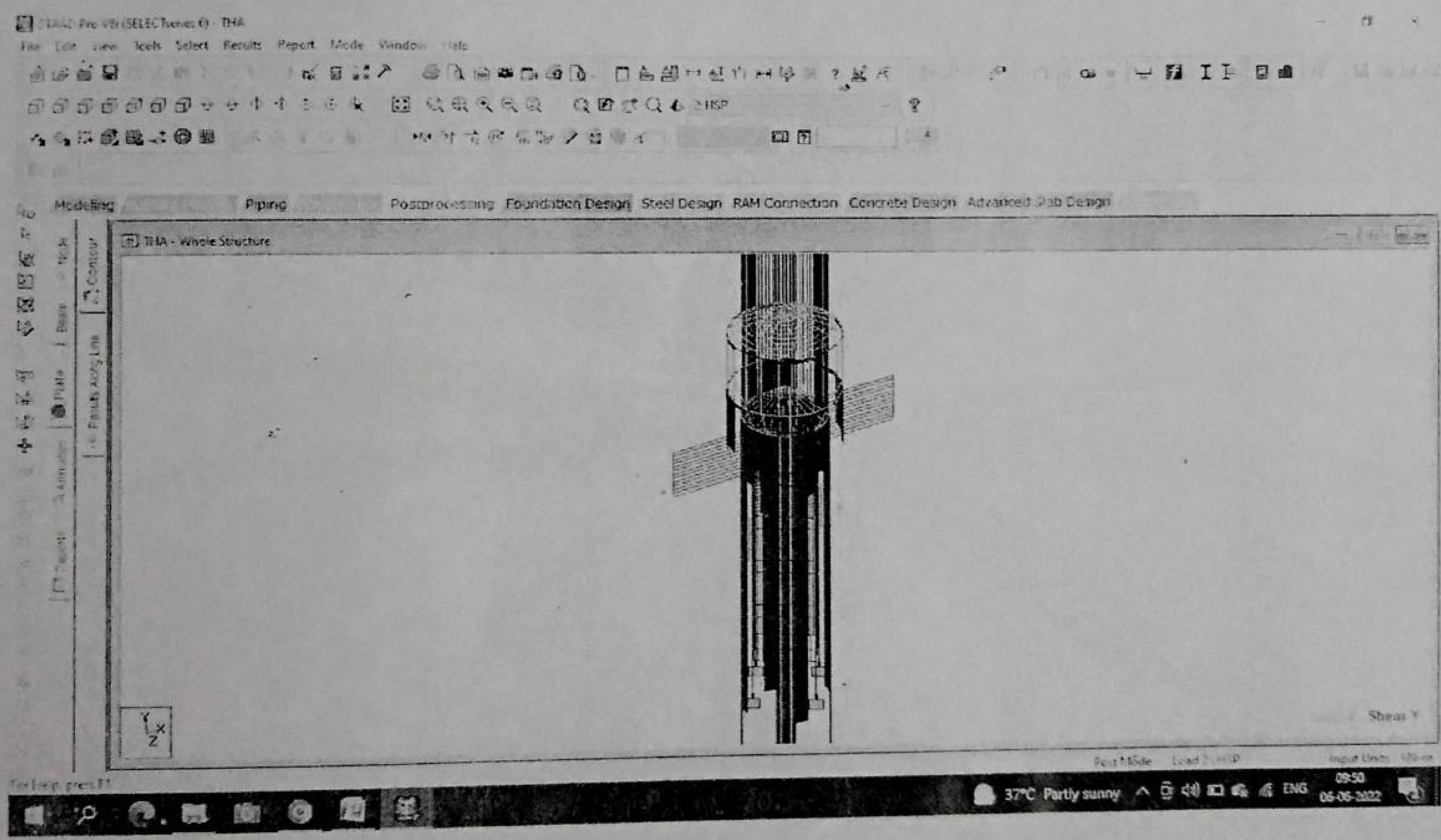
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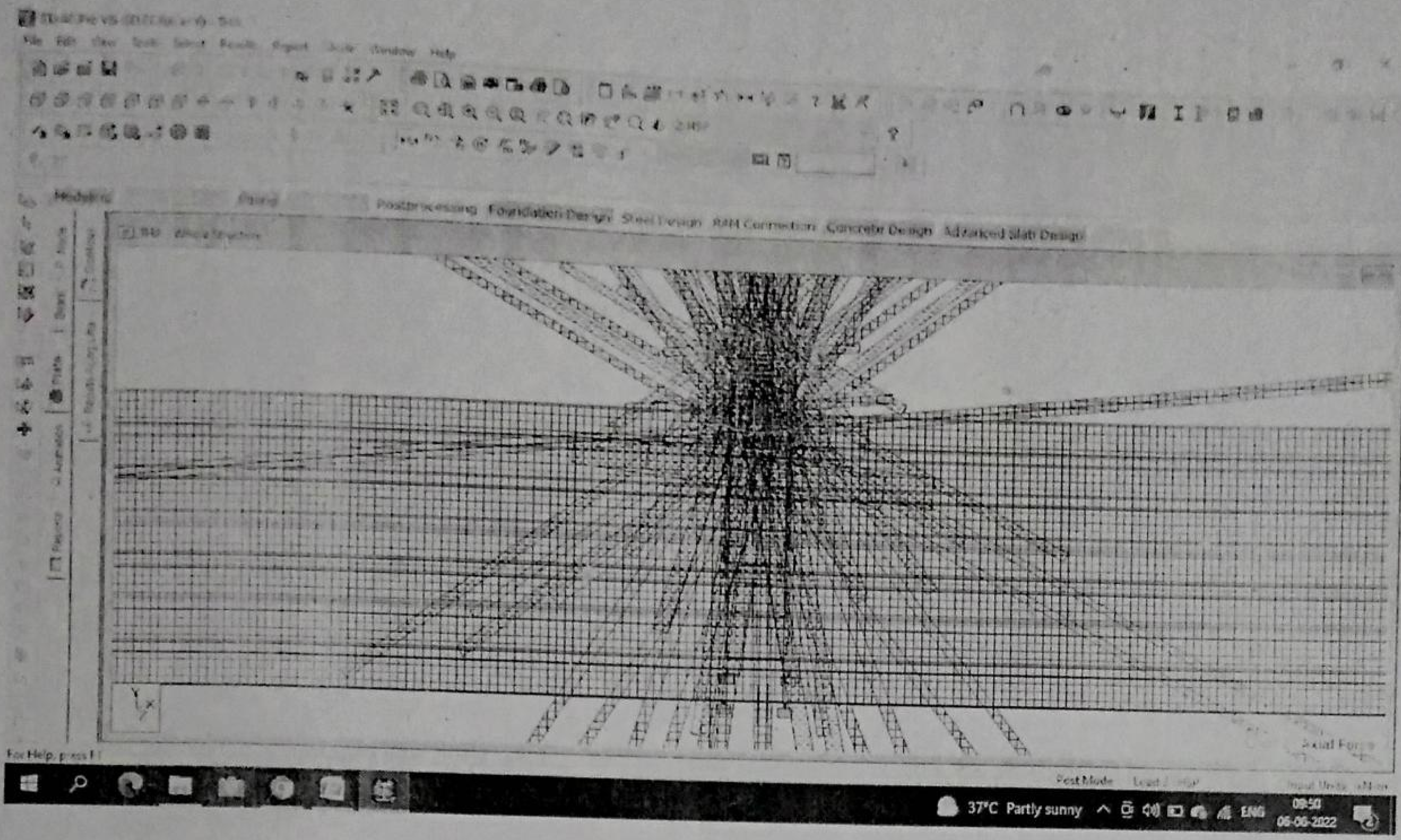
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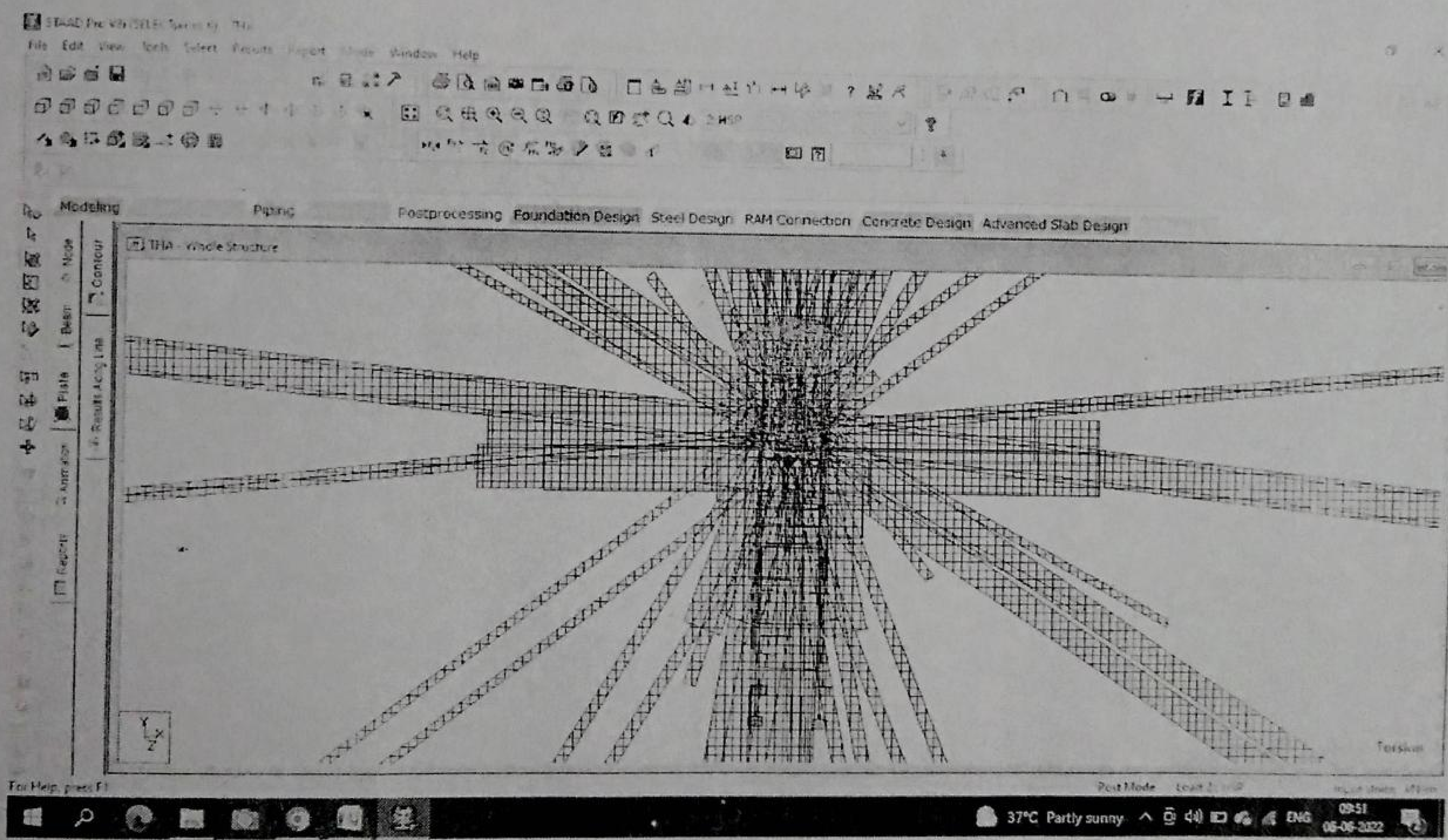
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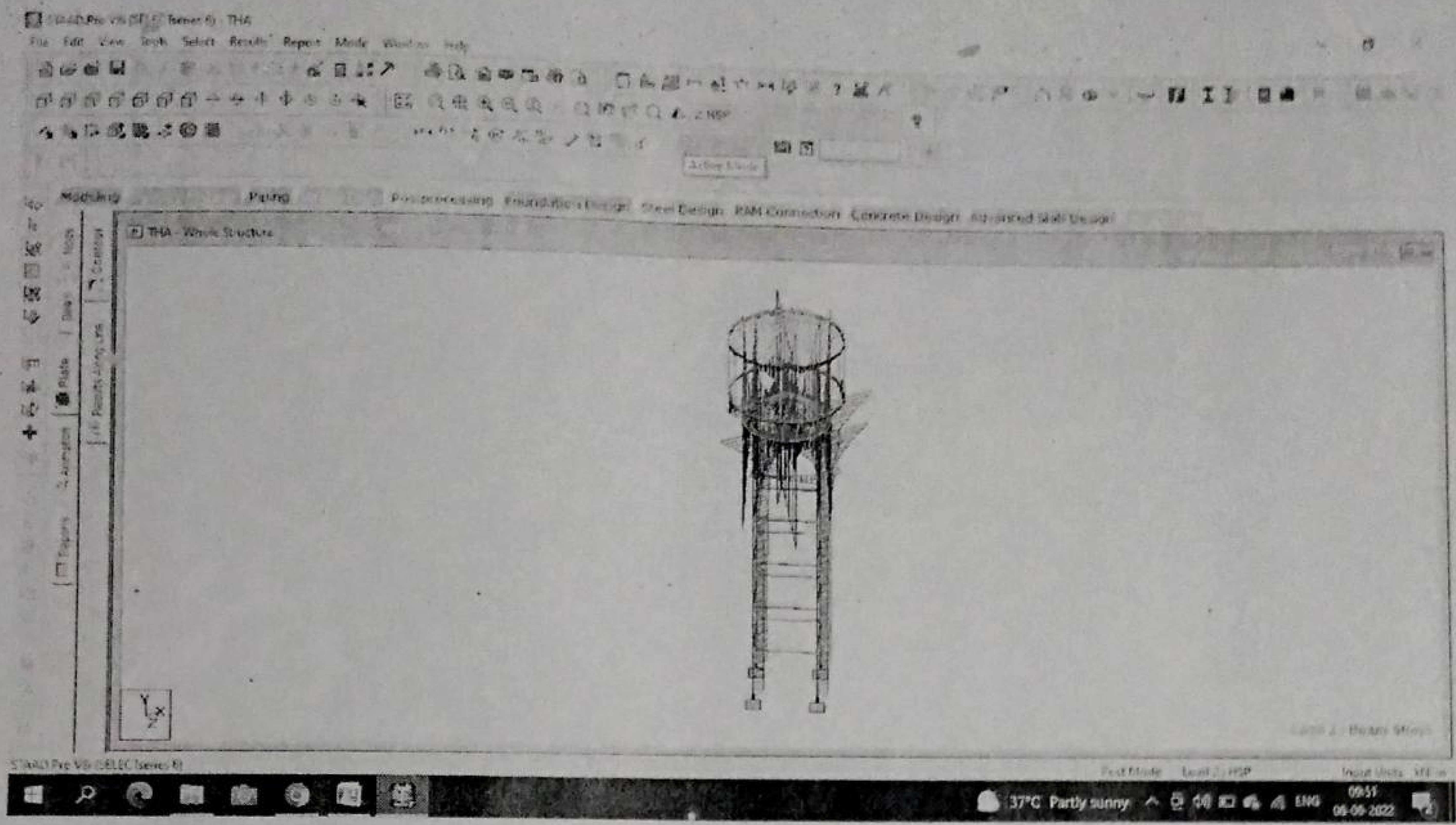
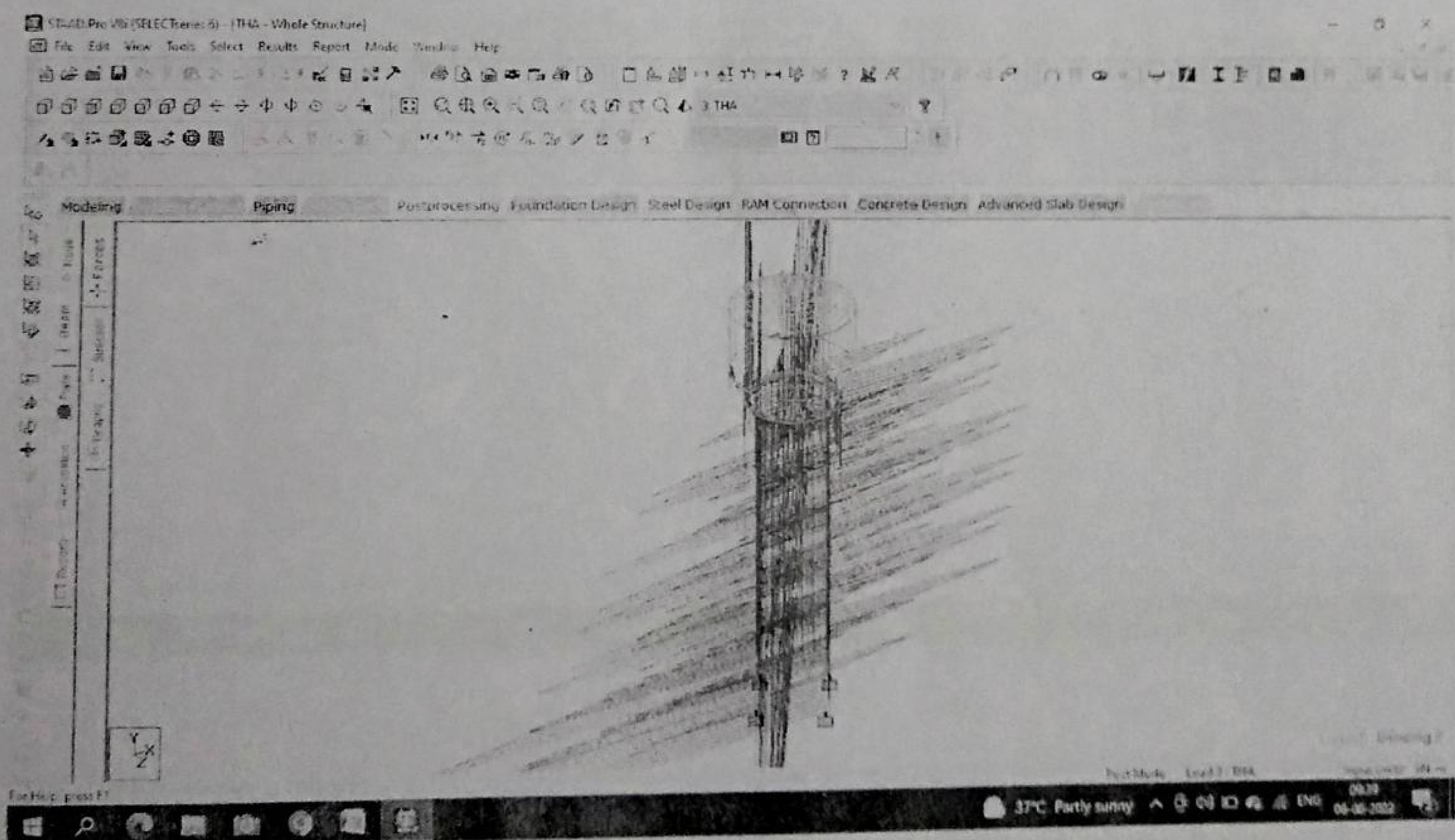
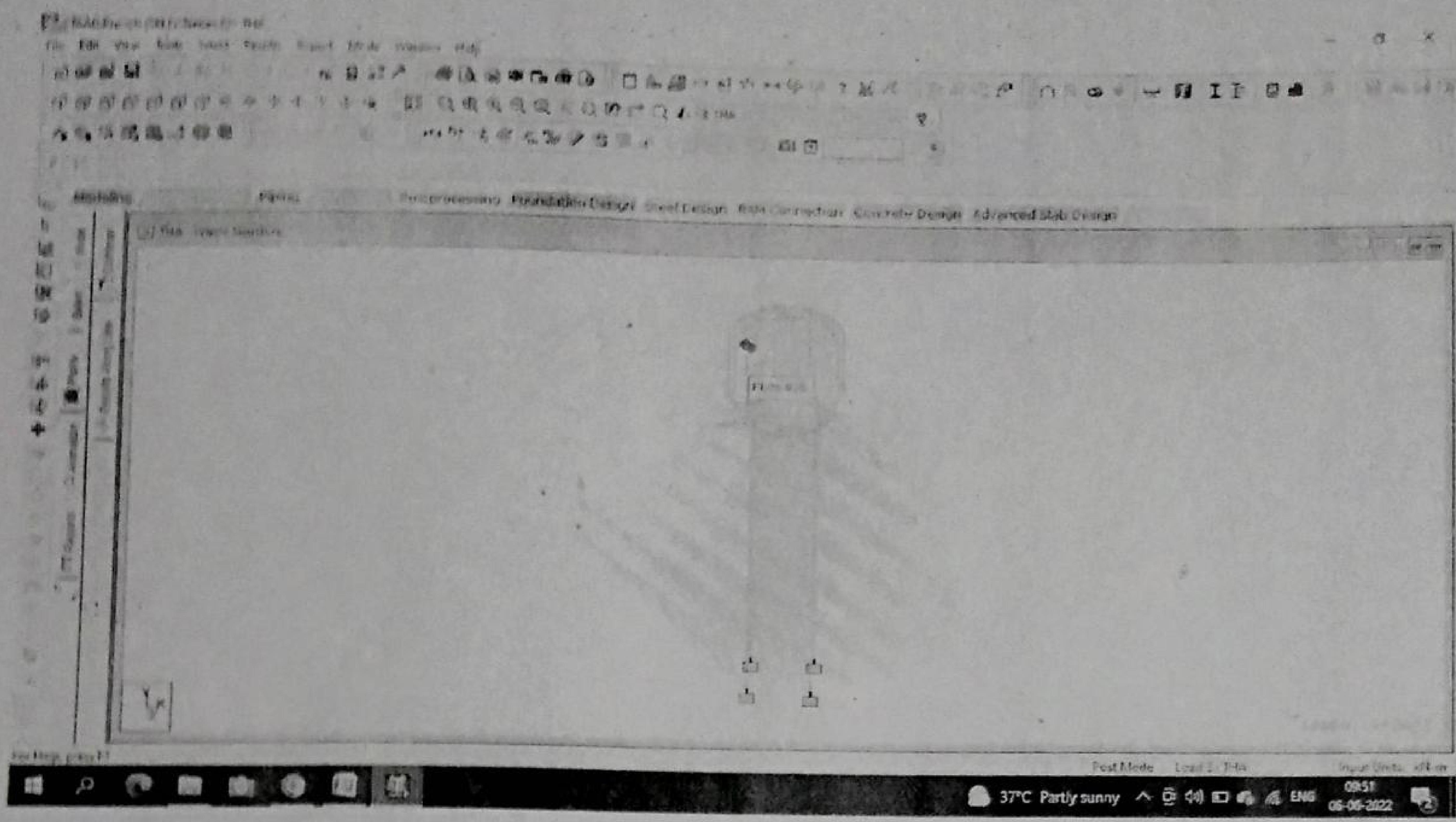


Fig 18 Response of Beam bending due to HSP

- Beam response due to THA

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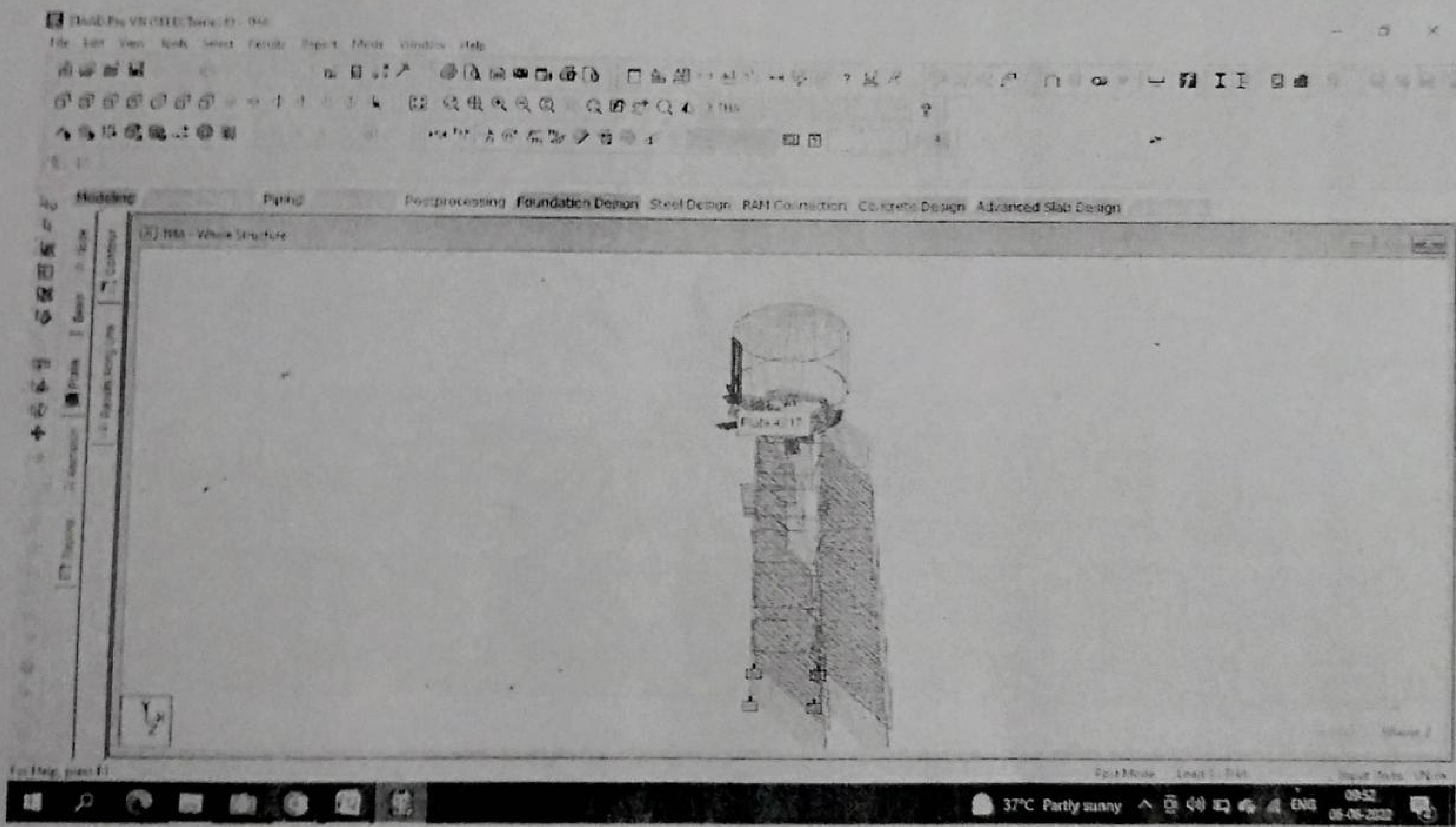
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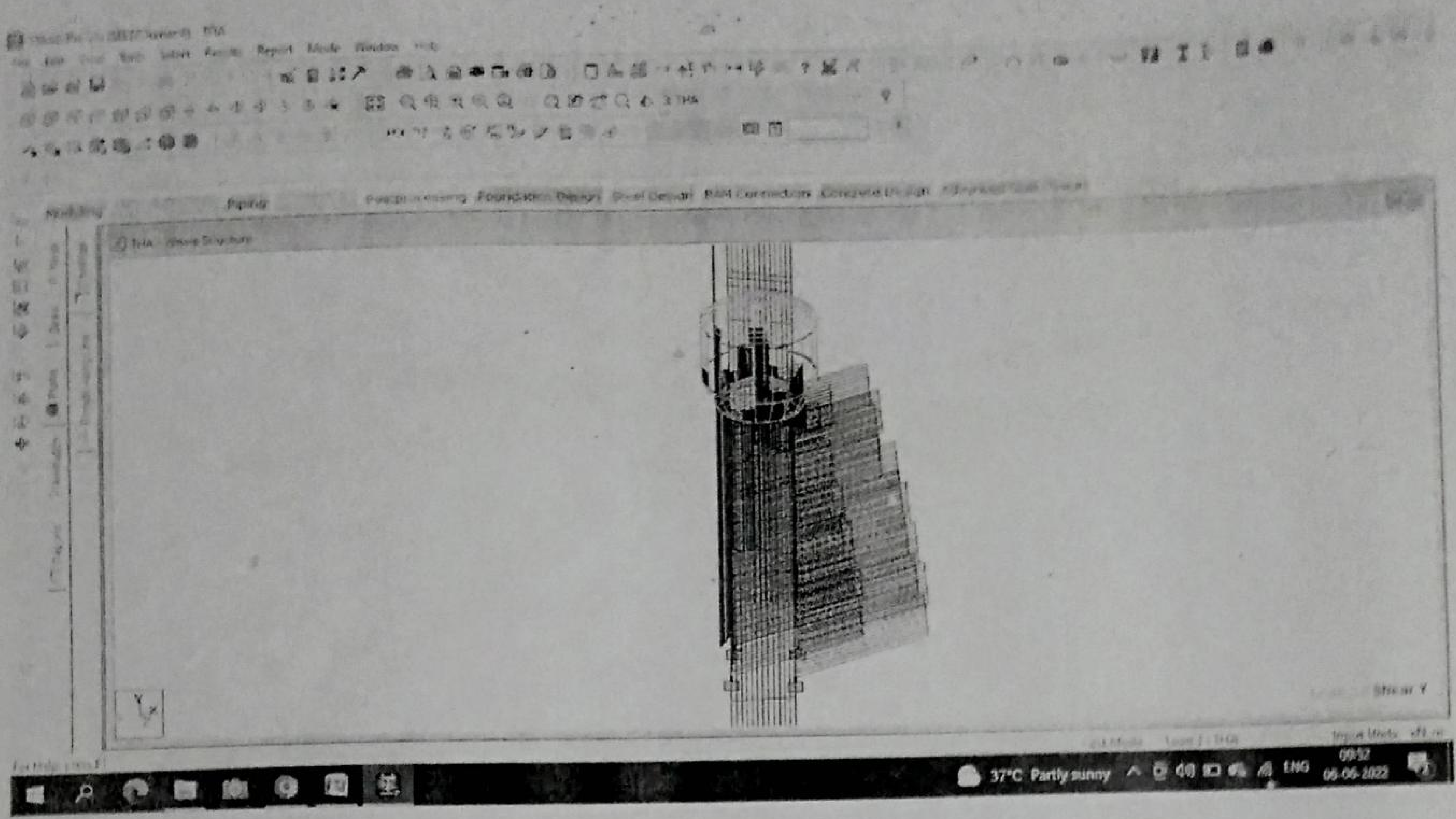
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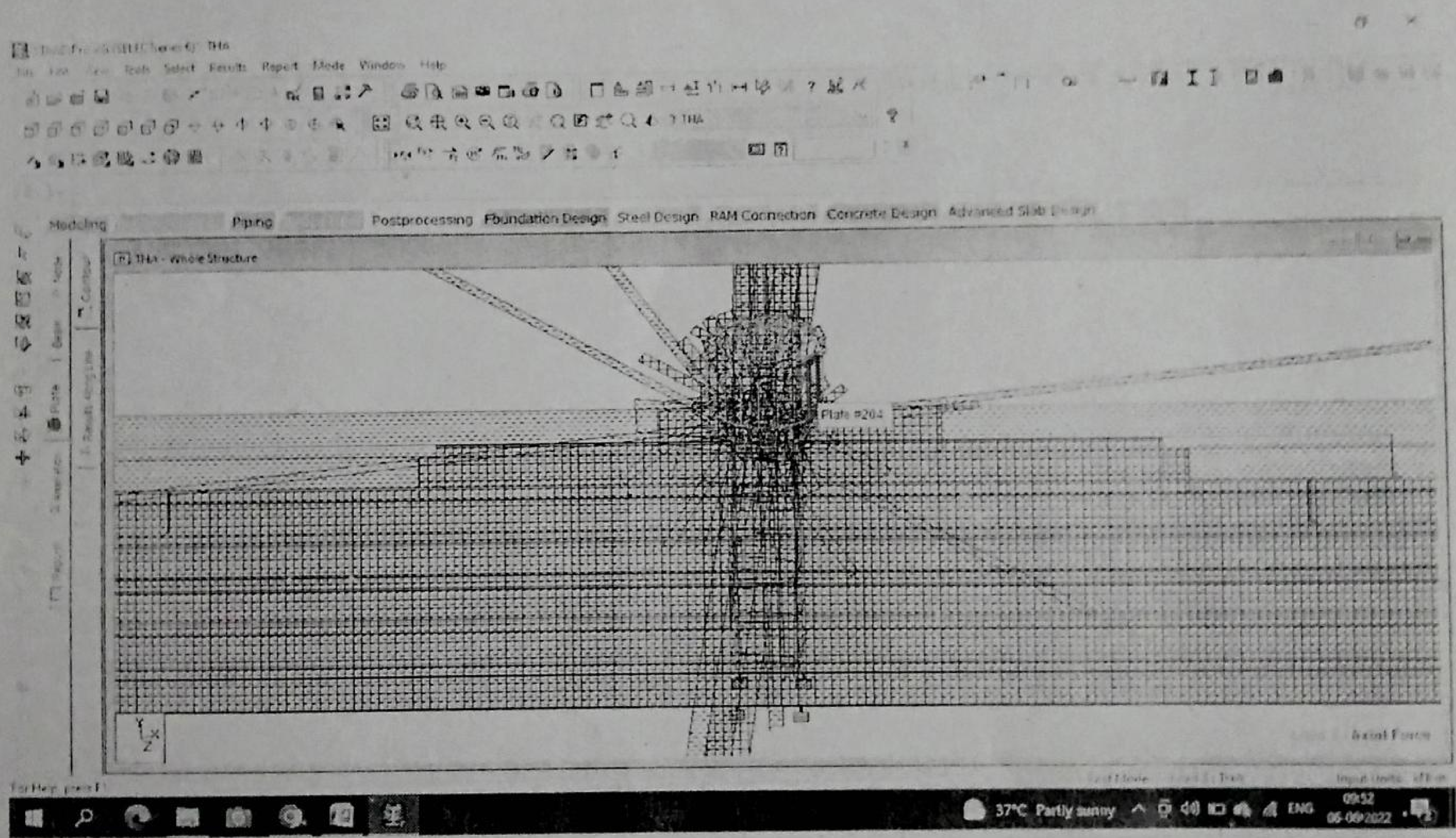
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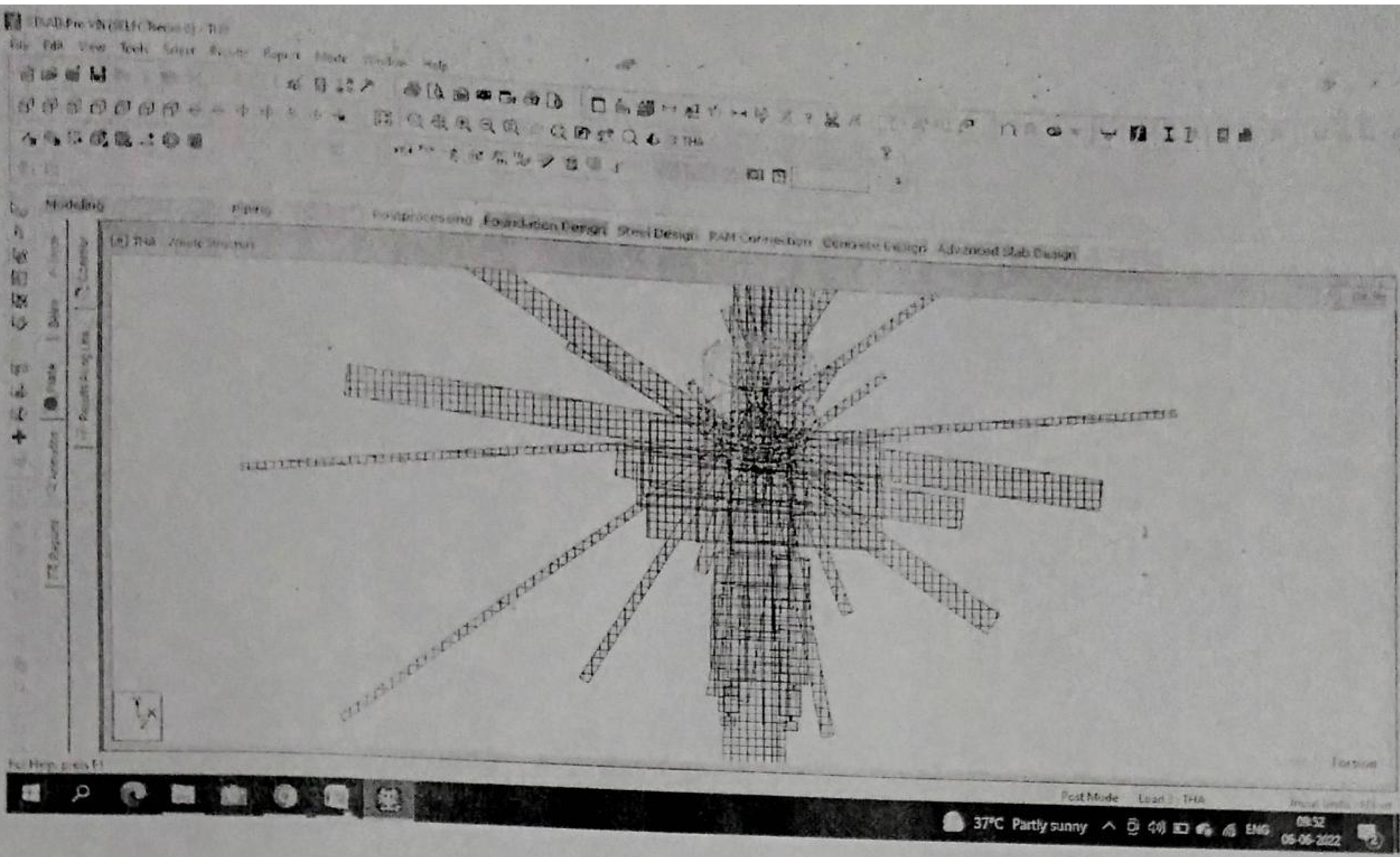


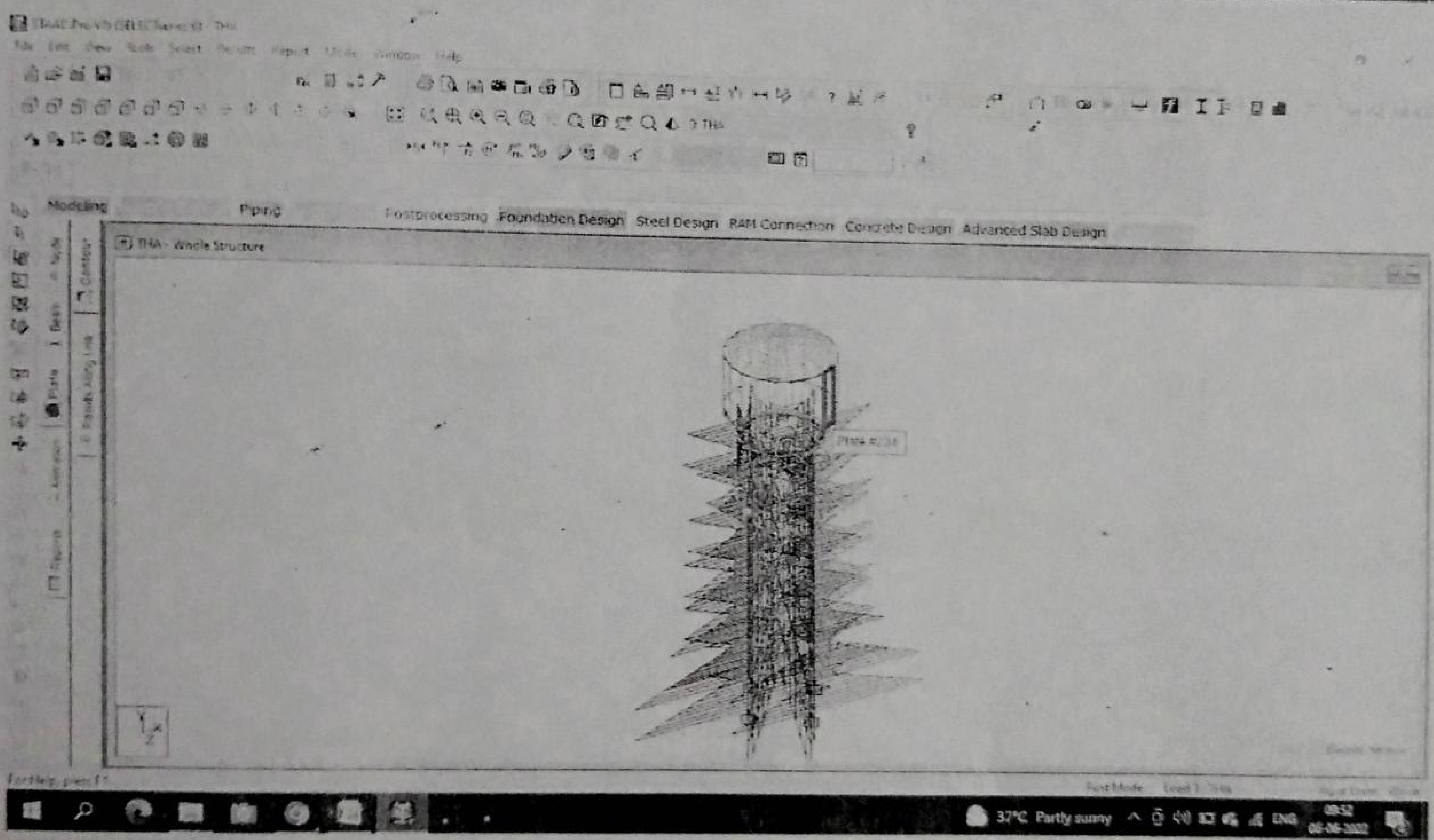
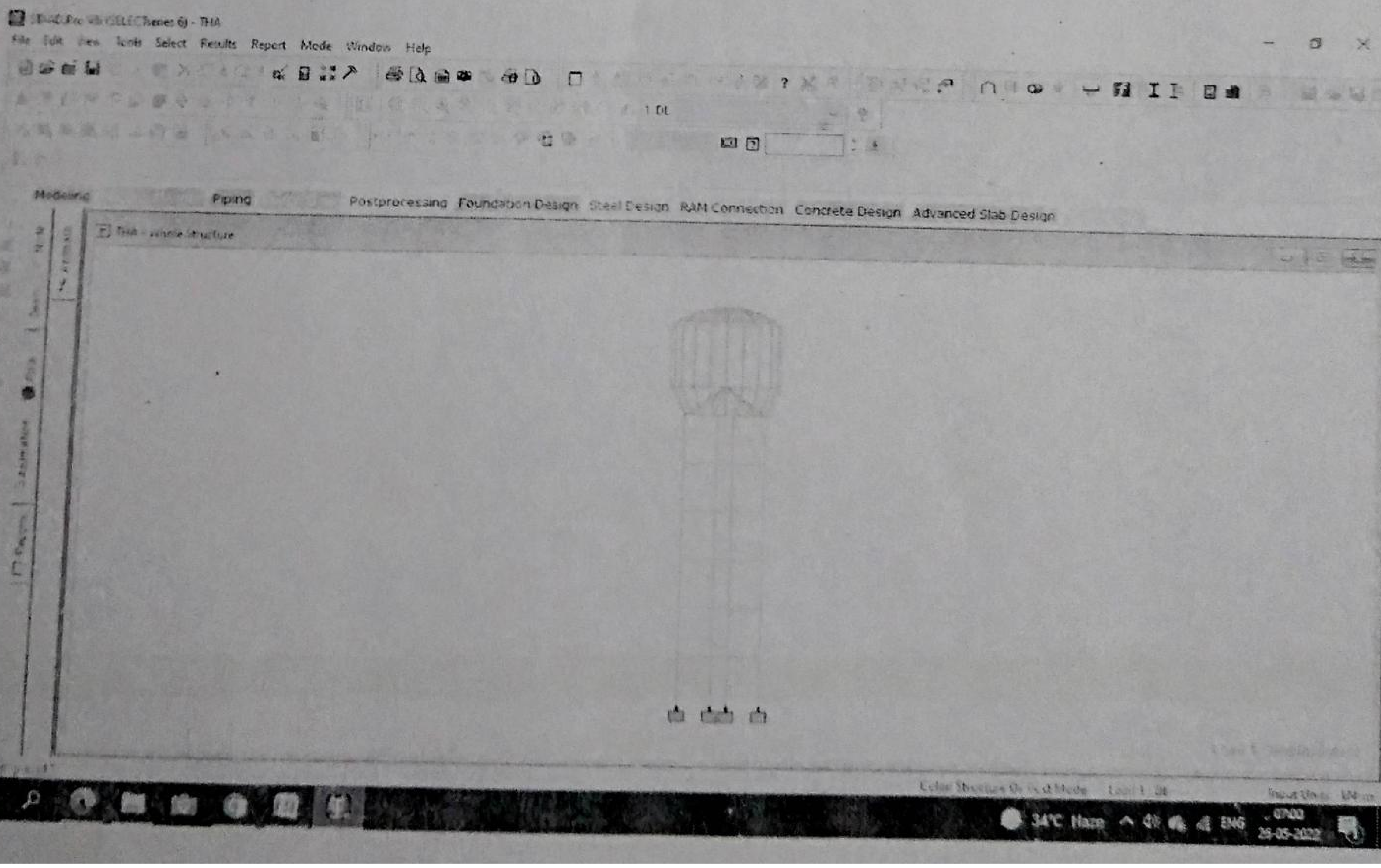


Fig 19 Response of Beam bending due to THA

Table 7. Shear , membrane . Bending Moment In plate

	Plate	L/C	Shear		Membrane			Bending Moment		
			SQX (local) N/mm2	SQY (local) N/mm2	SX (local) N/mm2	SY (local) N/mm2	SXY (local) N/mm2	Mx kNm/m	My kNm/m	Mxy kNm/m
Max Qx	257	2 HSP	1.901	-1.033	-0.076	0.061	5.564	108.184	14.259	-31.813
Min Qx	257	3 THA	-0.570	0.349	-0.770	0.347	-2.108	-29.891	-4.409	10.297
Max Qy	271	2 HSP	0.162	3.141	-0.078	15.285	-5.376	21.549	71.896	17.994
Min Qy	257	2 HSP	1.901	-1.033	-0.076	0.061	5.564	108.184	14.259	-31.813
Max Sx	15	2 HSP	0.172	-0.915	8.545	-2.325	0.288	2.538	20.942	-1.207
Min Sx	251	2 HSP	1.199	0.598	-13.773	10.995	5.276	82.420	10.682	13.488
Max Sy	261	2 HSP	0.157	3.137	0.282	15.991	-5.852	20.795	73.474	18.215
Min Sy	22	2 HSP	-0.010	-0.487	3.526	-5.261	-0.766	1.893	0.159	-0.248
Max Sx	242	2 HSP	1.799	-0.937	-0.337	-0.225	5.635	102.860	12.613	-30.151
Min Sx	261	2 HSP	0.157	3.137	0.282	15.991	-5.852	20.795	73.474	18.215
Max Mx	257	2 HSP	1.901	-1.033	-0.076	0.061	5.564	108.184	14.259	-31.813
Min Mx	257	3 THA	-0.570	0.349	-0.770	0.347	-2.108	-29.891	-4.409	10.297
Max My	261	2 HSP	0.157	3.127	0.282	15.991	-5.852	20.795	73.474	18.215
Min My	272	2 HSP	0.133	-0.862	-2.249	-1.453	2.642	20.122	-22.936	-9.549
Max Mx	261	2 HSP	0.157	3.137	0.282	15.991	-5.852	20.795	73.474	18.215
Min Mx	257	2 HSP	1.901	-1.033	-0.076	0.061	5.564	108.184	14.259	-31.813



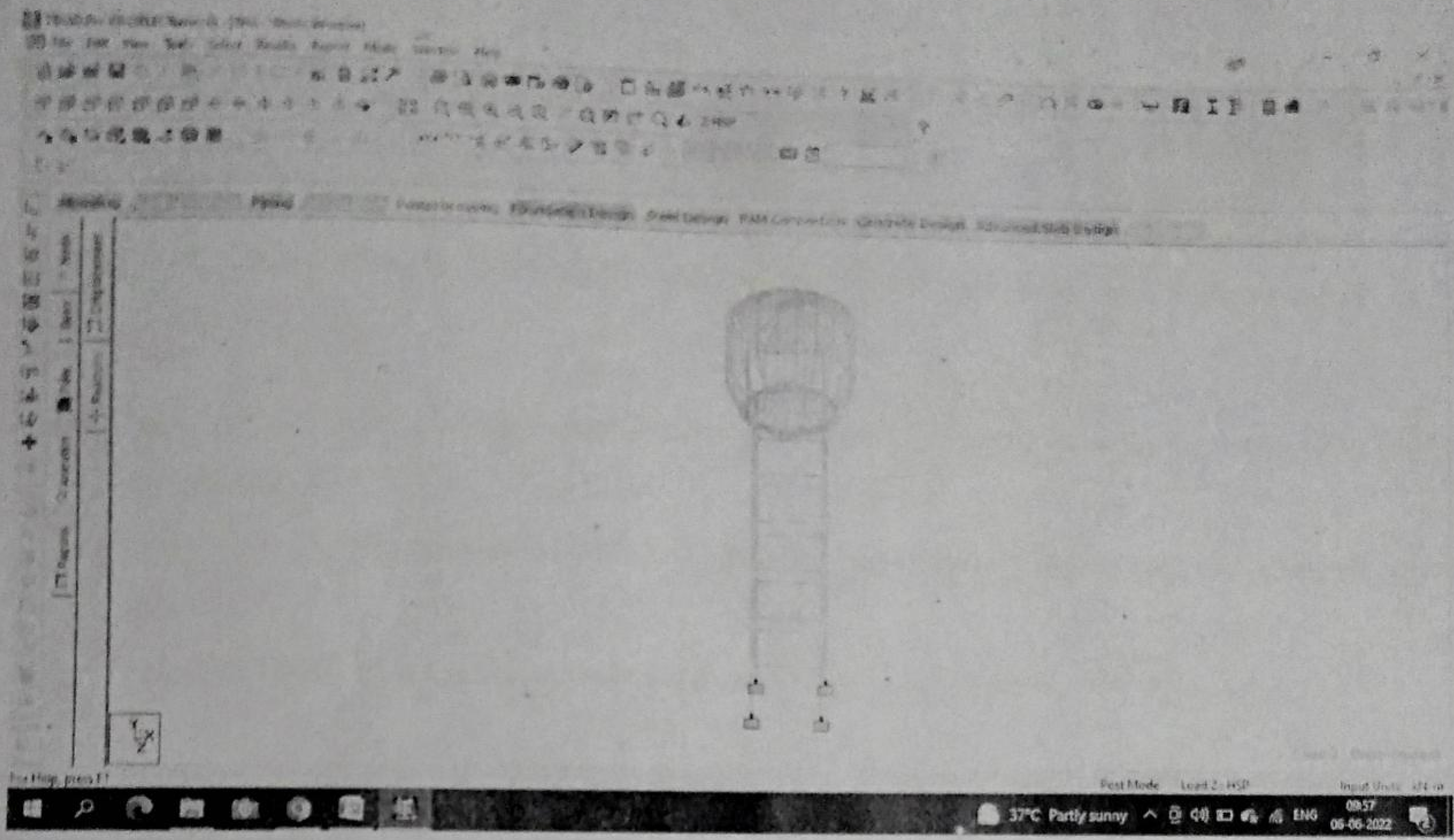


Fig 21Final animation due to HSP

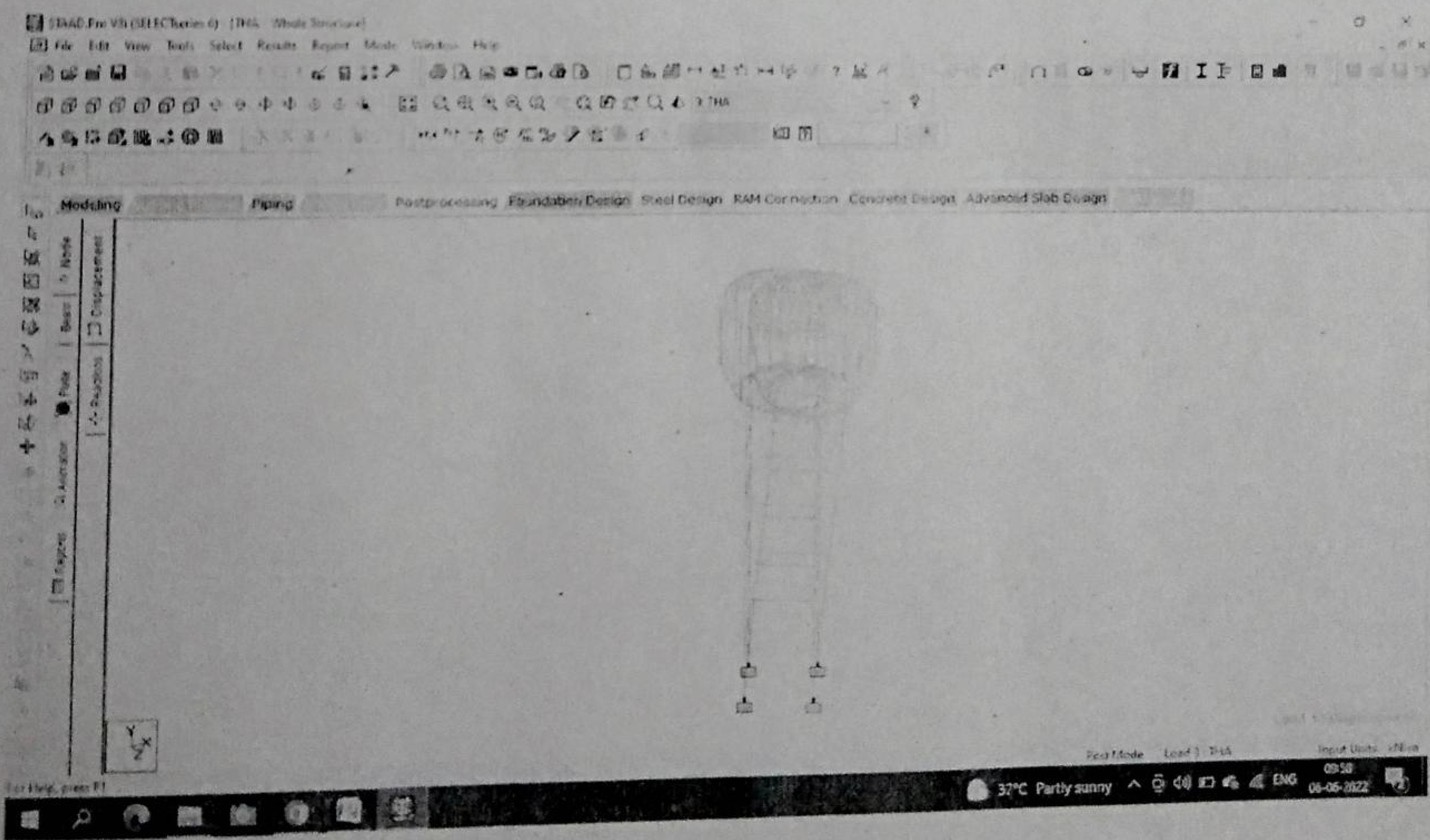


Fig 22 Final animation due to THA

CHAPTER 9
CONCLUSIONS

In this study,an Overhead intze tank has been designed and analysed. Thereafter, a time history analysis was performed by the STAAD.Pro software on that elevated water tank in the Gwalior region (seismic zone II)

- 150000 liters water storing capacity intze tank with 18m staging is designed with M30 grade of concrete.
- The tank is designed not just by STAAD.Pro but also manually and in both the cases, design is safe.

  Henceforth, it can be concluded after the study that the design is safe and secure.

CHAPTER 10

REFERENCES

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5. I.S-3370 (Part II-1967). Code of practice for concrete structures for the storage of liquids.
6. Reinforcement concrete structure vol.-2 book by Dr. B.C Punamia

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