ITM UNIVERSITY

GWALIOR

PBL (Project based learning)

On

"Tensegrity Structure"

Course Code: (CEL0432)

Course Name: Elementary Design of Steel Structures

Submitted By:

Arindam Kumar (BETN1CE21008)

Somnath Ray (BETN1CE21004)

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In partial fulfillment for the award of the degree of

B. TECH DEGREE

In

Civil Engineering

Submitted to: Mr. Shashank Gupta

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INTRODUCTION

Tensegrity Structure

Tensegrity structures represent an innovative design concept where components experience either pure tension or pure compression without bending or shear forces. The project aimed to explore the principles of tensegrity, its practical applications in structural engineering, and the challenges associated with designing and constructing such systems. This report details the project's objectives, methodology, design, construction process, analysis, and conclusions.

Tensegrity structures are composed of tension and compression components, where the compression components (struts) are discontinuously enclosed within continuous tensile components (cables). In which the tension elements stabilize the compression elements. Tensegrity structures are built of bars and strings attached to the ends of the bars. We will adopt the words "strings" for the tensile members, and "bars" for compressive members. (The different choices of words to describe the tensile members as "strings," "tendons," or "cables" are motivated only by the scale of applications).

Buckminster Fuller coined the word "Tensegrity" from two words: "tension" and "integrity". The word tensegrity, is a contraction of tensile integrity. This term has been proposed to name the structural rules, involving the creation of complex systems elements which are only compression or tension. The bars can resist compressive force and the strings cannot. Most bar string configurations which one might conceive are not in equilibrium, and if actually constructed will collapse to a different shape. If well designed, the application of forces to a tensegrity structure will deform it into a slightly different shape in a way that supports the applied forces

Objectives

The primary objectives of the project were:

1. To understand the fundamentals of tensegrity structures, including their mechanics and load distribution.
2. To design and construct a small-scale tensegrity structure using lightweight materials.
3. To analyze the structure's stability and load-bearing capacity.
4. To assess the potential applications of tensegrity structures in civil engineering.
5. To enhance teamwork, problem-solving, and practical construction skills.

Design and Planning

It is carried away in two stages

- A service stage design ensures that the deflection criterion is met, while remaining within the acceptable limit for the stress in the element. Moreover, as tensegrity system are tension structure we ensure that none of the cables present in the structure be slack.
- An ultimate design state verification, ensure the overall stability of the structure under extreme loading. Self-stress is a permanent action with both acting and resistance characteristics at the same time. Thus, when the ultimate design state is carried out, both aspects must be taken into account. The former will reduce self-stress to check that the structure keeps on overall stability the latter.

As the Design goes further it consists of two square wooden frames which will be acting as the compression members in the structure followed by the iron chains which will be attached at the vertices of the square frame connecting them symmetrically. The iron chains will be acting as tension members to hold the structure still

Testing and Analysis

Stability Testing

The structure was subjected to various small-scale stability tests, including:

- **Load Testing:** A 1 kg weight was suspended to test the load distribution and stability.
- **Perturbation Test:** The structure's response to lateral and vertical disturbances was observed.

Observations

- The structure maintained equilibrium under the applied load, with minimal deformation.
- The pre-stressed cables effectively balanced the compression forces in the struts.
- Slight adjustments to cable tension improved stability significantly

Applications and Future Scopes

Based on the findings, tensegrity structures have potential applications in:

- **Bridges:** Lightweight pedestrian bridges with efficient load distribution.
- **Deployable Structures:** Portable shelters and disaster relief structures.
- **Aesthetic Structures:** Pavilions and sculptures for public spaces.
- **Roof Systems:** Lightweight and durable roofing solutions for large-span structures.

Live Examples

The tensegrity concept has found applications within architecture and civil engineering, such as towers, large dome structures, stadium roofs, temporarily structures and tents. Towers which composed of interconnected tensegrity modules are the best known as tensegrity structures. The first civil structure inspired to the tensegrity principle is the cable dome proposed by Geiger and first employed for the roofs of the **Olympic Gymnastics Hall** and the **Fencing Hall in Seoul**. An important example of tensegrity being employed in roof structures is the stadia at La Plata. The largest existing cable dome is the Georgia Dome designed for the **Atlanta Olympics in 1996**. Moreover double-layer tensegrity grids and foldable tensegrity systems has been in the development. The design of double grid systems has resulted in an interest in the application of tensegrity to bridge construction. A recent achievement in this regard is the **Kurilpa Bridge** in Brisbane, Australia. It is the world's largest "tensegrity-like" bridge, which was opened on the 4th of October 2009

Glimpse of Project

ITM UNIVERSITY

GWALIOR

PBL (Project based learning)

On

"Design and Development of a Shake Table Model for Seismic Simulation"

Course Code: (CEE0704)

Course Name: Seismic Design of Structures

Submitted By:

Voice Raj Meena (BETN1CE21009)

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Abhi Arya (BETN1CE21001)

In partial fulfillment for the award of the degree of

B. TECH DEGREE

In

Civil Engineering

Submitted to: Mr. Aditya Sharma

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INTRODUCTION

Shake Table

Earthquakes are among the most destructive natural disasters, causing significant loss of life, property, and infrastructure. Designing structures that can withstand seismic forces is a fundamental challenge in civil engineering. Shake tables serve as essential tools for simulating earthquake-induced ground motion and studying the dynamic response of structures. These devices enable researchers and engineers to test models under controlled seismic conditions, facilitating the development of safer and more resilient buildings.

This project was undertaken to design and construct a small-scale shake table model capable of simulating horizontal ground motion. By recreating seismic conditions, the shake table provides a hands-on demonstration of how different structural designs respond to earthquakes. The project focused on designing a cost-effective and functional model, overcoming mechanical and operational challenges, and conducting experiments to analyze the performance of various structural configurations. The findings from this project contribute to a deeper understanding of seismic behavior and the principles of earthquake-resistant design.

This report outlines the objectives, methodology, design considerations, construction process, testing procedures, and conclusions drawn from the shake table project.

Objectives

The primary objectives of the project were:

1. To understand the principles of seismic simulation and dynamic loading.
2. To design and construct a low-cost, functional shake table model.
3. To simulate seismic waves and observe the behavior of model structures.
4. To analyze the performance of different structural designs under simulated earthquakes.
5. To enhance practical skills in mechanical design, construction, and testing.

Design and Planning

The shake table's base was made with good quality timber and additional wood blocks were used for support. It was equipped with a battery for providing charge, A switch to open and close the circuit, Wiring to make connections, wooden sticks used as axel for wheels, a small wooden plate for base of placing the building and moving it, plastic bottle caps to be used as wheels, a metallic spoke to connect the motor to the moving plate

Shake Table Construction: All the above-mentioned materials were joined together with the help of Copper wiring with cover, Hot Glue gun was used to stick the materials in their proper place. Simple wooden fences were created around the wood plate to prevent the moving plate from going in other directions. All this work was done by the combined effort of our teamwork and passion for the project

Structural Models: A Simple structural model simulating the shape of a G+3 storey building was made with the help of simple items such as ice cream sticks and threads. Which were glued together using simple adhesive glue. This model allows us to test the effects of an earthquake on a similar shaped building and how it gets effected with different weightings on its floors

Testing and Analysis

To evaluate the performance of the shake table, several small-scale structural models were tested. These models included simple rectangular block structures with different dimentions. Each model represented a different type of building or construction material commonly used in real-world scenarios.

The tests were conducted by subjecting the models to horizontal ground motion generated by the shake table. The amplitude and frequency of the motion were adjusted to simulate various earthquake intensities, ranging from minor tremors to severe seismic events. A series of observations were recorded during these tests to analyze how the models behaved under different conditions. The following points were observed

- The shake table provided a clear visual representation of how different structural designs and materials respond to seismic forces.
- The importance of structural height, base width, and damping mechanisms was effectively demonstrated.
- Resonance frequencies were identified as a critical factor in structural failure, emphasizing the need for precise frequency considerations in design

Glimpse of Project

Bridge Making Competition

Experiential Learning for CEL0514

Department of Civil Engineering

ITM University, Gwalior

Event Overview: The Civil Engineering Department of ITM University proudly presents a Bridge Making Competition, a thrilling and innovative event designed to challenge the creativity, engineering skills, and problem-solving abilities of the participants. The competition invites students to design and construct functional bridges using only **ice cream pop sticks** and adhesive materials. This hands-on challenge is a perfect blend of theoretical knowledge and practical application, providing participants an opportunity to showcase their understanding of structural engineering and bridge mechanics.

Event Objective: The goal of the competition is to test participants' ability to design and construct a bridge capable of withstanding the maximum load while using only the materials provided: **ice cream pop sticks** and adhesives (glue, tape, etc.). This competition will help participants apply principles of **structural analysis**, **material strength**, and **load distribution** to a real-world scenario, all while fostering creativity and teamwork.

Eligibility: This competition is open to all students currently enrolled in the Civil Engineering program at ITM University. Teams will consist of **4 members** each, encouraging collaboration and teamwork to solve engineering challenges effectively.

Competition Guidelines:

- **Materials Provided:**
  - 100 Ice cream pop sticks
  - Adhesives (glue and Strings)
- **Design Constraints:**
  - The bridge must be a freestanding structure.
  - The bridge must span a minimum of **15 cm** without support.
  - The bridge must be able to support a load placed at the center of the bridge.
- **Construction Period:**
  - Teams will have **3 hours** to design and construct their bridges.
- **Judging Criteria:**

- **Load-bearing capacity**: The amount of weight the bridge can support before failure.
- **Innovation**: The creativity and originality of the design.
- **Construction Quality**: The precision and neatness of the assembly.
- **Efficiency**: The ability to maximize strength while using minimal materials.
- **Aesthetic Appeal**: The overall visual design of the bridge.

Competition Phases:

1. **Design Phase**: Teams will start by sketching their bridge designs, taking into account factors like material distribution, load-bearing capacity, and structural efficiency.
2. **Construction Phase**: Teams will have a fixed time (3 hours) to construct their bridges. They must ensure that the bridge can span the required gap and support the maximum load.
3. **Testing Phase**: Once completed, each bridge will be subjected to a load test. A weight will be gradually added to the bridge until it fails. The maximum load the bridge can support will determine the winning team.

Important Dates:

- **Event Date**: 28/11/2024

Observations and Highlights The competition displayed a remarkable level of innovation and creativity, with several bridges featuring unique and ingenious design elements. The load-bearing tests demonstrated the participants' strong understanding of structural engineering principles, as many bridges successfully supported impressive weights. The event fostered a sense of camaraderie and teamwork, with participants sharing knowledge and techniques. The judging panel was impressed by the overall quality and attention to detail exhibited in the designs and construction of the bridges.

The winning teams bridge was able to uphold the load of 18 Kgs which is remarkable as they were able to use the limited material and created design up-to maximum efficiency to distribute load along the members of Bridge.

Conclusion The Bridge Making Competition was a resounding success, providing a platform for participants to apply their engineering knowledge and skills. The event celebrated innovation, teamwork, and practical problem-solving in the field of bridge construction. We look forward to future editions of the competition, which will undoubtedly continue to inspire and educate the next generation of engineers and architects.

Winners:

Ayush Kumar Sharma (BETN1CE22001)
Vishal Narwariya (BETN1CE22003)
Suryabhan Dhakad (BETN1CE22008)
Aditya Dhakad (BETN1CE22010)

Glimpse of Event:

Marks Assigned to the students as per observations

Sr. NO	Student ID	STUDENT NAME	Marks		
			Team Work (20)	Individual Contribution (10)	Total (30)
1	BETN1CE22001	Ayush Kumar Sharma	20	5	25
2	BETN1CE22003	Vishal Singh Narwaria	20	5	25
3	BETN1CE22004	Rohit Singh Tomar	5	10	15
4	BETN1CE22005	Shubham Singh Tomar	10	8	18
5	BETN1CE22007	Harsh Gurjar	10	8	18
6	BETN1CE22008	Suryabhan Dhakad	20	8	28
7	BETN1CE22010	Aditya Dhakad	20	8	28
8	BETN1CE22011	Sanon Moukiatou	15	10	25
9	BETN1CE22012	Anesu Ashman Chuma	15	10	25
10	BETN1CE22013	Aditya Gautam	10	10	20
11	BETN1CE22014	Hardesh Solanki	10	8	18
12	BETN1CE22019	Amit Raj	05	0	5
13	BETN1CE22020	Pramendra Kumar Singh	15	10	25
14	BETN1CE22021	Rohit Chaudhary Lekhi	15	10	25
15	BETN1CE22022	Vinay Sharma	05	0	5
16	BETN3CE23D01	Lal Rinmuana	15	10	25
17	BETN3CE23D02	Aman Kushwah	15	10	25

ITM UNIVERSITY
GWALIOR

PBL (Project based learning)

On

"Bridge Model"

Course Code: (CEL0514)

Course Name: Advanced Methods of Structural Design

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INTRODUCTION

Bridge Model

Bridge model making is a hands-on activity that involves designing and constructing scaled-down representations of bridges. This process provides valuable insight into the principles of structural engineering, such as load distribution, material strengths, and the behavior of forces like compression, tension, and shear. Model makers use various materials, including wood, plastic, metal, or even popsicle sticks and string, to replicate real-world bridge types like beam, arch, suspension, or truss bridges.

The activity allows individuals to experiment with different designs and construction techniques, learning how to balance aesthetics with functionality. It also challenges creators to optimize their designs for strength, stability, and cost-efficiency. Bridge model making is widely used in engineering education, design competitions, and research to demonstrate the practical application of theoretical knowledge. It also enhances skills like creativity, problem-solving, teamwork, and attention to detail, making it an excellent tool for both students and professionals in civil engineering and architecture.

The goal of the competition is to test participants' ability to design and construct a bridge capable of withstanding the maximum load while using only the materials provided: ice cream pop sticks and adhesives (glue, tape, etc.). This competition will help participants apply principles of structural analysis, material strength, and load distribution to a real-world scenario, all while fostering creativity and teamwork.

Objectives

The primary objectives of the project were:

1. Understanding Structural Principles: To demonstrate how different types of bridges distribute loads and withstand various forces, such as tension, compression, and shear.
2. Application of Engineering Concepts: To provide a practical application of theoretical knowledge in structural engineering, material science, and physics.
3. Enhancing Problem-Solving Skills: To foster creative thinking and innovative solutions when designing and building models that are both strong and functional.
4. Developing Technical Skills: To improve manual skills in construction, precision, and attention to detail while working with different materials.
5. Promoting Critical Thinking: To challenge students and engineers to consider design constraints such as budget, material limitations, and environmental factors in their bridge designs.
6. Encouraging Teamwork: To develop collaborative skills through group projects where participants work together to plan, design, and build a bridge model.
7. Fostering Creativity and Innovation: To encourage experimentation with new design ideas, materials, and techniques to enhance bridge performance.
8. Exploring Different Bridge Types: To understand the functional and aesthetic differences between various bridge designs, such as truss, arch, suspension, and beam bridges.
9. Simulating Real-World Challenges: To replicate real-world engineering challenges in a controlled environment, helping students and professionals visualize and test structural designs.
10. Promoting Sustainable Design: To consider environmental and sustainability factors in bridge design, such as using eco-friendly materials or minimizing waste during construction.

Event Overview

The Civil Engineering Department of ITM University proudly presents a Bridge Making Competition, a thrilling and innovative event designed to challenge the creativity, engineering skills, and problem-solving abilities of the participants. The competition invites students to design and construct functional bridges using only ice cream pop sticks and adhesive materials. This hands-on challenge is a perfect blend of theoretical knowledge and practical application, providing participants an opportunity to showcase their understanding of structural engineering and bridge mechanics.

The goal of the competition is to test participants' ability to design and construct a bridge capable of withstanding the maximum load while using only the materials provided: ice cream pop sticks and adhesives (glue, tape, etc.). This competition will help participants apply principles of structural analysis, material strength, and load distribution to a real-world scenario, all while fostering creativity and teamwork.

This competition is open to all students currently enrolled in the Civil Engineering program at ITM University. Teams will consist of 2-4 members each, encouraging collaboration and teamwork to solve engineering challenges effectively.

Competition Guidelines

Competition Guidelines:

- **Materials Allowed**:
  - Ice cream pop sticks (as the primary building material)
  - Adhesives (glue, tape, etc.)
- **Design Constraints**:
  - The bridge must be a freestanding structure.
  - The bridge must span a minimum of 30 cm without support.
  - The bridge must be able to support a load placed at the center of the bridge.
- **Construction Period**:
  - Teams will have 3 hours to design and construct their bridges.
- **Judging Criteria**:
  - Load-bearing capacity: The amount of weight the bridge can support before failure.
  - Innovation: The creativity and originality of the design.
  - Construction Quality: The precision and neatness of the assembly.
  - Efficiency: The ability to maximize strength while using minimal materials.

- **Aesthetic Appeal**: The overall visual design of the bridge.

Competition Phases

1. **Design Phase**: Teams started by sketching their bridge designs, taking into account factors like material distribution, load-bearing capacity, and structural efficiency.

2. **Construction Phase**: Teams had a fixed time (3 hours) to construct their bridges. They ensured that the bridge can span the required gap and support the maximum load.

3. **Testing Phase**: Once completed, each bridge was subjected to a load test. A weight was gradually added to the bridge until it fails. The maximum load the bridge can support will determine the winning team.

Glimpse of Project

ITM UNIVERSITY

GWALIOR

PBL (Project based learning)

On

"Analysis of High-Rise Multi-Storey Steel Building Using STAAD Pro"

Course Code: (CEL0723)

Course Name: Advanced Structural Design(Steel)

Submitted By:

Arindam Kumar (BETN1CE21008)

In partial fulfillment for the award of the degree of

B. TECH DEGREE

In

Civil Engineering

Submitted to: Dr. Mukesh Kumar Pandey

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Introduction

The construction of high-rise multi-storey buildings is a vital aspect of urban development. With the increasing demand for vertical expansion in cities, steel structures are widely used due to their high strength-to-weight ratio, durability, and ease of construction. This project focuses on the analysis of a high-rise multi-storey steel building using STAAD Pro, a powerful structural analysis and design software. The analysis includes dead load, live load, and seismic load, where the number of floors is determined by the roll number of the student (i.e., 10 + roll number).

Objectives

The main objectives of this project are:

- To model and analyze a high-rise multi-storey steel building.
- To evaluate the effects of dead load, live load, and seismic load on the building's structure.
- To understand the behavior of the building under different loading conditions using STAAD Pro.
- To ensure the safety and stability of the structure by evaluating internal forces (shear, bending moment, axial force) and displacement.

Scope

The scope of this study is limited to the analysis of a multi-storey steel building, using STAAD Pro to model the structure, apply loads, and analyze the results. The building is assumed to be located in a region subject to seismic activity. Fixed values of dead load and live load are applied, and seismic load is considered for the analysis. The structure's height and number of floors depend on the student's roll number.

Methodology

The methodology for this project includes the following steps:

1. **Structural Modeling**: Model the building with the required number of floors and define its geometry and material properties.

2. **Load Application**: Apply dead load, live load, and seismic load on the structure.

3. **Analysis**: Use STAAD Pro for structural analysis, including the effects of different loads.

4. **Result Interpretation**: Evaluate the results from STAAD Pro, such as displacement, internal forces, and design checks.

5. **Conclusion**: Based on the analysis, provide conclusions regarding the safety and stability of the structure.

Design of the structure

In this section, we will provide the details of the building's design, including the number of floors, material properties, and the structural layout.

- **Building Specification**:
    1. **Number of Floors**: 10
    2. **Material**: Steel (Fe 415 grade or similar).
    3. **Building Shape**: Rectangular or square footprint.
    4. **Floor Height**: 3 meters per floor (standard).
    5. **Structural System**: Frame structure (beam-column system).
    6. **Live Load**: Typically, for office buildings: 3 kN/m^2; for residential buildings: 2 kN/m^2.
    7. **Dead Load**: Based on the building materials and finishes (e.g., floor slab thickness,walls, roofing).

- **Material Properties**:
    1. **Steel Grade**: IS 2062 (Fe 415)
    2. **Young's Modulus**: 2.1×10^5 MPa
    3. **Poisson's Ratio**: 0.3
    4. **Density of Steel**: 7850 kg/m^3

Load Calculations

- **Dead Load**

  Dead load consists of the weight of the structural components of the building, including beams, columns, slabs, and non-structural elements like walls and finishes.

  Floor Slab Dead Load: 3.5 kN/m² (thickness of slab assumed 150mm).

  Wall Load: 12 kN/m for external walls (assuming 230 mm thickness).

  Column Load: Calculated based on the axial load transmitted by the floor above.

- **Live Load**

Live load is the load applied due to occupancy, furniture, and other movable objects. For a commercial or office building:

Live Load (Office): 3 kN/m² (typical for office spaces).

Live Load (Residential): 2 kN/m² (typical for residential areas).

- **Seismic Load**

Seismic load is calculated using the relevant IS 1893 (Part 1) guidelines. The following steps are taken into account:

Seismic Zone: Based on the location of the building (e.g., Zone II).

Response Spectrum: The method used in STAAD Pro to analyze seismic load.

Importance Factor: Based on the function of the building (e.g., residential, office).

Soil Type: Assumed as medium soil (Type II).

Analysis of the structure using STAAD Pro

- **Software Description:**

STAAD Pro is a comprehensive software used for structural analysis and design. It provides advanced tools for modeling, analysis, and design of structures under various load combinations. The software is capable of performing linear and nonlinear analysis, including the application of dead load, live load, seismic load, wind load, and more.

- **Modelling of the structure:**

1. **Geometry**: Define the building's geometry in STAAD Pro, including the number of floors, column and beam sizes, and slab thickness.
2. **Material Properties**: Assign steel material properties based on the design code.
3. **Support Conditions**: The base of the building is fixed, which means the supports are restrained in all directions.

- **Load Application:**

1. **Dead Load**: Applied based on the floor area and material properties.\

2. **Live Load**: Applied as per the occupancy type.

3. **Seismic Load**: Applied using the response spectrum method as per IS 1893.

Results

- **Deformation Analysis:**

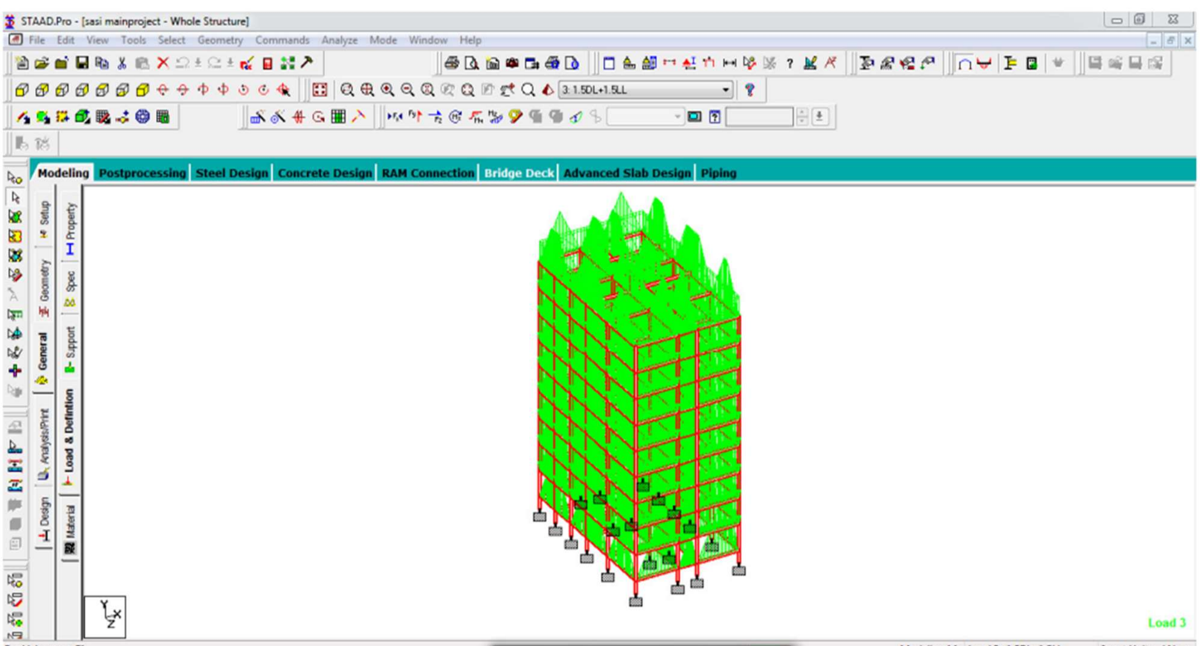
  STAAD Pro provides deformation results, which include the displacement of nodes and overall displacement of the building due to the applied loads. It is important to check if the displacements are within permissible limits and upon evaluation it is found out that it was under permissible limits.

- **Internal Forces:**

  The internal forces (shear, bending moment, axial force) are calculated for each member (beam, column). These results are essential for ensuring the safety and stability of the structure. If the internal forces exceed the material's capacity, redesigning may be necessary.

- **Deflection and Displacement:**

  The deflection at different points of the structure is calculated, and it is checked against the permissible deflection limits as per design codes (IS 800). Excessive deflection can lead to structural instability.



STAAD.Pro REPORT

Department of Civil Engineering
ITM UNIVERSITY, GWALIOR

Submitted in partial fulfilment of the

Requirements for the award of

Degree of Bachelor of Technology in Civil Engineering

SUBMITTD BY:
ARINDAM KUMAR
BETN1CE21008

SUBMITTED TO:

Department of Civil Engineering

School of Engineering and Technology,

ITM UNIVERSITY

Gwalior (MP)

ACKNOWLEDGEMENT

First and foremost, I wish to express my sincere thanks and gratitude to my esteemed Mentor, **“Mr. Shashank Gupta”,** who has contributed so much to the successful completion of my Industrial Training through his thoughtful reviews and valuable guidance at the construction site.

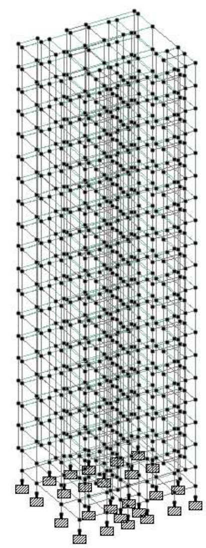
Next, I would like to tender my sincere thanks to “**Dr. Mukesh Pandey”** (Head of Civil Engineering Department) for his cooperation and encouragement.

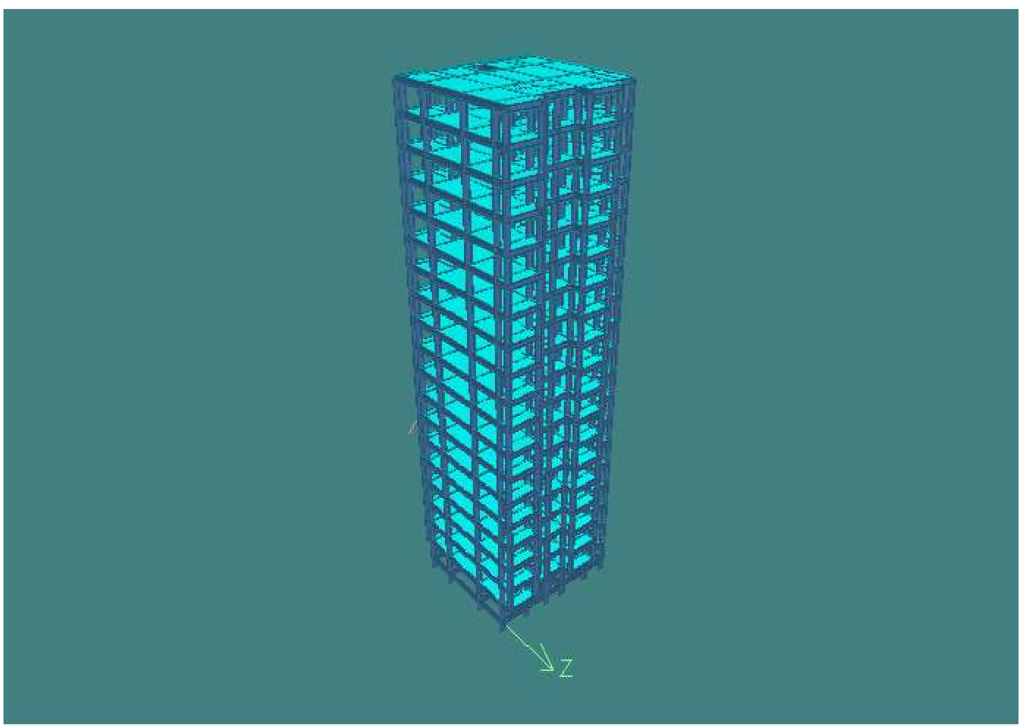
Name: Arindam Kumar

Roll No.: BETN1CE21008

Semester: 7th Semester

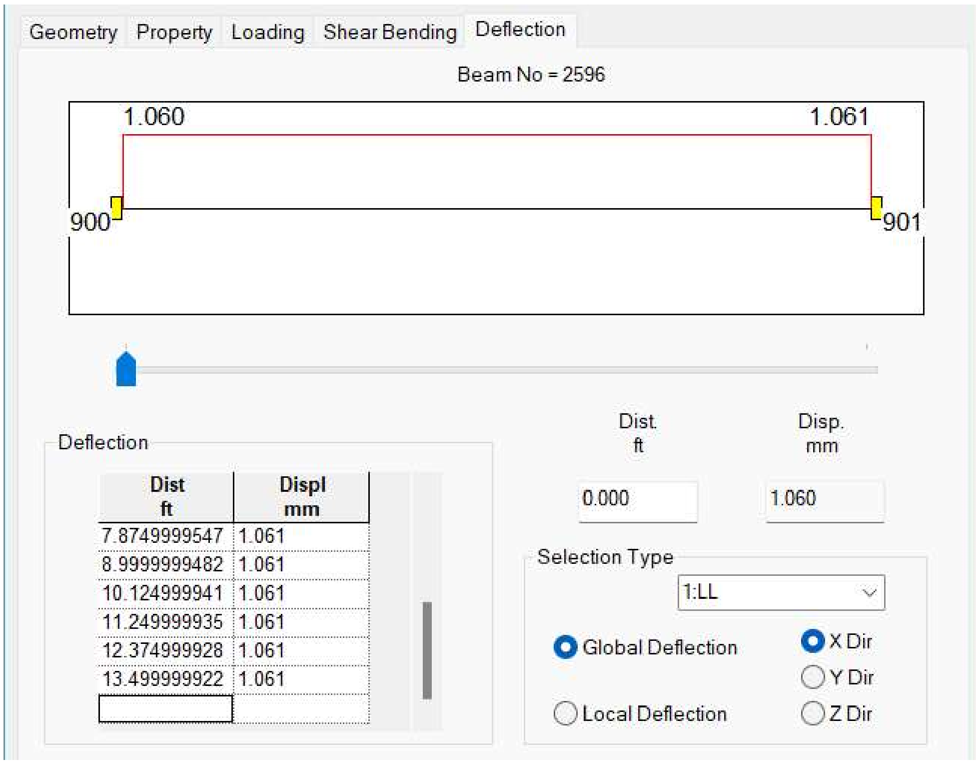
MODEL

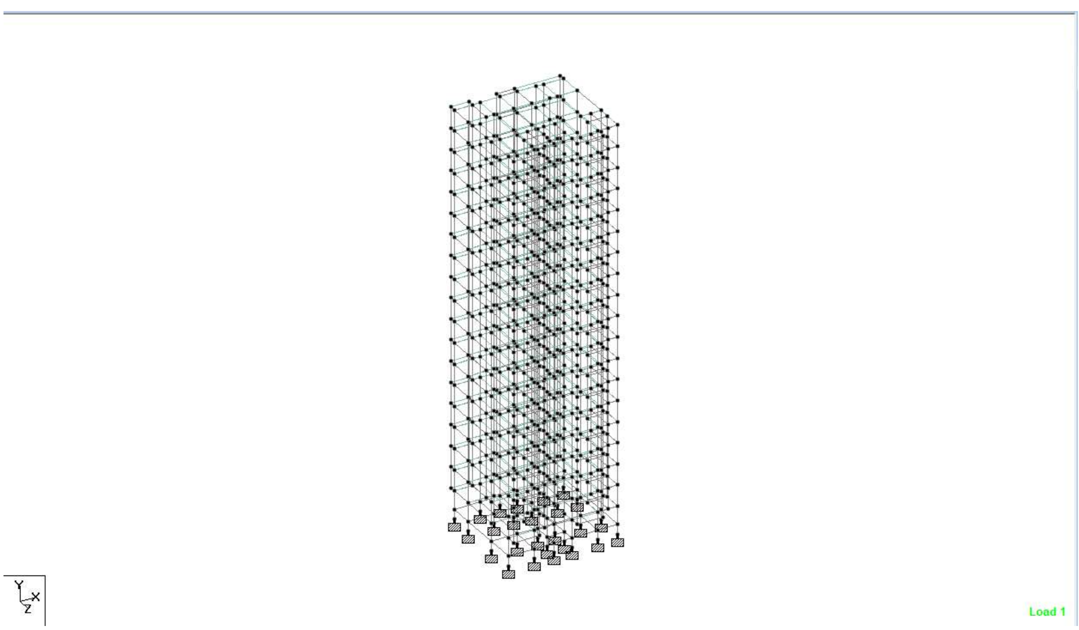




3D RENDER VIEW

DISPLACEMENTS





All | Summary

		Horizontal	Vertical	Horizontal	Resultant	Rotational		
Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
1	1 LL	-0.139	-2.030	0.082	2.036	0.000	0.000	0.000
	2 DL	-0.070	-1.107	0.032	1.109	0.000	0.000	0.000
	3 ULC, 1.5 DE	-0.314	-4.705	0.170	4.718	0.000	0.000	0.000
	4 ULC, 1.2 DE	-0.251	-3.764	0.136	3.775	0.000	0.000	0.000
	5 ULC, 1.5 DE	-0.105	-1.660	0.047	1.664	0.000	0.000	0.000
	6 ULC, 0.9 DE	-0.063	-0.996	0.028	0.998	0.000	0.000	0.000
2	1 LL	-0.065	-1.721	-0.031	1.723	0.000	-0.000	-0.000
	2 DL	-0.032	-0.959	-0.027	0.960	-0.000	-0.000	-0.000
	3 ULC, 1.5 DE	-0.146	-4.019	-0.086	4.023	-0.000	-0.000	-0.000
	4 ULC, 1.2 DE	-0.116	-3.216	-0.069	3.218	-0.000	-0.000	-0.000
	5 ULC, 1.5 DE	-0.048	-1.438	-0.040	1.439	-0.000	-0.000	-0.000
	6 ULC, 0.9 DE	-0.029	-0.863	-0.024	0.864	-0.000	-0.000	-0.000
3	1 LL	-0.043	-1.923	0.068	1.925	0.000	0.000	-0.000
	2 DL	-0.023	-1.089	0.027	1.089	0.000	0.000	-0.000
	3 ULC, 1.5 DE	-0.098	-4.518	0.143	4.521	0.000	0.000	-0.000
	4 ULC, 1.2 DE	-0.079	-3.614	0.114	3.617	0.000	0.000	-0.000
	5 ULC, 1.5 DE	-0.034	-1.633	0.041	1.634	0.000	0.000	-0.000
	6 ULC, 0.9 DE	-0.021	-0.980	0.025	0.980	0.000	0.000	-0.000
4	1 LL	-0.019	-1.891	-0.012	1.891	0.000	0.000	0.000
	2 DL	-0.012	-1.053	-0.011	1.053	-0.000	0.000	-0.000
	3 ULC, 1.5 DE	-0.046	-4.416	-0.034	4.417	0.000	0.000	0.000
	4 ULC, 1.2 DE	-0.036	-3.533	-0.027	3.533	0.000	0.000	0.000
	5 ULC, 1.5 DE	-0.018	-1.579	-0.017	1.579	-0.000	0.000	-0.000
	6 ULC, 0.9 DE	-0.011	-0.948	-0.010	0.948	-0.000	0.000	-0.000
5	1 LL	0.065	-1.780	-0.069	1.783	-0.000	-0.000	-0.000
	2 DL	0.033	-1.068	-0.035	1.069	-0.000	-0.000	-0.000
	3 ULC, 1.5 DE	0.147	-4.273	-0.156	4.278	-0.000	-0.000	-0.000
	4 ULC, 1.2 DE	0.117	-3.418	-0.125	3.423	-0.000	-0.000	-0.000
	5 ULC, 1.5 DE	0.050	-1.602	-0.052	1.604	-0.000	-0.000	-0.000
	6 ULC, 0.9 DE	0.030	-0.961	-0.031	0.962	-0.000	-0.000	-0.000
6	1 LL	0.092	-1.729	0.064	1.733	0.000	-0.000	-0.000
	2 DL	0.047	-1.134	0.046	1.136	0.000	-0.000	-0.000
	3 ULC, 1.5 DE	0.209	-4.296	0.166	4.304	0.000	-0.000	-0.000
	4 ULC, 1.2 DE	0.167	-3.437	0.132	3.443	0.000	-0.000	-0.000
	5 ULC, 1.5 DE	0.071	-1.702	0.070	1.704	0.000	-0.000	-0.000
	6 ULC, 0.9 DE	0.042	-1.021	0.042	1.023	0.000	-0.000	-0.000
7	1 LL	-0.001	-1.617	0.054	1.617	-0.000	0.000	-0.000
	2 DL	0.007	-0.823	0.016	0.823	-0.000	0.000	-0.000
	3 ULC, 1.5 DE	0.008	-3.659	0.106	3.660	-0.000	0.000	-0.000
	4 ULC, 1.2 DE	0.006	-2.927	0.085	2.928	-0.000	0.000	-0.000
	5 ULC, 1.5 DE	0.010	-1.234	0.024	1.234	-0.000	0.000	-0.000
	6 ULC, 0.9 DE	0.006	-0.740	0.014	0.740	-0.000	0.000	-0.000
8	1 LL	0.017	-1.838	-0.029	1.838	0.000	0.000	-0.000
	2 DL	0.015	0.935	0.026	0.936	0.000	0.000	0.000

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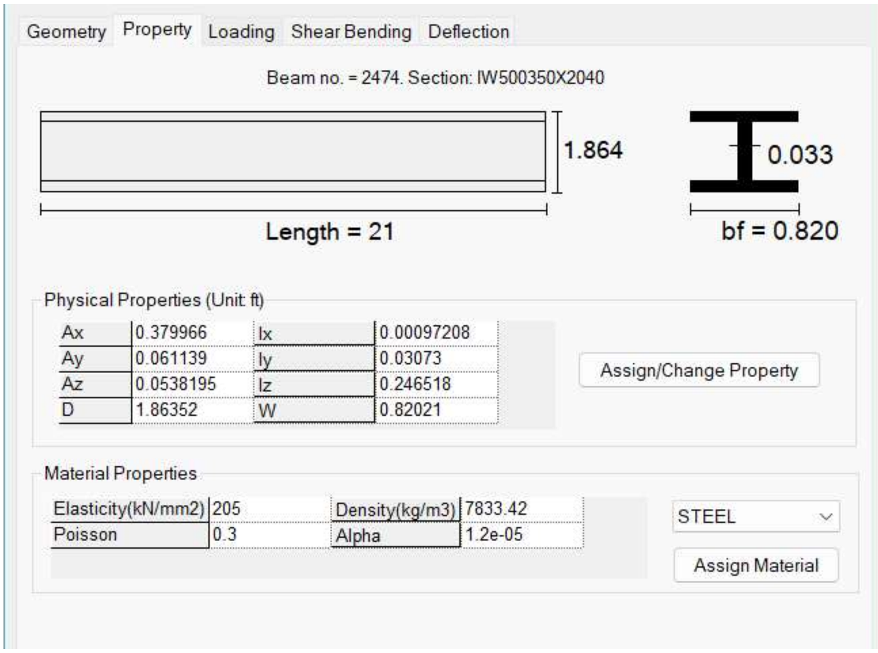
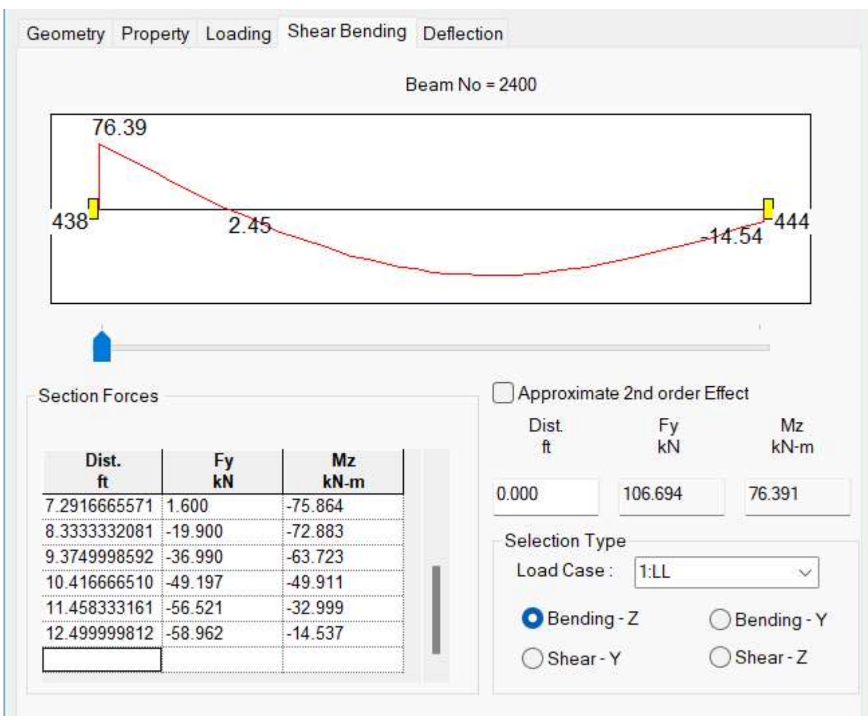
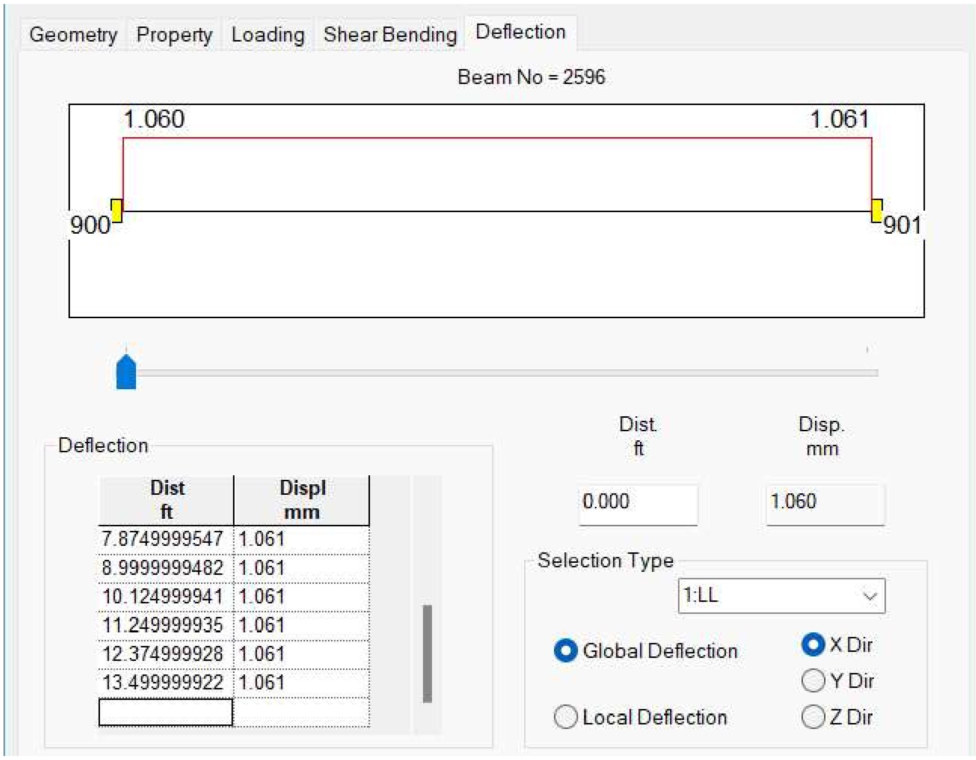
PROPERTIES



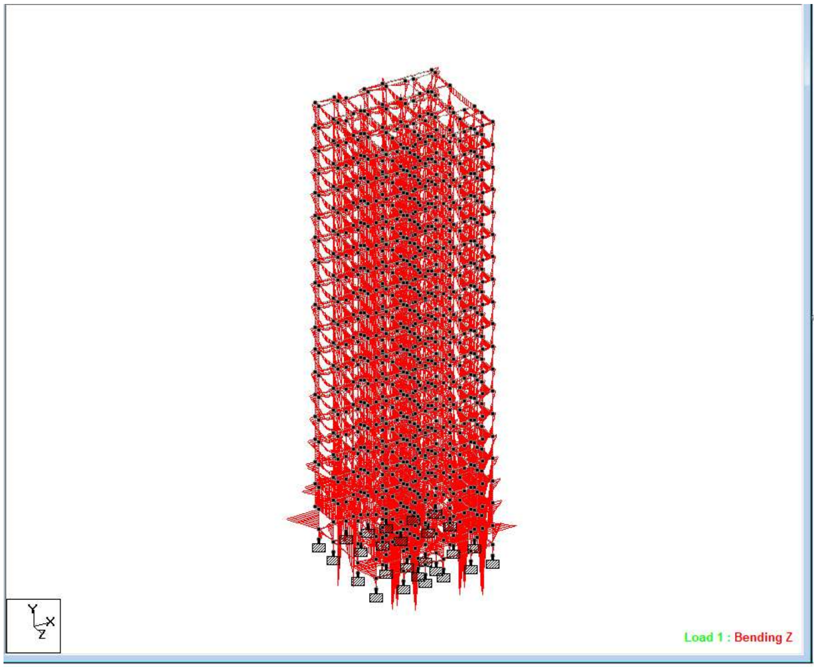


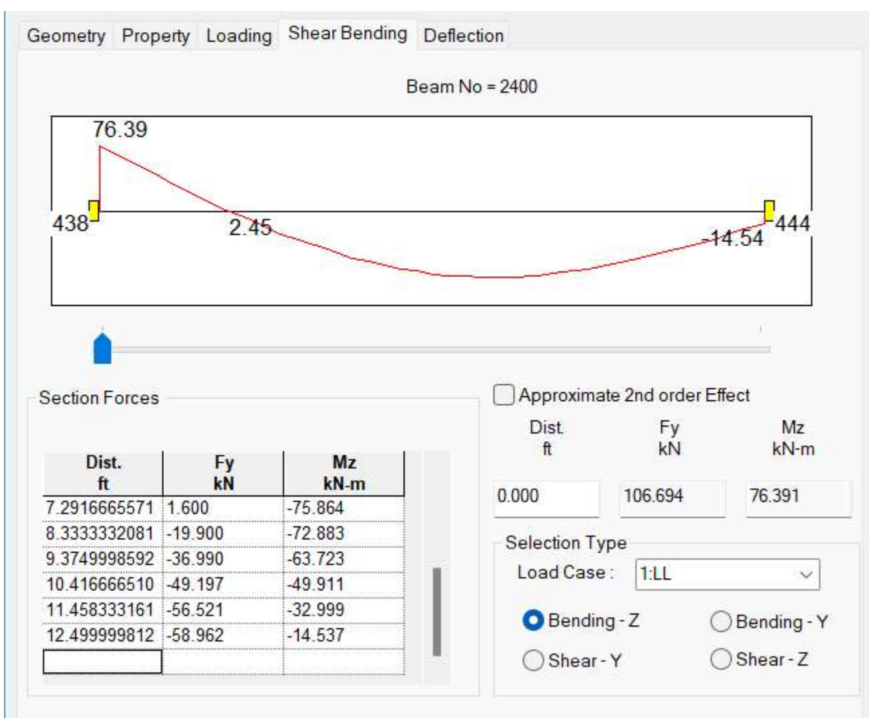
BENDING MOMENT



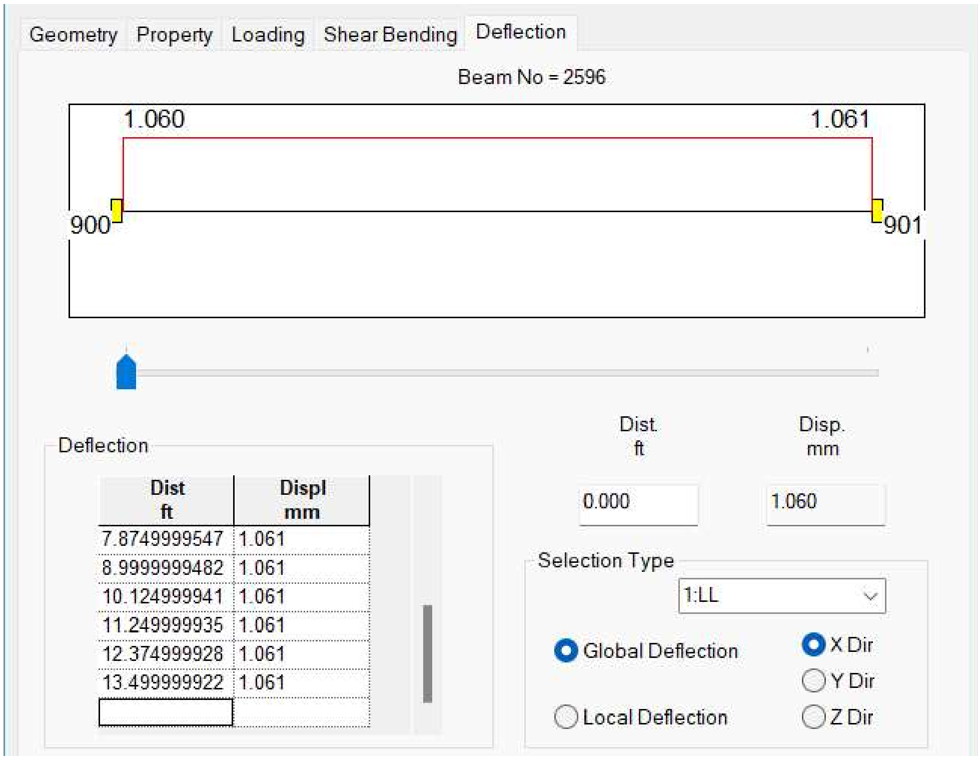
SHEAR FORCE DIAGRAM

BEAM RESULTS

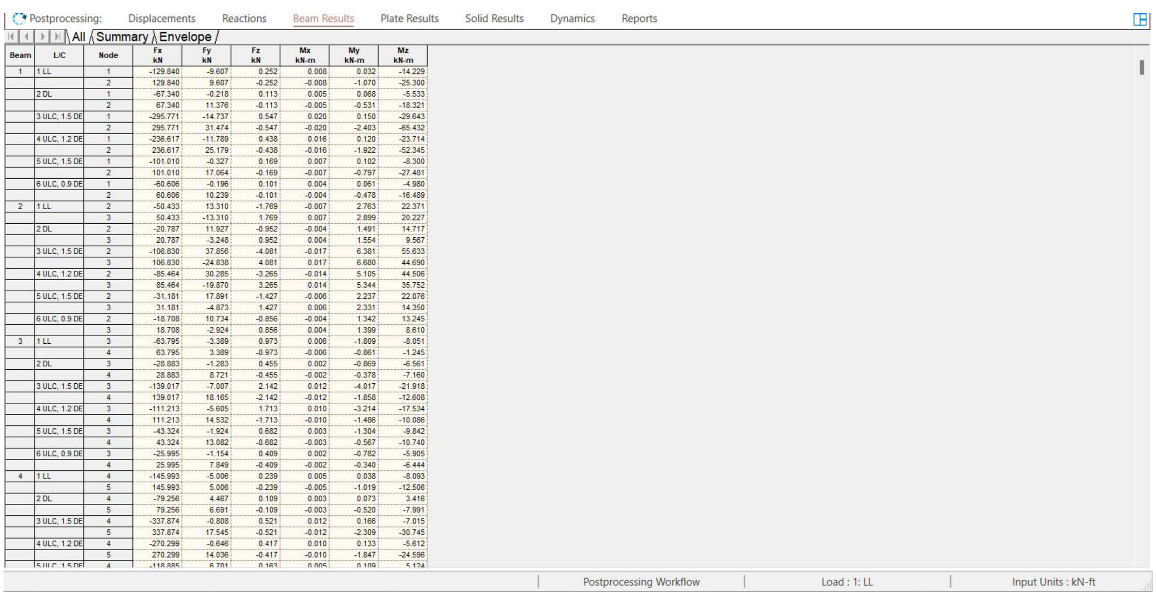




BENDING MOMENT DIAGRAM BEAM

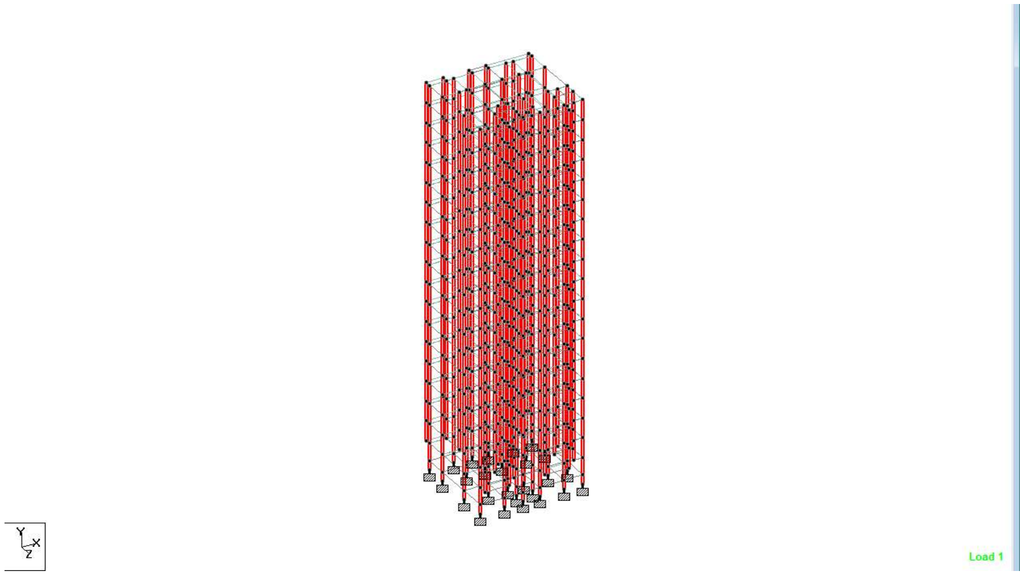


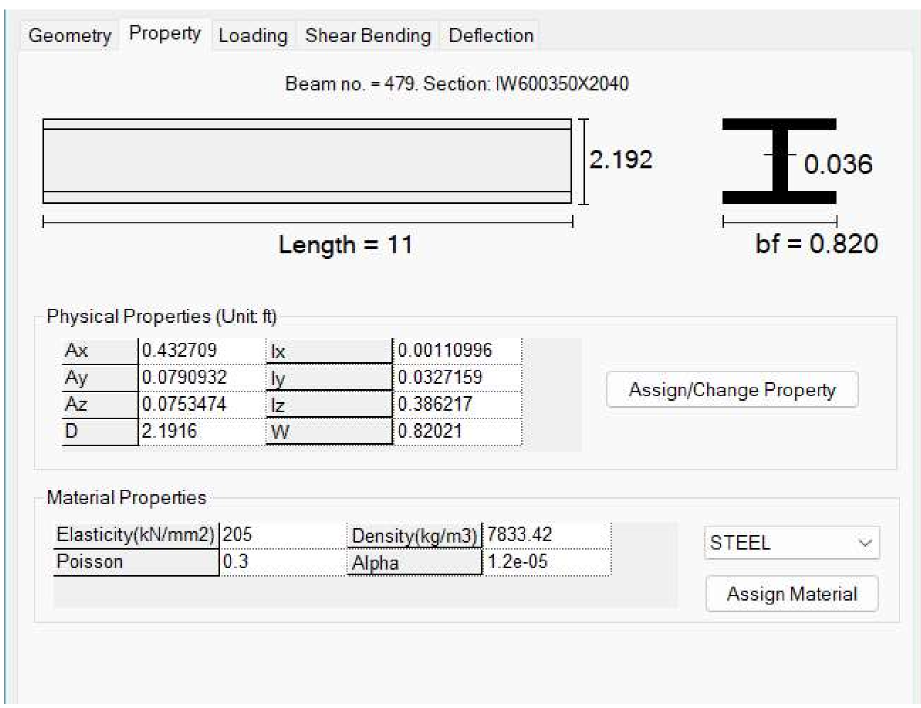
SHEAR FORCE DIAGRAM BEAM

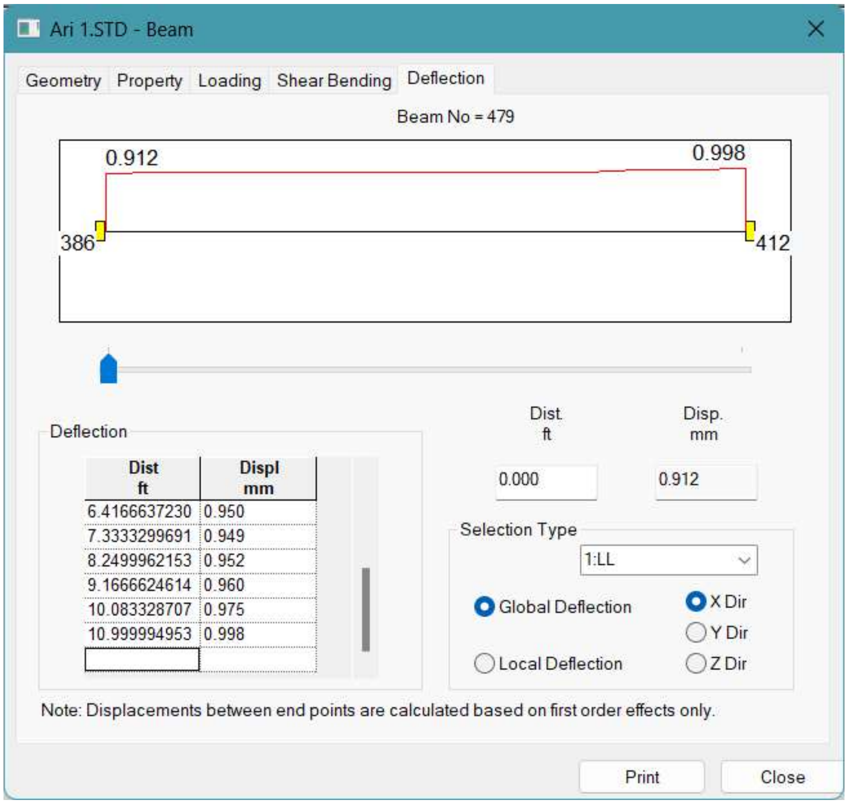


Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
1	1 LL	1	-129.840	-9.607	0.252	0.008	0.032	-14.229
		2	129.840	9.607	-0.252	-0.008	-1.070	-25.300
	2 DL	1	-67.340	-0.218	0.113	0.005	0.068	-5.533
		2	67.340	11.376	-0.113	-0.005	-0.531	-18.321
	3 ULC, 1.5 DE	1	-295.771	-14.737	0.547	0.020	0.150	-29.643
		2	295.771	31.474	-0.547	-0.020	-2.403	-65.432
	4 ULC, 1.2 DE	1	-236.617	-11.789	0.438	0.016	0.120	-23.714
		2	236.617	25.179	-0.438	-0.016	-1.922	-52.345
	5 ULC, 1.5 DE	1	-101.010	-0.327	0.169	0.007	0.102	-8.300
		2	101.010	17.064	-0.169	-0.007	-0.797	-27.481
	6 ULC, 0.9 DE	1	-60.606	-0.196	0.101	0.004	0.061	-4.980
		2	60.606	10.239	-0.101	-0.004	-0.478	-16.489
2	1 LL	2	-50.433	13.310	-1.769	-0.007	2.763	22.371
		3	50.433	-13.310	1.769	0.007	2.899	20.227
	2 DL	2	-20.787	11.927	-0.952	-0.004	1.491	14.717
		3	20.787	-3.248	0.952	0.004	1.554	9.567
	3 ULC, 1.5 DE	2	-106.830	37.856	-4.081	-0.017	6.381	55.633
		3	106.830	-24.838	4.081	0.017	6.680	44.690
	4 ULC, 1.2 DE	2	-85.464	30.285	-3.265	-0.014	5.105	44.506
		3	85.464	-19.870	3.265	0.014	5.344	35.752
	5 ULC, 1.5 DE	2	-31.181	17.891	-1.427	-0.006	2.237	22.076
		3	31.181	-4.873	1.427	0.006	2.331	14.350
	6 ULC, 0.9 DE	2	-18.708	10.734	-0.856	-0.004	1.342	13.245
		3	18.708	-2.924	0.856	0.004	1.399	8.610
3	1 LL	3	-63.795	-3.389	0.973	0.006	-1.809	-8.051
		4	63.795	3.389	-0.973	-0.006	-0.861	-1.245
	2 DL	3	-28.883	-1.283	0.455	0.002	-0.869	-6.561
		4	28.883	8.721	-0.455	-0.002	-0.378	-7.160
	3 ULC, 1.5 DE	3	-139.017	-7.007	2.142	0.012	-4.017	-21.918
		4	139.017	18.165	-2.142	-0.012	-1.858	-12.608
	4 ULC, 1.2 DE	3	-111.213	-5.605	1.713	0.010	-3.214	-17.534
		4	111.213	14.532	-1.713	-0.010	-1.486	-10.086
	5 ULC, 1.5 DE	3	-43.324	-1.924	0.682	0.003	-1.304	-9.842
		4	43.324	13.082	-0.682	-0.003	-0.567	-10.740
	6 ULC, 0.9 DE	3	-25.995	-1.154	0.409	0.002	-0.782	-5.905
		4	25.995	7.849	-0.409	-0.002	-0.340	-6.444
4	1 LL	4	-145.993	-5.006	0.239	0.005	0.038	-8.093
		5	145.993	5.006	-0.239	-0.005	-1.019	-12.506
	2 DL	4	-79.256	4.467	0.109	0.003	0.073	3.416
		5	79.256	6.691	-0.109	-0.003	-0.520	-7.991
	3 ULC, 1.5 DE	4	-337.874	-0.808	0.521	0.012	0.166	-7.015
		5	337.874	17.545	-0.521	-0.012	-2.309	-30.745
	4 ULC, 1.2 DE	4	-270.299	-0.646	0.417	0.010	0.133	-5.612
		5	270.299	14.036	-0.417	-0.010	-1.847	-24.596
	5 ULC, 1.5 DE	4	-118.885	6.701	0.163	0.005	0.109	5.124

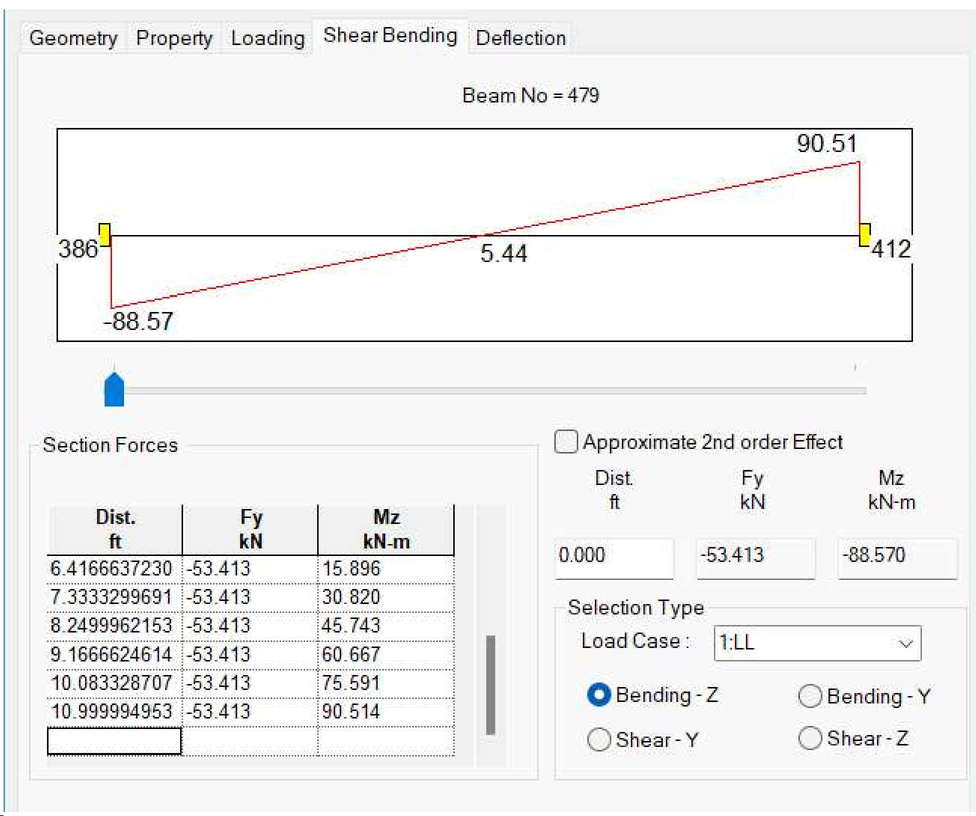
COLUMN RESULTS







Dist ft	Displ mm
6.4166637230	0.950
7.3333299691	0.949
8.2499962153	0.952
9.1666624614	0.960
10.083328707	0.975
10.999994953	0.998



Dist. ft	Fy kN	Mz kN-m
6.4166637230	-53.413	15.896
7.3333299691	-53.413	30.820
8.2499962153	-53.413	45.743
9.1666624614	-53.413	60.667
10.083328707	-53.413	75.591
10.999994953	-53.413	90.514

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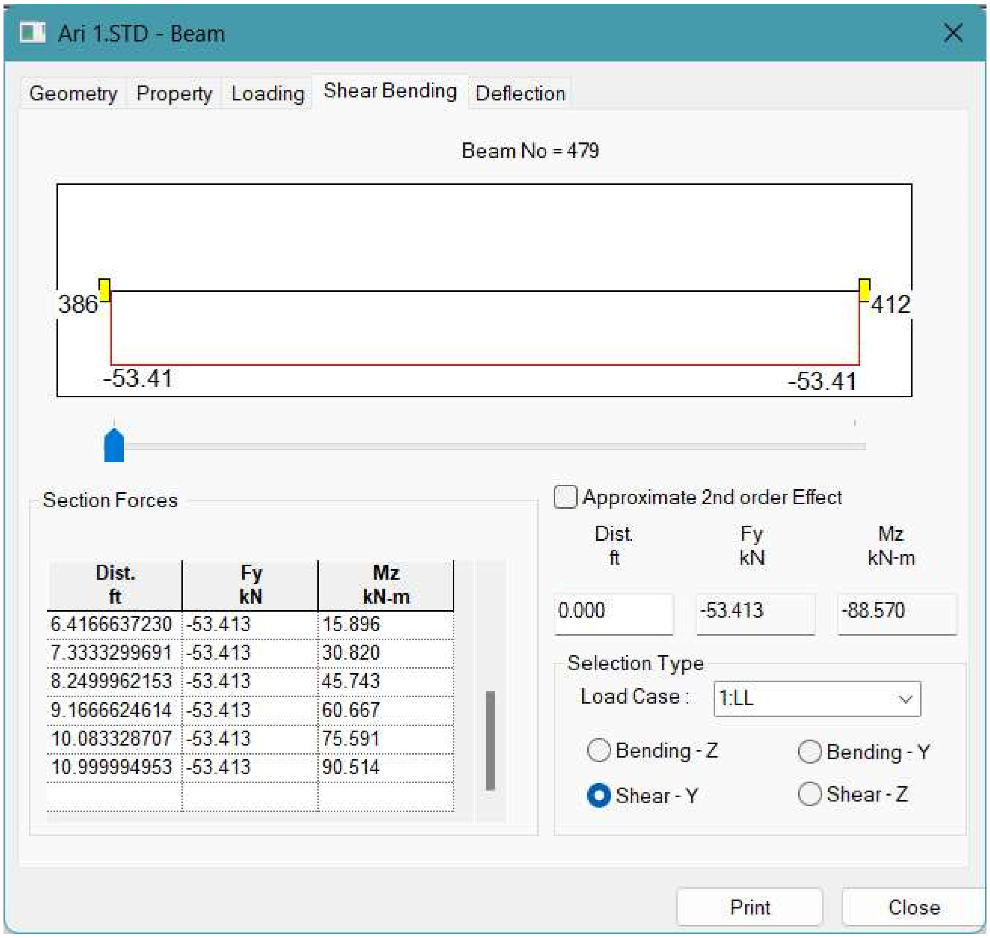
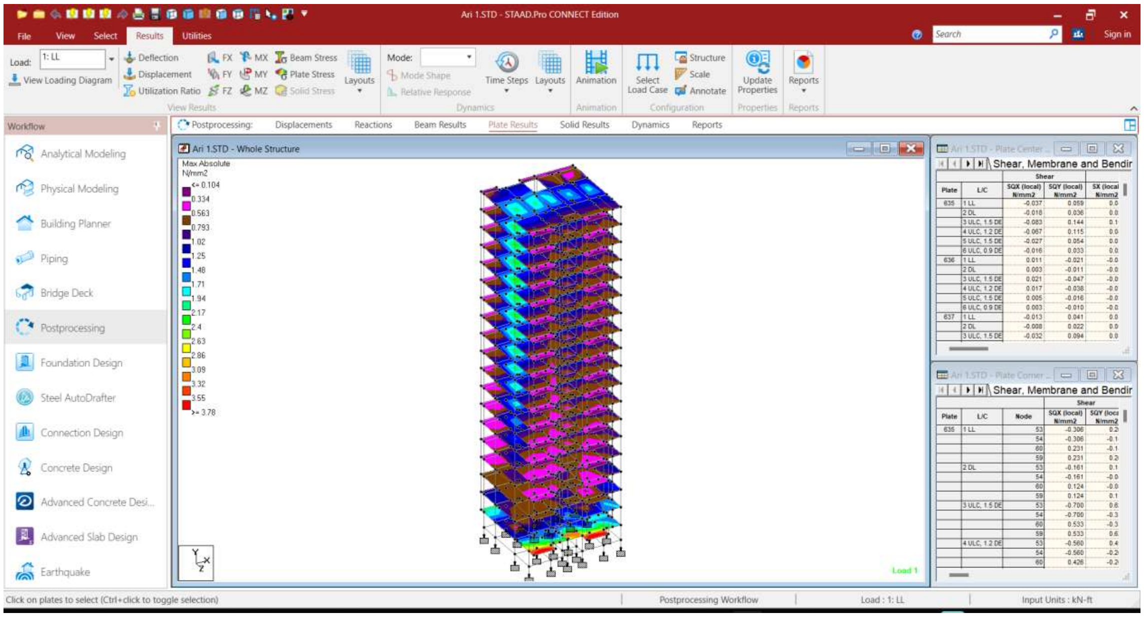
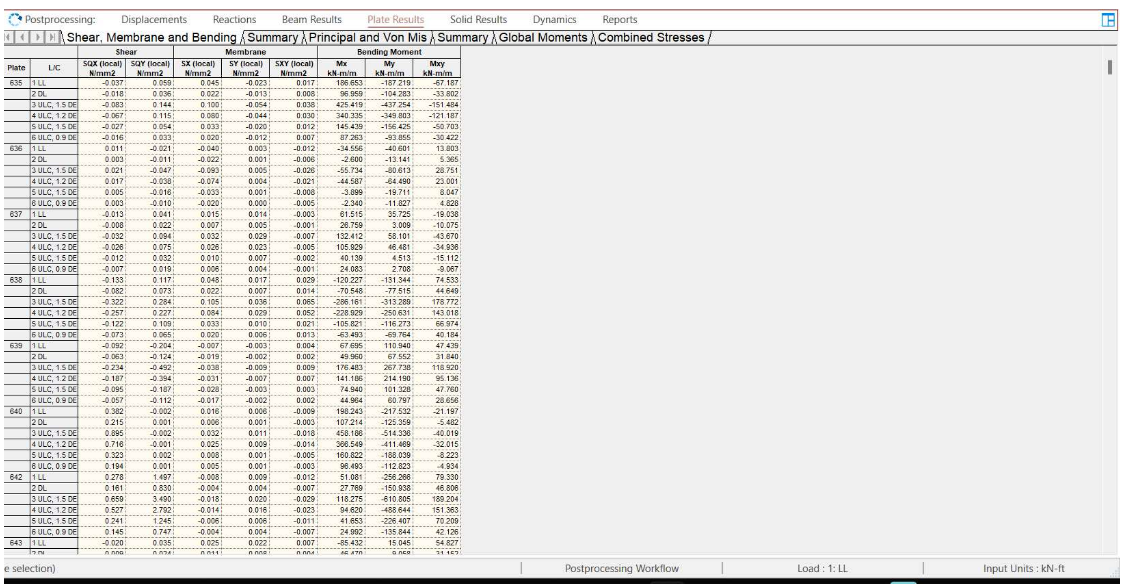
BENDING MOMENT DIAGRAM BEAM



SHEAR FORCE DIAGRAM BEAM

PLATE RESULTS





Postprocessing: Displacements Reactions Beam Results Plate Results Solid Results Dynamics Reports

Shear, Membrane and Bending | Summary | Principal and Von Mis | Summary | Global Moments | Combined Stresses

		Shear		Membrane			Bending Moment		
Plate	L/C	SQX (local) N/mm2	SQY (local) N/mm2	SX (local) N/mm2	SY (local) N/mm2	SXY (local) N/mm2	Mx kN-m/m	My kN-m/m	Mxy kN-m/m
635	1 LL	-0.037	0.059	0.045	-0.023	0.017	186.653	-187.219	-67.187
	2 DL	-0.018	0.036	0.022	-0.013	0.008	96.959	-104.283	-33.802
	3 ULC, 1.5 DE	-0.083	0.144	0.100	-0.054	0.038	425.419	-437.254	-151.484
	4 ULC, 1.2 DE	-0.067	0.115	0.080	-0.044	0.030	340.335	-349.803	-121.187
	5 ULC, 1.5 DE	-0.027	0.054	0.033	-0.020	0.012	145.439	-156.425	-50.703
	6 ULC, 0.9 DE	-0.016	0.033	0.020	-0.012	0.007	87.263	-93.855	-30.422
636	1 LL	0.011	-0.021	-0.040	0.003	-0.012	-34.556	-40.601	13.803
	2 DL	0.003	-0.011	-0.022	0.001	-0.006	-2.600	-13.141	5.365
	3 ULC, 1.5 DE	0.021	-0.047	-0.093	0.005	-0.026	-55.734	-80.613	28.751
	4 ULC, 1.2 DE	0.017	-0.038	-0.074	0.004	-0.021	-44.587	-64.490	23.001
	5 ULC, 1.5 DE	0.005	-0.016	-0.033	0.001	-0.008	-3.899	-19.711	8.047
	6 ULC, 0.9 DE	0.003	-0.010	-0.020	0.000	-0.005	-2.340	-11.827	4.828
637	1 LL	-0.013	0.041	0.015	0.014	-0.003	61.515	35.725	-19.038
	2 DL	-0.008	0.022	0.007	0.005	-0.001	26.759	3.009	-10.075
	3 ULC, 1.5 DE	-0.032	0.094	0.032	0.029	-0.007	132.412	58.101	-43.670
	4 ULC, 1.2 DE	-0.026	0.075	0.026	0.023	-0.005	105.929	46.481	-34.936
	5 ULC, 1.5 DE	-0.012	0.032	0.010	0.007	-0.002	40.139	4.513	-15.112
	6 ULC, 0.9 DE	-0.007	0.019	0.006	0.004	-0.001	24.083	2.708	-9.067
638	1 LL	-0.133	0.117	0.048	0.017	0.029	-120.227	-131.344	74.533
	2 DL	-0.082	0.073	0.022	0.007	0.014	-70.548	-77.515	44.649
	3 ULC, 1.5 DE	-0.322	0.284	0.105	0.036	0.065	-286.161	-313.289	178.772
	4 ULC, 1.2 DE	-0.257	0.227	0.084	0.029	0.052	-228.929	-250.631	143.018
	5 ULC, 1.5 DE	-0.122	0.109	0.033	0.010	0.021	-105.821	-116.273	66.974
	6 ULC, 0.9 DE	-0.073	0.065	0.020	0.006	0.013	-63.493	-69.764	40.184
639	1 LL	-0.092	-0.204	-0.007	-0.003	0.004	67.695	110.940	47.439
	2 DL	-0.063	-0.124	-0.019	-0.002	0.002	49.960	67.552	31.840
	3 ULC, 1.5 DE	-0.234	-0.492	-0.038	-0.009	0.009	176.483	267.738	118.920
	4 ULC, 1.2 DE	-0.187	-0.394	-0.031	-0.007	0.007	141.186	214.190	95.136
	5 ULC, 1.5 DE	-0.095	-0.187	-0.028	-0.003	0.003	74.940	101.328	47.760
	6 ULC, 0.9 DE	-0.057	-0.112	-0.017	-0.002	0.002	44.964	60.797	28.656
640	1 LL	0.382	-0.002	0.016	0.006	-0.009	198.243	-217.532	-21.197
	2 DL	0.215	0.001	0.006	0.001	-0.003	107.214	-125.359	-5.482
	3 ULC, 1.5 DE	0.895	-0.002	0.032	0.011	-0.018	458.186	-514.336	-40.019
	4 ULC, 1.2 DE	0.716	-0.001	0.025	0.009	-0.014	366.549	-411.469	-32.015
	5 ULC, 1.5 DE	0.323	0.002	0.008	0.001	-0.005	160.822	-188.039	-8.223
	6 ULC, 0.9 DE	0.194	0.001	0.005	0.001	-0.003	96.493	-112.823	-4.934
642	1 LL	0.278	1.497	-0.008	0.009	-0.012	51.081	-256.266	79.330
	2 DL	0.161	0.830	-0.004	0.004	-0.007	27.769	-150.938	46.806
	3 ULC, 1.5 DE	0.659	3.490	-0.018	0.020	-0.029	118.275	-610.805	189.204
	4 ULC, 1.2 DE	0.527	2.792	-0.014	0.016	-0.023	94.620	-488.644	151.363
	5 ULC, 1.5 DE	0.241	1.245	-0.006	0.006	-0.011	41.653	-226.407	70.209
	6 ULC, 0.9 DE	0.145	0.747	-0.004	0.004	-0.007	24.992	-135.844	42.126
643	1 LL	-0.020	0.035	0.025	0.022	0.007	-85.432	15.045	54.827
	2 DL	0.009	0.024	0.011	0.008	0.004	46.470	9.058	31.152

e selection) | Postprocessing Workflow | Load : 1: LL | Input Units : kN-ft