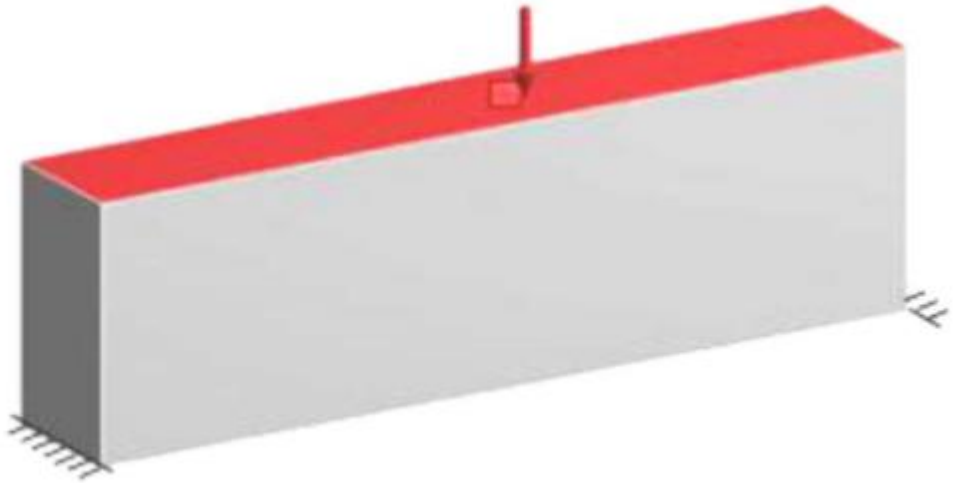
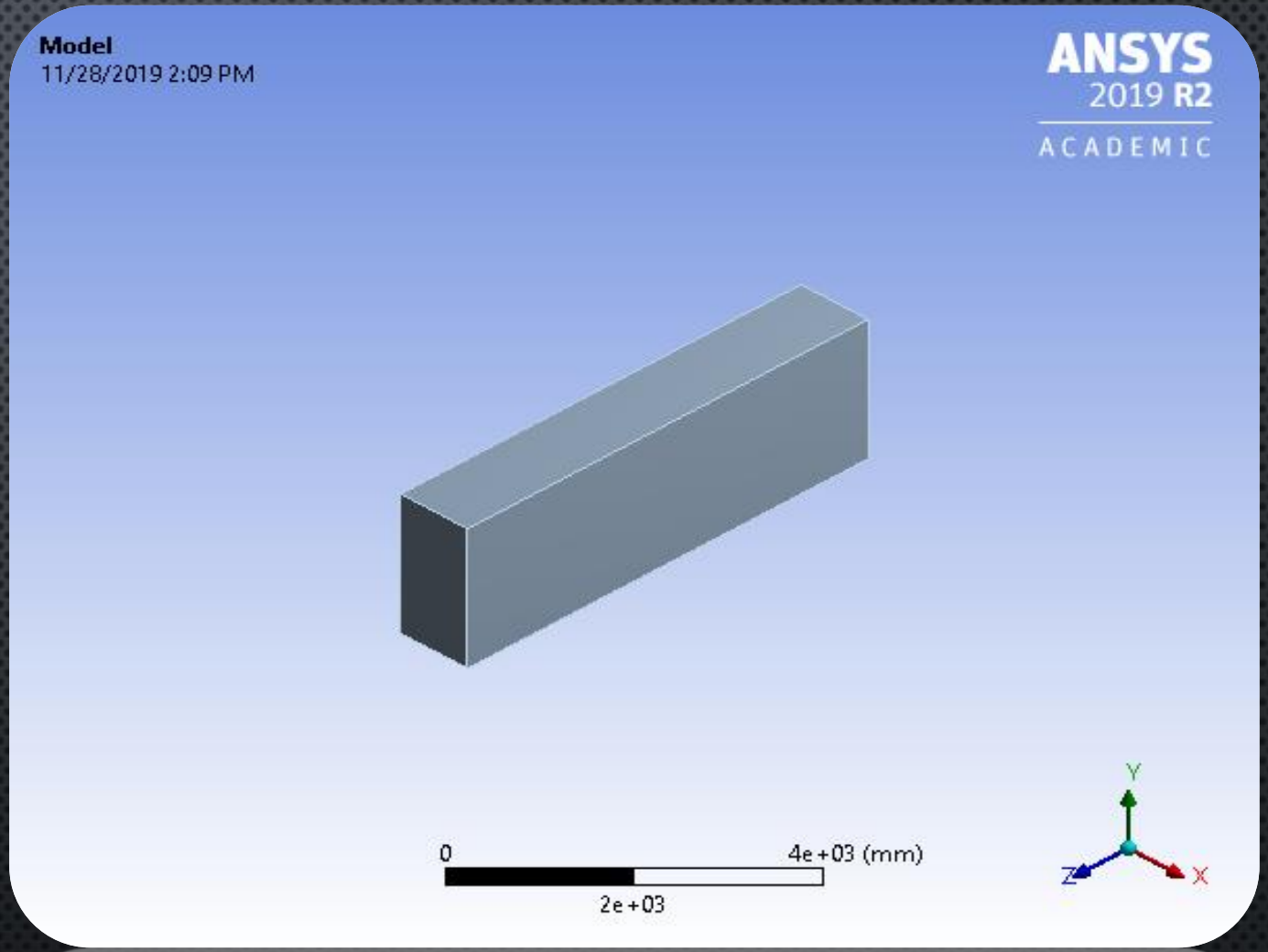
# ASSIGNMENT 11 – Q1

**Problem -1**

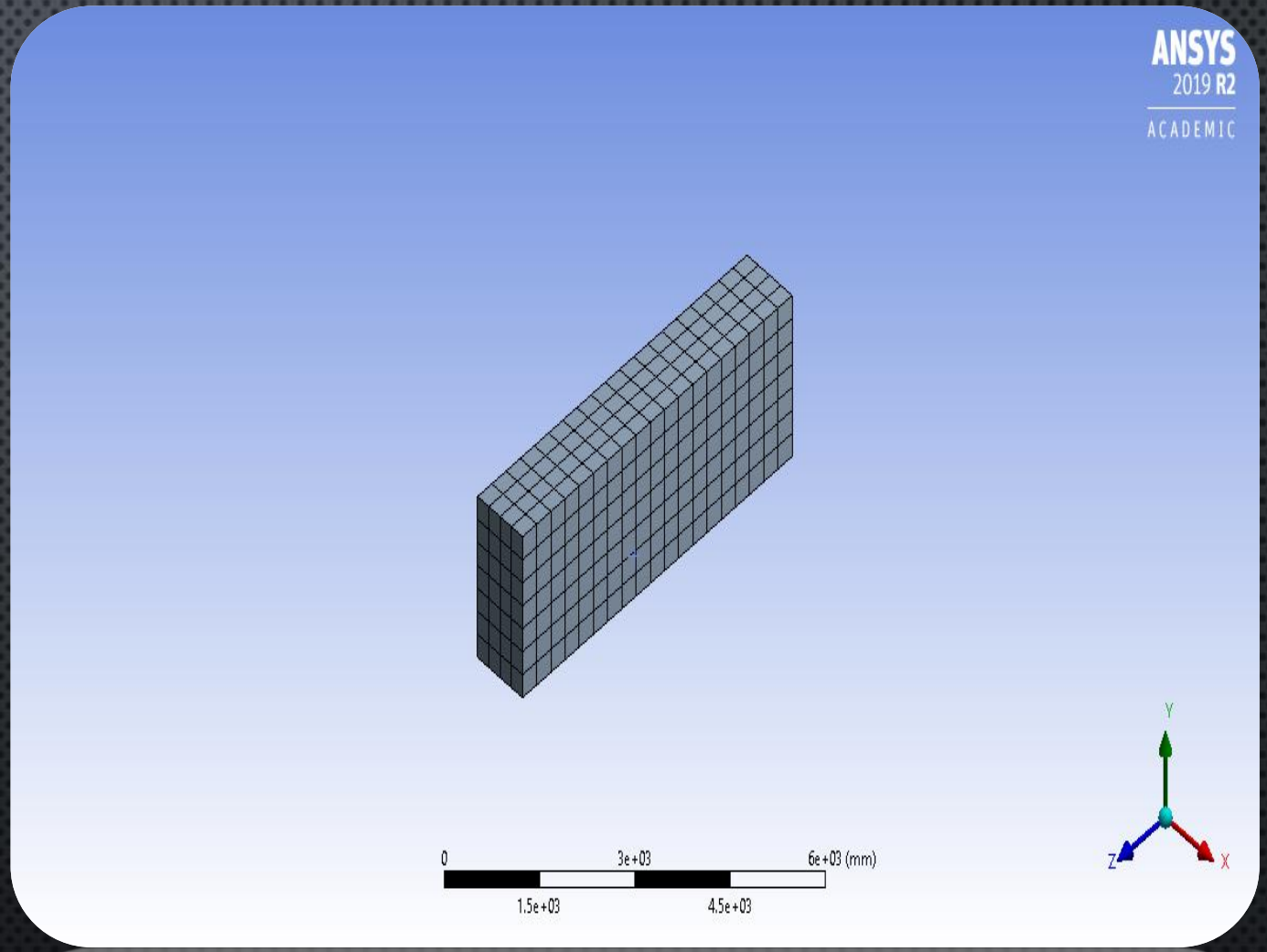
The 3-D design space of a steel bridge structure is 6 m long, 2 m tall, and 1 m wide, as shown below. Suppose the structure is fixed on the bottom two edges and is applied a uniform pressure load on the top surface. Perform topology optimization of the bridge using the given design space to achieve 80% weight reduction. Find out the effect of changing the load value.



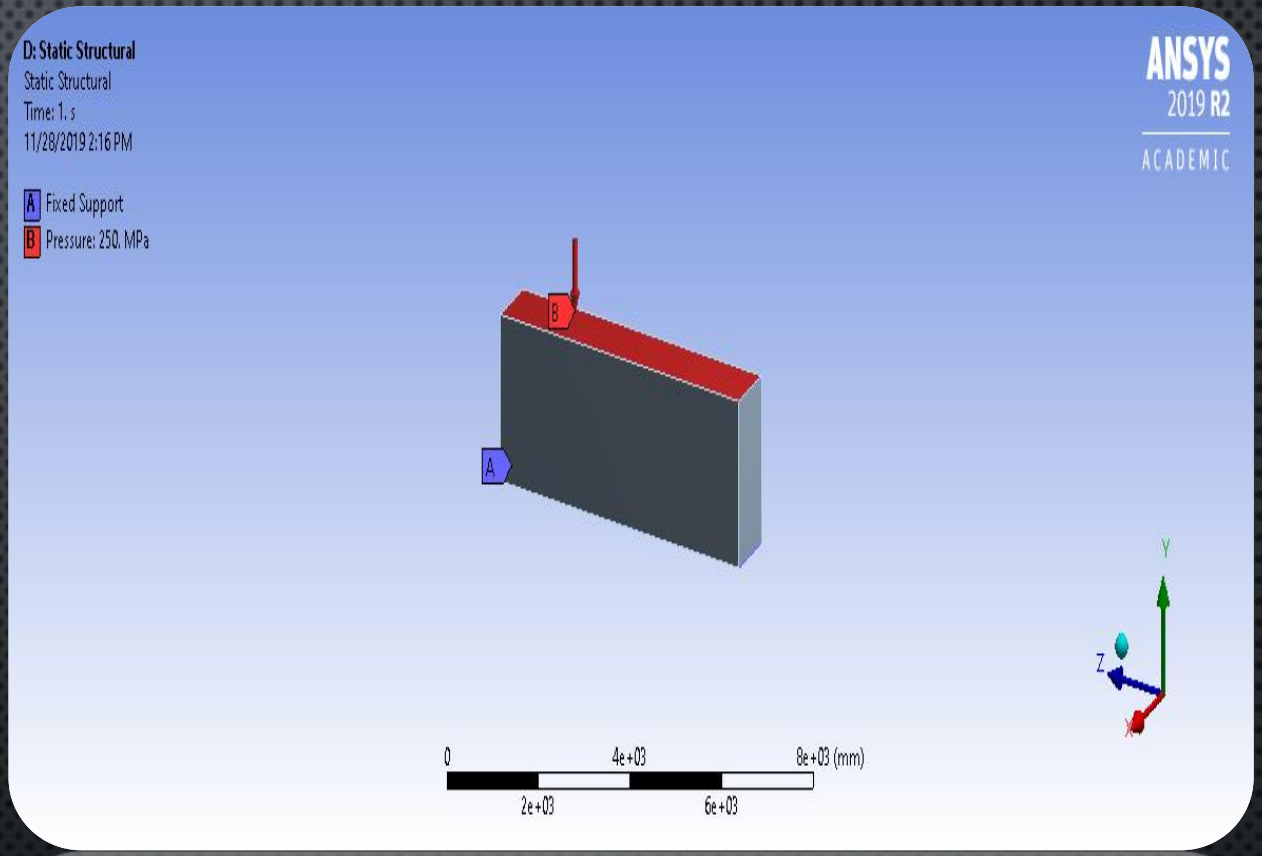
# Geometry


Model
11/28/2019 2:09 PM
ANSYS
2019 R2
ACADEMIC
0
4e+03 (mm)
2e+03
Y
Z
X

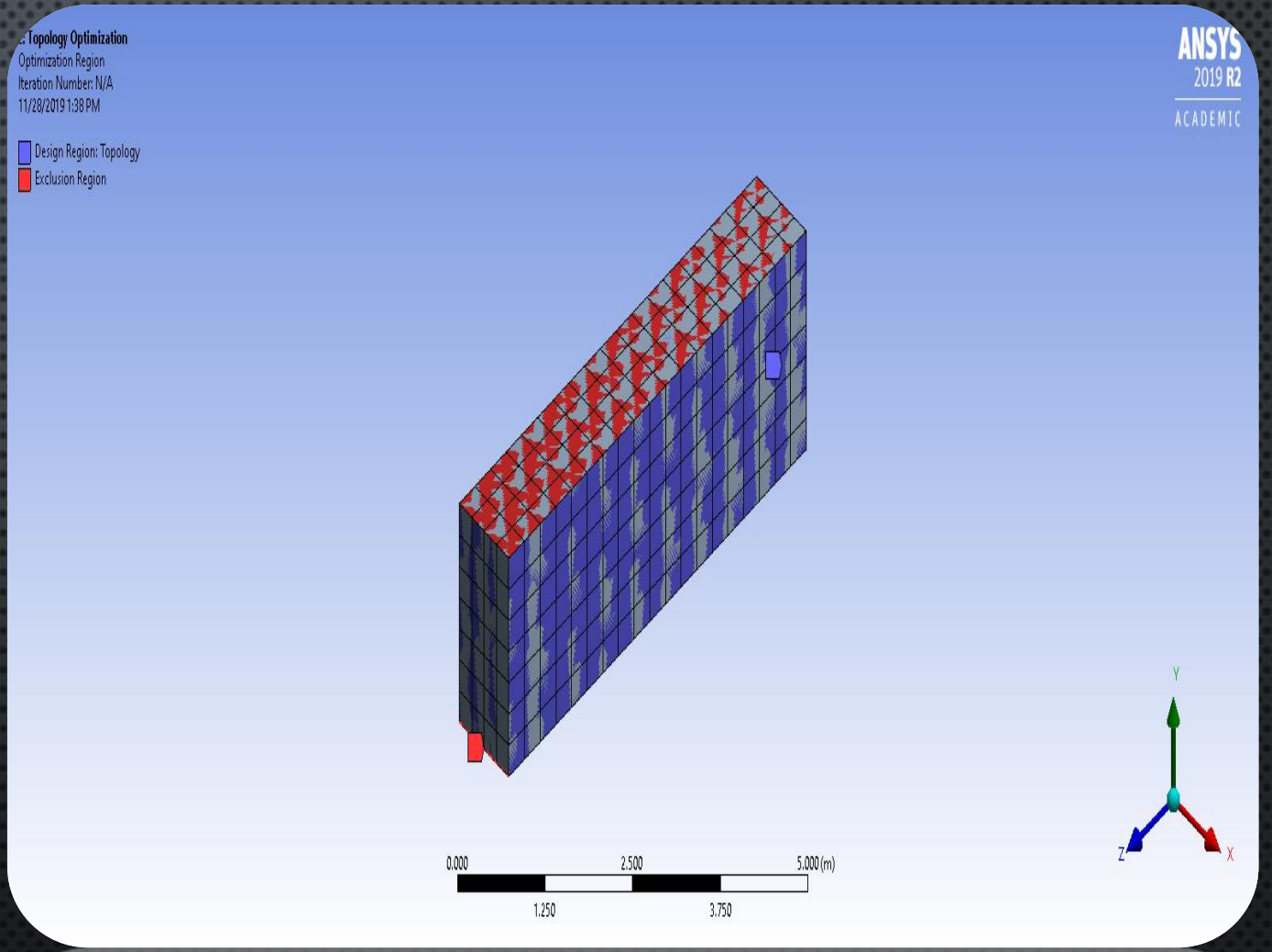
# Mesh



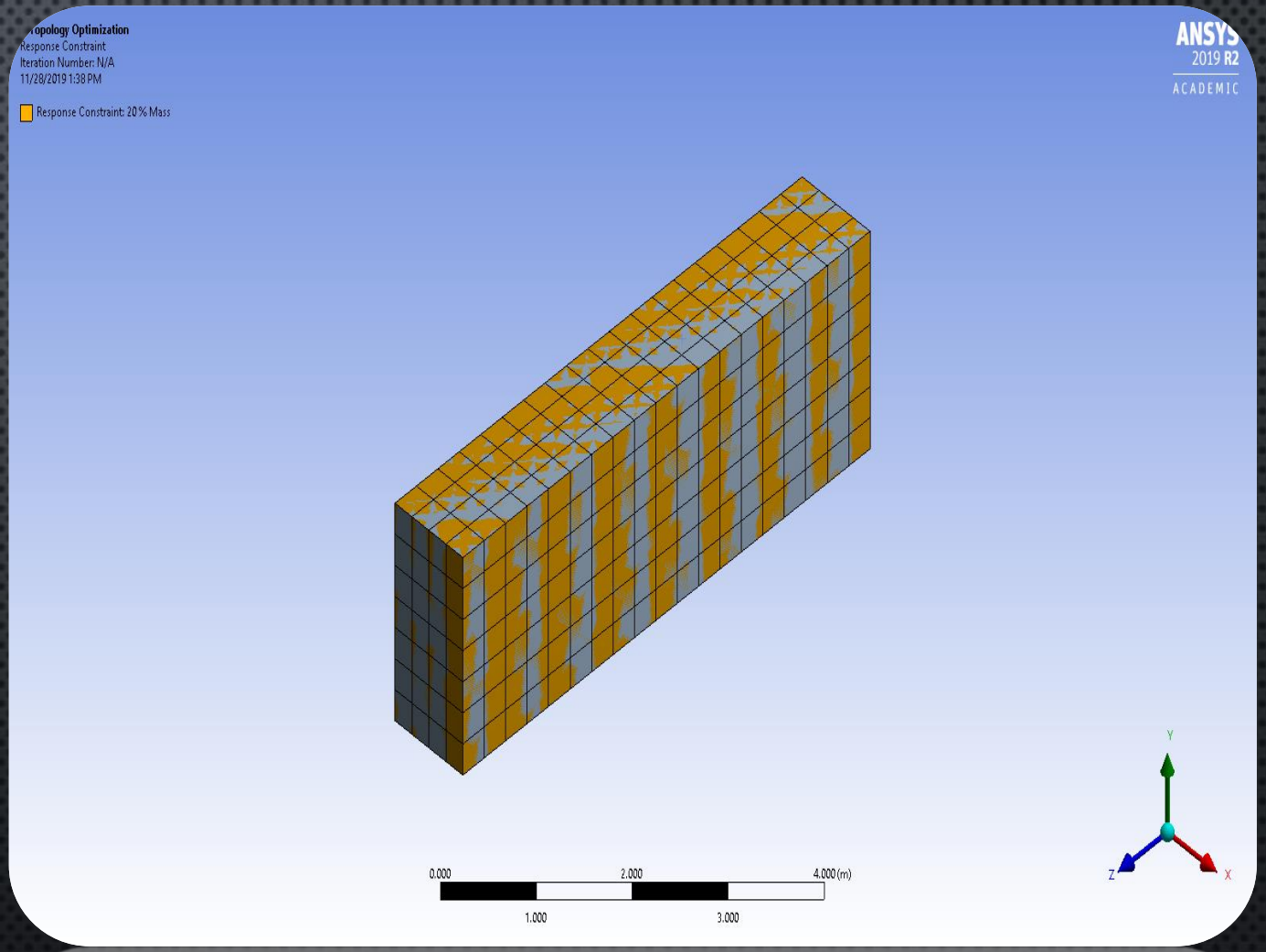
# Boundary Conditions



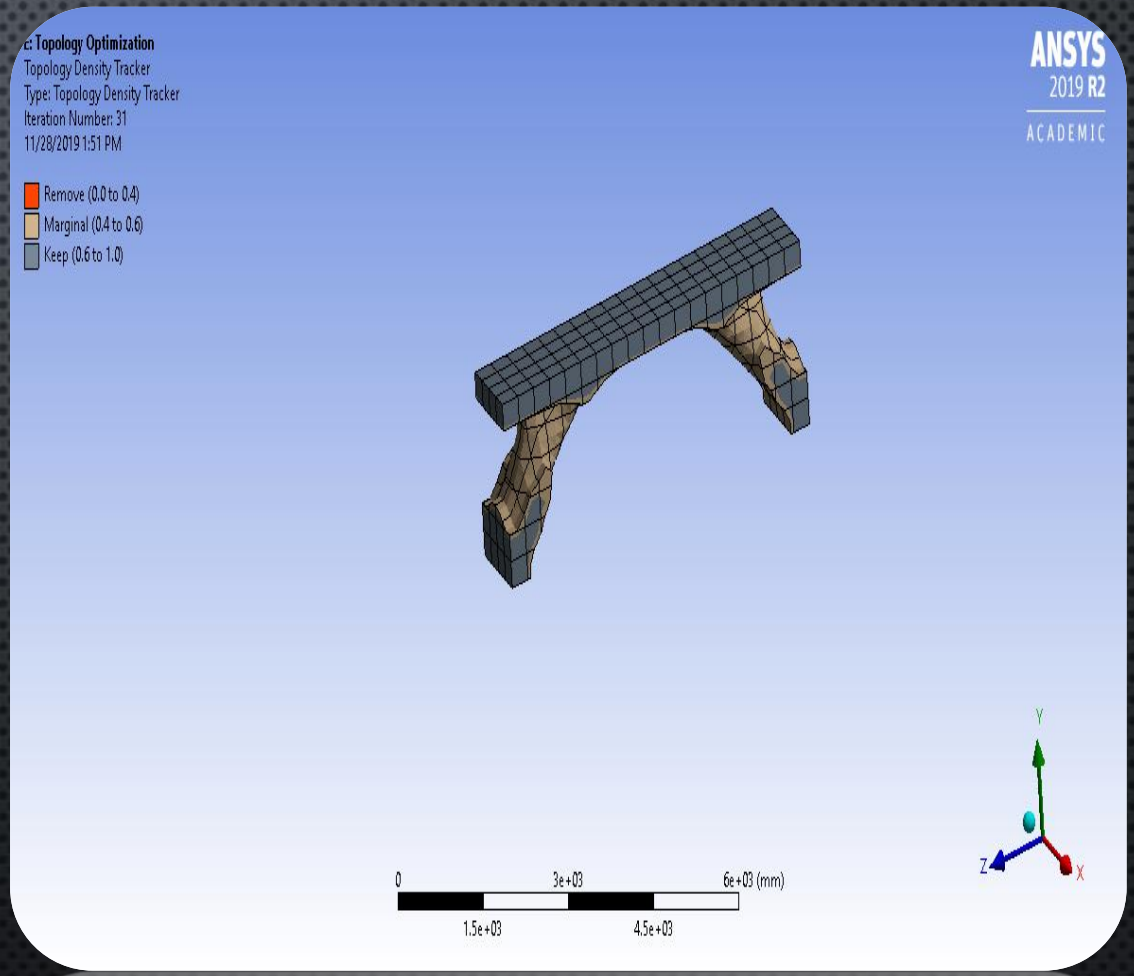
# Optimization Region



# Mass Reduction



# Final Geometry



# Comments:

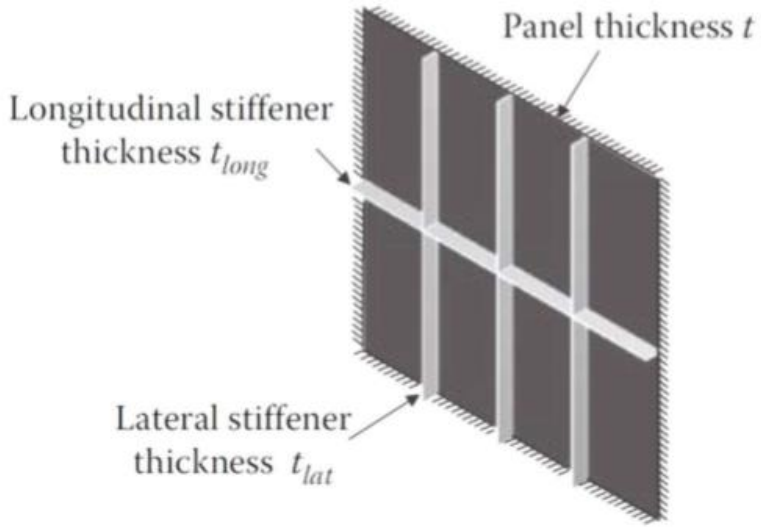
Topology optimization (TO) is a mathematical method that optimizes material layout within a given design space, for a given set of loads, boundary conditions and constraints with the goal of maximizing the performance of the system.

After applying pressure loads (250, 500 , 2000) MPa to study its effect on the geometry. The Topology Optimization generates the same geometry for all the applied load. Because it removes part of the geometry that doesn't been affect by load

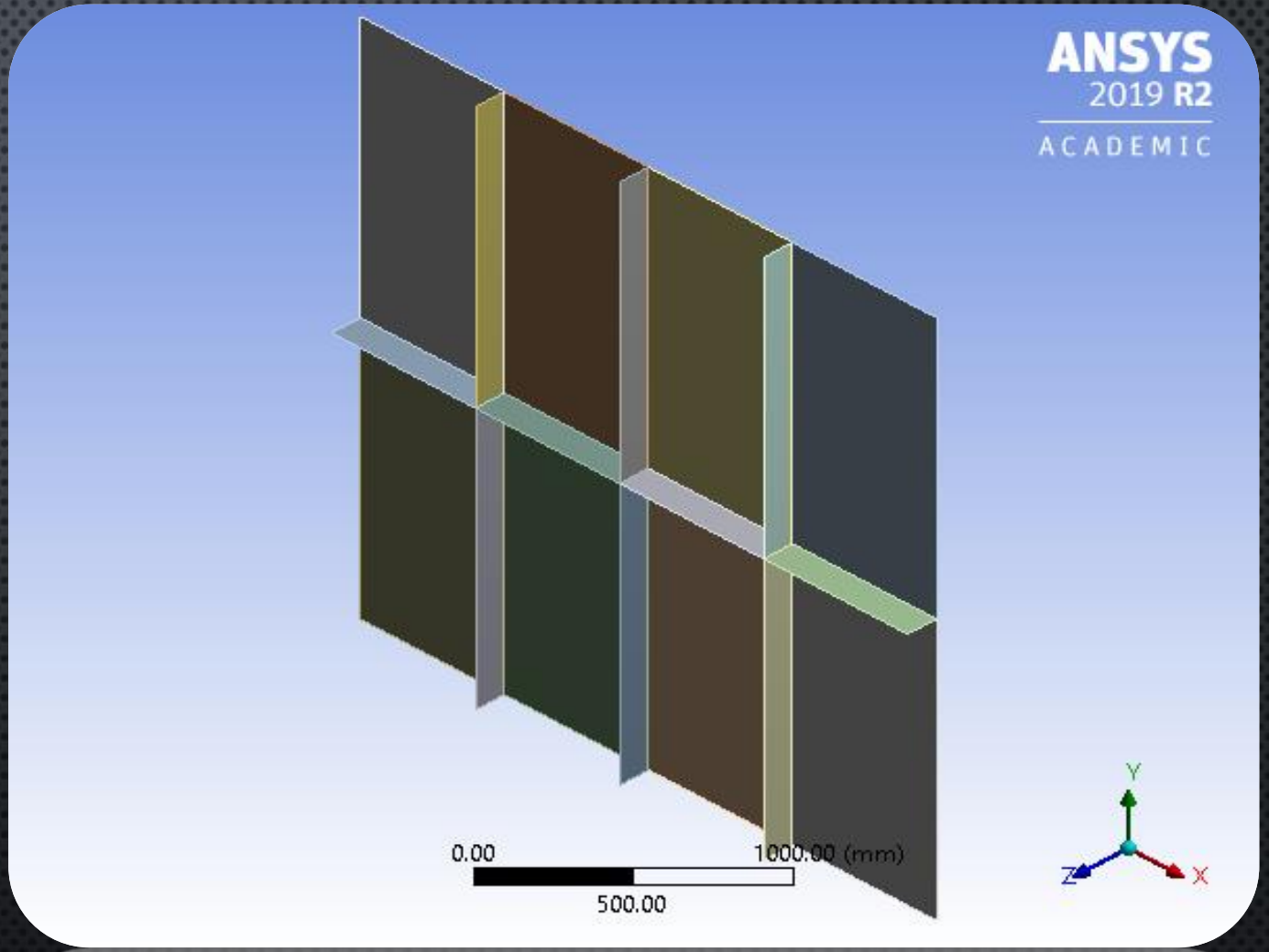
# ASSIGNMENT 11 – Q2

**Problem -2**

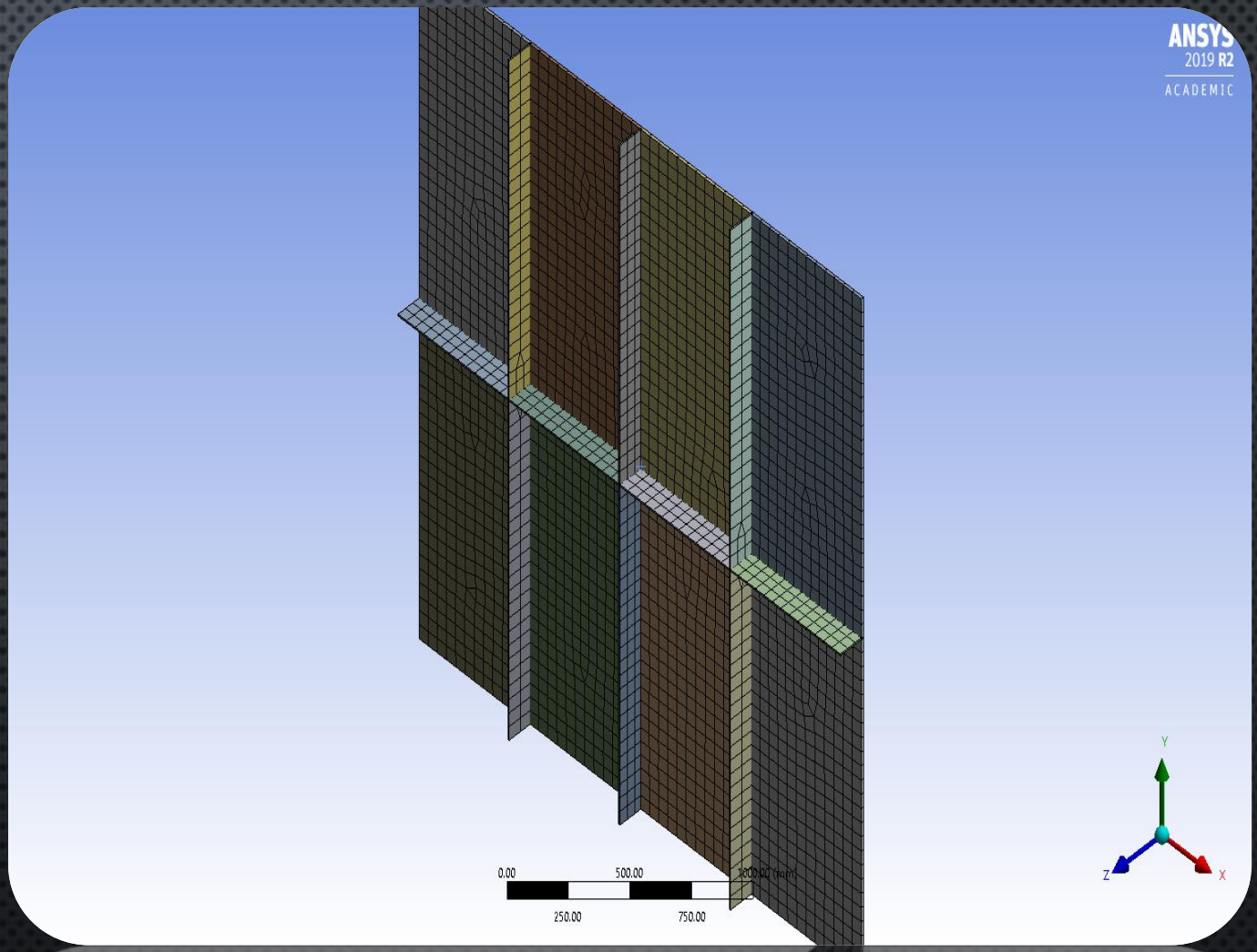
Optimize the stiffened aluminum panel design with clamped edges as shown below. In the initial design, the 100 in. × 100 in. panel has a thickness of 0.5 in. The stiffeners are each 100 in. long, 5 in. tall, and 0.25 in. thick, and divide the panel evenly into eight blocks of the same area. The design variables, that is, the panel thickness $t$, the longitudinal stiffener thickness $t_{long}$, and the lateral stiffener thickness $t_{lat}$, have the following range of variations: 0.4 in. $< t <$ 0.6 in., 0.2 in. $< t_{long} <$ 0.3 in., and 0.2 in. $< t_{lat} <$ 0.3 in. The optimization aims to minimize the panel's weight subject to the constraint of the panel's fundamental frequency $f_{base} \geq$ 130 Hz.



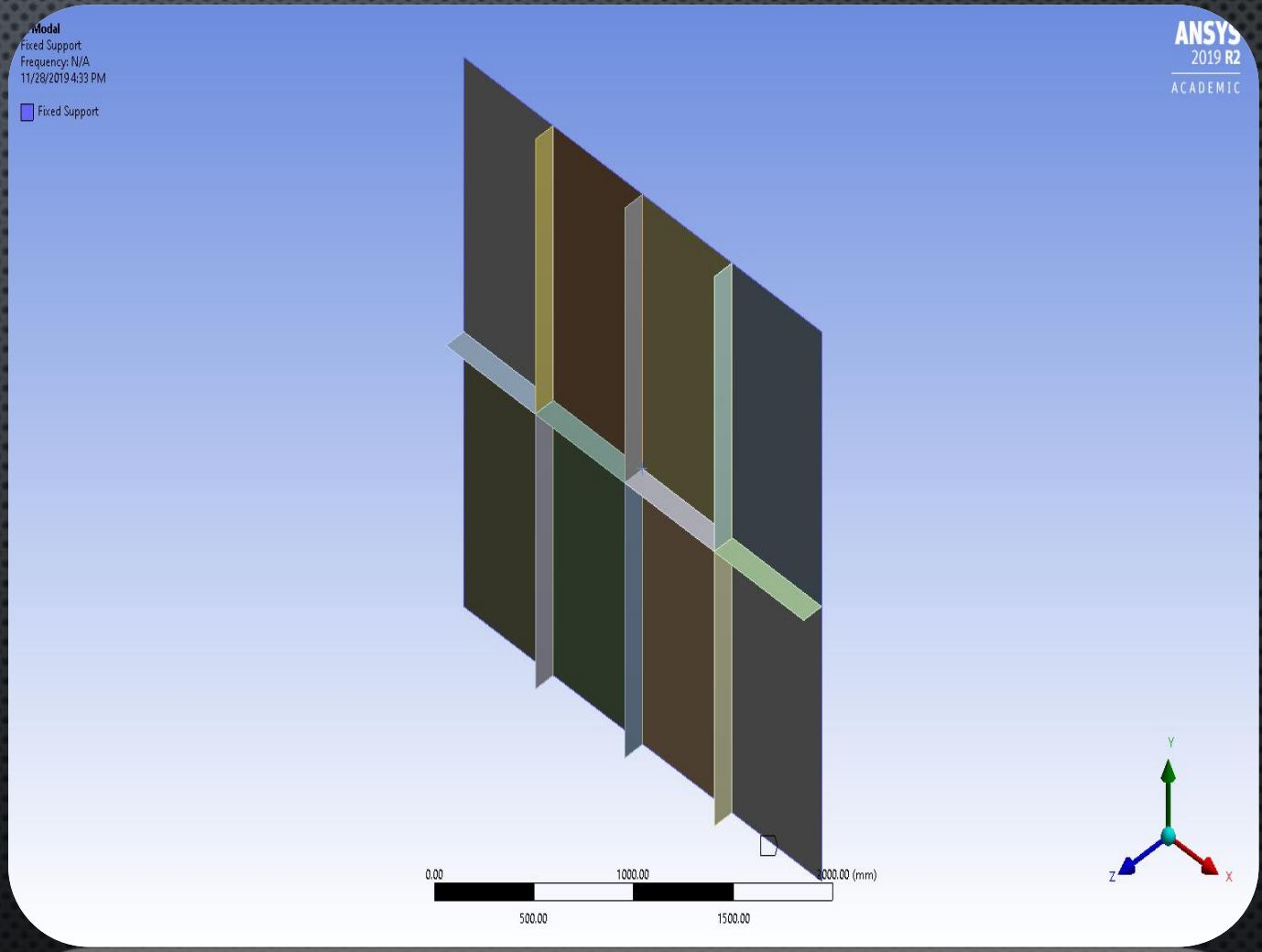
# Geometry



# Mesh

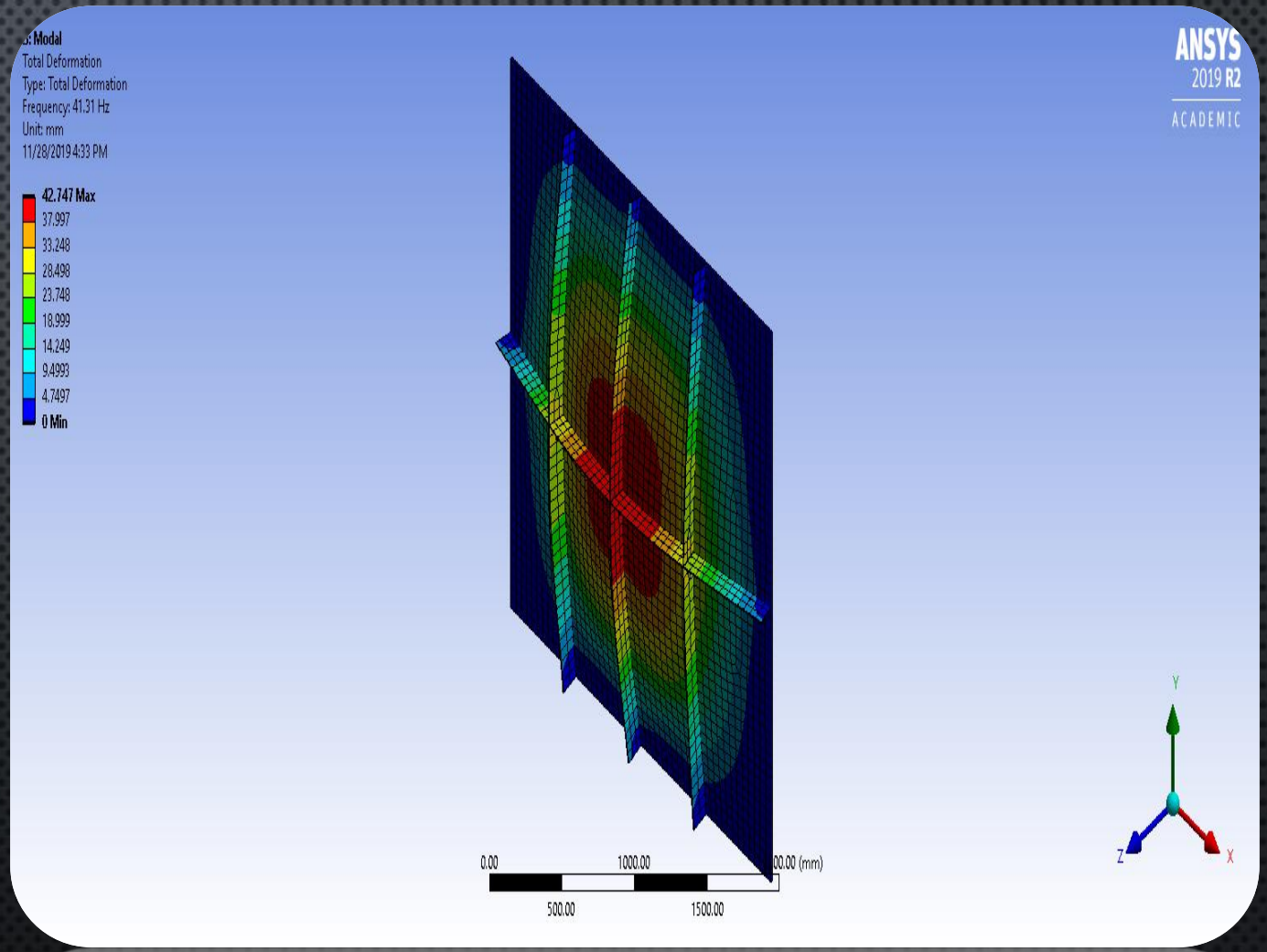


# Boundary Conditions

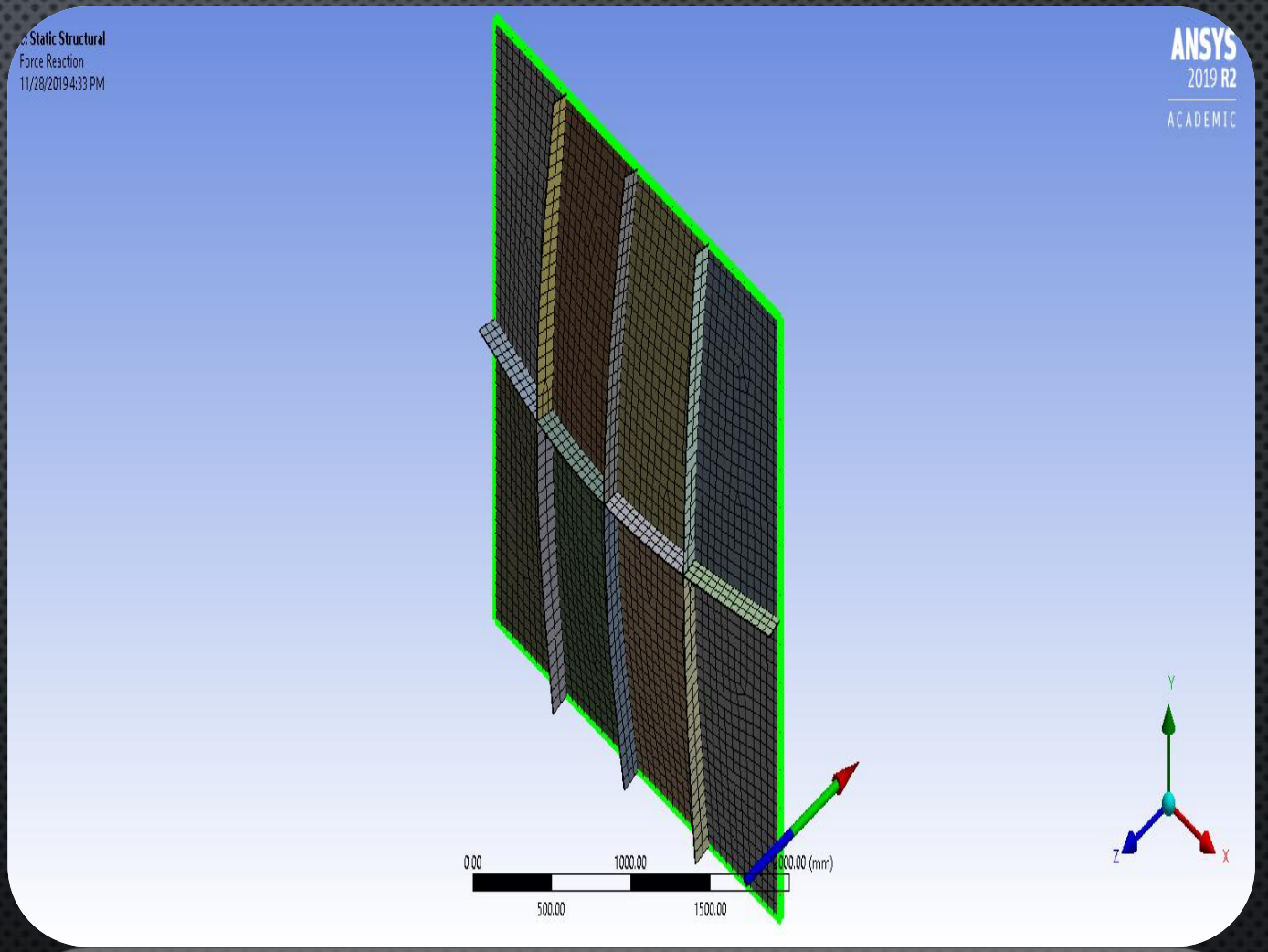


# Result:

Fundamental Freq. = 41.31Hz



# Result:


Static Structural
Force Reaction
11/28/2019 4:33 PM
ANSYS
2019 R2
ACADEMIC
0.00
1000.00
2000.00 (mm)
500.00
1500.00
Y
Z
X

# Parametric Table

Table of Schematic F2: Optimization

| | A | B | C | D |
|---|---|---|---|---|
| 1 | Input Parameters | | | |
| 2 | Name | Lower Bound | Upper Bound | |
| 3 | P1 - Thickness Thickness (in) | 0.4 | 0.6 | |
| 4 | P2 - Thickness 2 Thickness (in) | 0.2 | 0.3 | |
| 5 | P3 - Thickness 3 Thickness (in) | 0.2 | 0.3 | |
| 6 | Parameter Relationships | | | |
| 7 | Name | Left Expression | Operator | Right Expression |
| * | *New Parameter Relationship* | *New Expression* | <= | *New Expression* |

# Design Output

Table of Schematic F2: Optimization

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 1 | Name | Parameter | Objective | | Constraint | | |
| 2 | | | Type | Target | Type | Lower Bound | Upper Bound |
| 3 | Maximize P4; P4 >= 130 Hz | P4 - Total Deformation Reported Frequency | Maximize | | Values >= Lower Bound | 130 | |
| 4 | Maximize P5 | P5 - Force Reaction Maximum Z Axis | Maximize | | No Constraint | | |
| * | | Select a Parameter | | | | | |

# Comment:

The maximum Freq. is 44 Hz while it must be more than 130 Hz. So, we must increase the parametric range to achieve the design consideration.

e of Schematic F2: Optimization

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | Name | P1 - Thickness Thickness (in) | P2 - Thickness 2 Thickness (in) | P3 - Thickness 3 Thickness (in) | P4 - Total Deformation Reported Freque... | P5 - Force Reaction Maximum Z Axis (lbf) |
| 2 | 27 | 0.6 | 0.3 | 0.3 | 43.964 | -660.48 |
| 3 | 25 | 0.4 | 0.3 | 0.3 | 43.419 | -460.33 |
| 4 | 18 | 0.6 | 0.3 | 0.25 | 43.335 | -657.98 |
| 5 | 26 | 0.5 | 0.3 | 0.3 | 43.319 | -560.41 |
| 6 | 24 | 0.6 | 0.25 | 0.3 | 42.77 | -652.97 |
| 7 | 16 | 0.4 | 0.3 | 0.25 | 42.71 | -457.83 |
| 8 | 17 | 0.5 | 0.3 | 0.25 | 42.654 | -557.9 |
| 9 | 9 | 0.6 | 0.3 | 0.2 | 42.645 | -655.48 |
| 10 | 15 | 0.6 | 0.25 | 0.25 | 42.103 | -650.47 |
| 11 | 23 | 0.5 | 0.25 | 0.3 | 42.021 | -552.9 |
| 12 | 22 | 0.4 | 0.25 | 0.3 | 42 | -452.83 |
| 13 | 7 | 0.4 | 0.3 | 0.2 | 41.945 | -455.33 |
| 14 | 8 | 0.5 | 0.3 | 0.2 | 41.931 | -555.4 |
| 15 | 21 | 0.6 | 0.2 | 0.3 | 41.438 | -645.47 |
| 16 | 6 | 0.6 | 0.25 | 0.2 | 41.37 | -647.97 |
| 17 | 14 DP 0 | 0.5 | 0.25 | 0.25 | 41.31 | -550.4 |
| 18 | 13 | 0.4 | 0.25 | 0.25 | 41.235 | -450.33 |
| 19 | 12 | 0.6 | 0.2 | 0.25 | 40.726 | -642.97 |
| 20 | 20 | 0.5 | 0.2 | 0.3 | 40.575 | -545.4 |
| 21 | 5 | 0.5 | 0.25 | 0.2 | 40.536 | -547.9 |
| 22 | 19 | 0.4 | 0.2 | 0.3 | 40.416 | -445.32 |
| 23 | 4 | 0.4 | 0.25 | 0.2 | 40.407 | -447.82 |
| 24 | 3 | 0.6 | 0.2 | 0.2 | 39.944 | -640.46 |
| 25 | 11 | 0.5 | 0.2 | 0.25 | 39.81 | -542.89 |
| 26 | 10 | 0.4 | 0.2 | 0.25 | 39.584 | -442.82 |
| 27 | 2 | 0.5 | 0.2 | 0.2 | 38.977 | -540.39 |
| | 1 | 0.4 | 0.2 | 0.2 | 38.682 | -440.32 |