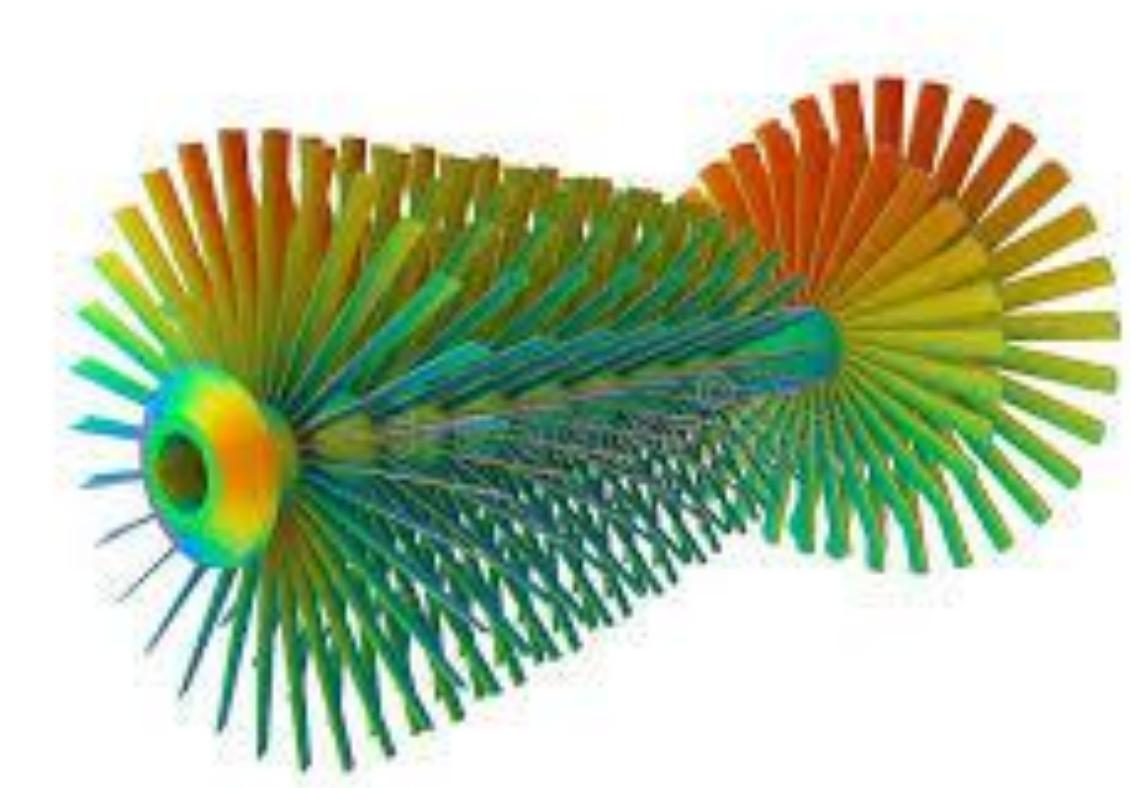


Finite Element Analysis of a Hexagon Structure

This project explores the structural behavior of a regular hexagon using Static Structural and Transient Structural simulation techniques.

Zarrar Ahmed Qureshi
ME-1867
Section: A



Abstract: Unveiling Structural Dynamics

Material Properties

Young's Modulus: 67,000 MPa (from roll number ME-1867).

Poisson's Ratio: 0.28.

Loading Conditions

Static Load: 2,011 N (from date of birth). Transient Load: 281.5 N (from USD to PKR exchange rate).

Boundary Conditions

One face fixed, remote force applied at one-third of the face length.

The analysis compares deformation and stress results between static equilibrium and time-dependent transient responses.

Introduction to FEA

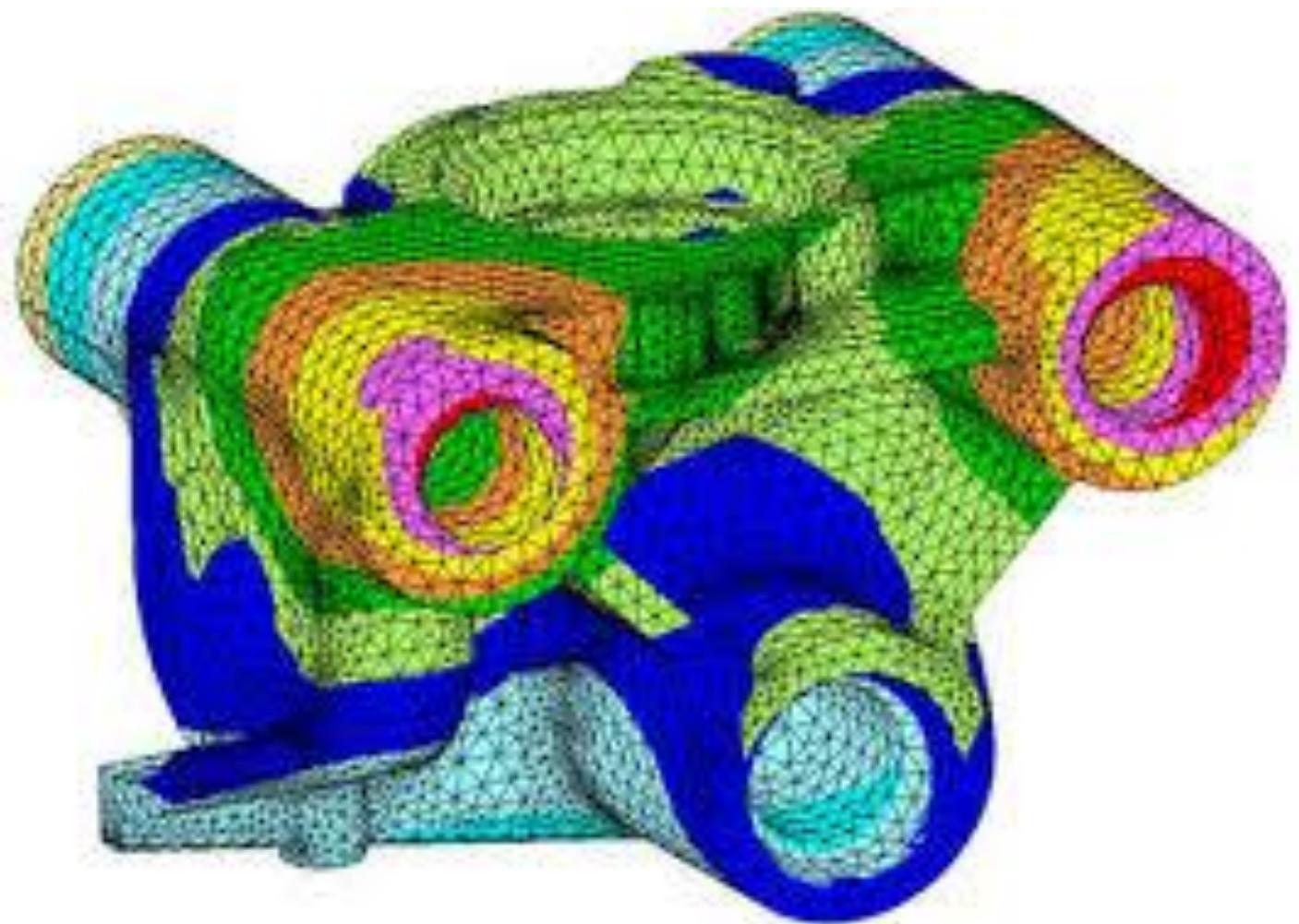
Finite Element Analysis (FEA) is a numerical method predicting part behavior under physical conditions. This project analyzes a regular hexagon under two conditions:

- **Static Structural**

Assumes slow load application, ignoring inertial and damping effects.

- **Transient Structural**

Analyzes dynamic response over time, considering inertia and damping.



Problem Statement: Custom Constraints

The objective is to analyze a regular hexagon structure under custom-defined constraints based on personal data.



Material Properties

Young's Modulus (E): $67 \text{ times } 1,000 = 67,000 \text{ MPa}$.

Poisson's Ratio: $\nu = 0.28$.



Loading Conditions

Static Load: $2,011 \text{ N}$ (from date of birth).
Transient Load: 280.5 N (from USD to PKR exchange rate).



Boundary Conditions

One face fixed, remote force at 1/3rd distance. Time Step (Transient): 0.2 seconds.

Geometry Modeling & Material Definition

Geometry Modeling

The regular hexagon was extruded to a specified thickness using DesignModeler/SpaceClaim within Ansys.

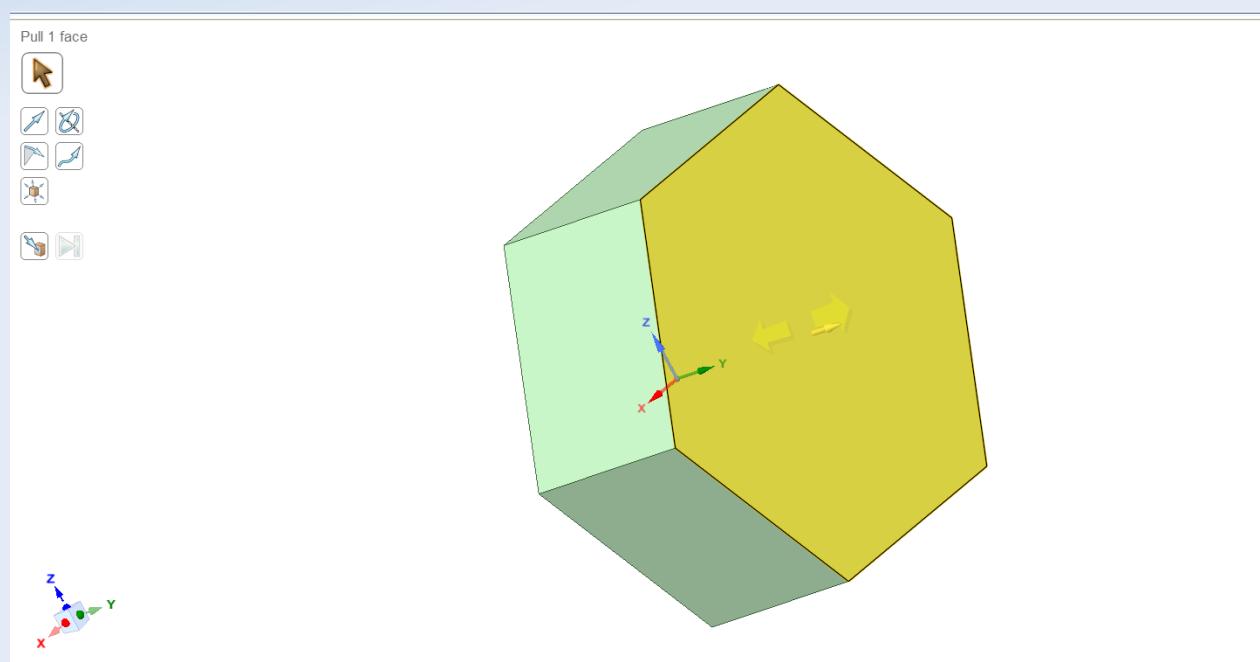


Figure 1: 3D Geometry of the extruded hexagon model.

Material Properties

A custom material, "ME-1867" was defined with calculated stiffness values.

Engineering Data: Material View	
ME-1867	
Density	8000 kg/m³
Structural	
Isotropic Elasticity	Young's Modulus and Poisson's Ratio
Derive from	6.7e+10 Pa
Young's Modulus	0.28
Poisson's Ratio	5.0758e+10 Pa
Bulk Modulus	2.6172e+10 Pa
Shear Modulus	

Figure 2: Engineering Data showing Young's Modulus of 67000 MPa.

Boundary Conditions: Simulating Reality

To simulate physical bending and shear, specific constraints were applied.

Fixed Support

Applied to one side face of the hexagon.

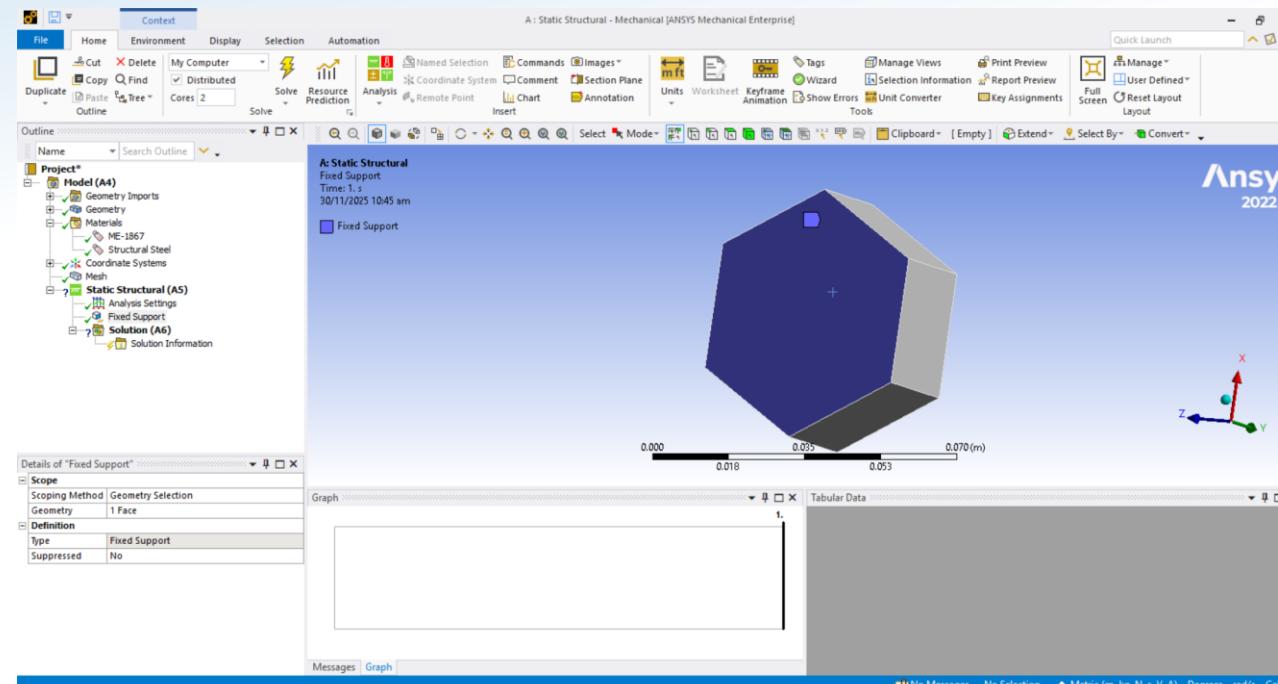


Figure 3: Fixed Support applied to the face.

Remote Force

Applied to the same face but offset to 1/3rd of the length, inducing rotation/bending.

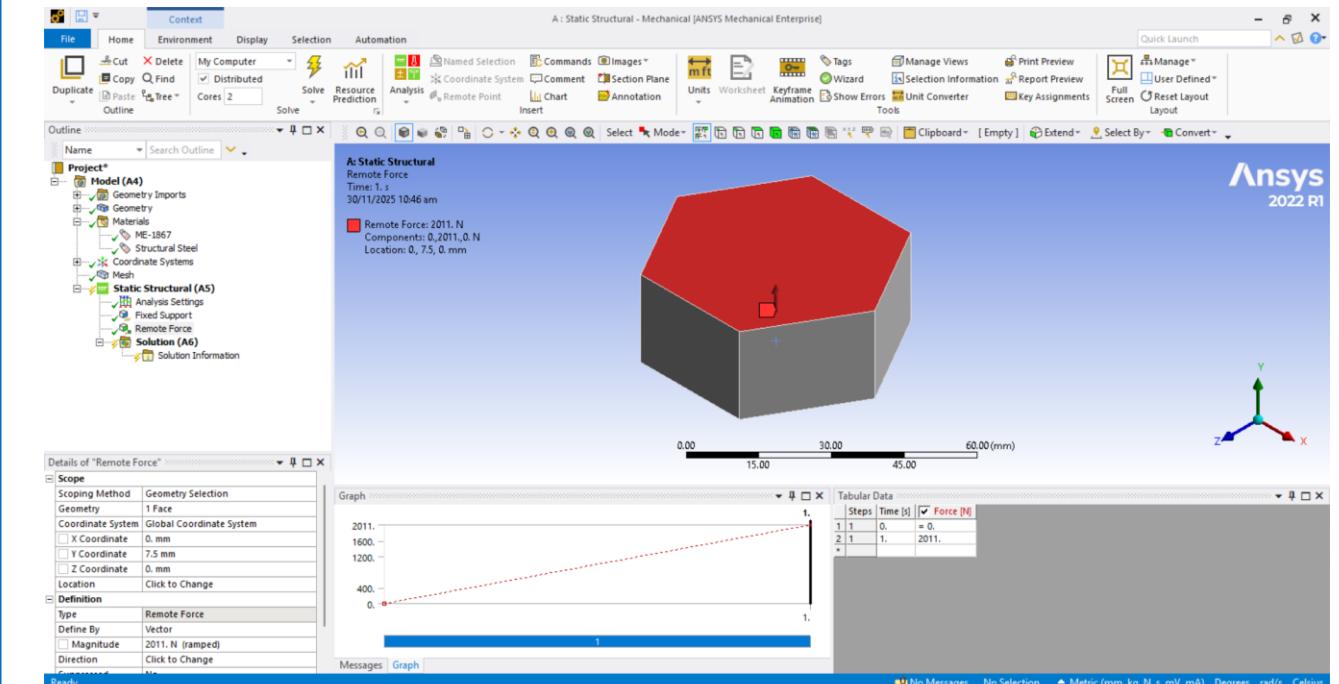


Figure 4: Remote Force applied at 1/3rd offset location.

Meshing & Convergence for Accuracy

A mesh convergence study was conducted to ensure result accuracy, refining the mesh in three iterations to observe Equivalent Stress stability.

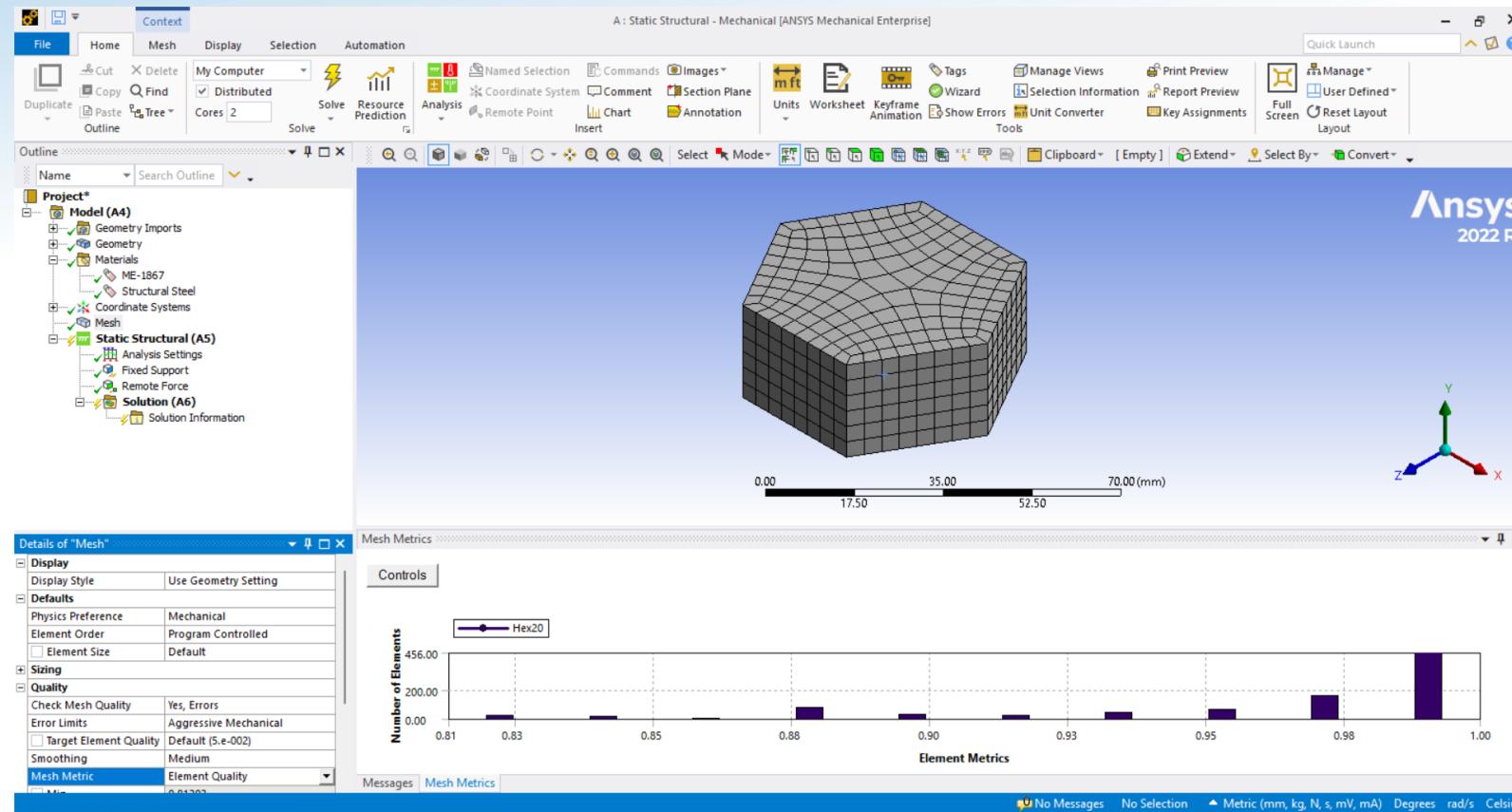


Figure 5: Meshed model of the hexagon with element Quality.

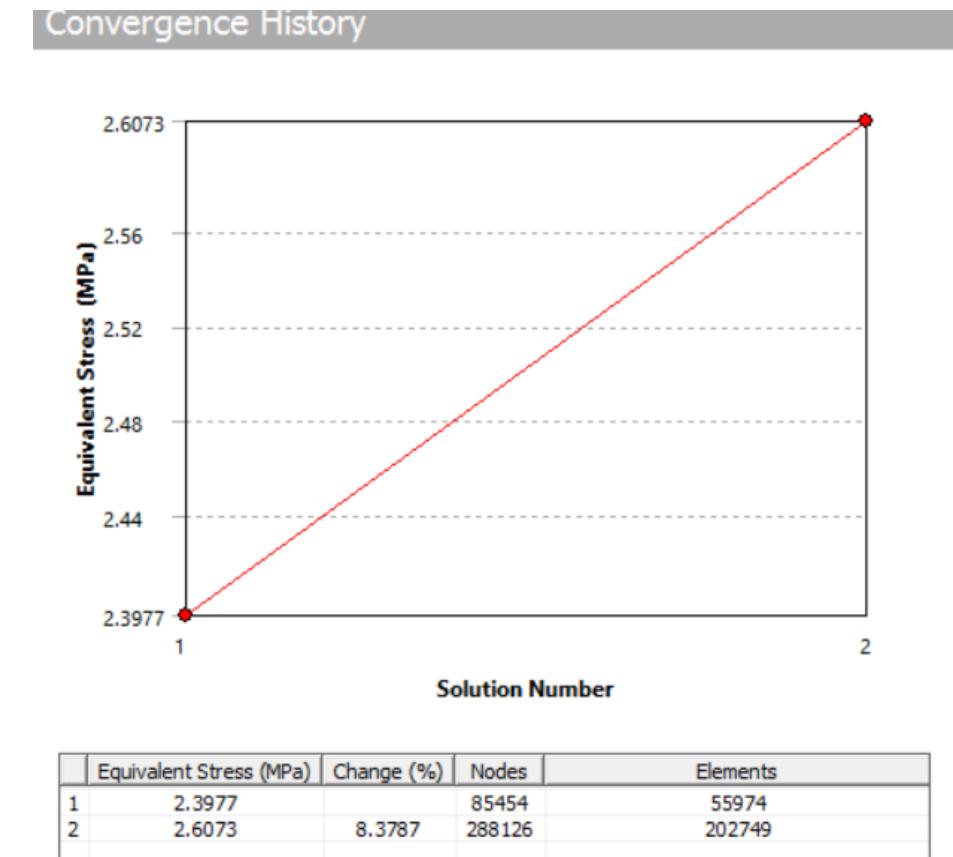
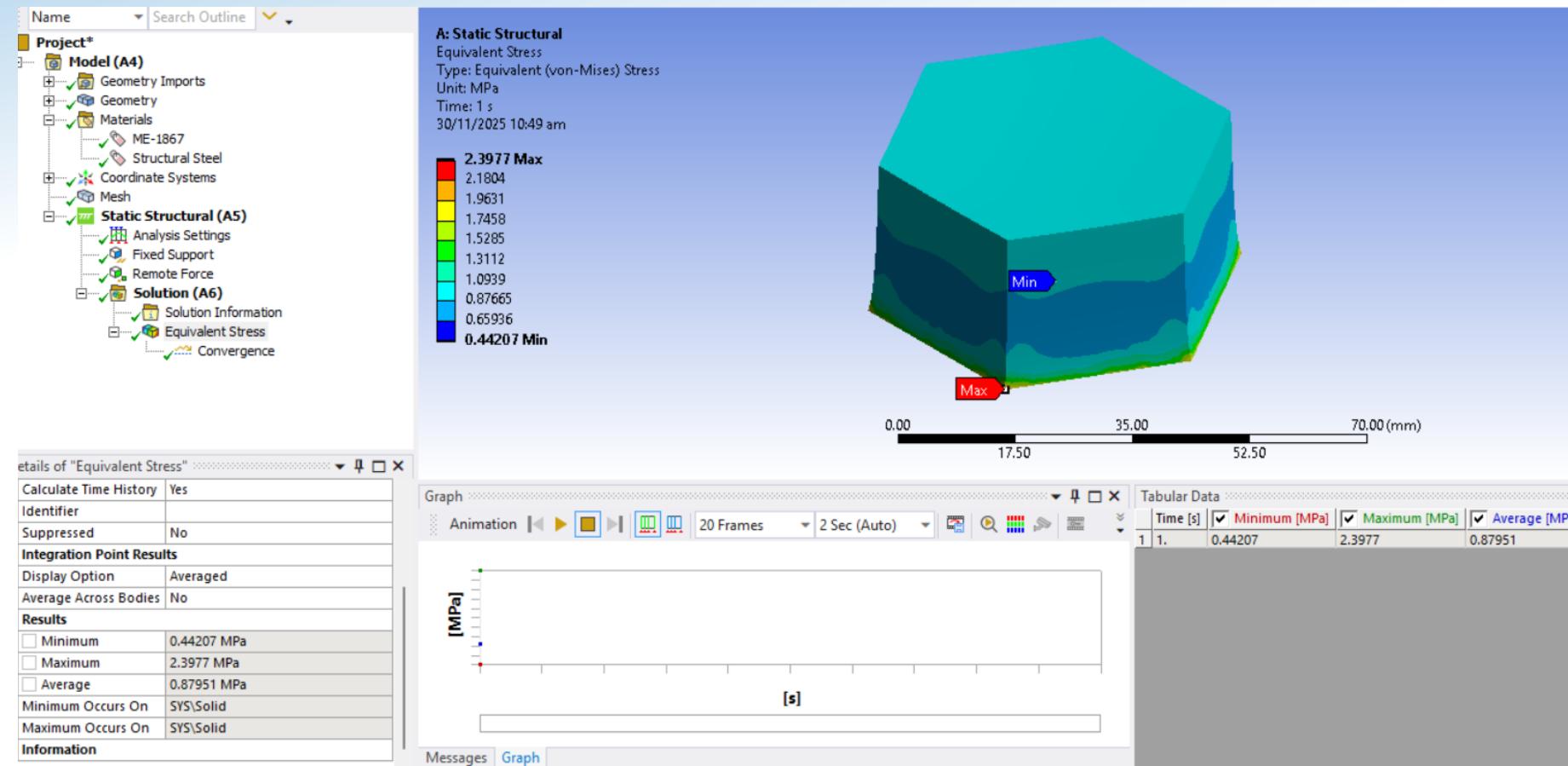


Figure 6: Mesh Convergence Graph (Nodes vs. Stress).

Static Structural Simulation: Equilibrium Analysis

In the static analysis, a load of **2,020 N** was applied, and the solver calculated the final equilibrium state.



Equivalent (von-Mises) Stress (Static)

Results: The static results show maximum stress at the hexagon's tips of the fixed face.

Transient Structural Simulation: Dynamic Response

The Transient Structural analysis determined the time-dependent response under a standard dynamic load over 1 second.

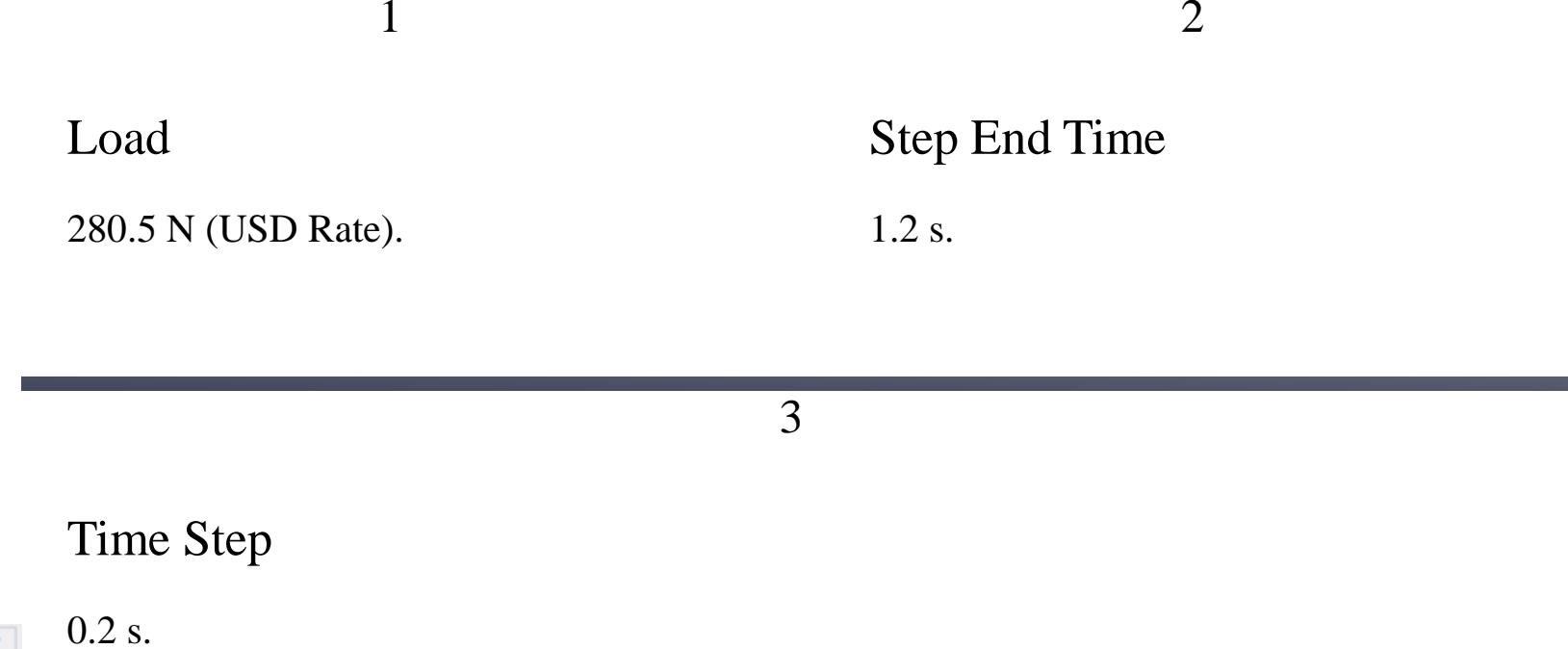
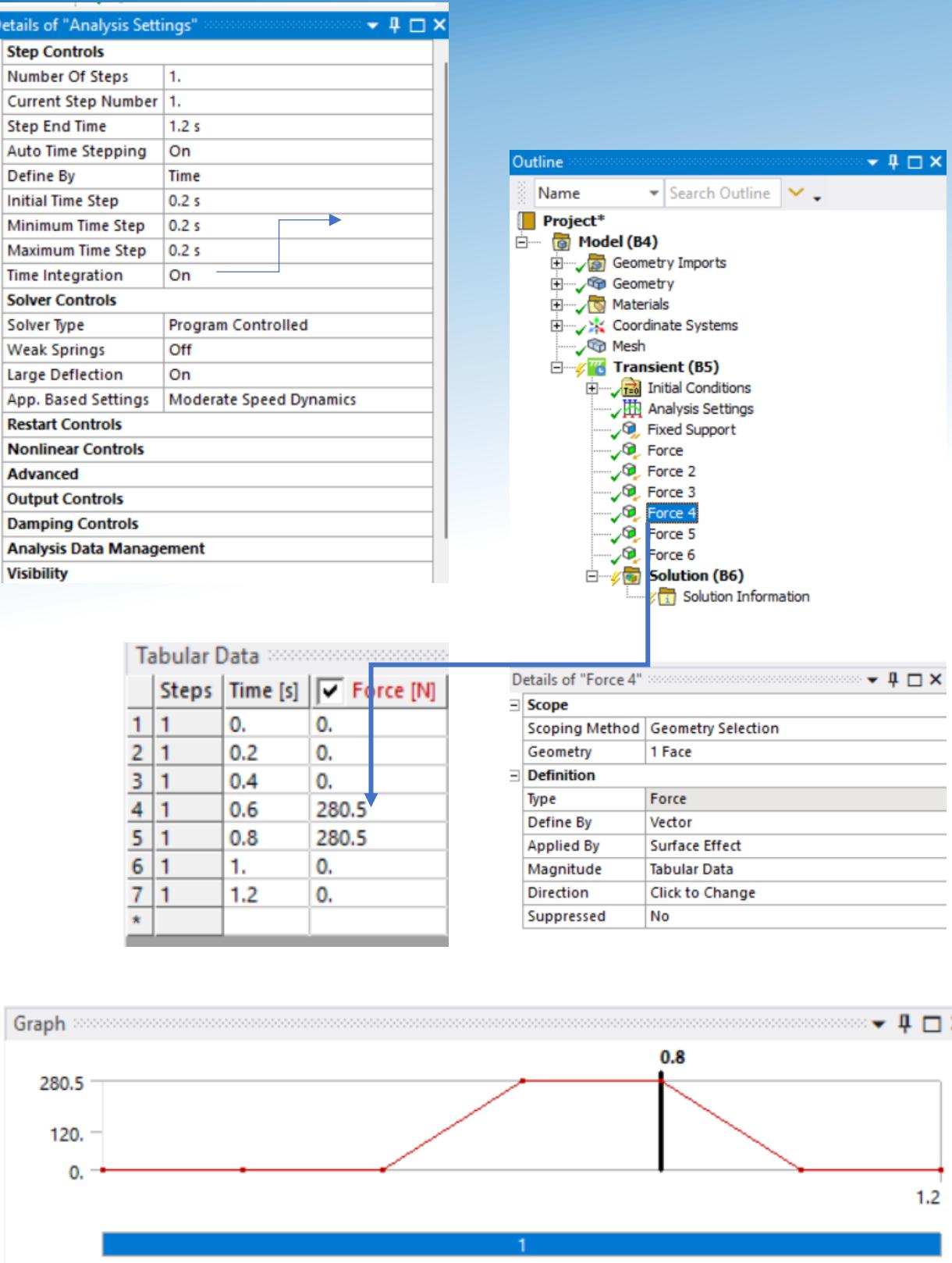


Figure 9: Transient setup showing time steps of 0.2s and tabular data of force 3 with graph.

Transient Results & Conclusion

Boundary Conditions (Transient)

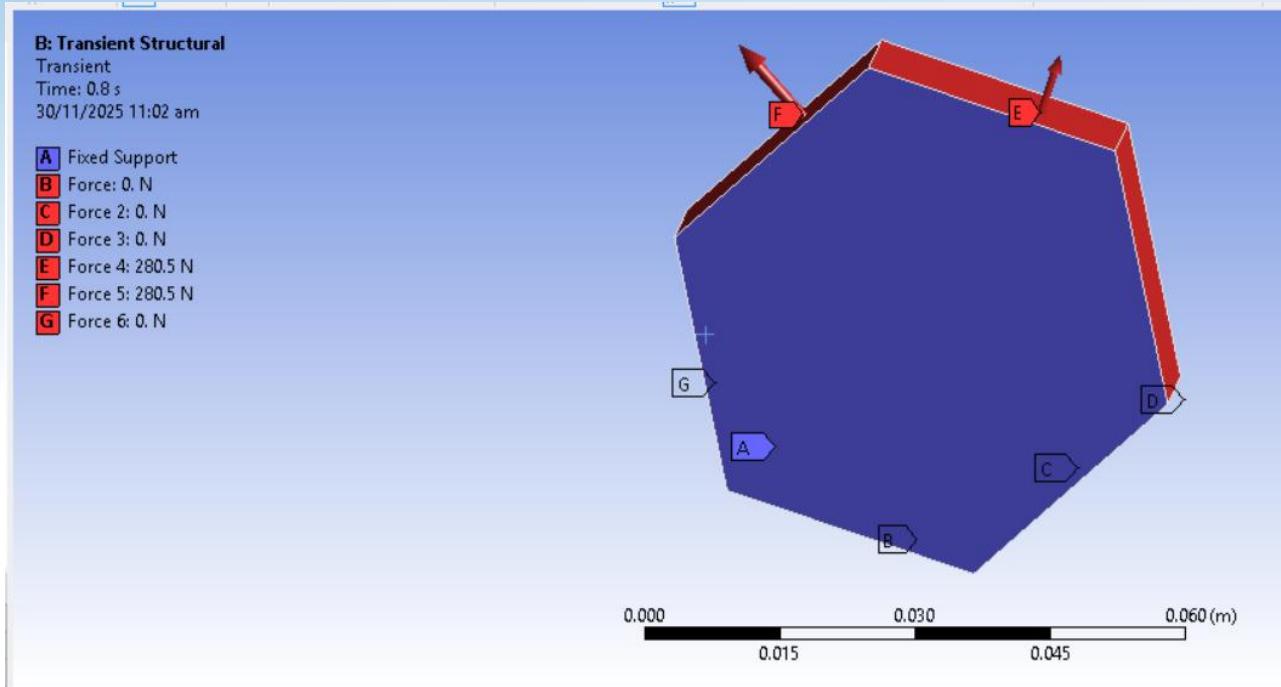


Figure 10: Fixed Support (face A) and Remote Force (B,C,D,E,F,G) applied.

Results & Conclusion

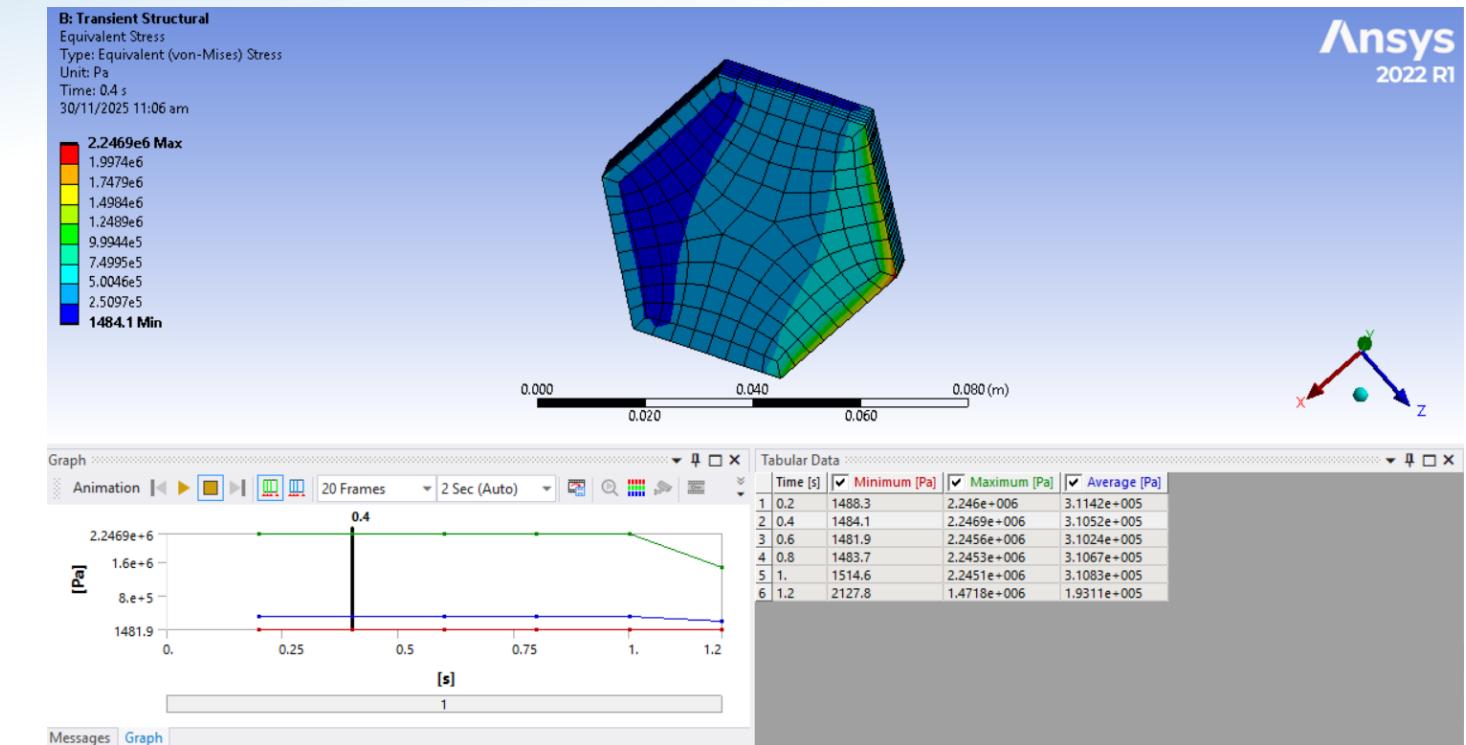


Figure 11: Total Deformation at t=0.4s = Total Deformation at 1.2s.

Transient Results & Conclusion

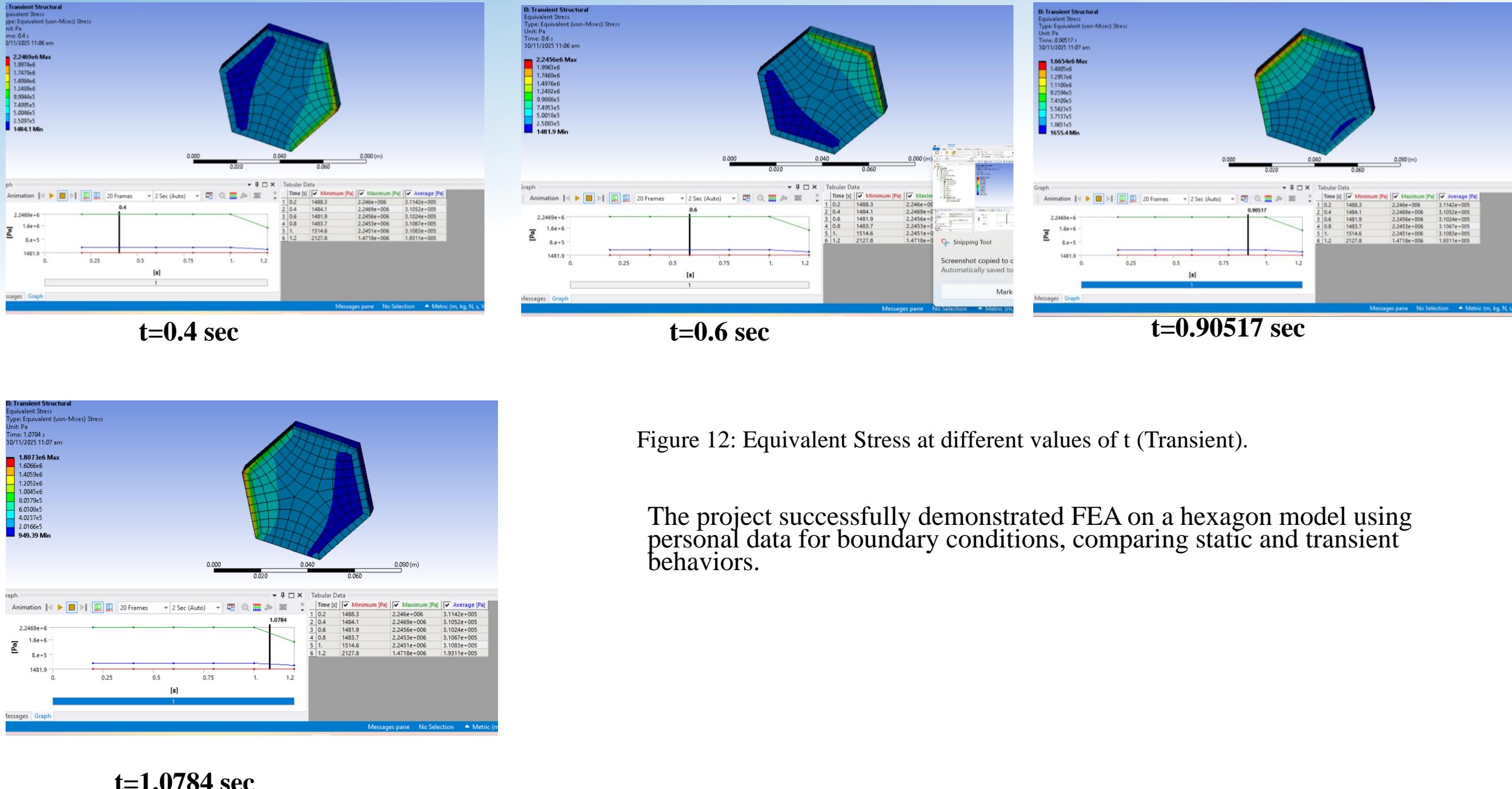


Figure 12: Equivalent Stress at different values of t (Transient).

The project successfully demonstrated FEA on a hexagon model using personal data for boundary conditions, comparing static and transient behaviors.