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OBJECTIVE

Path Planning: Fatigue Analysis

Objective is to conduct fatigue analysis of double wishbone suspension system components for use in vehicle path planning

1. Obtain joint force and moment values of cycle from PyChrono simulation
2. Use force and moment value with Ansys model to determine fatigue life of and stress history cycle
3. Results ultimately used to compare fatigue effect of planned paths

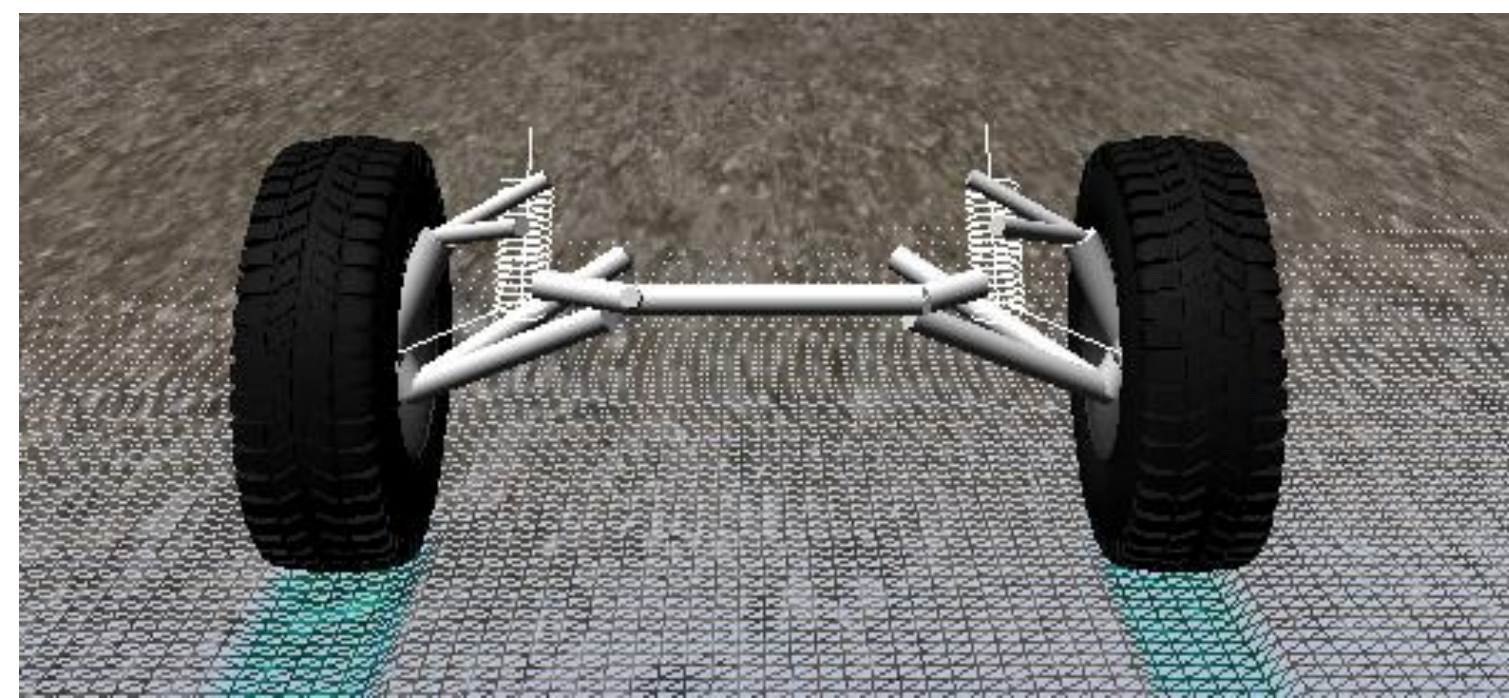


Figure 1
Partial rendering of suspension system in PyChrono

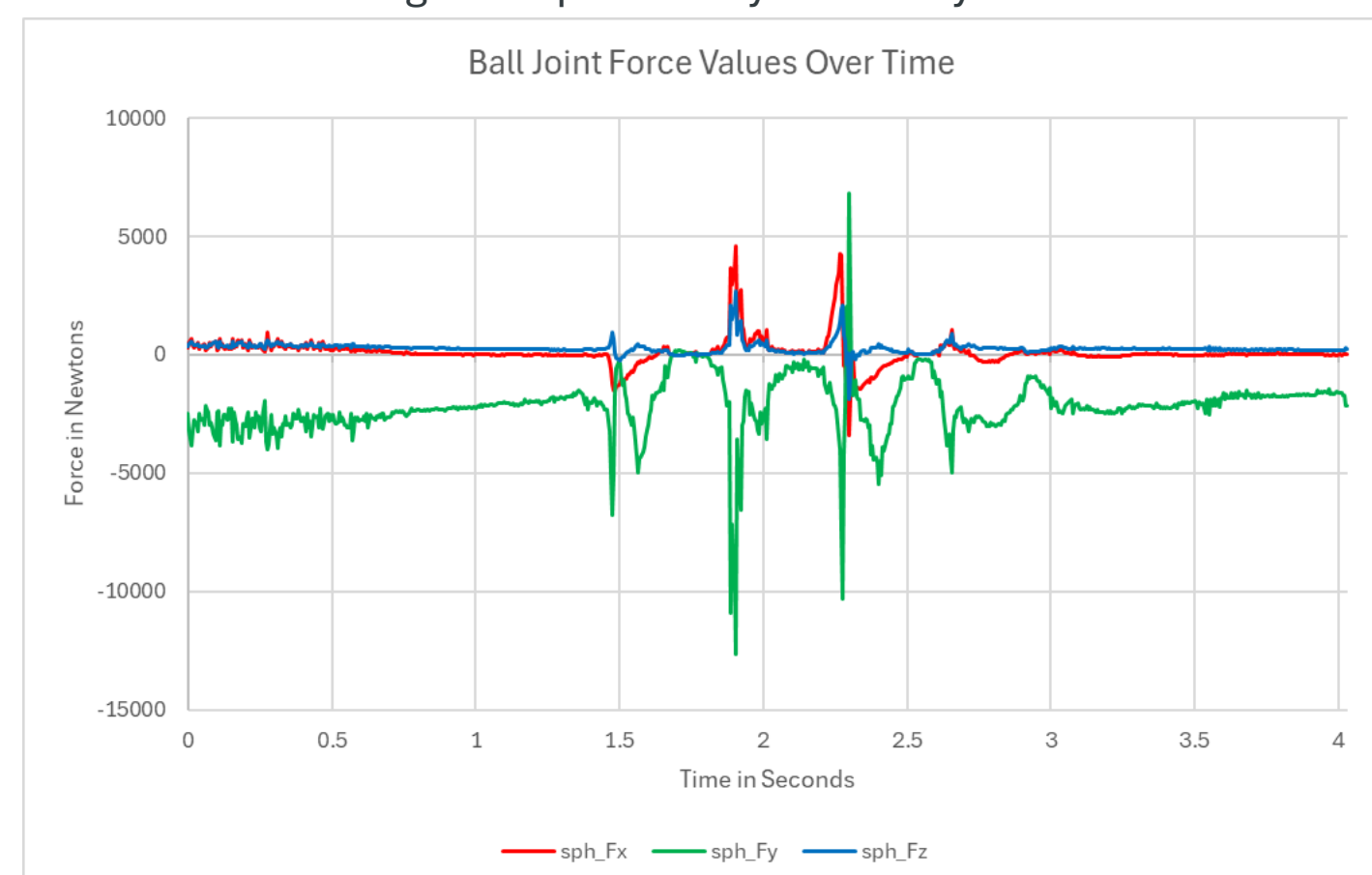


Figure 2
Force component data at UCA ball joint connection

METHOD

Finite element analysis in Ansys to conduct a fatigue analysis of upper and lower control arms (UCA & LCA). Geometry as close as possible to PyChrono using collected data for loadings.

Components Being Modeled:

- 3D LCA geometry
- 3D UCA geometry
- Shock absorber connection
- Wheel knuckle connection

MODEL

With more realistic CAD models for the control arms and the PyChrono design as a guide I created the suspension system model to be used for FEA

Simple Double Wishbone Model

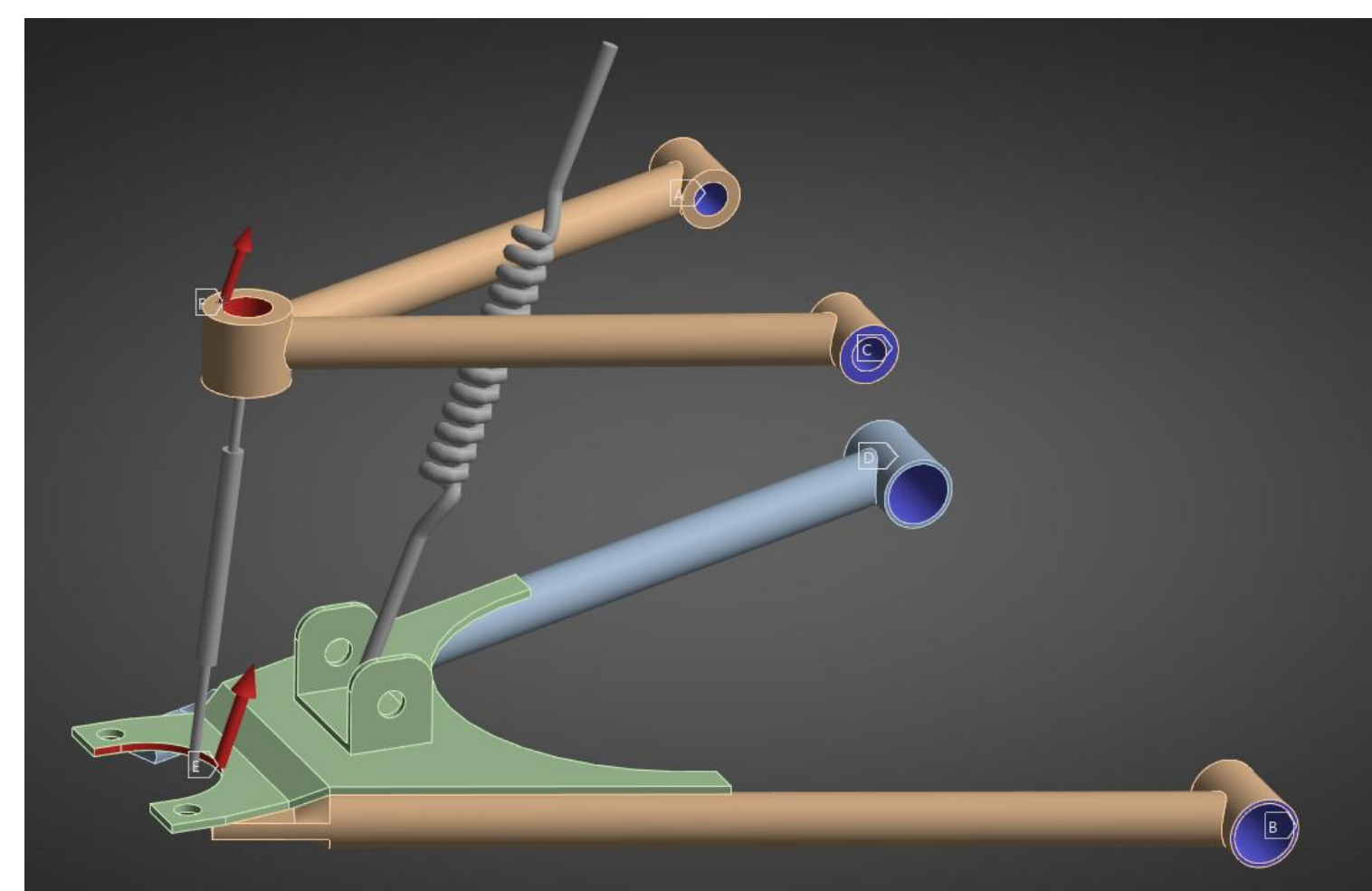


Figure 3
Ansys image of boundary conditions applied to model

Each applied load has a coordinate frame to ensure force vectors are applied in the right direction

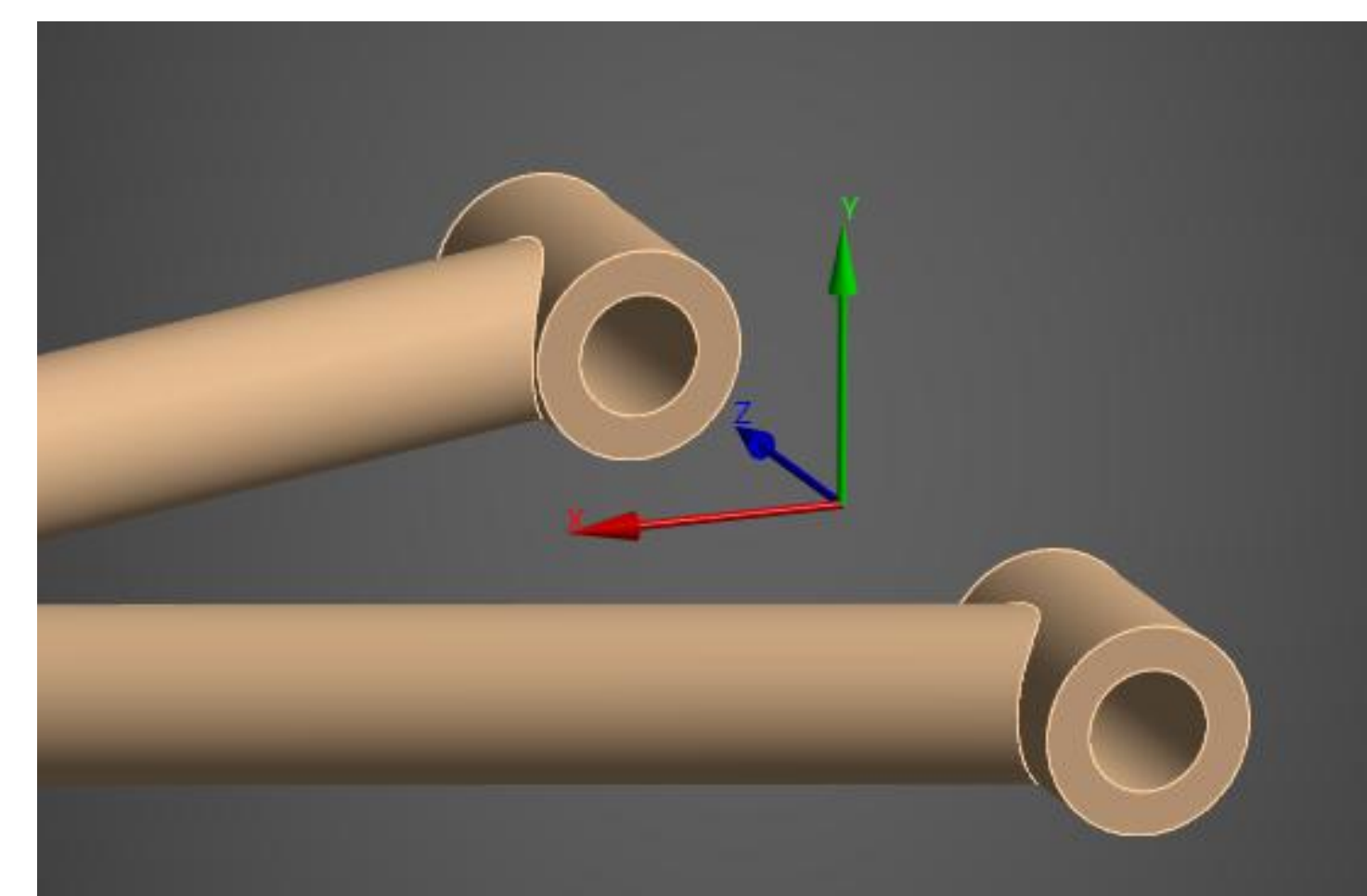


Figure 4
Ansys image of imposed frame for UCA revolute joint

Loads are applied to the ball joints of the LCA and UCA with frictionless supports on the hinges to constrain the model's motion. [1]

This model is then ready for **fatigue analysis** using the given forces and moments.

RESULTS

Fatigue analysis data including, deformation, minimum fatigue life, and equivalent stresses were collected for the system

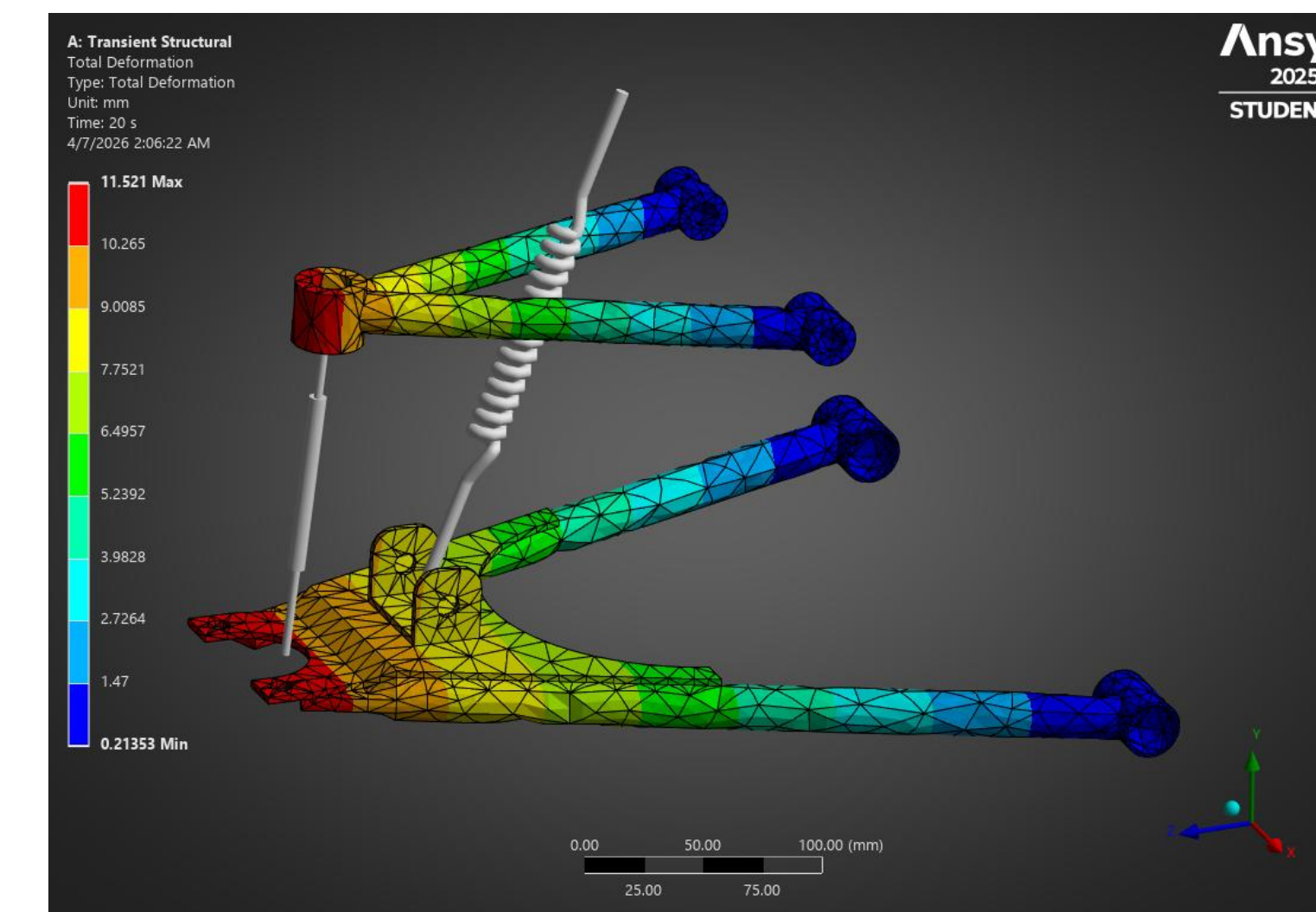


Figure 5
Deformation contour of combined system. Minimum 0.21353 mm and maximum 11.521 mm

The deformation is useful to see the movement of the system as a result of the realistic loading.

The data we are most interested in is the stress at possible points of failure and the **minimum fatigue life** of both of the control arms

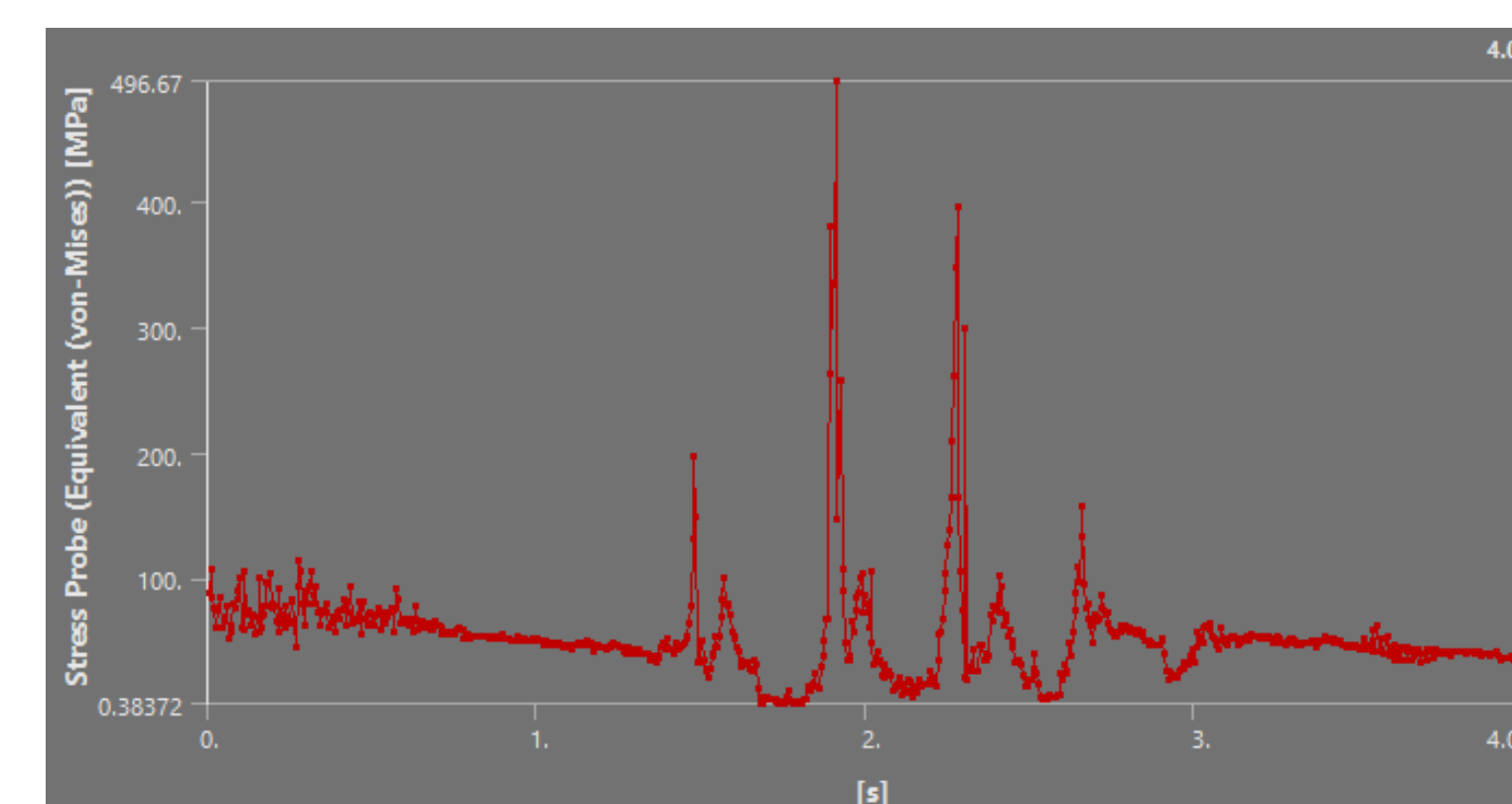


Figure 6
Equivalent (von-Mises) stress data collected from probe placed in UCA

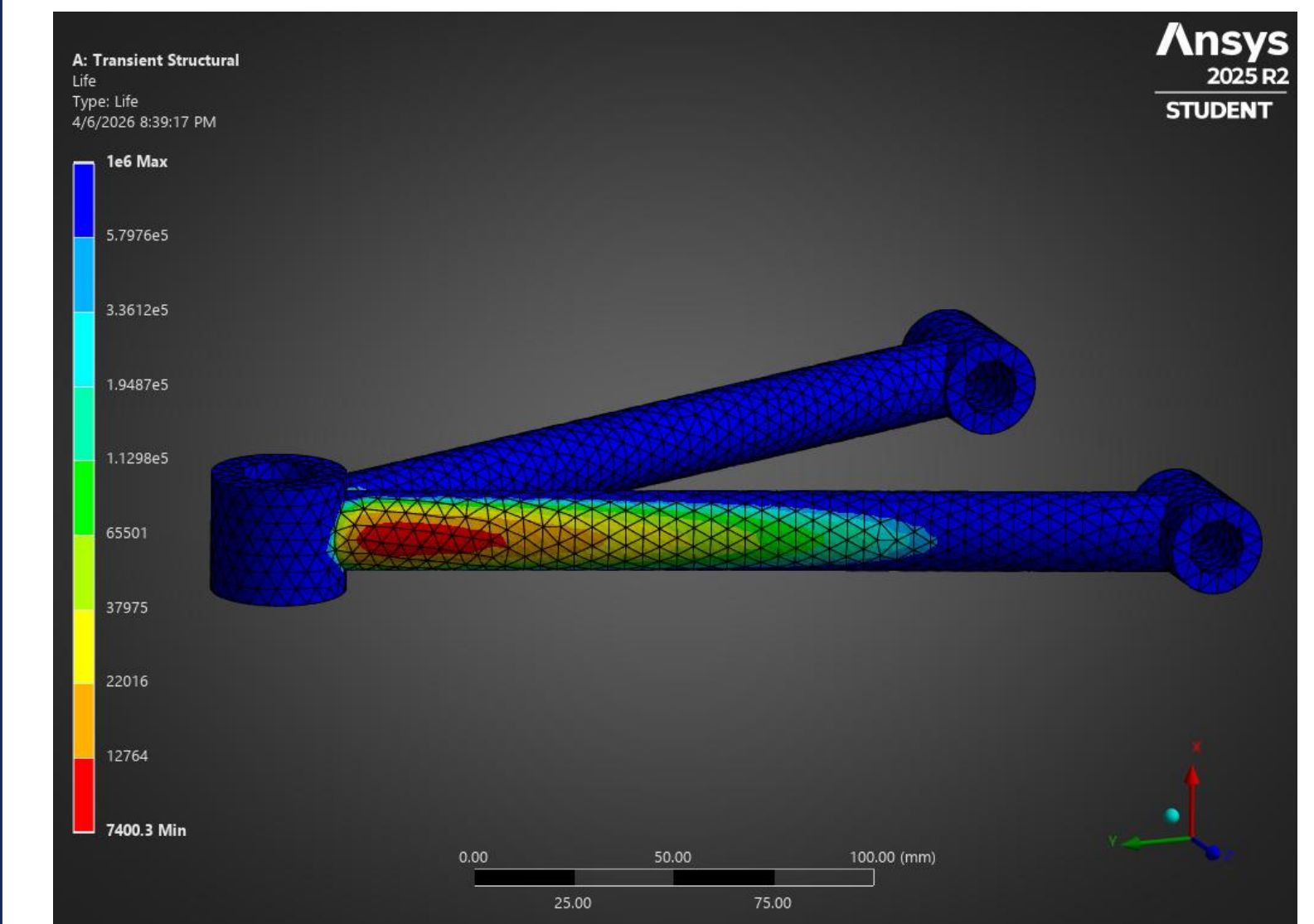


Figure 7
Fatigue life in UCA for 4.03 seconds of realistic loadings. Minimum 7400.3 and maximum 1e6

DISCUSSION

Path Planning: Implementation

Using Ansys to conduct a fatigue analysis of a component is an effective method to calculate metrics that can be used to compare the fatigue effect competing paths have on a suspension system. The least damaging path can be determined by either:

Maximum stress: Whichever path had a lower maximum stress for its loading would be considered less damaging

Minimum fatigue life: The path with the least number of cycles till failure for its loading would be considered the most damaging

Next steps

- Refine geometry to be more in line with model being used in PyChrono
- Determine if any other loads or moments need to be applied to the model

REFERENCES

1. Sierra, Alejandro & González Estrada, Octavio & Chacón Santamaría, Paula. (2018). Stress analysis of a suspension control arm. 10.13140/RG.2.2.12817.28007.

ACKNOWLEDGMENTS

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