URC DOCUMENTATION: REFINEMENT AND ANALYSIS

Solidworks refinement:

- The interference errors were identified in the following domains in the initial chassis that was handed to us:
  - Between two rods
  - Between two rods and a bracket
  - Between screws and rods
  - Between screws and brackets
- The first two among the aforementioned list of errors were a consequence of the fact that there were no cavities provided in the brackets while designing the chassis. This was simply resolved by providing the cavity. The model was further checked with interference evaluation
- This brought the total error count from an initial 200 to a 50.
- The remaining errors were being caused by the nuts and bolts, but were, to our surprise and delight, resolved on their own.
- A possible explanation for the same is the fact that there was a tangential touch between the nut and the bolt. Removing the cavity fixed the same.

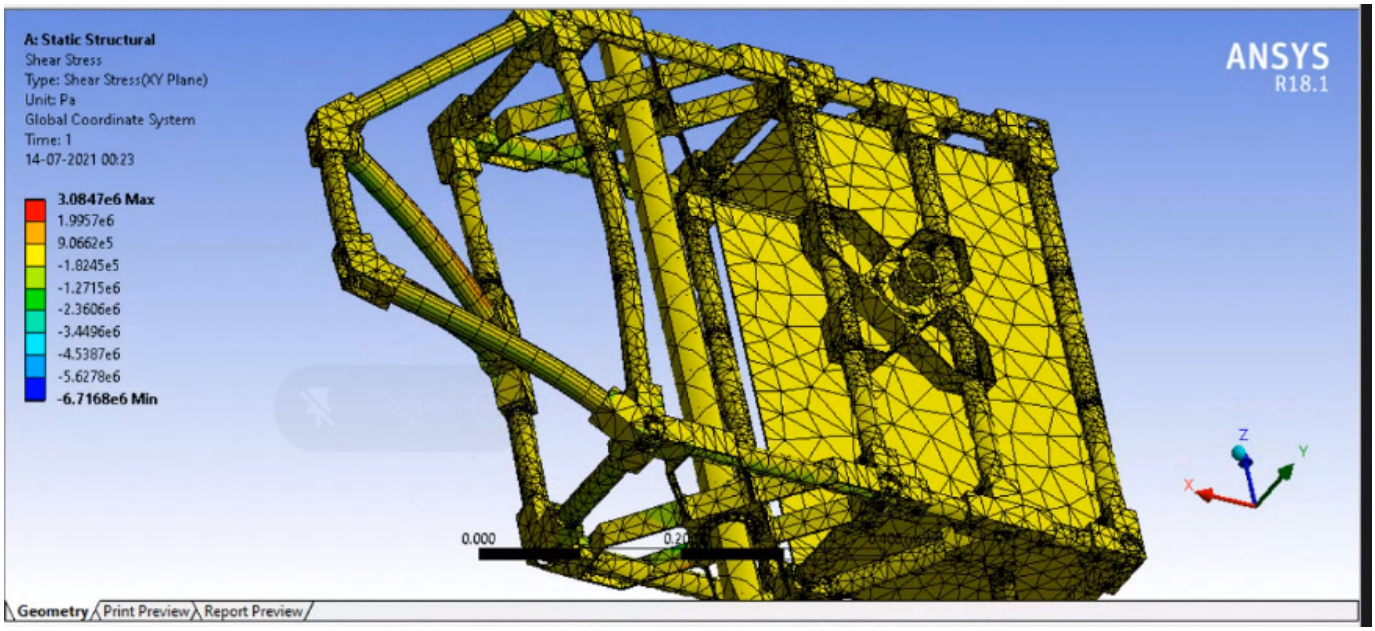
Stress Analysis in Ansys:

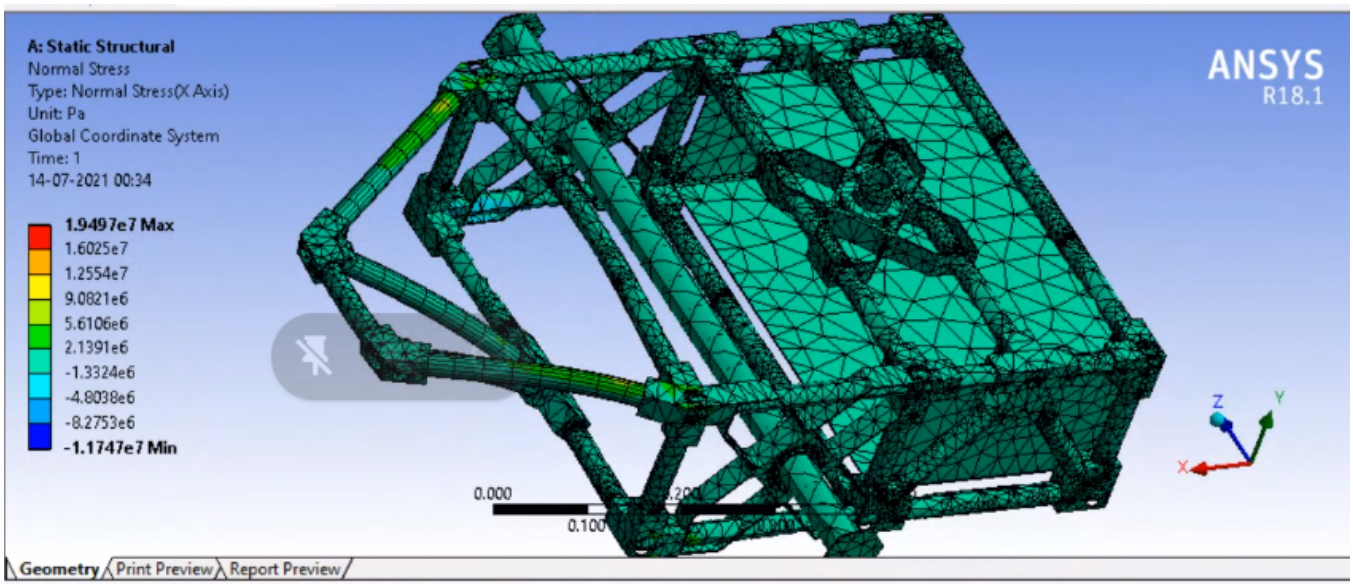
- Resolved ~200 errors that were present in the chassis of the rover involving conflicts in mate and interference.
- Identified 4 suppressed components in the sldasm file
- The chassis of the rover with the wheels was found to weigh roughly 198 kgs with structural steel. With Aluminium alloy 70 kgs.

ANSYS:

- Converted the .sldasm to an IGES file and imported into ANSYS
- There were some technical constraints initially owing to the fact that ANSYS student was used; however, on switching to a remote device and using the full version, no issues were faced and the meshing was smooth.

- A total of 395243 nodes and 189427 elements were used to calculate the various quantities and the meshing was done with structural steel for the whole chassis.
- Equivalent stress was not added for the initial analysis
- Errors:
    - The front region of the chassis which is responsible for holding the manipulator displayed a deformation while a torque of 50 N-m was applied. The maximum shear stress that was calculated within the structure was, however, found to be well within the limit. (the calculated shearing stress was 3.08 MPa while the yield limit is around 250 MPa. (The calculations were done in the absence of gravity)



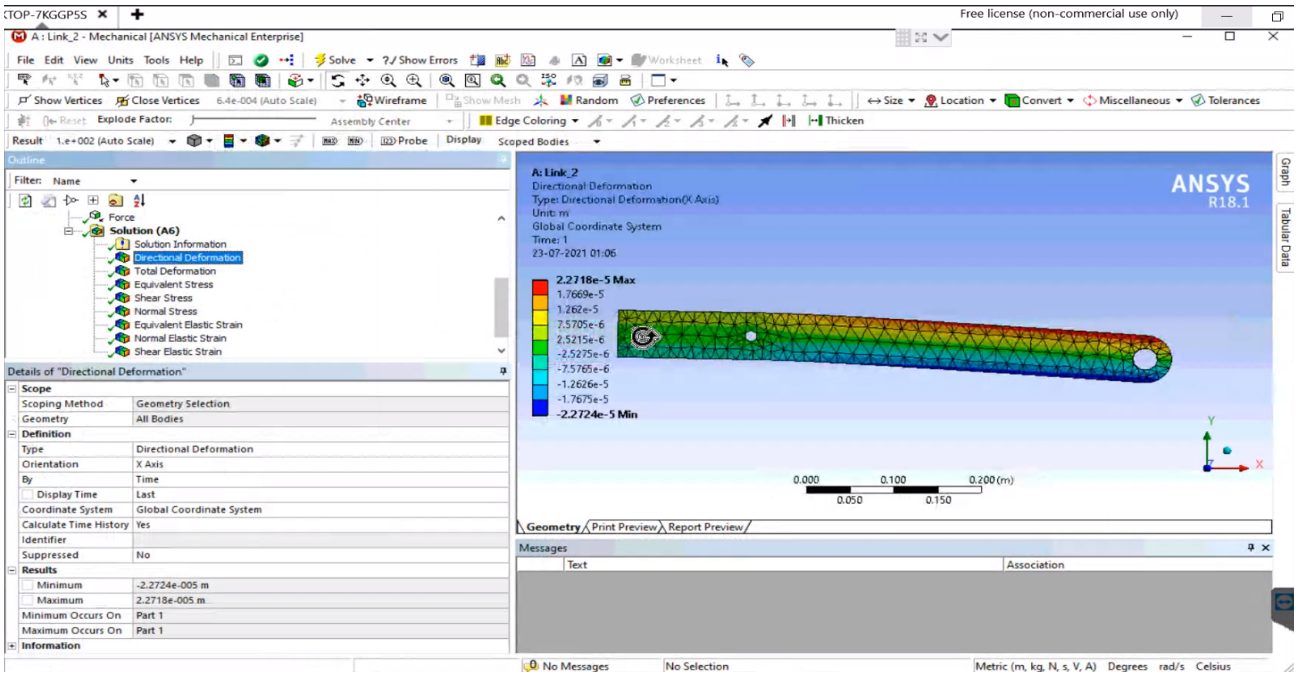


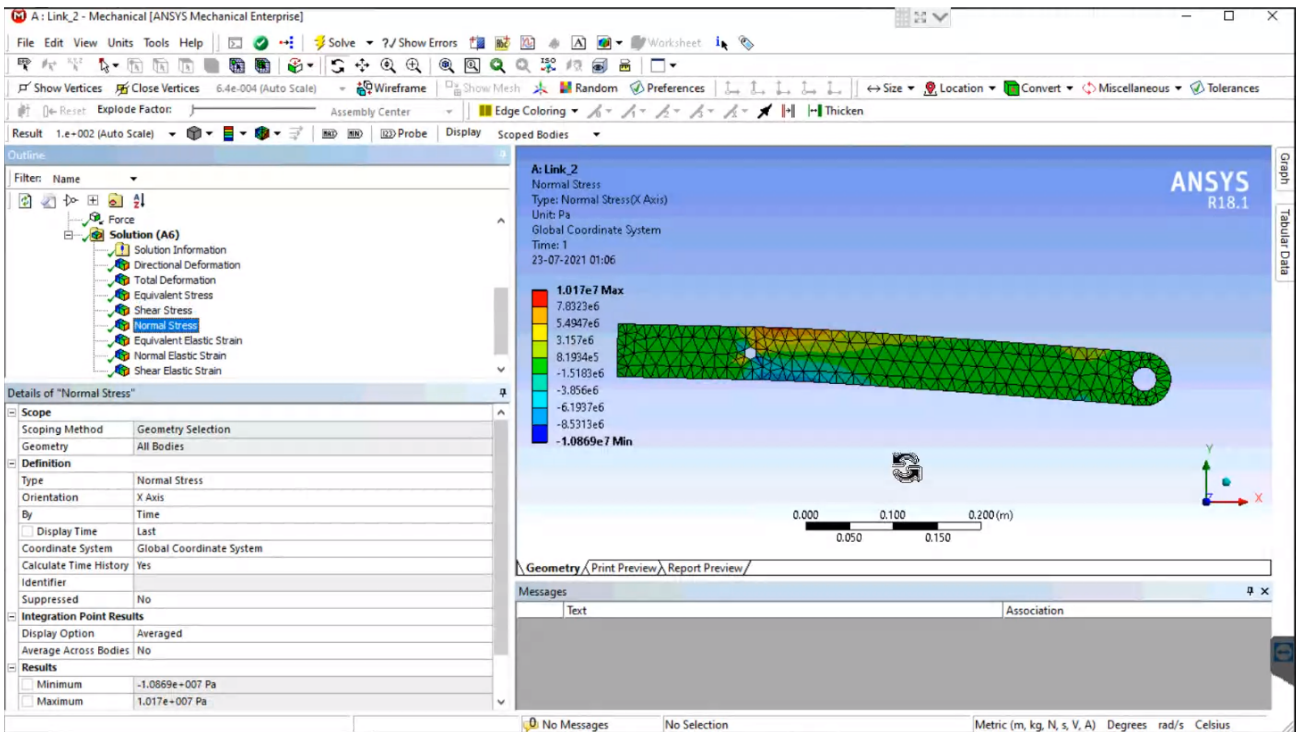
The model that we had imported into ansys had a node count of approximately 10 million and hence, was not computationally feasible.

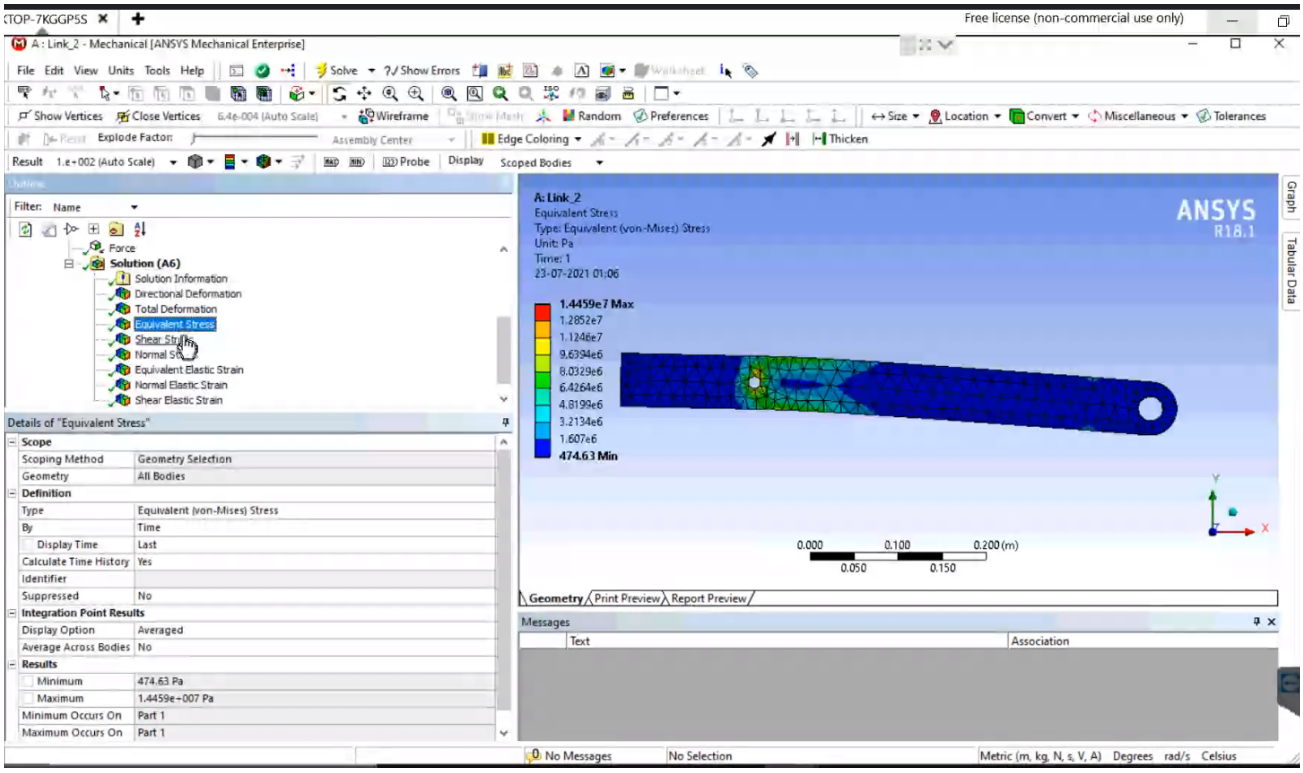
Manipulator Analysis:-

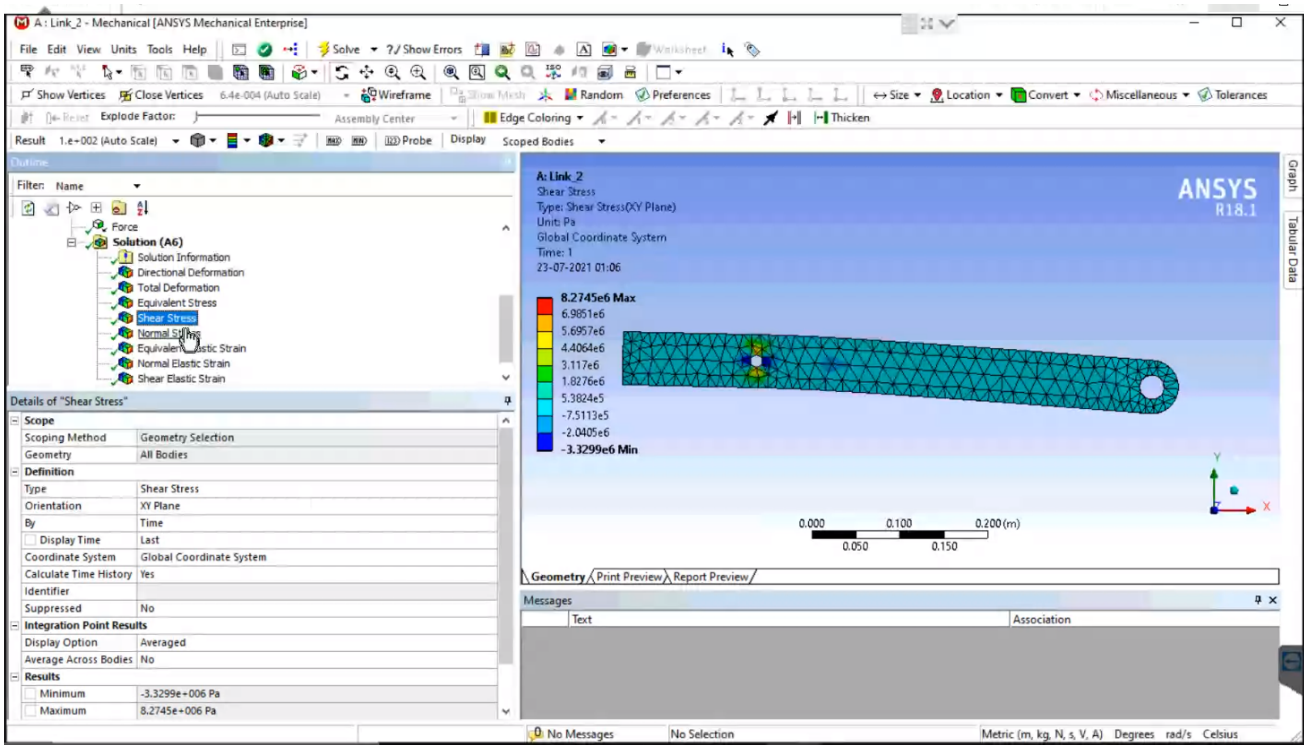
The Manipulator has been made up of Aluminium Alloy which has a yield strength of 280 Mpa and ultimate strength of 310 Mpa.

Link-1(Link attached to base):-



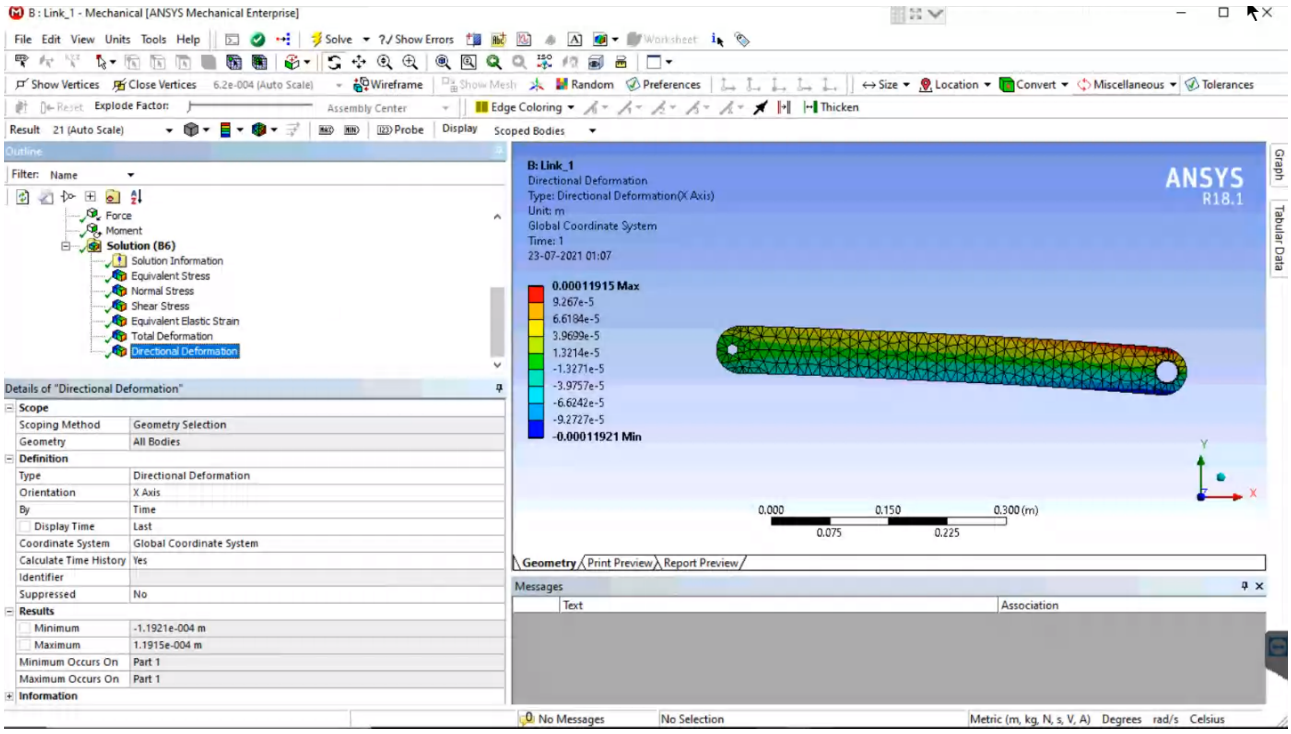


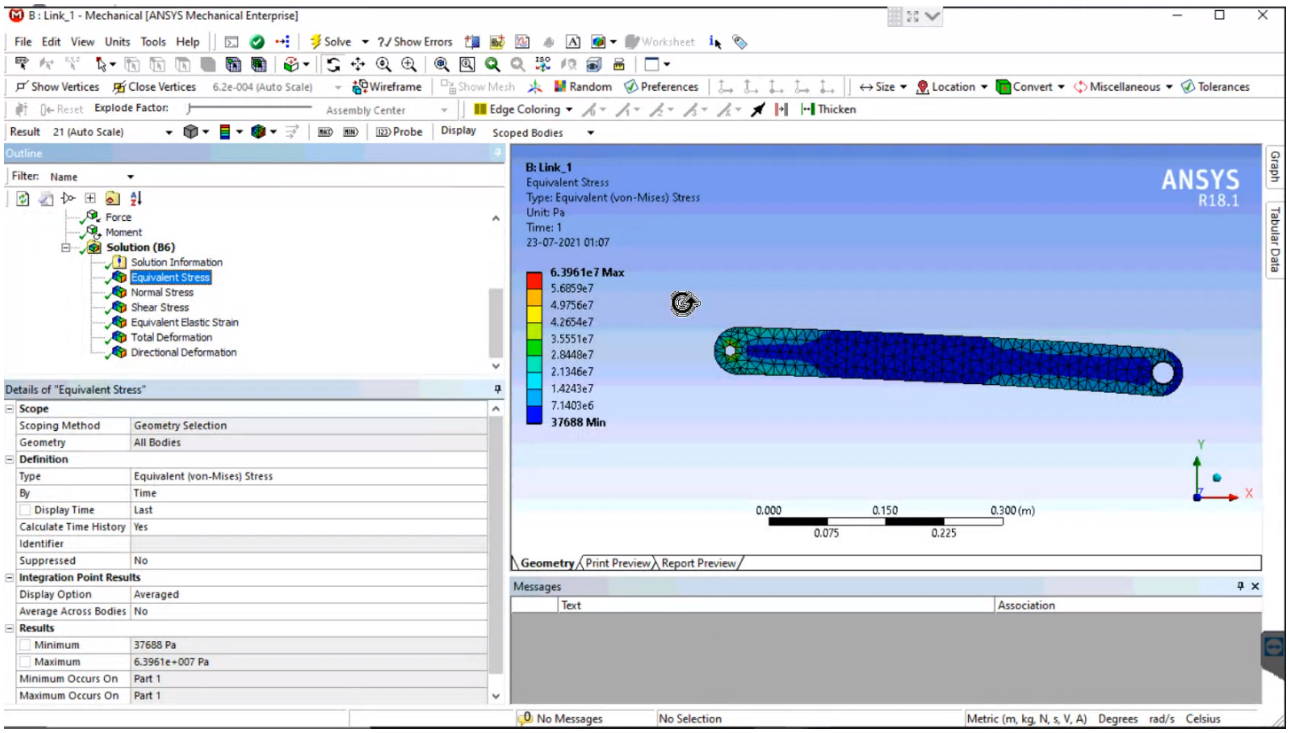


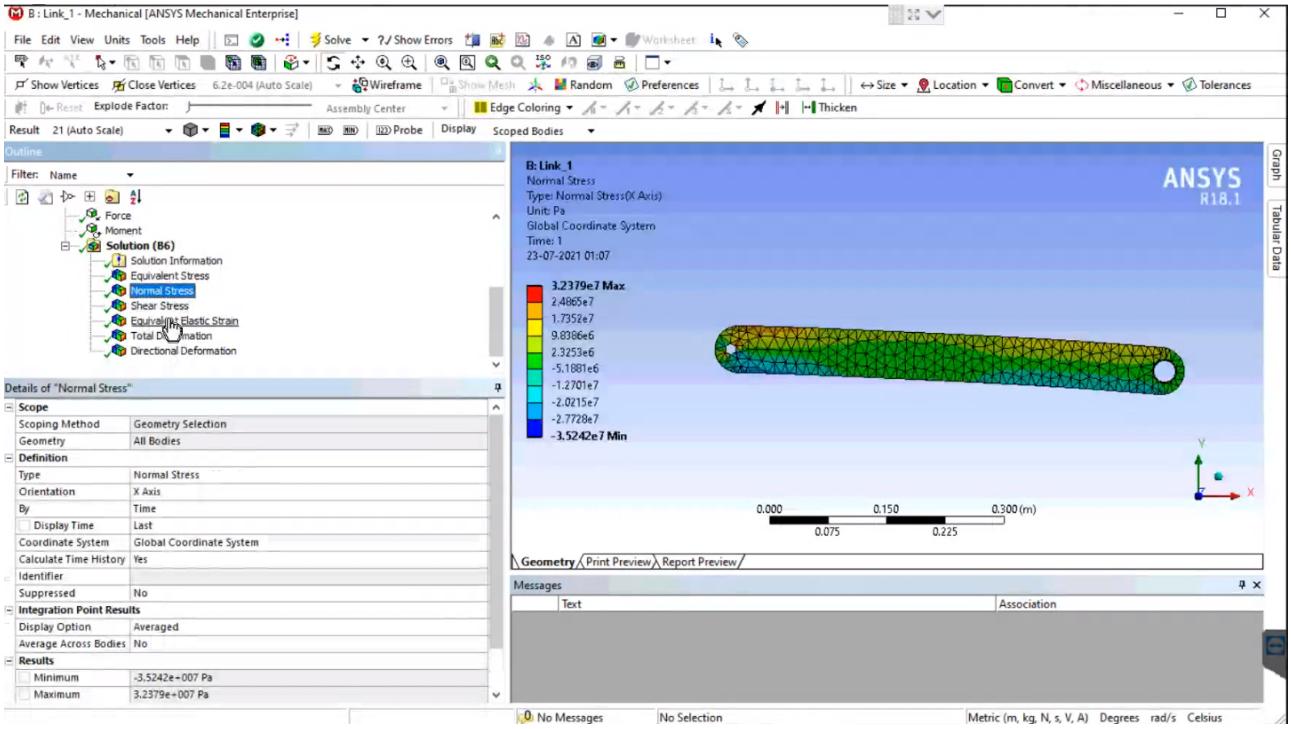


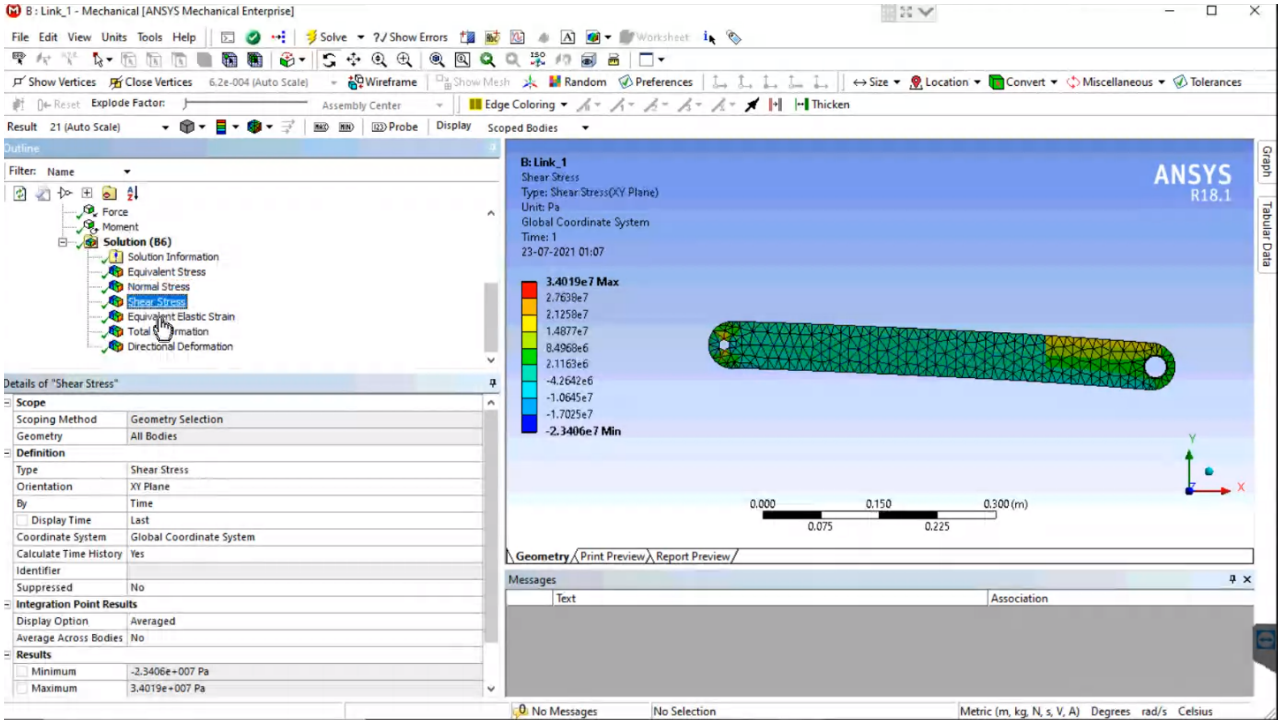
- We can see that stress is well within limits and the deformation is too less(of the order of 10^-4m).

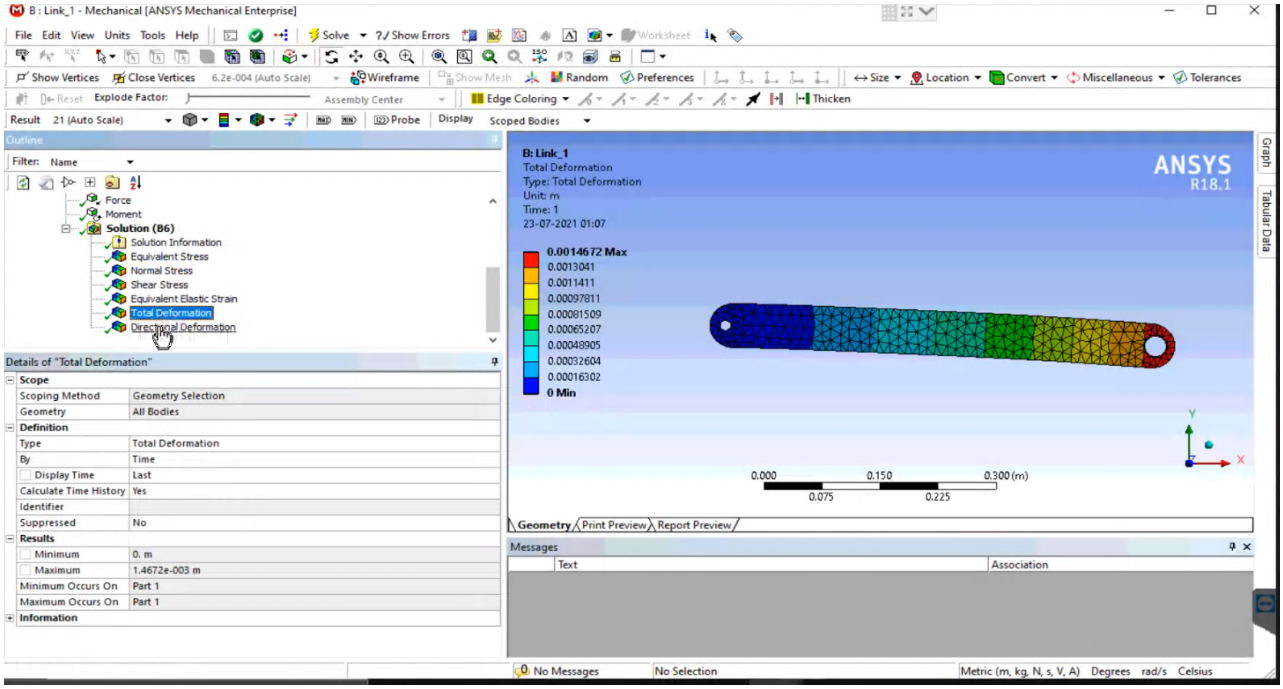
Link-2(Link attached to gripper):-





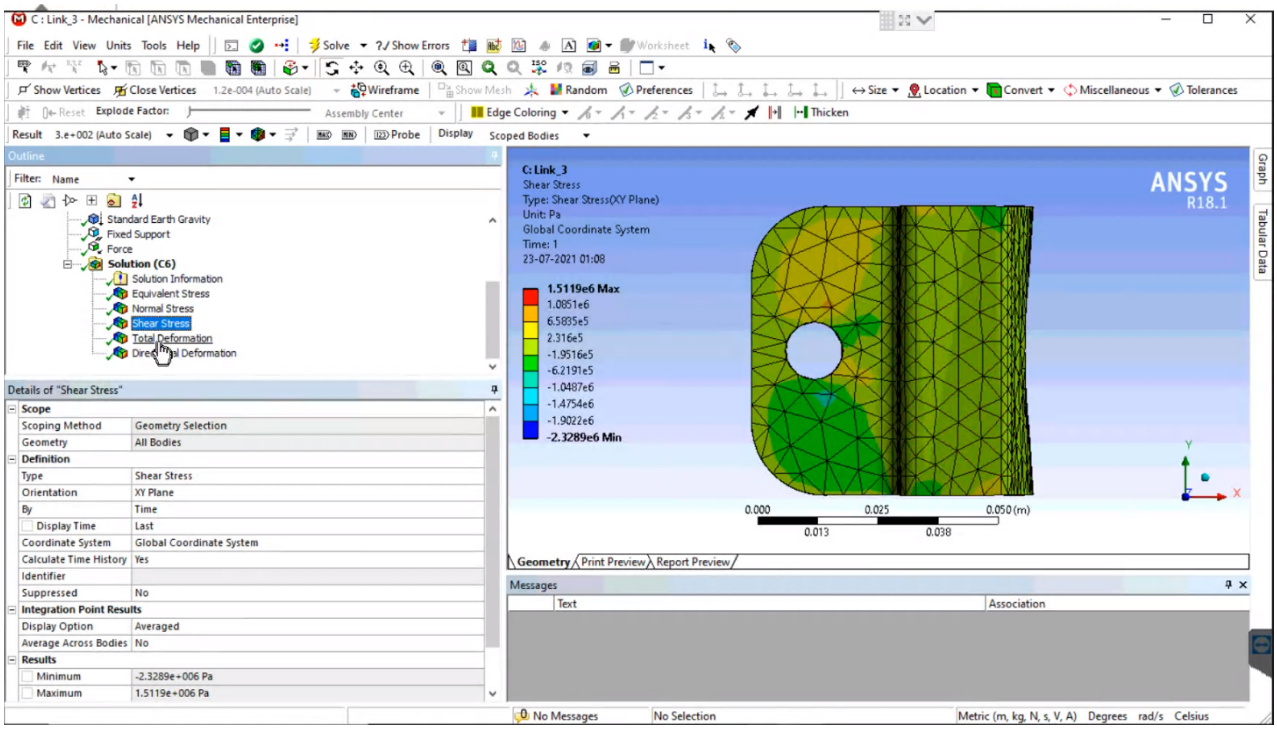

B : Link_1 - Mechanical [ANSYS Mechanical Enterprise]
File Edit View Units Tools Help
Solve
Show Errors
Worksheet
Show Vertices
Close Vertices
Wireframe
Show Mesh
Random
Preferences
Size
Location
Convert
Miscellaneous
Tolerances
Reset
Explode Factor:
Assembly Center
Edge Coloring
Thicken
Result
21 (Auto Scale)
Probe
Display
Scoped Bodies
Outline
Filter: Name
Force
Moment
Solution (B6)
Solution Information
Equivalent Stress
Normal Stress
Shear Stress
Equivalent Elastic Strain
Total Deformation
Directional Deformation
Details of "Normal Stress"
Scope
Scoping Method
Geometry Selection
Geometry
All Bodies
Definition
Type
Normal Stress
Orientation
X Axis
By
Time
Display Time
Last
Coordinate System
Global Coordinate System
Calculate Time History
Yes
Identifier
Suppressed
No
Integration Point Results
Display Option
Averaged
Average Across Bodies
No
Results
Minimum
-3.5242e+007 Pa
Maximum
3.2379e+007 Pa
B: Link_1
Normal Stress
Type: Normal Stress(X Axis)
Unit: Pa
Global Coordinate System
Time: 1
23-07-2021 01:07
3.2379e7 Max
2.4865e7
1.7352e7
9.8386e6
2.3253e6
-5.1881e6
-1.2701e7
-2.0215e7
-2.7728e7
-3.5242e7 Min
ANSYS
R18.1
0.000
0.150
0.300 (m)
0.075
0.225
Geometry
Print Preview
Report Preview
Messages
Text
Association
No Messages
No Selection
Metric (m, kg, N, s, V, A) Degrees rad/s Celsius
Graph
Tabular Data

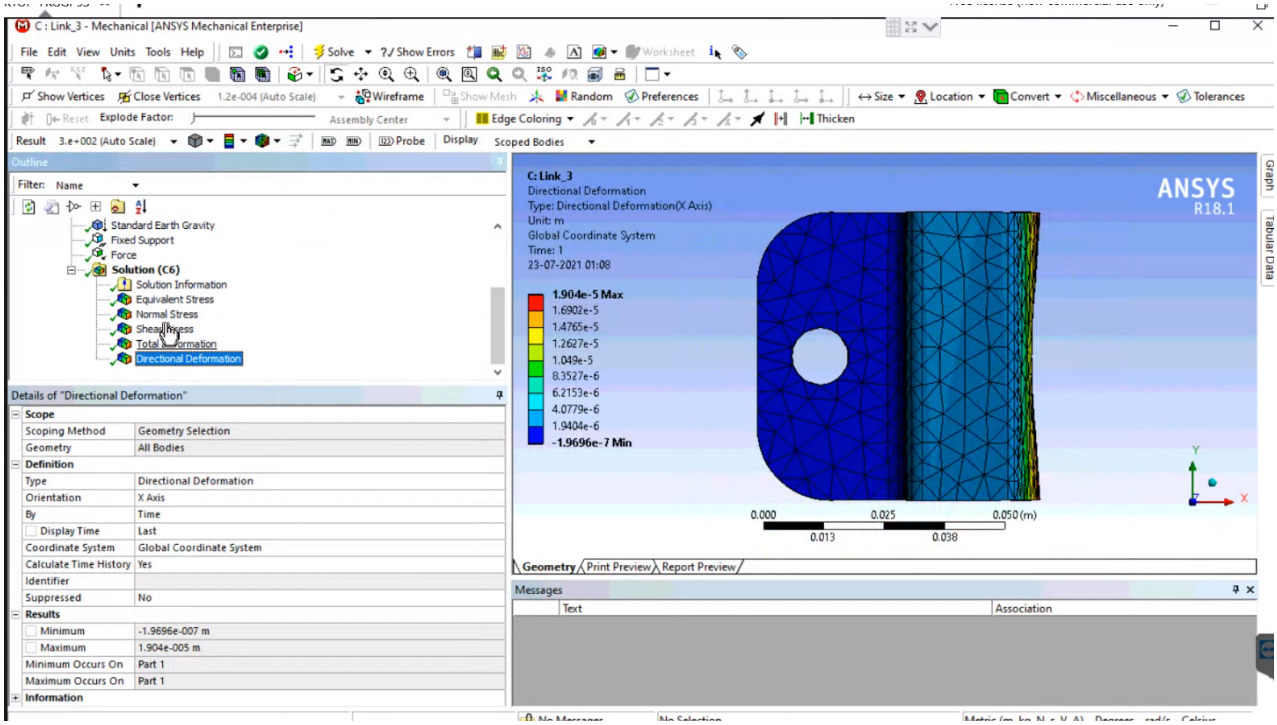


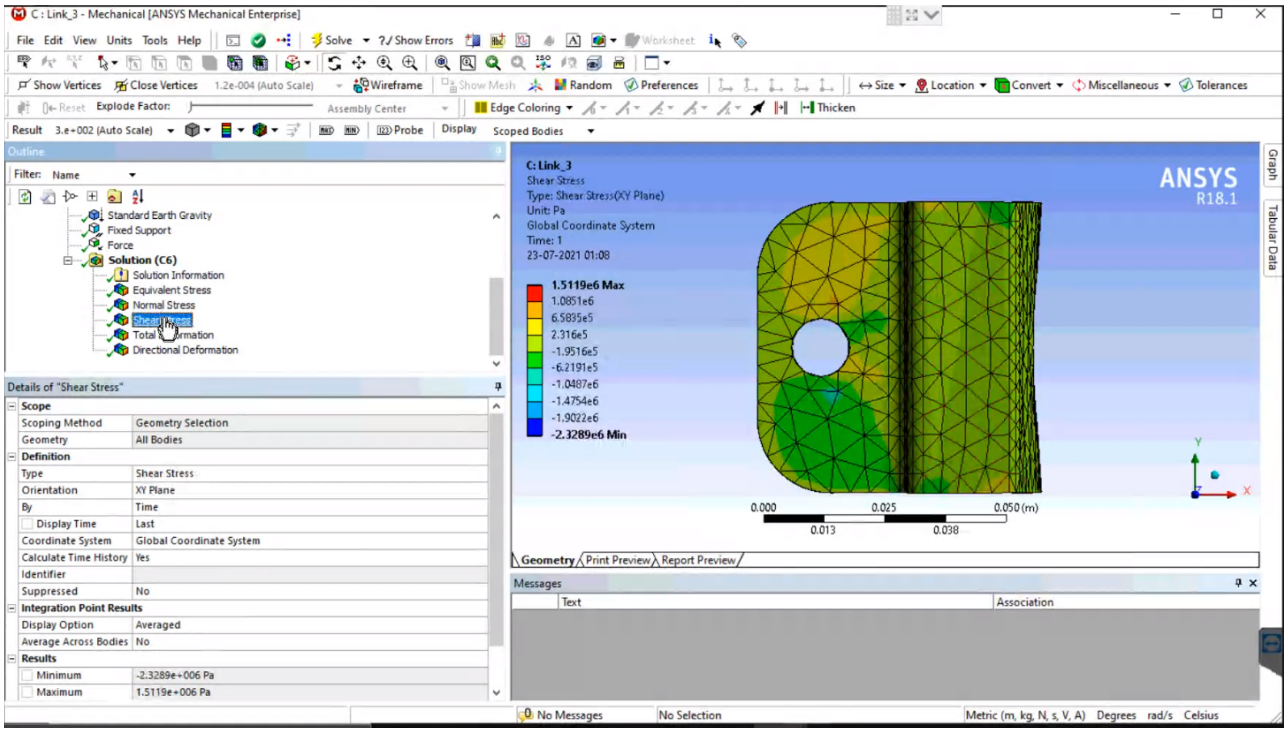


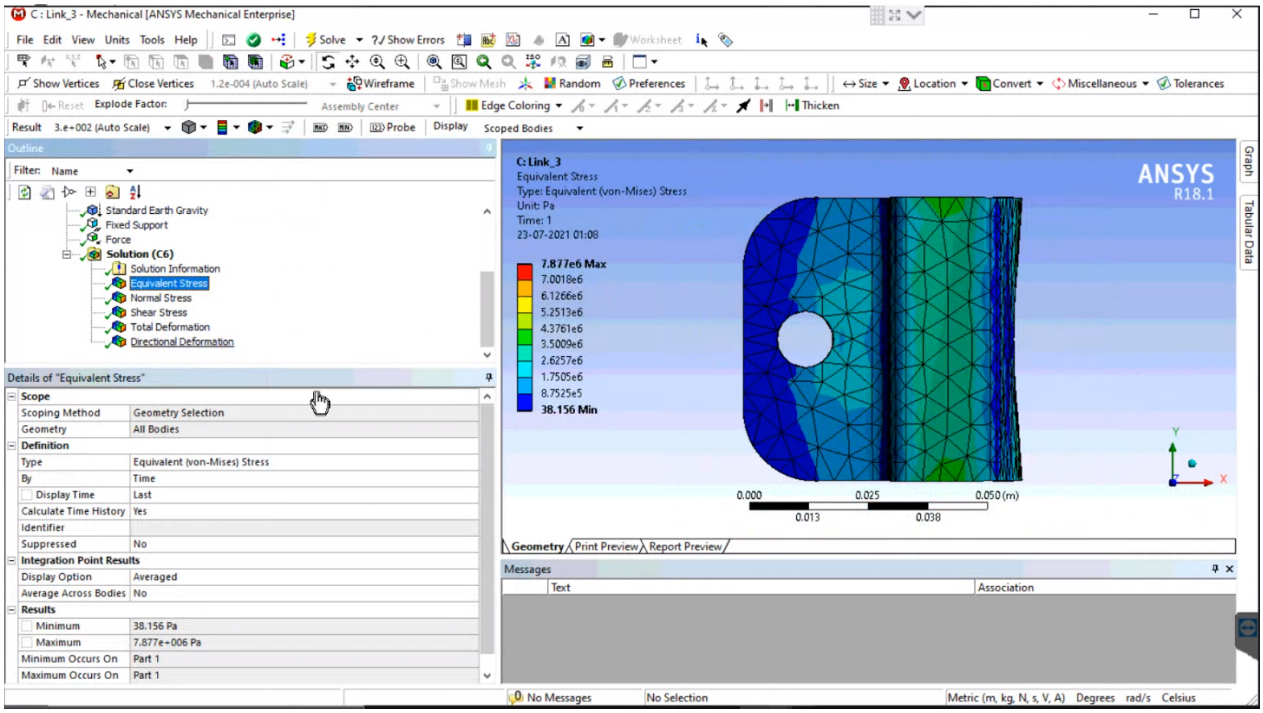
- We can see that stress is well within limits and the deformation is too less(of the order of 10^-3m).

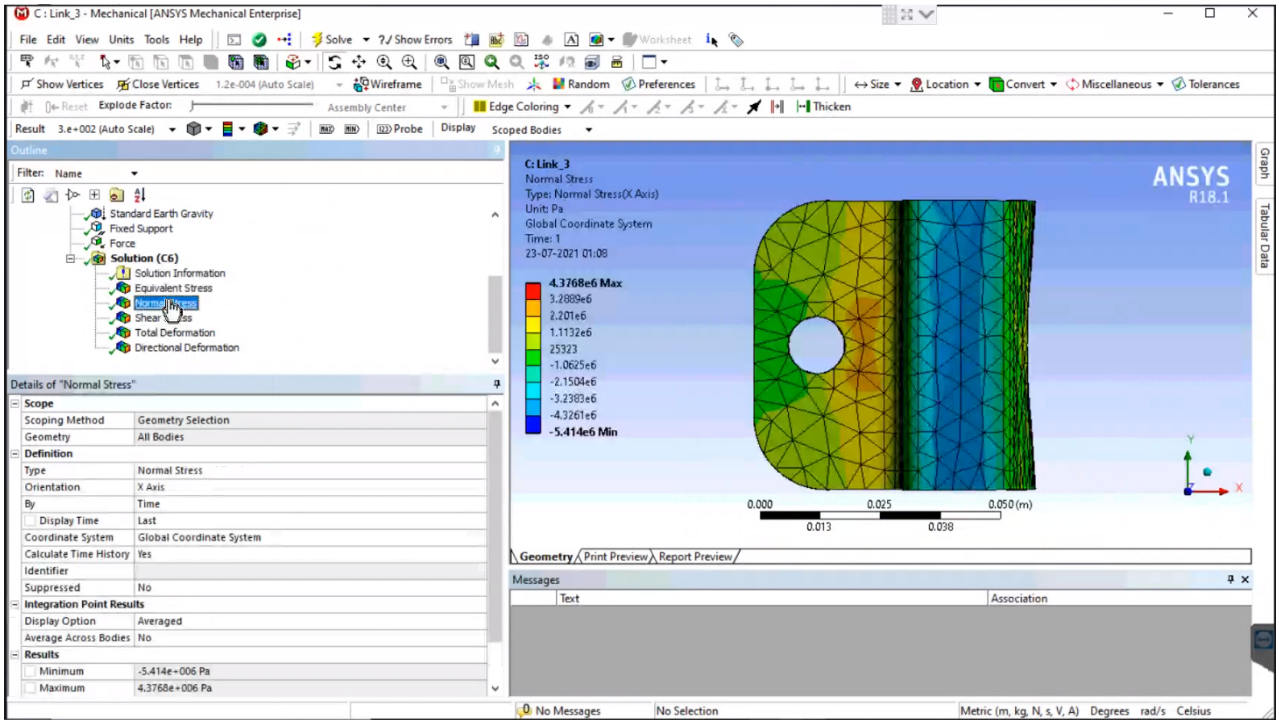
Link-3(Link between Link-2 and Gripper):-





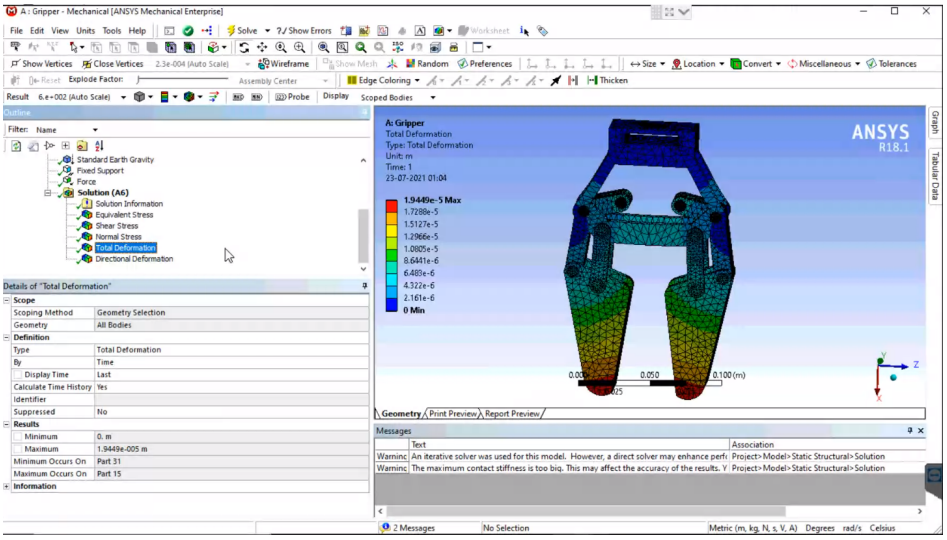

C : Link_3 - Mechanical [ANSYS Mechanical Enterprise]
Outline
Standard Earth Gravity
Fixed Support
Force
Solution (C6)
Solution Information
Equivalent Stress
Normal Stress
Shear Stress
Directional Deformation
Details of "Shear Stress"
Scope
Scoping Method Geometry Selection
Geometry All Bodies
Definition
Type Shear Stress
Orientation XY Plane
By Time
Display Time Last
Coordinate System Global Coordinate System
Calculate Time History Yes
Identifier
Suppressed No
Integration Point Results
Display Option Averaged
Average Across Bodies No
Results
Minimum -2.3289e+006 Pa
Maximum 1.5119e+006 Pa
C: Link_3
Shear Stress
Type: Shear Stress(XY Plane)
Unit: Pa
Global Coordinate System
Time: 1
23-07-2021 01:08
1.5119e6 Max
1.0851e6
6.5835e5
2.316e5
-1.9516e5
-6.2191e5
-1.0487e6
-1.4754e6
-1.9022e6
-2.3289e6 Min
ANSYS
R18.1
0.000
0.025
0.050 (m)
0.013
0.038
Geometry
Print Preview
Report Preview
Messages
Text
Association
No Messages
No Selection
Metric (m, kg, N, s, V, A) Degrees rad/s Celsius

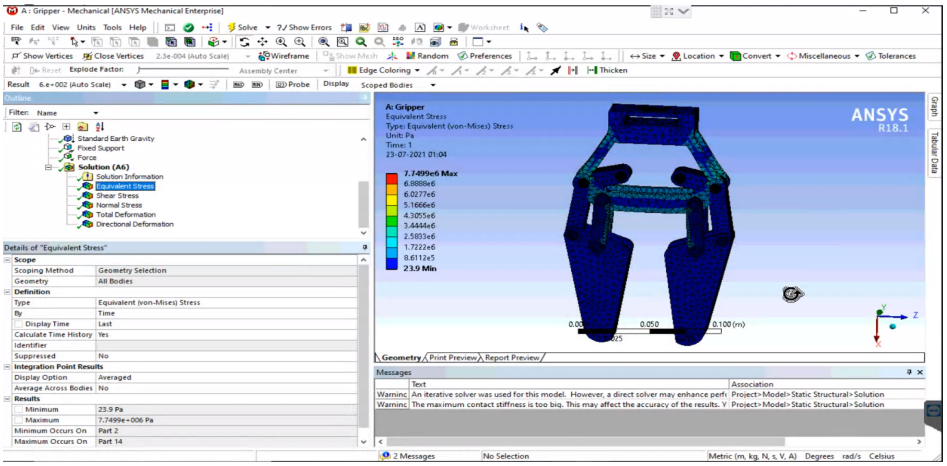

C : Link_3 - Mechanical [ANSYS Mechanical Enterprise]
Outline
Standard Earth Gravity
Fixed Support
Force
Solution (C6)
Solution Information
Equivalent Stress
Normal Stress
Shear Stress
Total Deformation
Directional Deformation
Details of "Equivalent Stress"
Scope
Scoping Method Geometry Selection
Geometry All Bodies
Definition
Type Equivalent (von-Mises) Stress
By Time
Display Time Last
Calculate Time History Yes
Identifier
Suppressed No
Integration Point Results
Display Option Averaged
Average Across Bodies No
Results
Minimum 38.156 Pa
Maximum 7.877e+006 Pa
Minimum Occurs On Part 1
Maximum Occurs On Part 1
C: Link_3
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: Pa
Time: 1
23-07-2021 01:08
7.877e6 Max
7.0018e6
6.1266e6
5.2513e6
4.3761e6
3.5009e6
2.6257e6
1.7505e6
8.7525e5
38.156 Min
ANSYS
R18.1
0.000
0.025
0.050 (m)
0.013
0.038
Geometry
Print Preview
Report Preview
Messages
Text
Association
No Messages
No Selection
Metric (m, kg, N, s, V, A) Degrees rad/s Celsius

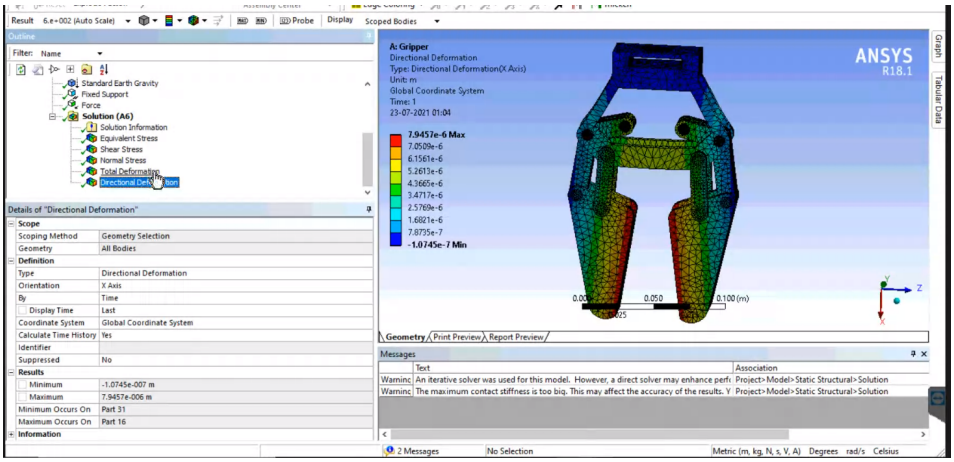


- We can see that stress is well within limits and the deformation is too less(of the order of 10^-5m).

Gripper:-

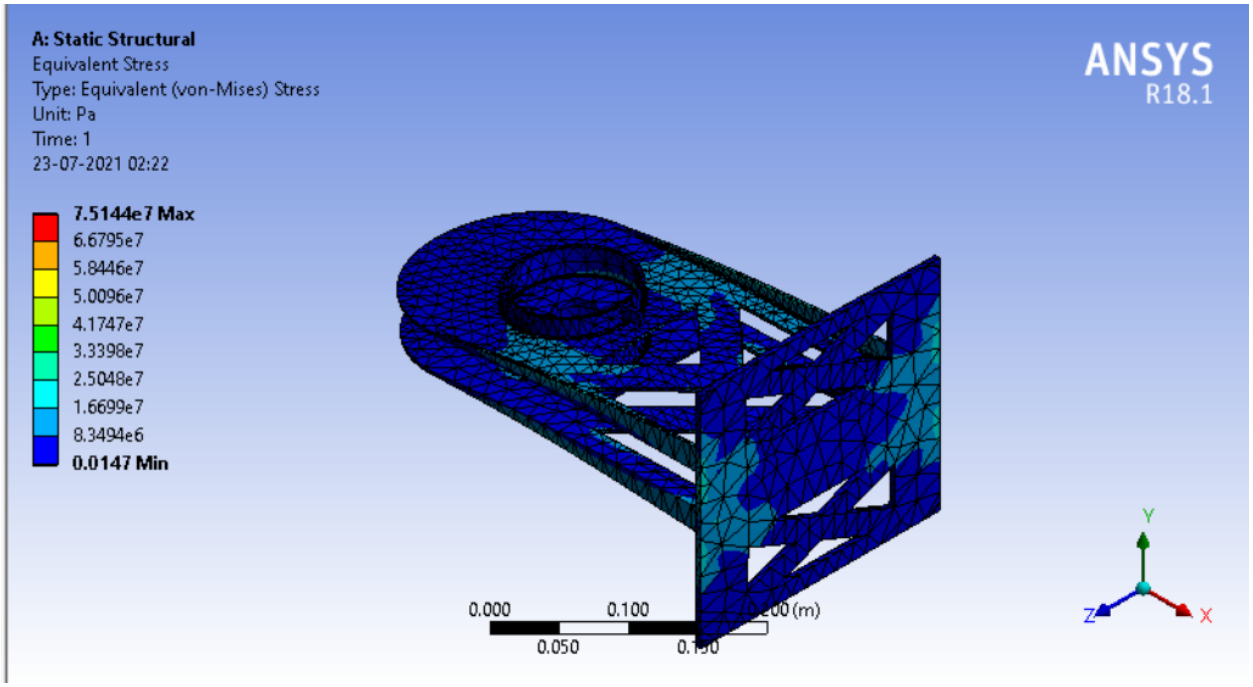


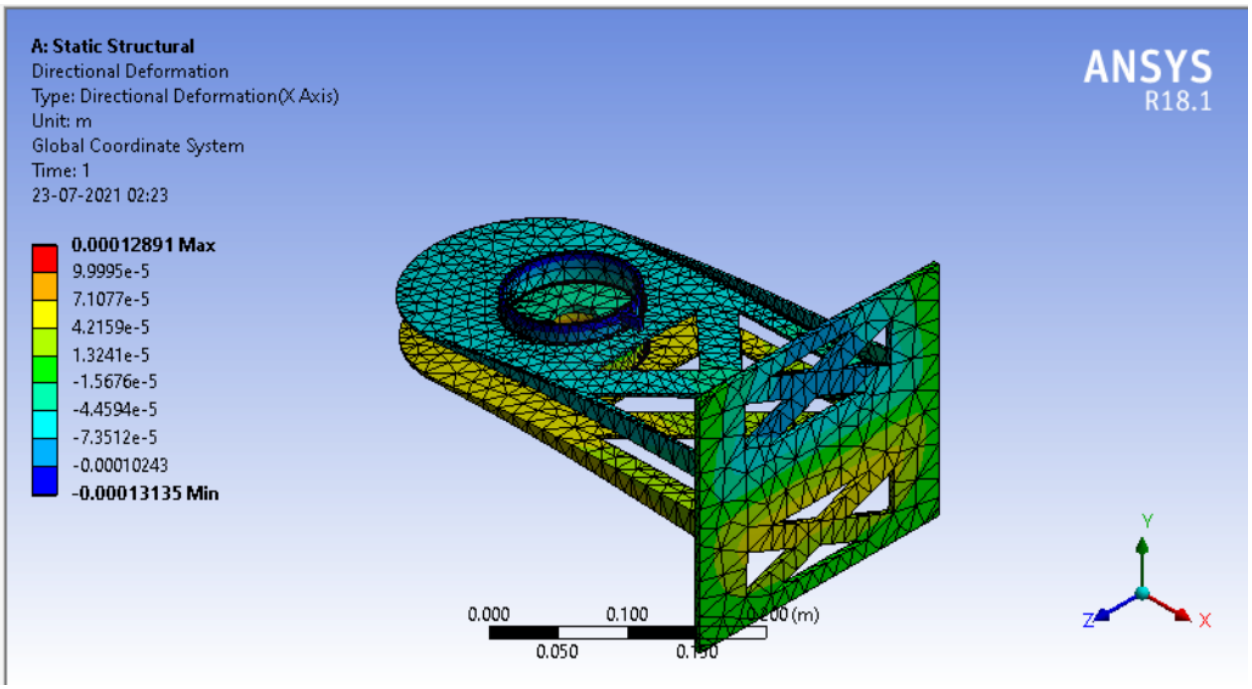


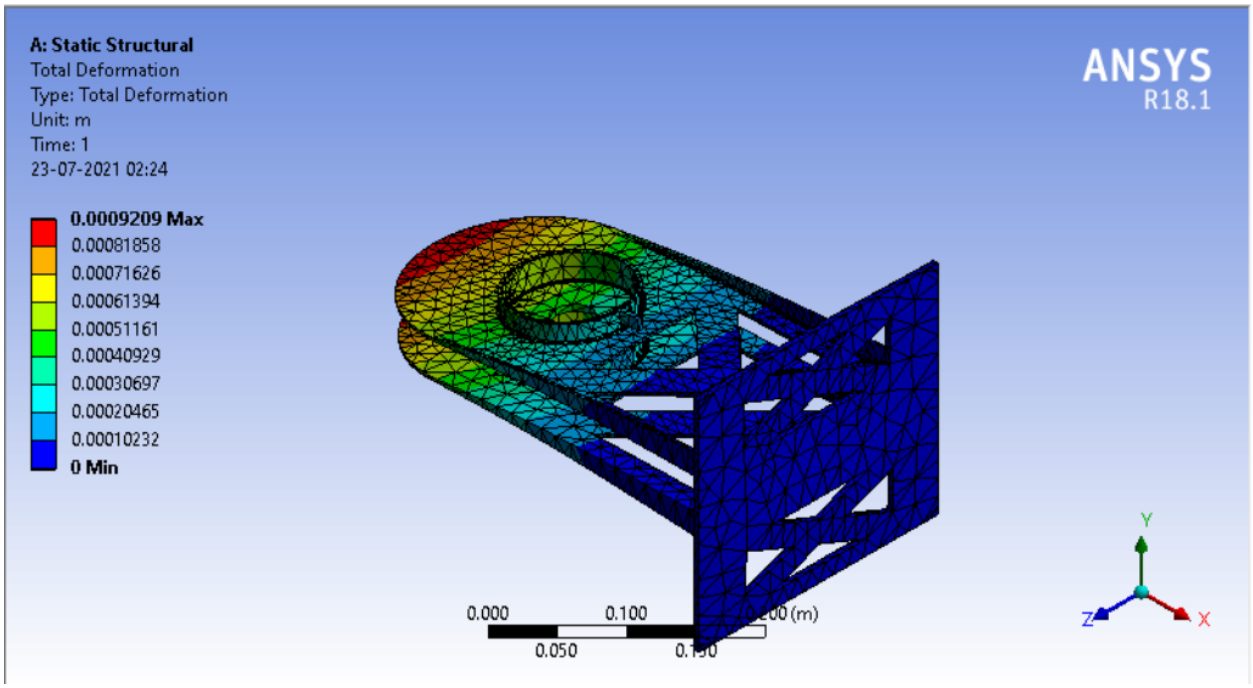


- We can see that stress is well within limits and the deformation is too less(of the order of 10^-6m).

Manipulator mount:-






A: Static Structural
Total Deformation
Type: Total Deformation
Unit: m
Time: 1
23-07-2021 02:24
0.0009209 Max
0.00081858
0.00071626
0.00061394
0.00051161
0.00040929
0.00030697
0.00020465
0.00010232
0 Min
ANSYS
R18.1
0.000
0.100
0.050
Y
Z
X