Stress Analysis

Contents

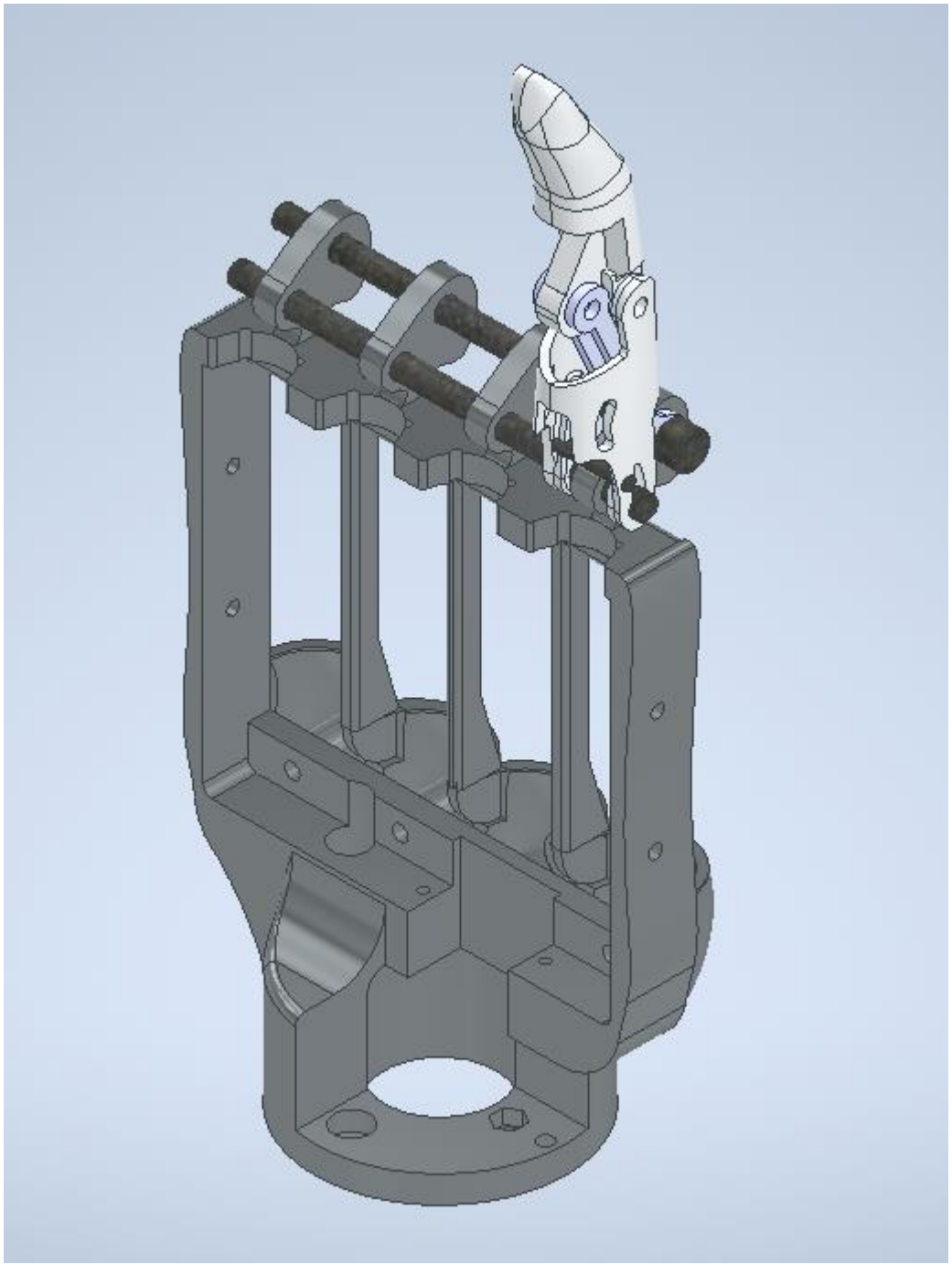
Assumptions:

- The hand is to handle objects of 30 KGs of weight, slightly less than the BeBionic model which can handle up to 45 KGs, This Weight is not the recommended weight to carry using the prosthetic and is used just for analysis purposes.

- The weight force is to be evenly distributed at each finger so each finger will be carrying 6 KGs of weight alongside the tensile force from the actuator (150 Newtons as calculated in the report)
- “ABS” yield strength is 51 MPa as extracted from its datasheet.
- The Force acting on the finger will be considered as a moment at the phalange simulating rotation motion.
- The total moment value will be divided into 4, 2 moments will be at the 2 halves of the bottom phalange and 2 moments will be at the 2 halves of the upper phalange.
- Total Moment value can be calculated as = 150 * (Distance from C.O.G to Base) + 6 * 9.8 * (Distance from C.O.G to Base)
- Moment Value Affecting Each Phalange Half = Total Moment / 4

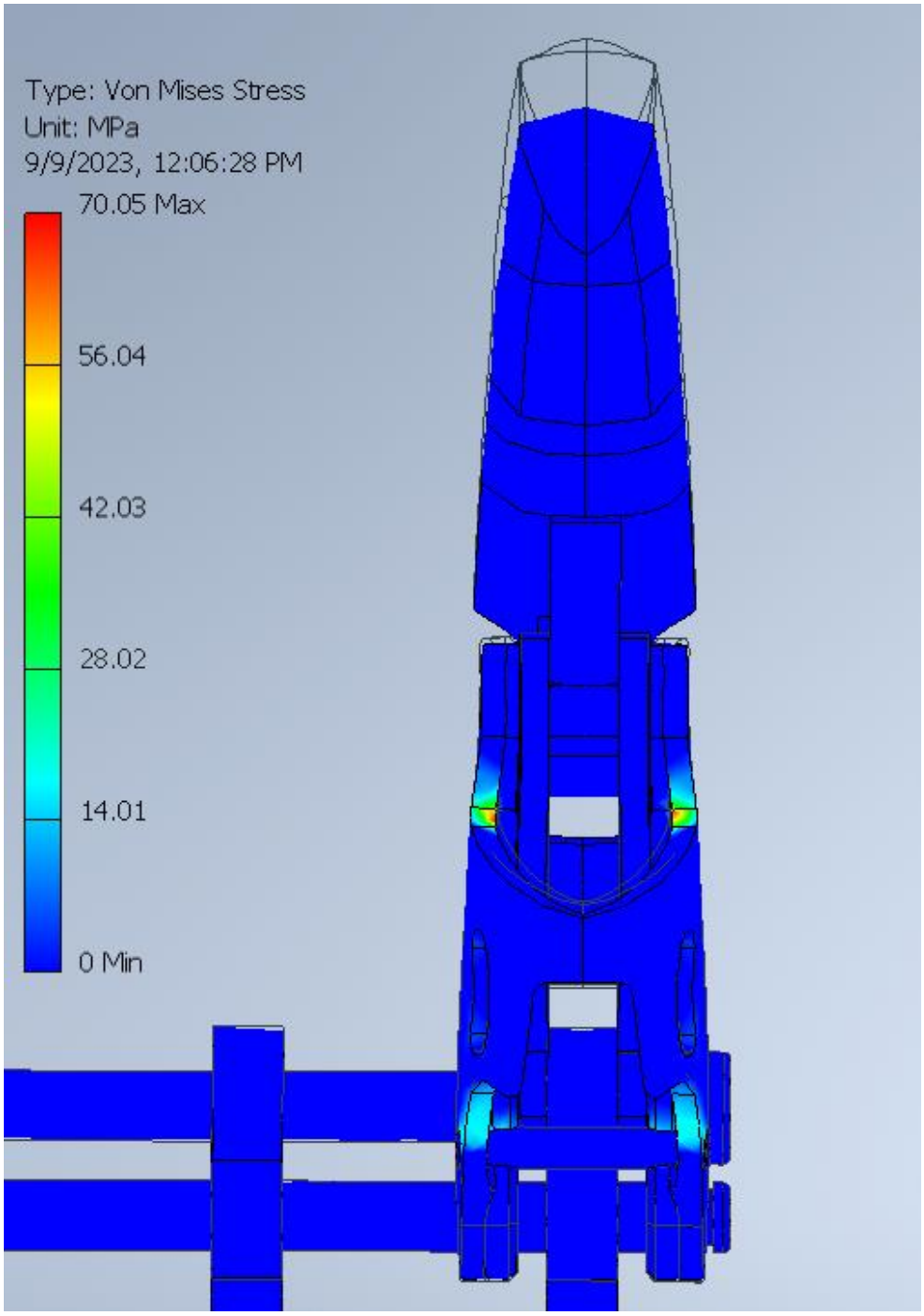
Fingers Stress analysis

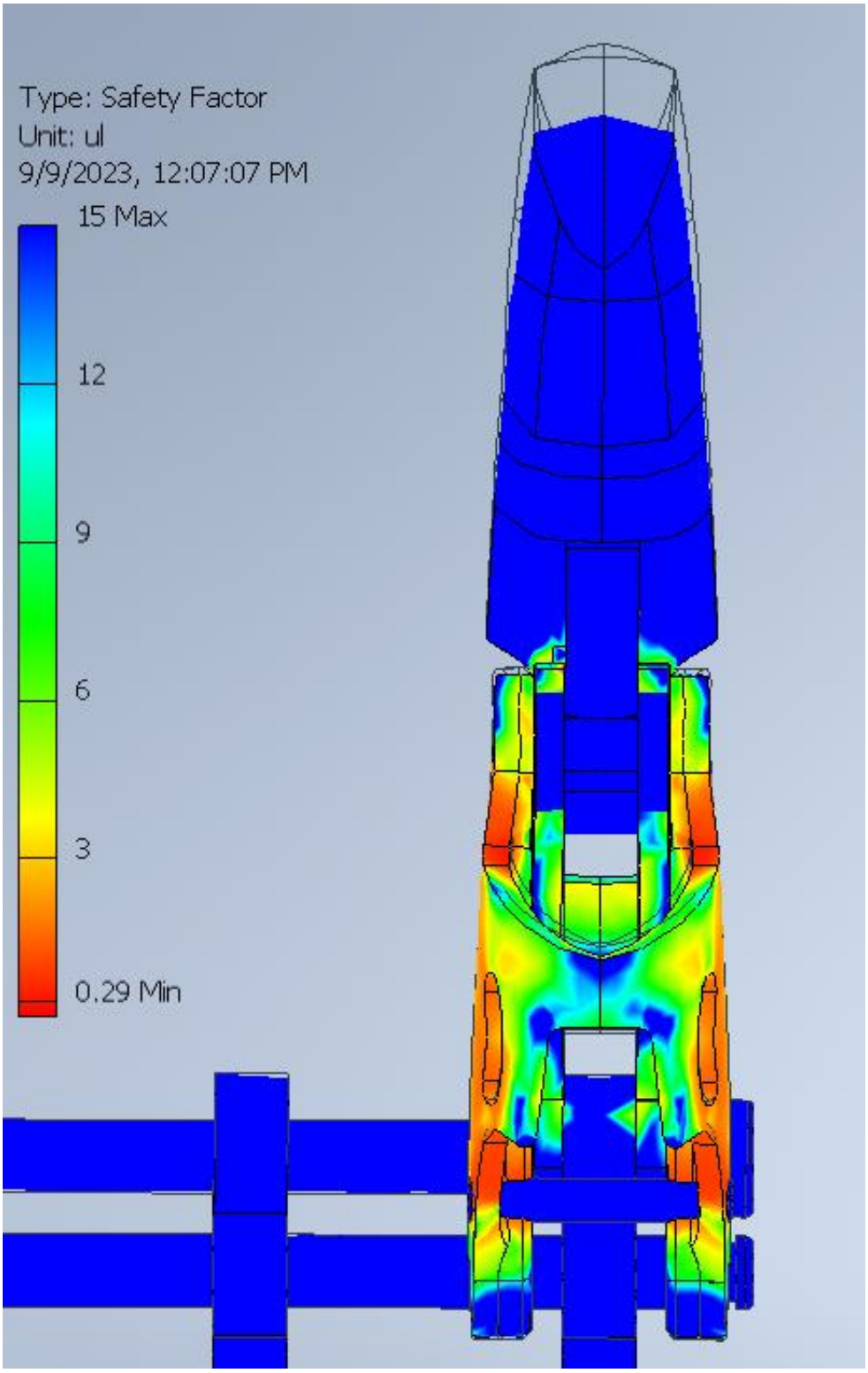
Index Finger:

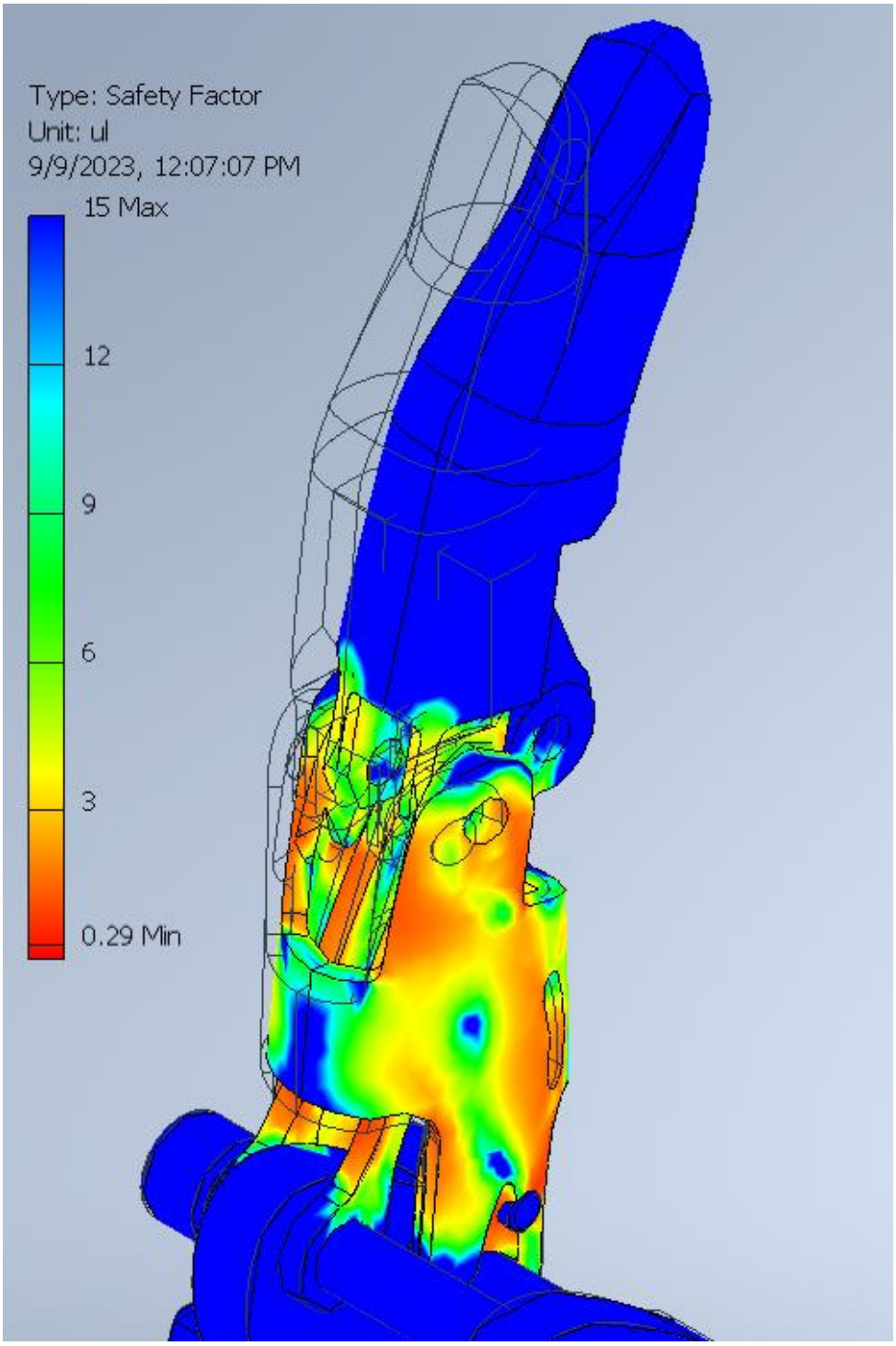


- Distance from C.O.G to Base = 40 mm
- Total moment = 8352 N.mm
- Moment At each half of the phalange = 2088 N.mm

- Results:

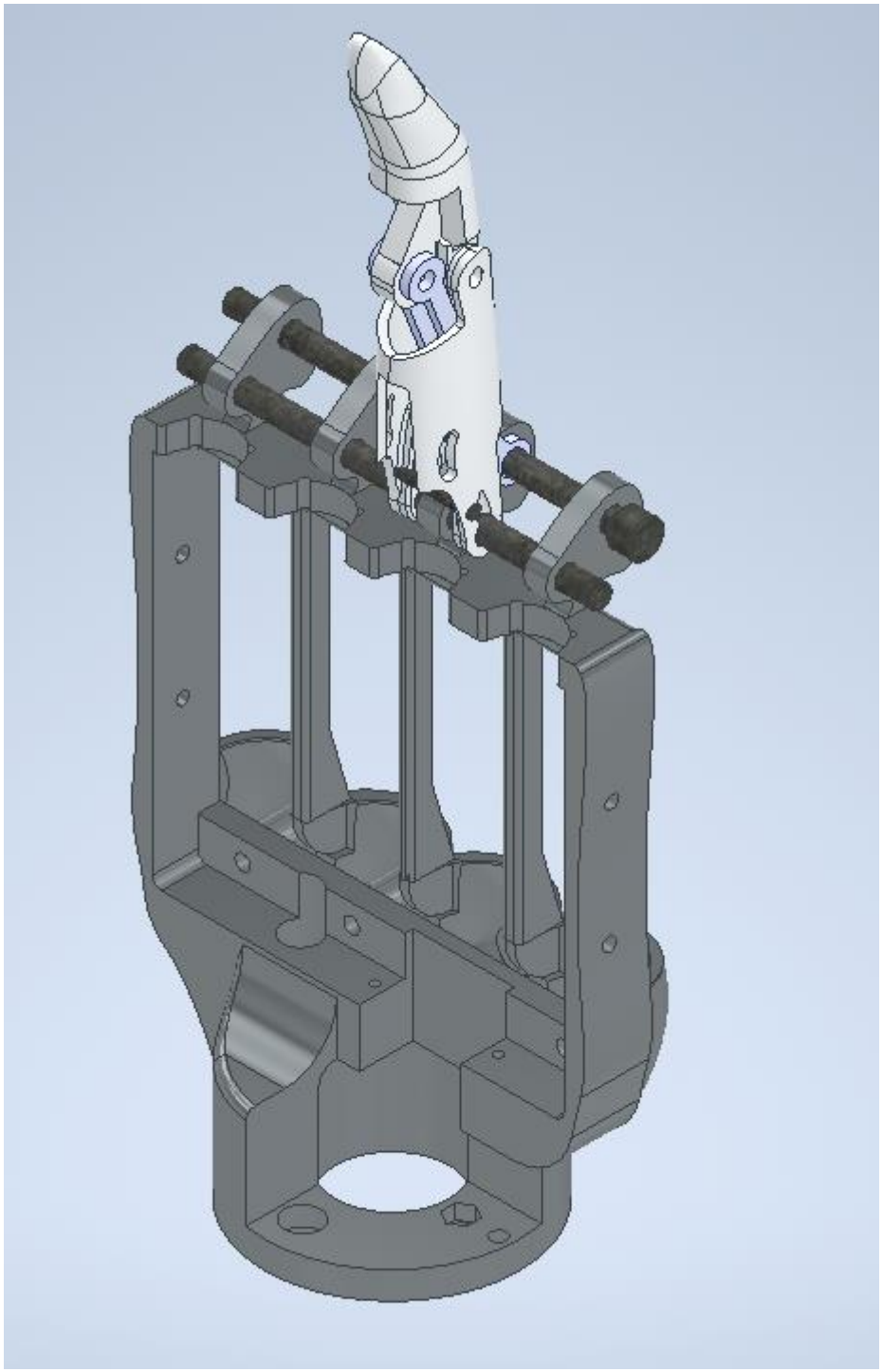

Type: Von Mises Stress
Unit: MPa
9/9/2023, 12:06:28 PM
70.05 Max
56.04
42.03
28.02
14.01
0 Min


Type: Safety Factor
Unit: ul
9/9/2023, 12:07:07 PM
15 Max
12
9
6
3
0.29 Min

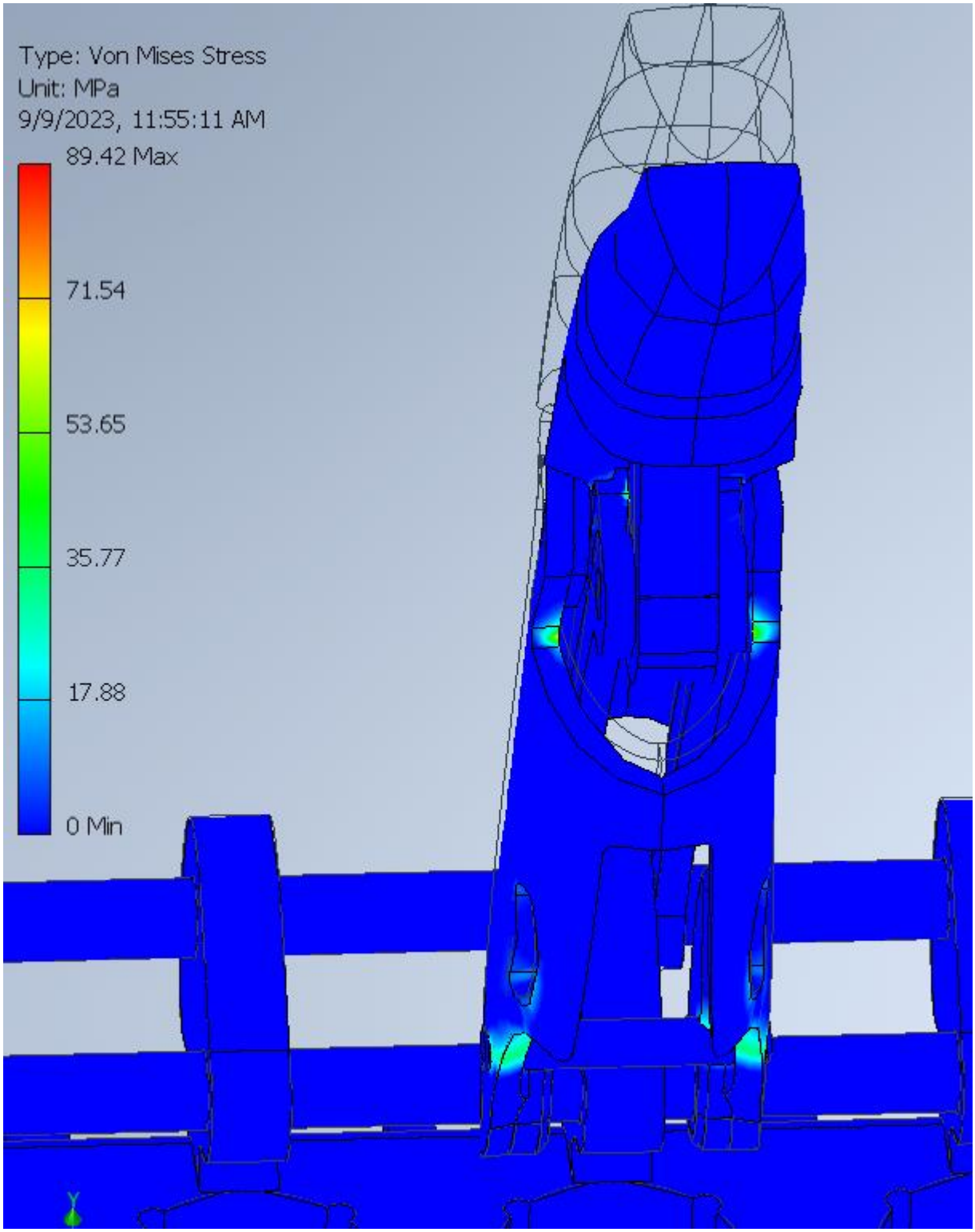


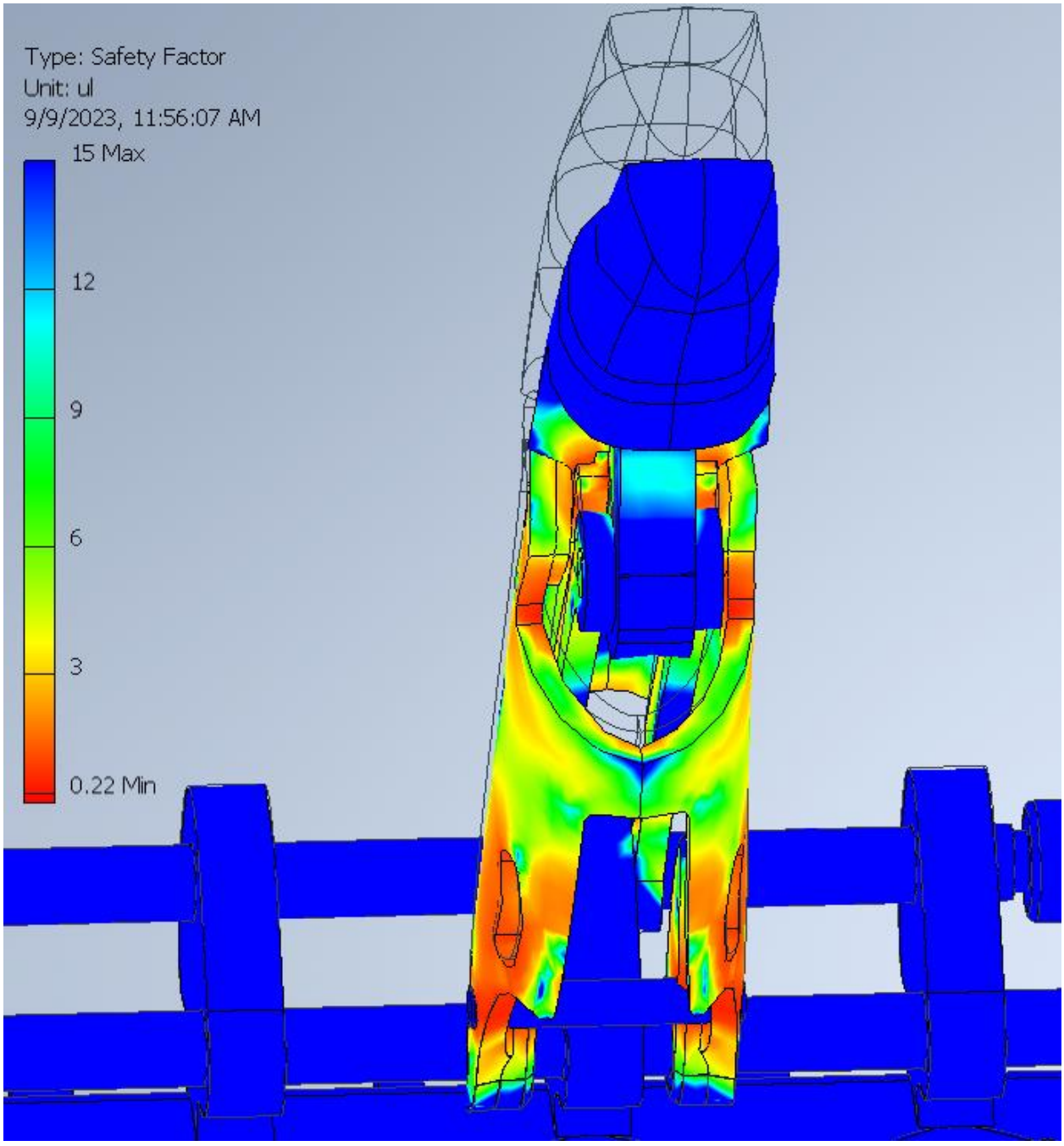
- Comments:
  - Stress Analysis Environment Indicates No Failure
  - Combined Stress Max Value: 70.05 MPa
  - Critical areas of highest combined stresses: (Bottom Phalange & 2 Links)
  - Recommendations:
    - Changing Links in Index Finger from ABS To Steel for extra safety
    - Keeping Weight to be carried below 10 KGs.
    - For Handling of Heavier Weights, Changing the Raw Material of the prosthetic from ABS To Steel Is Recommended

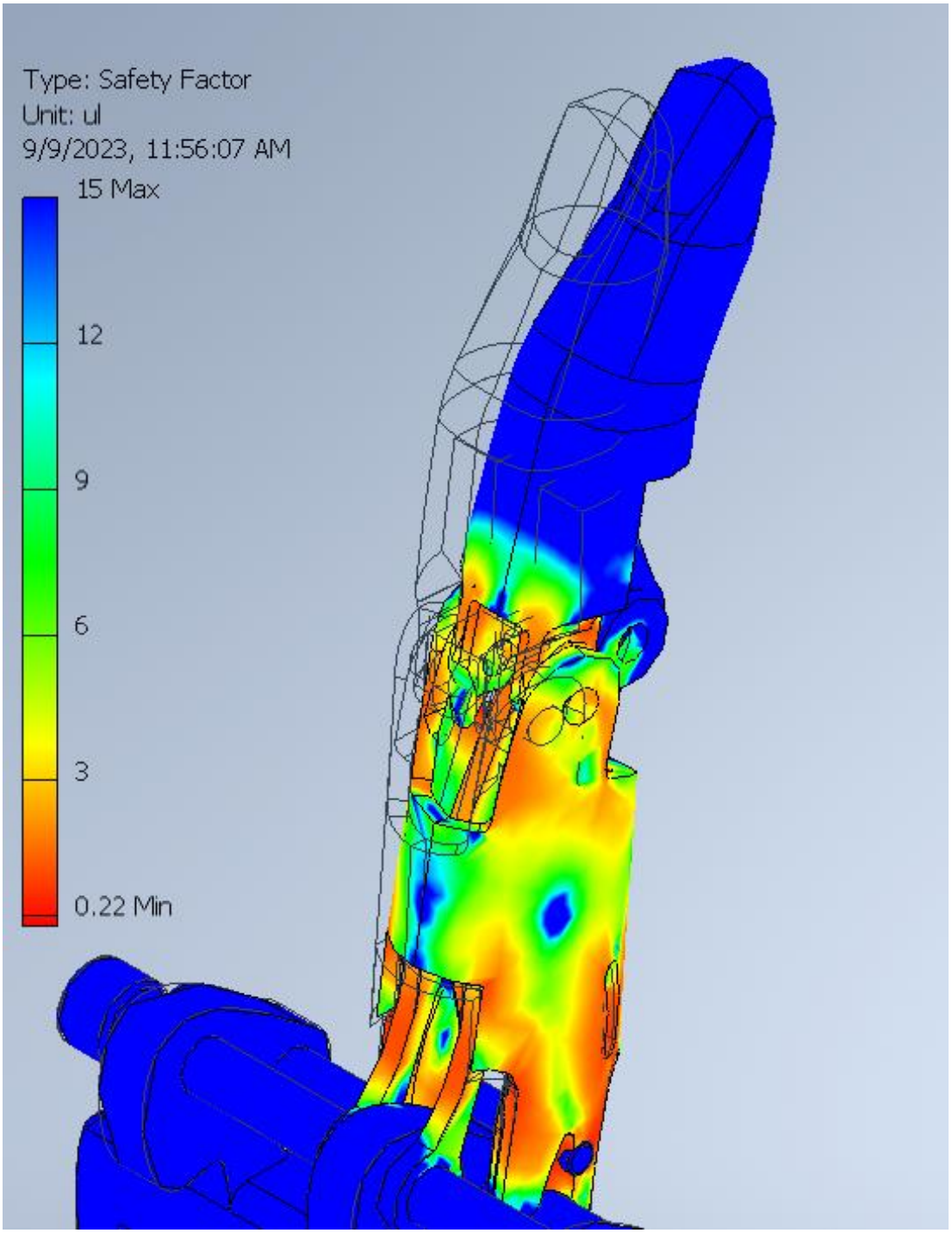
Middle Finger:



- Distance from C.O.G To Base = 51 mm
- Total moment = 10648.8 N.mm
- Moment At each half of the phalange = 2662.2 N.mm
- Results:

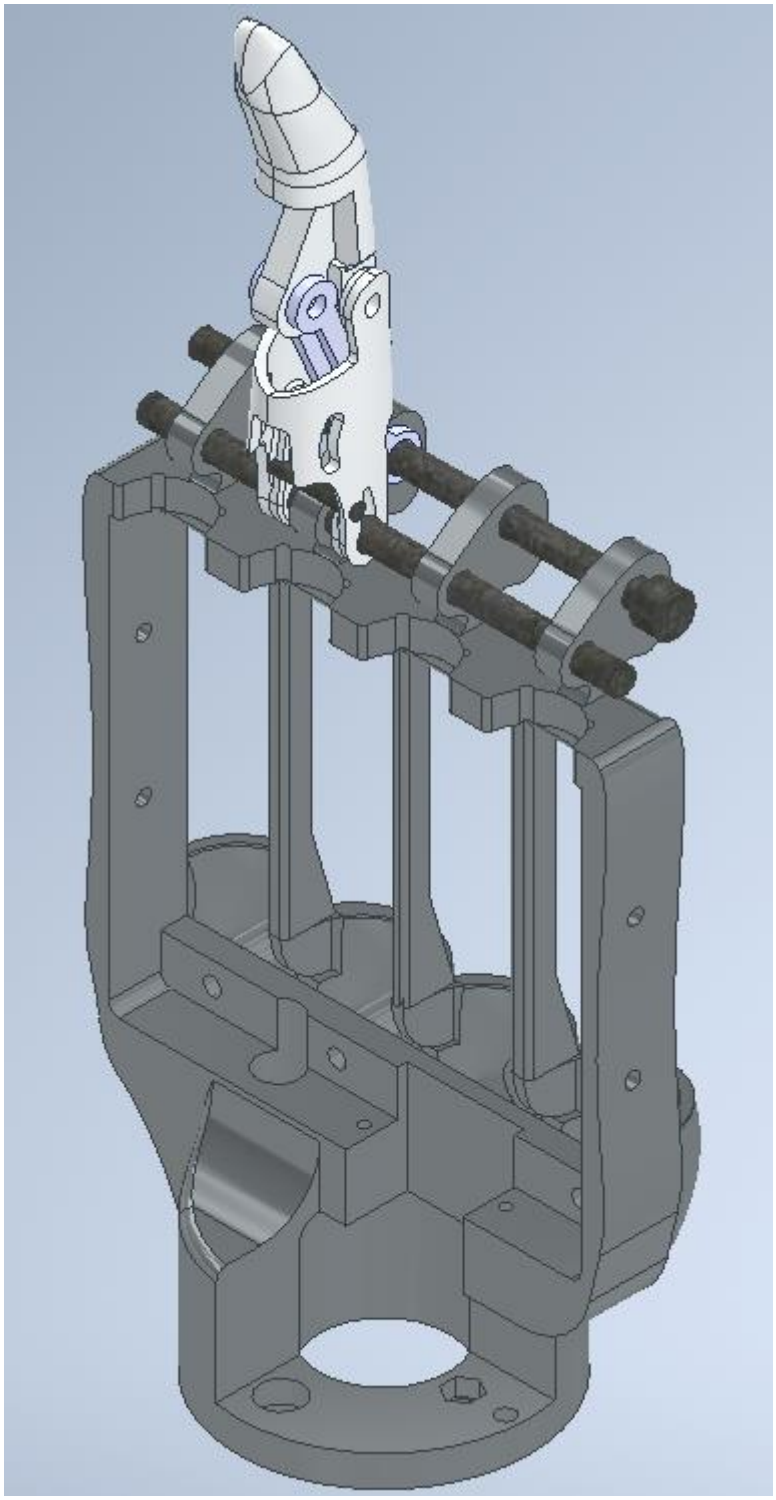

Type: Von Mises Stress
Unit: MPa
9/9/2023, 11:55:11 AM
89.42 Max
71.54
53.65
35.77
17.88
0 Min


Type: Safety Factor
Unit: ul
9/9/2023, 11:56:07 AM
15 Max
12
9
6
3
0.22 Min

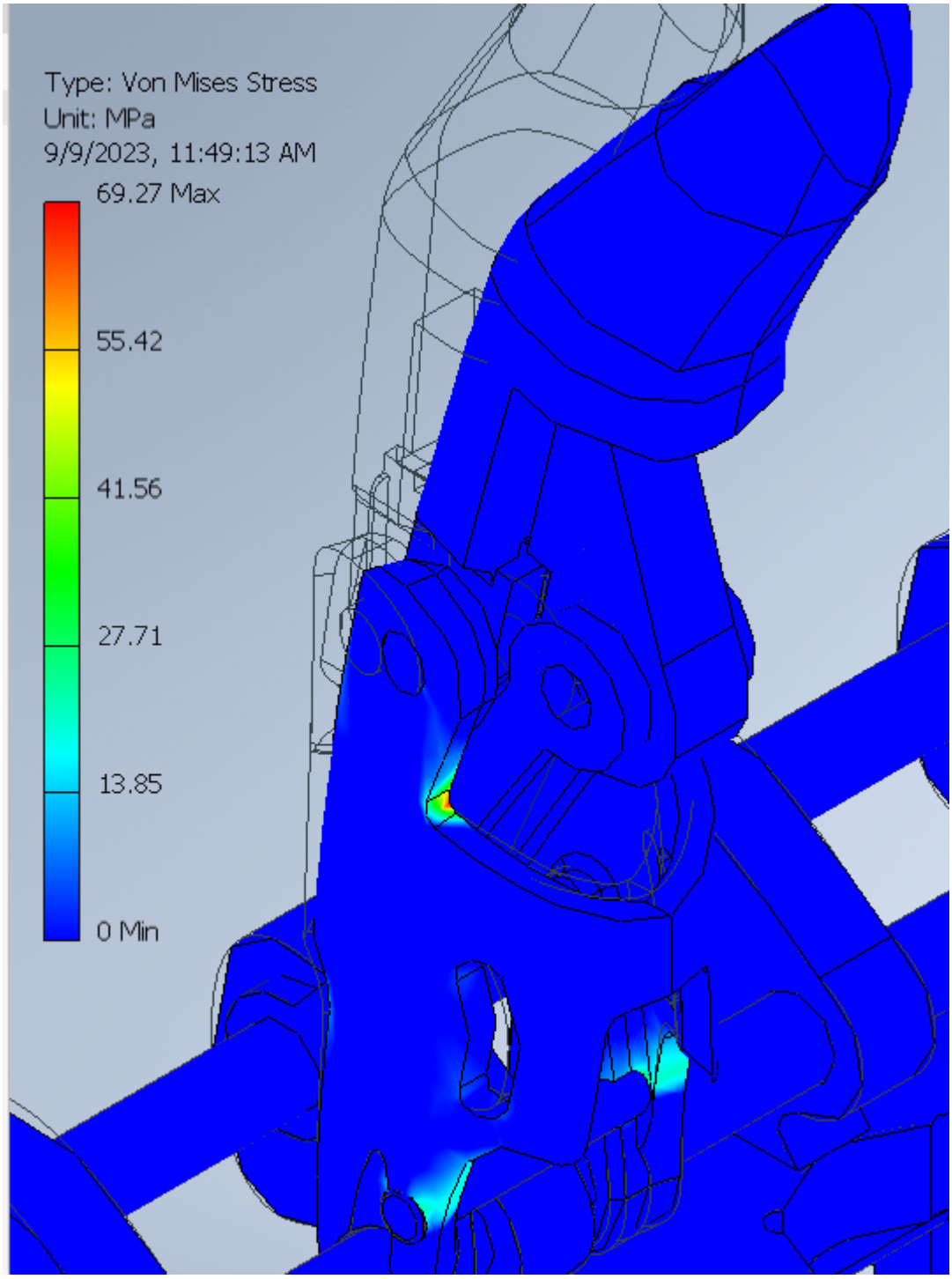


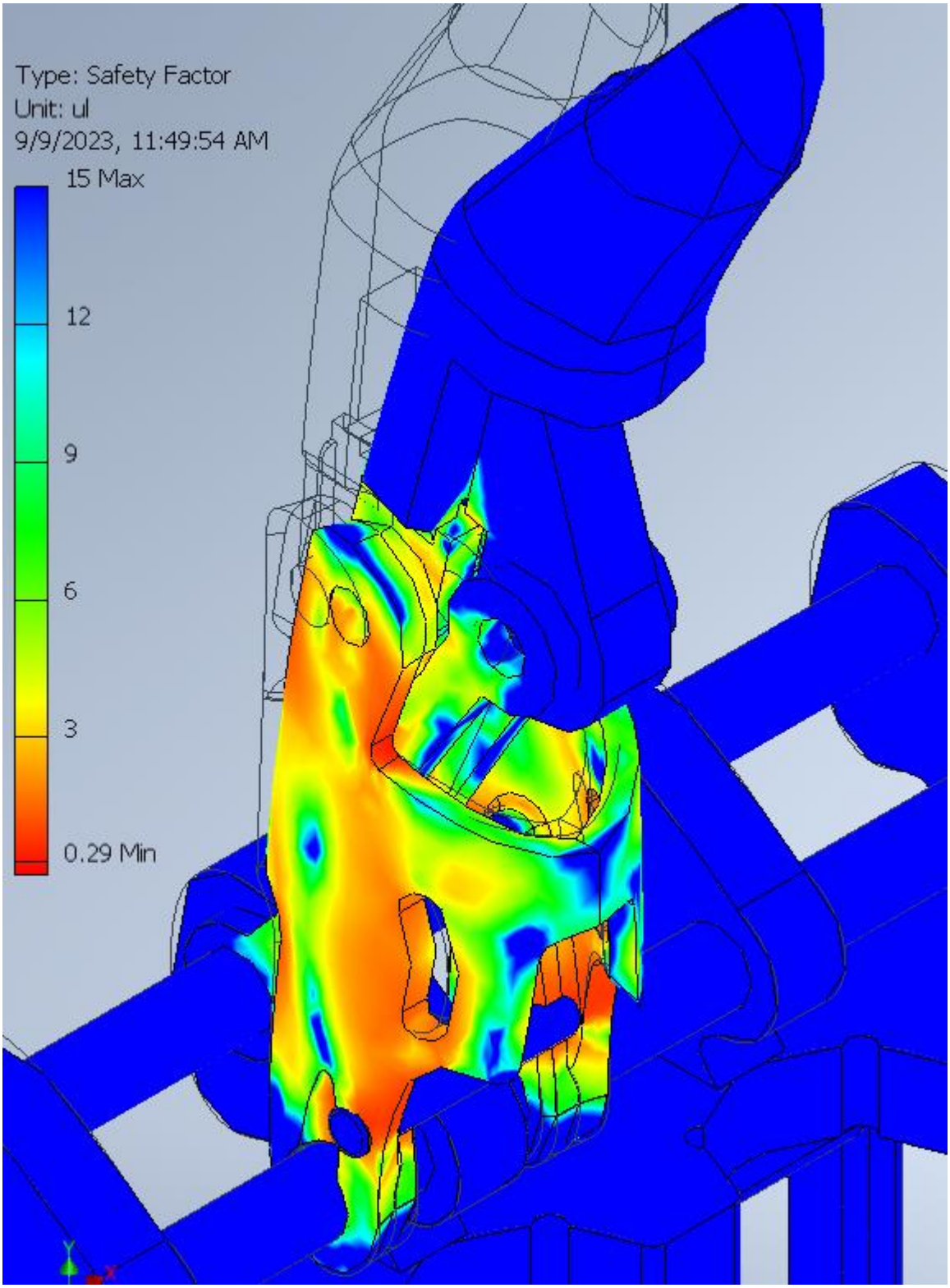
- Comments:
  - Stress Analysis Environment Indicates No Failure
  - Maximum Combined Stress Value: 89.42 MPa
  - Critical areas of highest combined stresses: (Bottom Phalange & 2 Links)
  - Recommendations:
    - Changing Links in Middle Finger from ABS To Steel for extra safety
    - Keeping Weight to be carried below 10 KGs
    - For Handling of Heavier Weights, Changing the Raw Material of the prosthetic from ABS To Steel Is Recommended

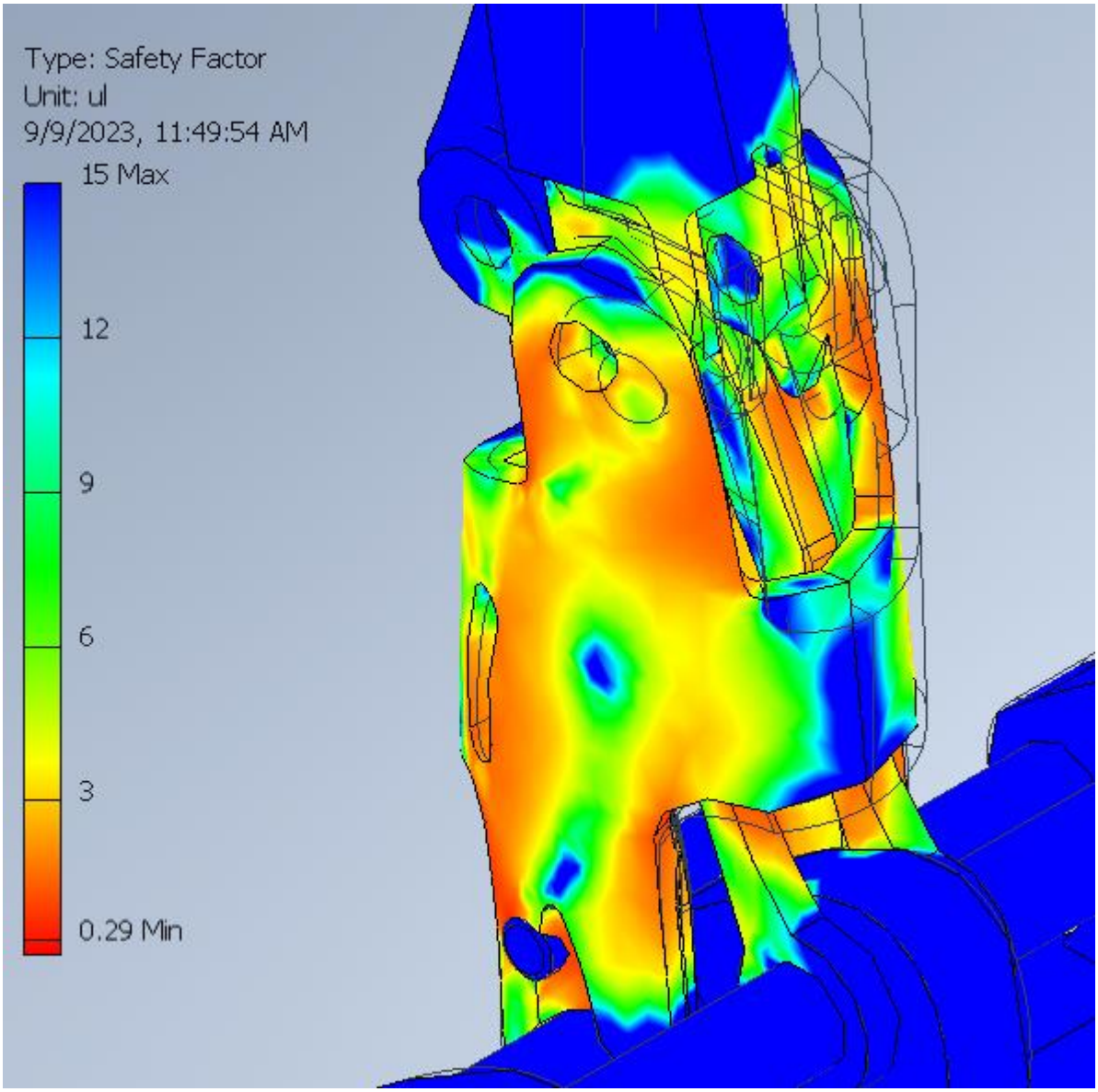
Ring Finger:



- Distance from C.O.G To Base = 38 mm
- Total moment = 7934.4 N.mm
- Moment At each half of the phalange = 1983.6 N.mm
- Results:

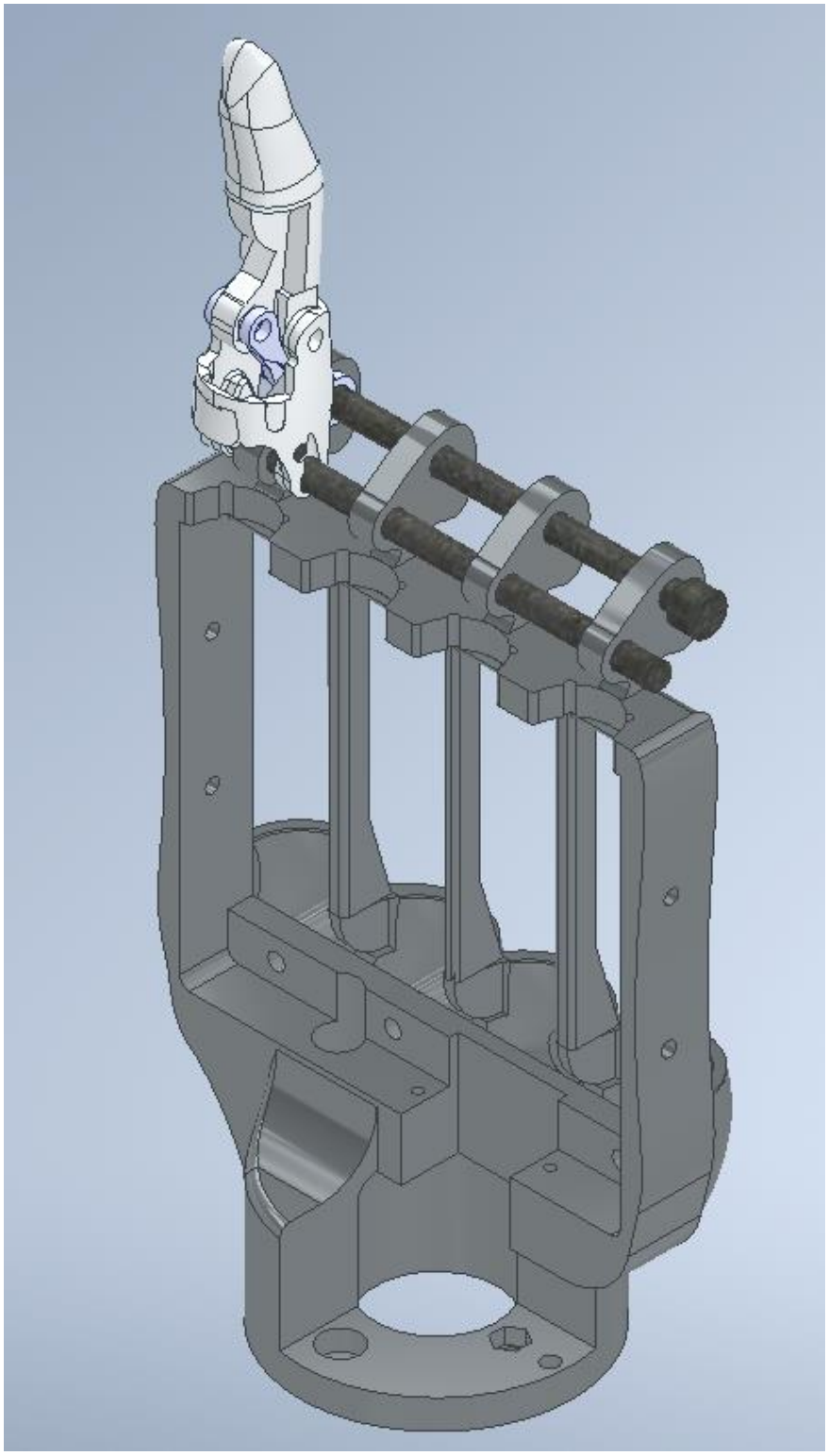

Type: Von Mises Stress
Unit: MPa
9/9/2023, 11:49:13 AM
69.27 Max
55.42
41.56
27.71
13.85
0 Min


Type: Safety Factor
Unit: ul
9/9/2023, 11:49:54 AM
15 Max
12
9
6
3
0.29 Min

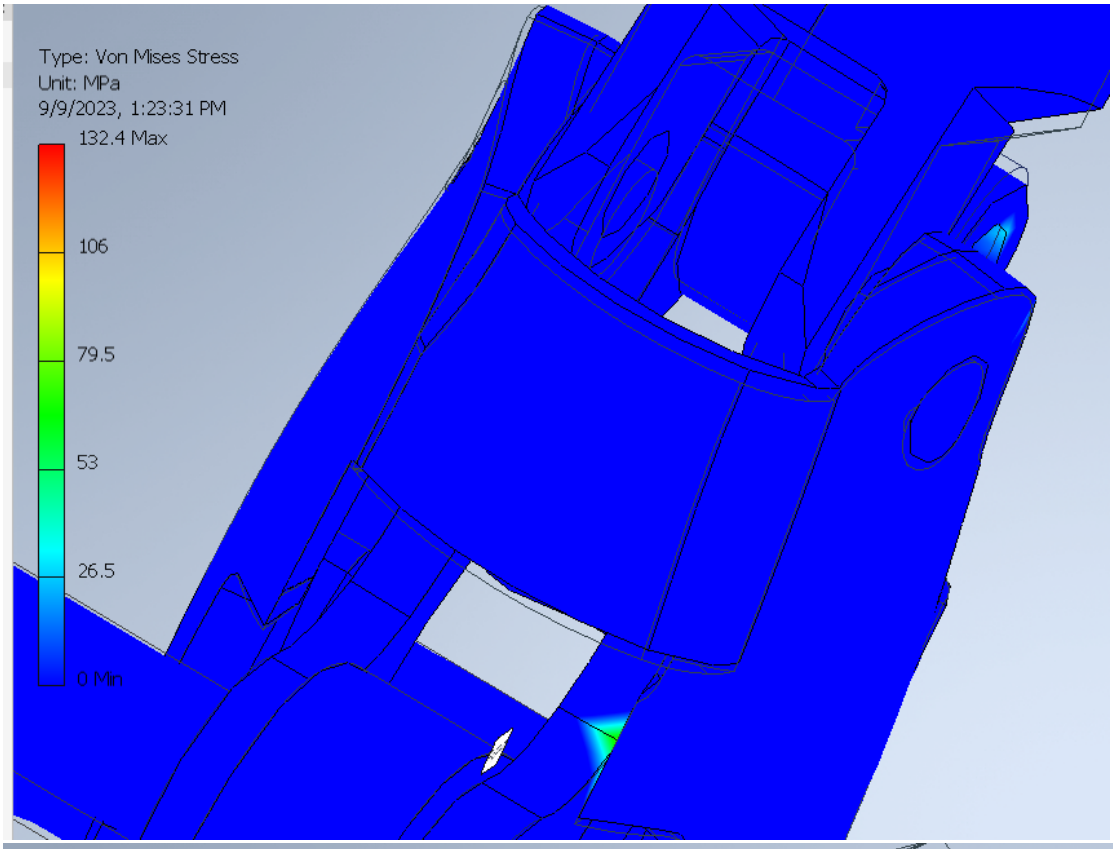


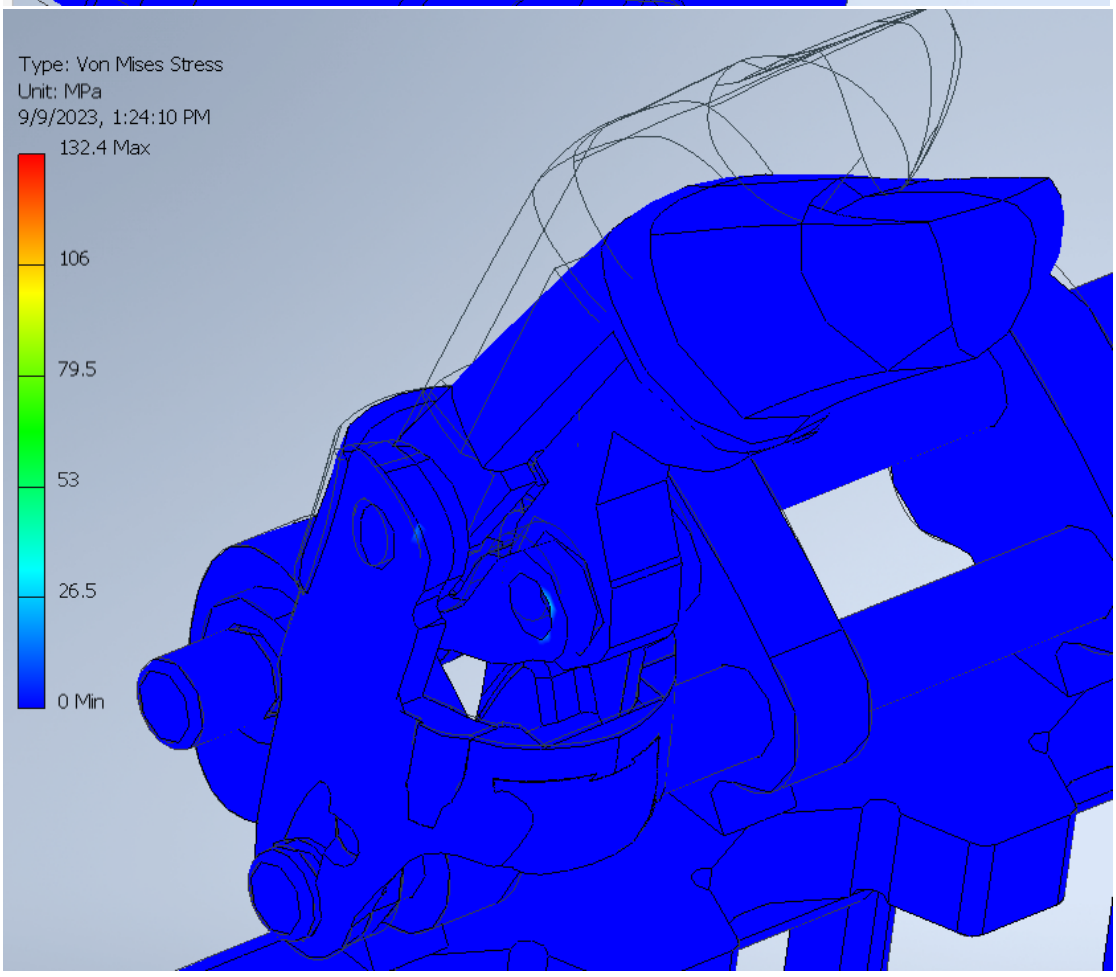
- Comments:
  - Stress Analysis Environment Indicates No Failure
  - Combined Stress Max Value: 69.27 MPa
  - Critical areas of highest combined stresses: (Base Phalange & 2 Links)
  - Recommendations:
    - Changing Links in Ring Finger from ABS To Steel
    - Keeping Weight to be carried below 10 KGs
    - For Handling of Heavier Weights, Changing the Raw Material of the prosthetic from ABS To Steel Is Recommended

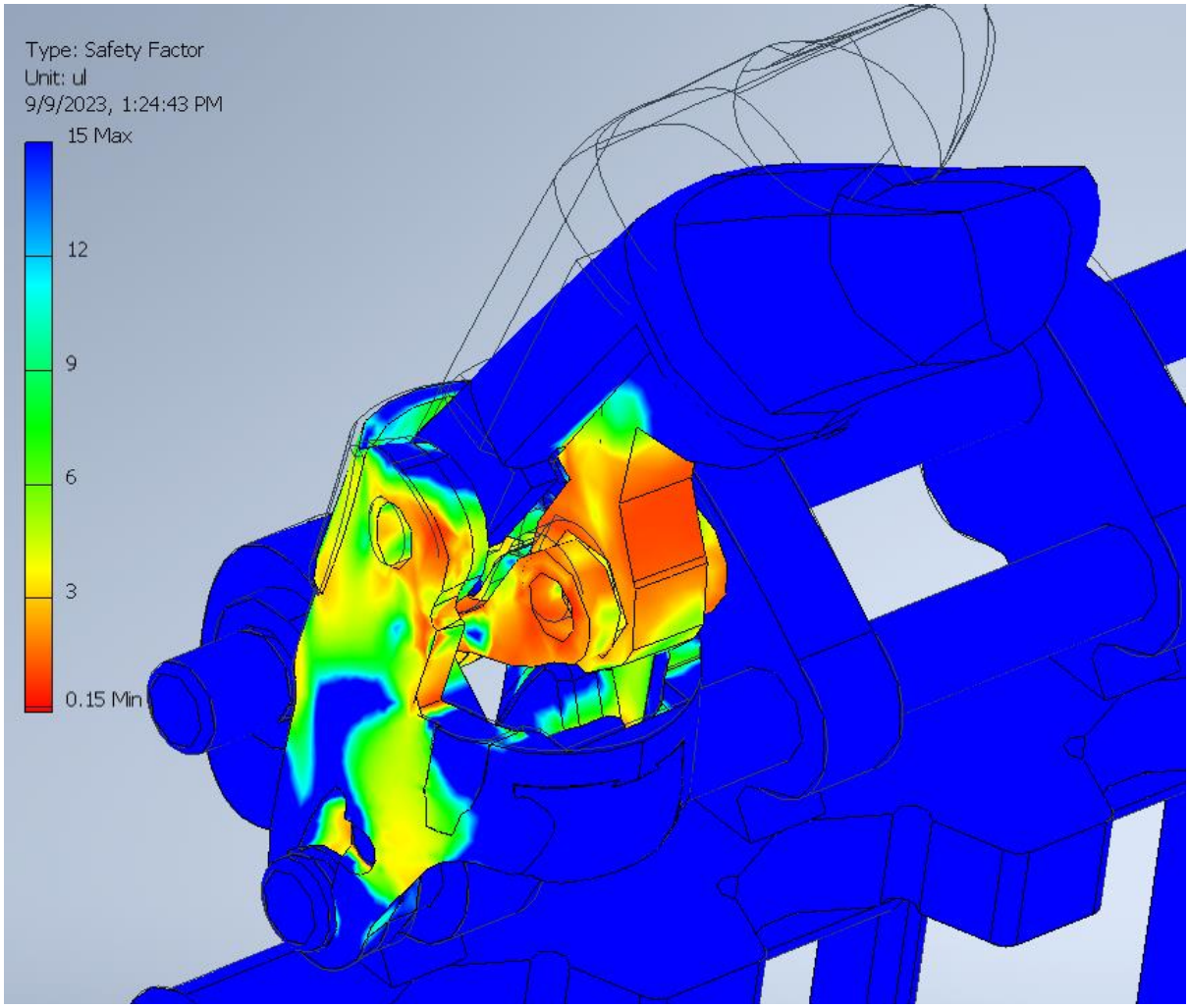
Pinky Finger:

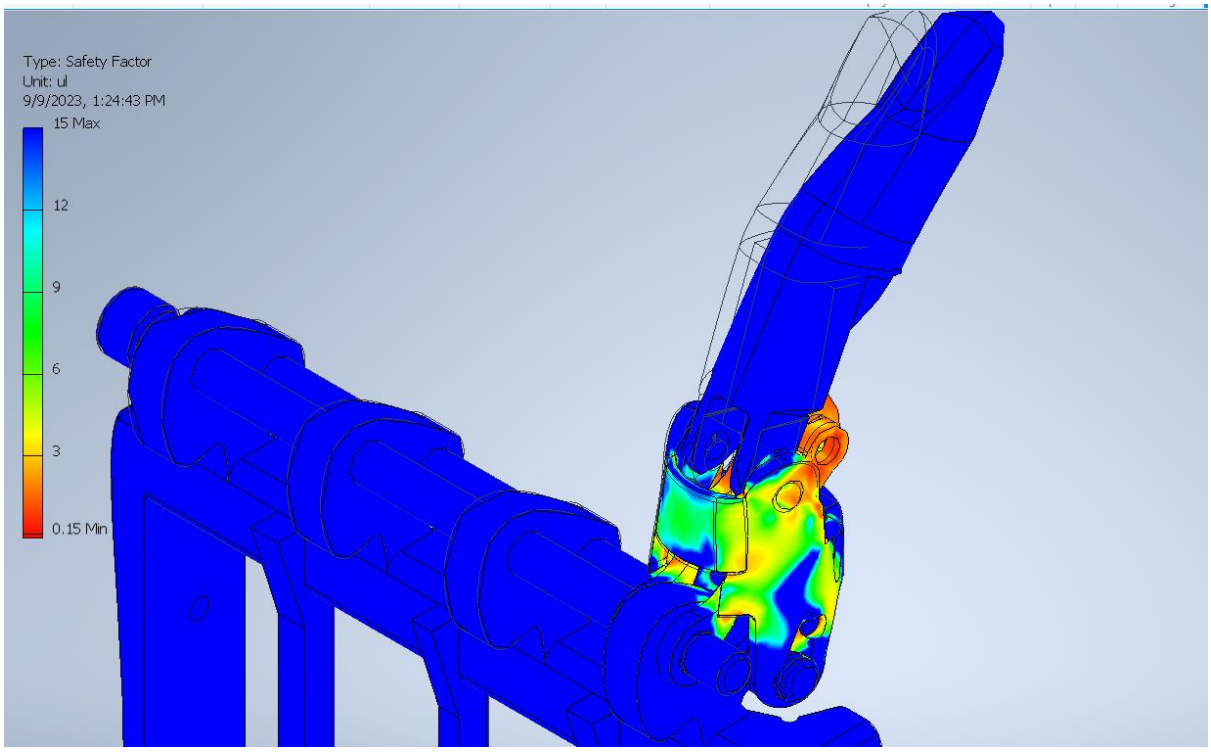


- Distance from C.O.G to Base = 27.5 mm
- Total moment = 5742 N.mm
- Moment At each half of the phalange = 1435.5 N.mm
- Result:


Type: Von Mises Stress
Unit: MPa
9/9/2023, 1:23:31 PM
132.4 Max
106
79.5
53
26.5
0 Min


Type: Von Mises Stress
Unit: MPa
9/9/2023, 1:24:10 PM
132.4 Max
106
79.5
53
26.5
0 Min

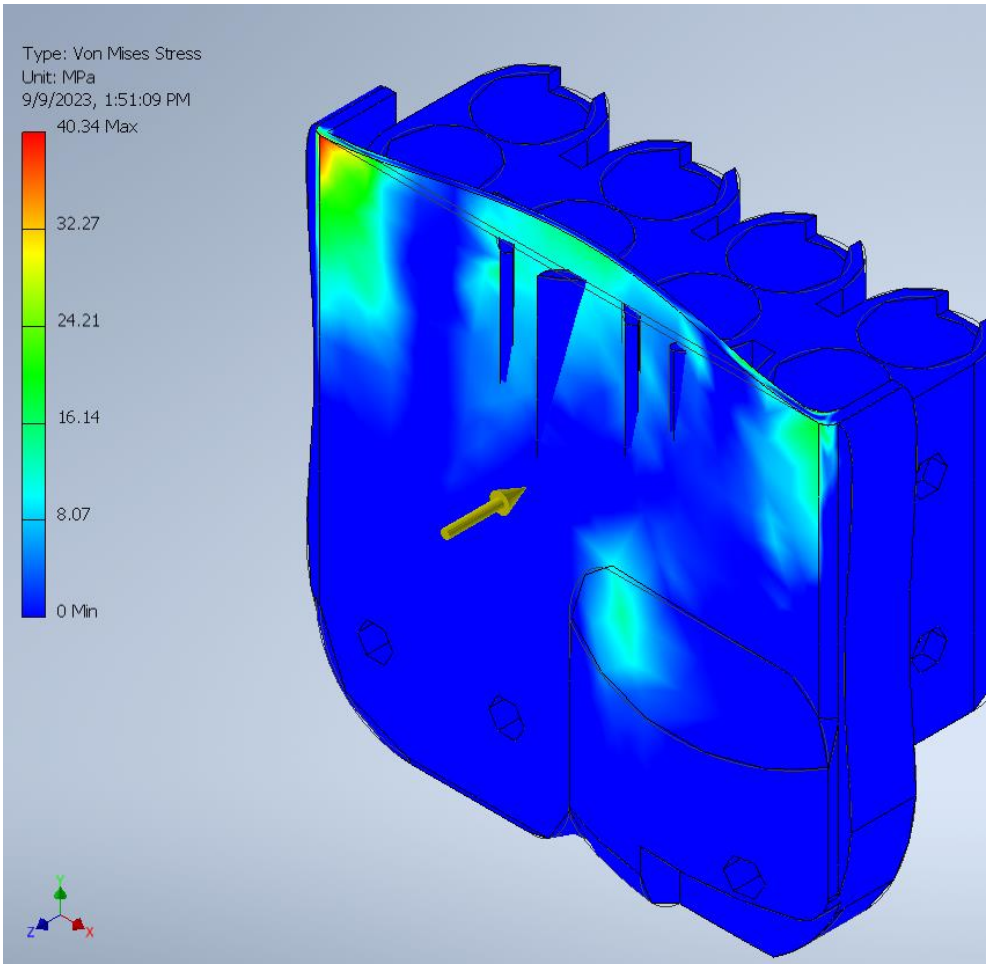

Type: Safety Factor
Unit: ul
9/9/2023, 1:24:43 PM
15 Max
12
9
6
3
0.15 Min

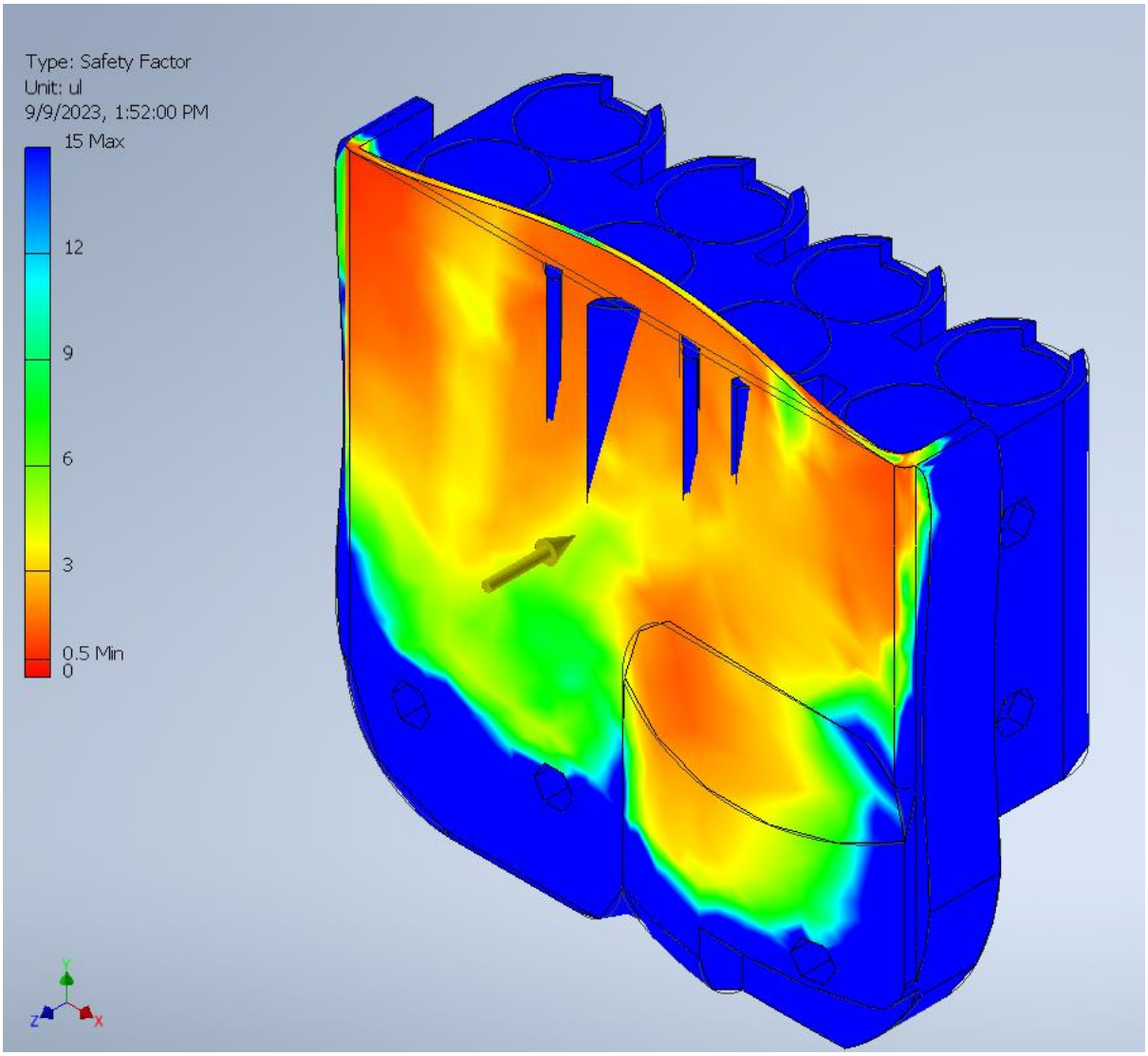

Type: Safety Factor
Unit: ul
9/9/2023, 1:24:43 PM
15 Max
12
9
6
3
0.15 Min

- Comments:
  - Stress Analysis Environment Indicates No Failure
  - Combined Stress Max Value: 132.4 MPa
  - Combined Stress is Higher than other Fingers due to Error in bond auto solver in Inventor FEA Environment and does not reflect the real actual combined stress value, expected value should be less than 69 MPa.
  - Critical areas of highest combined stresses: (Base Phalange & 2 Links)
  - Recommendations:
    - Changing Links in Pinky Finger from ABS To Steel
    - Keeping Weight to be carried below 10 KGs.
    - For Handling of Heavier Weights, Changing the Raw Material of the prosthetic from ABS To Steel Is Recommended

Palm Stress analysis:

- Assumption:
  A concentrated Force will affect the center of the palm with a value of
  20*9.8 = 196 N , this should simulate the carrying weight of palm
- Result:





- Comments:
  - Stress Analysis Environment Indicates No Failure
  - Combined Stress Max Value: 40.34 MPa
  - The Palm Is supported From Behind By the Motor Housing and the Back Hand Housing, it is able to withstand more pressure thanks to that support which means no failure will occur due to load
  - Recommendations:
    - Keeping the maximum carrying weight 10 KGs or less
    - For Handling of Heavier Weights, Changing the Raw Material of the prosthetic from ABS To Steel Is Recommended

General Comments and Recommendations

- Links in Fingers Should Be made of steel instead of ABS to further secure the fingers and guarantee no failures.
- Keeping The Maximum Carrying weight for the hand 10 KGs Or Below is recommended to guarantee no failures in the links or phalanges.
- For Handling Heavier objects above the recommended range, the prosthetic should be manufactured with steel instead of ABS to guarantee no failures.