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MONTEITH PERSONAL ALL-TERRAIN VEHICLE

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EGR 486C, 03 Dec 2016

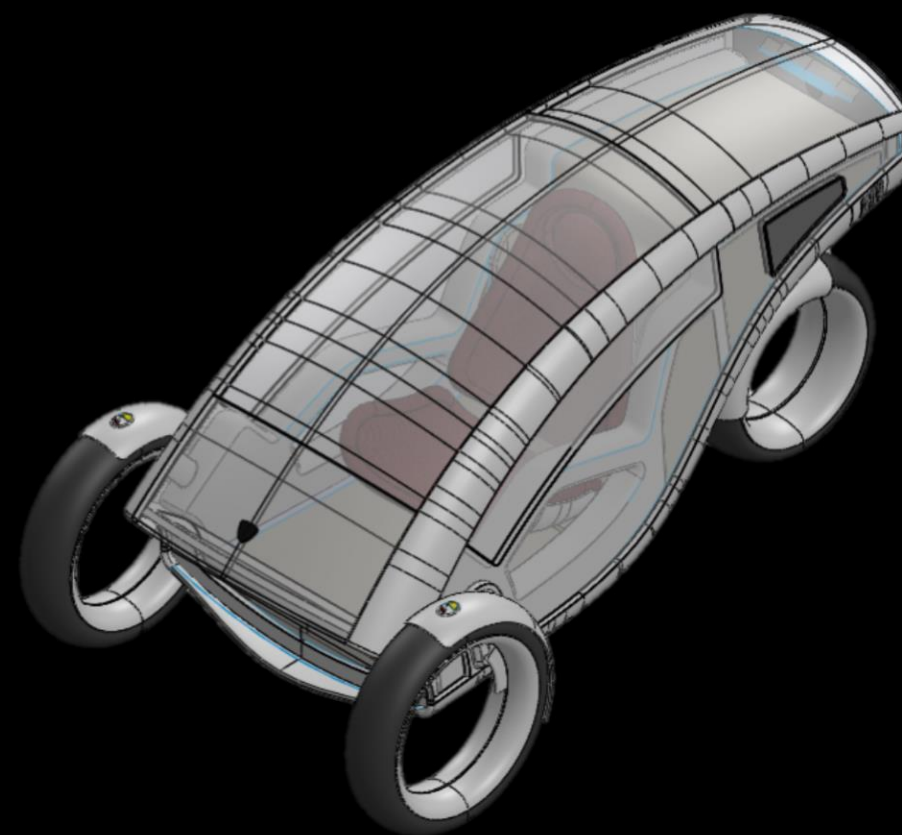
OVERVIEW

- Introduction
- Initial examination of original design
- New design alternatives
- Static force analysis
- Flow analysis
- Recommendations



INTRODUCTION

- Client presented us with a new concept in personal transportation
- Highly advanced human electric hybrid hardware platform
- Issues addressed:
 - Urban congestion
 - Safety
 - Pollution
 - Cost
- Client request: construct vehicle body
- Project scope:
 - Model vehicle body
 - Analyze the feasibility of the design



INITIAL EXAMINATION OF ORIGINAL DESIGN

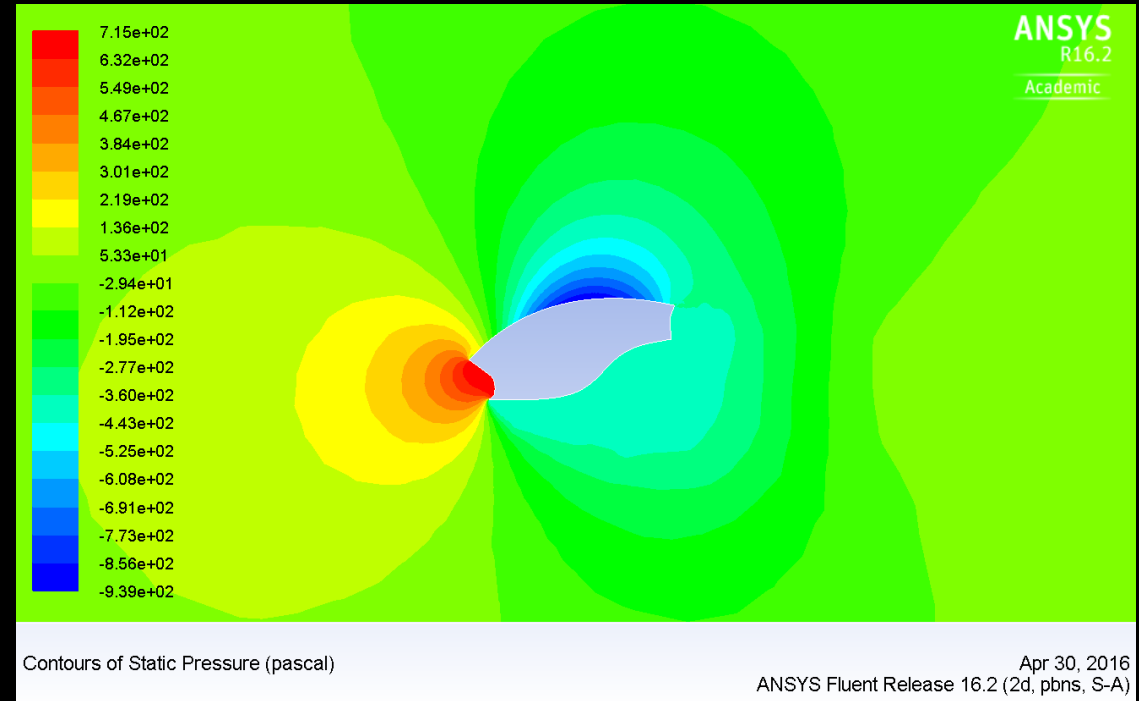
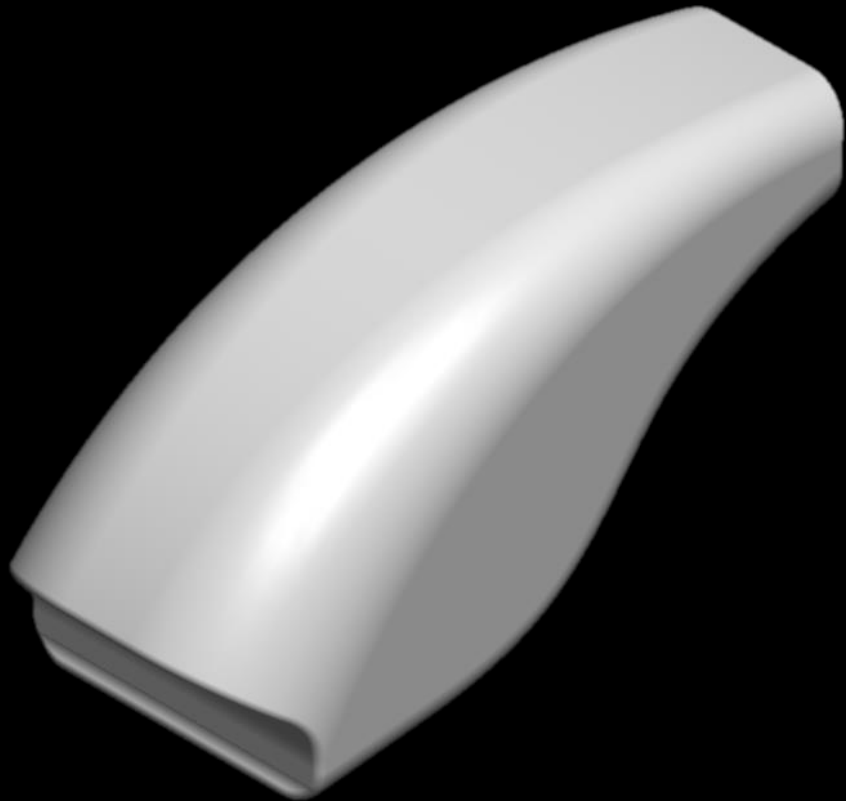


Figure 1: Original design provided by client

Figure 2: Pressure profile from initial investigation of original design

NEW DESIGN ALTERNATIVES

- 2 design alternatives:
 1. Rounded nose design
 2. Ventilation design

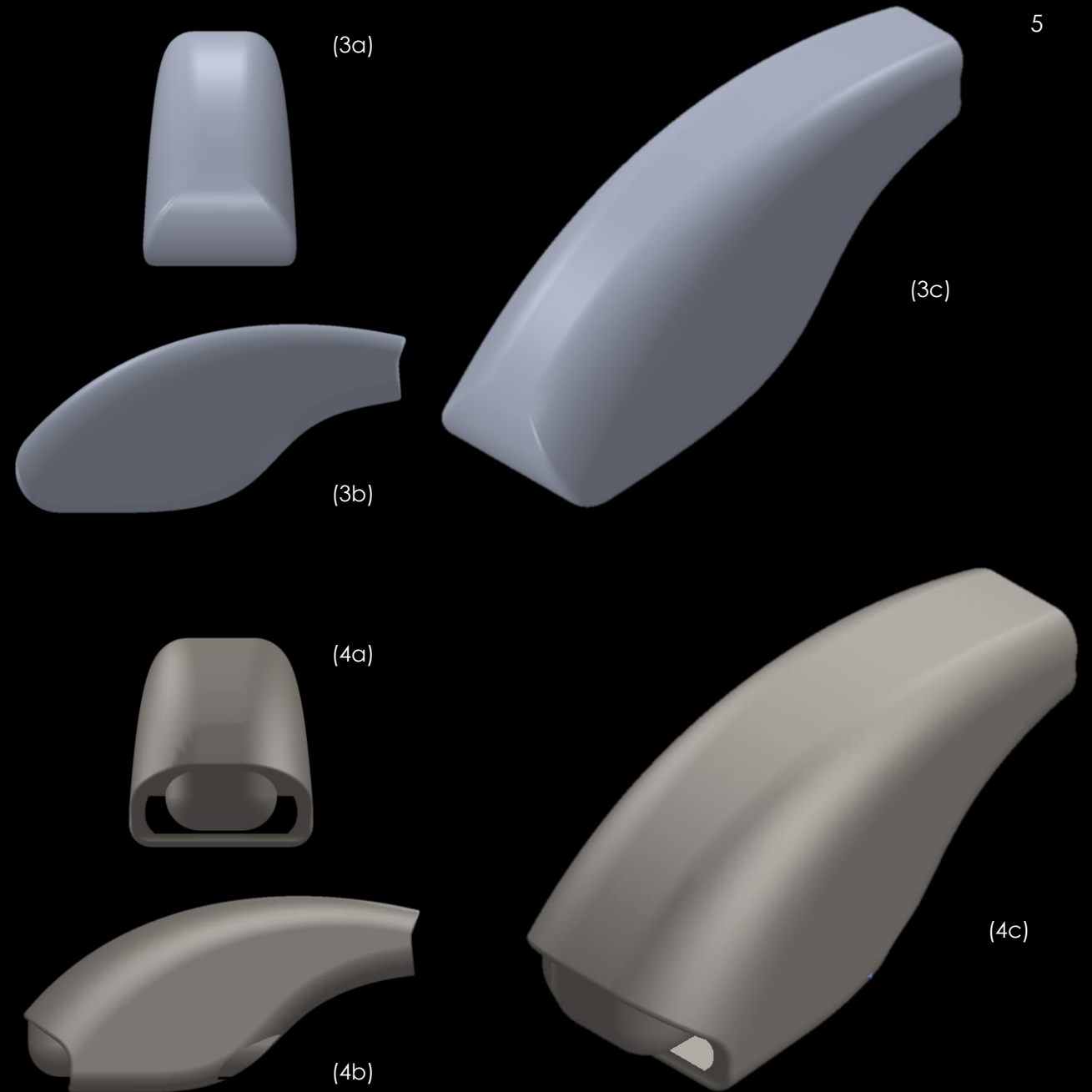


Figure 3 (top right): Front view (a), right view (b), and isometric view (c) of the rounded nose design

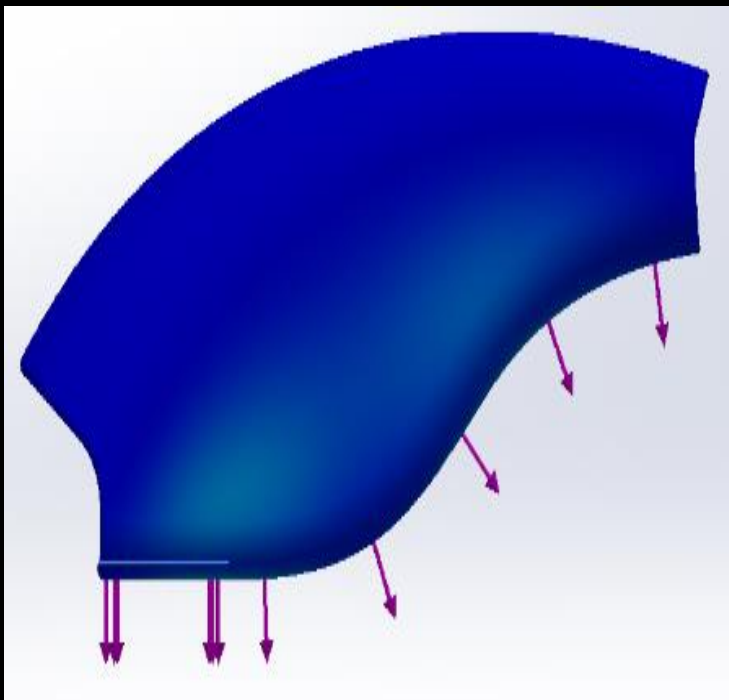
Figure 4 (bottom right): Front view (a), right view (b), and isometric view (c) of the ventilation design

STATIC FORCE ANALYSIS

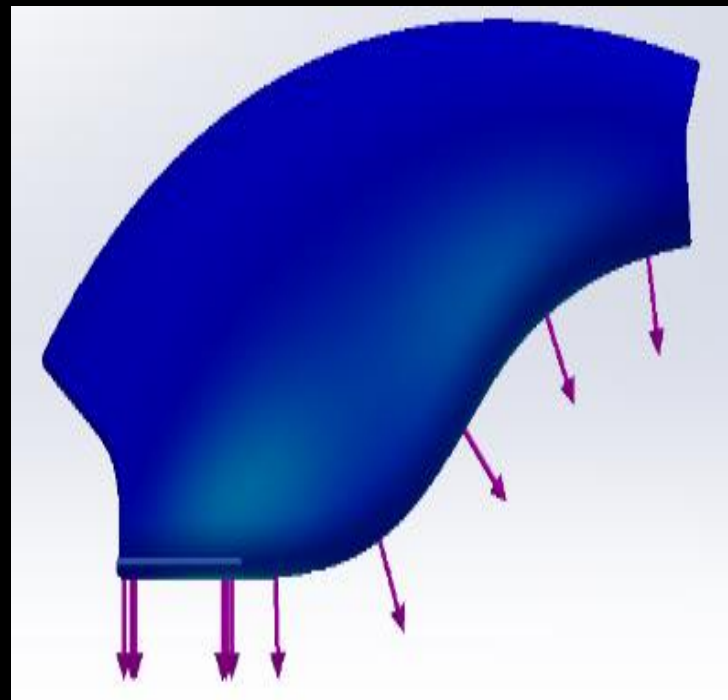
- 3 static force analyses:
 1. Deflection - the degree to which a structural element is displaced under an applied load
 2. Strain - ratio of deformation by initial length
 3. Stress - force applied over a cross-sectional area of an object
- 3 applied force values in analyses:
 1. 700 N
 2. 1500 N
 3. 2000 N

DEFLECTION: RIGHT VIEW

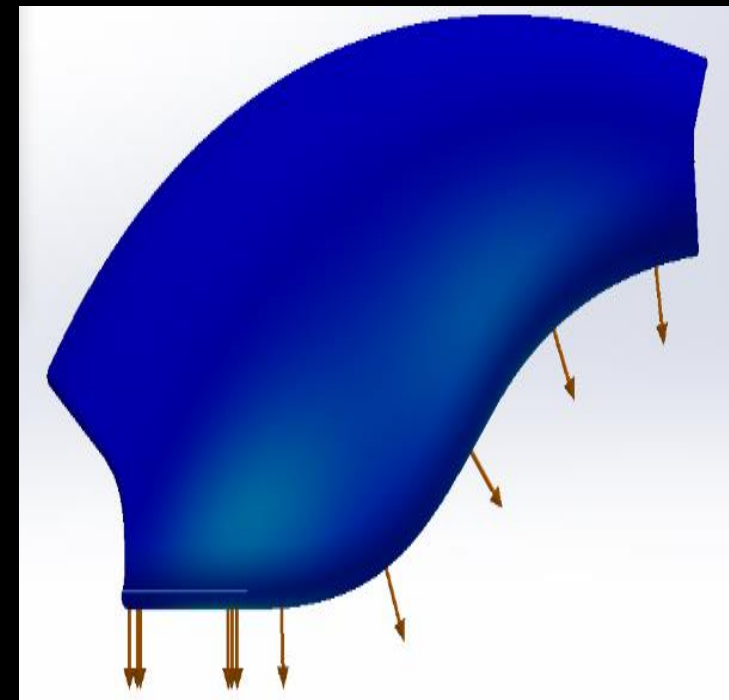
700 N

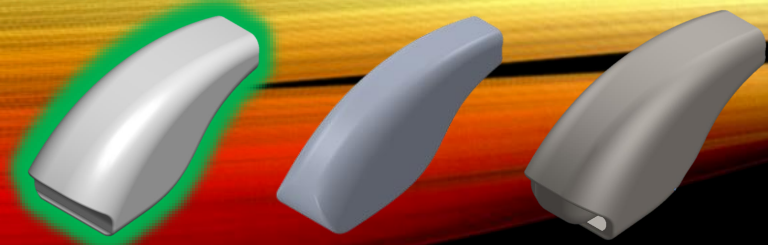


1500 N



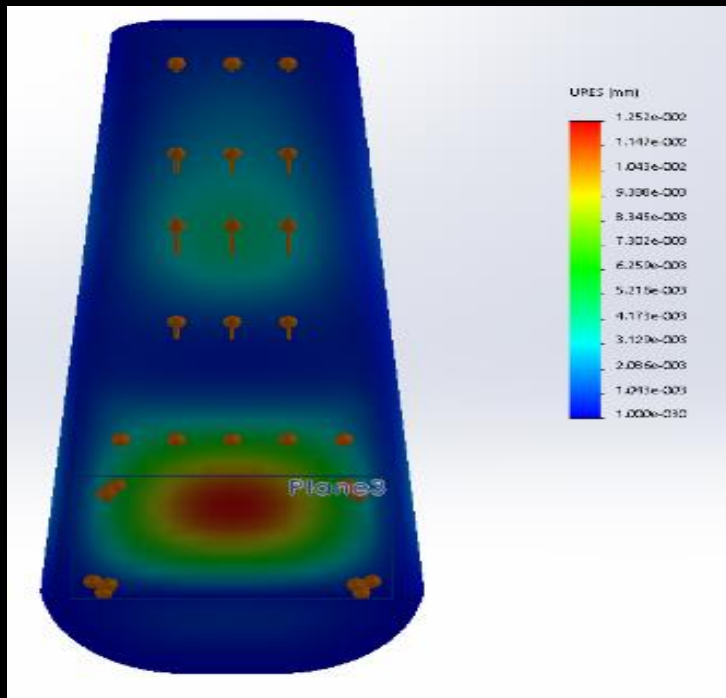
2000 N



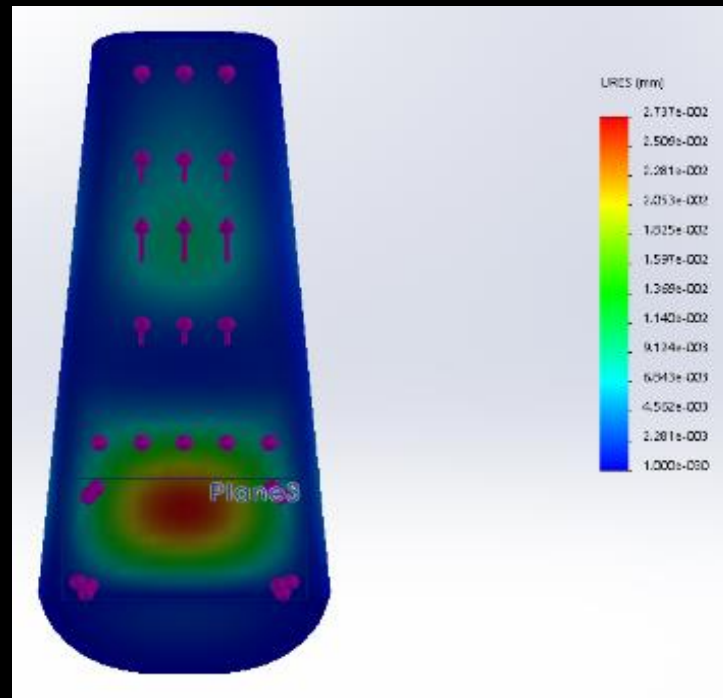


DEFLECTION: BOTTOM VIEW

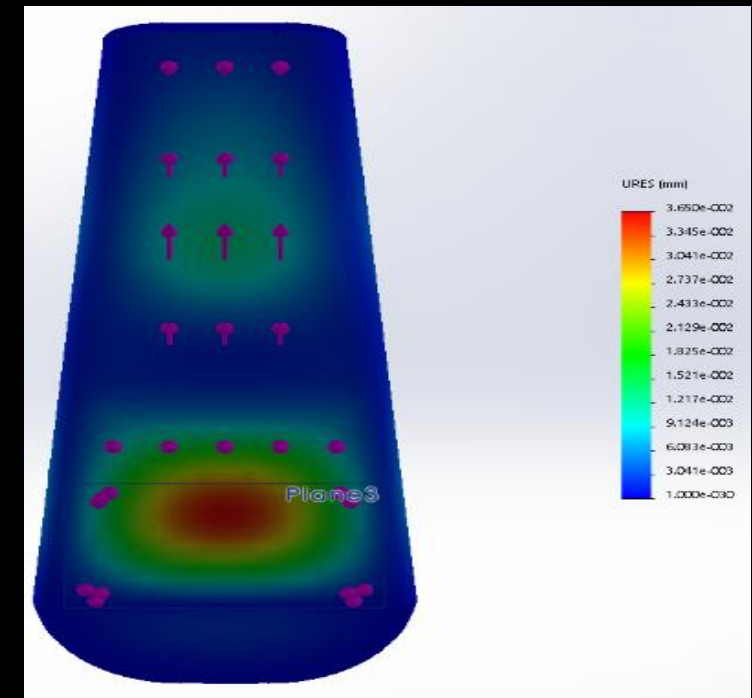
700 N

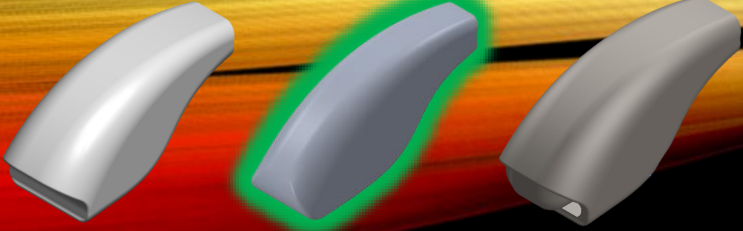


1500 N



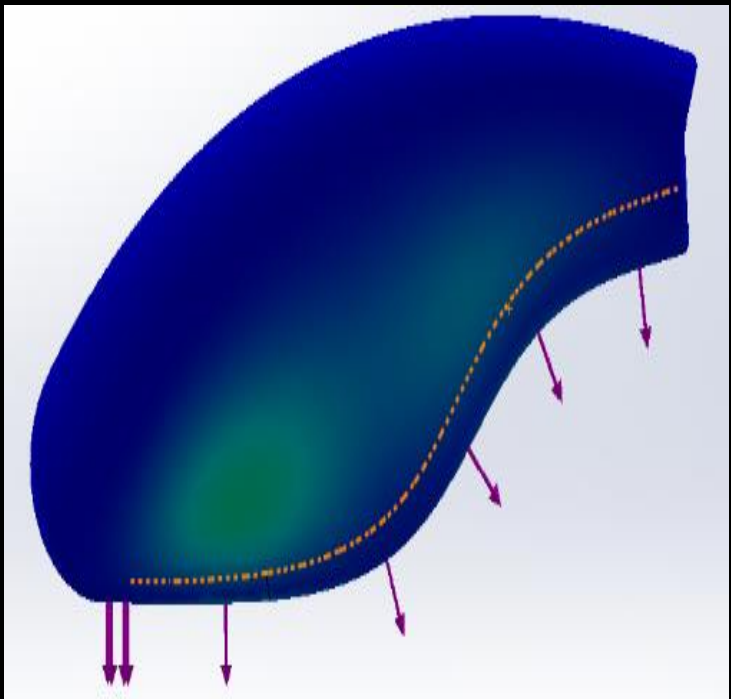
2000 N



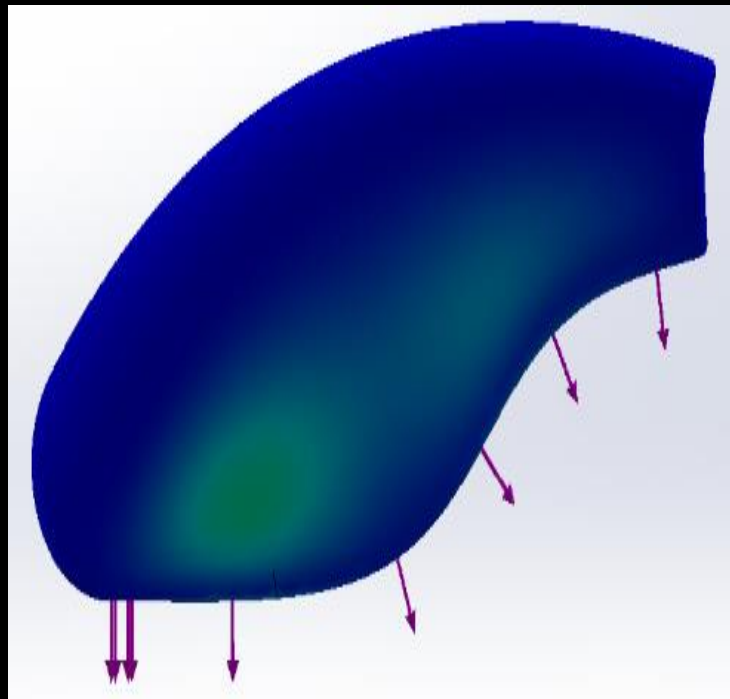


DEFLECTION: RIGHT VIEW

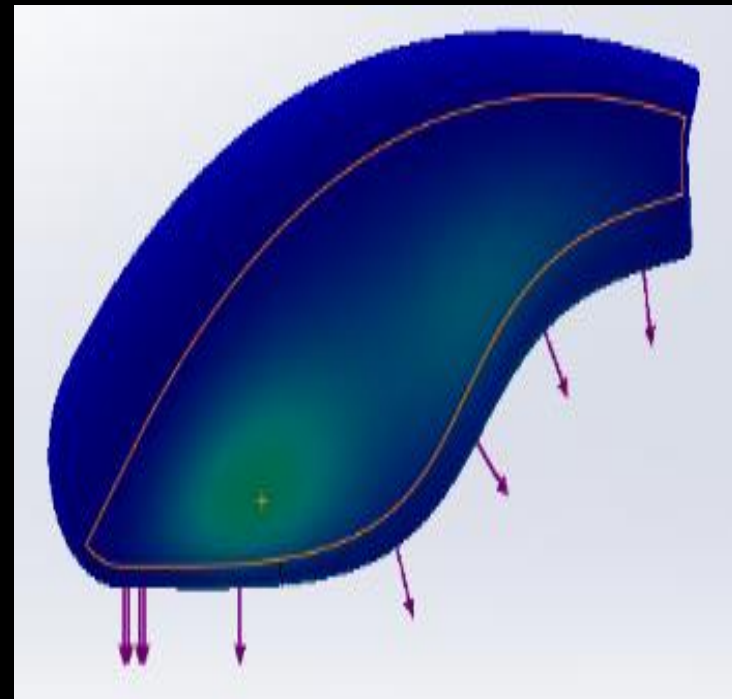
700 N

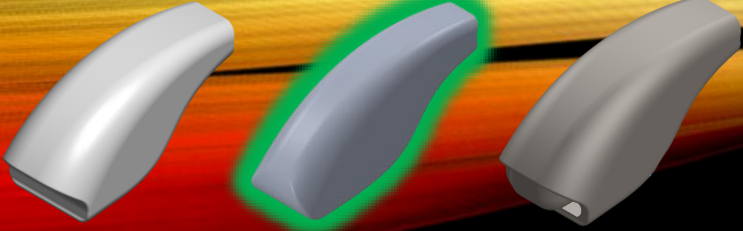


1500 N



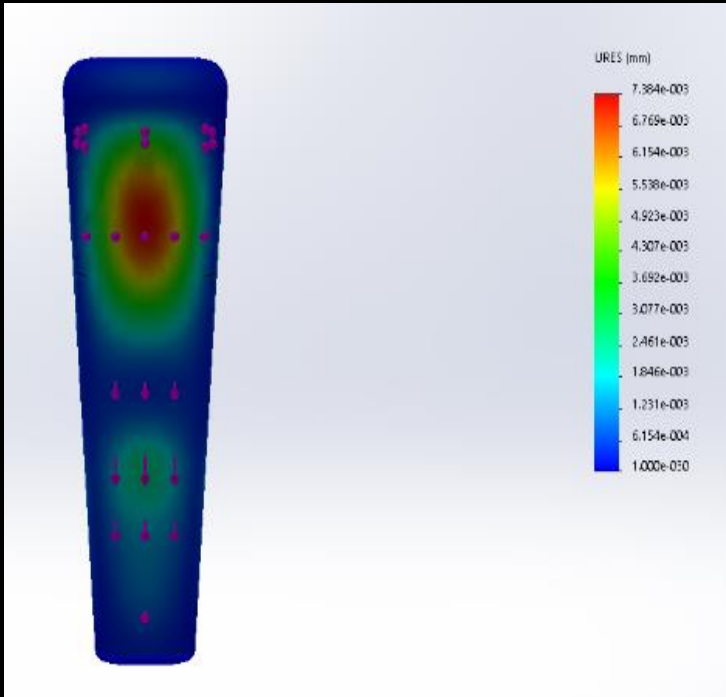
2000 N



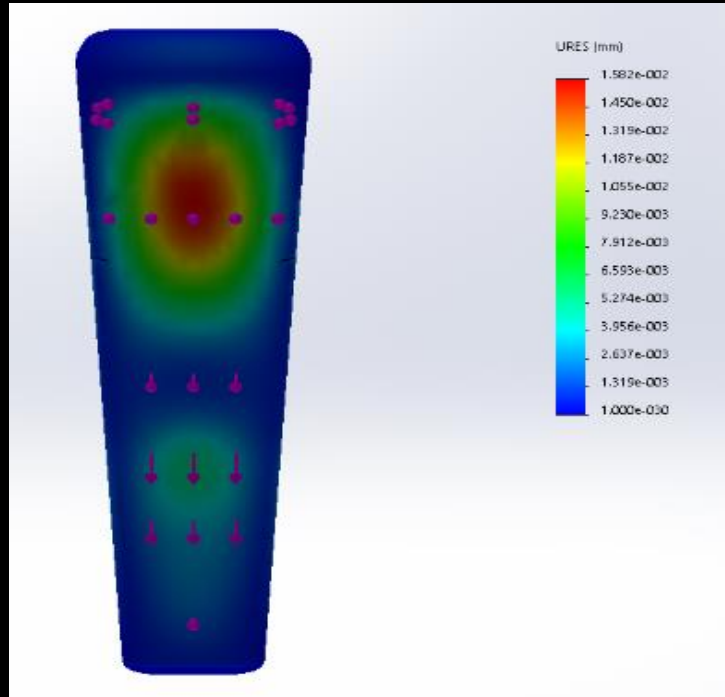


DEFLECTION: BOTTOM VIEW

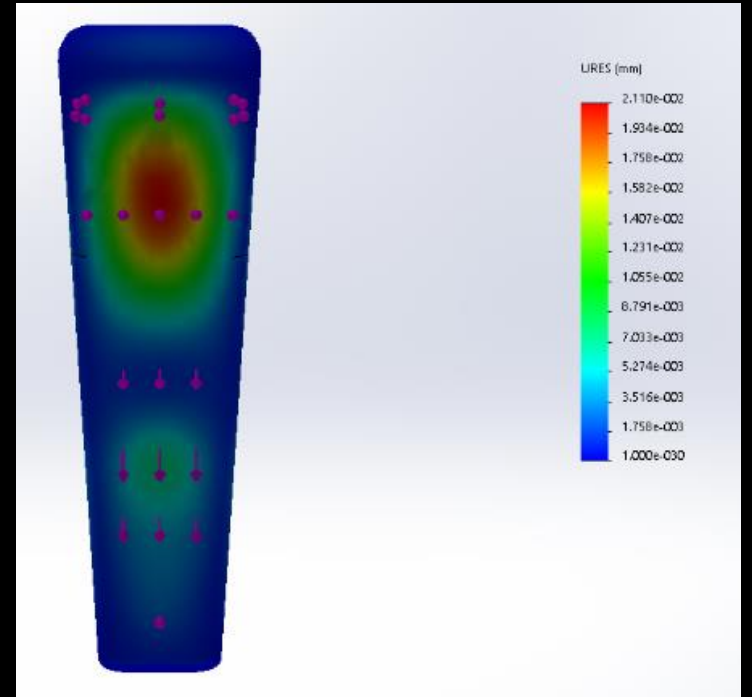
700 N

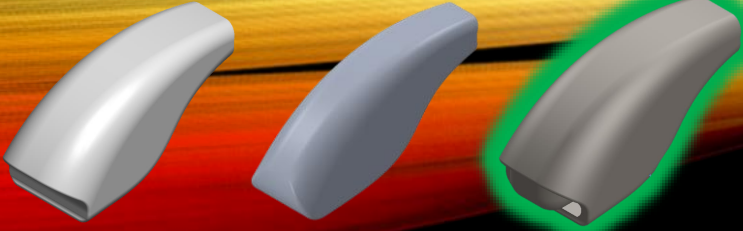


1500 N



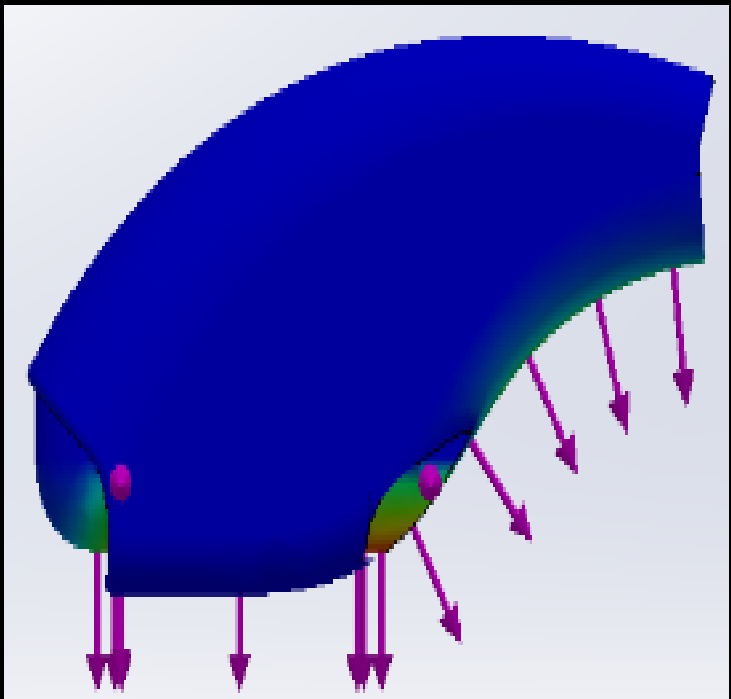
2000 N



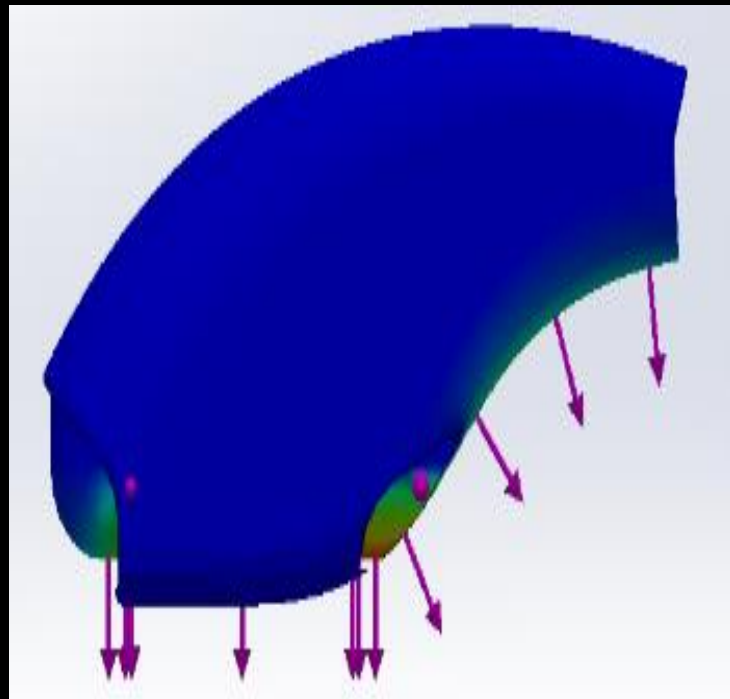


DEFLECTION: RIGHT VIEW

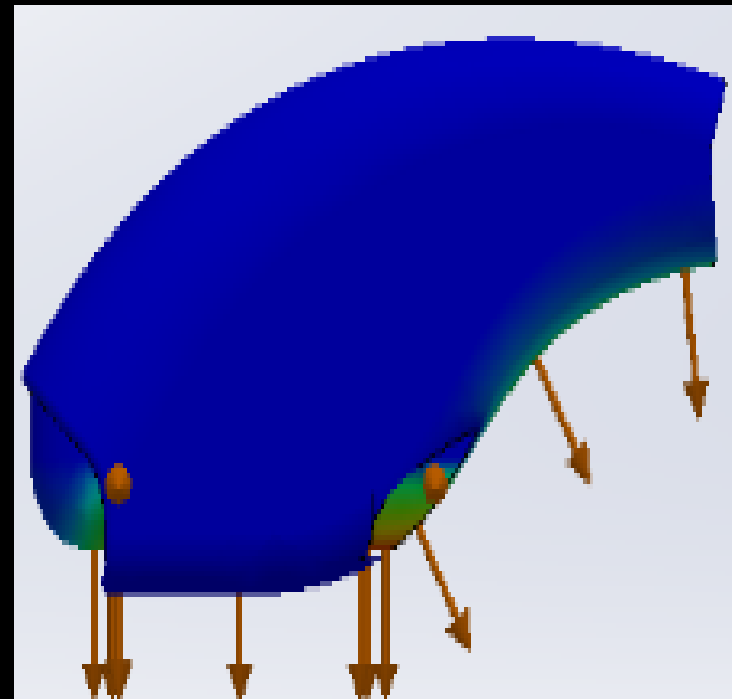
700 N

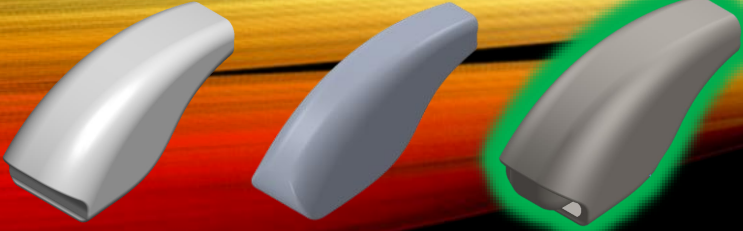


1500 N



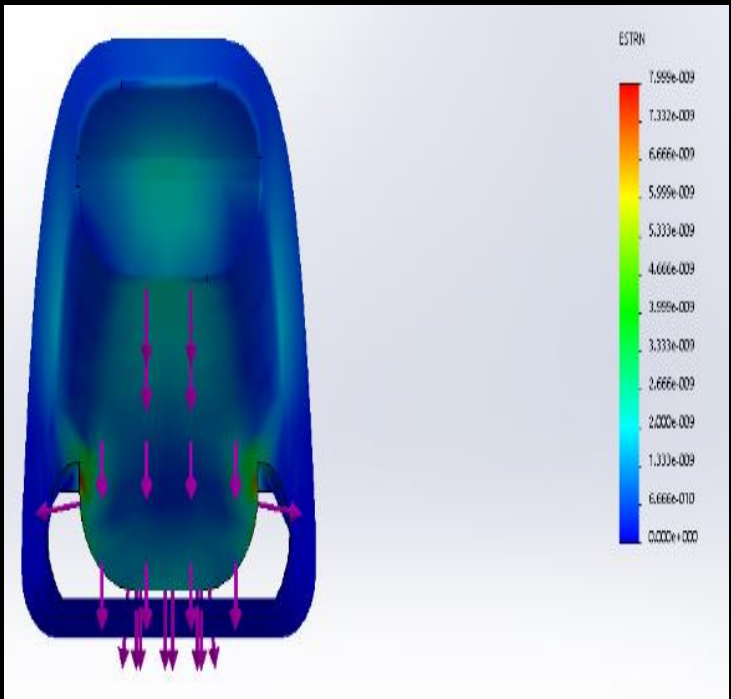
2000 N



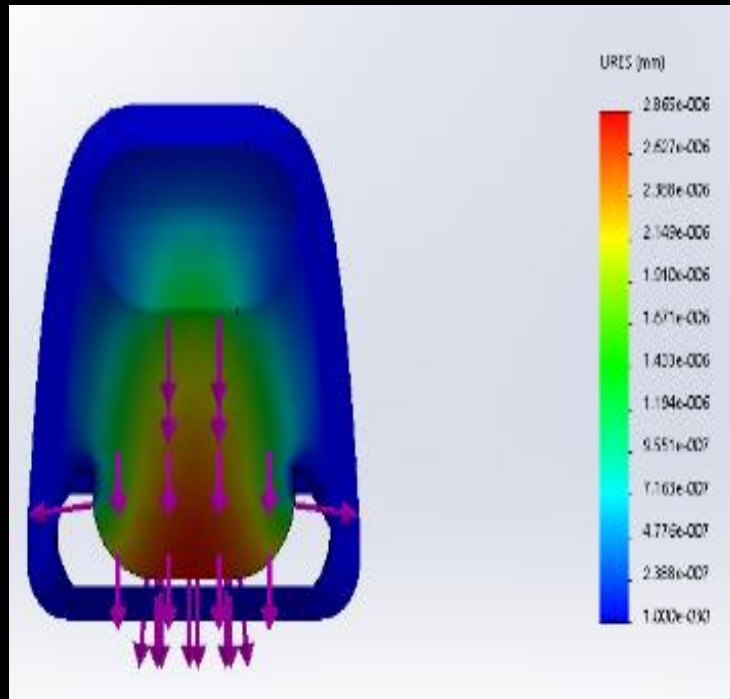


DEFLECTION: BACK VIEW

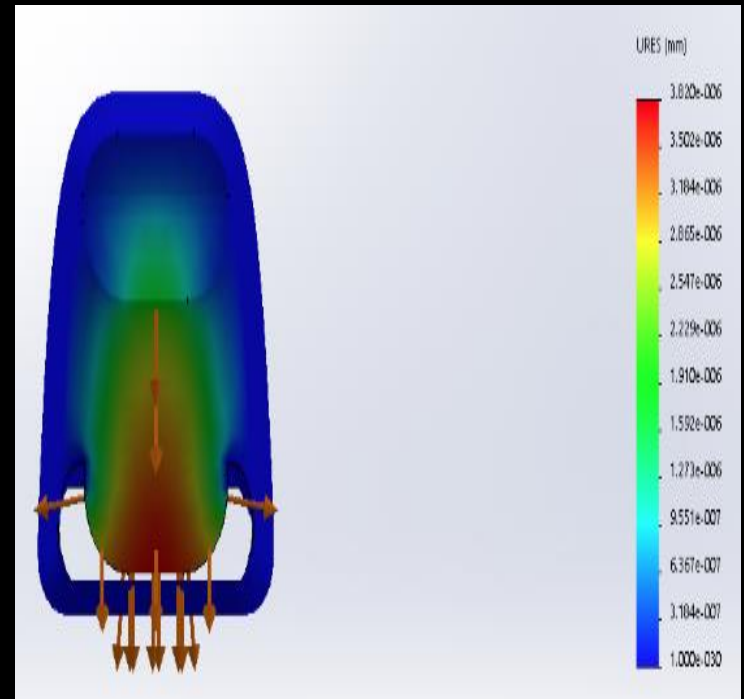
700 N



1500 N



2000 N



DEFLECTION DATA [MM]

700 N

Original design:

- Maximum deflection = 0.0128
- Average deflection = 0.0124

Rounded nose design:

- Maximum deflection = 0.00738
- Average deflection = 0.00721

Ventilation design:

- Maximum deflection = 0.0134
- Average deflection = 0.0130

1500 N

Original design:

- Maximum deflection = 0.0274
- Average deflection = 0.0267

Rounded nose design:

- Maximum deflection = 0.0158
- Average deflection = 0.0154

Ventilation design:

- Maximum deflection = 0.0287
- Average deflection = 0.0278

2000 N

Original design:

- Maximum deflection = 0.0365
- Average deflection = 0.0356

Rounded nose design:

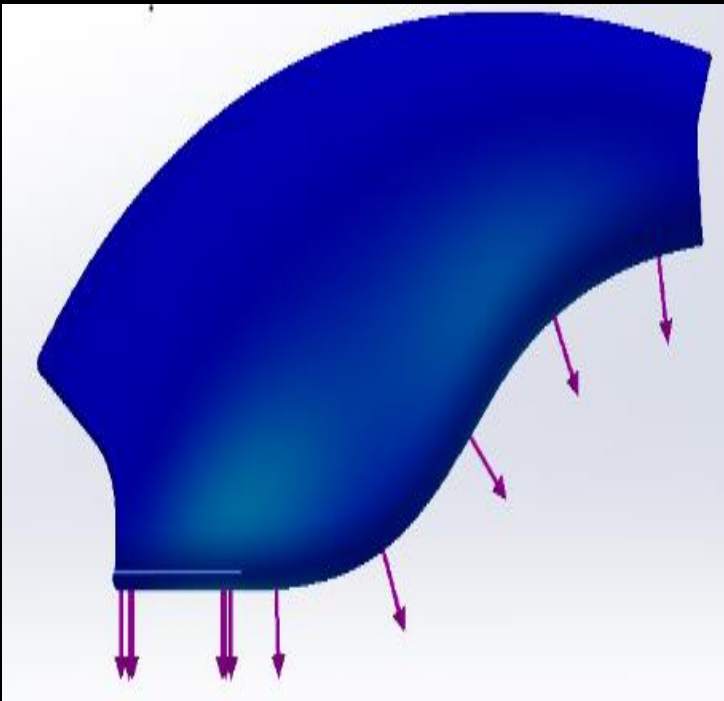
- Maximum deflection = 0.0211
- Average deflection = 0.0206

Ventilation design:

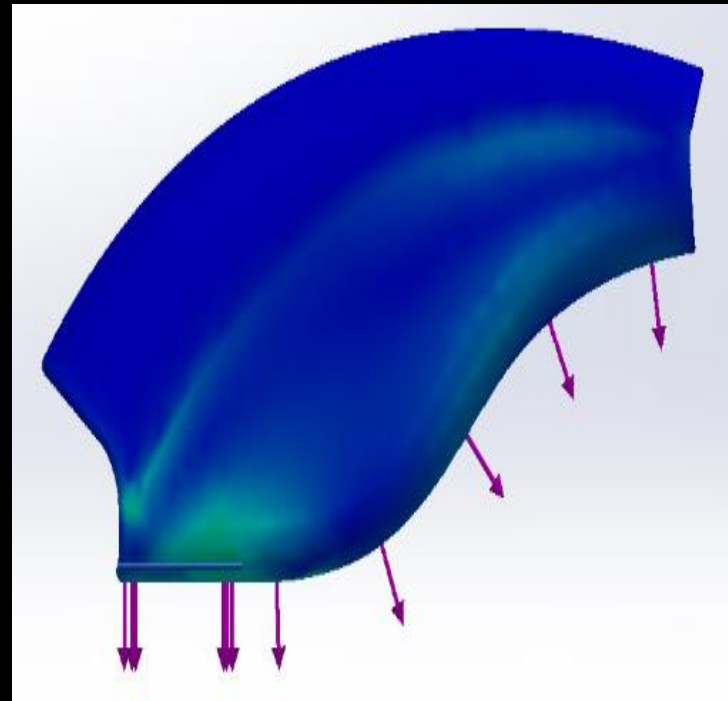
- Maximum deflection = 0.0382
- Average deflection = 0.0371

STRAIN: RIGHT VIEW

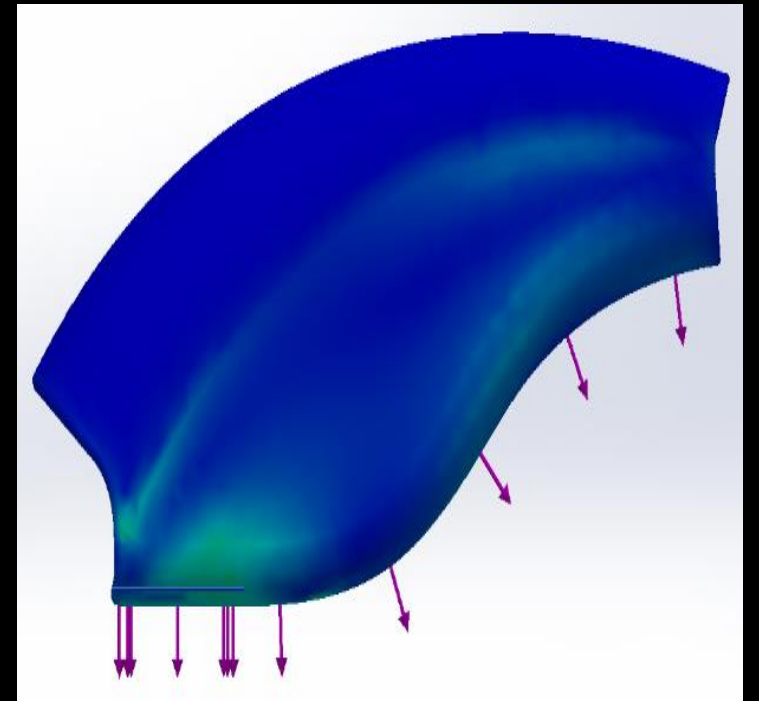
700 N



1500 N

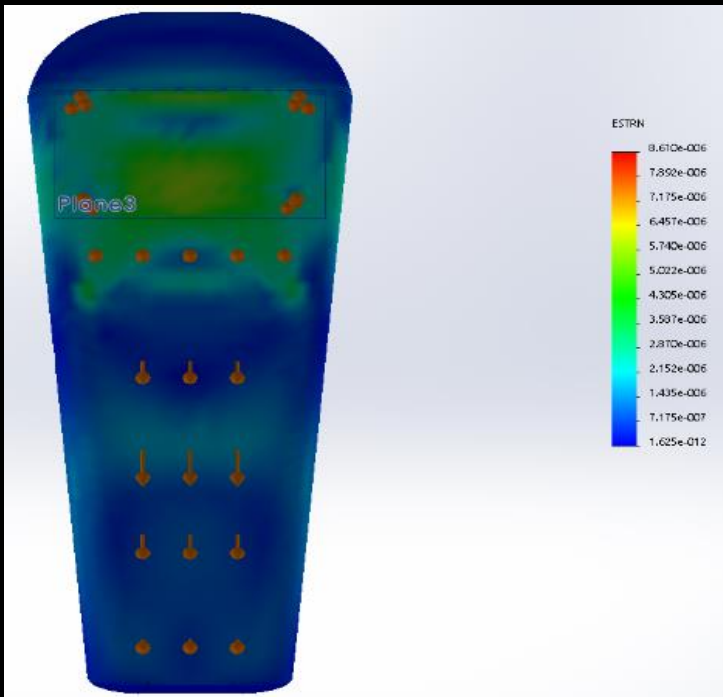


2000 N

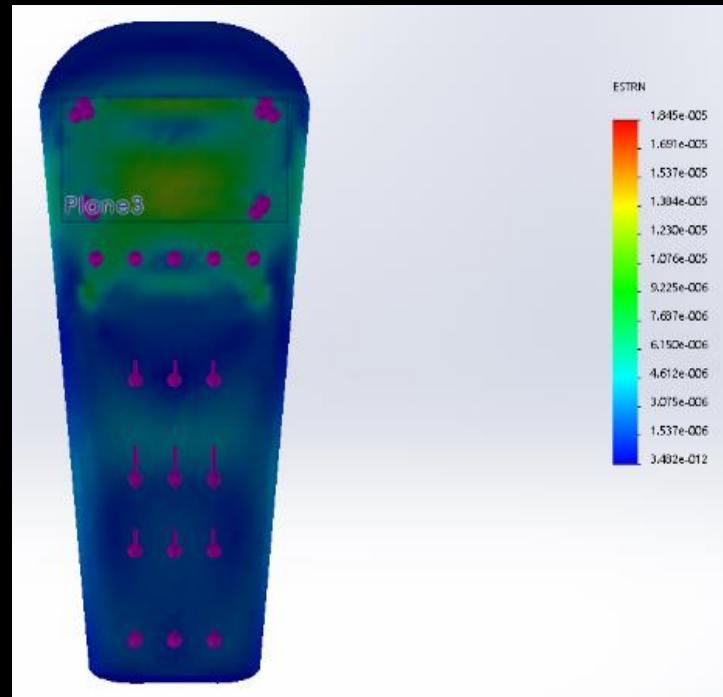


STRAIN: BOTTOM VIEW

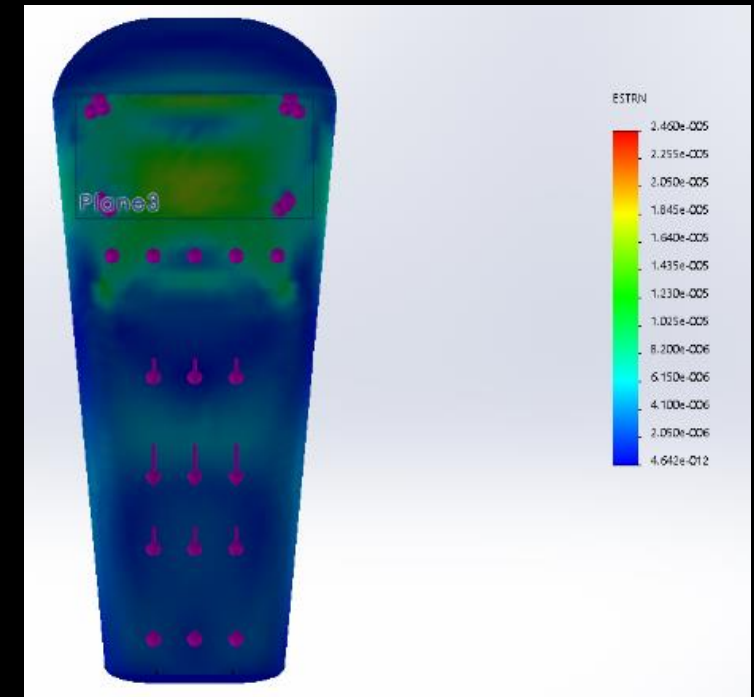
700 N



1500 N

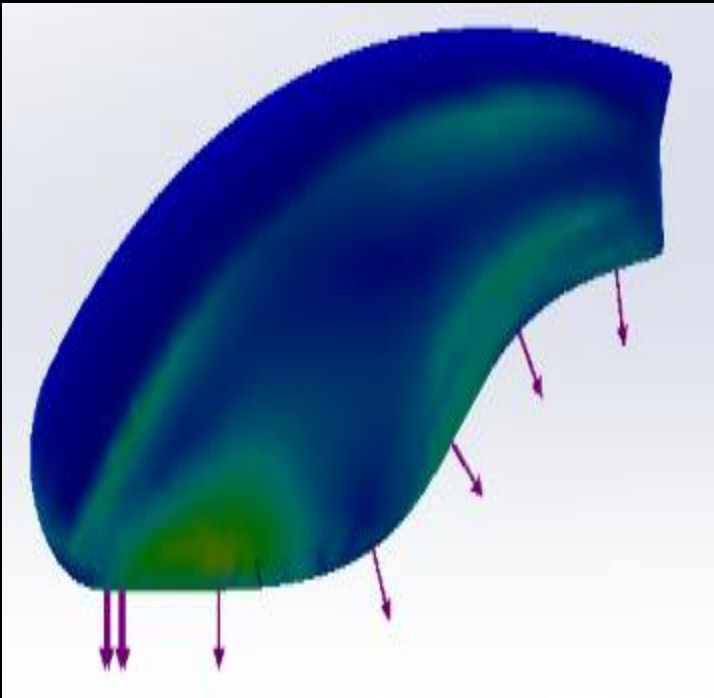


2000 N

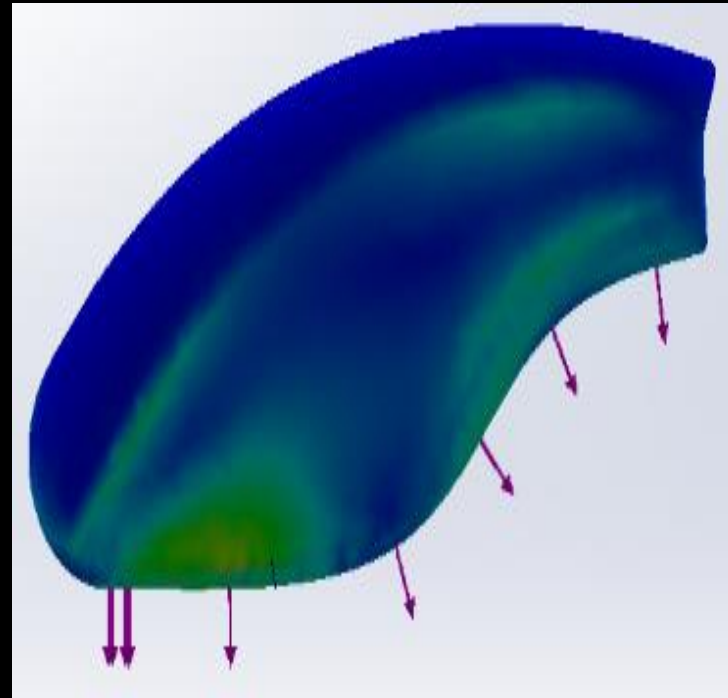


STRAIN: RIGHT VIEW

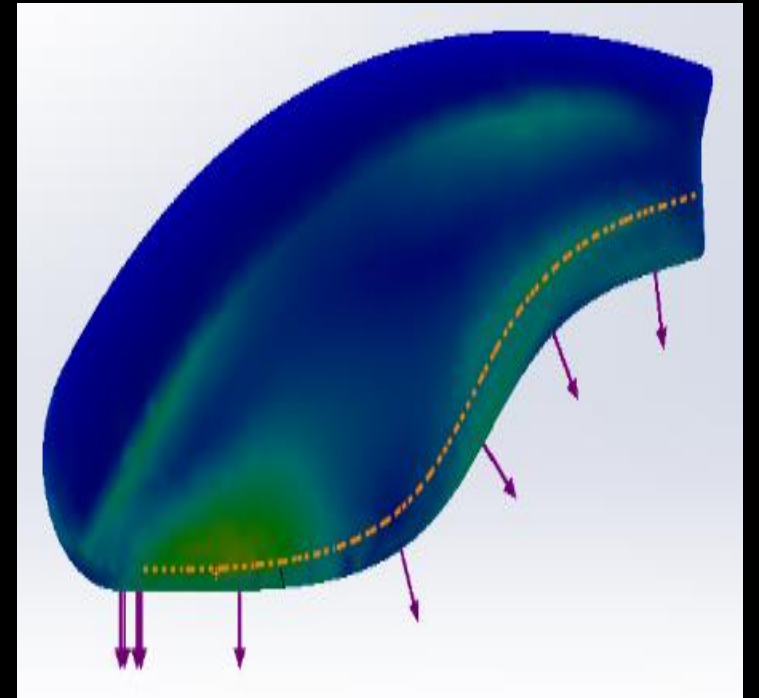
700 N



1500 N

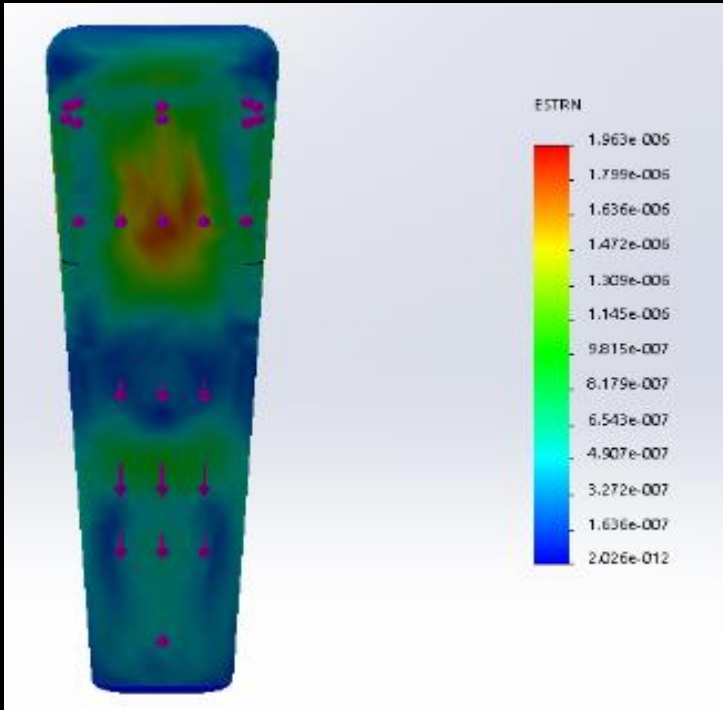


2000 N

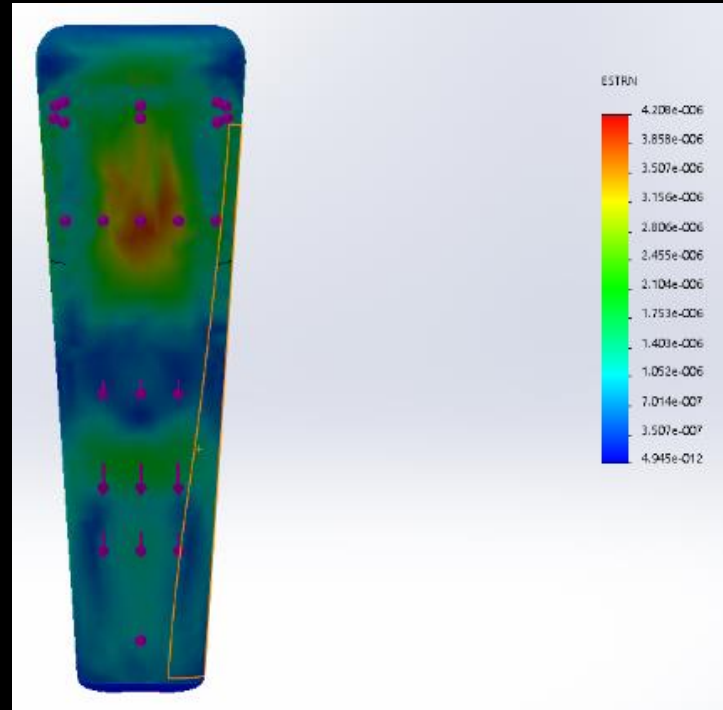


STRAIN: BOTTOM VIEW

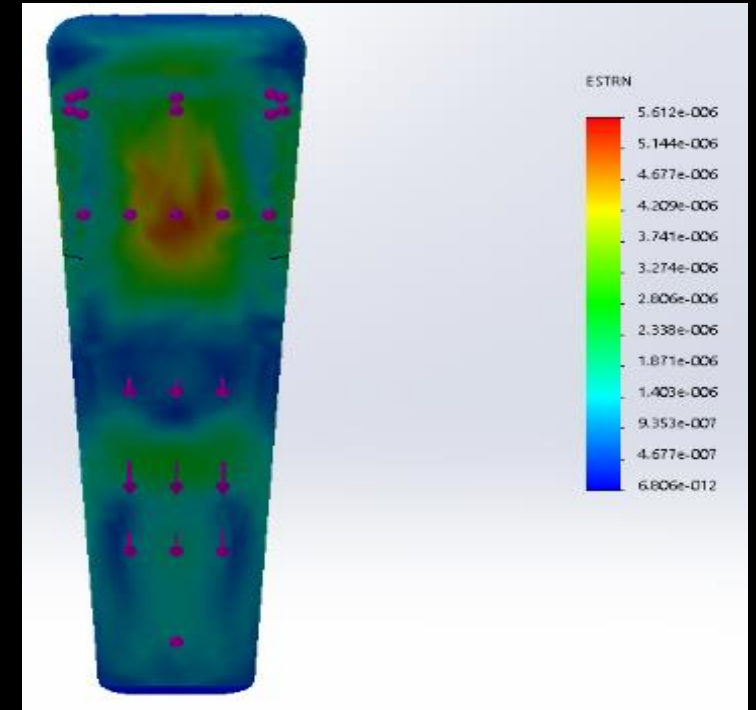
700 N

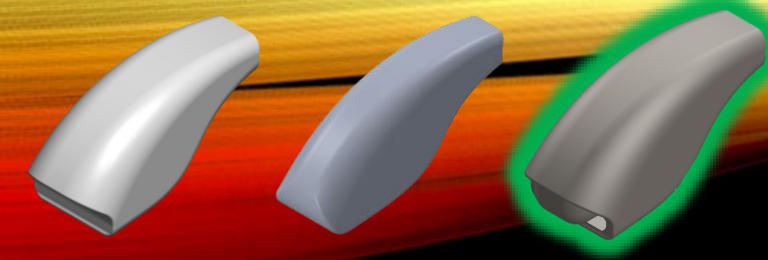


1500 N



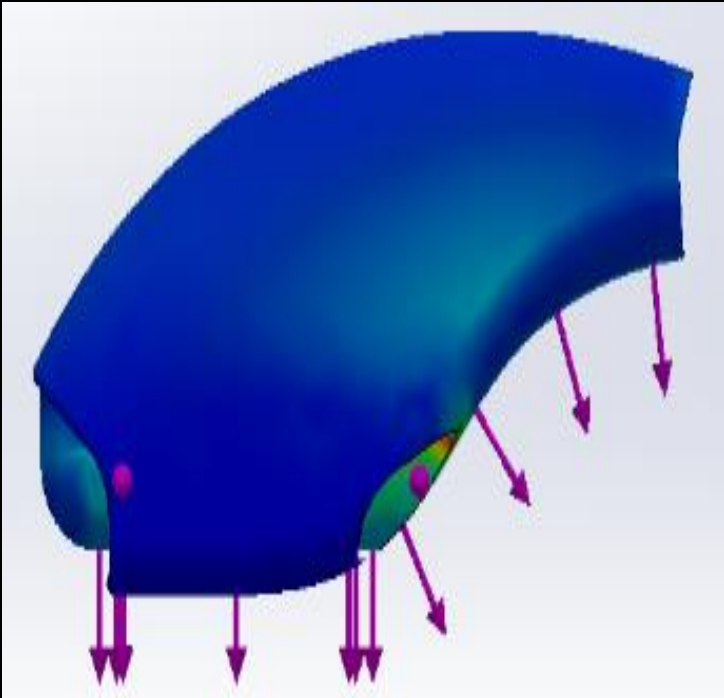
2000 N



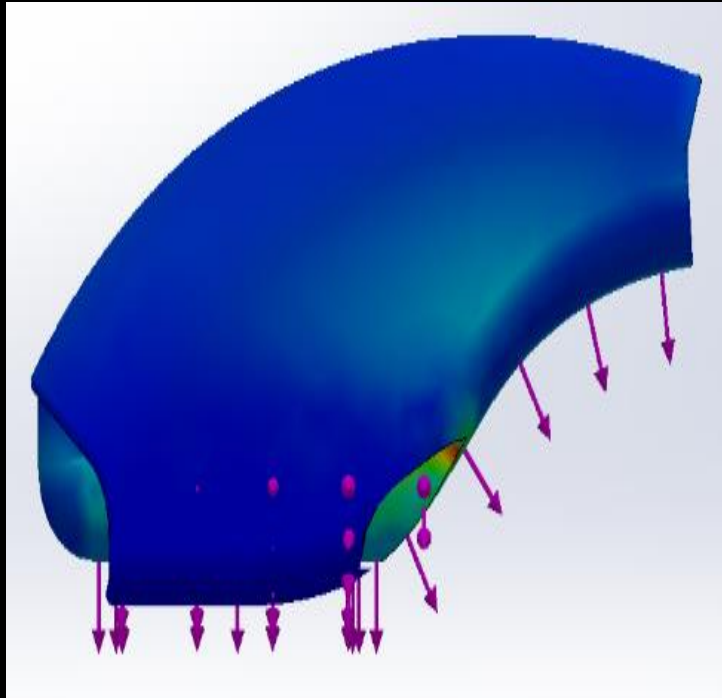


STRAIN: RIGHT VIEW

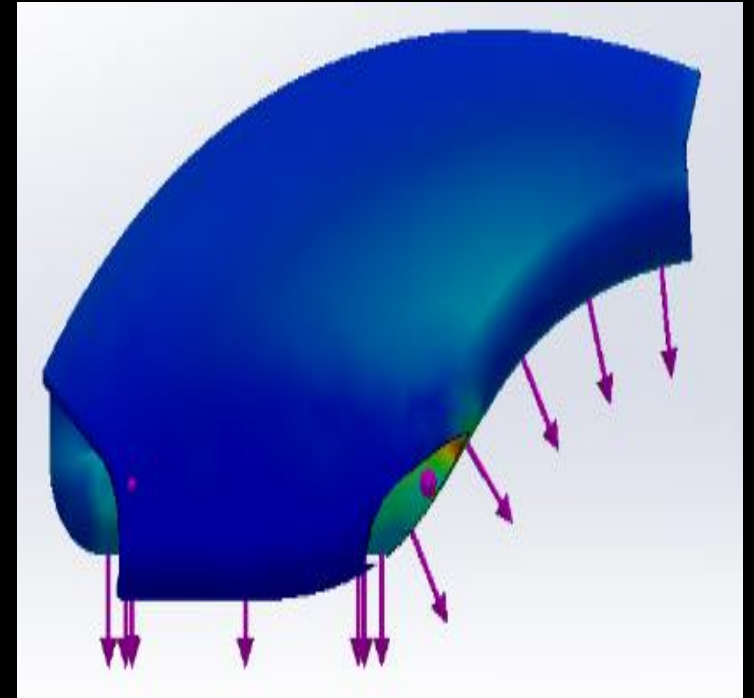
700 N

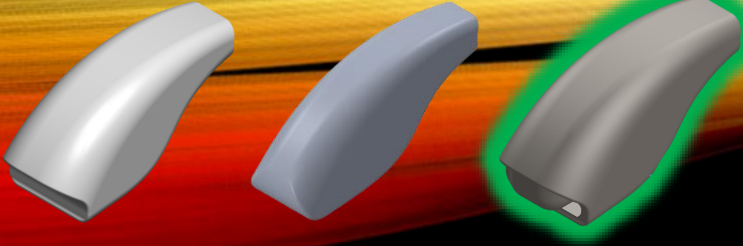


1500 N



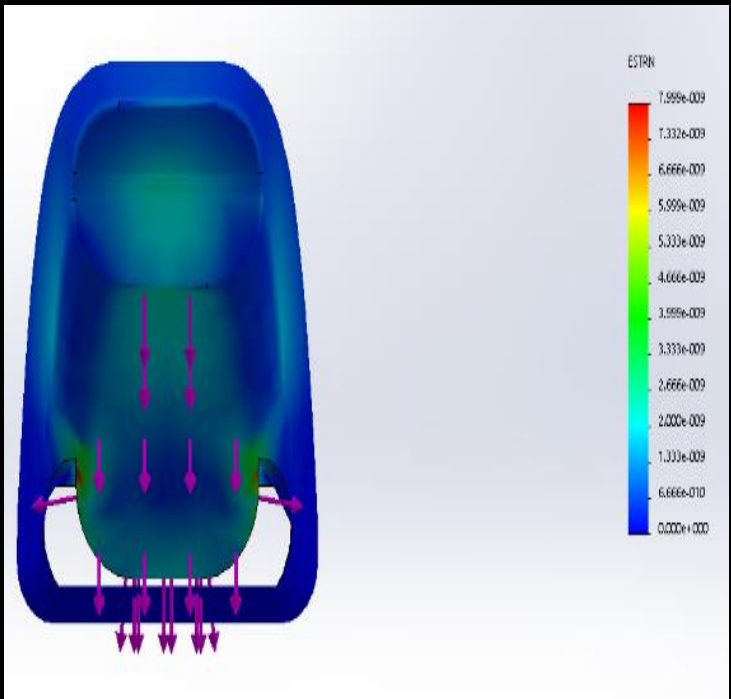
2000 N



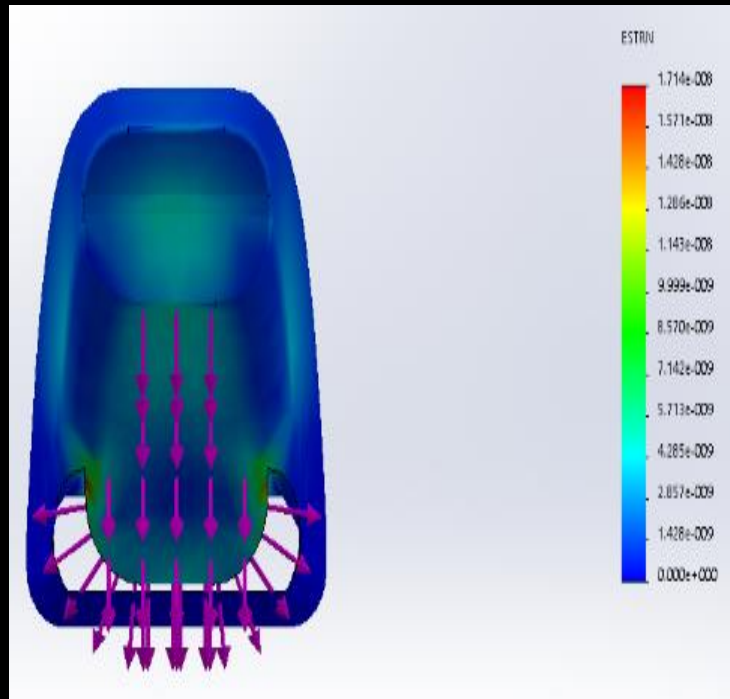


STRAIN: BACK VIEW

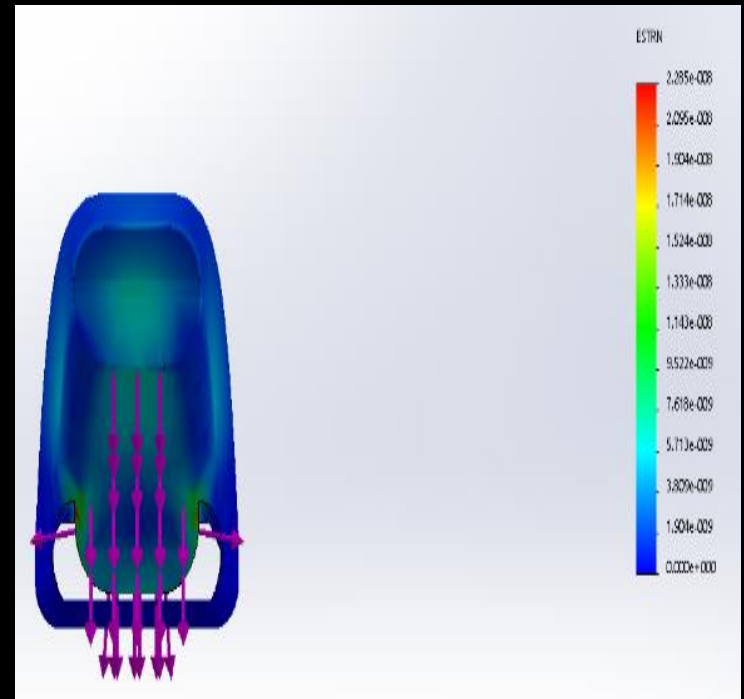
700 N



1500 N



2000 N



STRAIN DATA

700 N

Original design:

- Maximum strain = $6.82E(-6)$
- Average strain = $6.75E(-6)$

Rounded nose design:

- Maximum strain = $1.20E(-6)$
- Average strain = $1.17E(-6)$

Ventilation design:

- Maximum strain = $5.77E(-6)$
- Average strain = $5.71E(-6)$

1500 N

Original design:

- Maximum strain = $8.19E(-6)$
- Average strain = $8.04E(-6)$

Rounded nose design:

- Maximum strain = $2.56E(-6)$
- Average strain = $2.51E(-6)$

Ventilation design:

- Maximum strain = $6.24E(-6)$
- Average strain = $6.23E(-6)$

2000 N

Original design:

- Maximum strain = $10.9E(-6)$
- Average strain = $10.7E(-6)$

Rounded nose design:

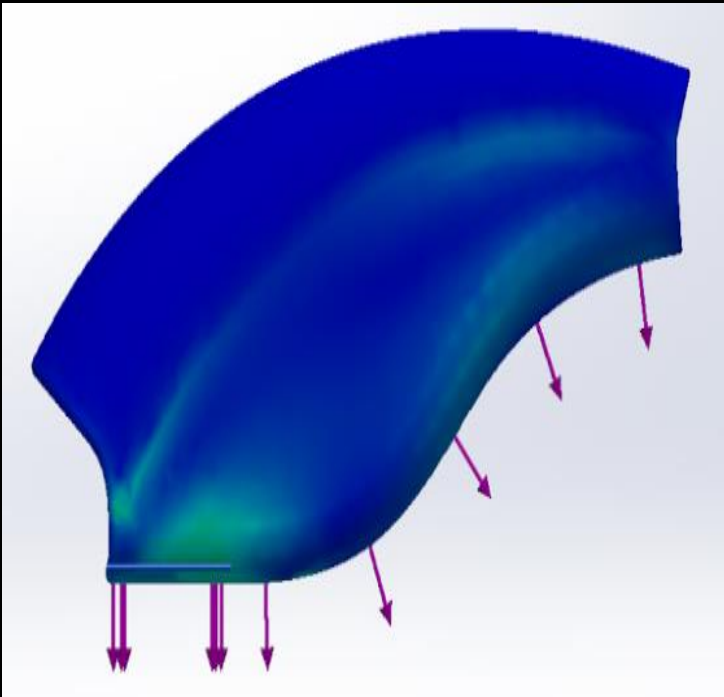
- Maximum strain = $3.42E(-6)$
- Average strain = $3.34E(-6)$

Ventilation design:

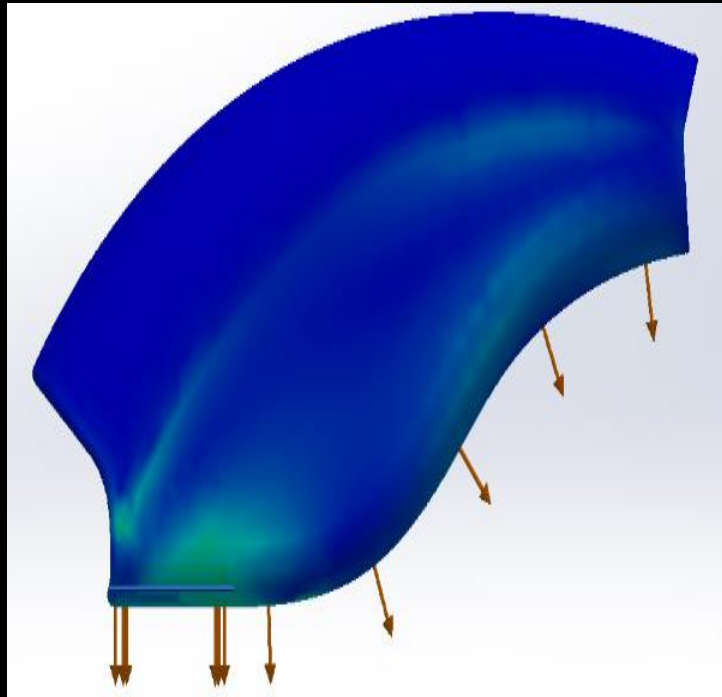
- Maximum strain = $7.65E(-6)$
- Average strain = $7.63E(-6)$

STRESS: RIGHT VIEW

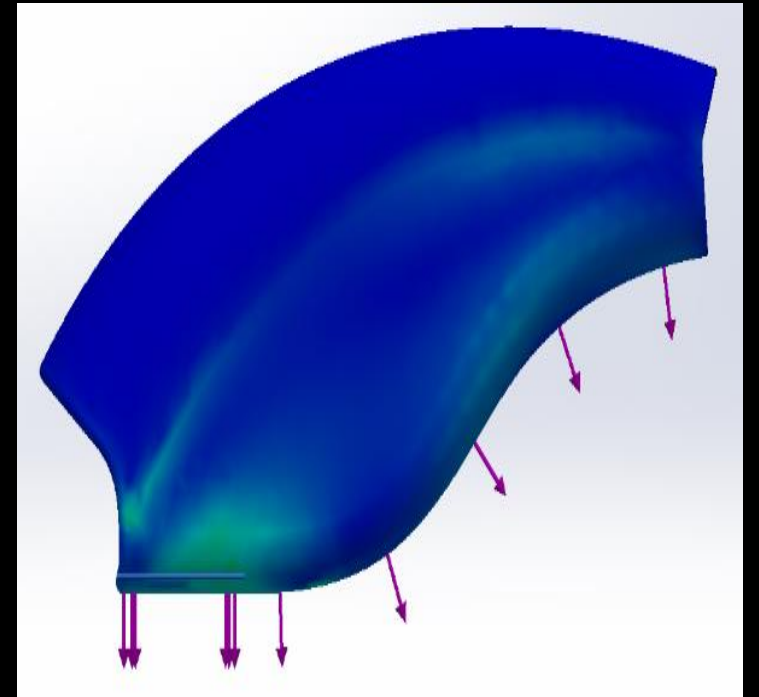
700 N



1500 N

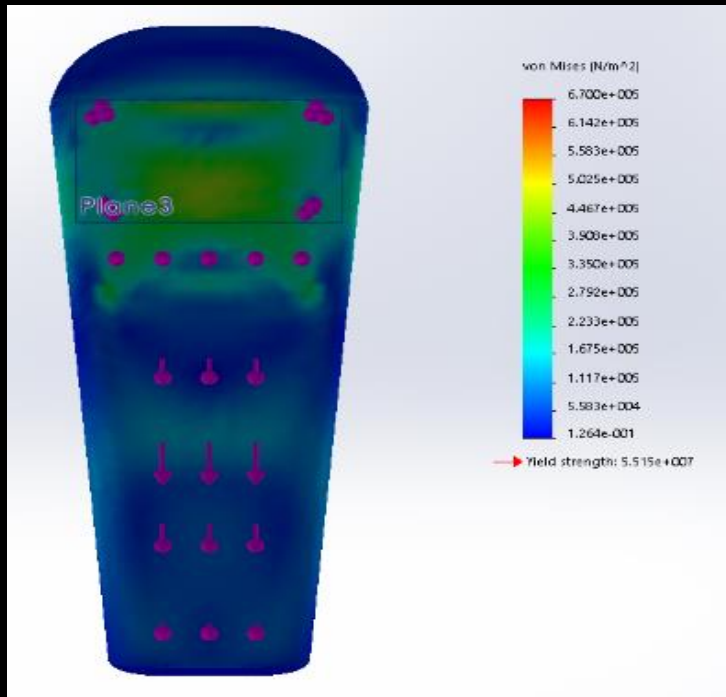


2000 N

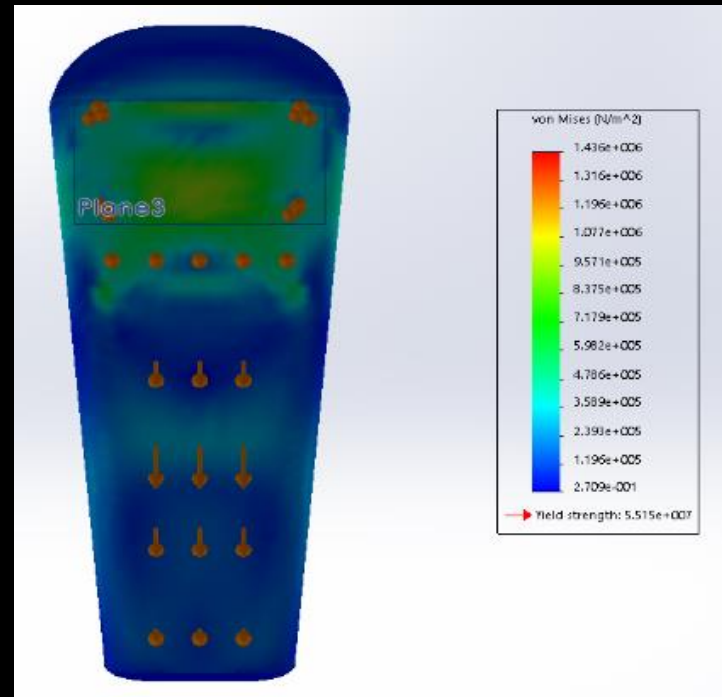


STRESS: BOTTOM VIEW

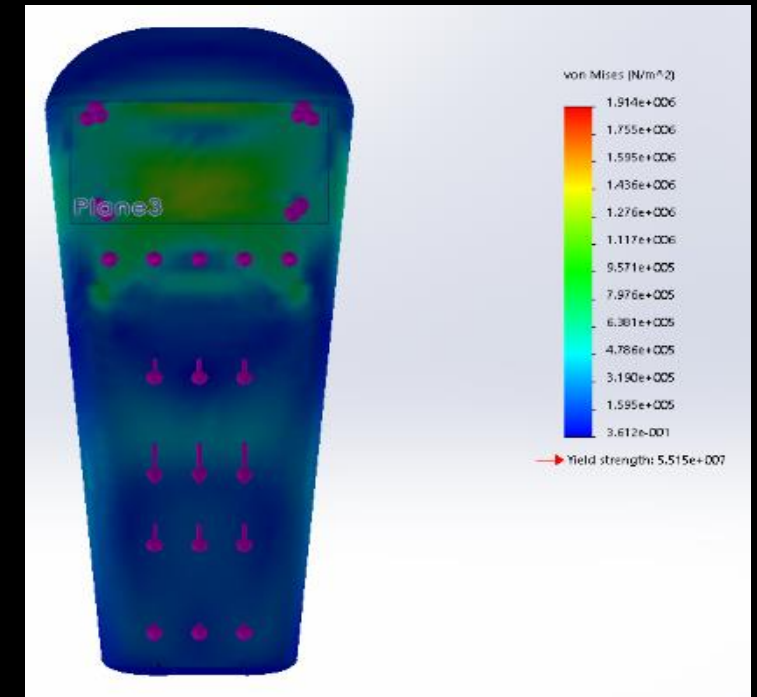
700 N



1500 N

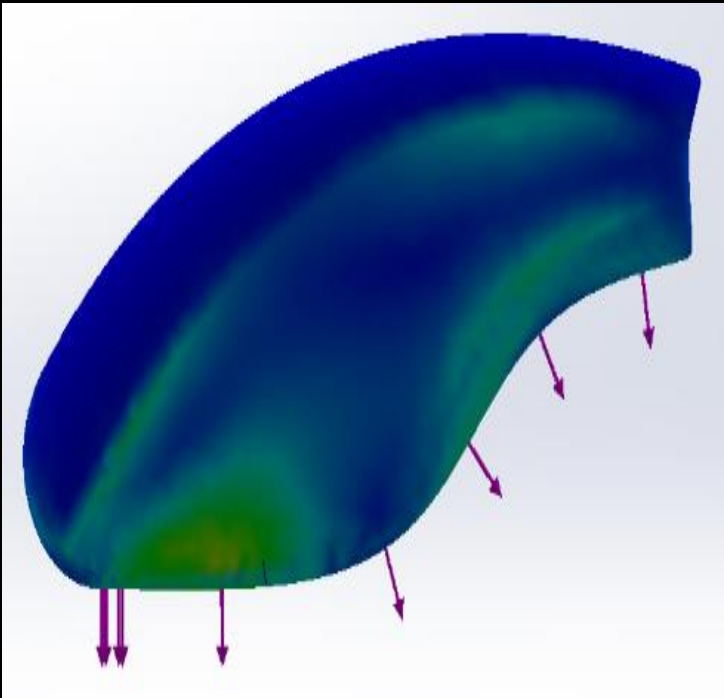


2000 N

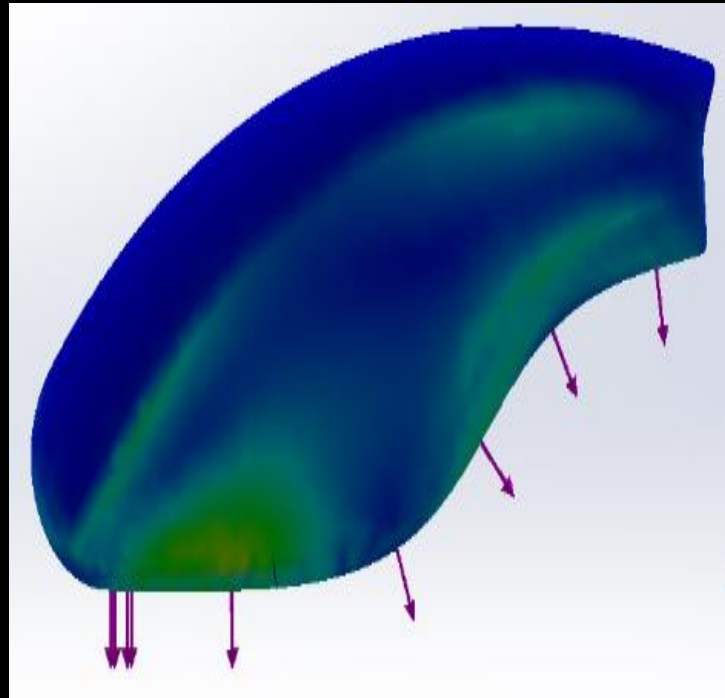


STRESS: RIGHT VIEW

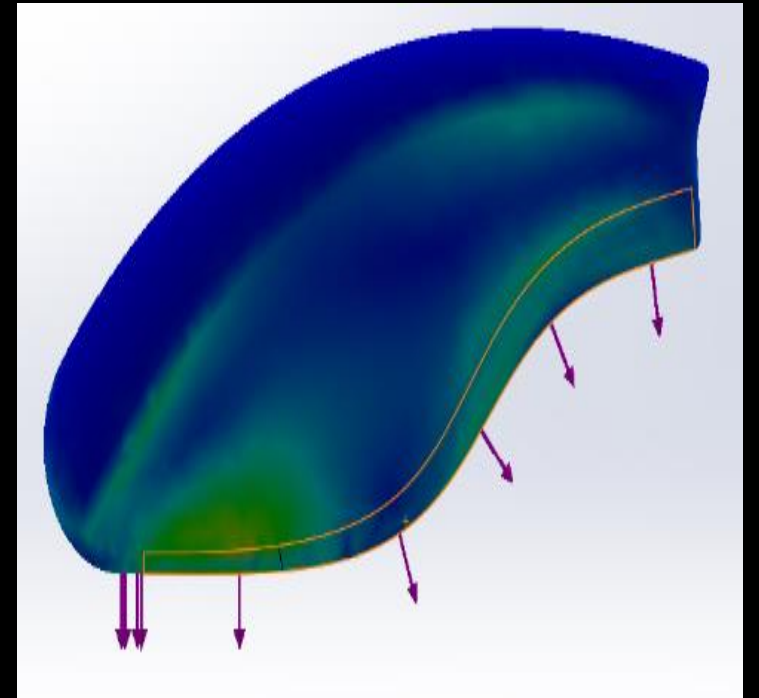
700 N



1500 N

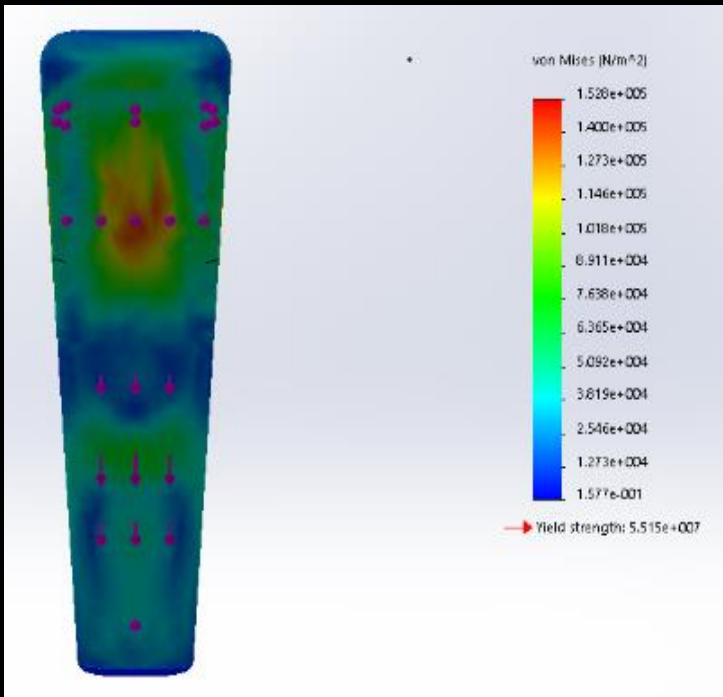


2000 N

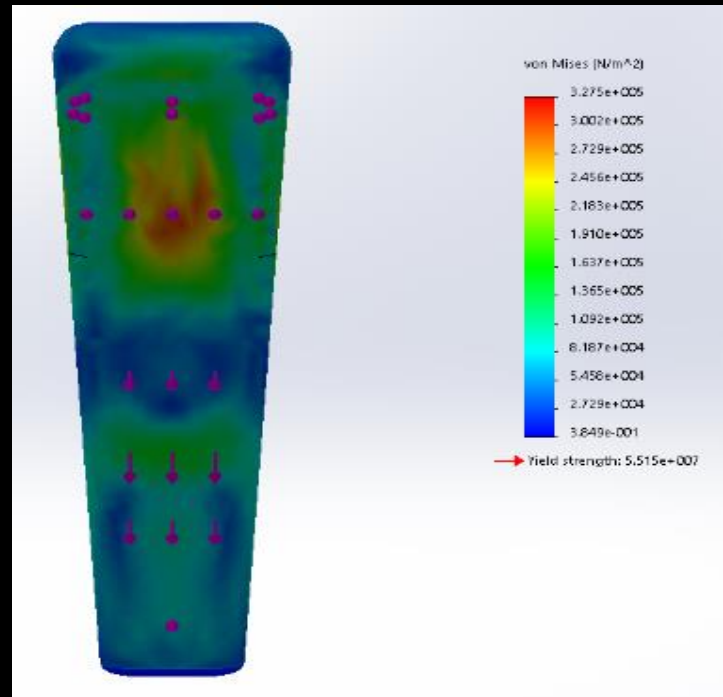


STRESS: BOTTOM VIEW

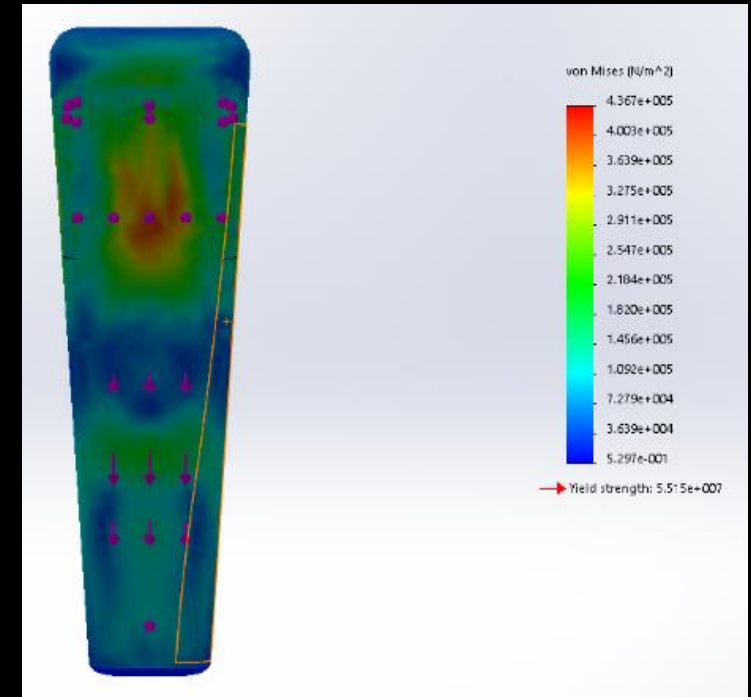
700 N

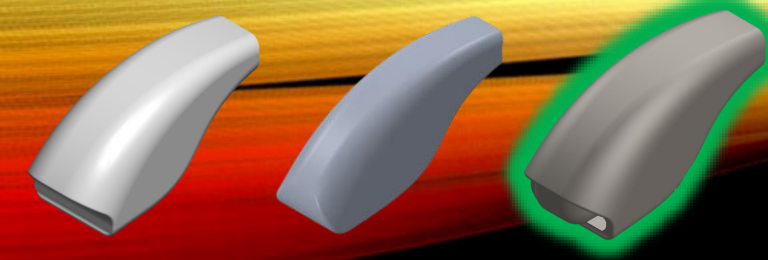


1500 N



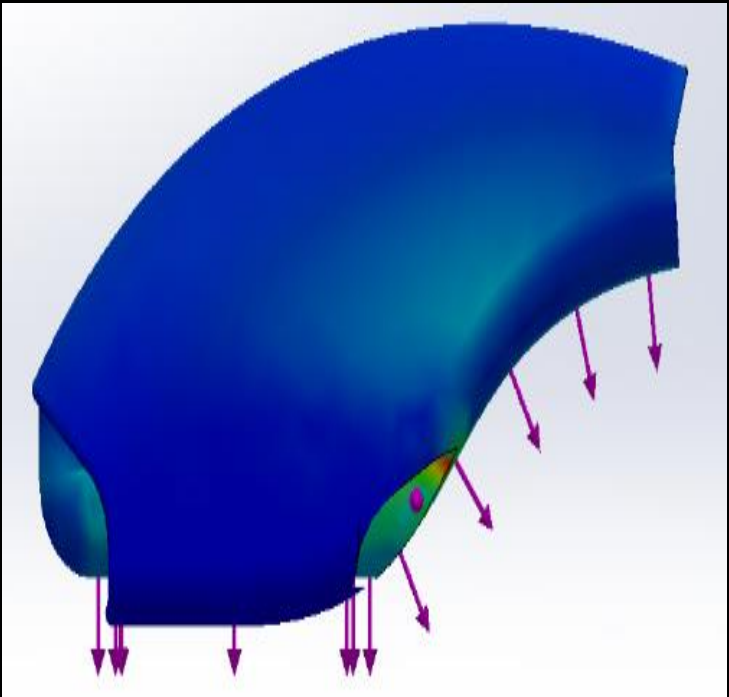
2000 N



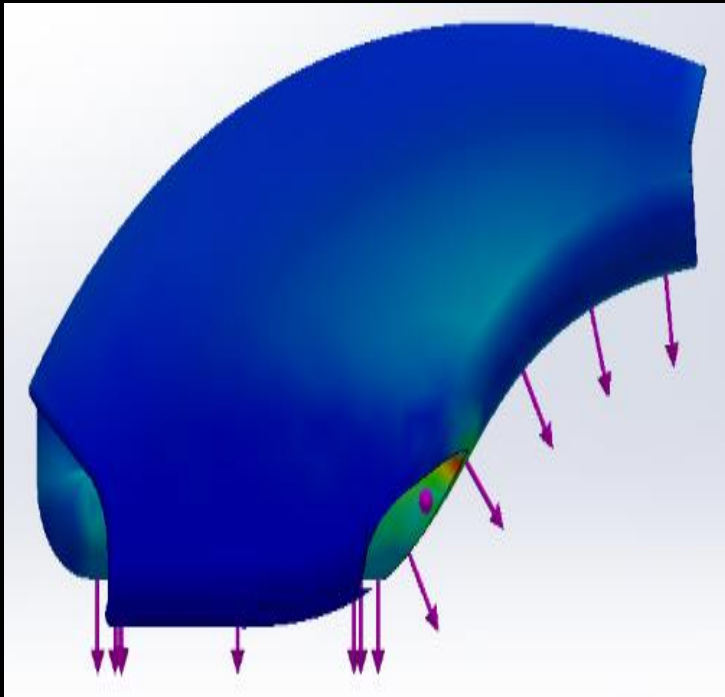


STRESS: RIGHT VIEW

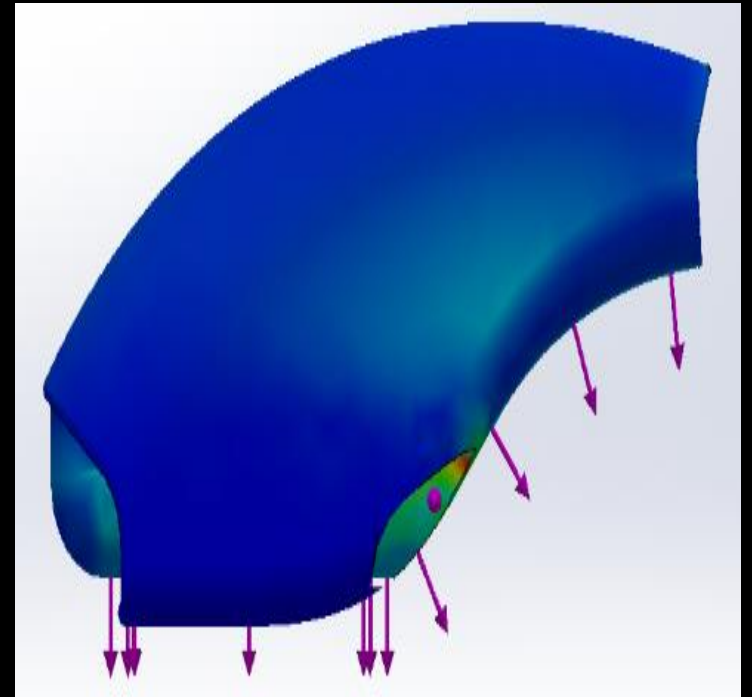
700 N



1500 N

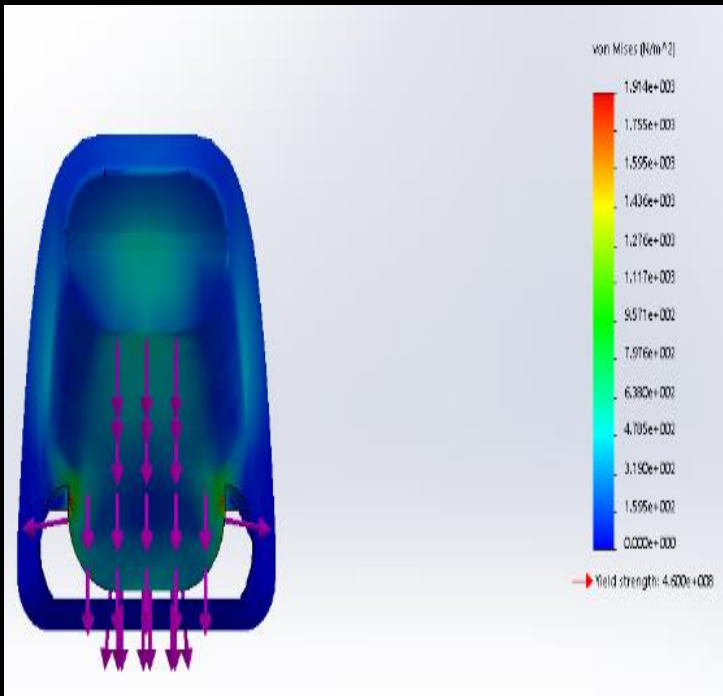


2000 N

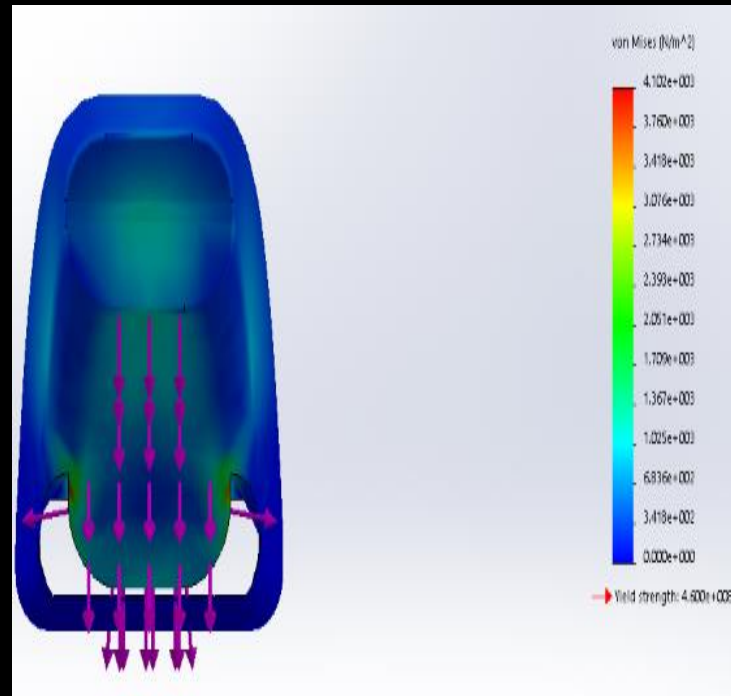


STRESS: BACK VIEW

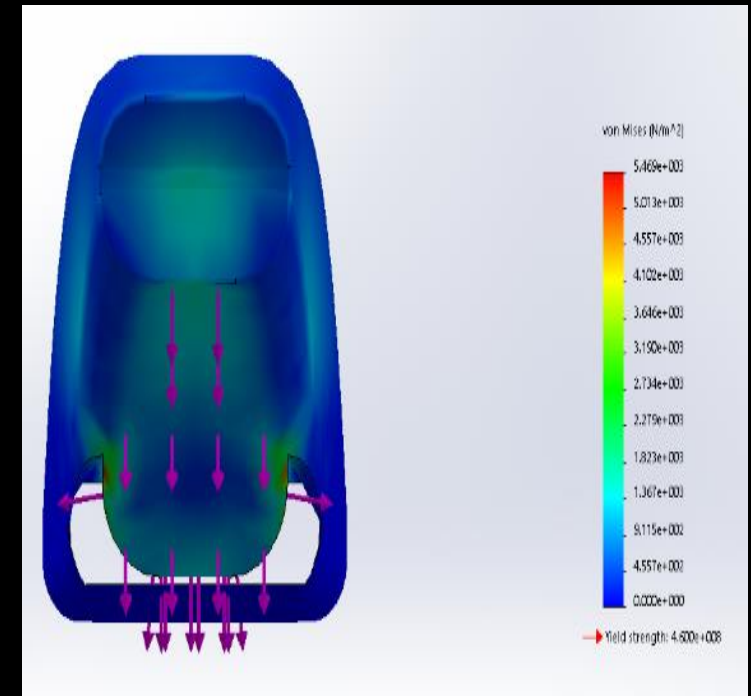
700 N



1500 N



2000 N



STRESS DATA [MPA]

700 N

Original design:

- Maximum stress = 0.670

Rounded nose design:

- Maximum stress = 0.153

Ventilation design:

- Maximum stress = 1.91

1500 N

Original design:

- Maximum stress = 1.44

Rounded nose design:

- Maximum stress = 0.327

Ventilation design:

- Maximum stress = 4.10

2000 N

Original design:

- Maximum stress = 1.91

Rounded nose design:

- Maximum stress = 0.437

Ventilation design:

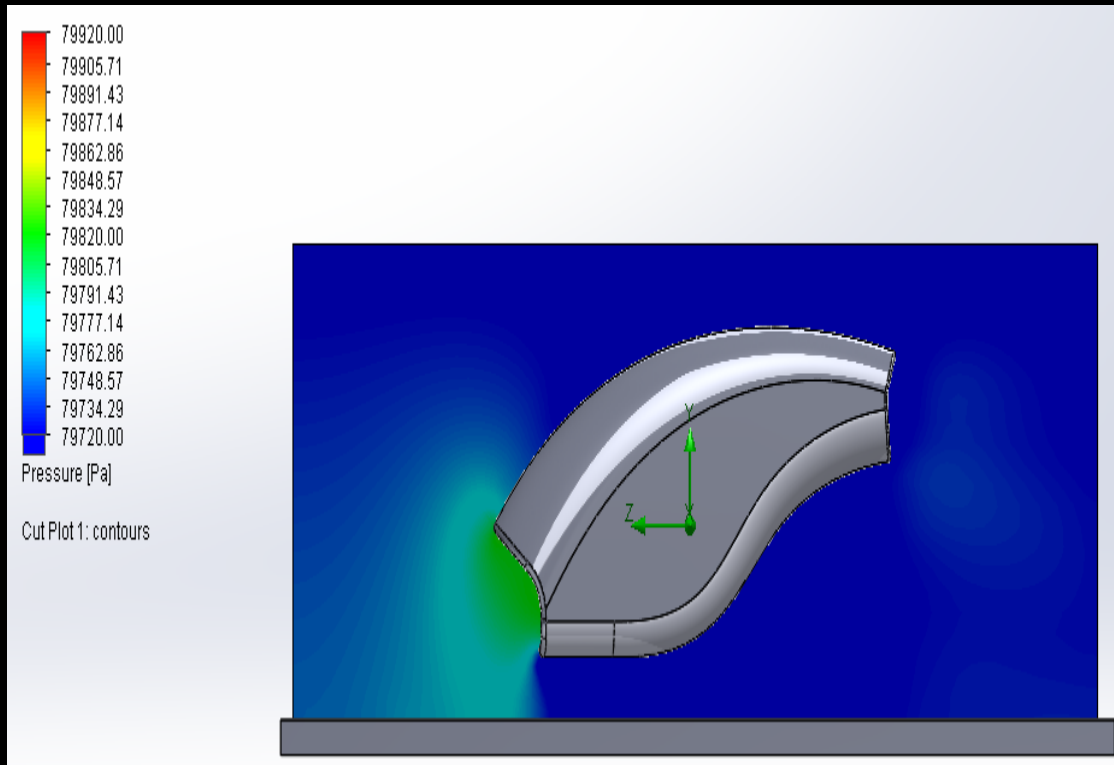
- Maximum stress = 5.47

FLOW ANALYSIS

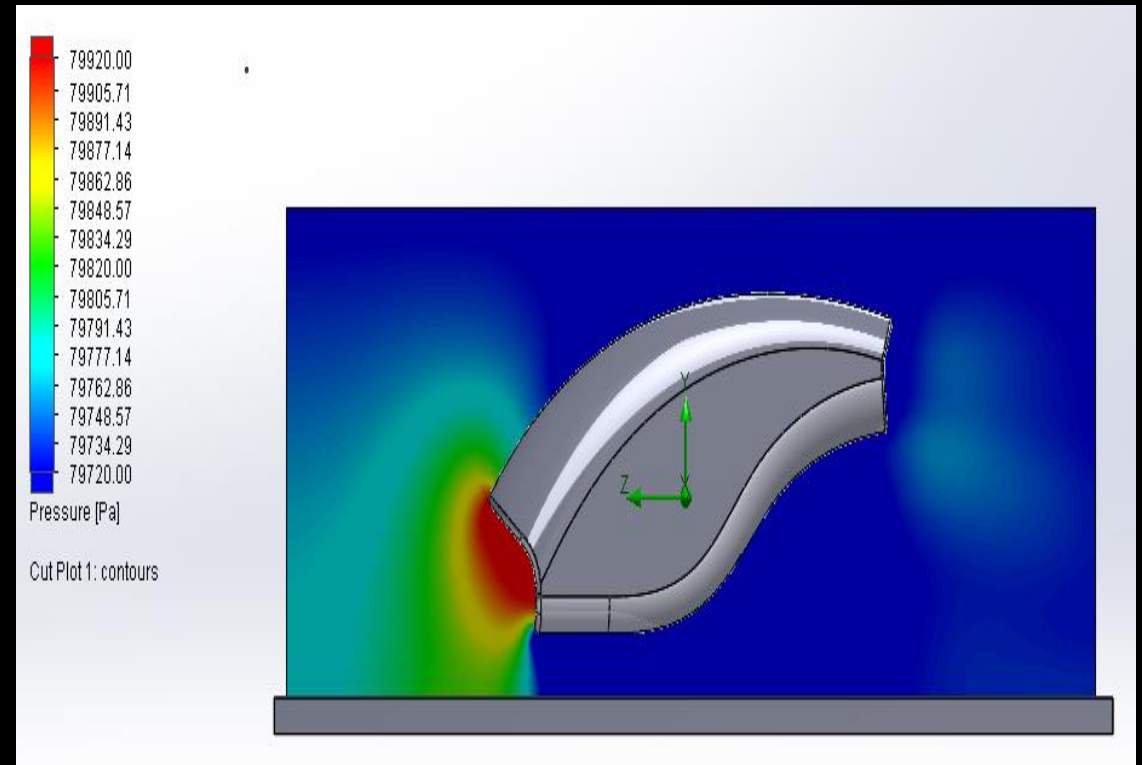
- 2 flow analyses:
 1. Pressure - the force applied perpendicular to the surface of an object per unit area
 2. Velocity - the rate and direction of the change in position of an object
- 4 different flow rates:
 1. 30 mph
 2. 45 mph
 3. 60 mph
 4. 75 mph

PRESSURE PROFILE

- 30 mph

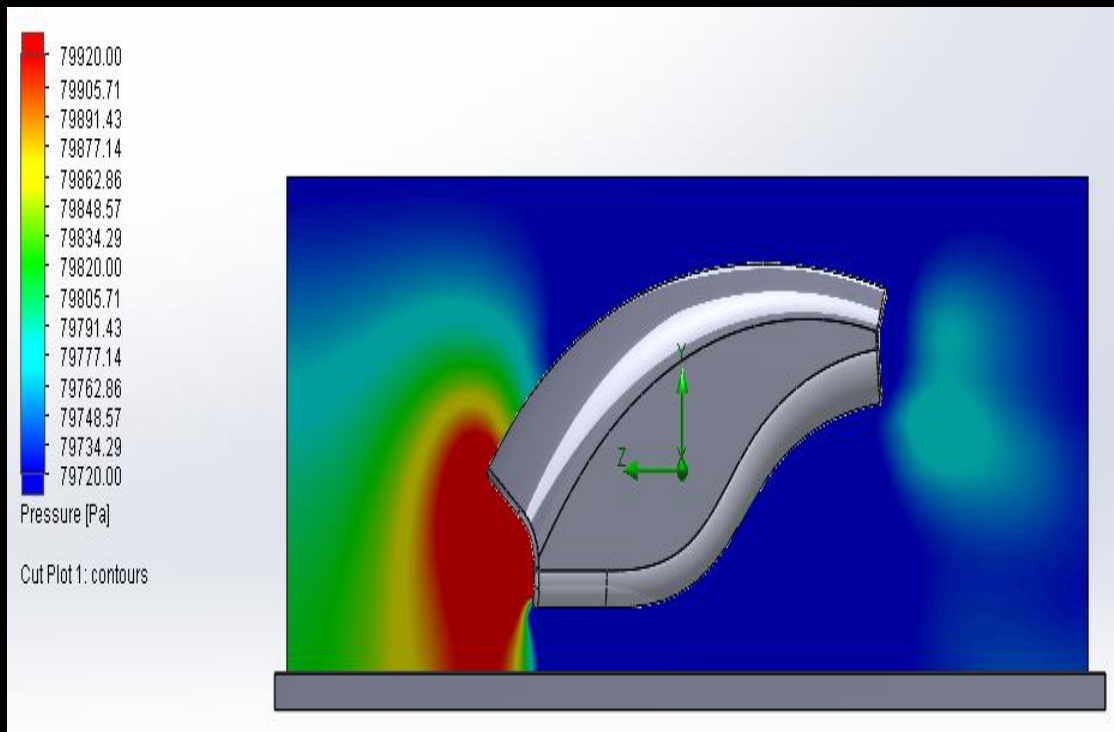


- 45 mph

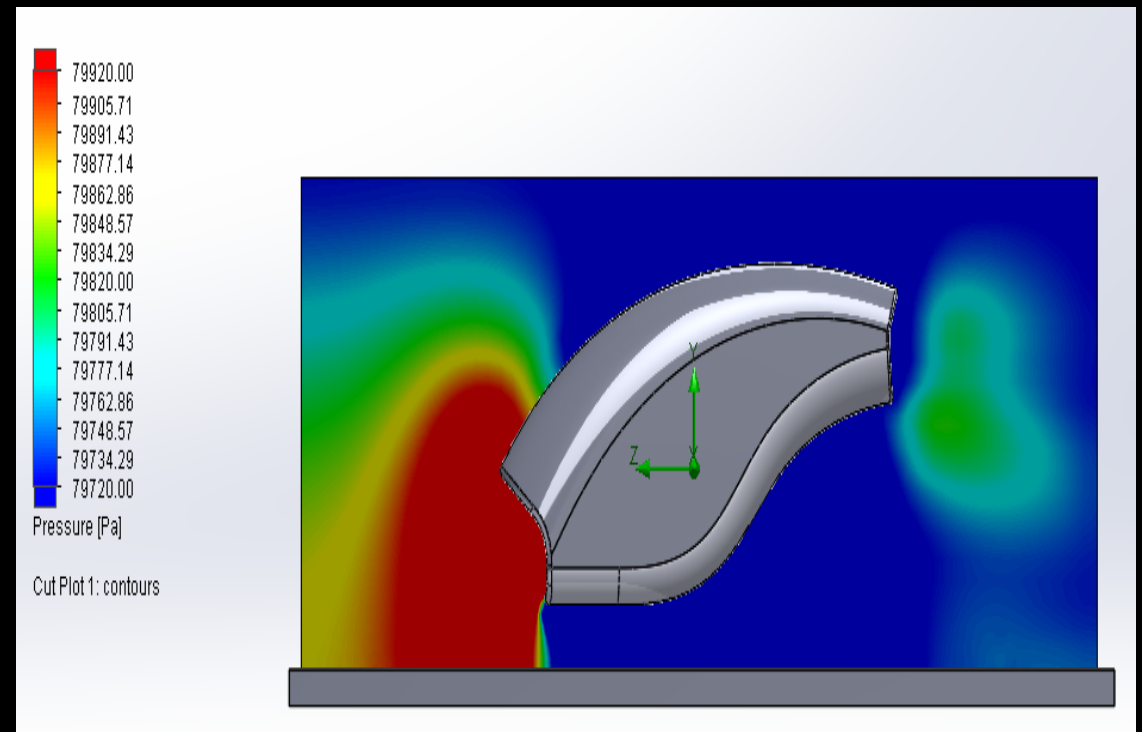


PRESSURE PROFILE

- 60 mph

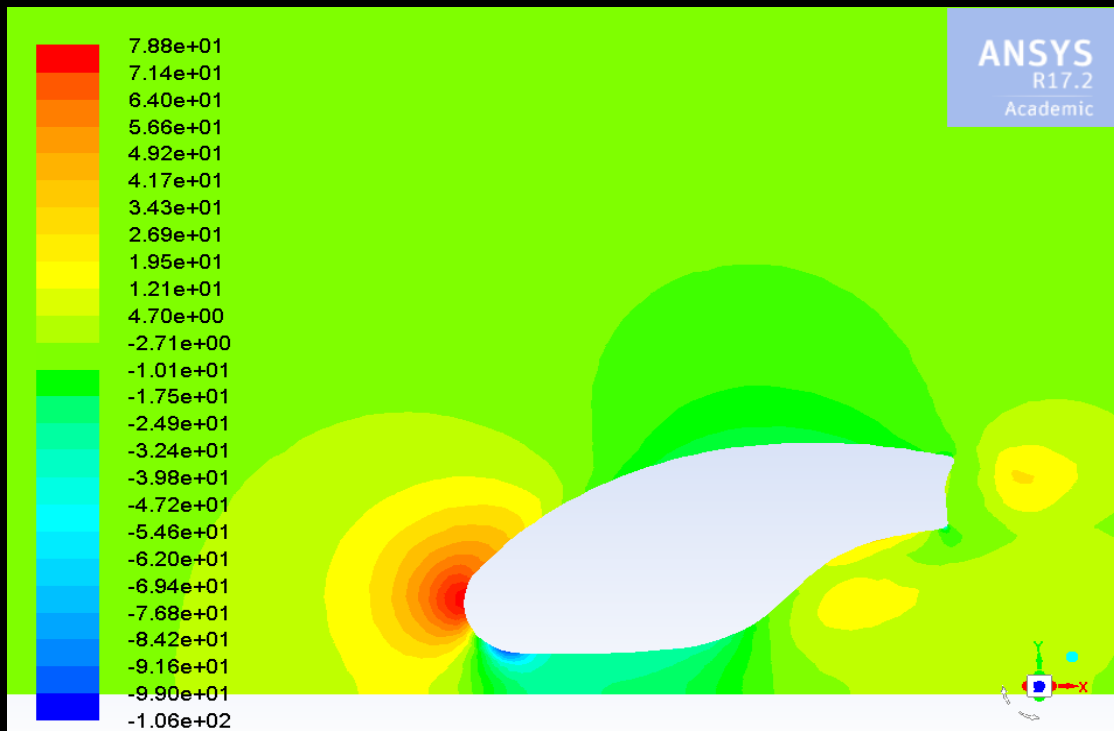


- 75 mph

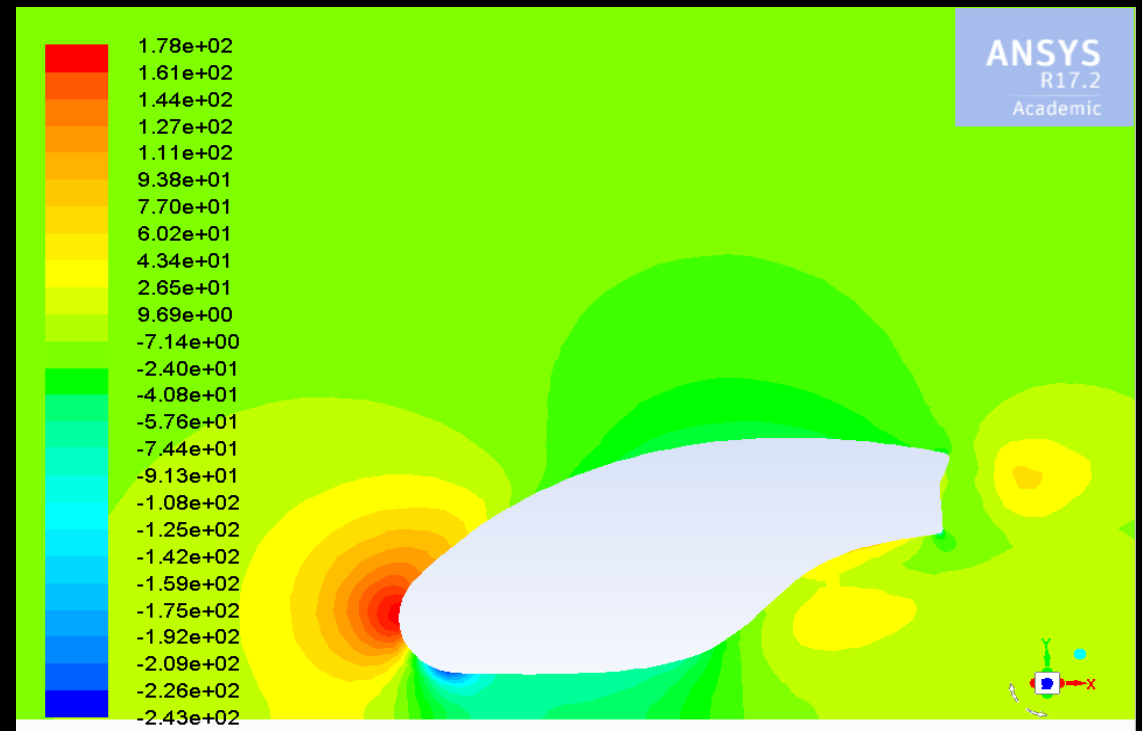


PRESSURE PROFILE

- 30 mph

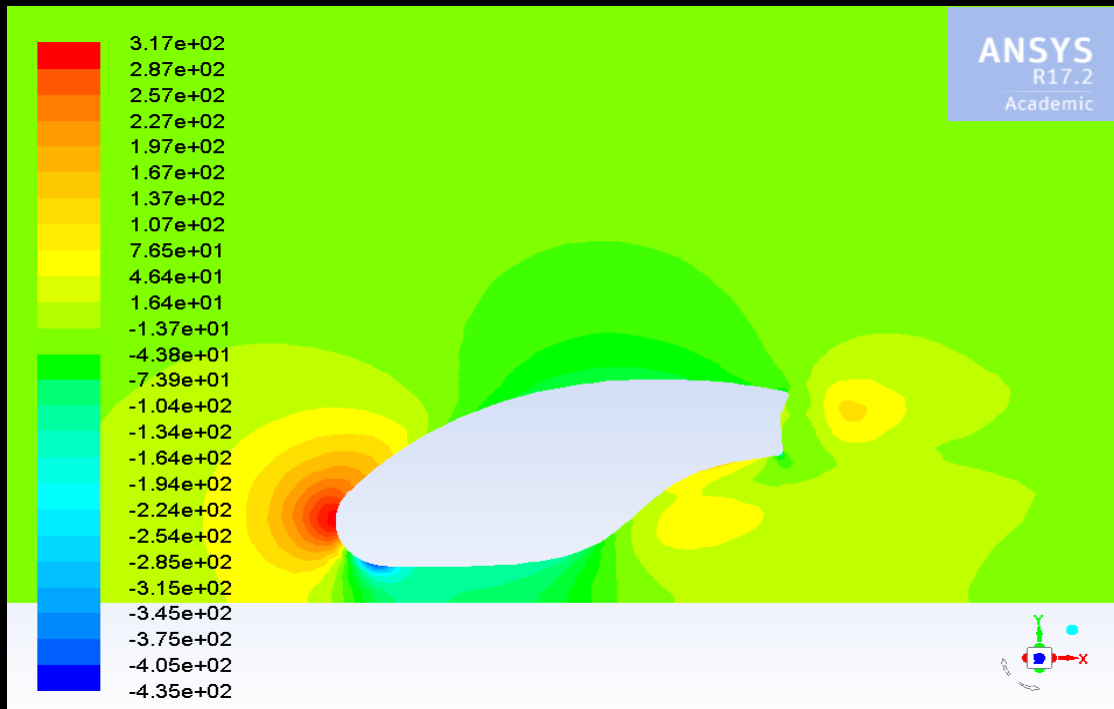


- 45 mph

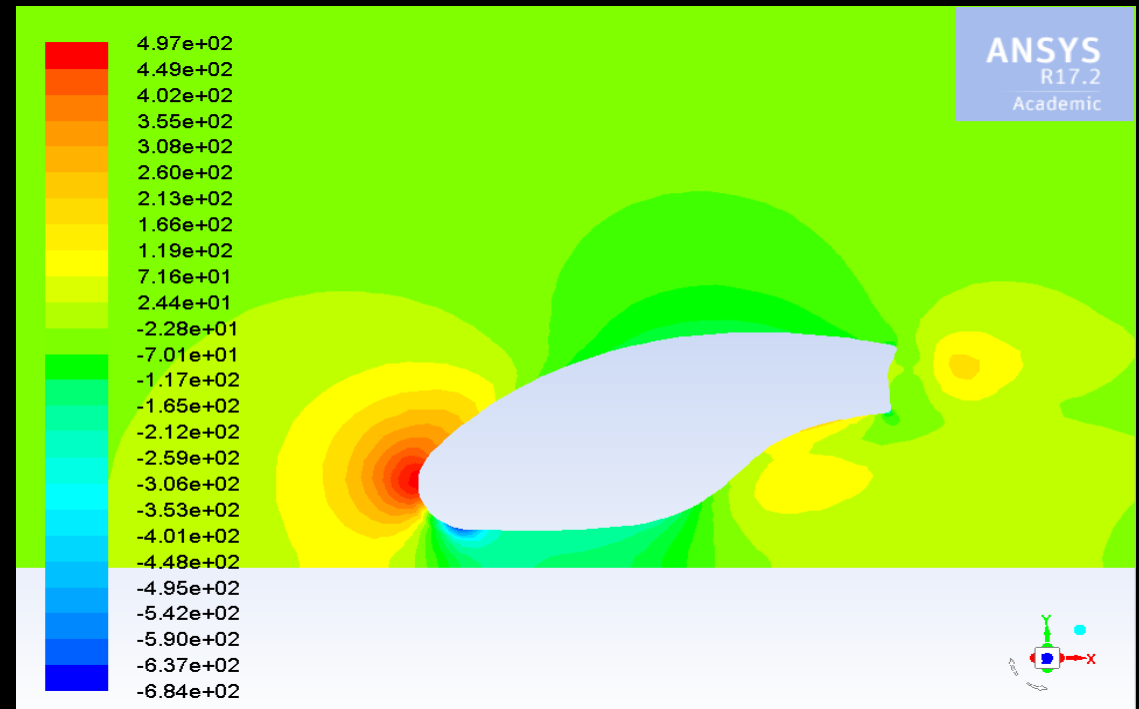


PRESSURE PROFILE

- 60 mph

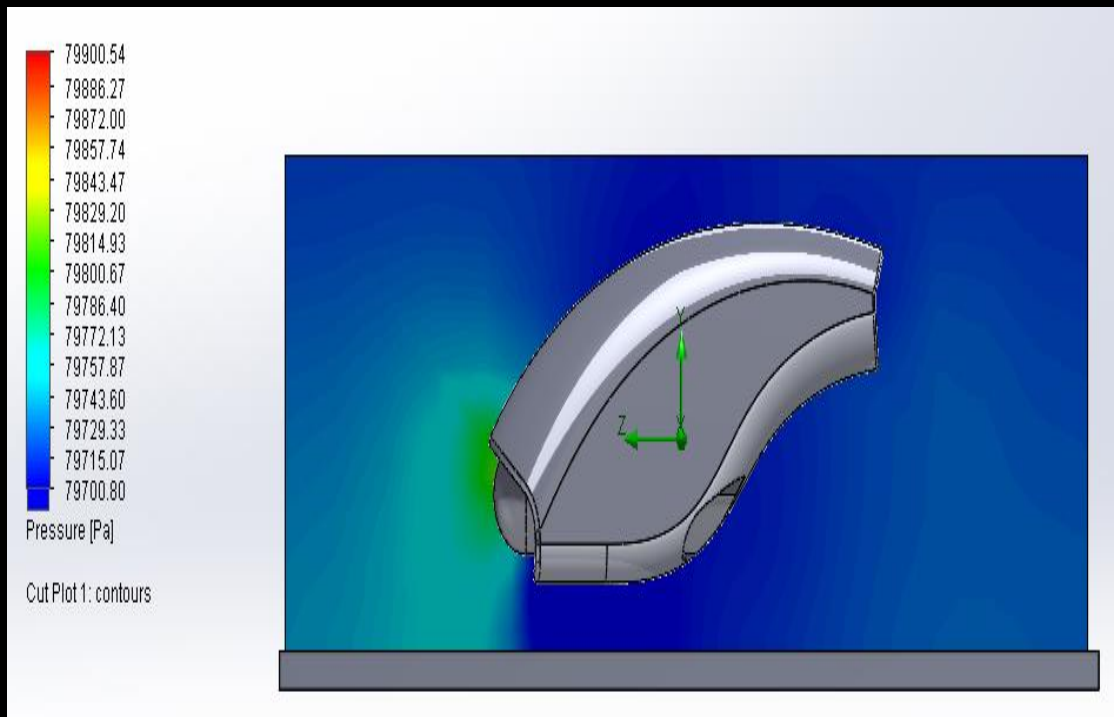


- 75 mph

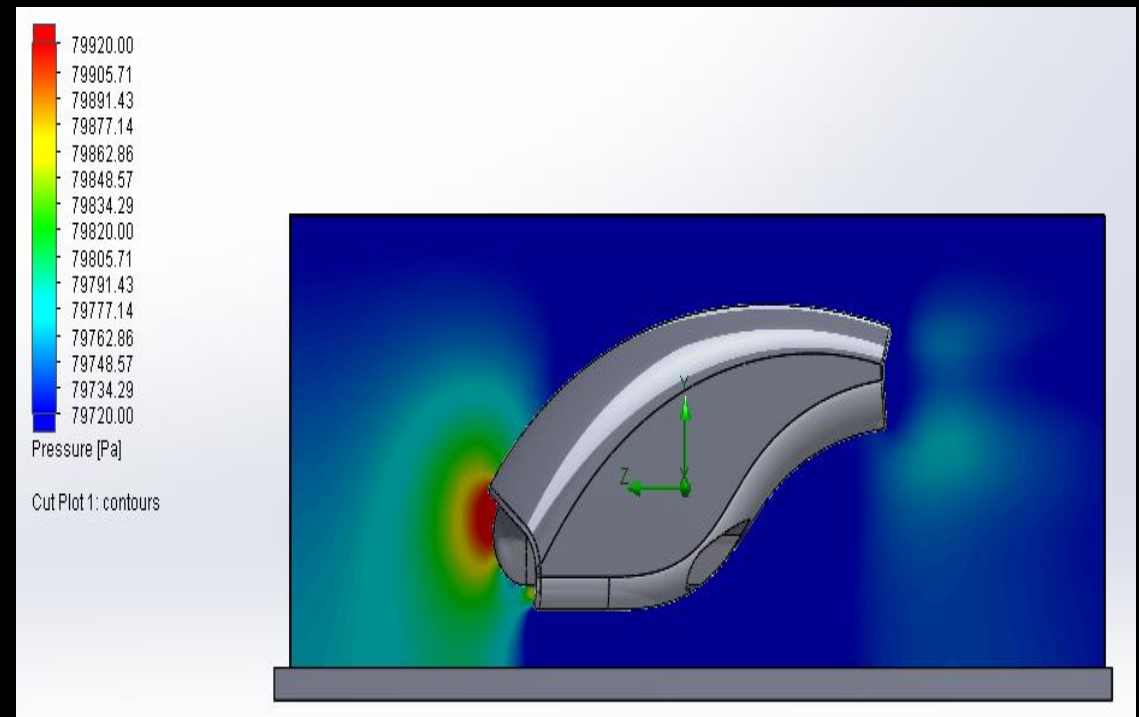


PRESSURE PROFILE

- 30 mph

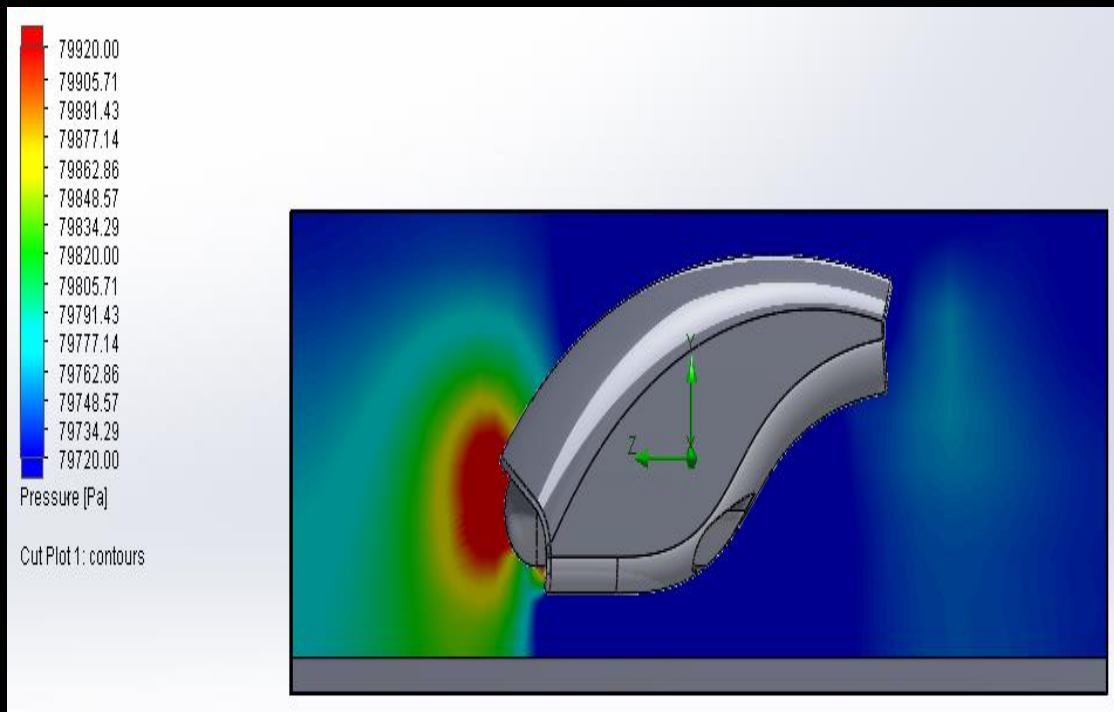


- 45 mph

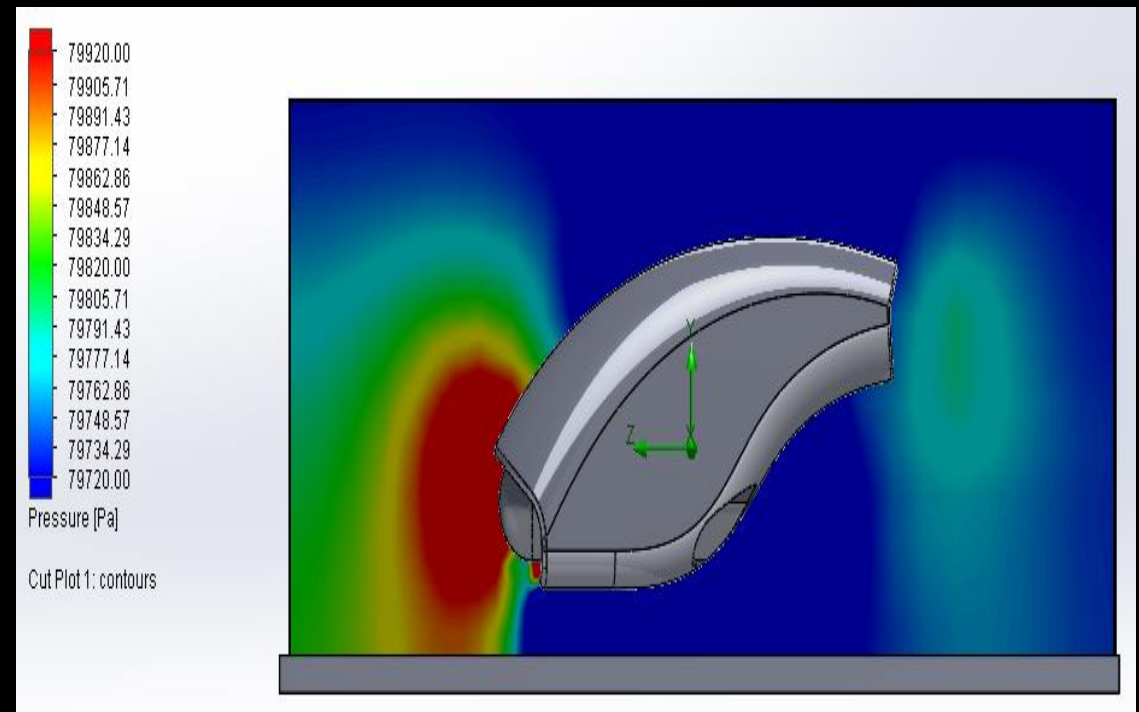


PRESSURE PROFILE

- 60 mph



- 75 mph



PRESSURE DATA [KPA]

Original Design

At 30 mph:

- Maximum pressure = 80.0
- Average pressure = 79.8

At 45 mph:

- Maximum pressure = 80.3
- Average pressure = 80.0

At 60 mph:

- Maximum pressure = 80.7
- Average pressure = 80.0

At 75 mph:

- Maximum pressure = 81.2
- Average pressure = 80.3

Rounded Nose Design

At 30 mph:

- Maximum pressure = 78.8
- Average pressure = 78.5

At 45 mph:

- Maximum pressure = 79.4
- Average pressure = 79.0

At 60 mph:

- Maximum pressure = 79.9
- Average pressure = 79.1

At 75 mph:

- Maximum pressure = 80.3
- Average pressure = 79.6

Ventilation Design

At 30 mph:

- Maximum pressure = 80.0
- Average pressure = 79.8

At 45 mph:

- Maximum pressure = 80.4
- Average pressure = 80.0

At 60 mph:

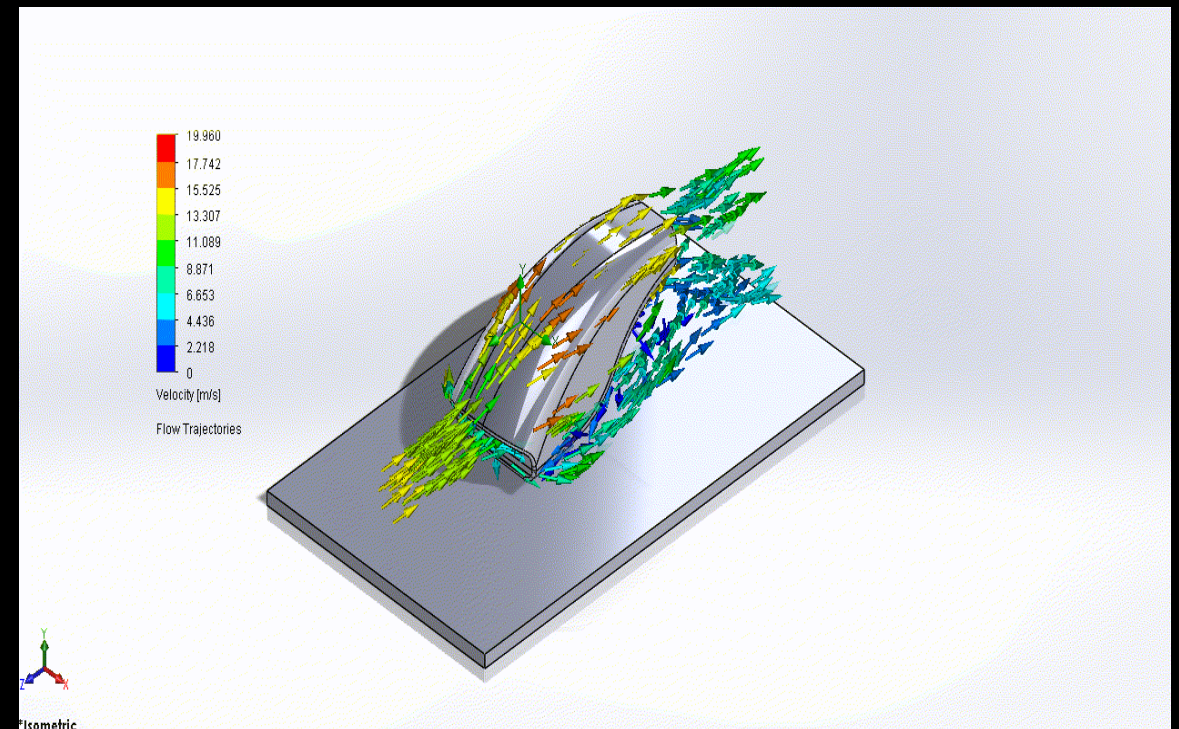
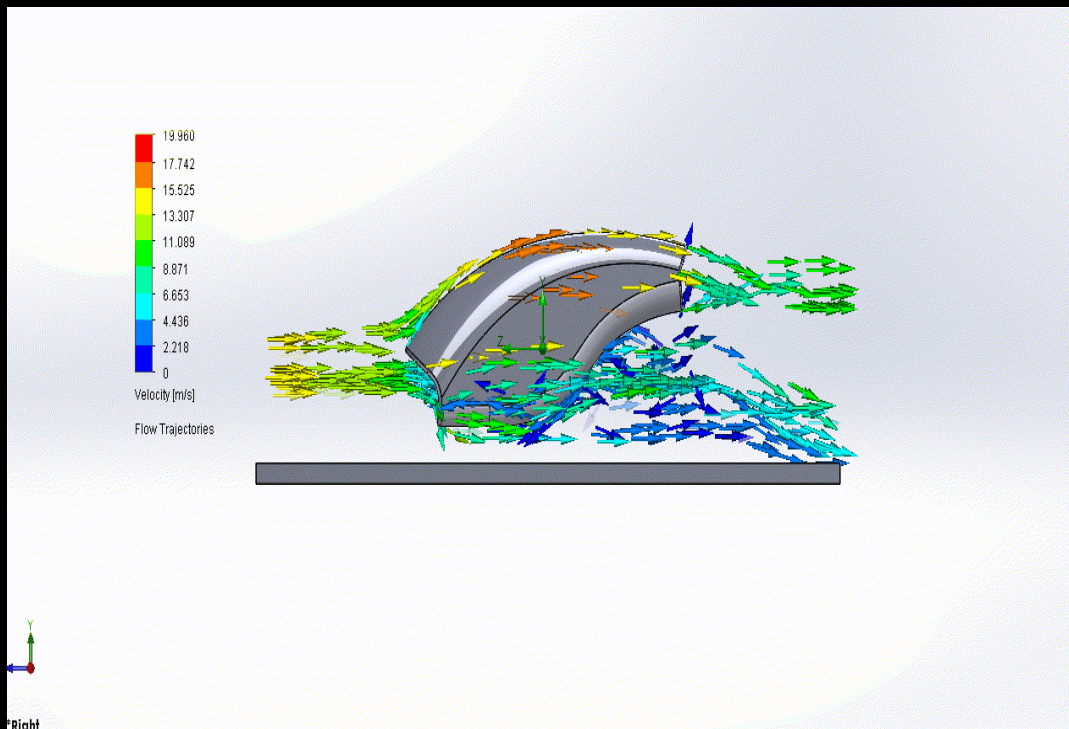
- Maximum pressure = 80.9
- Average pressure = 80.0

At 75 mph:

- Maximum pressure = 81.5
- Average pressure = 80.3

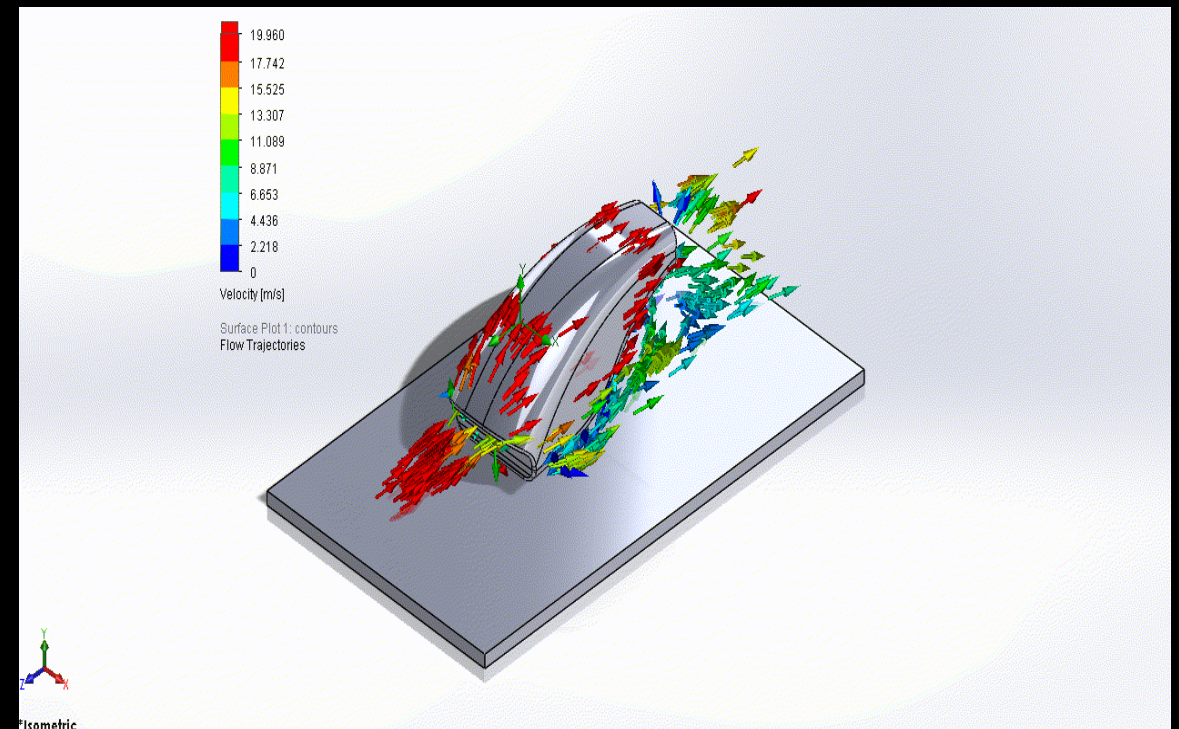
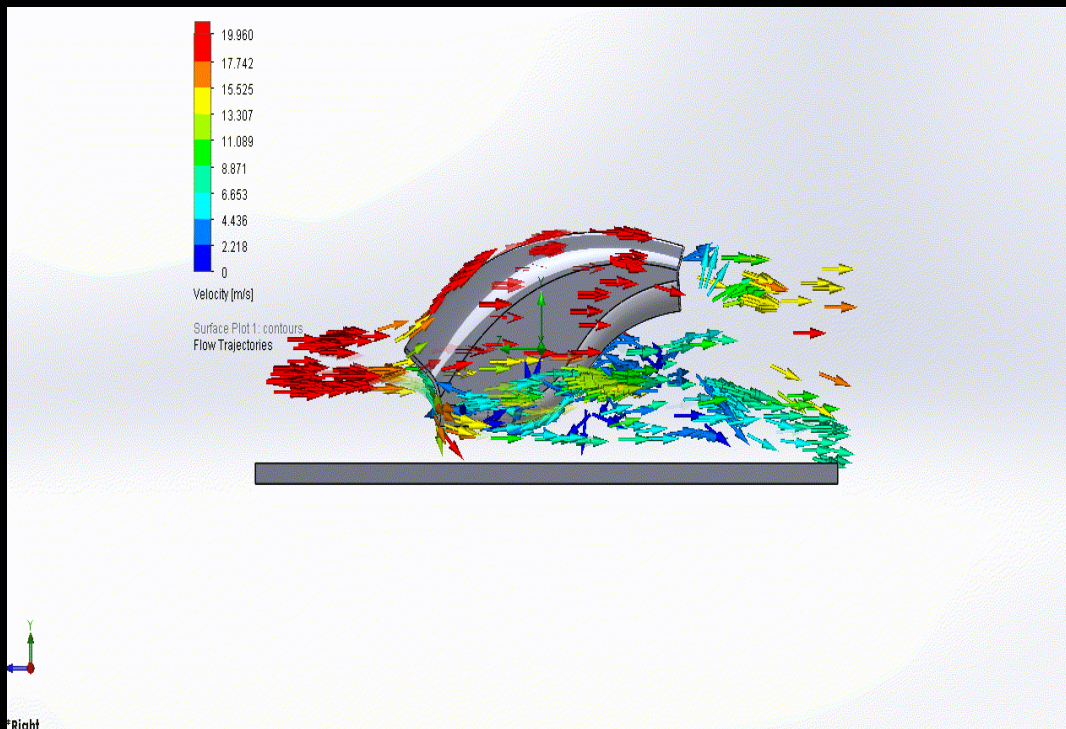
VELOCITY PROFILE

- 30 mph



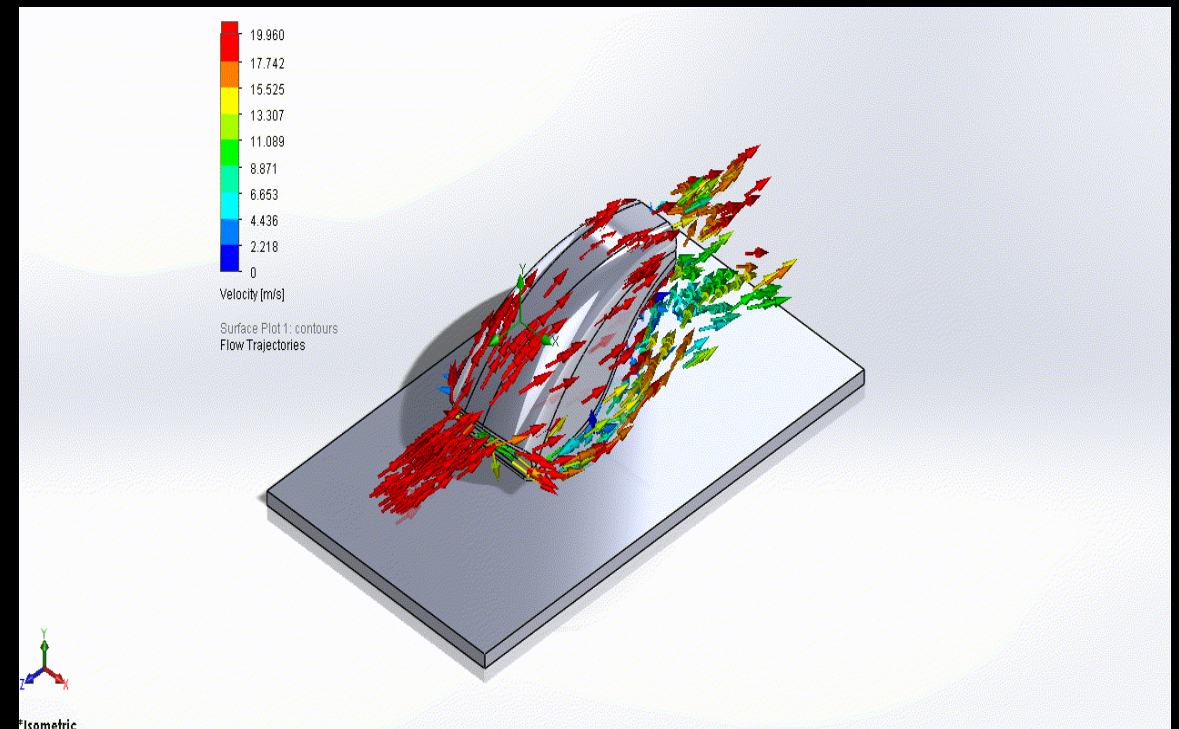
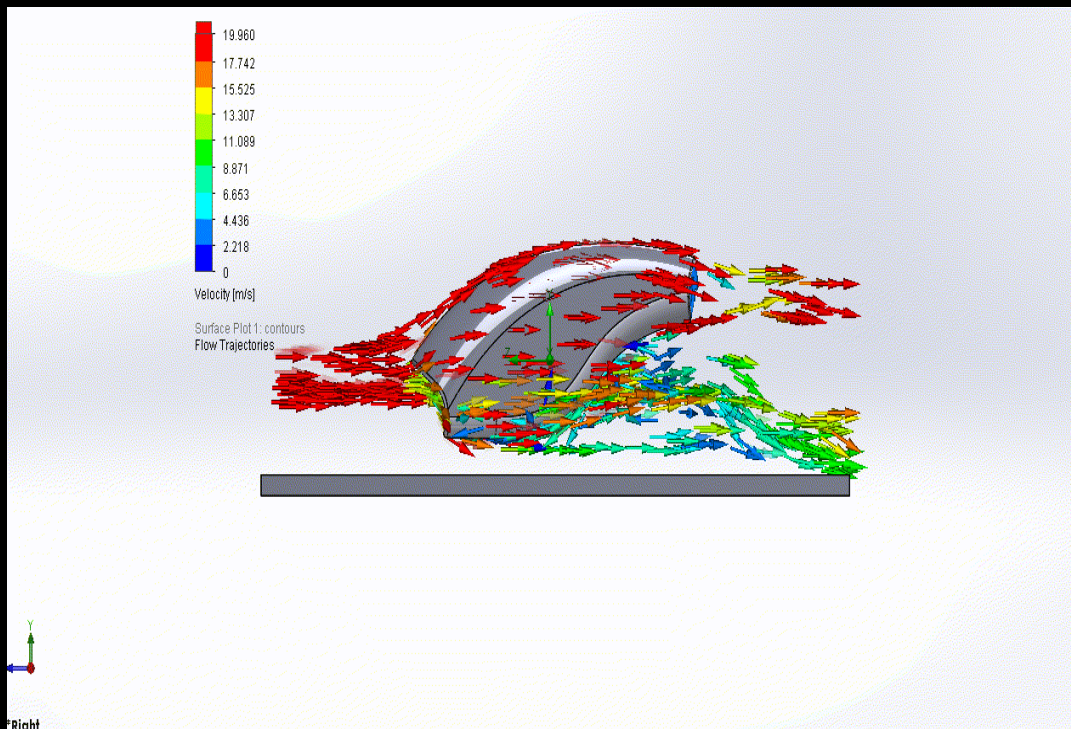
VELOCITY PROFILE

- 45 mph



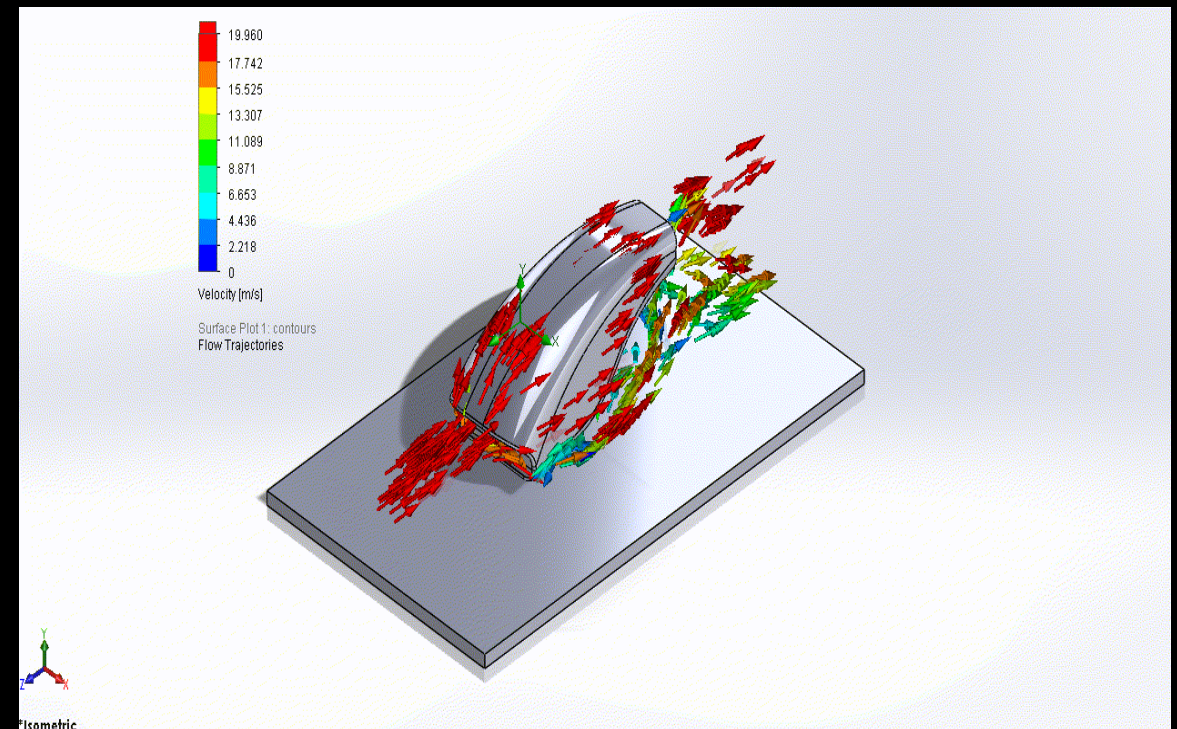
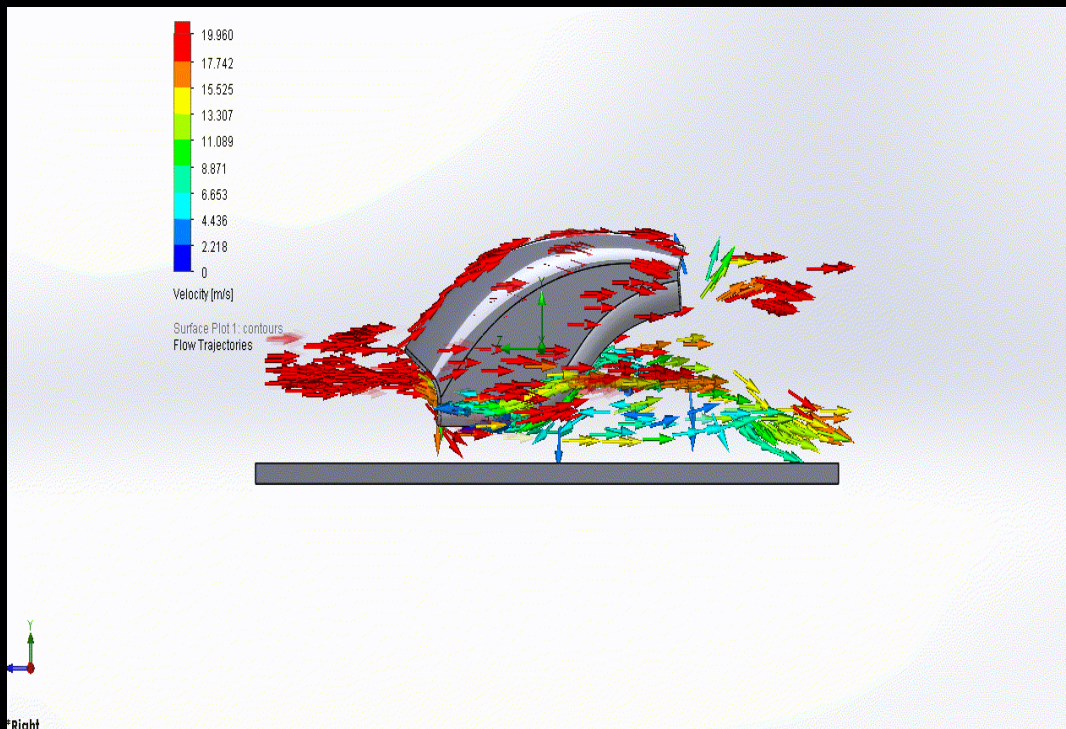
VELOCITY PROFILE

- 60 mph



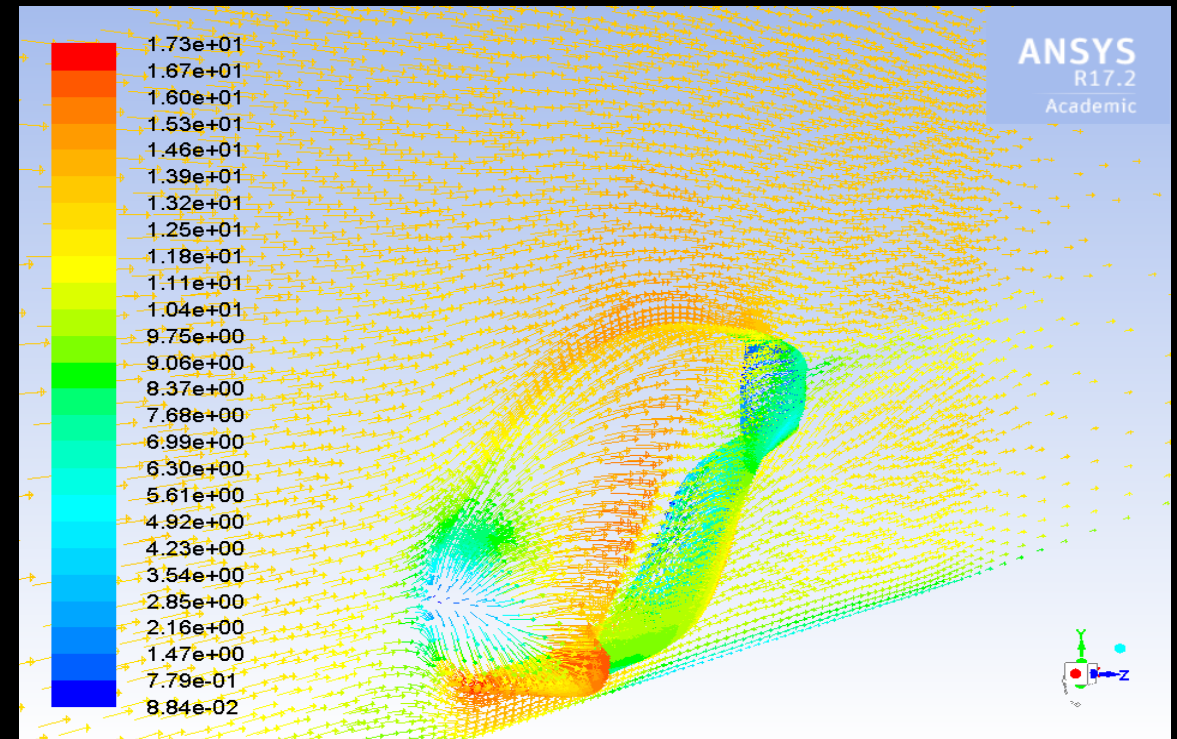
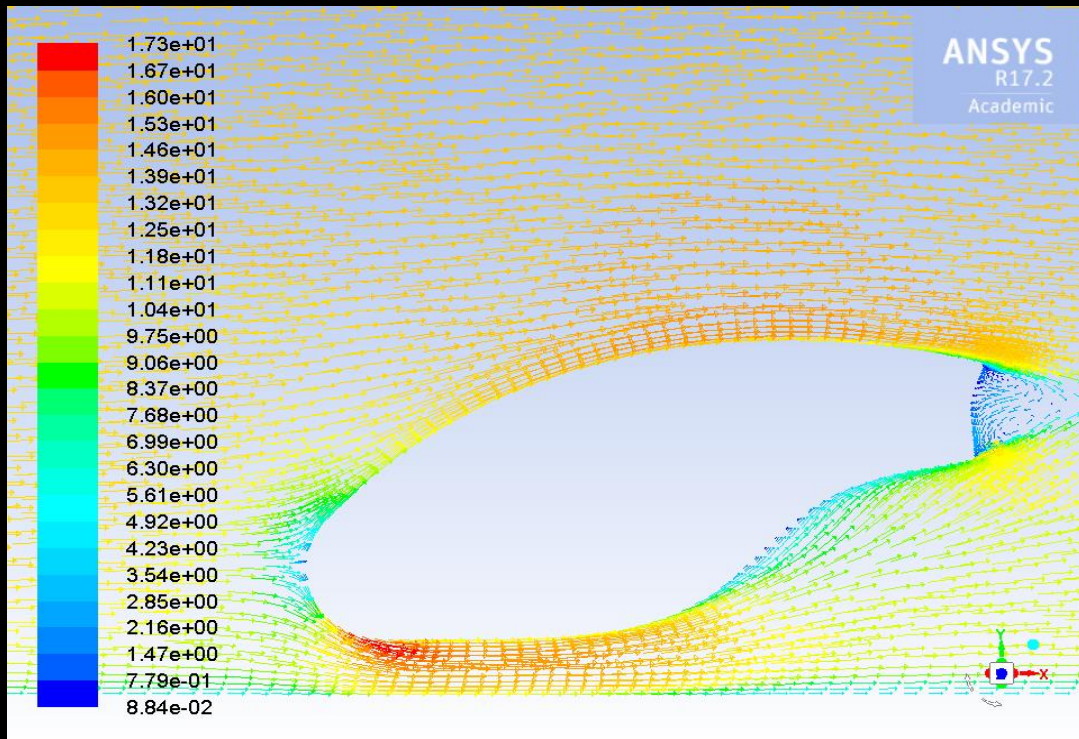
VELOCITY PROFILE

- 75 mph



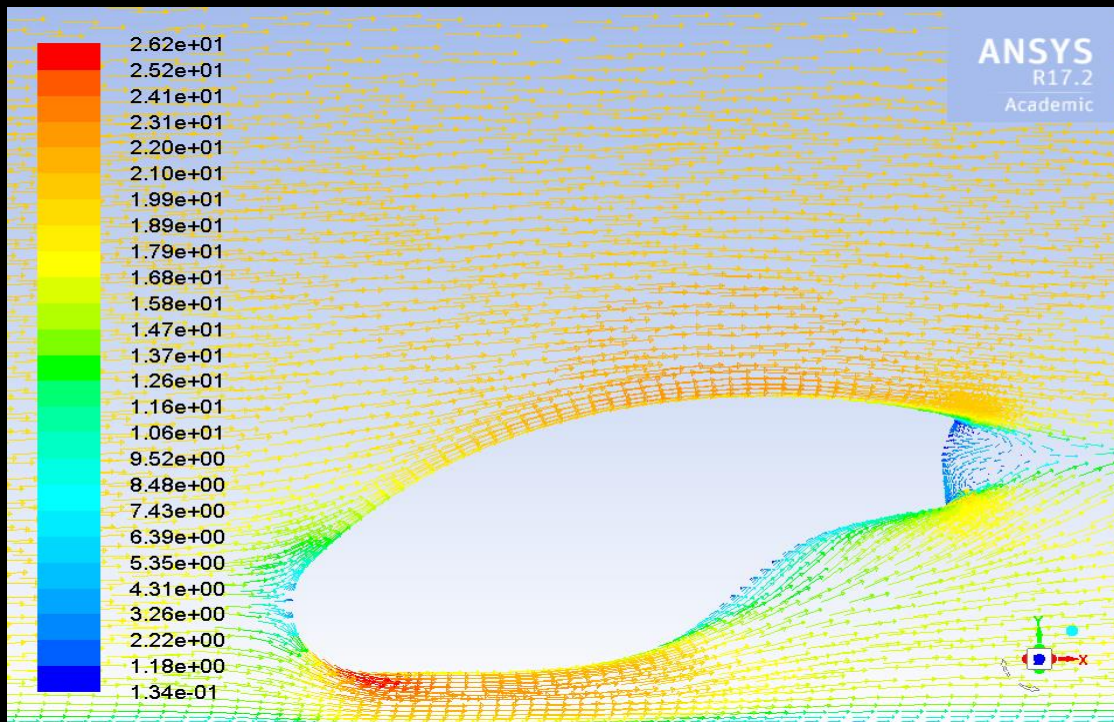
VELOCITY PROFILE

- 30 mph



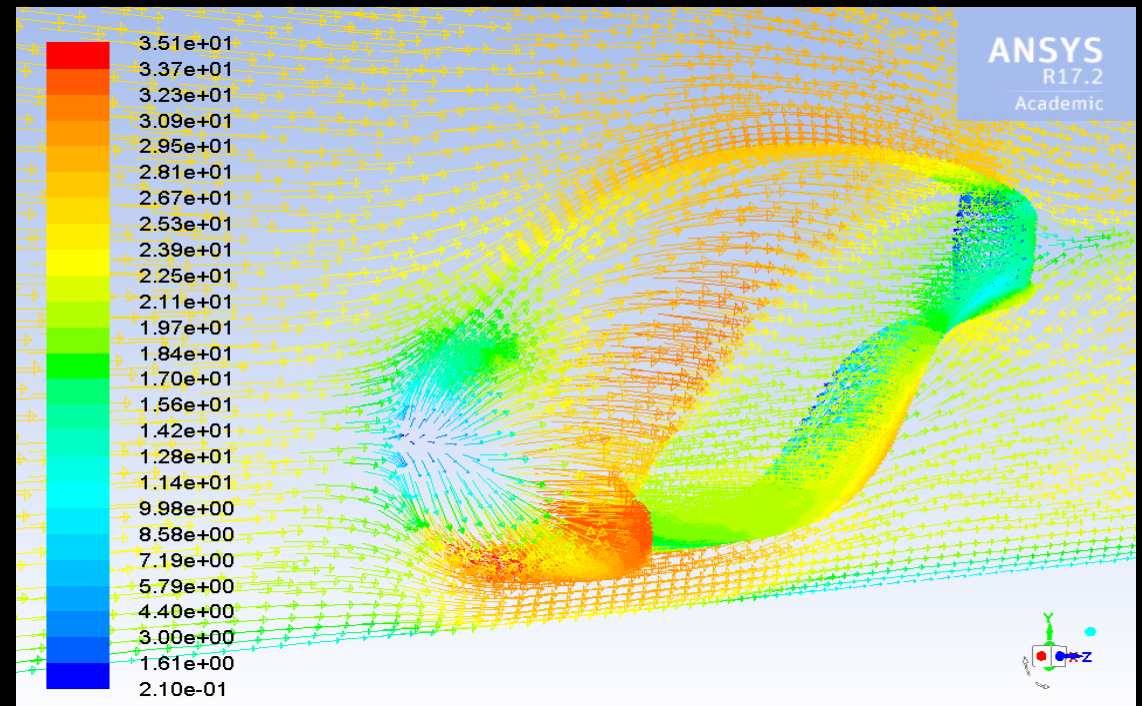
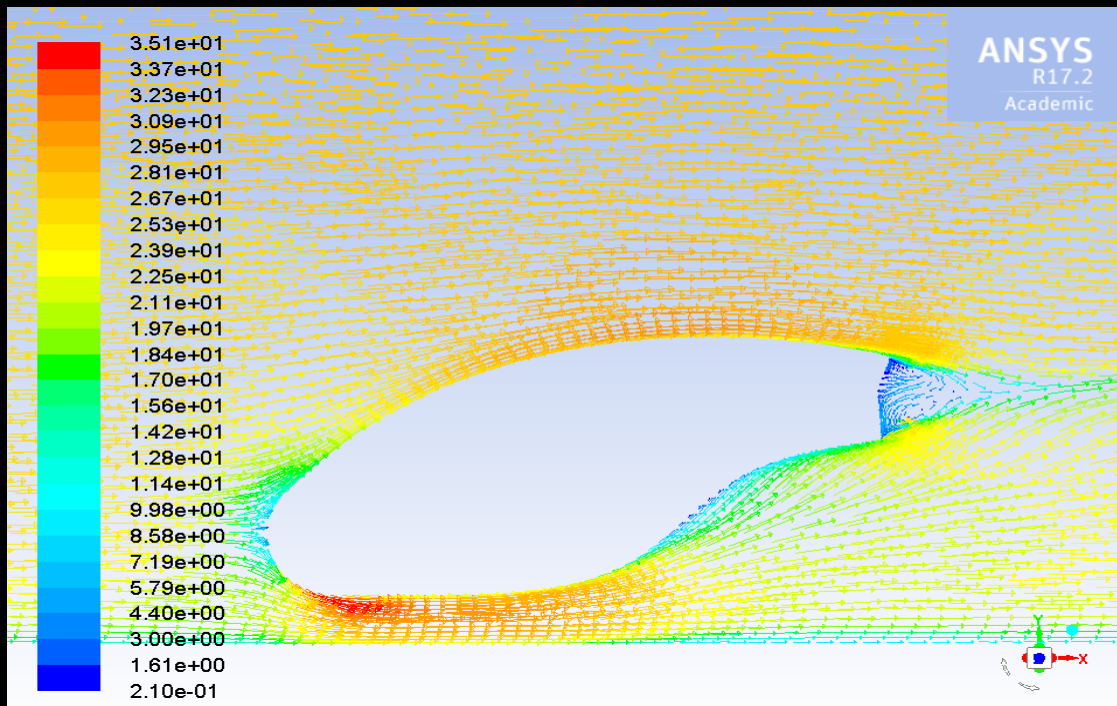
VELOCITY PROFILE

- 45 mph



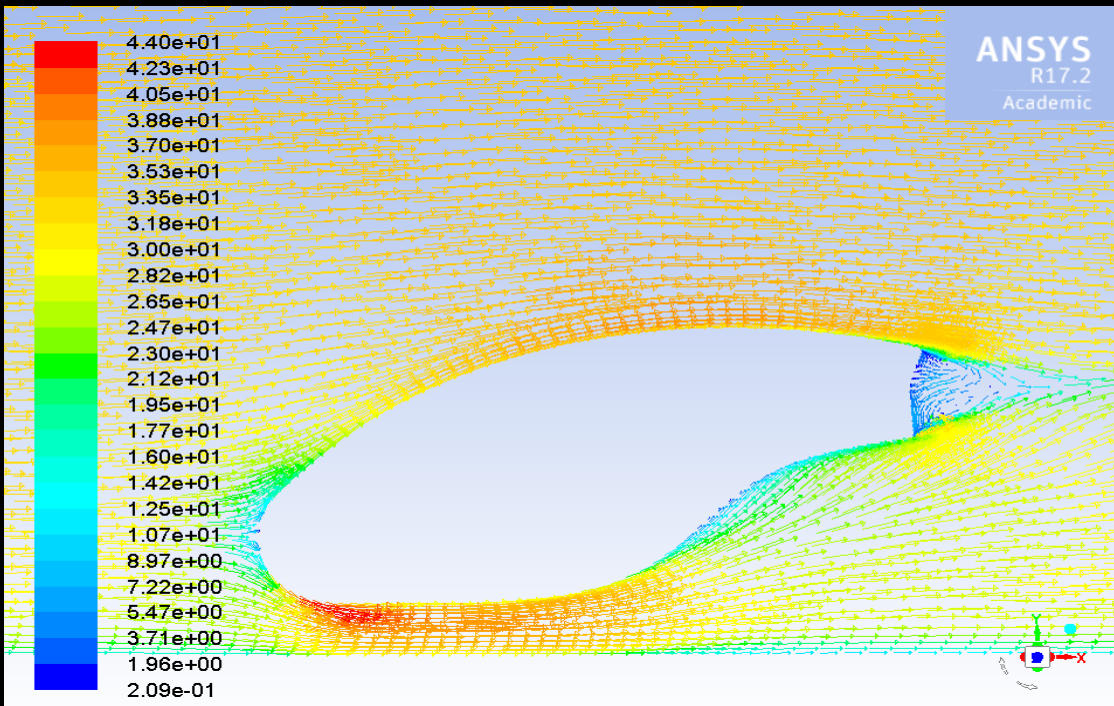
VELOCITY PROFILE

- 60 mph



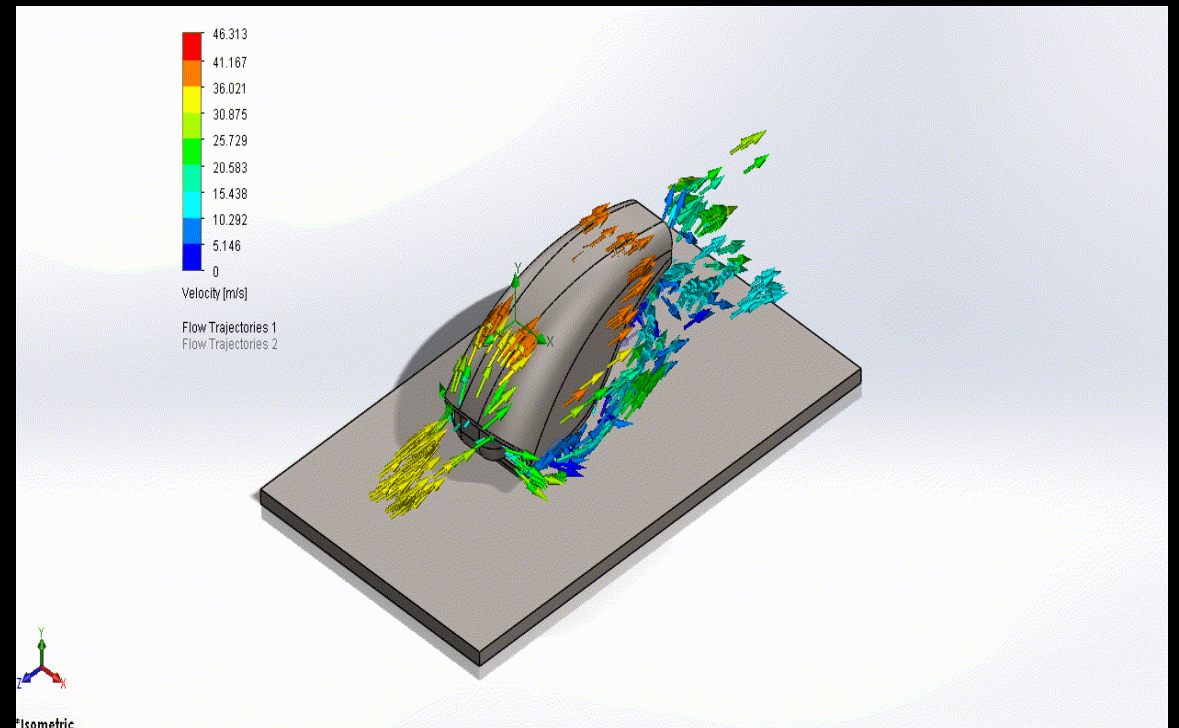
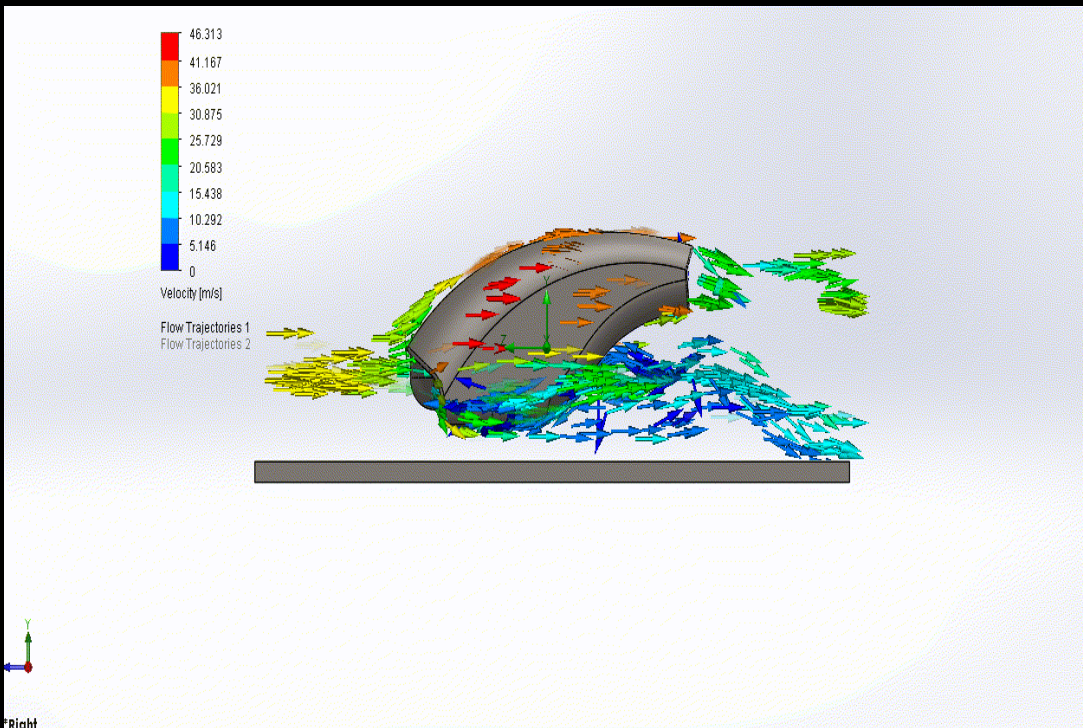
VELOCITY PROFILE

- 75 mph



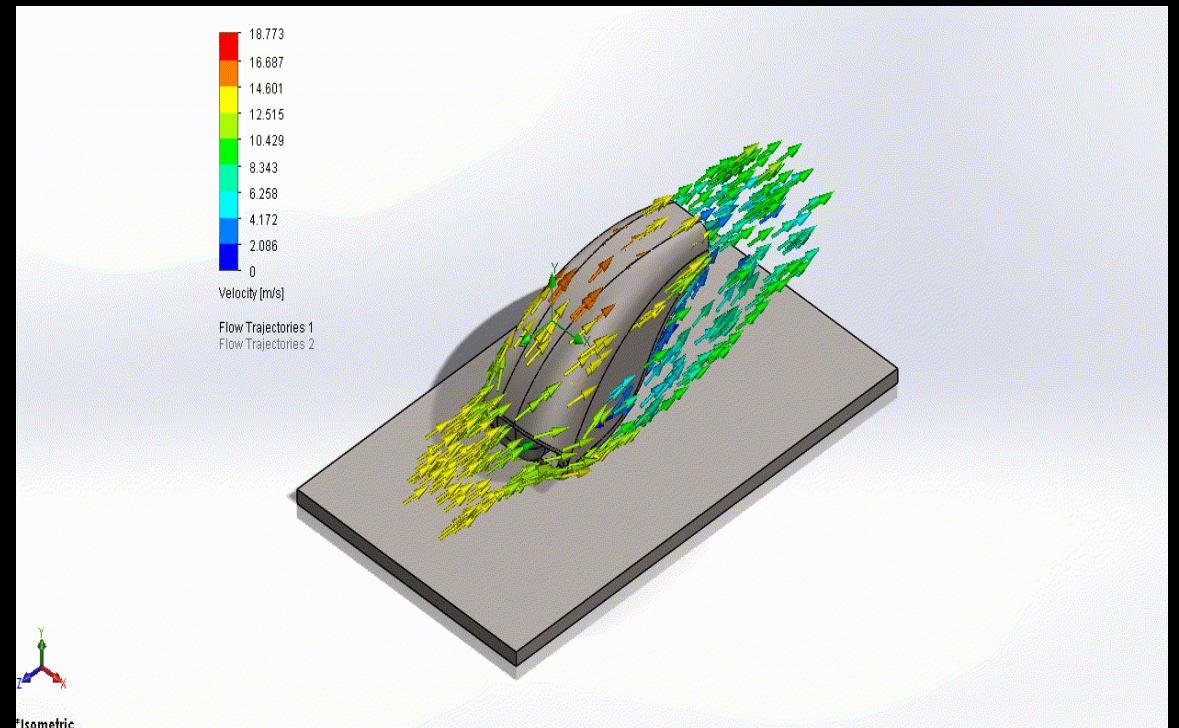
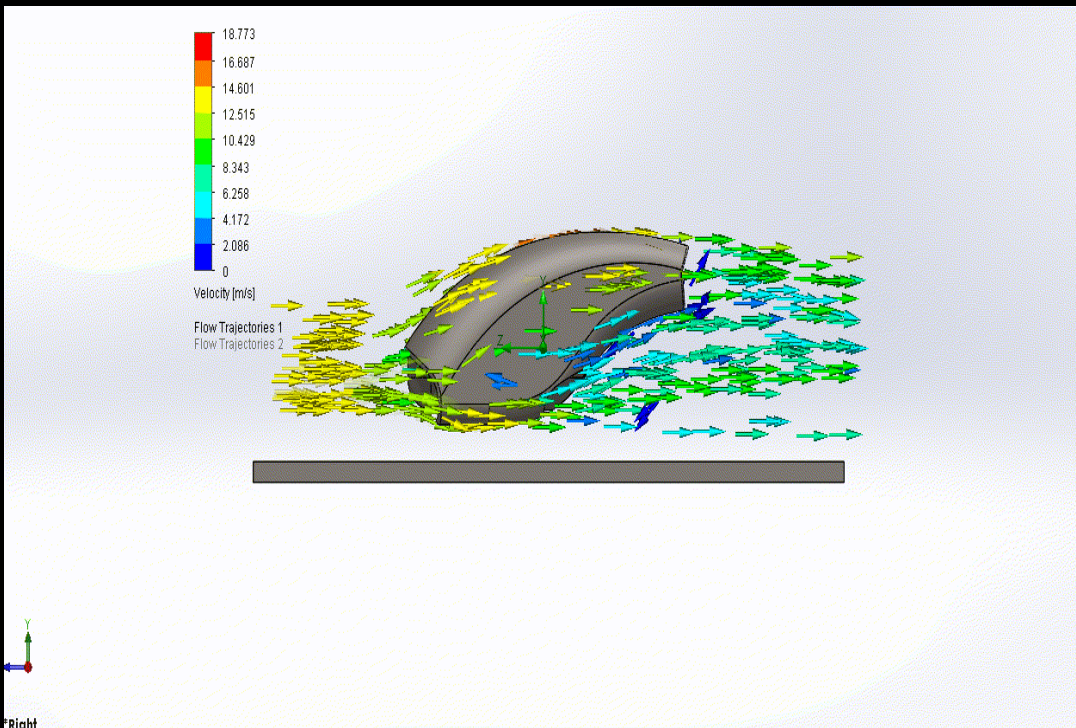
VELOCITY PROFILE

- 30 mph



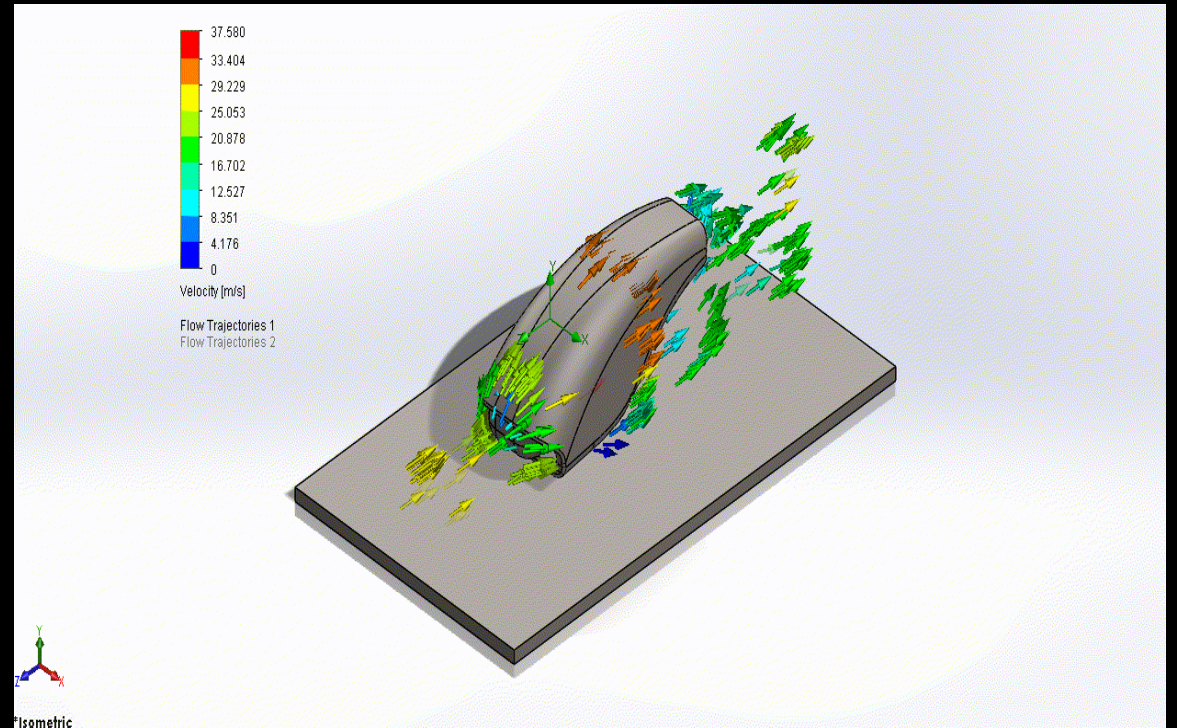
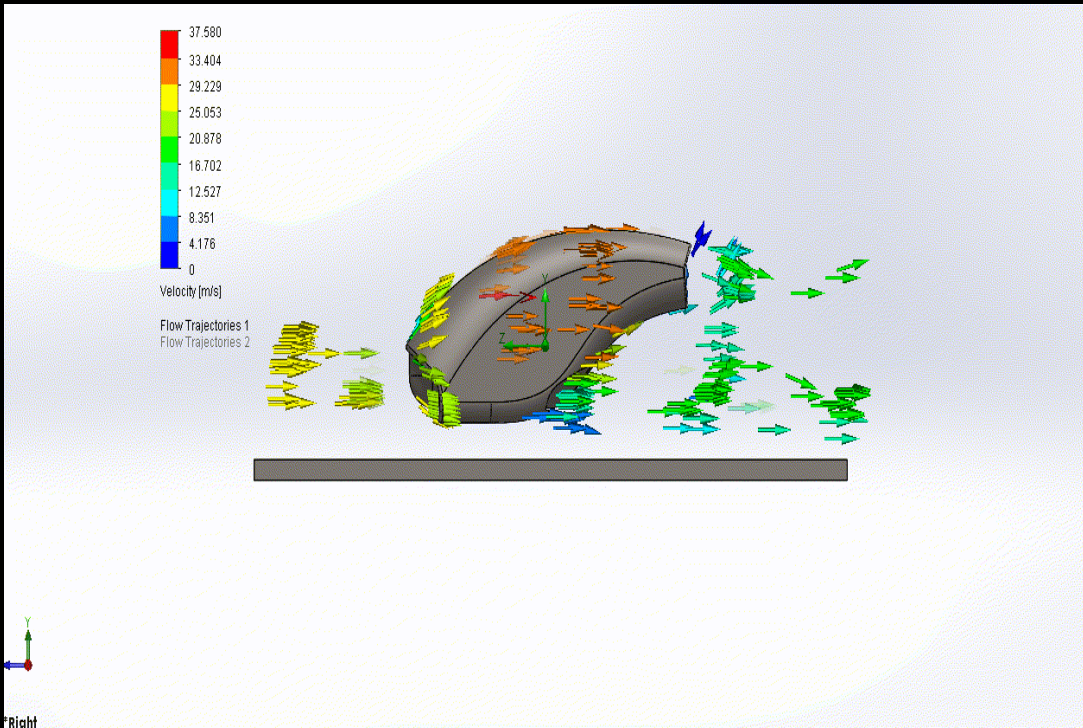
VELOCITY PROFILE

- 45 mph



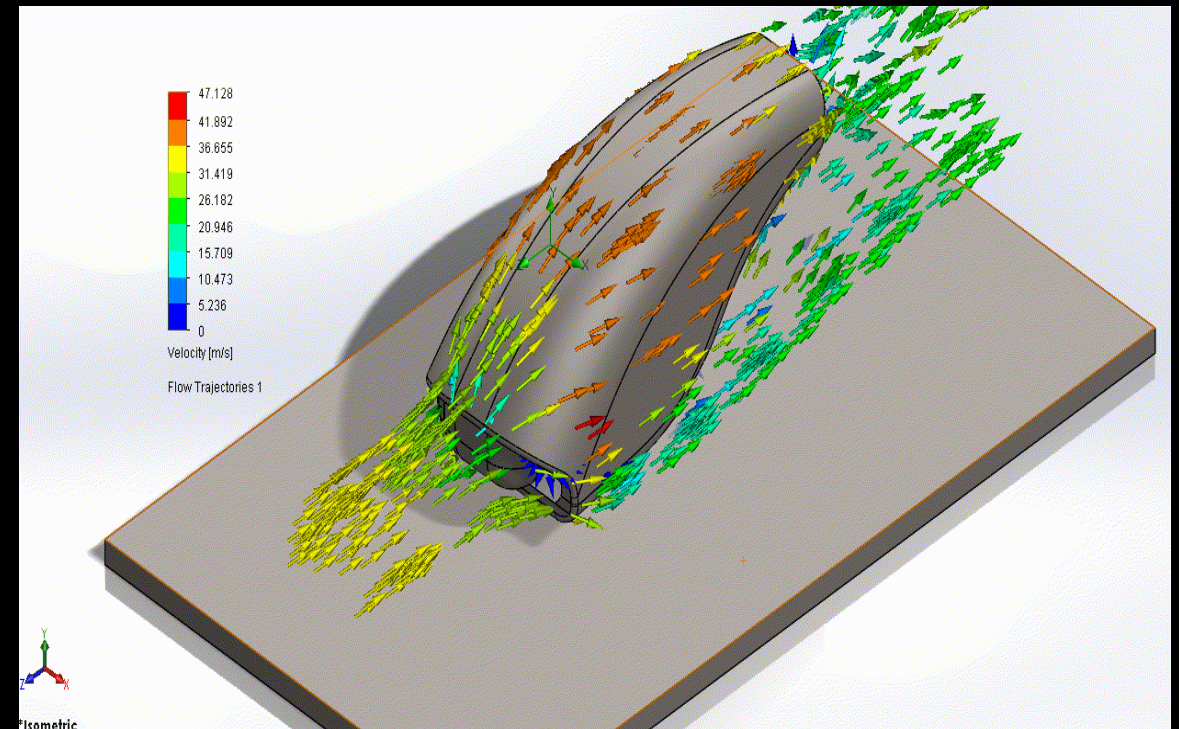
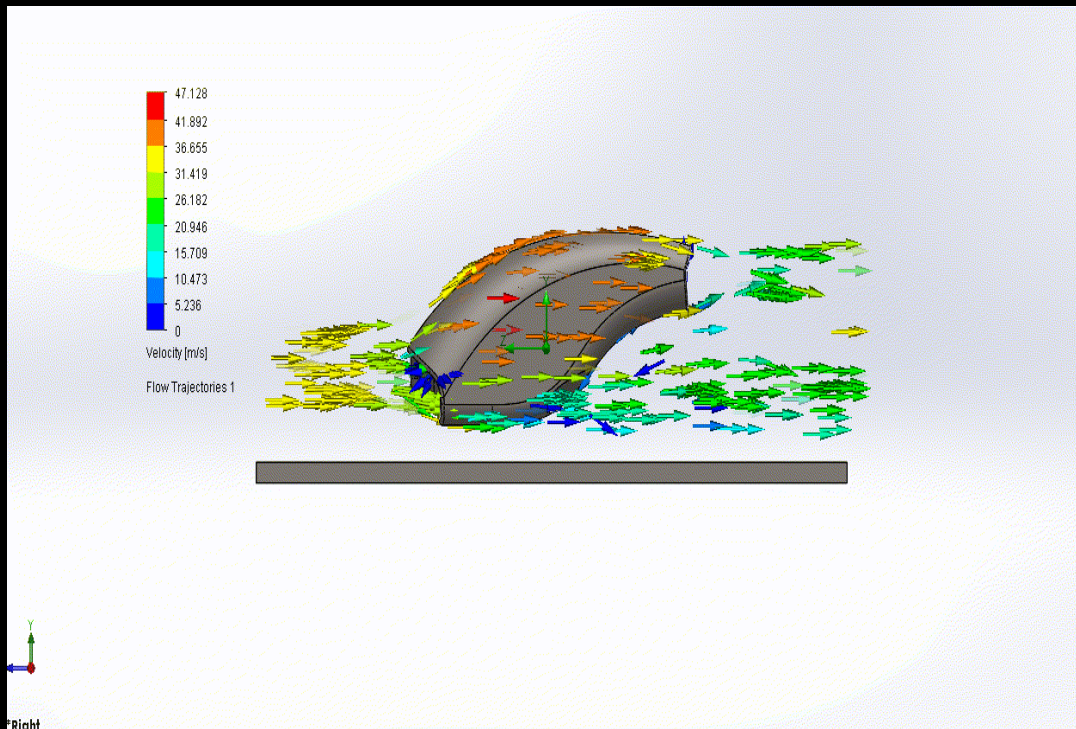
VELOCITY PROFILE

- 60 mph



VELOCITY PROFILE

- 75 mph



VELOCITY DATA [M/S]

Original Design

At 30 mph:

- Maximum velocity = 20.3
- Average velocity = 13.4

At 45 mph:

- Maximum velocity = 30.6
- Average velocity = 20.1

At 60 mph:

- Maximum velocity = 40.6
- Average velocity = 26.8

At 75 mph:

- Maximum velocity = 50.7
- Average velocity = 33.4

Rounded Nose Design

At 30 mph:

- Maximum velocity = 17.3
- Average velocity = 10.5

At 45 mph:

- Maximum velocity = 26.2
- Average velocity = 17.0

At 60 mph:

- Maximum velocity = 35.1
- Average velocity = 21.5

At 75 mph:

- Maximum velocity = 44.0
- Average velocity = 28.3

Ventilation Design

At 30 mph:

- Maximum velocity = 20.2
- Average velocity = 13.2

At 45 mph:

- Maximum velocity = 29.0
- Average velocity = 19.9

At 60 mph:

- Maximum velocity = 41.2
- Average velocity = 26.5

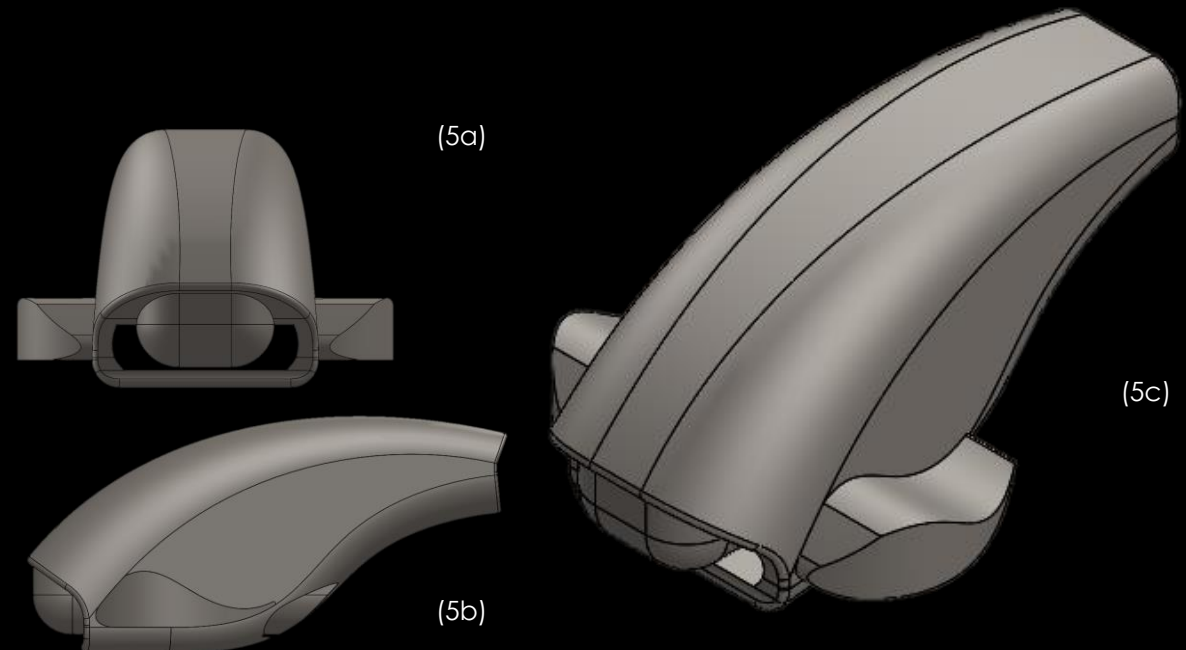
At 75 mph:

- Maximum velocity = 48.2
- Average velocity = 33.1

RECOMMENDATIONS

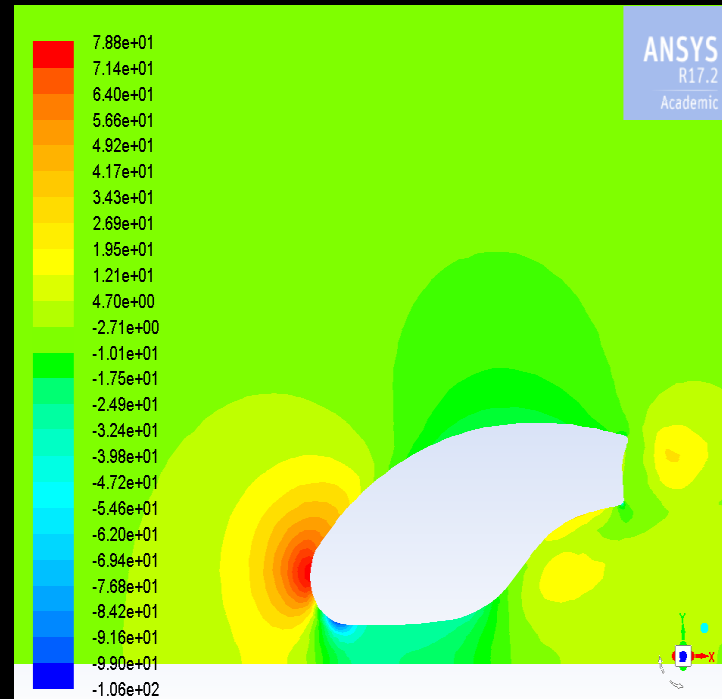
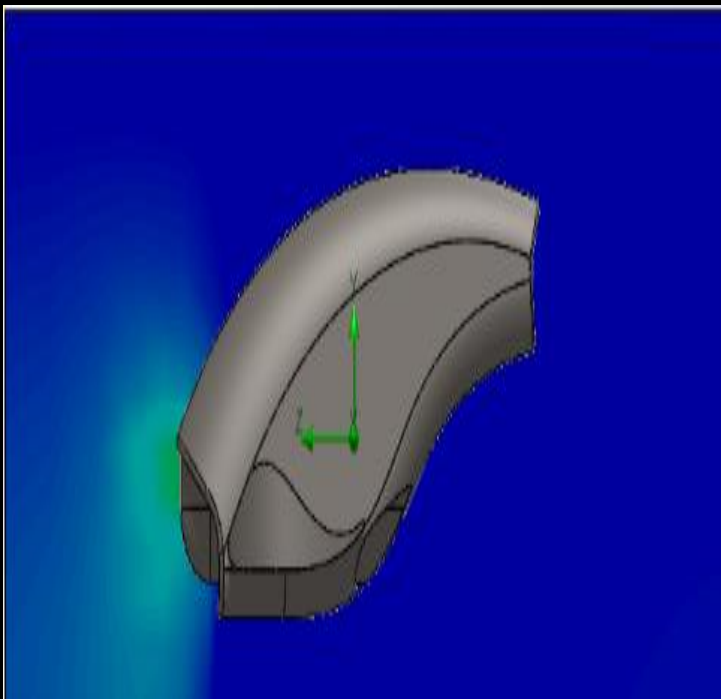
- Recommended additional analysis: temperature distribution
 - Temperature distribution at varying battery temperatures
 - Temperature distribution at varying battery positions
- Recommended design: rounded nose design
 - At higher velocities, concern arises over the magnitude of the lift force at the front lower section of the vehicle body
 - Winged design satisfies this consideration by lowering the lift force under the body

Figure 5: Front view (a), right view (b), and isometric view (c) of the winged design



PRESSURE PROFILE [KPA]

30 mph

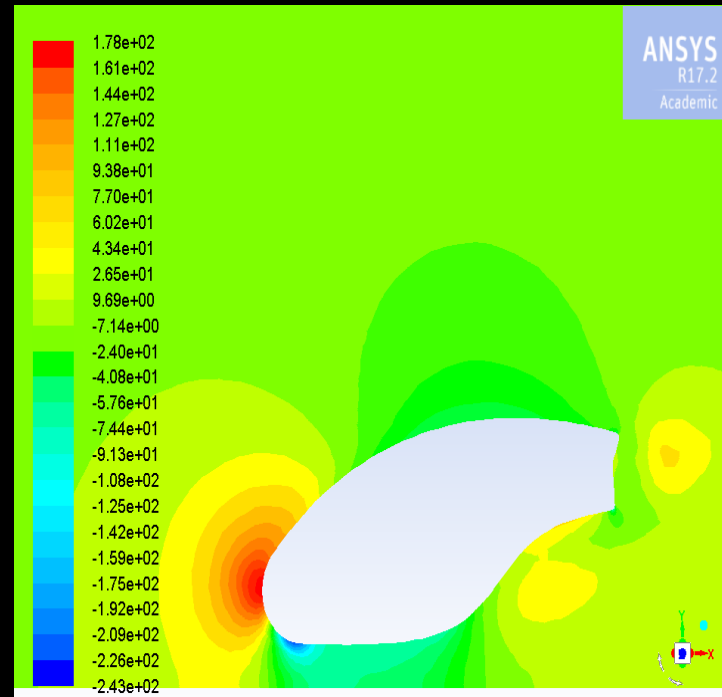
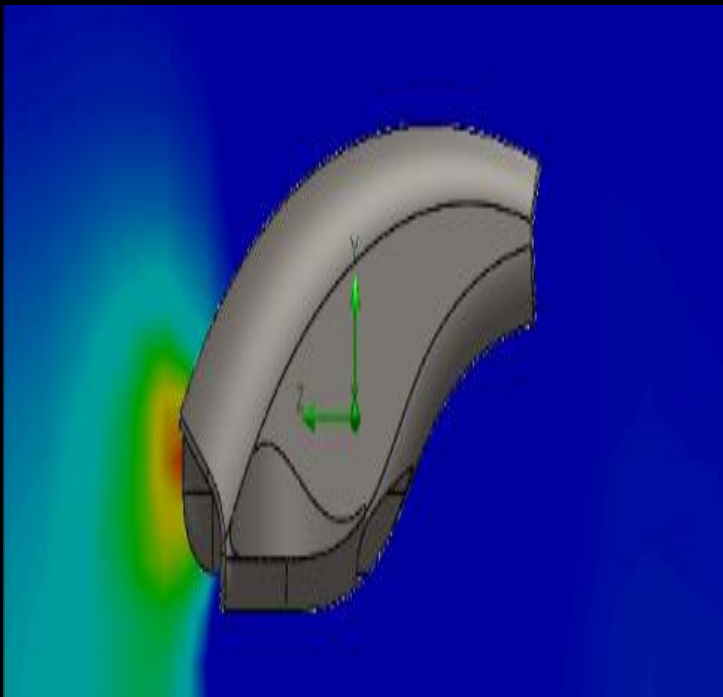


- Winged design:
 - Maximum pressure: 80.0
 - Average pressure: 79.8
- Rounded nose design:
 - Maximum pressure: 78.8
 - Average pressure: 78.5

Figure 6: Pressure profile of winged design (left) compared to pressure profile of rounded nose design (right)

PRESSURE PROFILE [KPA]

45 mph

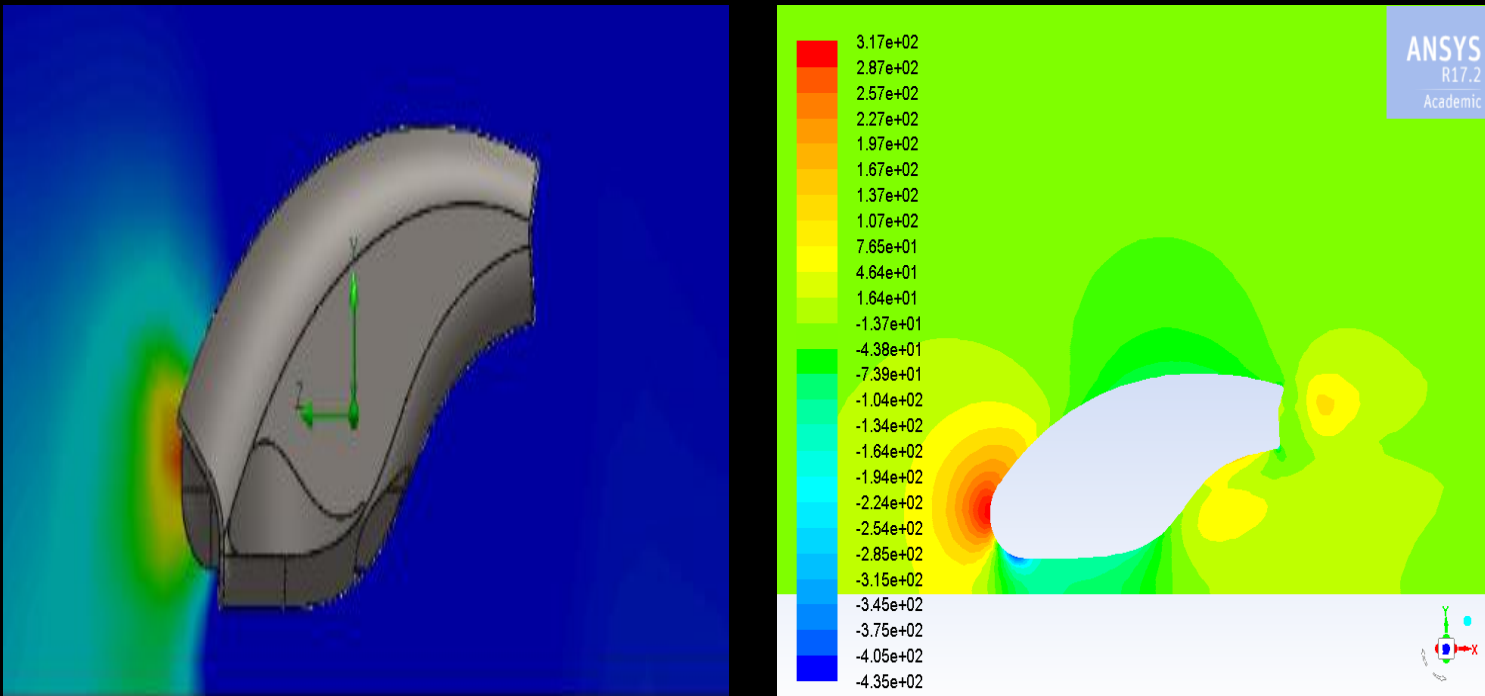


- Winged design:
 - Maximum pressure: 80.6
 - Average pressure: 79.9
- Rounded nose design:
 - Maximum pressure: 79.4
 - Average pressure: 79.0

Figure 7: Pressure profile of winged design (left) compared to pressure profile of rounded nose design (right)

PRESSURE PROFILE [KPA]

60 mph

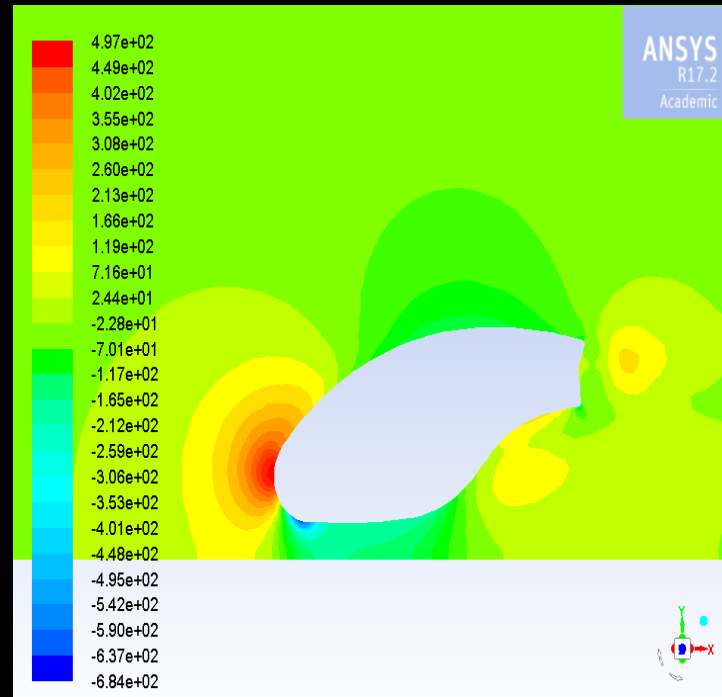
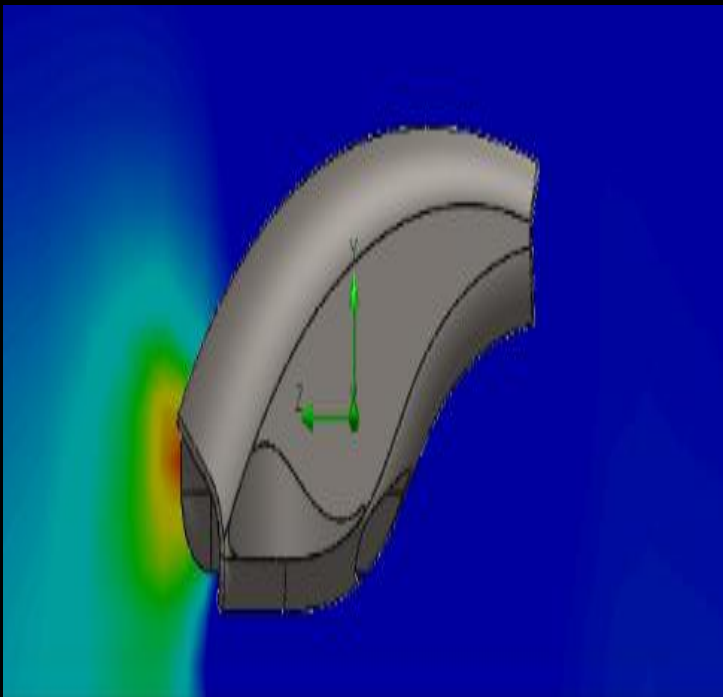


- Winged design:
 - Maximum pressure: 81.2
 - Average pressure: 80.2
- Rounded nose design:
 - Maximum pressure: 79.9
 - Average pressure: 79.1

Figure 8: Pressure profile of winged design (left) compared to pressure profile of rounded nose design (right)

PRESSURE PROFILE [KPA]

75 mph



- Winged design:
 - Maximum pressure: 81.5
 - Average pressure: 80.9
- Rounded nose design:
 - Maximum pressure: 80.3
 - Average pressure: 79.6

Figure 9: Pressure profile of winged design (left) compared to pressure profile of rounded nose design (right)

QUESTIONS?