CAE simulation 4

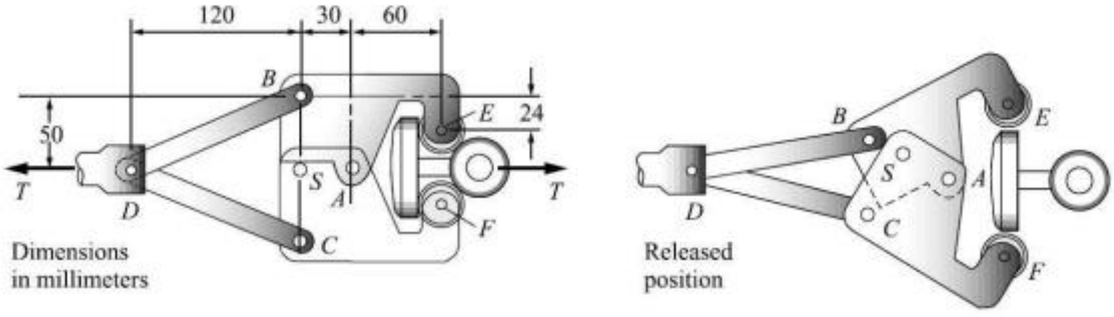


Figure 1. Overload protection device

$$T = 1858\ [N]$$

$$A_x = 0, \qquad A_y = -743.4\ [N]$$

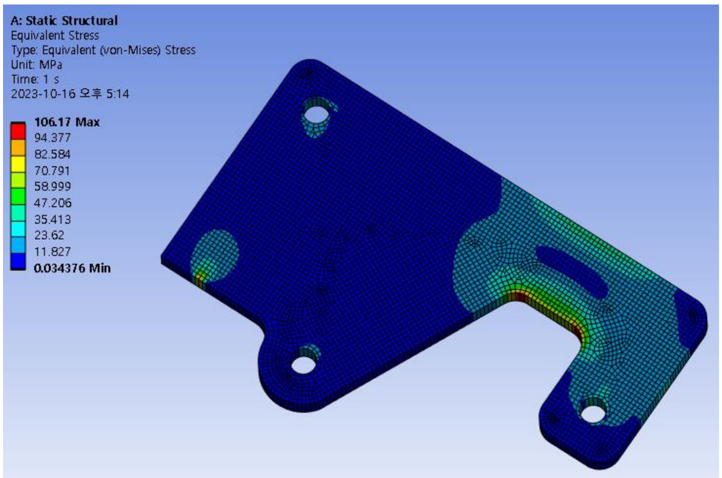


Figure 2. Ansys model analysis

1. Reaction force at pin A

Details of "Force Reaction"

Definition	
Type	Force Reaction
Location Method	Boundary Condition
Boundary Condition	Frictionless Support
Orientation	Global Coordinate System
Suppressed	No
Options	
Result Selection	All
Display Time	End Time
Results	
Maximum Value Over Time	
X Axis	2.1249e-002 N
Y Axis	-743.31 N
Z Axis	0. N
Total	743.31 N
Minimum Value Over Time	
X Axis	2.1249e-002 N
Y Axis	-743.31 N
Z Axis	0. N
Total	743.31 N
Information	

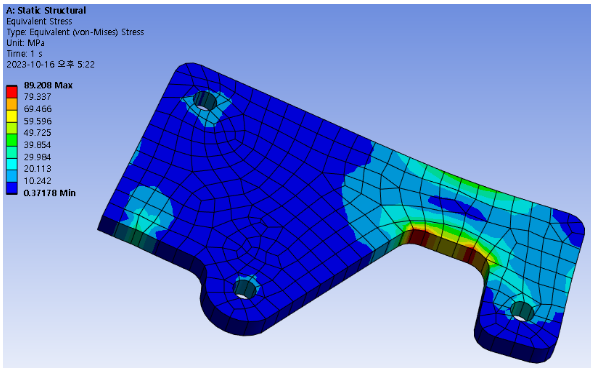
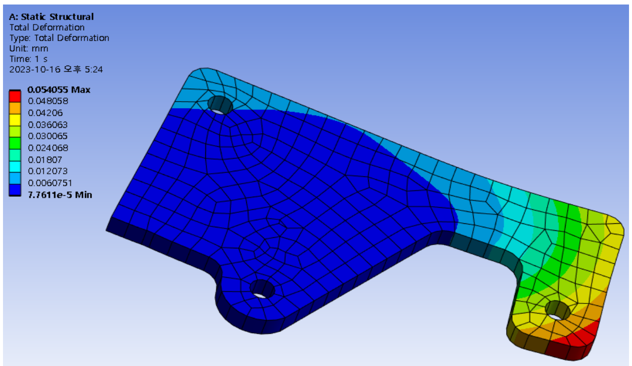
Figure 3. Reaction force at pin A

$$A_x = 0, \qquad A_y = -743.31\ [N]$$

As can be seen in the **Figure 2**, reaction force value at pin A is same with theoretical value.

2. Mesh convergence test

1) mesh size : 5 $[mm]$

<table>
<tr><th>Equivalent stress</th><th>Total deformation</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

2) mesh size : 4 $[mm]$

<table>
<tr><th>Equivalent stress</th><th>Total deformation</th></tr>
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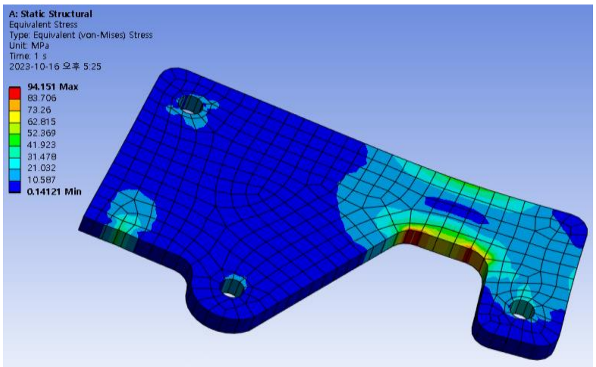

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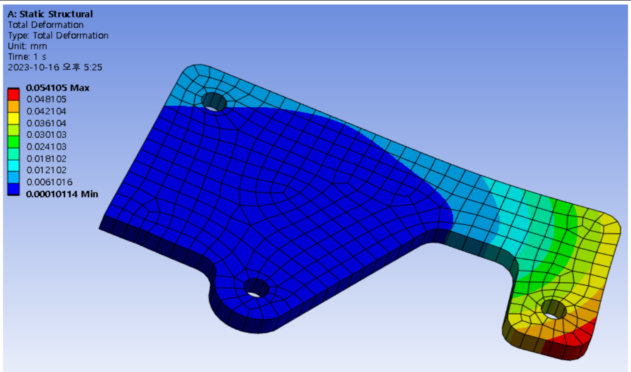
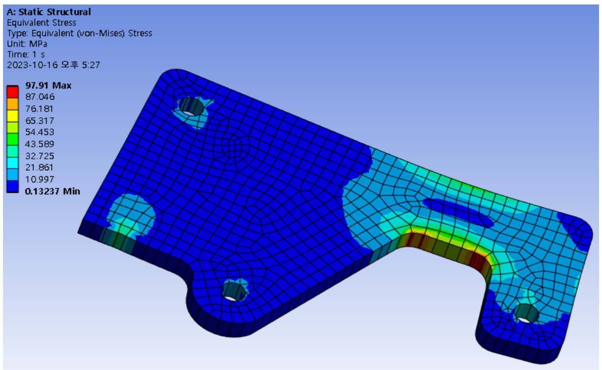


</td></tr>
</table>

3) mesh size : 3 $[mm]$

<table>
<tr><th>Equivalent stress</th><th>Total deformation</th></tr>
<tr><td>


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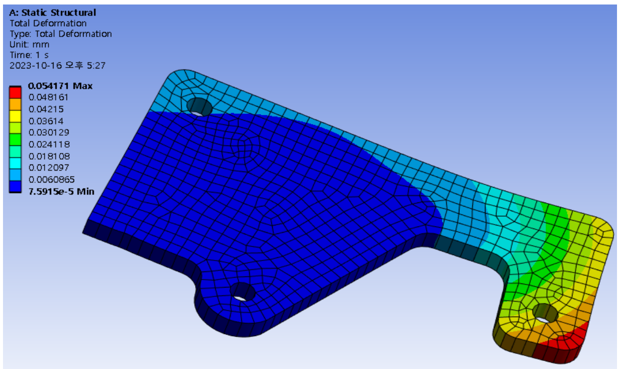

</td></tr>
</table>

4) mesh size : 2 $[mm]$

<table>
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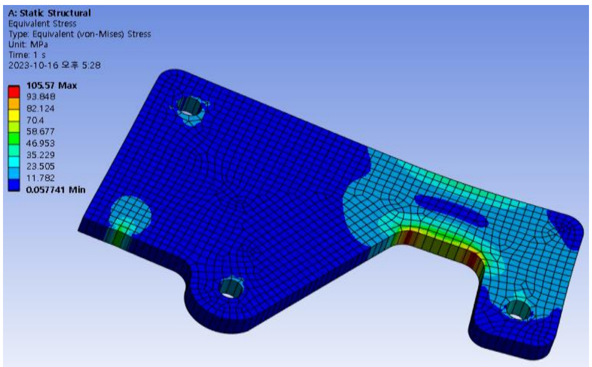

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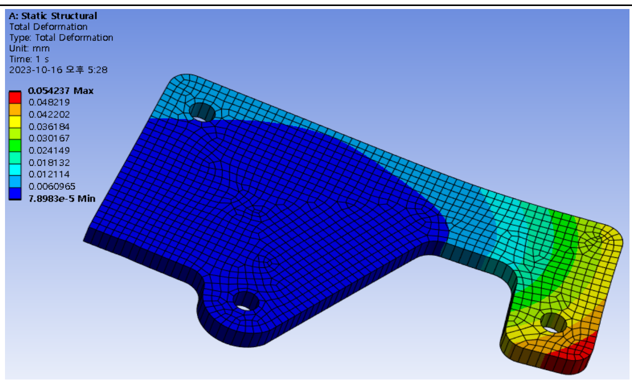
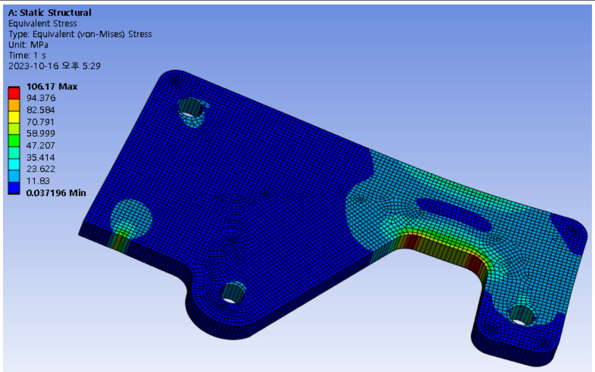
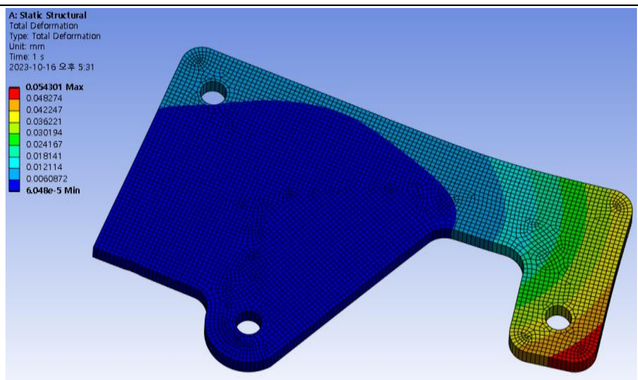


</td></tr>
</table>

5) mesh size : 1 $[mm]$

<table>
<tr><th>Equivalent stress</th><th>Total deformation</th></tr>
<tr><td>
</td><td>
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</table>

As can be seen in the figures above, unlike deformation values, equivalent stress values increase as mesh size decreases. This is because as mesh size gets smaller, the more stress concentration at specific point occurs. Furthermore, skewness of mesh used in this simulation is under 0.9, which indicates that the quality of mesh is good enough to use.

× Sheet | ✓ Solid | ✓ Solid - Surface

Error Check	Quality Criterion	Warning Limit	Error (Failure) Limit	Worst
☐	Max Aspect Ratio	Default (5)	Default (1000)	30.863
☐	Min Element Quality	Default (0.05)	Default (5e-04)	0.024
☐	Min Jacobian Ratio (Corner Nodes)	Default (0.05)	Default (0.025)	0.26
☐	Min Jacobian Ratio (Gauss Points)	Default (0.05)	Default (0.025)	0.384
☐	Max Element Edge Length	Default (65.057 mm)	Default (130.114 mm)	6 mm
☐	Max Corner Angle	Default (150 °)	Default (170 °)	137.77 °
☐	Min Element Edge Length	Default (0.651 mm)	Default (0.065 mm)	0.303 mm
☐	Max Skewness	Default (0.9)	Default (0.999)	0.531
☐	Min Tet Collapse	Default (0.1)	Default (1e-03)	NA
☐	Max Warping Angle	Default (20 °)	Default (30 °)	NA

Figure 4. Mesh quality worksheet

3. Thickness of device to prevent material yield (safety factor = 3)

Tensile yield strength of material used in this simulation is 280 $[MPa]$. To consider the safety factor over 3 in the aspect of material yield, thickness of it has to be increased. Stress concentration factor K is considered with 1.9.

$$I = \frac{t \cdot (0.02)^3}{12}$$

$$\sigma_{max} = \frac{Mc}{I} = \frac{22.3 \cdot 0.01}{\frac{t \cdot (0.02)^3}{12}}, \quad \sigma_{max}' = K \cdot \sigma_{max} = 1.9 \cdot \sigma_{max} = \frac{1.9 \cdot 22.3 \cdot 0.01}{\frac{t \cdot (0.02)^3}{12}} = \frac{5.0844}{t \cdot (0.02)^3}$$

$$\frac{\sigma_{yield}}{\sigma_{max}'} = \frac{280 \cdot 10^6}{\frac{5.0844}{t \cdot (0.02)^3}} \geq 3.0\ (safety\ factor)$$

$$t \geq 6.84\ [mm]$$