CAE
Simulation #1

Stress Concentration of A Plate with Hole

21900416
Gyeonheal An

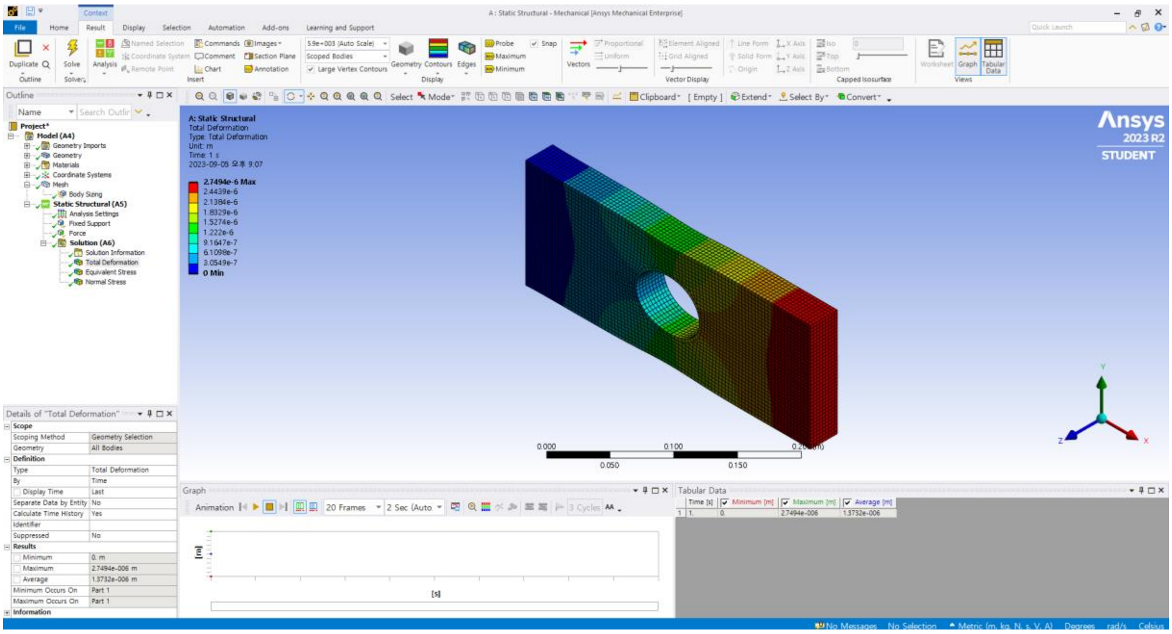

Figure 1.1 Total Deformation (Case 1)

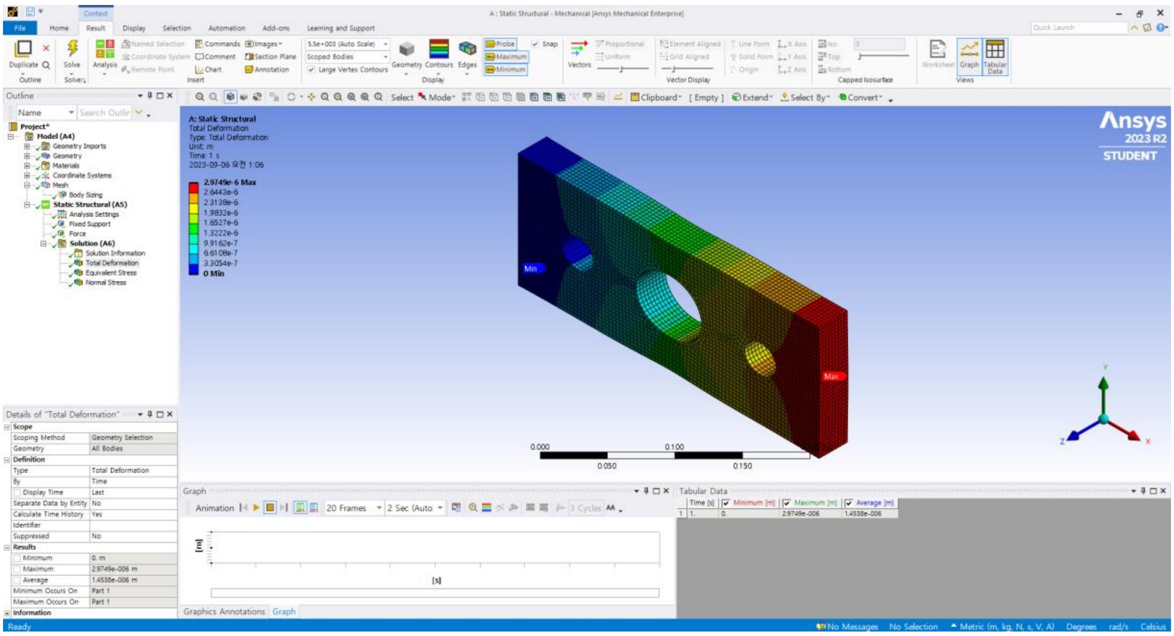

Figure 1.2 Total Deformation (Case 2)

Case No.	Minimum Deformation [m]	Maximum Deformation [m]	Average Deformation [m]
1	0	2.749×10^{-6}	1.373×10^{-6}
2	0	2.974×10^{-6}	1.454×10^{-6}

Table 1. Deformation Value of Each Cases

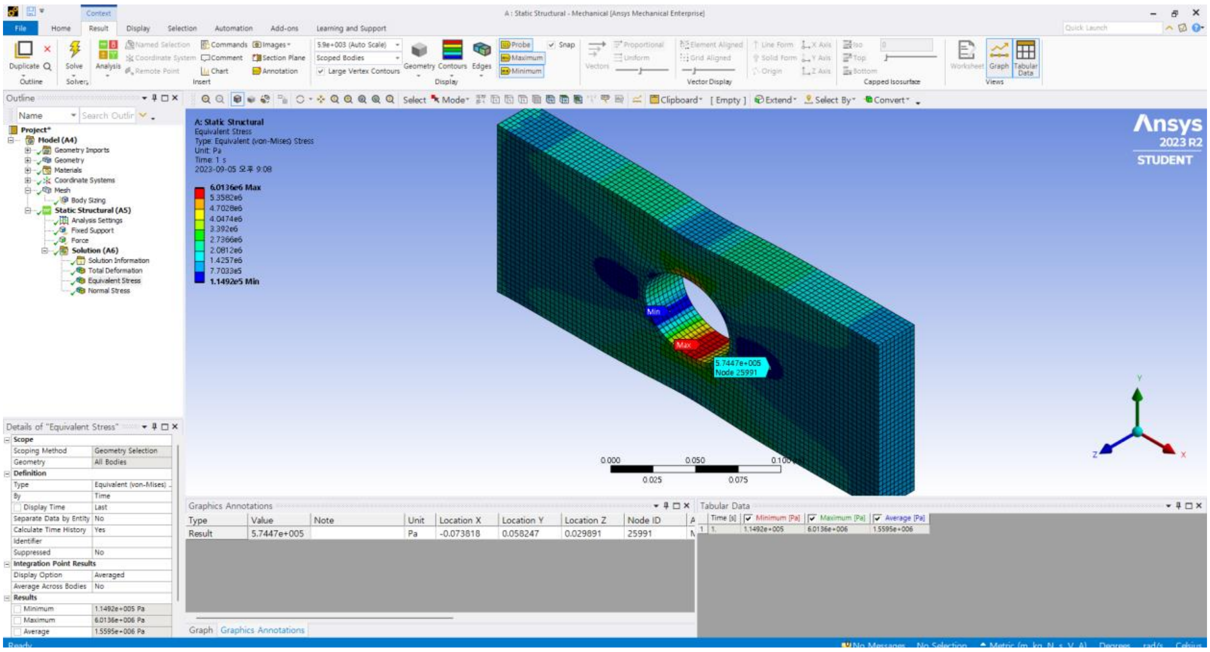

Figure 2.1 Equivalent Stress (Von-mises Stress) (Case 1)

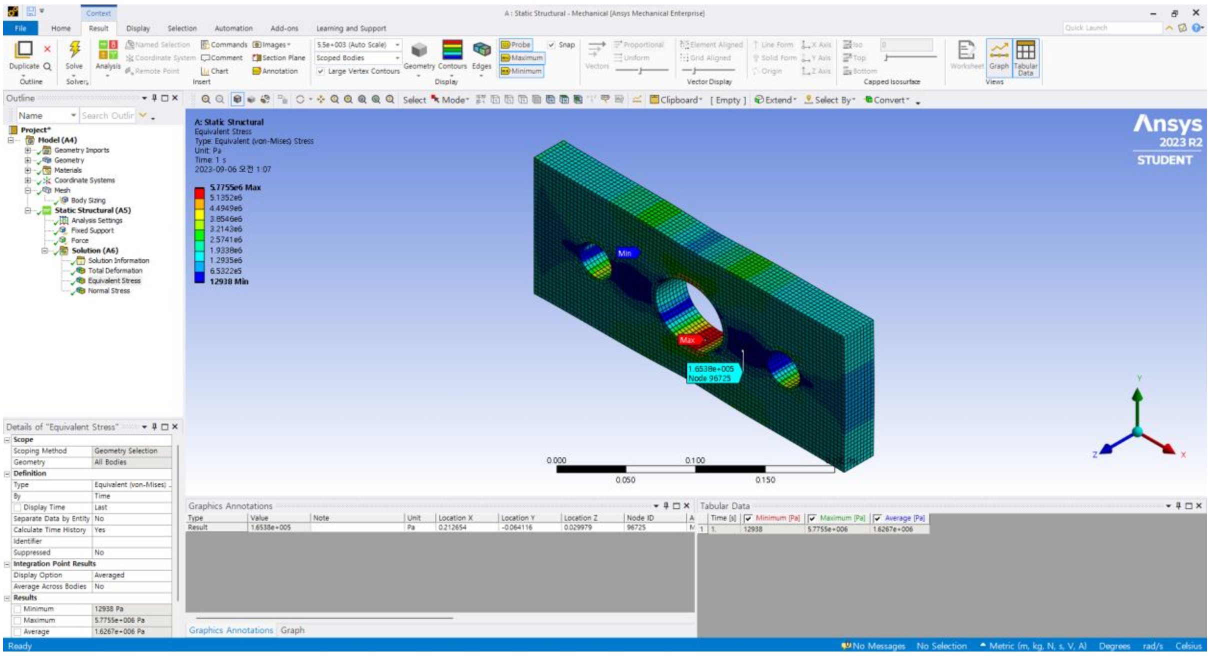

Figure 2.2 Equivalent Stress (Von-mises Stress) (Case 2)

Case No.	Minimum Stress [Mpa]	Maximum Stress [Mpa]	Average Stress [Mpa]
1	0.115	6.013	1.560
2	0.001	5.776	1.637

Table 2. Equivalent Stress Value of Each Cases

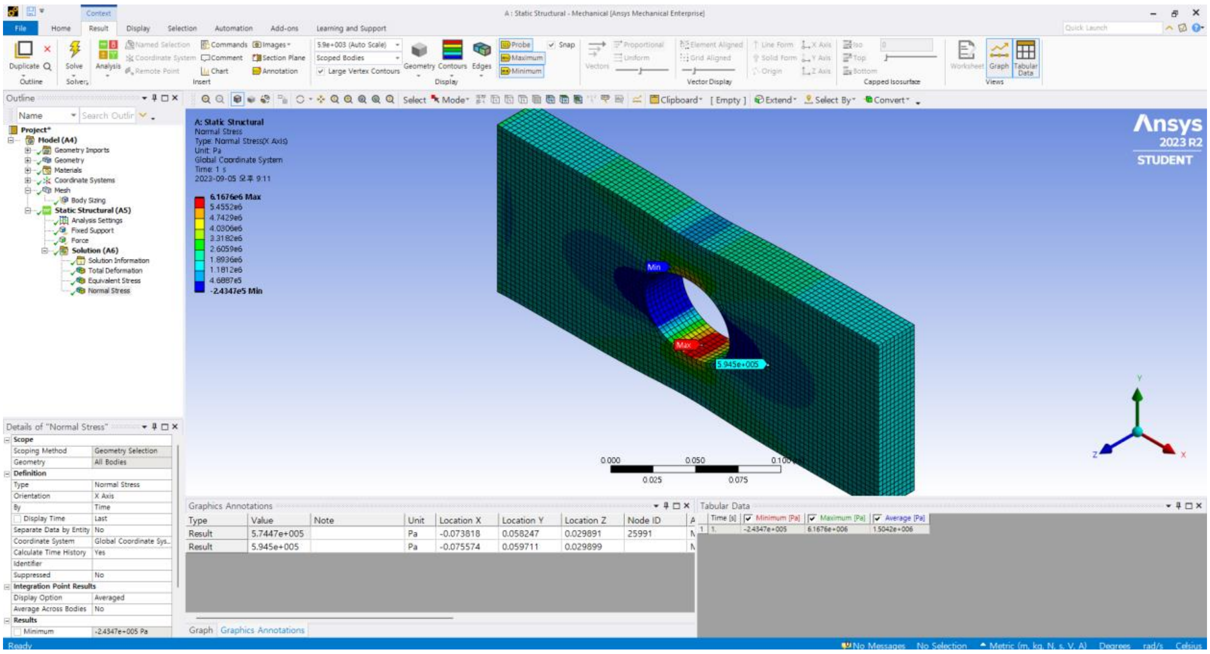

Figure 3.1 Normal Stress (Case 1)

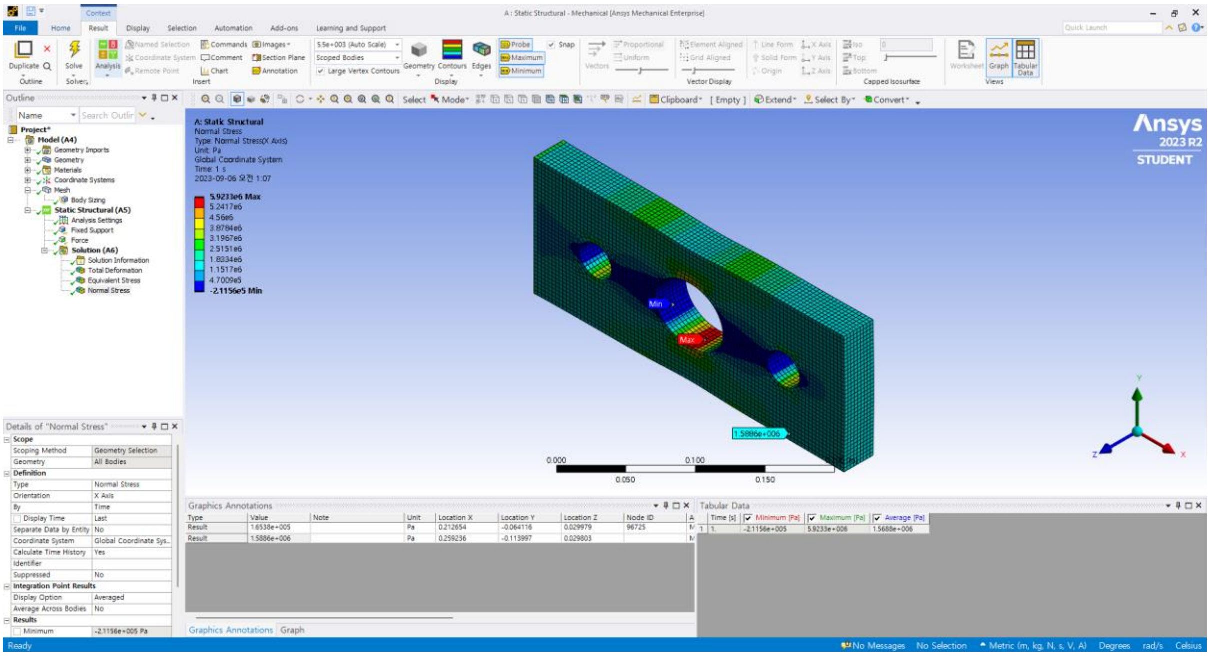

Figure 3.1 Normal Stress (Case 2)

Case No.	Minimum Stress [Mpa]	Maximum Stress [Mpa]	Average Stress [Mpa]
1	−0.243	6.168	1.504
2	−0.212	5.923	1.569

Table 3. Normal Stress Value of Each Cases

1. Compare maximum stress and deformation for the two cases.

When the same force was applied to cases with two different shapes, the degree of deformation and equal stress were compared. Mesh Sizing was set to 3.5mm in the same case, with a fixed support on one side and a tensile force of 5000N on the opposite side. In the case of deformation, it may be seen that the second case, in which two more 30 pi holes in diameter were added, had more deformation of 0.225×10^{-6} [m]. Comparing the Maximum Equivalent Stress, the first case with only one hole with a diameter of 60 pi is 0.3 [Mpa] higher. As a result of comparing the Maximum Normal Stress, the first case is 0.2 [Mpa] higher.

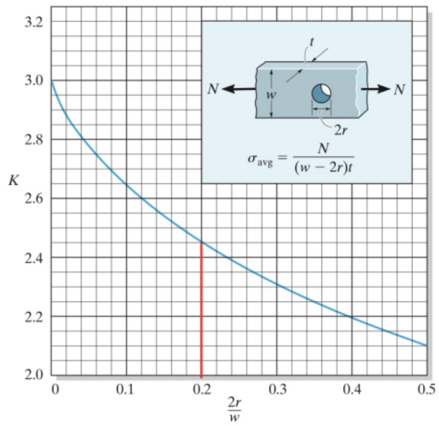

Figure 4. Stress Concentration Factor Graph

We can obtain the maximum stress from the following equation.

$$K = \frac{\sigma_{max}}{\sigma_{avg}}$$

If the stress concentration factor (K) of Case 1 is obtained from the above graph and the average stress is obtained from the equation of Figure 4, the maximum stress of Case 1 is 5.83 [Mpa]. The maximum stress indicated in the simulation is 6 [Mpa], which is almost similar. Through Simulation and Figure 4, it can be confirmed that the maximum stress that an object can withstand is reduced when there are many holes or when the hole is large compared to the object area. In addition, large stresses occur in local areas where irregular stress distribution occurs, such as holes.

2. Which of the design will you select from an analysis standpoint?

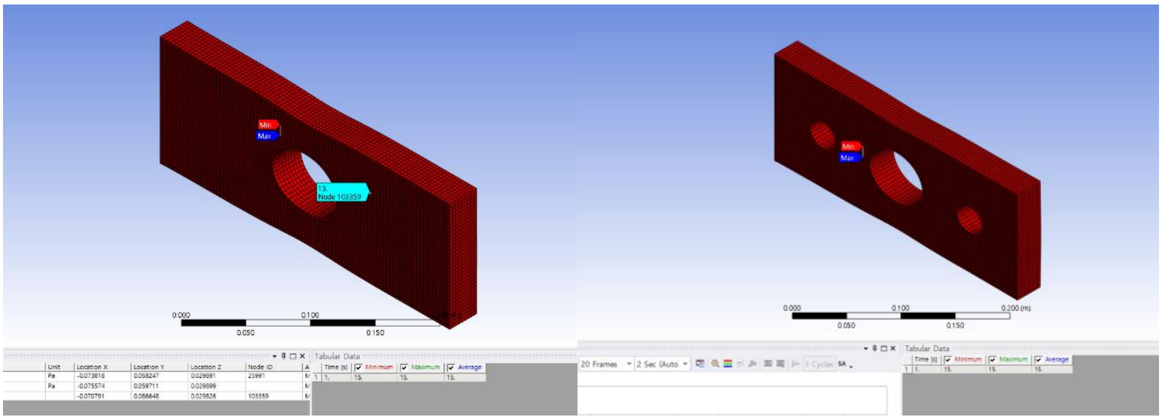

Figure 5. Safety Factor of Each Cases

If the Structural steel is used for both Case 1 and Case 2, the safety factor is the same as 15, and thus it can be safely used. However, unlike steel, in an environment where deformation occurs easily due to low ultimate stress, or where deformation occurs easily, Case 2 is more easily deformed than Case 1, so Case 1 with a low strain rate should be used. In addition, since Case 2 has a lower maximum stress than Case 1, it can be seen that Case 1 is more resistant to external forces than Case 2. Therefore, Case 1 should be selected for situations where a lot of force is applied to the member.

3. Which of the design will you select from a manufacturing standpoint?

As illustrated in Fig. 5, in an environment where a material capable of enduring external force is used or a large force is not applied to a member, the unit cost can be reduced by reducing the use of a material used by drilling a hole. In addition, it is possible to benefit from a manufacturing perspective through lightening. Therefore, unless the safety coefficient of the product is exceeded, manufacturing Case 2 can benefit from lowering the unit price in the manufacturing process compared to manufacturing Case 1.