| Cortical Bone Properties | | | |
|---|---|---|---|
| **Property** | **Units** | **Minimum Value** | **Maximum Value** |
| Elastic Limit | MPa | 90 | 144 |
| Density | $Kg/m^3$ | 1800 | 2080 |
| Fracture Toughness | $MPa*m^{0,5}$ | 3,5 | 6,1 |
| Fatigue Resistance at 10^7 cicles | MPa | 23 | 80 |
| Hardness | HV | 50 | 80 |
| Poisson's ratio | - | 0,13 | 0,3 |
| Shear Rigidity Modulus | GPa | 4,5 | 6,7 |
| Thermal Conductivity | W/m*°C | 0,41 | 0,63 |
| Young's Module | GPa | 18 | 26 |
| Specific Heat Capacity | J/Kg*°C | 1100 | 1260 |

**Table 1.** Orthotropic Properties of Cortical Bone.

| Composite Materials Properties | | |
|---|---|---|
| Materials | Properties | |
| | Young's Module (GPa) | Thermal conductivity (W/m*°C) |
| PEK with 30% Fiberglass | 18,2 - 19,1 | 0,608 - 0,632 |
| PEEK with 40% Carbon Fiber | 33,4 - 40 | 2 |
| PARA with 60% Fiberglass | 20,5 - 25,5 | 0,672 - 0,691 |
| PC with 40% Carbon Fiber | 20,7 - 21,4 | 0,696 - 0,753 |
| Modified PEEK with Carbon Fiber between 45% and 55% | 32,8 - 34,4 | 0,686 - 0,714 |

**Table 2.** Properties of Composite Materials.

| Simulation Properties | | | | |
|---|---|---|---|---|
| Interest Properties | Units | Materials | | |
| | | PEK (30% CF) | PARA (60% GF) | PC (40% CF) |
| Thermal Conductivity | W/m*°C | 0,608 - 0,632 | 0,672 - 0,691 | 0,696 - 0,753 |
| Young's Module | GPa | 18,2 - 19,1 | 20,5 - 25,5 | 20,7 - 21,4 |
| Density | $Kg/m^3$ | 1440 - 1460 | 1770 - 1810 | 1360 - 1380 |
| Elastic Limit | MPa | 197 - 217 | 223 - 262 | 159 - 165 |
| Poisso's ratio | - | 0,323 - 0,336 | 0,324 - 0,326 | 0,318 - 0,331 |
| Shear Rigidity Module | GPa | 6,84 - 7,18 | 8,46 - 8,89 | 7,81 - 8,08 |
| Biocompatibility | Si | Si | Si | Si |
| Tensile Limit | MPa | 263 - 290 | 324 - 380 | 234 - 241 |
| Compression Limit | MPa | 222 - 245 | 270 - 330 | 144 - 159 |

**Table 3.** Properties for Simulation.

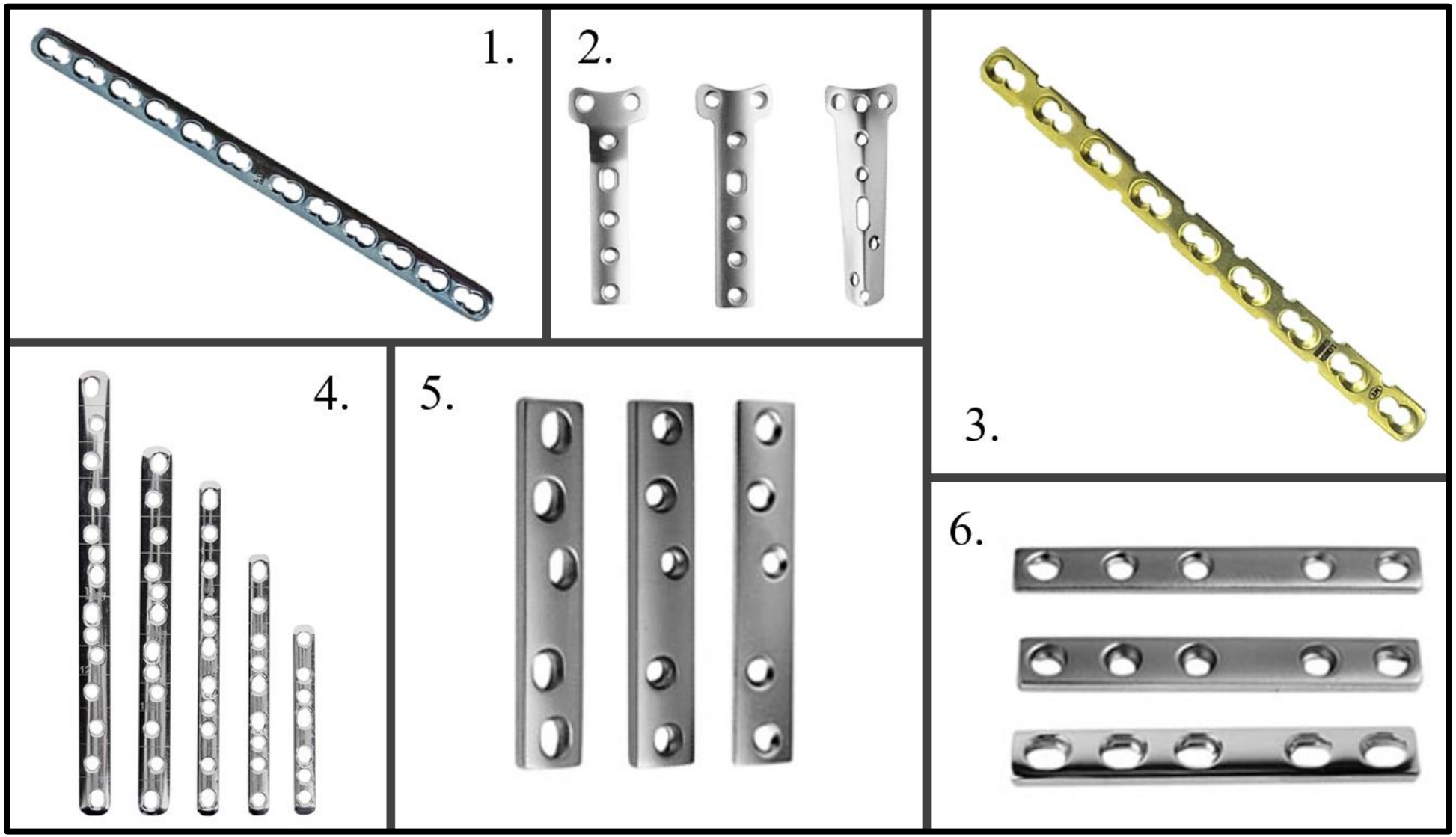
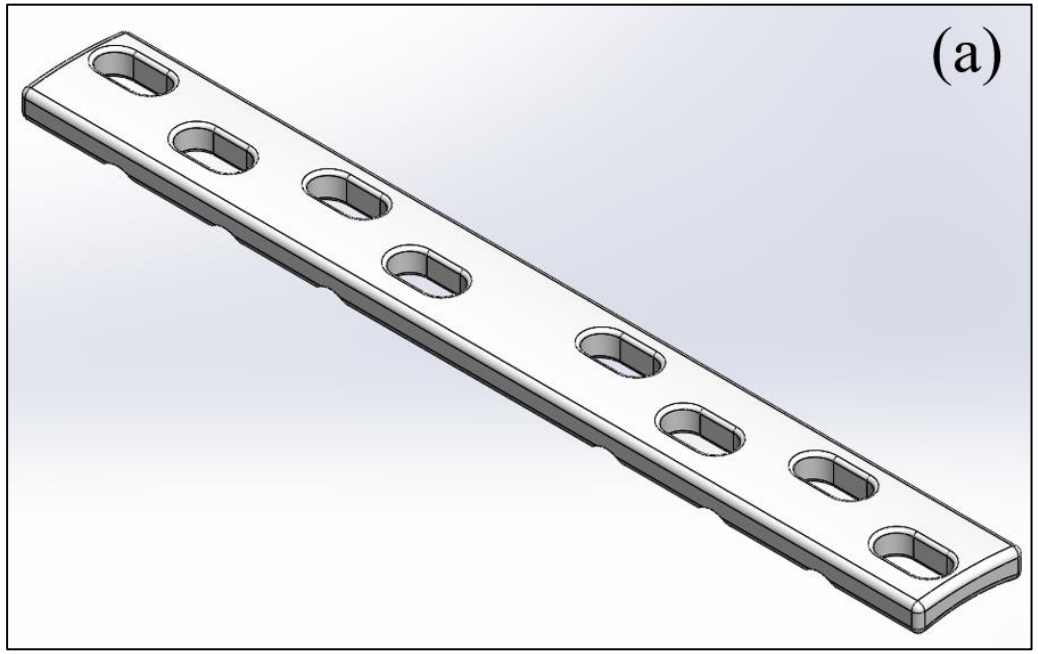
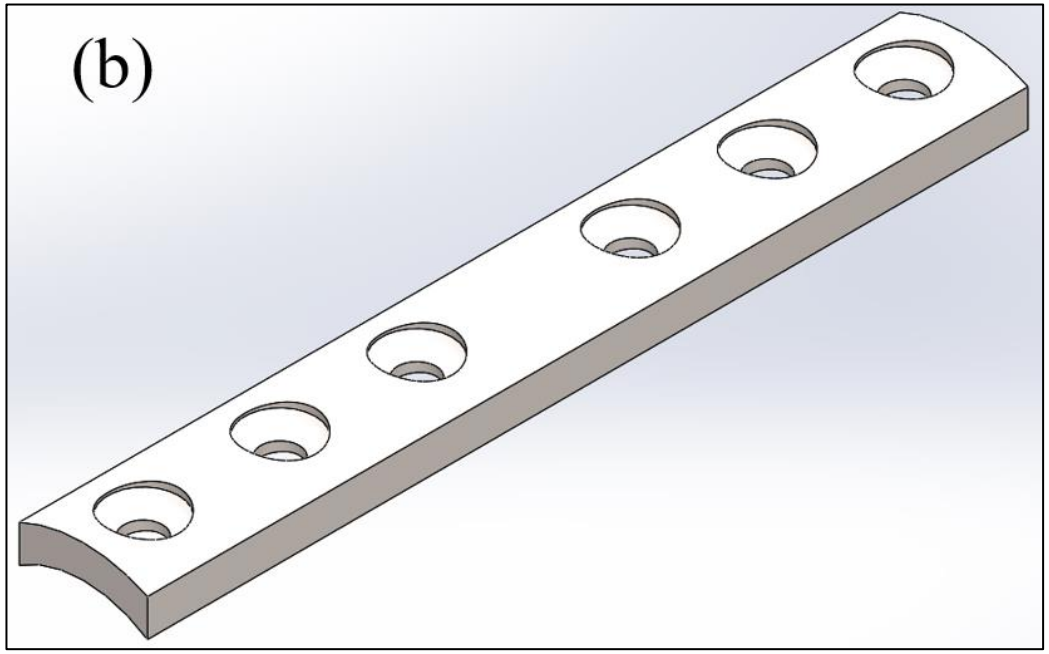



**Figure 1.** References for Titanium Implant.



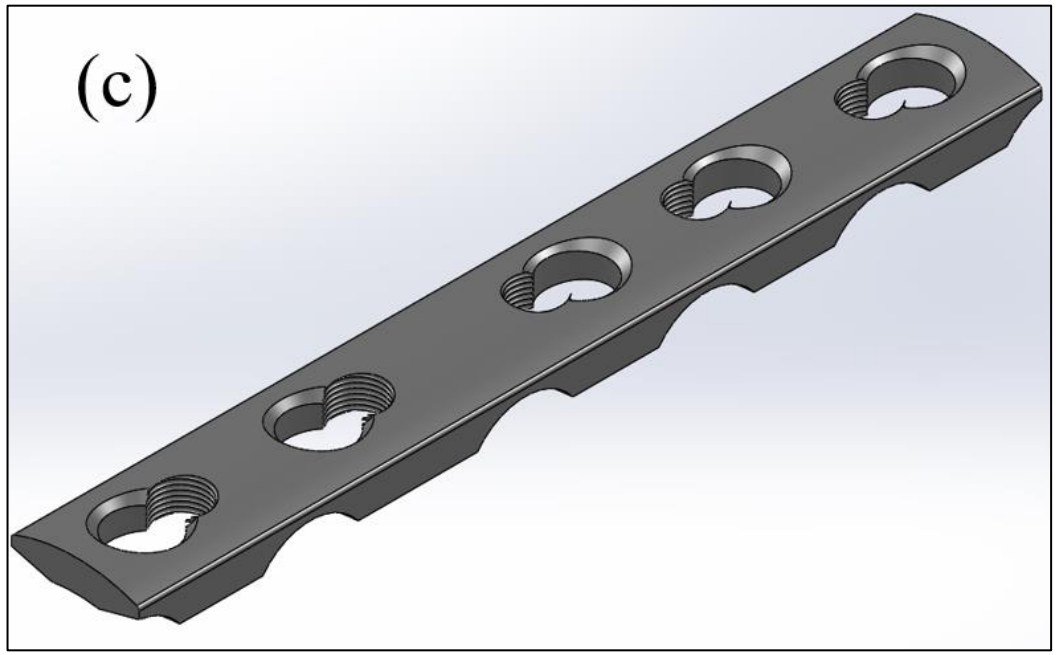




**Figure 2.** Existing Model of Titanium Implants.

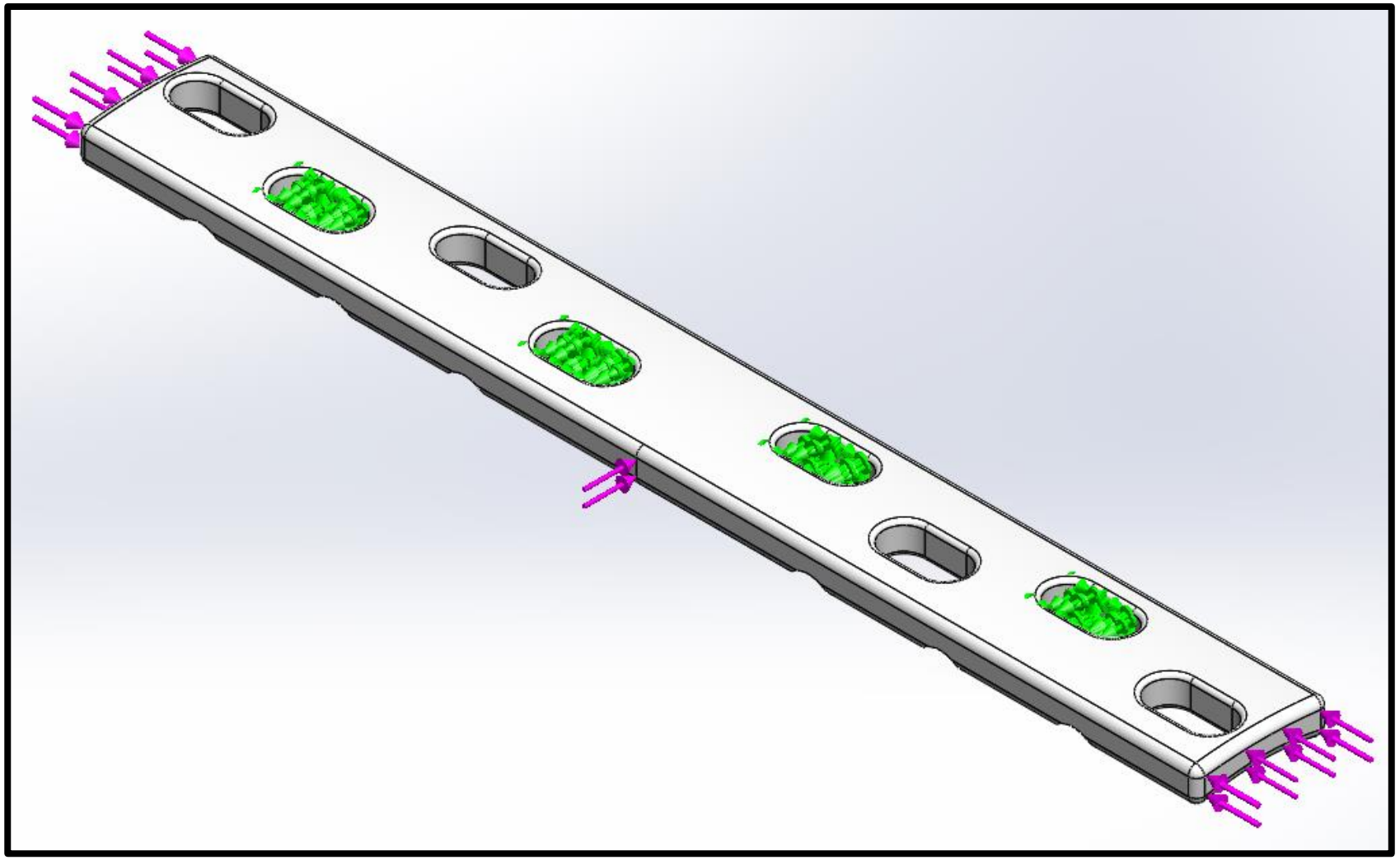


**Figure 3.** DCP Wide Plate Charging Status.

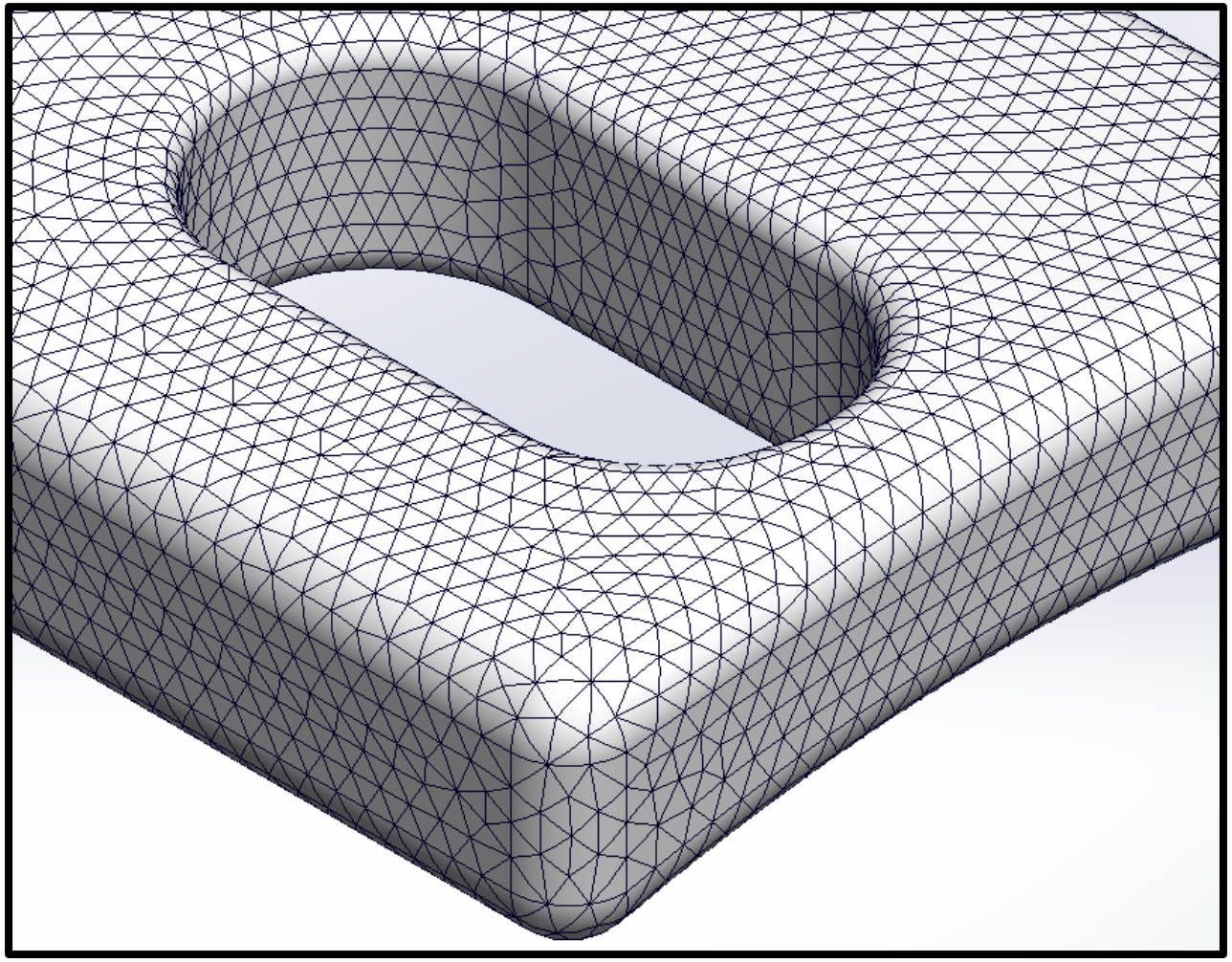


**Figure 4.** Mesh Layout of the Wide DCP Plate.

| Mesh Details | |
|---|---|
| Data | Plate Type |
| | Wide DCP Plate |
| Mesh Type | Based on Combined Curvature |
| Maximum Element Size | 0,5 mm |
| Minimum Element Size | 0,0508817 mm |
| Total Number of Nodes | 626721 |
| Total Number of Elementes | 943098 |
| Maximum Aspect Radius | 4,565 |

**Table 4.** Characteristics of the Model Mesh.

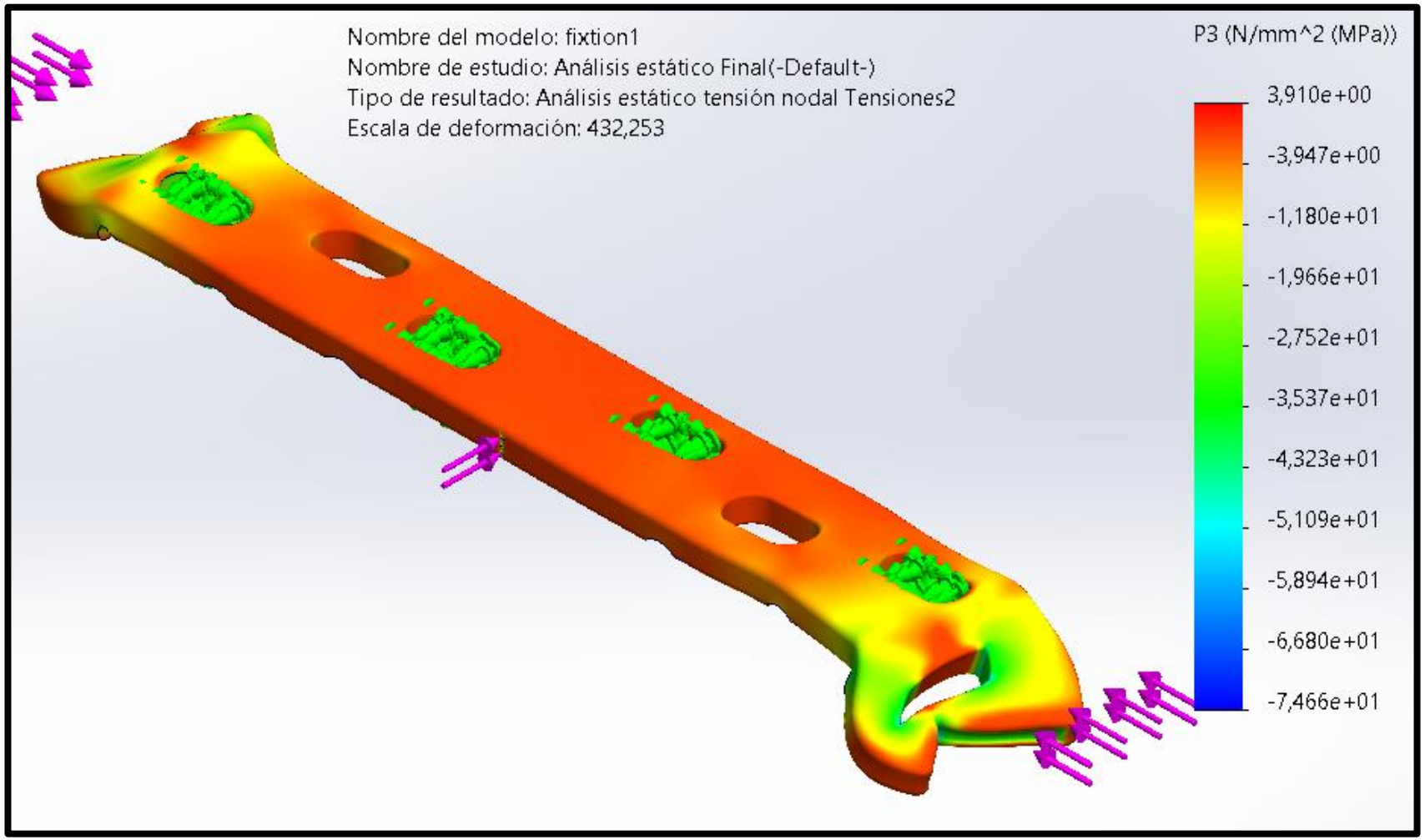



**Figure 5.** Compressive Stress Wide DPC Plate - PARA.

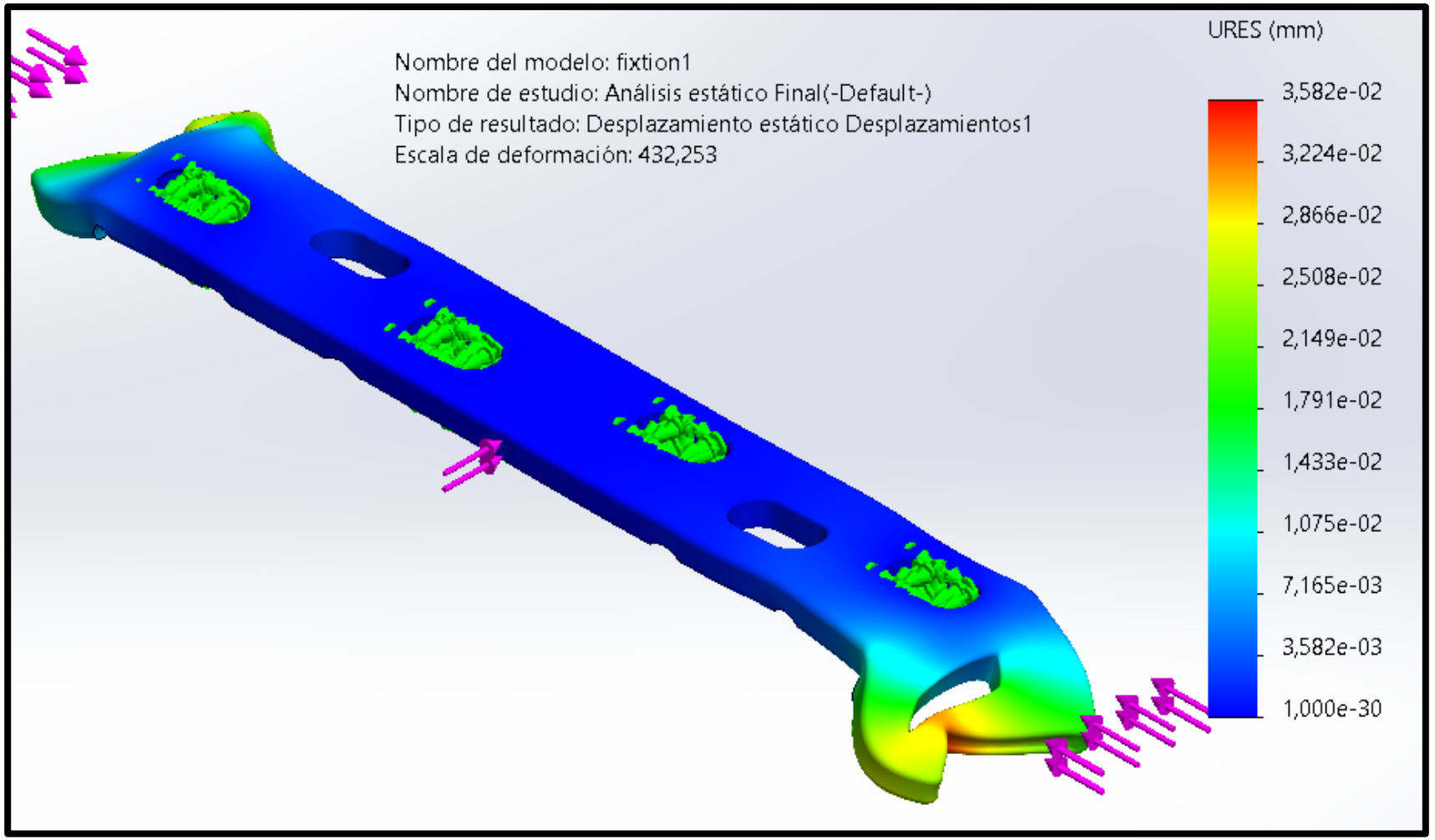



**Figure 6.** Wide DCP Plate Deformation - PARA.

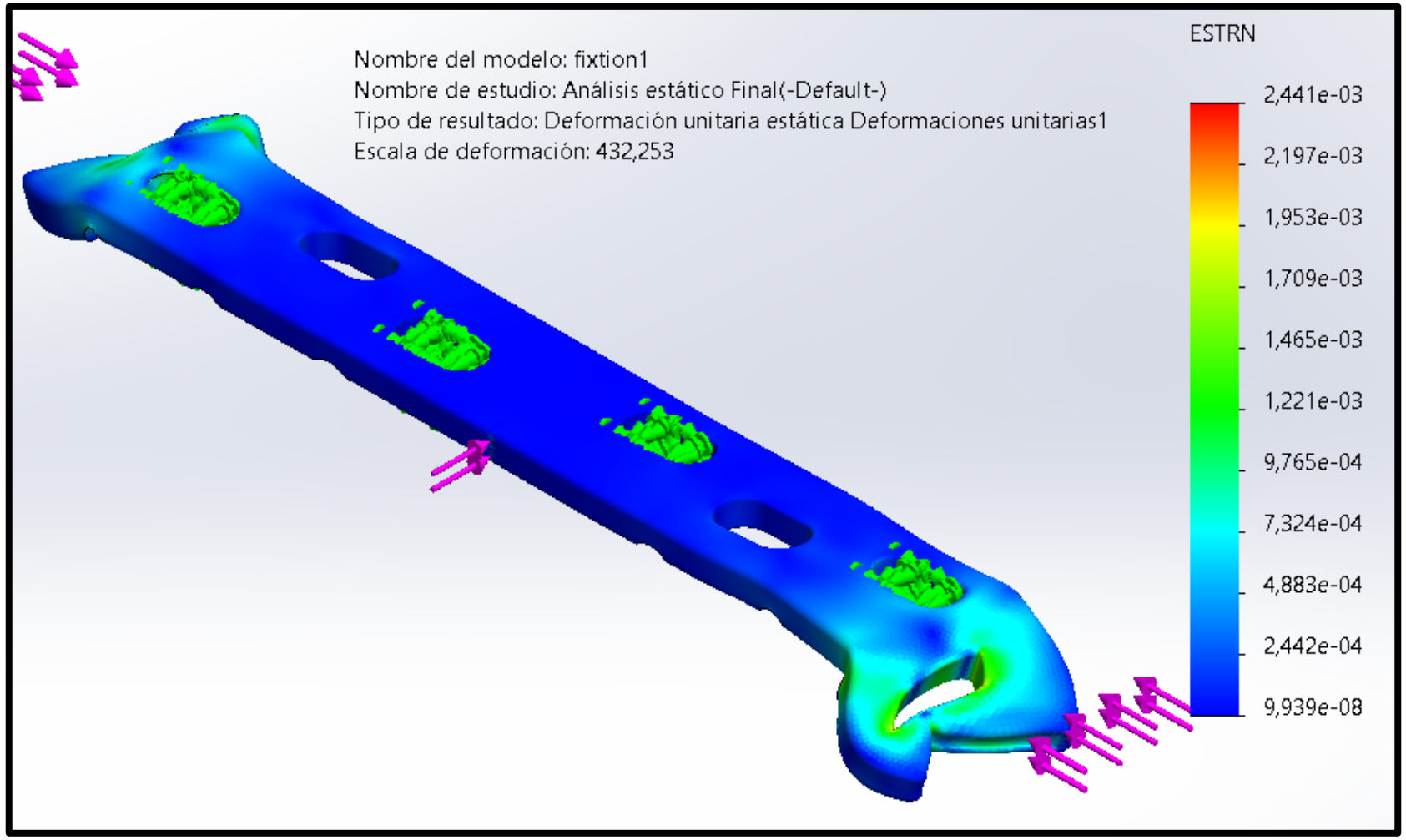



**Figure 7.** Unitary Deformation Wide DCP Plate - PARA.

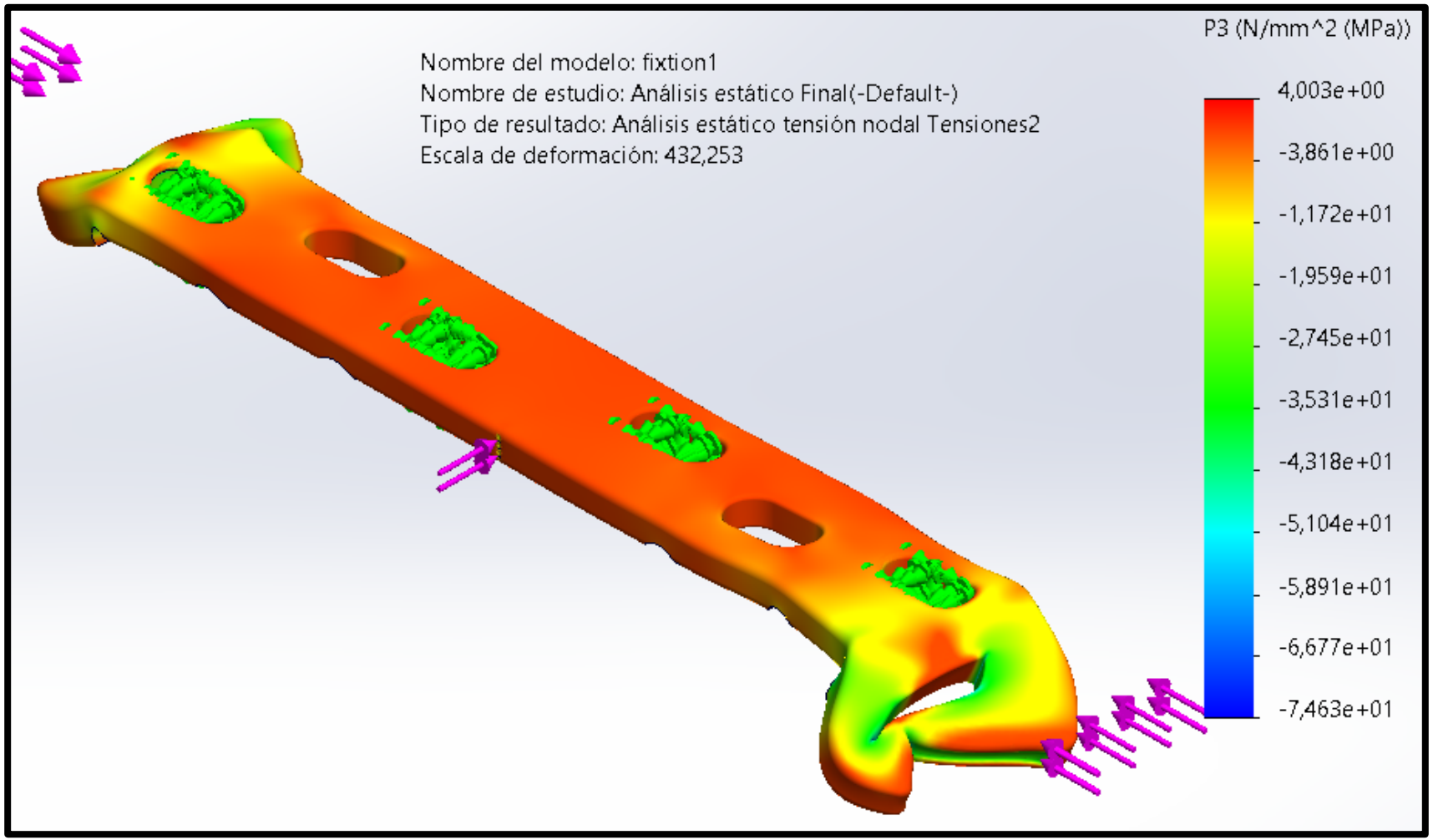



**Figure 8.** Compressive Stress Wide DCP Plate - PEK.

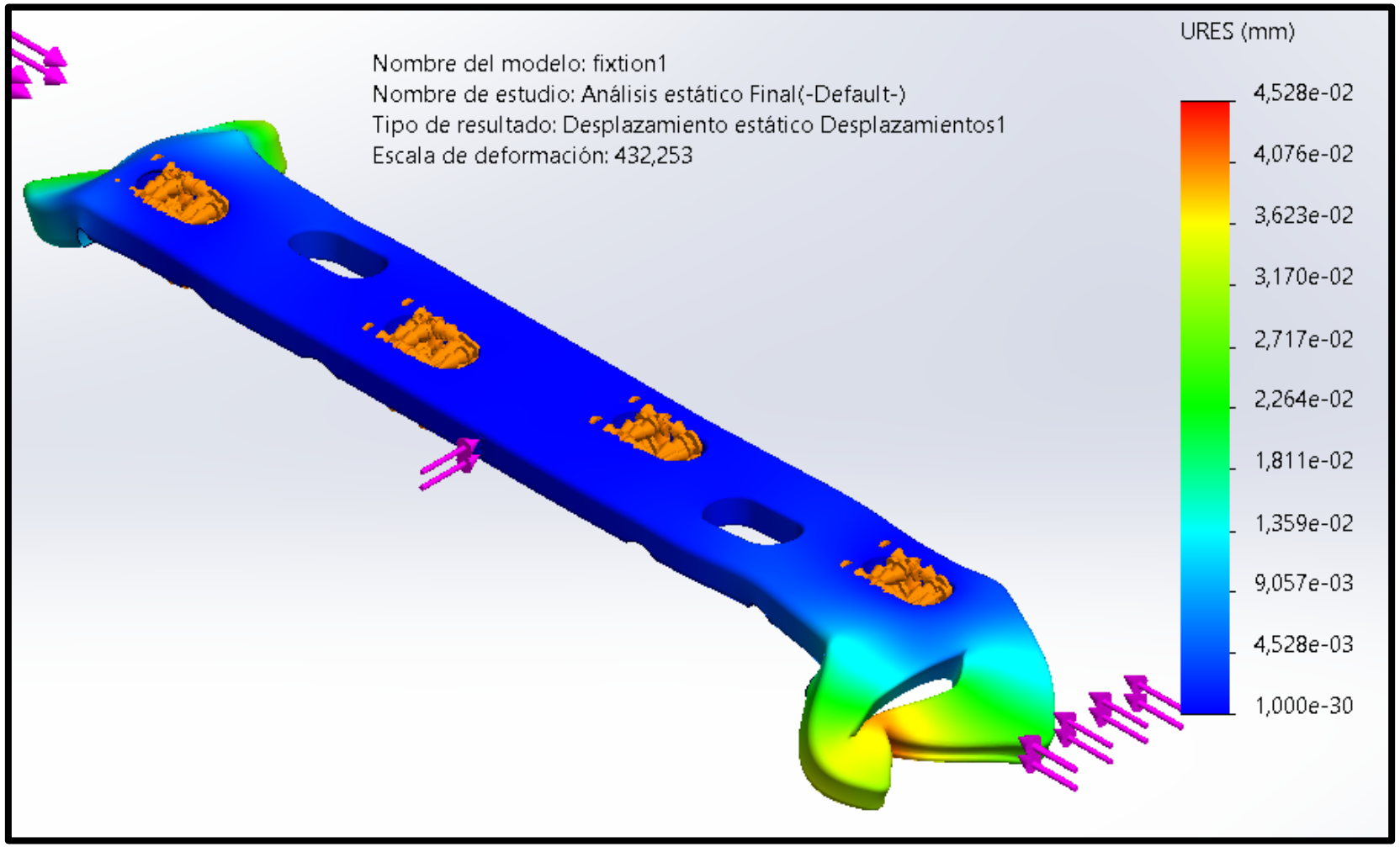



**Figure 9.** Wide DCP Plate Deformation - PEK.

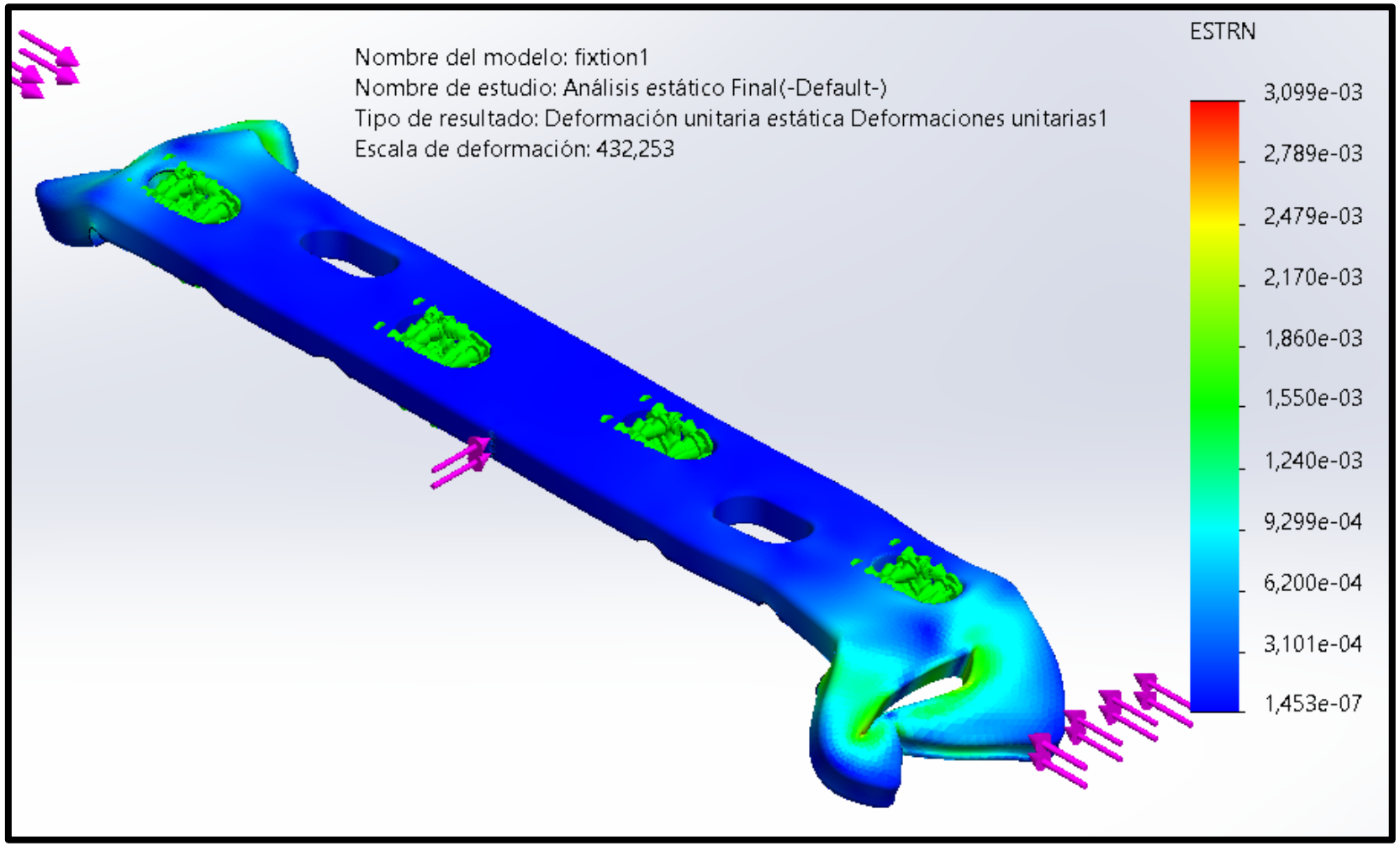



**Figure 10.** Unitary Deformation Wide DCP Plate - PEK.

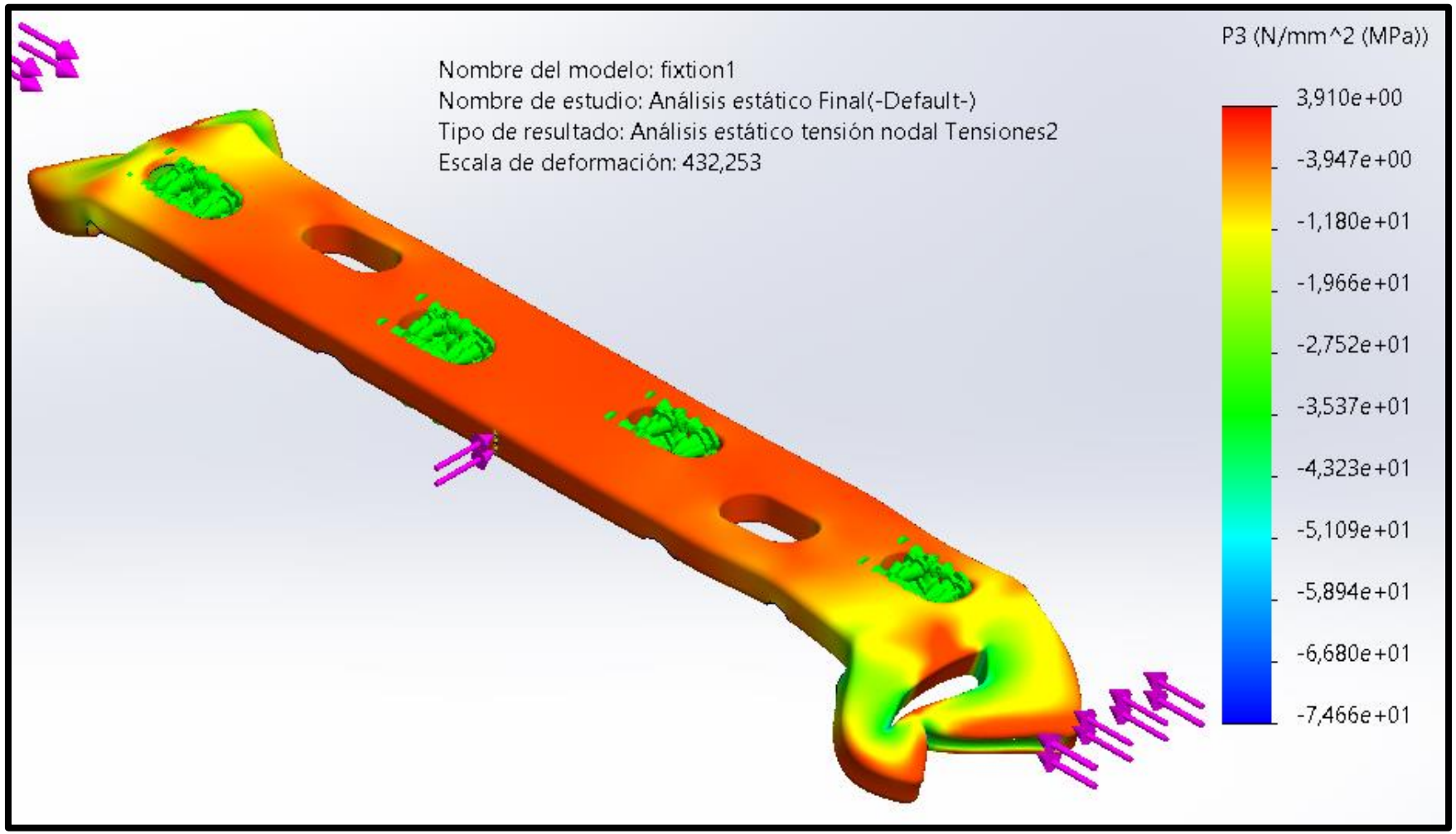



**Figure 11.** Compressive Stress Wide DCP Plate - PC.

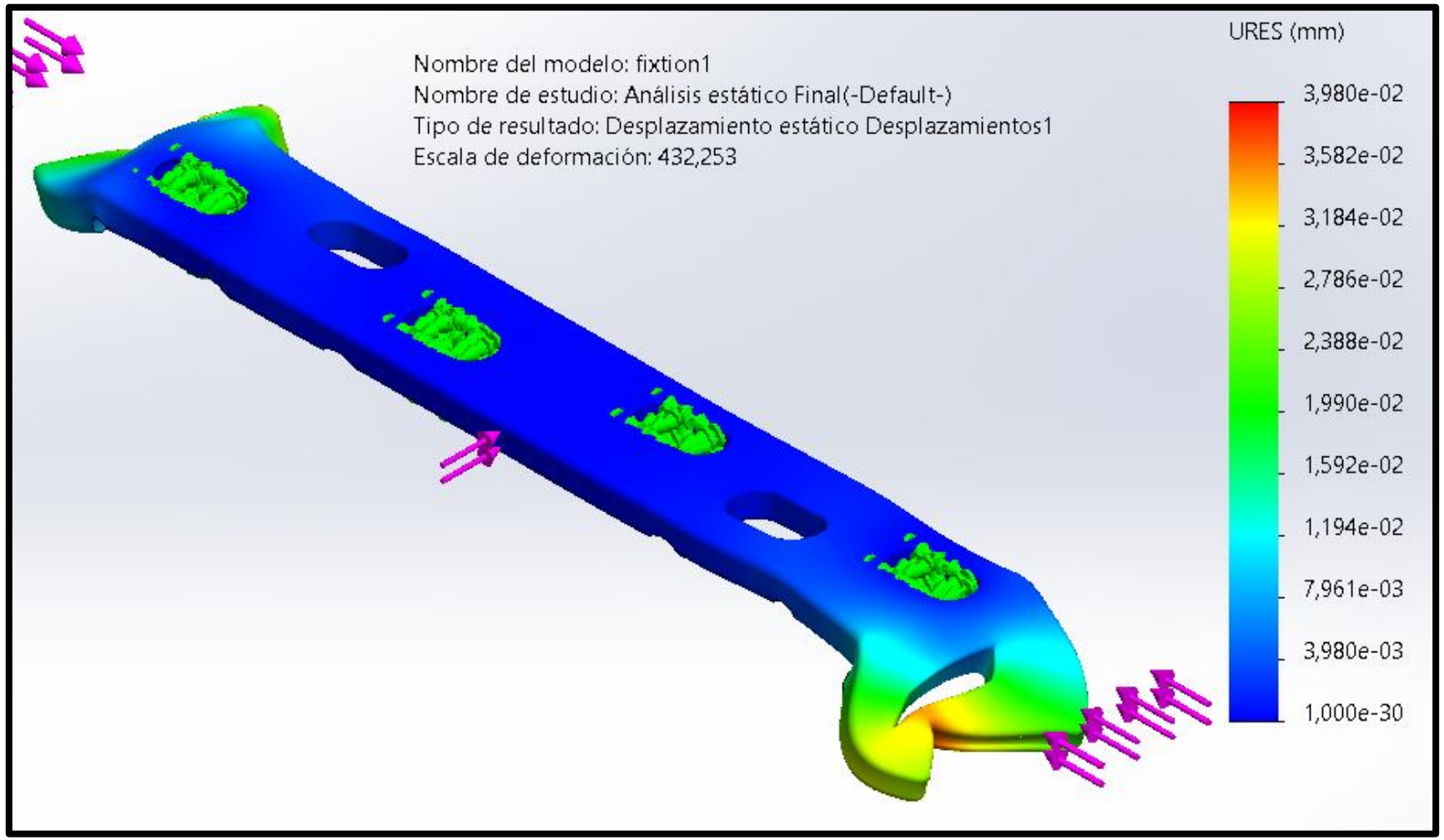



**Figure 12.** Wide DCP Plate Deformation - PC.

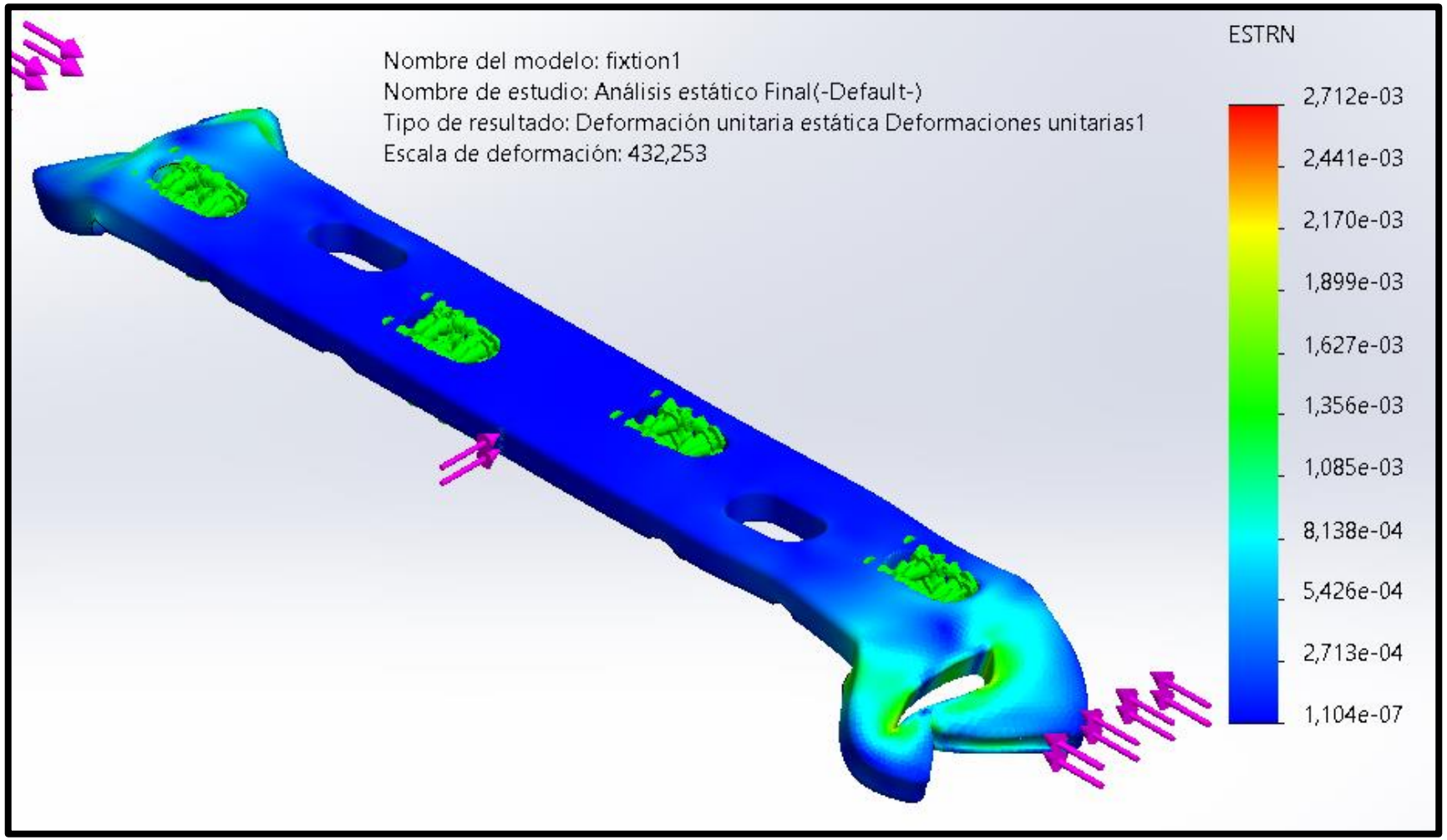



**Figure 13.** Unitary Deformation Wide DCP Plate - PC.

| Simulation Results - Wide DCP Plate | | | | |
|---|---|---|---|---|
| Analyzed Data | Unit | Used Material | | |
| | | PARA (60% GF) | PEK (30% CF) | PC (40% CF) |
| Compressive Stress | MPa | 3,91 | 4,003 | 3,91 |
| Desplacement | mm | 0,03582 | 0,04528 | 0,0398 |
| Resulting Unit Strain | N/A | 0,002441 | 0,003099 | 0,002712 |

**Table 5.** Results from the Wide DCP Plate Study.

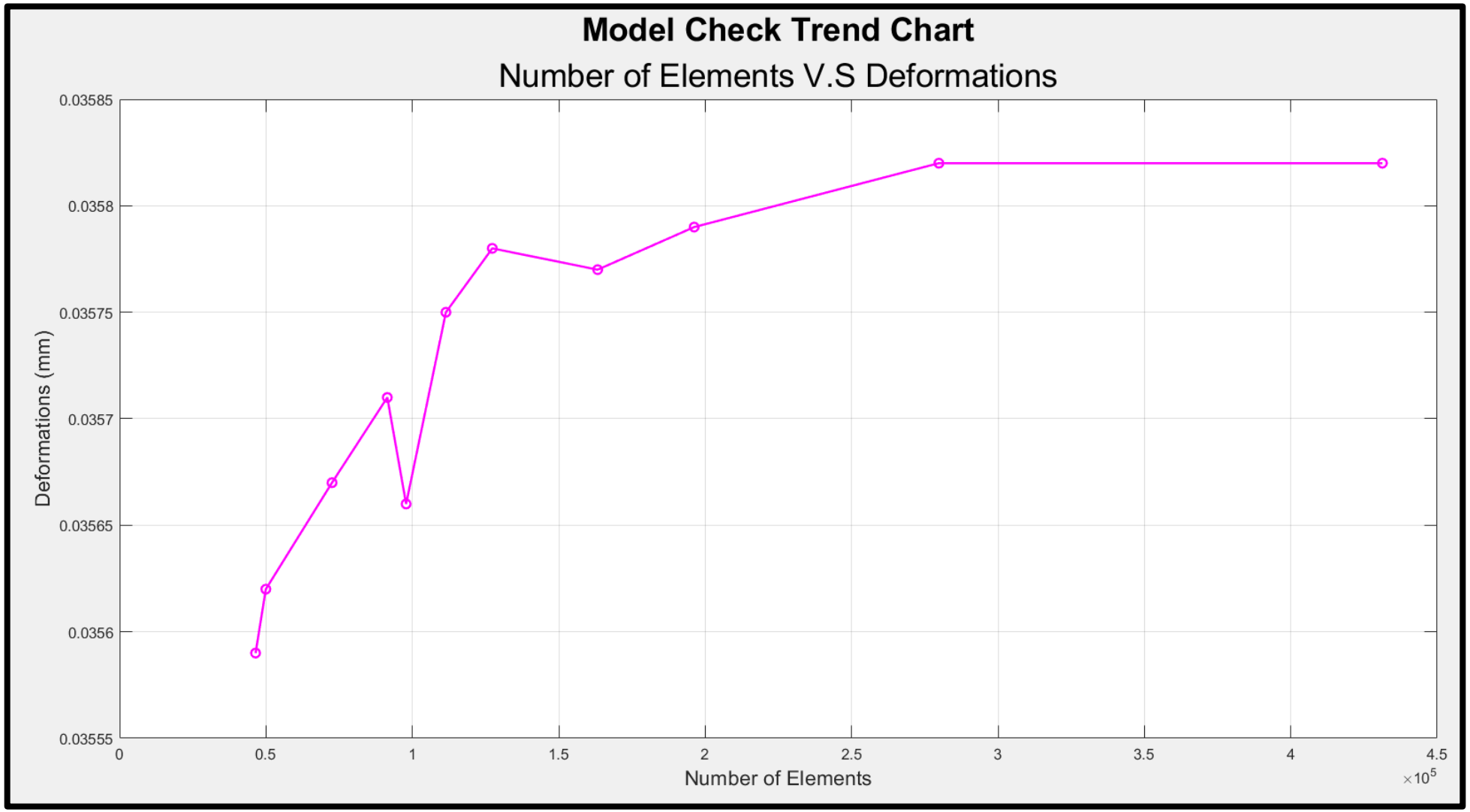



**Figure 14.** Convergence Analysis Graph.

| Mesh Convergence Analysis | | | | | |
|---|---|---|---|---|---|
| Iteration | Mesh Density | Number of Elements | Maximum Element Size (mm) | Maximum Aspect Radius | Deformations (mm) |
| 1 | Very Thick Mesh | 46451 | 7,52101 | 7,0168 | 0,03559 |
| 2 | Thick Mesh | 49956 | 6,7 | 6,6104 | 0,03562 |
| 3 | Thick Mesh | 72558 | 4,6 | 4,0376 | 0,03567 |
| 4 | Standard Mesh | 91440 | 3,3 | 9,2041 | 0,03571 |
| 5 | Standard Mesh | 97862 | 2,1 | 5,2713 | 0,03566 |
| 6 | Fine Mesh | 111455 | 1 | 6,9402 | 0,03575 |
| 7 | Fine Mesh | 127302 | 0,9 | 9,2038 | 0,03578 |
| 8 | Fine Mesh | 163276 | 0,8 | 4,683 | 0,03577 |
| 9 | Very Fine Mesh | 196249 | 0,7 | 6,9394 | 0,03579 |
| 10 | Very Fine Mesh | 279821 | 0,6 | 9,2186 | 0,03582 |
| 11 | Very Fine Mesh | 431286 | 0,5 | 4,565 | 0,03582 |

**Table 6.** Convergence Analysis Results.