

COMPUTER AIDED DESIGNING AND FINITE ELEMENT METHOD

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What if AFO's were cracking open??

As state by the literature, is usual for **thermoplastic AFO's to open cracks** as result of the undergoing stress forces of human gait. That mechanical stress forces trigger fractures areas on critical points, **normally near the malleoli** (see the picture below), as result as the range of movement of that specific region[1][2].



Figure 1 - AFO with a fracture [1]

David Showers and Lair David, claim that is possible to increase AFO's resistance trough the inclusion of reinforcements (by waving the plastic) at the retromalleolar area[3].

The purpose of this study is to verify **the influence of the application of structural reinforcements has on the distribution of tension and deformation in an AFO** in the stance phase of gait.

MAYBE WE JUST FIGURED SOMETHING OUT !!!

In order to evaluate the stress and deformation on the models (using CAE), we had first to scan a patient leg with a laser scanner (Rodin 4D), and then edit it using CAD software (ANSYS-Spaceclaim).

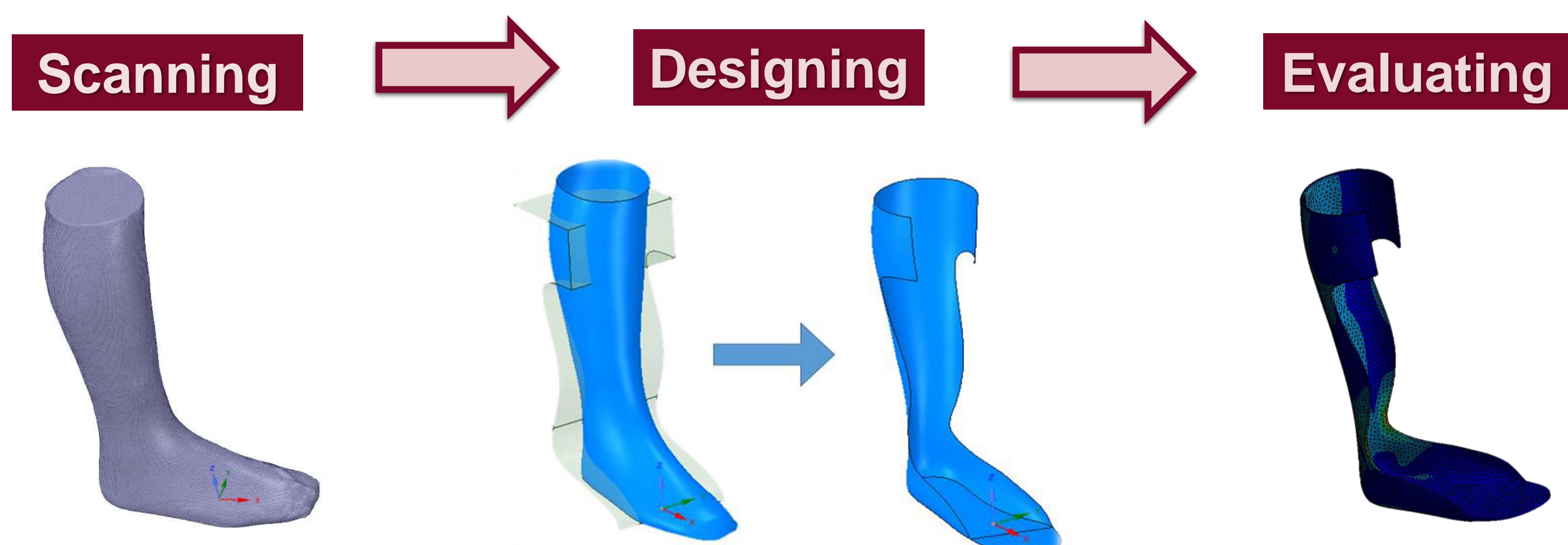


Figure 2 – Methodologic process.

After evaluating the model (that was set as reference model), the **structural reinforcements were included**, creating several different models to be evaluated as well.

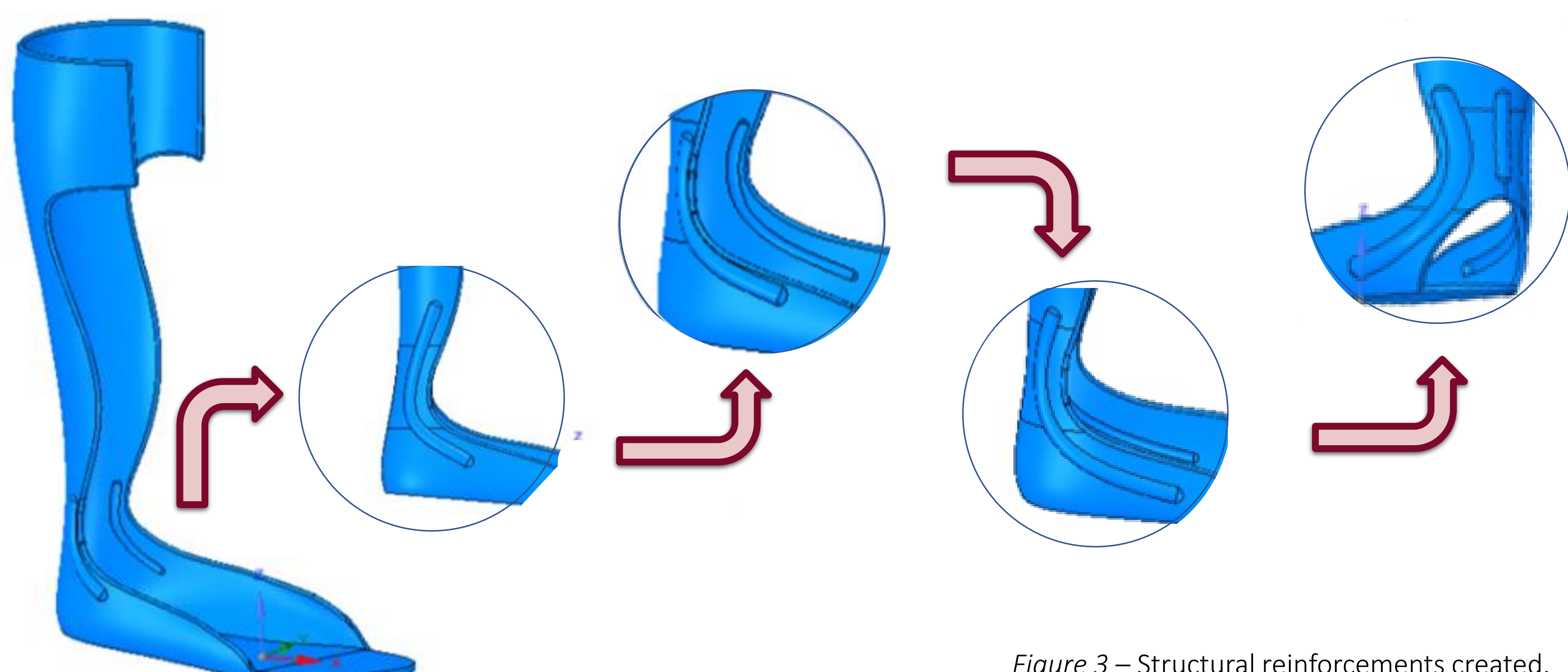


Figure 3 – Structural reinforcements created.

Did it result??

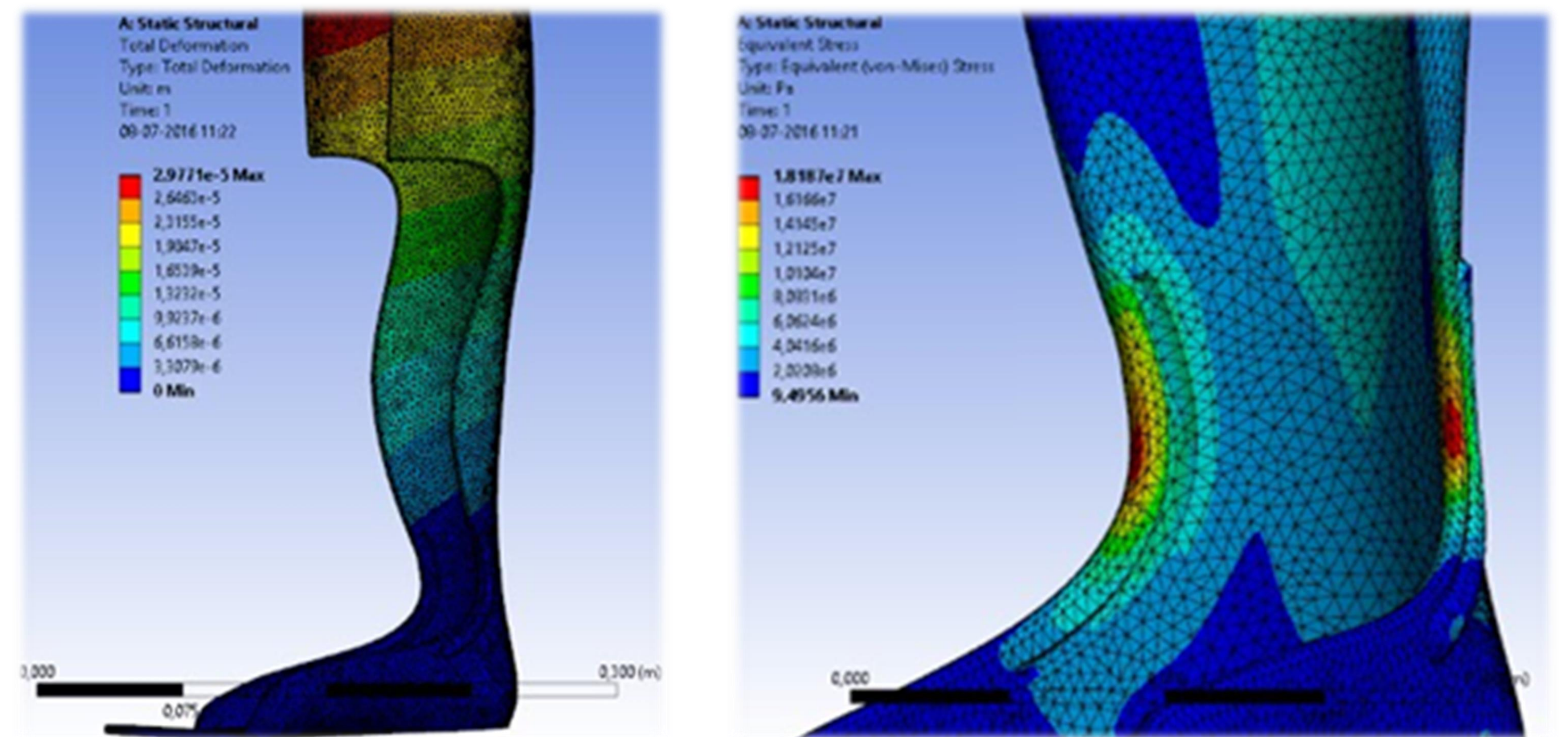


Figure 4 – Evaluating modified AFO model deformation (left), and tension (right).

Model analyzed	Results from the 50N method		Results from the dislocation method	
	Max Stress (MPa)	Deformation (m)	Max Stress (MPa)	Deformation (m)
Reference model	19,79	0,025	47,7	0,047
Model 1	20,11	0,026	47,7	0,047
Model 2	19,33	0,025	46,20	0,047
Model 3	19,06	0,025	47,6	0,047
Model 4	19,71	0,026	46,39	0,0473
Model 5	19,12	0,025	46,14	0,0472
Model 6	19,60	0,025	47,04	0,047
Model 7	29,24	0,047	54,59	0,05

Table 1 – Evaluation results.

As seen on table 1, the models with structural reinforcements have **improvements on stress forces with both methods**.

Although here is a slightly difference in terms of values when comparing both methods, they present similar percentage of reduction.

AND OUR CONCLUSIONS ABOUT ALL THIS ARE...

Despite the reduction of stress values in most of the reinforced models, not every model presented an improvement. The stress and deformation reduction didn't appear to be related, as the model with least stress weren't the model with the least deformation.

Despite the general improvement on reinforced models, presenting **less amount of stress**, it **didn't appear to be as significant as expected**, and the impact of reinforcements in AFO's lifetime can only be assessed with a transient study, including multiple cycles.

Reference:

- [1] Lautenschlager E, Bayne S, Wildes R, Russ J, Yanke M, "Materials investigation of failed plastic ankle-foot orthoses," *J. Orthot. Prosthetics*, vol. 29, no. 3, pp. 25–27, 1975.
- [2] Chu T and Feng R, "Determination of Stress Distribution In Various Ankle-Foot Orthoses: Experimental Stress Analysis," *J. Prosthetics Orthot.*, vol. 10, no. 1, pp. 11–16, 1998.
- [3] Showers DC, David L, "Technical Note: A Reinforcing Technique In Orthotics and Prosthetics," *Orthot Prosthetics.*, vol. 36, no. 2, pp. 108–112, 1982.