

Glass Windscreen Forming Optimization by Finite Element Analysis Using COMSOL Multiphysics

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Introduction: An interesting glass application field is in the transportation area. An high temperature windscreen forming process, for automotive application is here studied (figure 1). A first optimization study, in order to reduce the forming time, is also presented (figure 2).

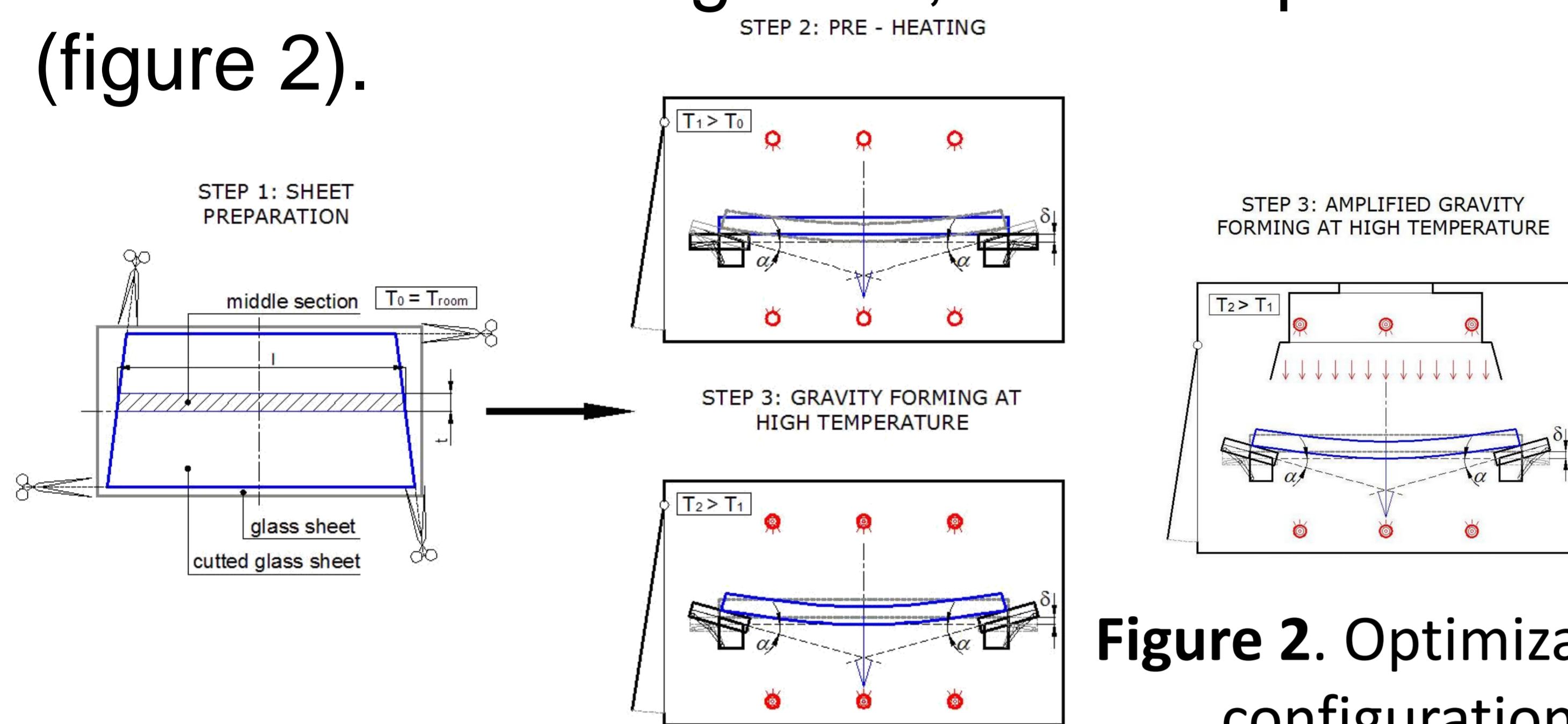


Figure 1. Windscreen forming process

Computational Methods: The secondary creep is modeled in COMSOL Multiphysics 3.5a using a coupled analysis. A 2D Structural Mechanical Module is coupled with PDE Modules to consider the relaxation of the shear modulus, $G(t)$.

$$\left\{ \begin{array}{l} \sigma(t) = E_r \varepsilon(t) + \sum_{j=1}^n E_j \varepsilon_j(t) \\ \frac{d\varepsilon_j(t)}{dt} + \frac{E_j}{\eta_j} \varepsilon_j(t) = \frac{d\varepsilon(t)}{dt} \\ \varepsilon_j(0) = 0 \quad j = 1, 2, \dots, n \\ \dot{\varepsilon}_c = \frac{3}{2} \frac{1}{3\eta} \sigma^d \end{array} \right. \quad \begin{array}{l} n \text{ is the number of} \\ \text{Prony terms,} \\ \text{The subscript } c \text{ denote} \\ \text{the creep terms,} \\ \eta \text{ is the viscosity} \end{array}$$

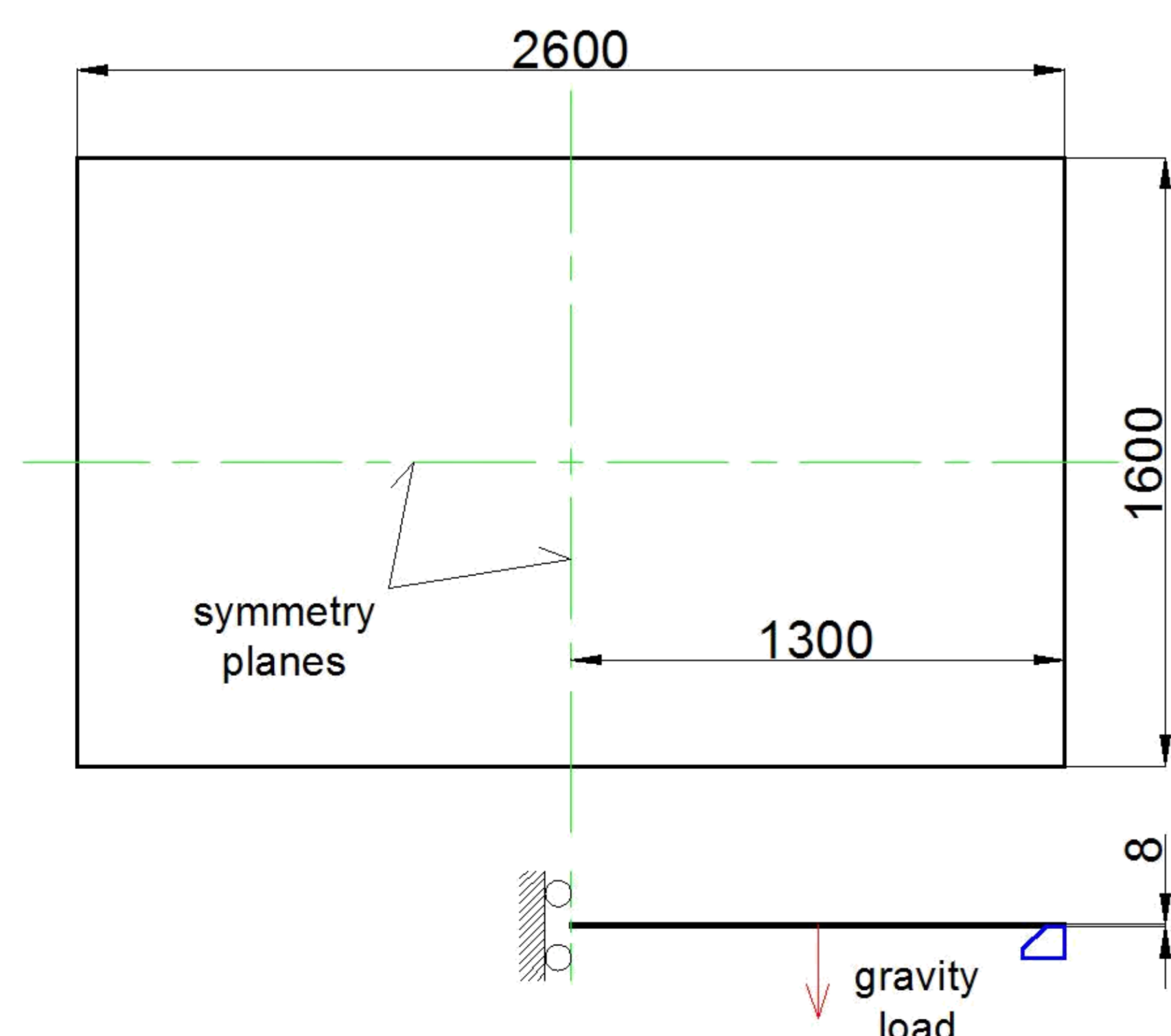


Figure 3. Analyzed windscreen geometry

Results: The von Mises stress distributions are showed in figure 4. As expected, figures 5, when the applied load is two times the gravity

load, the process is speeded up but the stresses magnitude is higher. The material could not withstand and the windscreen could break during the forming process.

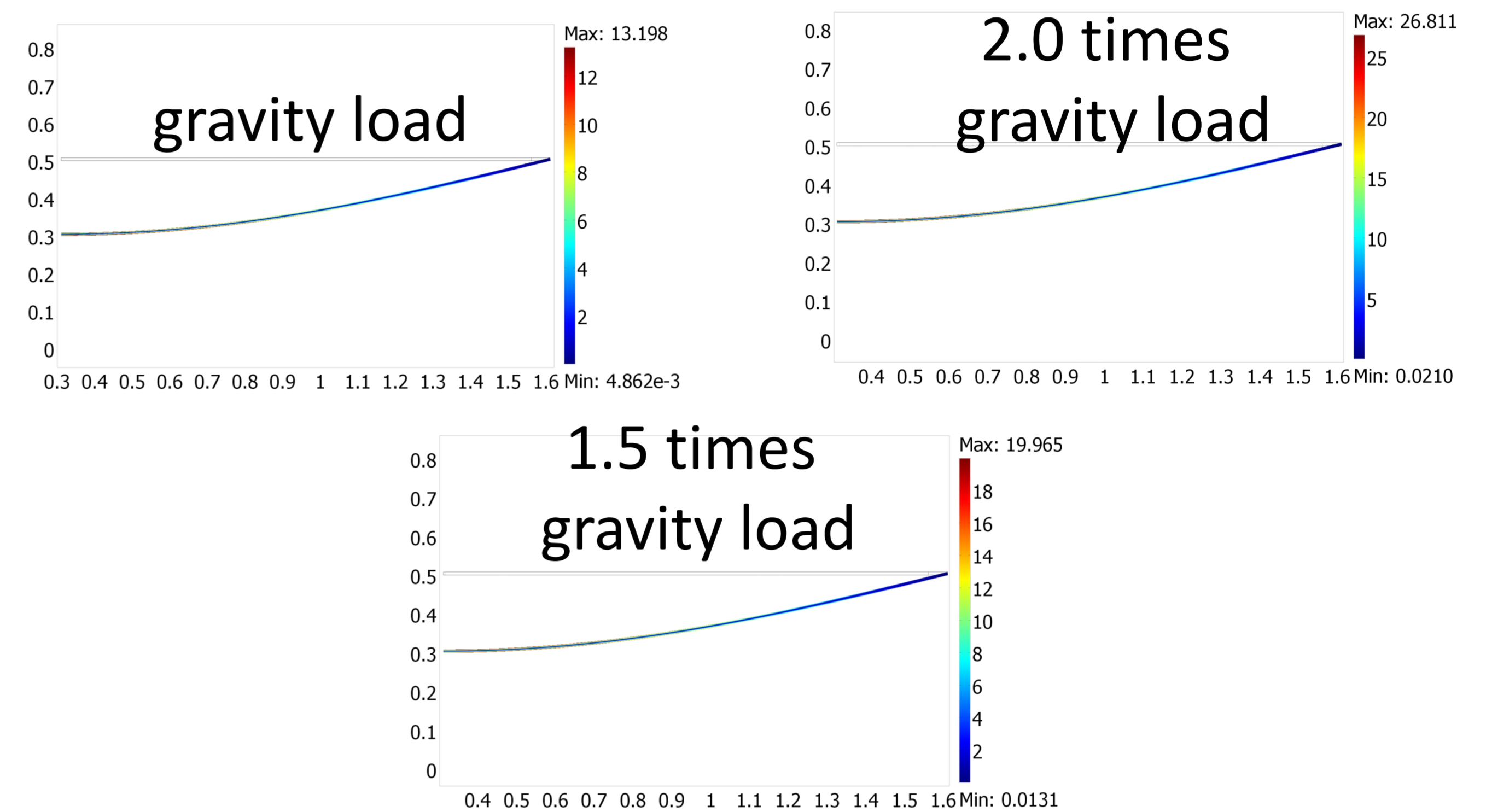


Figure 4. von Mises stress distributions.

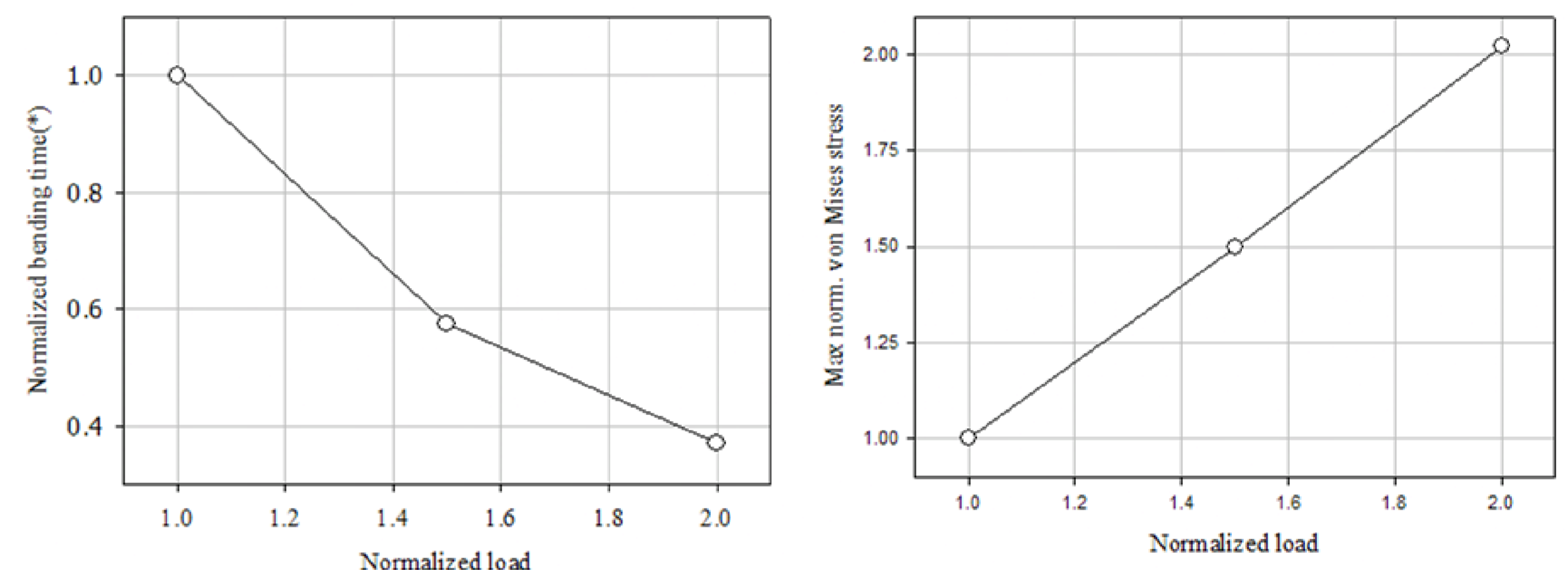


Figure 5. Optimization results.

Conclusions: The computed results allow to study the “best” forming conditions in order to speed up the production rate without compromise the windscreen integrity. Improvement have to be done to account the preheating step process, and more complex windscreen shapes.

References:

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