Numerical investigation on the influence of fiber orientation mapping procedure to the mechanical response of short-fiber reinforced composites using Moldflow, Digimat and Ansys software

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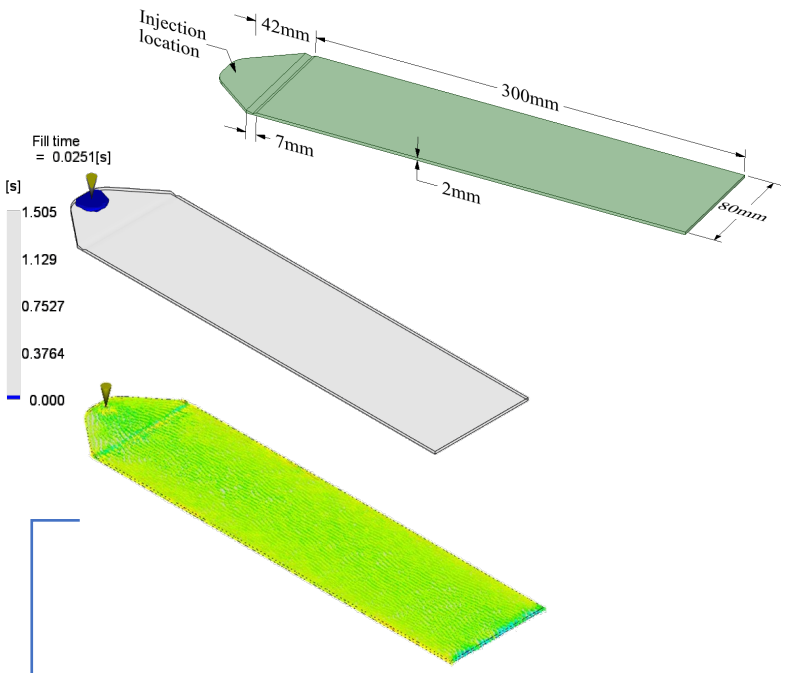
AIM and OBJECTIVES

The main objectives were:

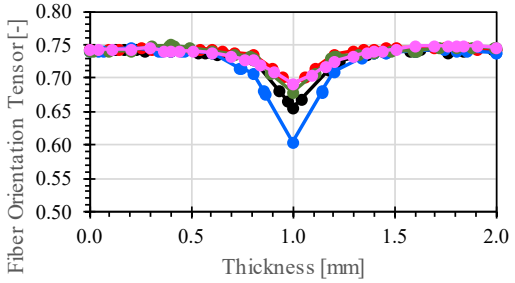
- Evaluate the fiber orientation tensor within the injection molding analysis;
- Calibrate the material model with test data considering the results from the injection molding analysis;
- Assess the influence of mapping procedure to the mechanical response;
- Assess the influence of fiber orientation to the mechanical response of dog bone specimens in terms of reaction force, stress and strain.

Overview

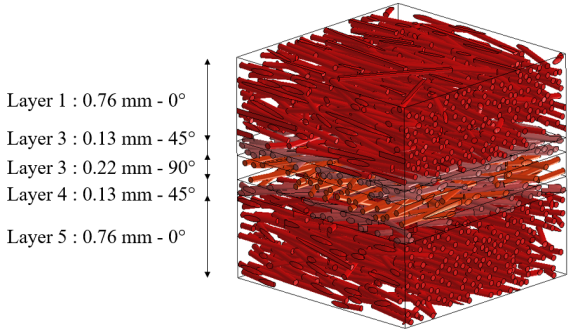
Moldflow



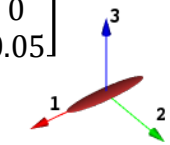
10 elements / thickness

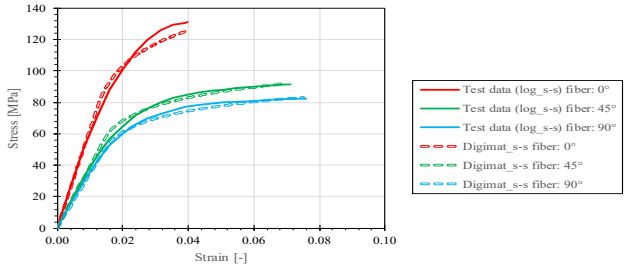


Digimat

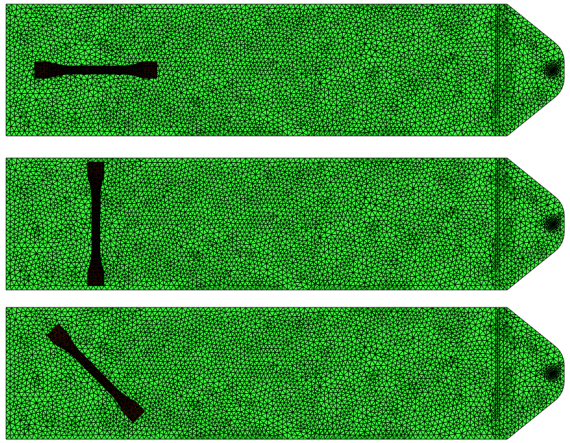


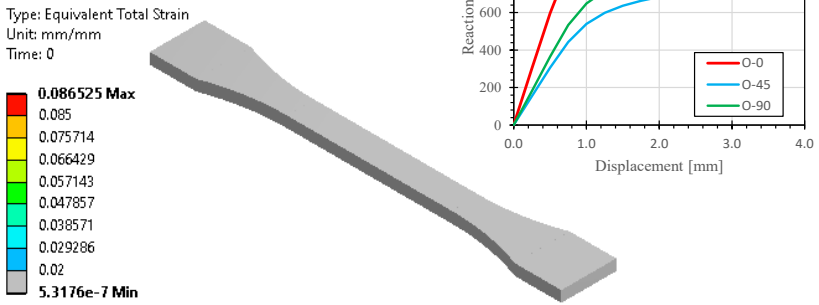
$$a_{ij} = \begin{bmatrix} 0.80 & 0 & 0 \\ 0 & 0.15 & 0 \\ 0 & 0 & 0.05 \end{bmatrix}$$





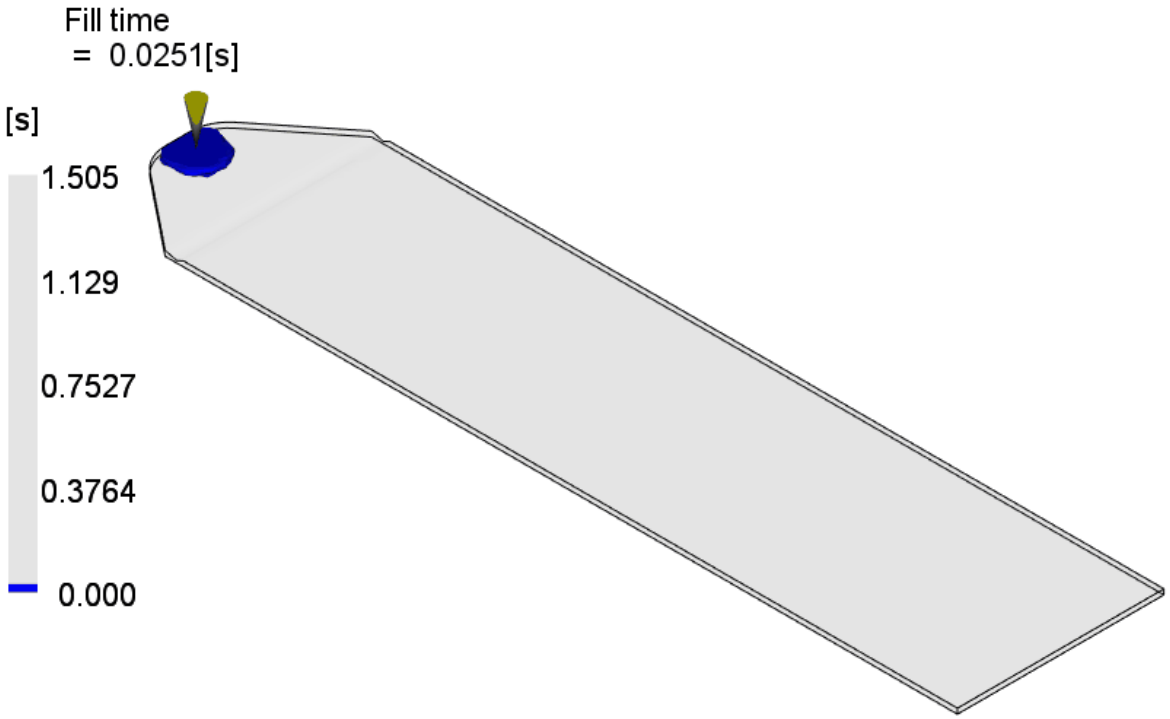
Ansys



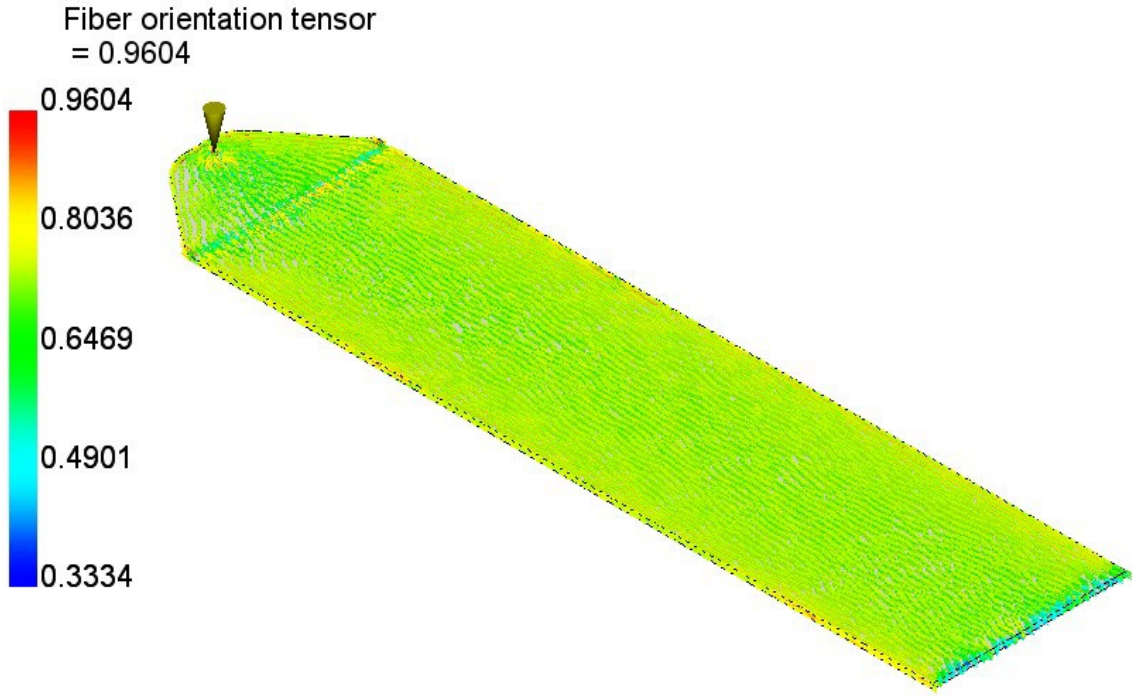


Moldflow Analysis

Fill Time [s]

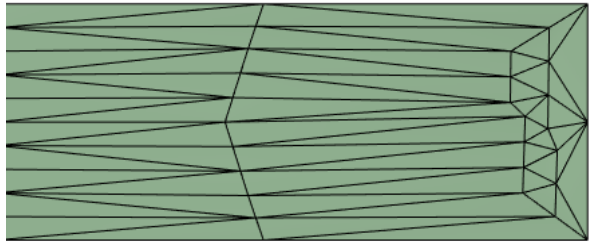


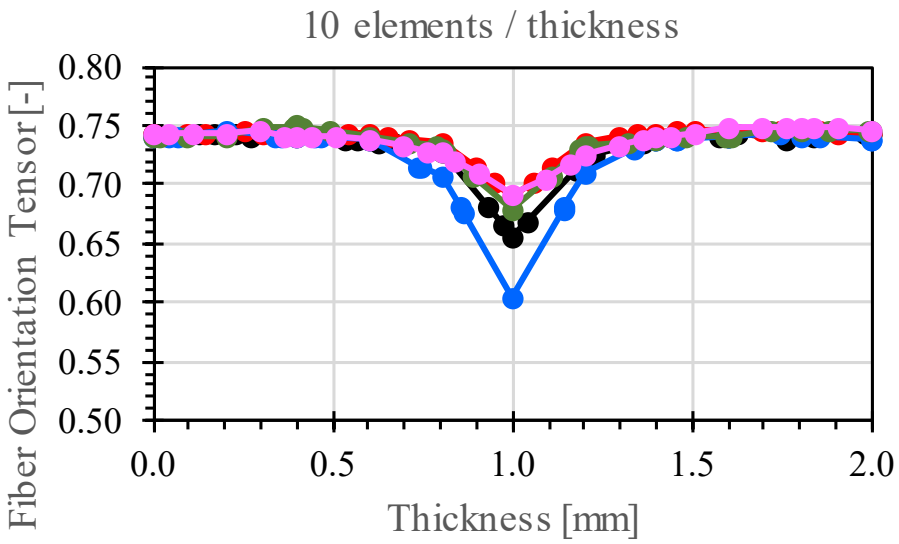
Fiber Orientation Tensor [-]

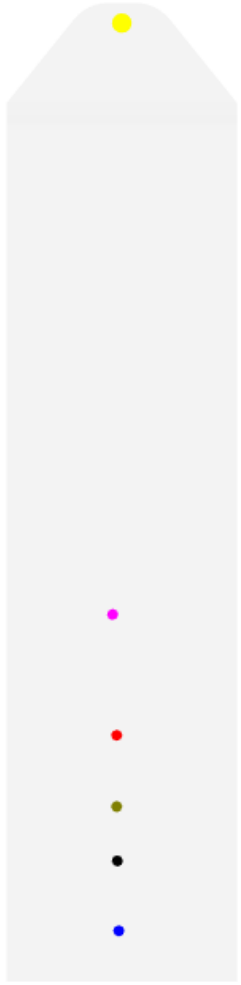


Moldflow Analysis

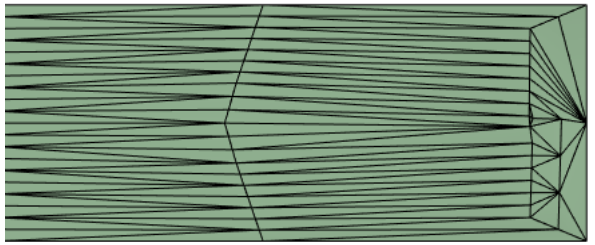
10 elements / thickness

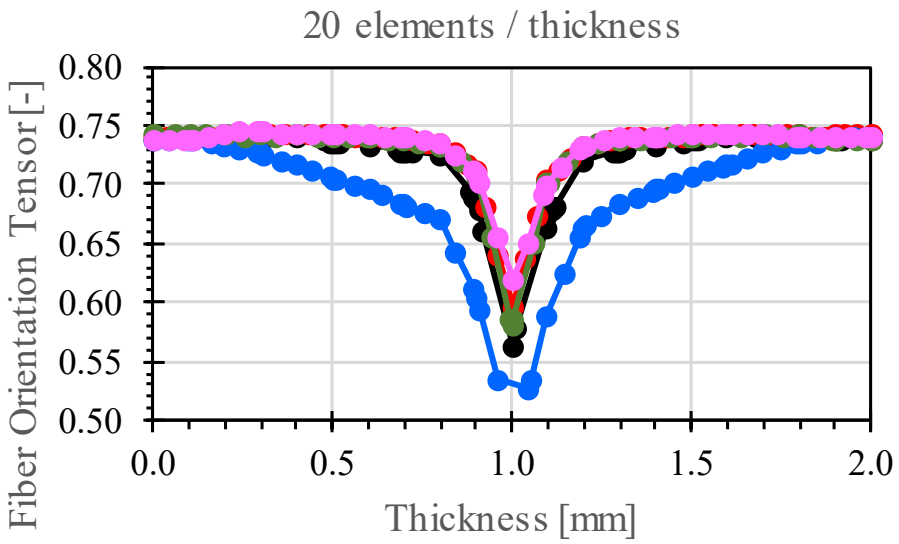






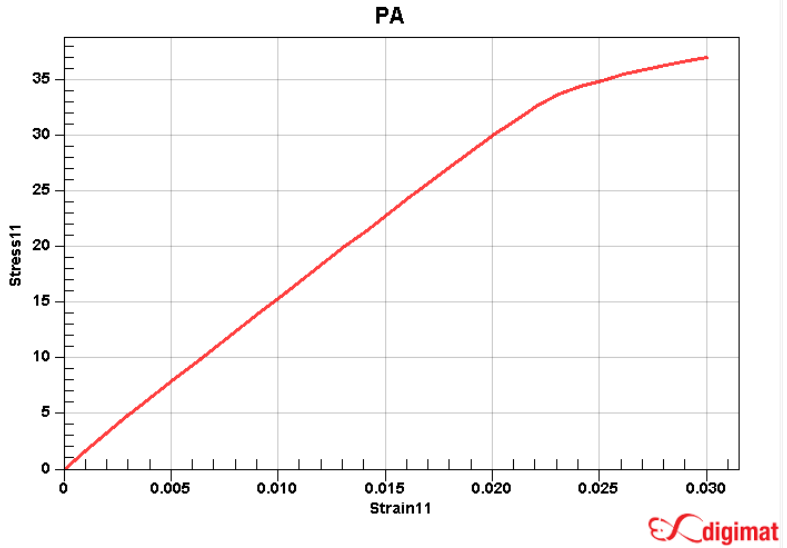
20 elements / thickness





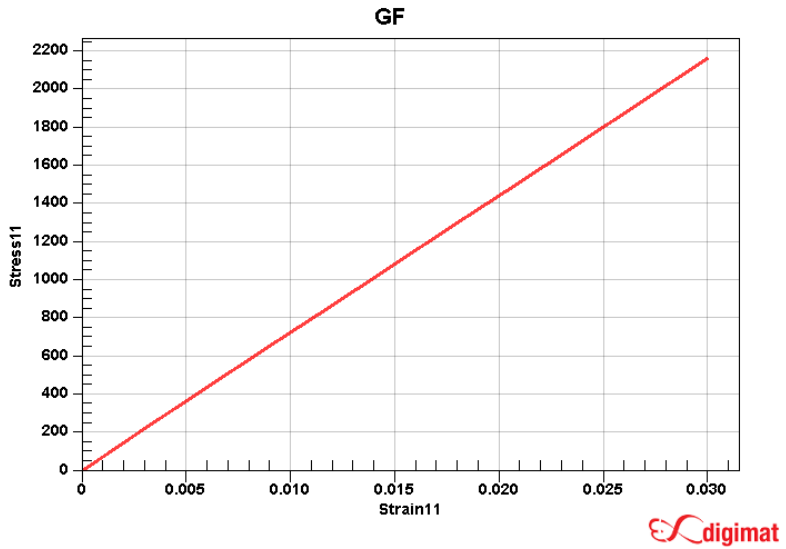
Digimat Analysis

Matrix: Polyamide



PA66 GF30

Inclusion: Glass Fiber



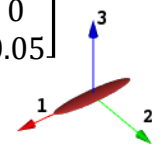
Material Model: Elastoplastic
J2 Plasticity Model

E = 1600 MPa
v = 0.40

Material Model: Elastic

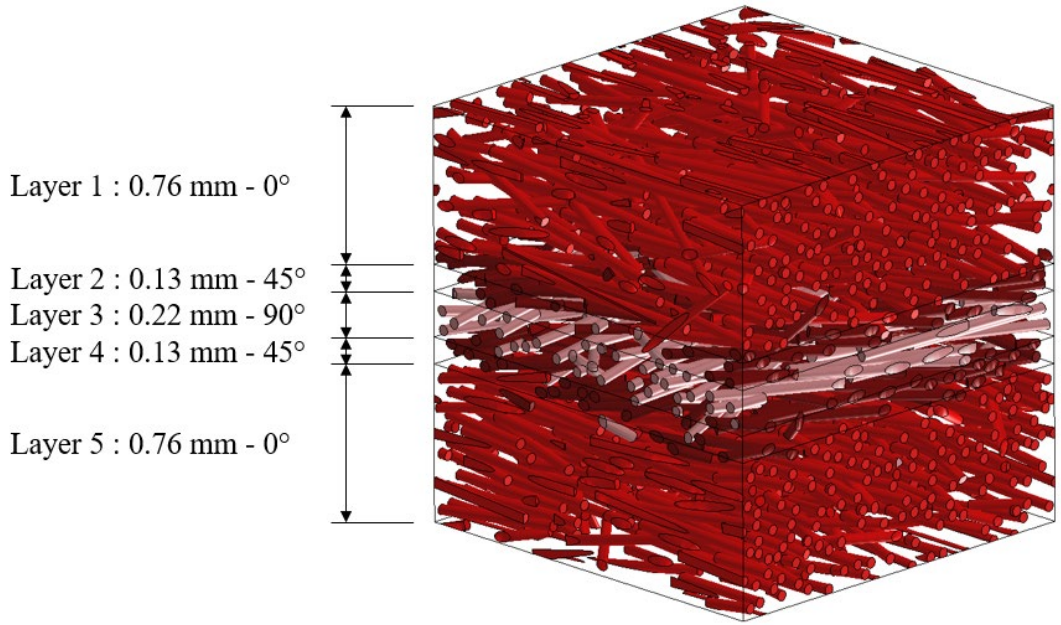
E = 72000 MPa
v = 0.22
Mass fraction: 30%
Aspect ratio: 20

$$a_{ij} = \begin{bmatrix} 0.80 & 0 & 0 \\ 0 & 0.15 & 0 \\ 0 & 0 & 0.05 \end{bmatrix}$$

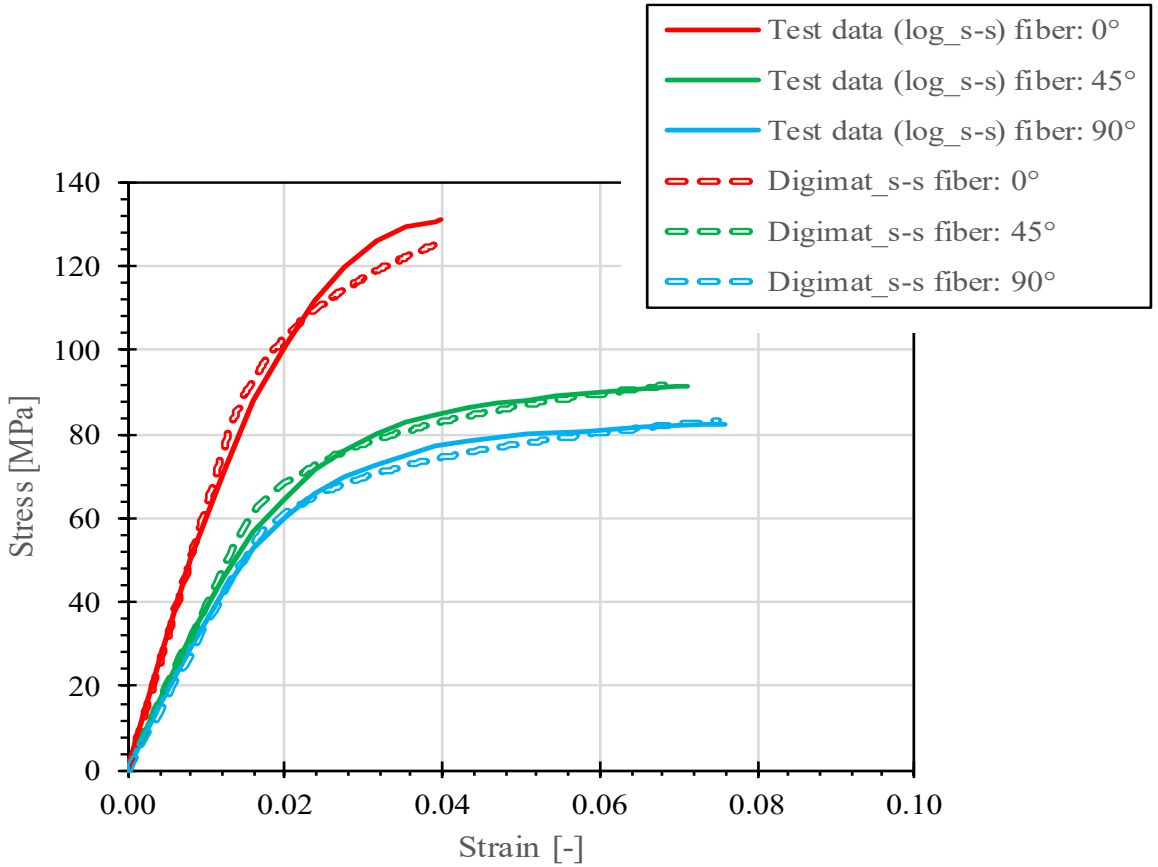


Digimat Analysis

RVE – Representative Volume Element

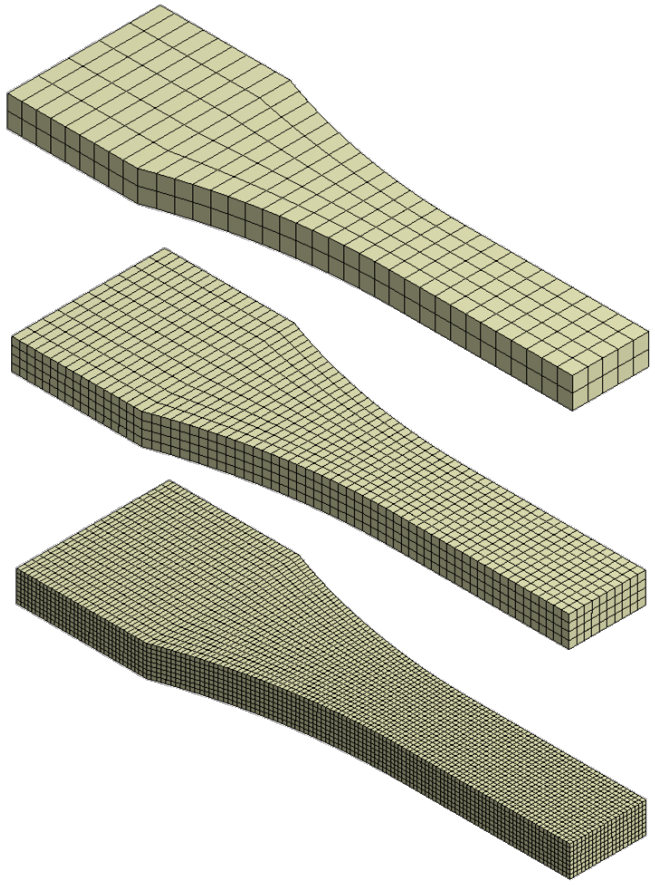


Stress – Strain Curves



Ansys Analysis

Mesh

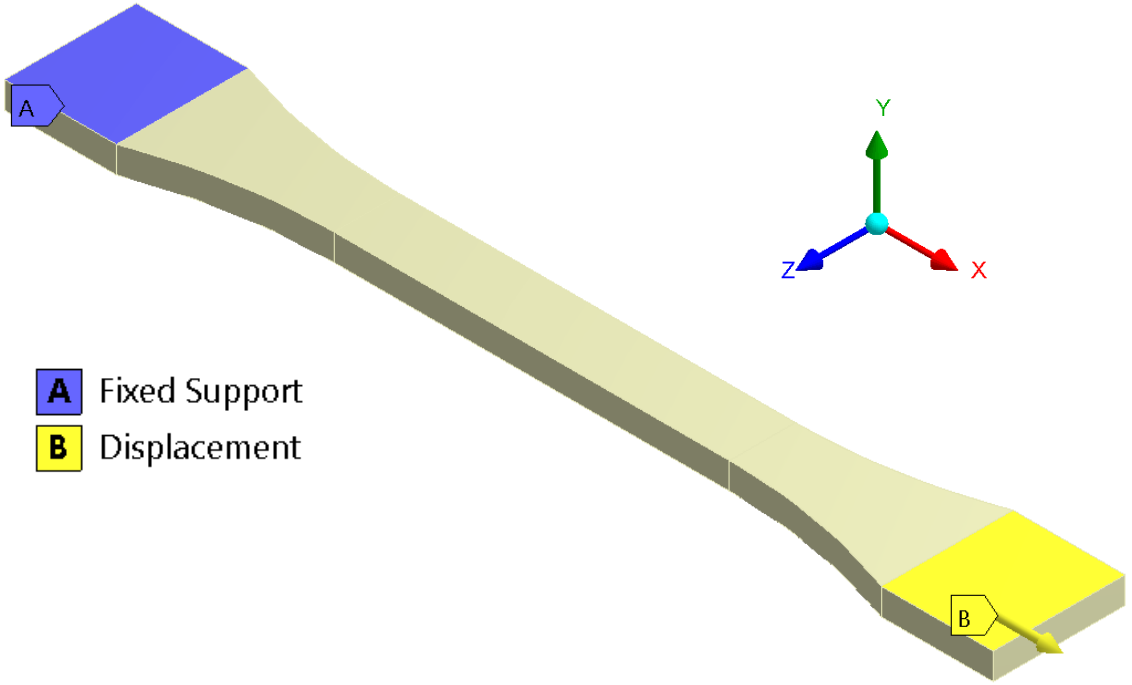


1.00 mm sizing

0.50 mm sizing

0.25 mm sizing

Boundary Conditions



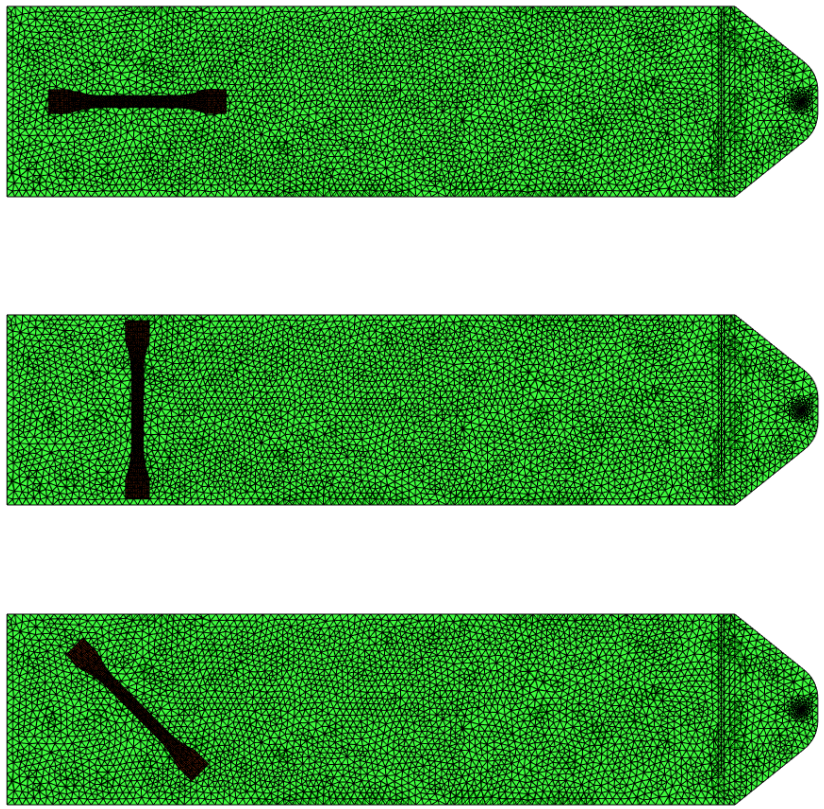
A Fixed Support

B Displacement

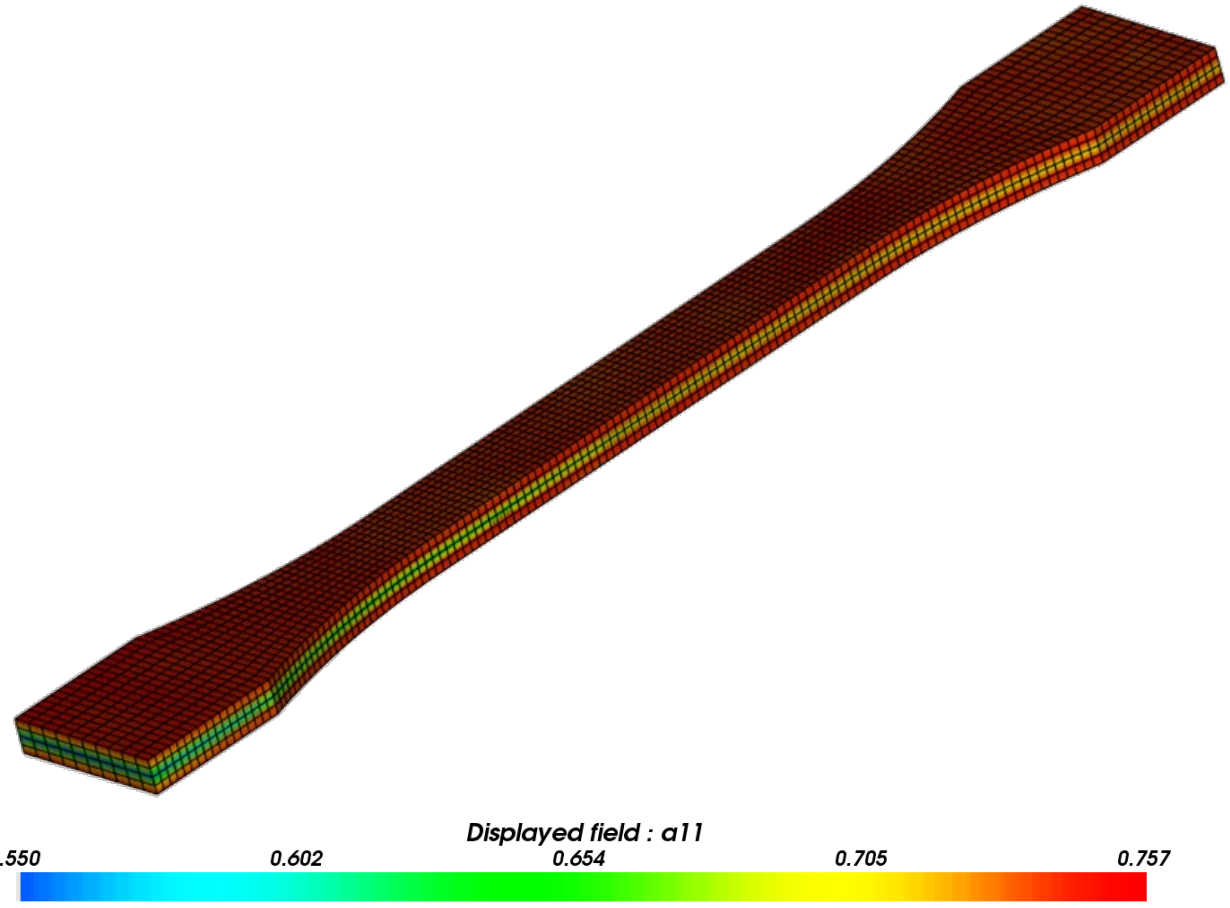
Specimen Type: 1BA
ISO 527

Ansys Analysis

Mapping Orientations

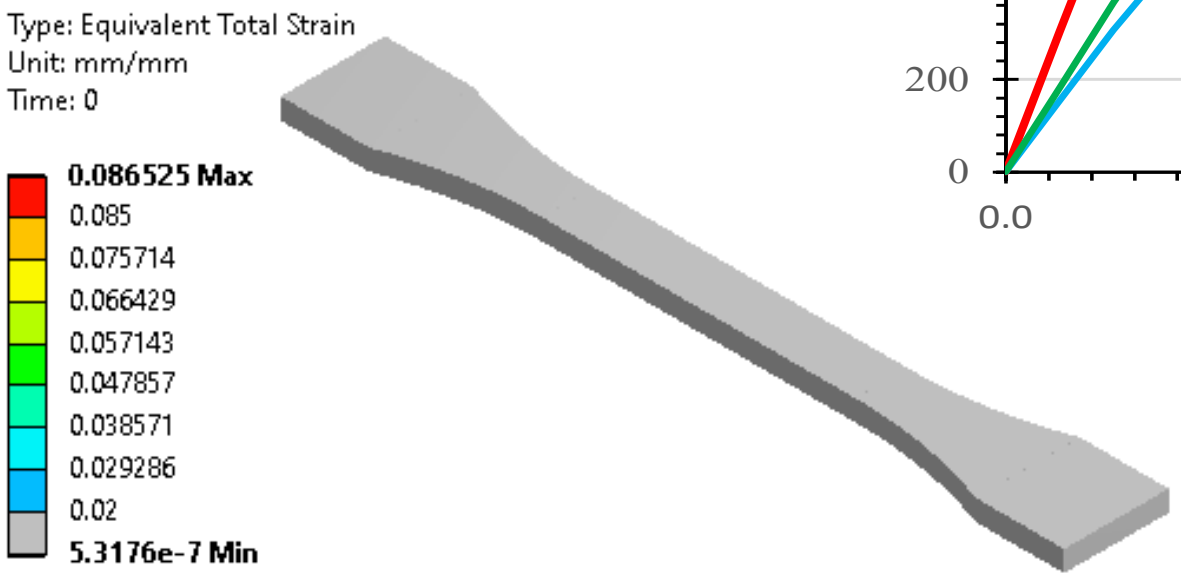


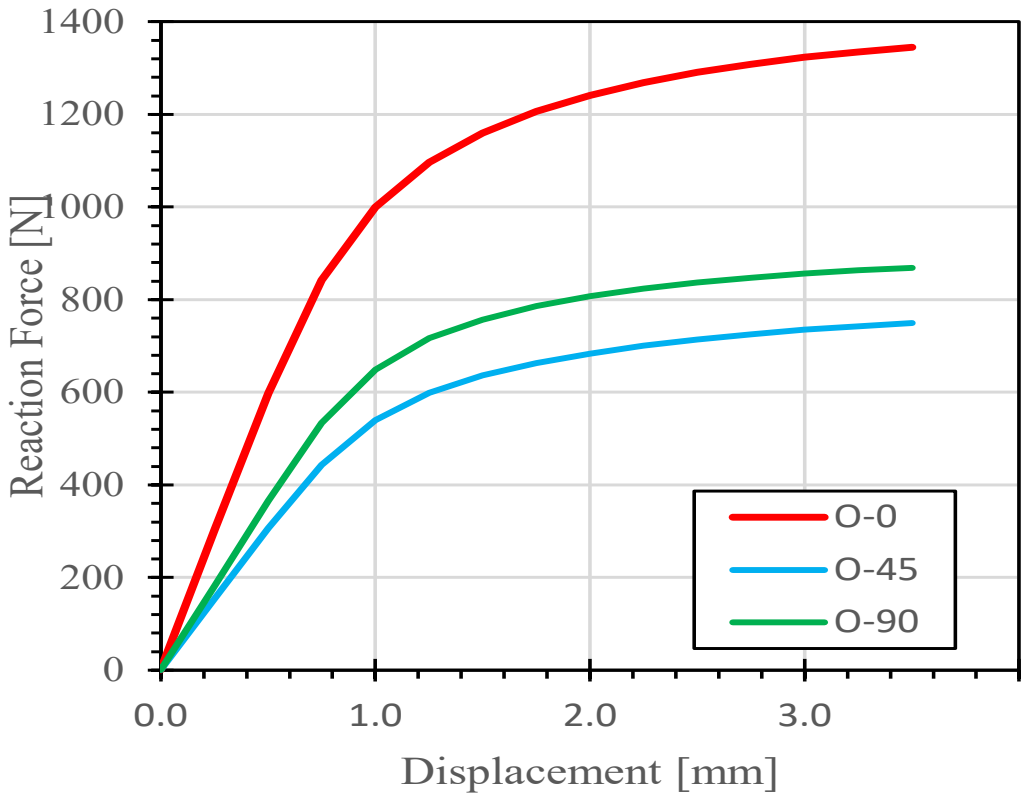
Mapped Probe

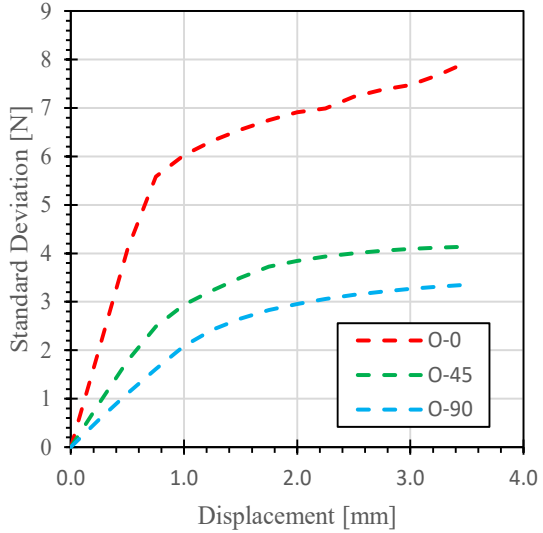


2 (moldflow) x 3 (orientations) x 3 (ansys) = 18 models

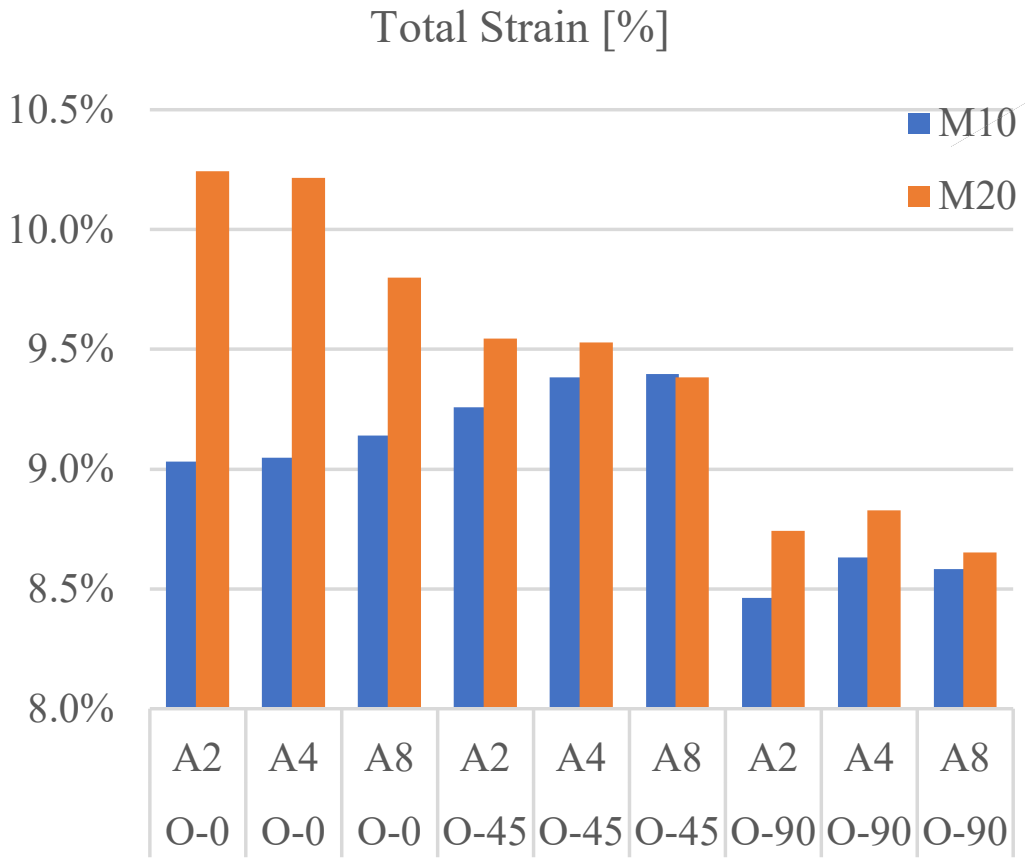
Ansys Analysis

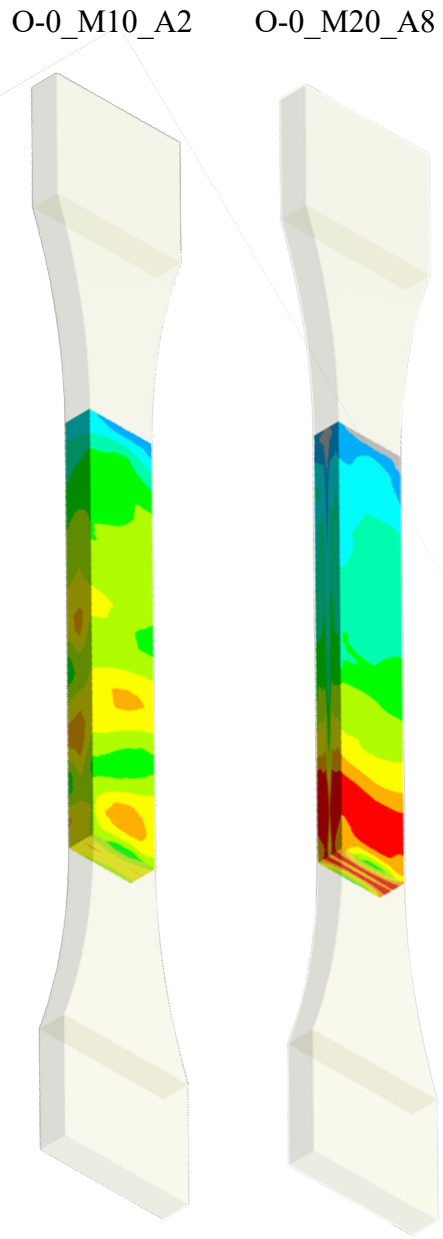






Ansys Analysis





Conclusions

- For tensile specimens, the orientation of the fibers has an important effect to the results.
- The mapping procedure does not have an influence on the reaction force.
- The total strain is higher for the models that consider 20 elements along the thickness of the injected plate. These differences are becoming smaller with the increase of the mesh resolution in the structural analysis.
- The maximum principal stress obtained in the specimens has some small variations regardless the model that was used. The differences between M10 and M20 are minimal.
- We can state that although it is quite challenging, time-consuming and that it requires the knowledge of using multiple software packages in order to correctly define and use a SFRC material, the benefits of doing so are clear.
- Ignoring the effects of the fiber orientation in such material can lead to unrealistic results.

Thank you for your attention!
Questions?