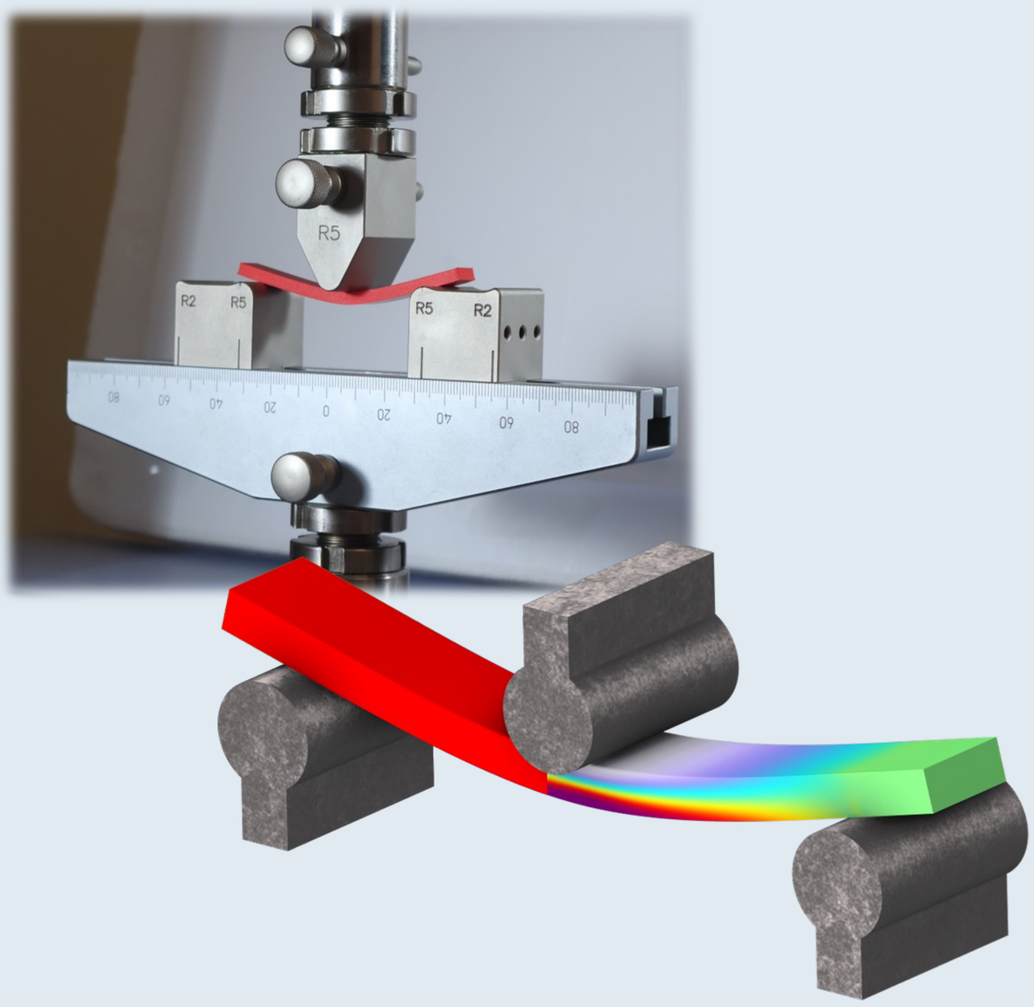

# Structural Analyses on 3D Printed Objects Made of Experimentally Characterized Materials

## Mechanical characterization of materials printed using different settings: from experimental to numerical validation

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## Abstract

Additive manufacturing (AM) significantly affects the mechanical strength of printed parts depending on the specific 3D printing process used.

The goal of this activity is to assess the **mechanical behaviour** of specimens printed with different parameters, like **infill density** and outer layers, and to **develop numerical models** in COMSOL Multiphysics® for structural analysis.

Our workflow included: printing specimens, conducting tensile and bending tests, performing numerical-experimental validation of the model.

Modeling and simulations have been carried out using the Structural Mechanics Module in COMSOL Multiphysics®. The non-linear elastic material model and a plasticity model with a hardening function were used due to non-linear stress-strain relationships.

## Methods

- Standard test specimens (ISO 527-1-2) were printed for mechanical testing with three infill grades: **100%, 75%,** and **25%.** Test performed:
  1. **Tensile test** at 1-5 [mm/min] and 50 [mm/min].
  2. **Bending test** at 2 [mm/min] and 50 [mm/min].
- Number of specimens: 10 per test.
- The tensile test allowed to identify the **YP** and the ***Stress function*** used to characterize materials in the model. **NUM-EXP validation** was carried out for tensile and bending tests.

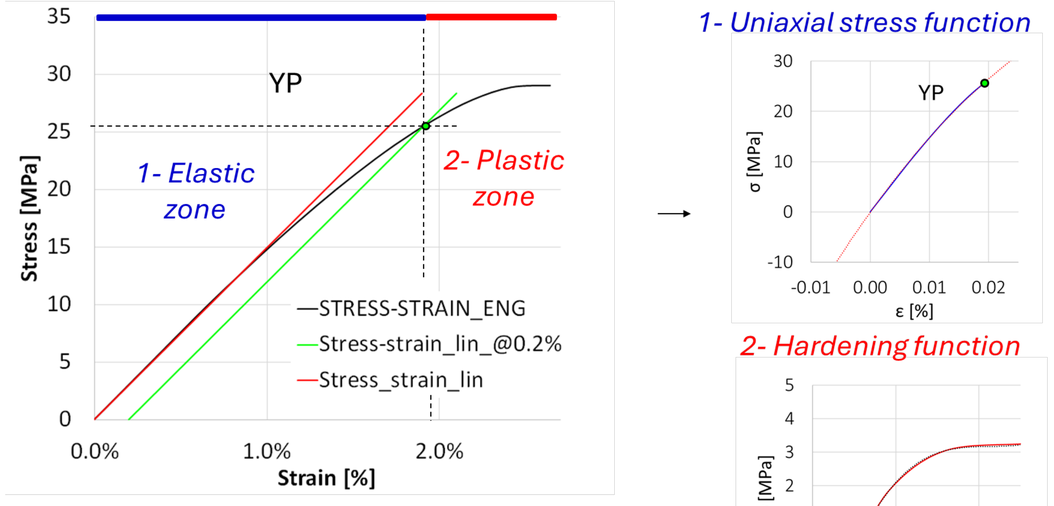


FIGURE 1. Yield Point (YP) individuation on the left, stress function on the right.

## Results

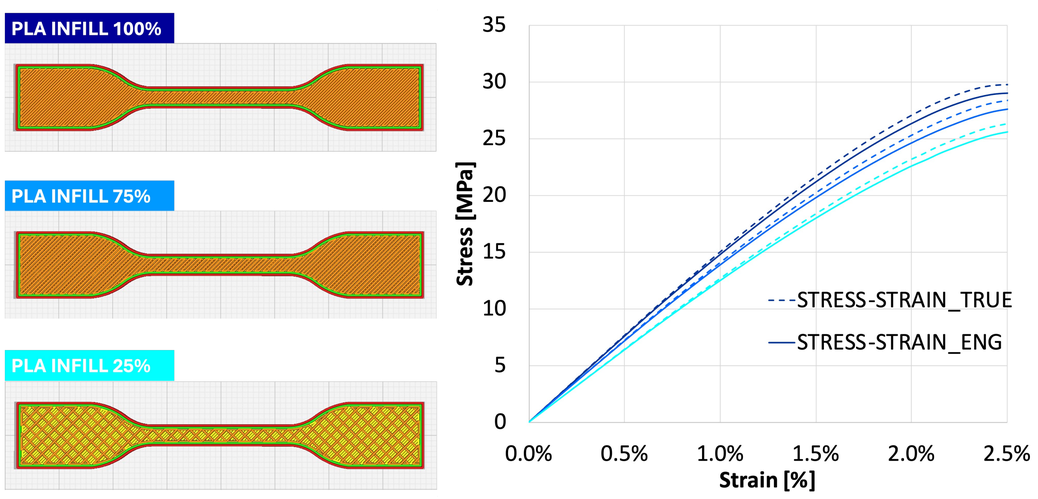


FIGURE 2. Average experimental stress-strain curves at different infill grades.

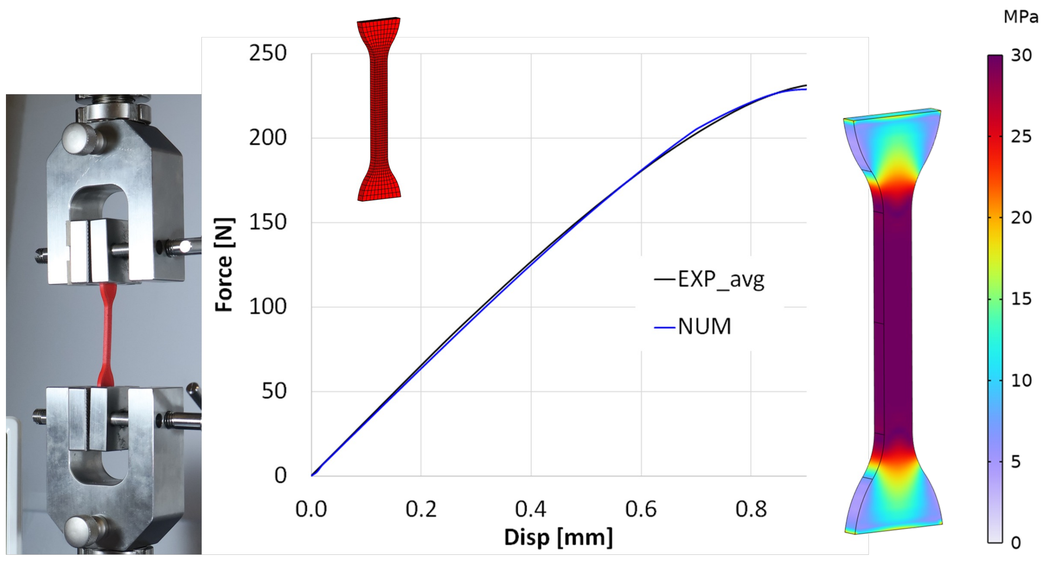


FIGURE 3. NUM Vs EXP comparison between Force/Displacement curves (PLA 100%).

## REFERENCES

1. Standard UNI ISO 527 1-2.
2. COMSOL, Structural Mechanics Module.

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