# Investigation of the performance of the two-layer viscoplastic model applied for simulating airsoft ball impacts

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## ABSTRACT

In the field of machine tool vibrations, the impulse excitation of high-speed rotating tools can be provided using shots of airsoft pellets. In order to estimate properly the transfer function of the tool, the impact time and the contact forces during the impact should be accurately approximated based on finite element (FE) simulations. This requires the complete understanding of the mechanical behavior of the ball during the impact.

The mechanical tests performed on the pellets showed that the deformation of the balls exhibits elastic, viscous and plastic properties as well. Hence, the applied material model should describe the viscoelastic and the yielding behavior in addition the elastic contribution at finite strain. The only available material model, among the implemented ones, that describes such material behavior in the commercial FE software ABAQUS [1] is the two-layer viscoplastic (TLVP) model. The TLVP model is comprised of a viscoelastic branch in parallel with an elastic-plastic network in 1D [2-3].

This report addresses to investigate the performance of the two-layer viscoplastic model using several models for the viscoelastic and the elastic-plastic branches, respectively. Since the analytical solutions are not available even for simple uniaxial compression tests, the material parameters are fitted by minimizing the error of the mechanical test data (e.g. uniaxial cyclic compression of the pellets) and the model prediction using FE simulation. This implies that in each iteration step of the fitting, a complete FE simulation for the compression and contact has to be performed. Finally, the performances of the investigated models are compared based on the FE simulations of the impact and validated using high-speed camera recordings.

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