Integrated Laboratory Testing and FEM-Simulation of Materials in Teaching and Research

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Abstract

The main theme of this article is a systematically integrated material testing and FEM-simulation in teaching and research. In order to perform FEM-Simulation realistically, a deep knowledge of the characteristics of the materials modelled is a pre-requisite. This work employs HyperWorks for FEM-Modelling and three calibrated laboratory testing machines for material characterization. Tensile and compression tests, impact test, and buckling test are presented along with the corresponding FEM-Models as examples. Among others, 3D-Printed materials are tested. In the results, some of the material parameters implemented in non-linear FEM-Solvers that play an important role in material testing will be discussed, such as, strain rate and temperature effect.

The comparison of FEM-Simulation results with experimental results is important from both a pedagogically-didactic point of view and for quality assurance of the simulation. Students can be better motivated when they are confronted with results from practical experiments and simulation early in the lecture. It is also important to make students aware of the significance of verification and validation of simulation results. Otherwise there is a danger of over-interpretation easily obtainable simulation results, especially considering the new developments in user-friendly software. Not only simulation are prone to failure and, therefore, must be validated, experiments can also deliver false data, for example, when the sensors are not working perfectly. In such situations, simulation can in turn be used to check the plausibility of laboratory test results. All in all, systematically integrated computer simulation and laboratory experiments can assure quality and reduce cost. It brings added value into teaching and research.

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