Selecting a heterogeneous mechanical test for sheet metal characterization

M. Gonçalves [(a,)], M.G. Oliveira [(a,b)], S. Thuillier [(b)], A. Andrade-Campos [(a)]*
(a) – Centre for Mechanical Technology and Automation (TEMA), Department of Mechanical Engineering, University of Aveiro; (b) - Univ. Bretagne Sud, UMR CNRS, IRDL, F-56100.
(a) Aveiro, Portugal; (b) – Lorient, France.
(*) - mafalda.goncalves@ua.pt

***Abstract* — Accurate simulation of sheet metal forming processes in a virtual environment requires a good understanding of the mechanical behavior of sheet metal. However, the characterization of the material behavior involves a time-consuming and costly classical testing procedure. Due to that, standard mechanical tests are being overtaken by new testing methods. These present more complex configurations and, thus, richer mechanical fields, providing a greater variety of data on material behavior [1]. Full-field measurement techniques such as Digital Image Correlation (DIC) are able to extract data from the test, taking advantage of the large quantity of information they provide. Although several test designs have already been proposed, selecting the best test to calibrate a material model remains a key challenge [2]. This study aims at proposing Key Performance Indicators (KPIs) to rank mechanical tests based on their ability to improve the material behavior characterization process. Three different mechanical tests, obtained from distinct design approaches [3,4,5], are analyzed using the proposed KPIs. Numerical information is extracted from a uniaxial load test up to rupture. The performance of each test is then evaluated and compared based on their ability to provide accurate and reliable mechanical data for characterizing sheet metal behavior. The results show that the KPIs are effective in ranking the different test designs and in identifying the most informative test. This highlights the importance of considering the design of mechanical tests when characterizing sheet metal behavior and the potential benefits of using KPIs to guide this process.**

Keywords— heterogeneous tests; KPIs; material behavior; sheet metal.

ACKNOWLEGEMENTS

This project has received funding from the Research Fund for Coal and Steel under grant agreement No 888153. The authors also acknowledge the financial support under the projects UIDB/00481/2020 and UIDP/00481/2020 – FCT – Fundação para a Ciência e Tecnologia; and CENTRO-01-0145-FEDER-022083 – Centro Portugal Regional Operational Programme (Centro2020), under the PORTUGAL 2020 Partnership Agreement through the European Regional Development Fund. M. Gonçalves is grateful to the FCT for the Ph.D. grant Ref. UI/BD/151257/2021.

DISCLAIMER

The results reflect only the authors' view, and the European Commission is not responsible for any use that may be made of the information it contains.

TOPIC

1) a.: Sustainable Manufacturing Solutions – Manufacturing Processes & Simulation

REFERENCES

[1] N. Souto, S. Thuillier and A. Andrade-Campos, "Design of an indicator to characterize and classify mechanical tests for sheet metals", Int. J. Mech. Sci., vol. 101-102, pp. 252-271, 2015.

[2] M.G. Oliveira, S. Thuillier and A. Andrade-Campos, "Evaluation of heterogeneous mechanical tests for model calibration of sheet metals", J. Strain Anal. Eng. Des., vol. 57(3), pp. 208-224, 2022.

[3] M. Rossi, F. Pierron and M. Štamborská, "Application of the virtual fields method to large strain anisotropic plasticity", Int. J. Solids Struct., vol. 97-98, pp. 322-335, 2016.

[4] E.M.C. Jones et al., "Parameter covariance an non-uniqueness in material model calibration using the Virtual Fields Method", Comput. Mater. Sci., vol. 152, pp. 268-290, 2018.

[5] M.Goncalves, A. Andrade-Campos and S. Thuillier, "On the topology design of a mechanical heterogeneous specimen using material and geometric nonlinearities", IOP Conf. Ser. Mater. Sci. Eng., vol. 1238, pp. 012055, 2022.