A nonlinear topology-based optimization approach for the design of a heterogeneous mechanical test

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***Abstract*— Numerical simulation is being widely applied in the virtualization of sheet metal forming processes. An accurate reproduction of the material behavior is of major relevance for the quality of the obtained results. Material characterization and model calibration procedures usually rely on the use of a whole range of classical mechanical tests. With nonhomogeneous displacement and strain fields, heterogeneous mechanical tests have appeared to enhance this costly procedure. New specimen geometries have already been proposed by several authors, who adopted nonefficient design methodologies, for instance, trial and error approaches based on their empirical knowledge [1]. This issue can be solved using an optimization approach to find efficiently the specimen geometry that can provide the highest quantity of information about the material behavior. This work proposes a topology-based optimization methodology for the design of a heterogeneous mechanical test. The potential of topology optimization to obtain an innovative geometry consists in a major advantage of the proposed methodology [2,3]. Moreover, a mechanism design approach is used alongside the design by topology optimization to directly introduce heterogeneity in the displacement field [4]. A nonlinear finite element analysis is employed to account for material and geometric nonlinearities. The nonlinear elastoplastic behavior and the large deformations that the specimen is subjected to are taken into account in the design procedure. As a result, an optimal specimen geometry is obtained, being the heterogeneity of its stress field evaluated using a mechanical indicator. It was proved that the proposed nonlinear design methodology produces a mechanical test capable of improving the mechanical characterization of sheet metals.**

Keywords— Heterogeneous test; Topology optimization; Mechanism design; Nonlinear FEA; Elastoplasticity.

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 of the Portuguese Foundation for Science and Technology (FCT) under the project PTDC/EME-APL/29713/2017 by UE/FEDER through the programs CENTRO 2020 and COMPETE 2020, and UID/EMS/00481/2013-FCT under CENTRO-01-0145-FEDER-022083. M. Gonçalves is grateful to the FCT for the Ph.D. grant Ref. UI/BD/151257/2021.

TOPIC

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

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