On the topology design of a mechanical heterogeneous specimen using geometric and material nonlinearities

Mafalda Gonçalves[1]*, António Andrade-Campos[1] and Sandrine Thuillier[2]

[1] *Department of Mechanical Engineering, University of Aveiro, Aveiro, Portugal*
[2] *Univ. Bretagne Sud, UMR CNRS 6027, IRDL, F-56100, Lorient, France*

* *mafalda.goncalves@ua.pt*

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Abstract

Material characterization and the calibration of constitutive models are of upmost importance for the majority of the forming processes nowadays. For an accurate virtualization of the development processes, the material mechanical behavior needs to be known a priori. The classical characterization procedure involves carrying out several standard mechanical tests to identify the required information about the material. However, this procedure turns out to be expensive and time-consuming. Heterogeneous mechanical tests have been used to overcome this issue. By providing richer information with a reduced number of tests, their use can enhance the actual material characterization process. This work aims at making a significant contribution towards this goal by designing a heterogeneous mechanical test using topology optimization. A specimen topology is obtained with a heterogeneous displacement field by applying the theory of compliant mechanisms [1]. Due to the large displacements considered, a geometrically nonlinear finite element analysis and topology optimization procedure are proposed [2]. Material nonlinearity is taken into account as well, to design solutions closer to reality [3]. An optimal mechanical test with a highly heterogeneous strain field is obtained and evaluated, considering its diversity, using mechanism theory and a mechanical indicator [1].

References

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