Modeling of Softening Behavior by Deep Symbolic Regression

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Rubber-like materials demonstrate pronounce softening under cyclic loading. This phenomenon known as Mullins effect [1] plays an important role in the stress-strain response of these materials. In spite of long term research and numerous modeling approaches proposed in literature an accurate prediction of the Mullins effect especially under complex loading conditions still remains a challenging task.

In this work, we propose a novel approach to model the Mullins effect using deep symbolic regression [2]. The goal is to find a strain energy in the form of an algebraic expression fitting the given data as closely as possible. By incorporating into the continuum mechanical framework the method combines advantages of known physical relationships with the unbiased optimization approach of symbolic regression. The procedure has already been applied to discover incompressible hyperelastic material models and will be extended here to inelastic effects as well [3]. The proposed approach is validated through benchmark tests using the generalized Mooney-Rivlin and the Ogden-Roxburgh model. In addition, the proposed framework is tested on an experimental temperature-dependent data set. Good agreement between the obtained material models and the experimental data is demonstrated.

References

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