The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

A Microplane Model for Textile Reinforced Concrete at Finite Strains

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Keywords: *Finite Deformations, Non-local Damage, Textile Reinforced Concrete, Microplane Model*

In civil engineering application, concrete is the most utilized material due to its flexibility in design, relative low production costs and easy usage at the building site. The major downside of this material is the high CO_2 emission in the production process. Another downside is the comparatively limited carrying capacity under tensile loading conditions. Therefore, different materials are used to reinforce concrete. The most used material is steel due to its high tensile strength, which results in a high concrete consumption in order to protect the steel from environmental influences. To reduce the required amount of concrete, new reinforcement technologies are currently developed. A material to overcome the downsides of steel is textile reinforced concrete.

In the research of computational mechanics, a frequently used material model for capturing the characteristics of concrete is the microplane model as pointed out in [1] and [2]. The main characteristic is the initially isotropic material behavior, which evolves into an anisotropic behavior due to damage effects. Furthermore, softening behavior can be observed, which leads to instabilities in numerical simulations due to localization phenomena. In [2], regularization techniques are applied to overcome these phenomena.

The contribution at hand focuses on the application of the microplane model for textile reinforced concrete structures. Therefore, the formulation from [2] is taken and developed for finite strains. The free HELMHOLTZ energy formulation is expanded to include a smeared representation of the fibers. Furthermore, the regularization method from [2] is applied to ensure a stable convergence of the NEWTON type solver, solving the Finite Element problem. Additionally, mesh dependencies are overcome by the usage of a non-local damage formulation.

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