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# A Traction-Compression Asymmetric Damage Phase Field Model based on a Fourth-order Degradation Tensor

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## Abstract

In this work, we extend a previous phase-field model with a fourth-order degradation tensor to simulate failure mechanisms for components with traction and compression asymmetric behavior. We apply the obtained model for reinforced concrete (RC) beams, particularly in beams with high steel reinforcement ratios. The model is designed to capture complex fracture behaviors under tensile and compressive loadings by employing distinct phase-field parameters. Numerical analyses focus on RC beams under four-point bending, comparing results with experimental data from the literature to validate its accuracy. Quantitative results show that the model effectively replicates load-displacement curves, accurately reflecting the influence of geometric and material properties on the mechanical behavior of RC beams. Qualitatively, the model reproduces crack initiation, propagation, and coalescence patterns that closely correspond to experimental observations, capturing complex failure modes such as diagonal tension (DT), shear-compression (SC) and concrete crushing (CC).

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