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PREDICTION OF SHEAR BANDS IN TUNNELLING – COMPARISON OF TWO REGULARIZATION APPROACHES

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In this contribution, the application of a damage plasticity model for rock mass, proposed in [1], in finite element simulations of deep tunnel advance, derived from a real tunnel construction in Innsbruck quartz phyllite, is discussed. Rock is a frictional-cohesive material characterized by nonlinear stress-strain relations including softening material behaviour. The isotropic damage plasticity model for intact rock and rock mass is characterized by considering irreversible strains, strain hardening, and the degradation of stiffness and strength. Employing the damage plasticity rock model in numerical simulations of tunnelling allows predicting the formation of shear bands emanating from the tunnel surface during the excavation and securing process. Hence, potential failure of the tunnel structure can be analysed in numerical simulations.

Since considering strain softening in constitutive relations leads to strain localization at structural level, its description by a constitutive model without regularization yields mesh-dependent results in the context of a finite element simulation. Hence, in the original rock model [1] the crack band approach by Bažant and Oh [2] was adopted. To remedy known deficiencies related to this regularization approach, an extension of the rock model based on the over-nonlocal gradient enhancement, as presented in [3], is proposed.

Based on two-dimensional finite element simulations of deep tunnel advance, the two regularization approaches are compared aiming at the capability to predict objective results with respect to the finite element discretization. It is shown that the over-nonlocal implicit gradient enhancement of the rock model allows predicting the formation of shear bands in tunnelling in an objective manner.

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