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# Experimental and Numerical Modelling of Shotcrete, and Application to a Numerical Study of Deep Tunnelling

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The present contribution addresses the nonlinear, time-dependent material behaviour of shotcrete in the context of numerical simulations of deep tunnel advance. To this end, the recently proposed damage plasticity model for shotcrete [1], denoted as the SCDP model, is discussed and its application to finite element simulations of deep tunnel advance is presented.

The SCDP model represents inelastic deformations, hardening and softening material behaviour, stiffness degradation due to damage, shrinkage and nonlinear creep of shotcrete. For the calibration of the material model, test results from a new experimental program on shotcrete [2] are taken. Furthermore, an advanced regularization technique, based on the over-nonlocal implicit gradient-enhanced formulation proposed by [3] for an objective description of softening material behaviour in finite element simulations, is discussed.

The presented finite element study is derived from a stretch of the Brenner Base Tunnel, for which in-situ measurement records are available. By means of this study, it is demonstrated that based on the proposed model the time-dependent deformations arising in the shotcrete shell during tunnel advance and even collapse of the tunnel support structure can be predicted. A comparison with the in-situ measurement records reveals the good performance of the model.

## REFERENCES

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