Damage with plasticity at small strains - an overview of various models

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Coupling of plasticity with damage allows for modelling many complex processes occurring in solid continuum mechanics and physics, in contrast to mere plasticity or mere damage. First, a quasistatic model of linearized plasticity with hardening at small strains combined with gradient damage will be presented in its basic scenario with unidirectional damage and in the fully rate-independent setting. Various concepts of weak solutions will be discussed, ranging from the concept of energetic (i.e., in particular, energy conserving) solutions to stress-driven local solutions. Some modifications of this model will then be presented. In particular a rate-dependent damage allowing possibly also healing, and plasticity possibly without hardening and with damageable yield stress. This variant seems to need the concept of 2nd-grade non-simple materials and allows e.g. for modelling of thin shearbands surrounded by a wider damage zone. An "opposite" variant is rate-dependent plasticity but damage again rate independent and unidirectional, which allows for energy conservation and in particular for extension towards anisothermal processes. Also combination of this model with a concept of large plastic strains or some other rate-dependent processes like diffusion of some "fluidic" medium with wide applications covering e.g. heat/moisture transport in concrete or rocks, or a metal/hybrid transformation under diffusion of hydrogen will be discussed.