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Theoretical and computational challenges in blast loading and penetration of geological materials[1]

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Soils, rocks, and rock-like materials (concretes and ceramics) are usually modeled in the framework of plasticity, with inelasticity attributed to failure mechanisms such as microcracking and pore collapse as well as dislocations at high confinement. Alternatives to plasticity will be mentioned, but the focus will be on the features that distinguish geological plasticity models from traditional models for metals, such as stronger dependence on all stress invariants as well as failure-mode-sensitivity of rate effects. Geological materials are often anisotropic from the outset and almost certainly develop induced anisotropy, which is not well modeled in general-purpose constitutive models (nor is the possibility of induced anisotropy adequately considered in many analyses of experimental data). Geological materials exhibit significant non-associativity, which is relevant to shock physics because non-associativity allows plastic waves to travel faster than elastic waves (and therefore implies an unrealistic instability that might be eliminated through the use of non-classical incremental nonlinearity in the plasticity model). Perhaps the most vexing aspect of modeling geological materials is irreducible uncertainty in material properties, which contributes to scale-dependent localization and leads to numerical troubles. Applications of some statistical engineering plasticity models for rocks will be shown in the context of tunnel collapse and penetration.

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