Stress-strain relationships

Elastic strain

linear stress $\sigma_n = E.e$

Poisson's ratio $\nu = - e_1/e_3$

shear stress $\sigma_s = G.\gamma$

mean stress $\sigma_m = -K\Delta$

where E = Young's modulus of elasticity;
G = shear modulus of elasticity;
K = bulk modulus of elasticity;
e_1, e_3 are principal extensions of sample under uniaxial compression.

Relationships between the elastic moduli

$$G = \frac{E}{2(1+\nu)} \qquad K = \frac{E}{3(1-2\nu)}$$

Brittle Failure

Coulomb fracture criterion

$\sigma_s = C + \sigma_n \tan\phi$

where C is a constant and ϕ is the angle of internal friction.

"Byerlee's law" for movement on existing fractures

$\sigma_s = 0.85\sigma_n$ ($\sigma_n < 200$ MPa)

$\sigma_s = 50 + 0.60\sigma_n$ ($\sigma_n > 200$ MPa)

Viscous (Newtonian) flow

Strain rate $\dot{e} \propto \sigma_d$

where σ_d is differential stress. Alternatively:

$\sigma_d = \eta\dot{e}$

where η = viscosity.

Specific equation for diffusional creep

$$\dot{e} = A\sigma_d \exp\left(-E^*/RT\right) d^{-r}$$

where d is the grain size and r is 2 for grain-boundary diffusion and 3 for volume diffusion

Plastic (Von Mises) Creep

$\sigma_d = C$ (constant)

Power Law Creep

$\dot{e} \propto \sigma_d{}^n$ where k and n are constants

or more specifically

$$\dot{e} = A\sigma_d^n \exp\left(-E^*/RT\right)$$

where A and n are constants for the material, E* is the activation energy, R is the gas constant and T is the absolute temperature.

Exponential Creep

$\dot{e} \propto \exp(\sigma_d)$ where k and n are constants

or more specifically:

$$\dot{e} = A\exp(\sigma_d)\exp\left(-E^*/RT\right)$$

where A is a constant for the material, E* is the activation energy, R is the gas constant and T is the absolute temperature