PHASE-FIELD DRUCKER-PRAGER MODEL FOR CONCRETE

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ABSTRACT

An efficient, accurate and minimal-parameter constitutive model for a simulation of concrete structures behavior can be developed based on Drucker-Prager elastic-plastic yield criterion: $\phi = \alpha I_1 + \sqrt{J_{2D}} - k$, where $k = \sigma_0 + h\bar{\varepsilon}_p$, σ_0 is the initial yield stress, h is the hardening parameter, α is the material parameter, and $\bar{\varepsilon}_p$ is the equivalent plastic strain [1]. Total free energy consists of the elastic-plastic and the fracture contribution as [2]: $\psi = \psi^{ep} + \psi^f$, where $\psi^{ep} = g(1/2\boldsymbol{\sigma} : \boldsymbol{\varepsilon}_e + \sigma_0\bar{\varepsilon}_p + 1/2h\bar{\varepsilon}_p^2)$, $\psi^f = G_v(d + l_c^2|\nabla d|^2)$, $\boldsymbol{\sigma}$ is the stress tensor and $\boldsymbol{\varepsilon}_e$ is the elastic strain tensor. The phase-field damage evolution law is defined as: $G_v[d - l_c^2\nabla^2 d] + g'H_{max} = 0$, where the degradation function is $g = (1-d)^2$, l_c is the characteristic length, d is the damage variable, and $H_{max} = \psi^{ep} - \psi^{cr}$ is the maximal total strain energy. The fracture energy G_v is calculated in a relation to the tension and compression strength and the threshold value of critical total strain energy $\psi^{cr} = G_v/2$. The results of uniaxial tension and compression tests are presented in Fig.1.

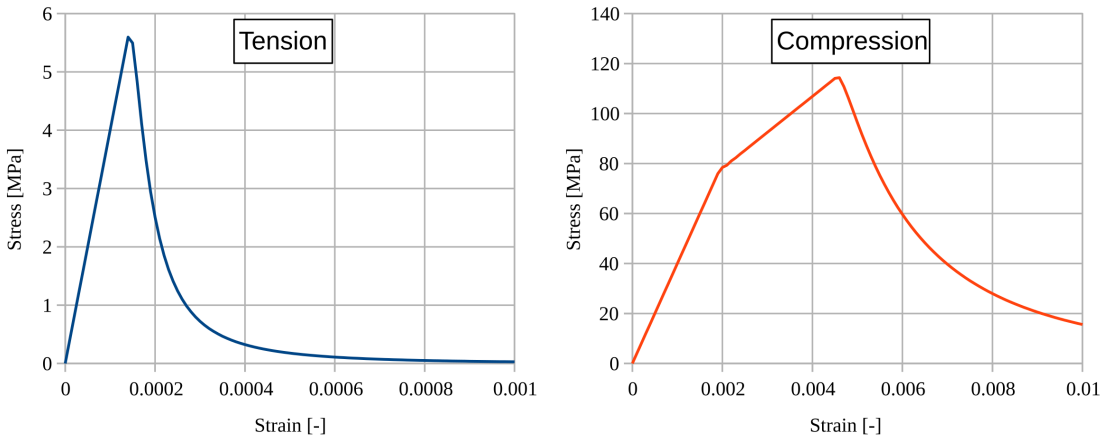

Figure 1: Stress-strain response for tension and compression test

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