Parameters of Plastic Damage Concrete Model

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This documents gives a brief overview of the required input parameters of the plastic damage concrete model. Table 1 summarizes the parameters, which can be roughly categorized into 3 groups:

(1) *Parameters based on material properties*: the Young modulus E, the Poisson ratio ν, the tensile yield strength f_t, and the compressive yield strength f_c

(2) *Plastic strain rate parameter*: the plastic strain rate coefficient β

(3) *Damage parameters*: the parameters governing the damage evolution A_p, A_n, B_n

Table 1: Model parameters

Parameter	Description
E	elastic modulus
ν	Poission ratio
f_t	tensile yield strength
f_c	compressive yield strength
β	plastic strain rate parameter
A_p	positive damage parameter
A_n	negative damage parameter #1
B_n	negative damage parameter #2

Parameters in the first group are directly based on properties of concrete material. It is noteworthy that in this model the tensile yield strength f_t assumes to coincide with the peak strength in uniaxial tension. The compressive yield strength f_c is the stress at the transition from elastic to plastic range in uniaxial compression and is typically less than the maximum compressive strength.

The following sections discuss the parameters in the second and the third group.

1 Plastic strain rate coefficient, β

The plastic strain rate coefficient β governs the post-yield hardening modulus in the effective (undamaged) space and the plastic strain rate. Fig. 1 shows sample stress-strain relation with complete load removal at strain value of 5×10^{-3} to illustrate the effect of β. A higher value of β increases the amount of plastic strain accumulated. A special case of $\beta = 0$ represents elastic behavior with elastic unloading. Typical values of β are 0.3 - 0.6.

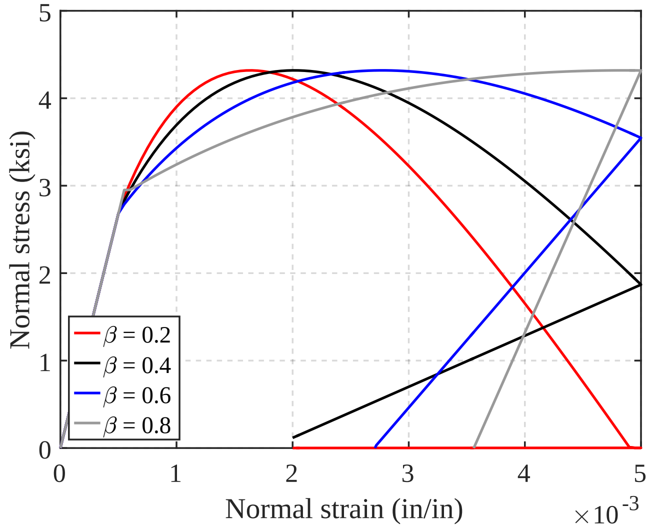


Figure 1: Effect of β on the stress-strain relation and damage evolution

2 Damage parameter A_p

Parameter A_p governs the tensile fracture energy and affects the "ductility" of the tensile response. Fig. 2 shows the effect of parameter A_p on the response in uniaxial tension for different values of A_p. A higher A_p results in a more "ductile" tensile response. Faria et al [1] suggests an expression to relate A_p to the characteristic length l_{ch} and fracture energy G_f:

$$A_p = \left(\frac{G_f E}{l_{ch}(f_t)^2} - \frac{1}{2} \right)^{-1} \geq 0 \tag{1}$$

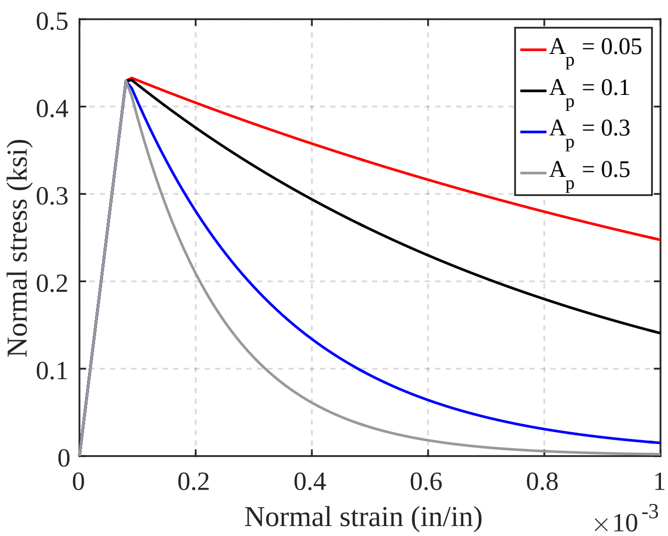
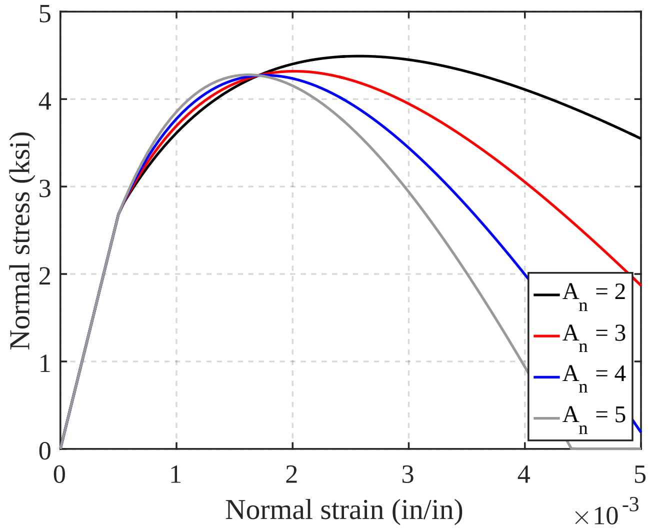


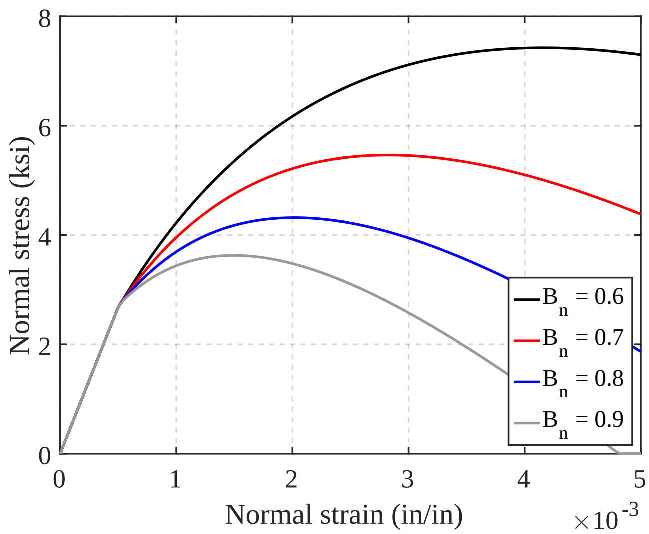
Figure 2: Effect of A_p on the stress-strain relation

3 Damage parameters A_n and B_n

Parameters A_n and B_n govern the softening behavior of concrete in compression. Fig. 3 show the effect of parameters A_n and B_n on the response un uniaxial compression for different values of the parameters. Both parameters affect the ductility of the compressive response; however, parameter A_n changes the ductility but does not alter the peak strength significantly, whereas parameter B_n changes both the ductility and the peak strength. It is noteworhty that the numerical solution is rather sensitive to change in parameter B_n.



(a) Effect of A_n



(b) Effect of B_n

Figure 3: Effect of A_n and B_n on the stress-strain relation

References

[1] Faria R, Oliver J, Cervera M. A strain-based plastic viscous-damage model for massive concrete structures. *International Journal of Solids and Structures* 1998; **35**(14):1533–1558.