

Concrete Material Models

Concrete_1: Concrete Model with No Tensile Strength

INPUT

Concrete_1, matID

$f'_c, \epsilon_0, f_{cu}, \epsilon_u$

Definitions (Fig. 1):

f'_c : concrete compressive strength at 28 days (compression is negative)

ϵ_0 : concrete strain at maximum strength (compression is negative)

f_{cu} : concrete crushing strength (compression is negative)

ϵ_u : concrete strain at crushing strength (compression is negative)

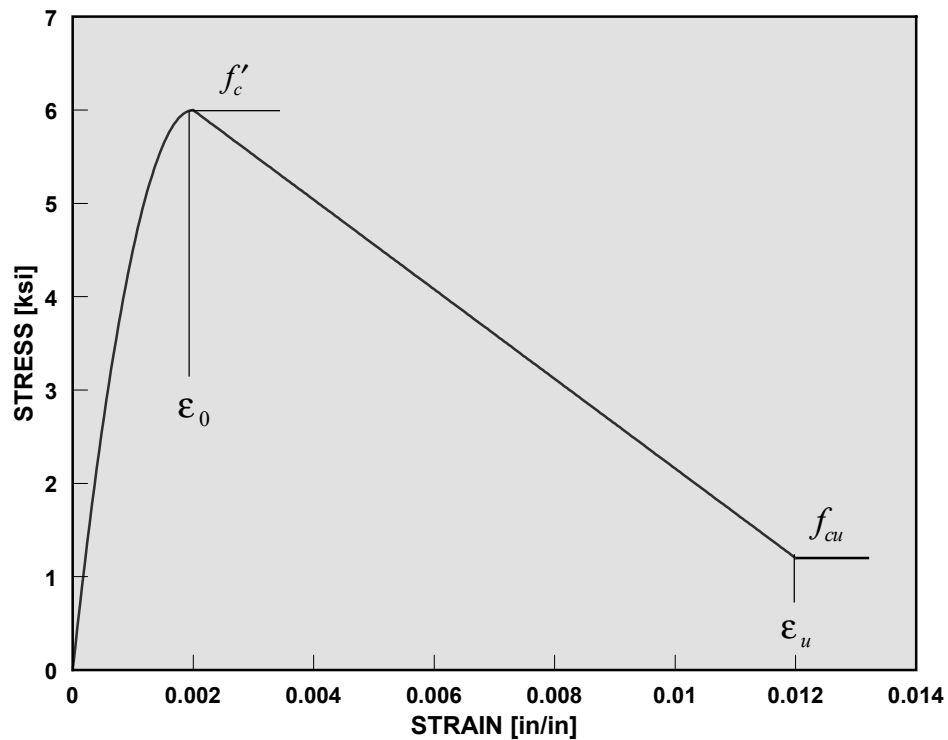


Figure 1. Material Parameters of Monotonic Compression Envelope of Concrete_1 Model

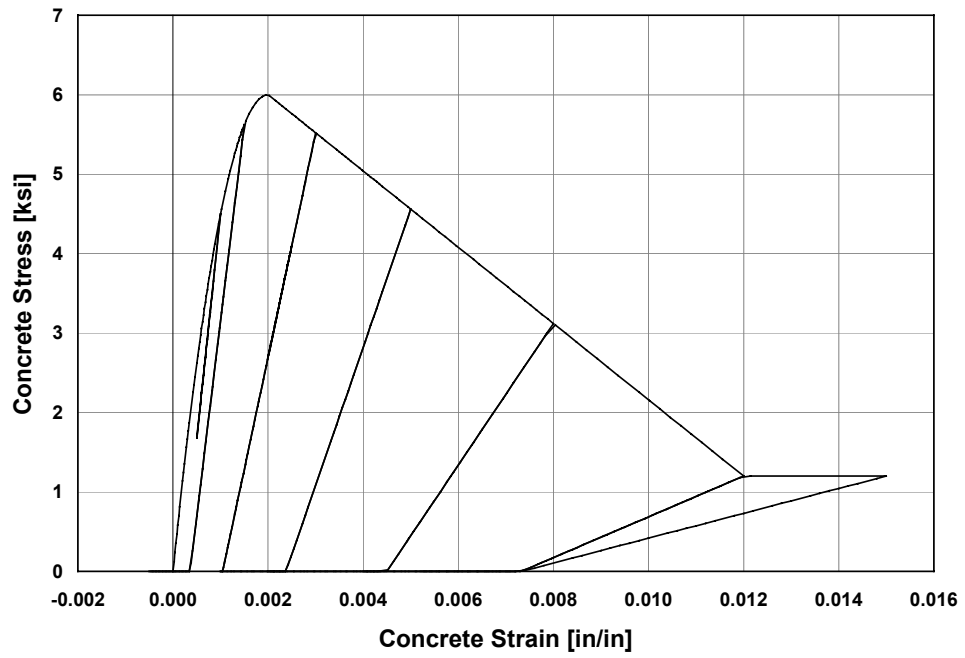


Figure 2. Typical Hysteretic Stress-Strain Relation of Concrete_1 Model

Concrete_2: Concrete Model with Tensile Strength and Linear Tension Softening

INPUT

Concrete_2, matID

$f'_c, \epsilon_0, f_{cu}, \epsilon_u, \lambda, f_t, E_{ts}$

Definitions (Fig. 3):

f'_c : concrete compressive strength at 28 days (compression is negative)

ϵ_0 : concrete strain at maximum strength (compression is negative)

f_{cu} : concrete crushing strength (compression is negative)

ϵ_u : concrete strain at crushing strength (compression is negative)

$$\lambda = \frac{E_u}{E_c}$$

f_t : tensile strength

E_{ts} : tension softening stiffness (absolute value)

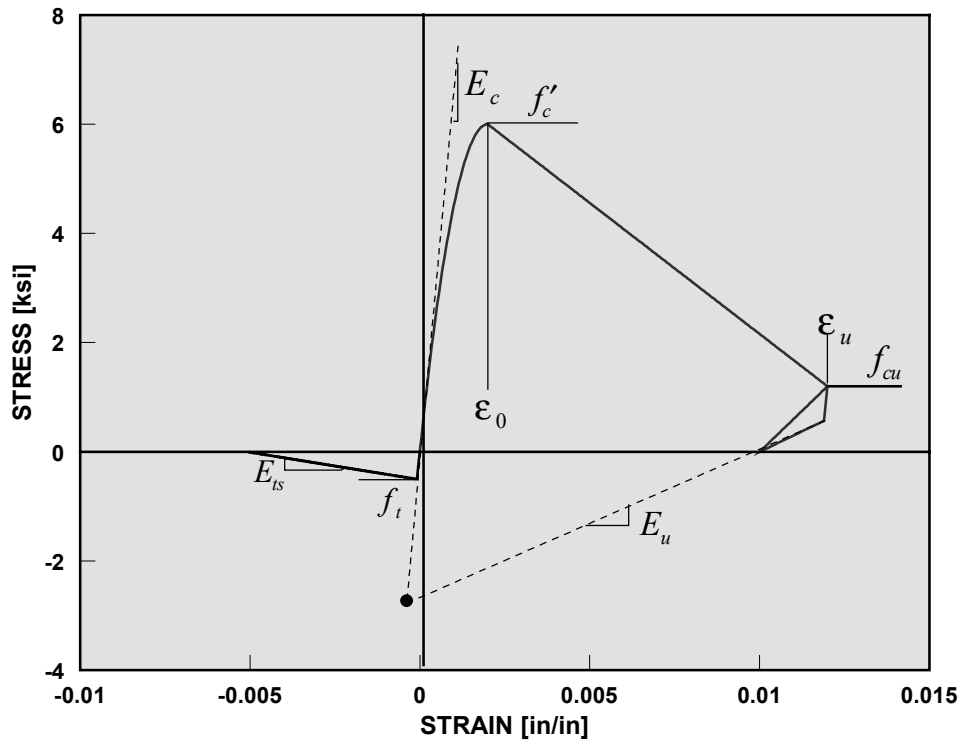


Figure 3. Material Parameters of Monotonic Envelopes of Concrete_2 Model

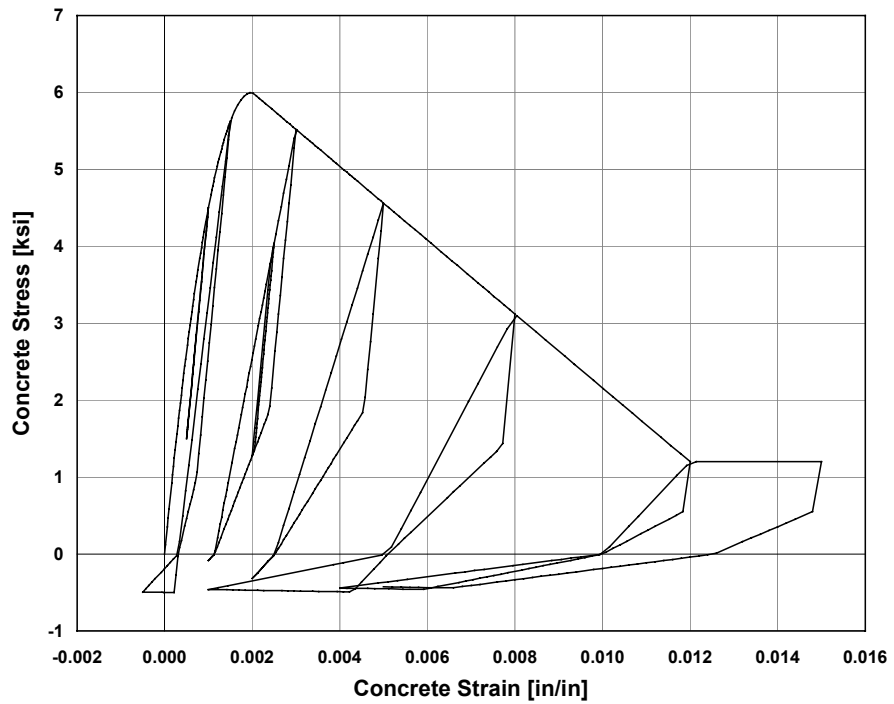


Figure 4. Typical Hysteretic Stress-Strain Relation of Concrete_2 Model

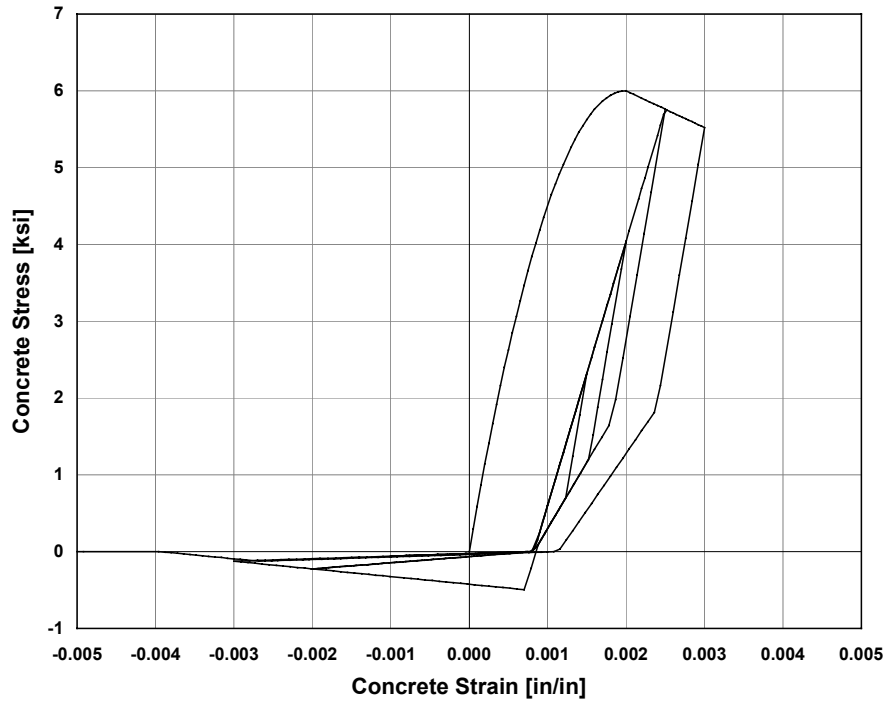


Figure 5. Hysteretic Stress-Strain Relation of Concrete_2 Model in Tension-Compression

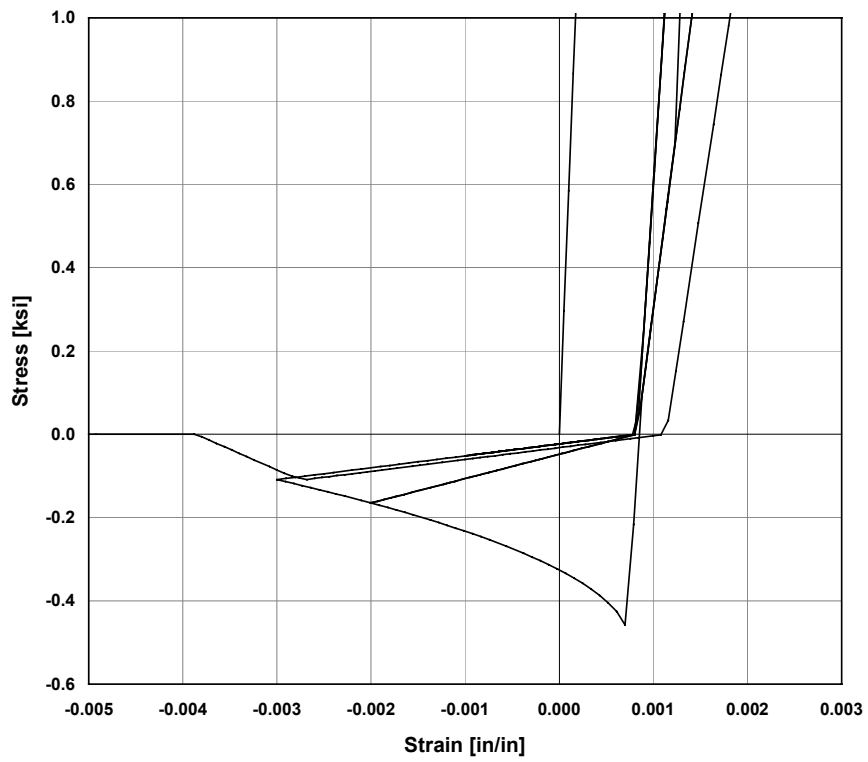


Figure 6. Hysteretic Stress-Strain Relation of Concrete_2 Model in Tension-Compression (Detail)

Concrete_3: Concrete Model with Tensile Strength and Nonlinear Tension Softening

INPUT

Concrete_3, matID
$f'_c, \epsilon_0, f_{cu}, \epsilon_u, \lambda$
$f_t, \epsilon_{t1}, f_{t1}, \beta, \epsilon_{tu}$

Definitions:

f'_c : concrete compressive strength at 28 days (Fig. 3) (compression is negative)

ϵ_0 : concrete strain at maximum strength (Fig. 3) (compression is negative)

f_{cu} : concrete crushing strength (compression is negative)

ϵ_u : concrete strain at crushing strength (Fig. 3) (compression is negative)

$$\lambda = \frac{E_u}{E_{co}} \text{ (Fig. 3)}$$

f_t : tensile strength (Fig. 7)

ϵ_{t1} : tensile strain at transition from nonlinear to linear softening branch (Fig. 7)

f_{t1} : tensile stress at transition from nonlinear to linear softening branch (Fig. 7)

β : exponent of nonlinear softening branch (Fig. 7)

ϵ_{tu} : tensile strain at zero tensile stress (Fig. 7)

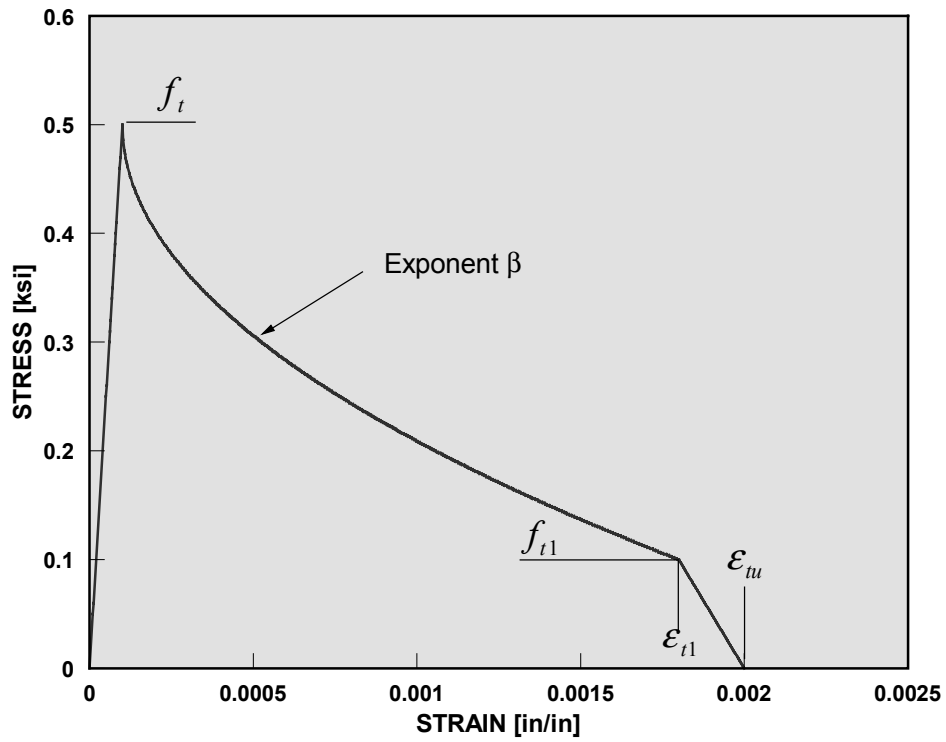


Figure 7. Material Parameters of Tension Envelope of Concrete_3 Model

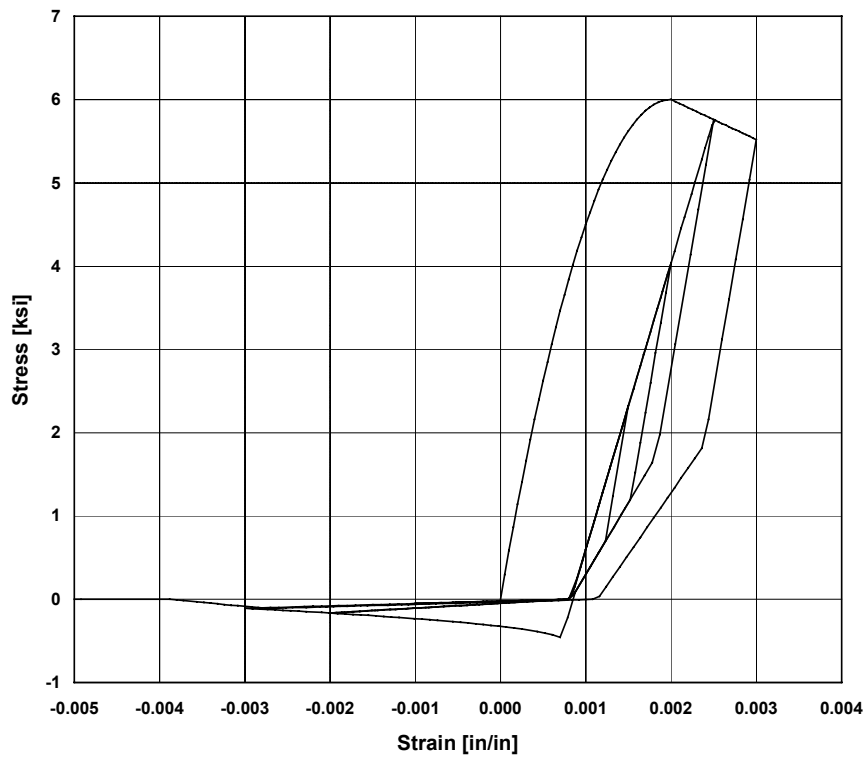


Figure 8. Hysteretic stress-strain relation of Concrete_3 model in Tension-Compression

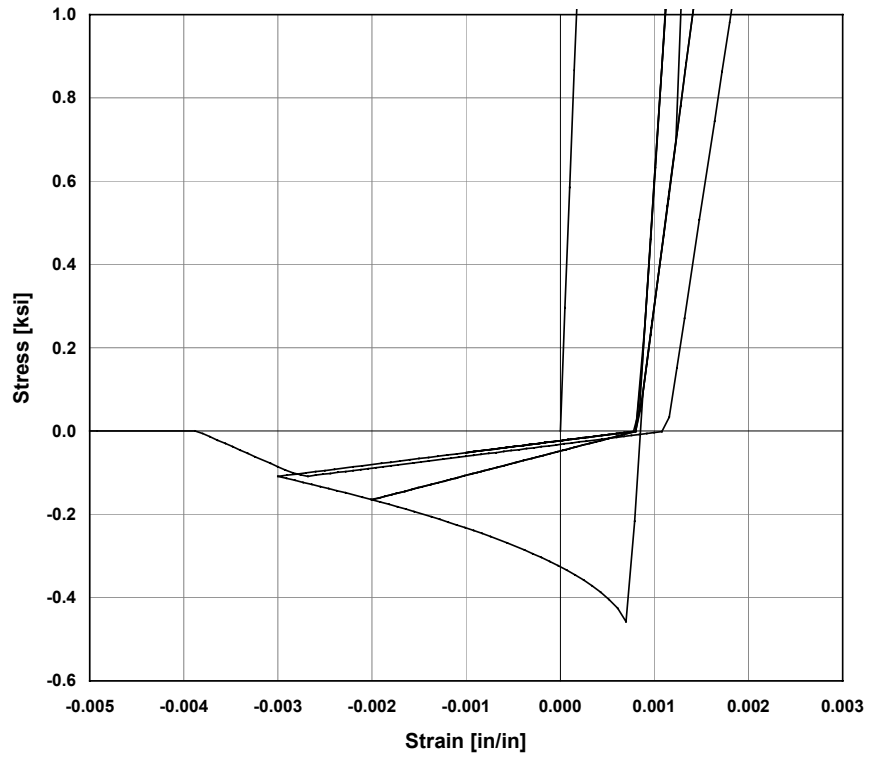


Figure 9. Hysteretic stress-strain relation of Concrete_3 model in Tension-Compression (Detail)

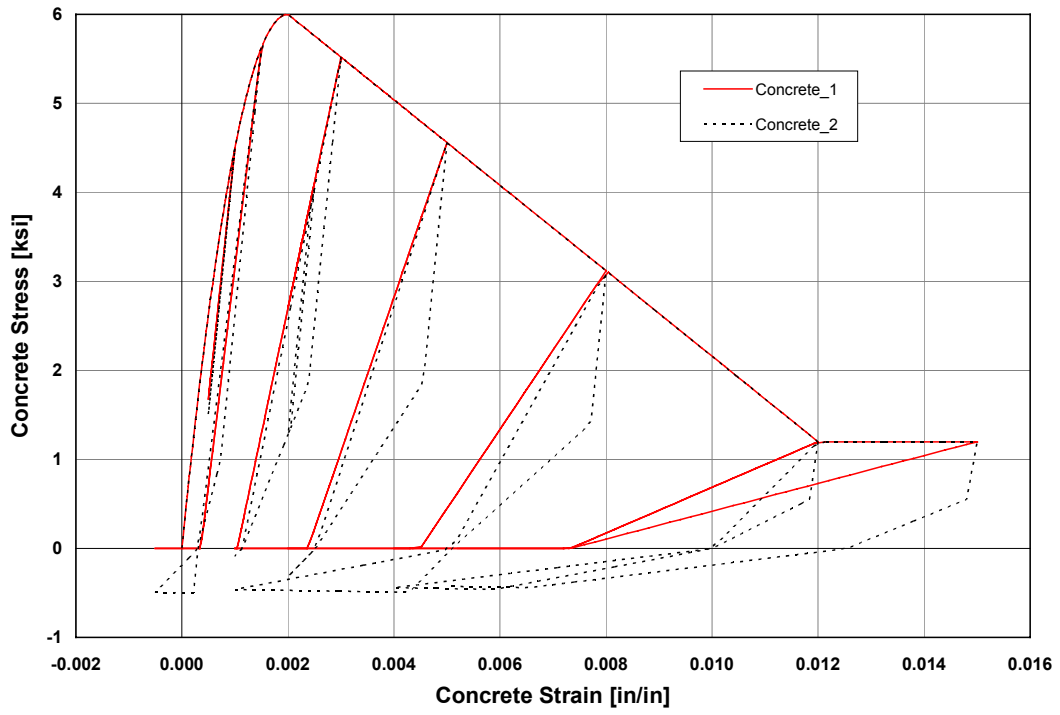


Figure 10. Comparison of Hysteretic Behavior of Concrete_1 and Concrete_2 model