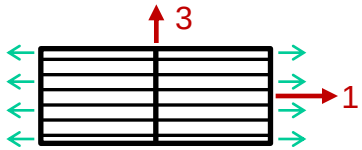
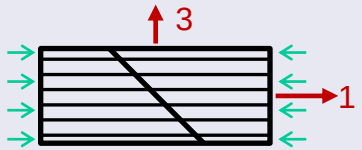
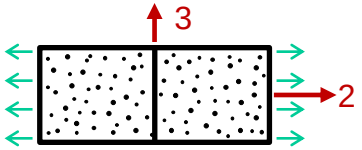
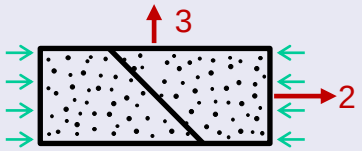
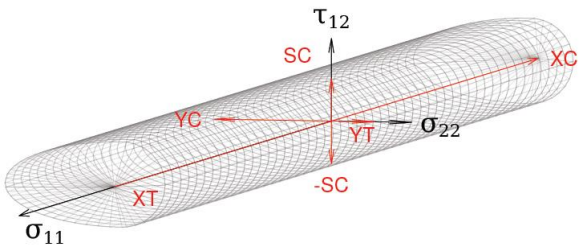
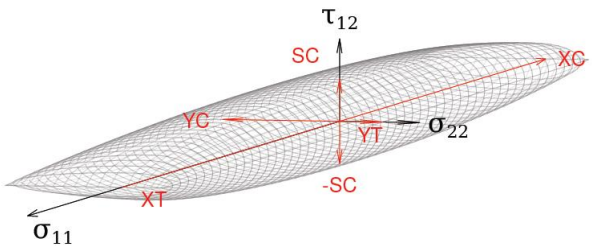
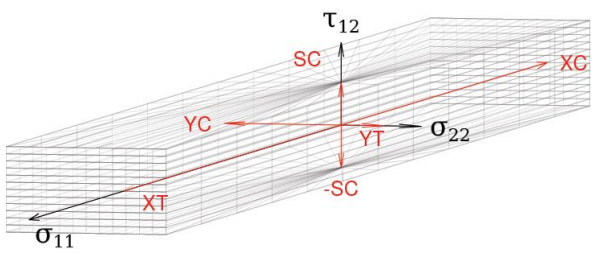
- *MAT_LAMINATED_COMPOSITE_FABRIC (*MAT_058)

Failure mode	FS=0.0	FS=1.0	FS=-1.0
 Tensile fiber mode	Failure is assumed whenever $e_m^2 > 0$ $e_m^2 = \left(\frac{\sigma_{11}}{X_T}\right)^2 - 1$	$e_m^2 = \left(\frac{\sigma_{11}}{X_T}\right)^2 + \left(\frac{\sigma_{12}}{S_C}\right)^2 - 1$	$e_m^2 = \left(\frac{\sigma_{11}}{X_T}\right)^2 - 1$
 Compressive fiber mode	Failure is assumed whenever $e_d^2 > 0$ $e_d^2 = \left(\frac{\sigma_{11}}{X_c}\right)^2 - 1$	$e_d^2 = \left(\frac{\sigma_{11}}{X_C}\right)^2 + \left(\frac{\sigma_{12}}{S_C}\right)^2 - 1$	$e_d^2 = \left(\frac{\sigma_{11}}{X_C}\right)^2 - 1$
 Tensile matrix mode	Failure is assumed whenever $\varepsilon_m^2 > 0$ $\varepsilon_m^2 = \left(\frac{\sigma_{22}}{Y_T}\right)^2 + \left(\frac{\sigma_{12}}{S_C}\right)^2 - 1$	$\varepsilon_m^2 = \left(\frac{\sigma_{22}}{Y_T}\right)^2 + \left(\frac{\sigma_{12}}{S_C}\right)^2 - 1$	$\varepsilon_m^2 = \left(\frac{\sigma_{22}}{Y_T}\right)^2 - 1$
 Compressive matrix mode	Failure is assumed whenever $\varepsilon_d^2 > 0$ $\varepsilon_d^2 = \left(\frac{\sigma_{22}}{Y_C}\right)^2 + \left(\frac{\sigma_{12}}{S_C}\right)^2 - 1$	$\varepsilon_d^2 = \left(\frac{\sigma_{22}}{Y_C}\right)^2 + \left(\frac{\sigma_{12}}{S_C}\right)^2 - 1$	$\varepsilon_d^2 = \left(\frac{\sigma_{22}}{Y_C}\right)^2 - 1$
			$\varepsilon_s^2 = \left(\frac{\sigma_{12}}{S_C}\right)^2 - 1$

- *MAT_LAMINATED_COMPOSITE_FABRIC (*MAT_058)

FS=0.0	FS=1.0	FS=-1.0
		
multisurface failure surface	smooth failure surface	faceted failure surface

effective stresses

$$\begin{bmatrix}\hat{\sigma}_{11}\\ \hat{\sigma}_{22}\\ \hat{\sigma}_{12}\end{bmatrix}=\begin{bmatrix}1/(1-w_{11}) & 0 & 0\\ 0 & 1/(1-w_{22}) & 0\\ 0 & 0 & 1/(1-w_{12})\end{bmatrix}\begin{bmatrix}\sigma_{11}\\ \sigma_{22}\\ \sigma_{12}\end{bmatrix}$$

w_{ij} : Damage parameter

constitutive relation

$$\hat{\boldsymbol{\sigma}}=\boldsymbol{C}\left(w_{ij}\right)\boldsymbol{\varepsilon}$$

$$\boldsymbol{C}\left(w_{ij}\right)=\frac{1}{D}\begin{bmatrix}(1-w_{11})E_{11} & (1-w_{11})(1-w_{22})\nu_{21}E_{22} & 0\\ (1-w_{11})(1-w_{22})\nu_{12}E_{11} & (1-w_{22})E_{22} & 0\\ 0 & 0 & D(1-w_{12})G_{12}\end{bmatrix}$$

$$with: \quad D=1-(1-w_{11})(1-w_{22})\nu_{12}\nu_{21}>0$$

- *MAT_LAMINATED_COMPOSITE_FABRIC (*MAT_058)

exponential evolution of damage parameters

$$w_{11} = \begin{cases} w_{11C} & if \quad \sigma_{11} < 0.0 \\ w_{11T} & if \quad \sigma_{11} > 0.0 \end{cases}; \qquad w_{22} = \begin{cases} w_{22C} & if \quad \sigma_{22} < 0.0 \\ w_{22T} & if \quad \sigma_{22} > 0.0 \end{cases}$$

$$w_{11C,T} = 1 - \exp\left[-\frac{1}{m_{11C,T}\, e} \left(\frac{E_{11}\varepsilon_{11}}{X_{C,T}} \right)^{m_{11C,T}} \right]; \qquad w_{22C,T} = 1 - \exp\left[-\frac{1}{m_{22C,T}\, e} \left(\frac{E_{22}\varepsilon_{22}}{Y_{C,T}} \right)^{m_{22C,T}} \right]$$

$$w_{12} = 1 - \exp\left[-\frac{1}{m_{12S}\, e} \left(\frac{G_{12}\varepsilon_{12}}{S_C} \right)^{m_{12S}} \right]$$

$$m_{11C,T} = \frac{1}{\ln\left(\varepsilon_{11C,T} \dfrac{E_{11}}{X_{C,T}} \right)}; \qquad m_{22C,T} = \frac{1}{\ln\left(\varepsilon_{22C,T} \dfrac{E_{22}}{Y_{C,T}} \right)}; \qquad m_{12S} = \frac{1}{\ln\left(\varepsilon_{12S} \dfrac{G_{12}}{S_C} \right)}$$

$\varepsilon_{11C,T}$: Comp./Ten. long. strain at max. strength

$\varepsilon_{22C,T}$: Comp./Ten. transv. strain at max. strength

ε_{12S} : Shear strain at max. strength

range of damage parameters

$$w_{ij} \in [0,1] \quad with \begin{cases} w_{ij} = 0 & \text{elastic} \\ w_{ij} = 1 & \text{fully damage} \end{cases}$$