APPENDIX 1

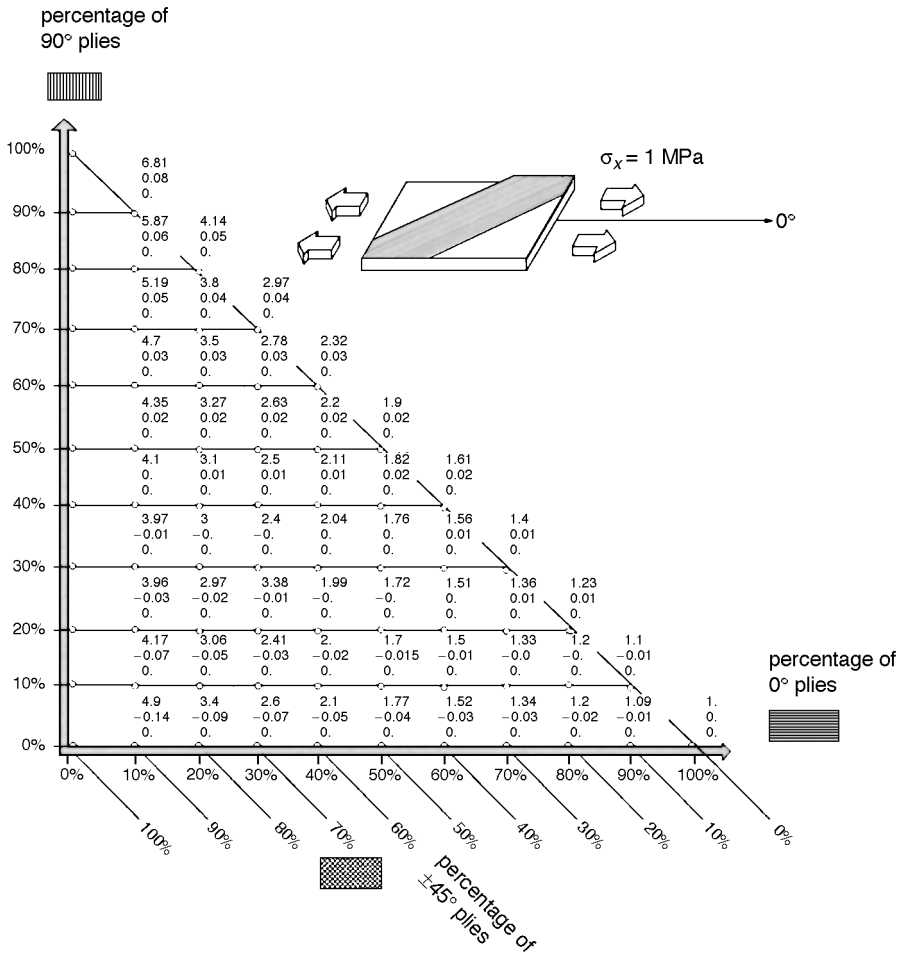
STRESSES IN THE PLIES OF A LAMINATE OF CARBON/EPOXY LOADED IN ITS PLANE

The tables in this appendix give for each ply in the laminate the stresses along the principal orthotropic directions of the ply, denoted as ℓ and t. These stresses are denoted as σ_ℓ, σ_t, $\tau_{\ell t}$. The laminate is successively subjected to three cases of simple loading:

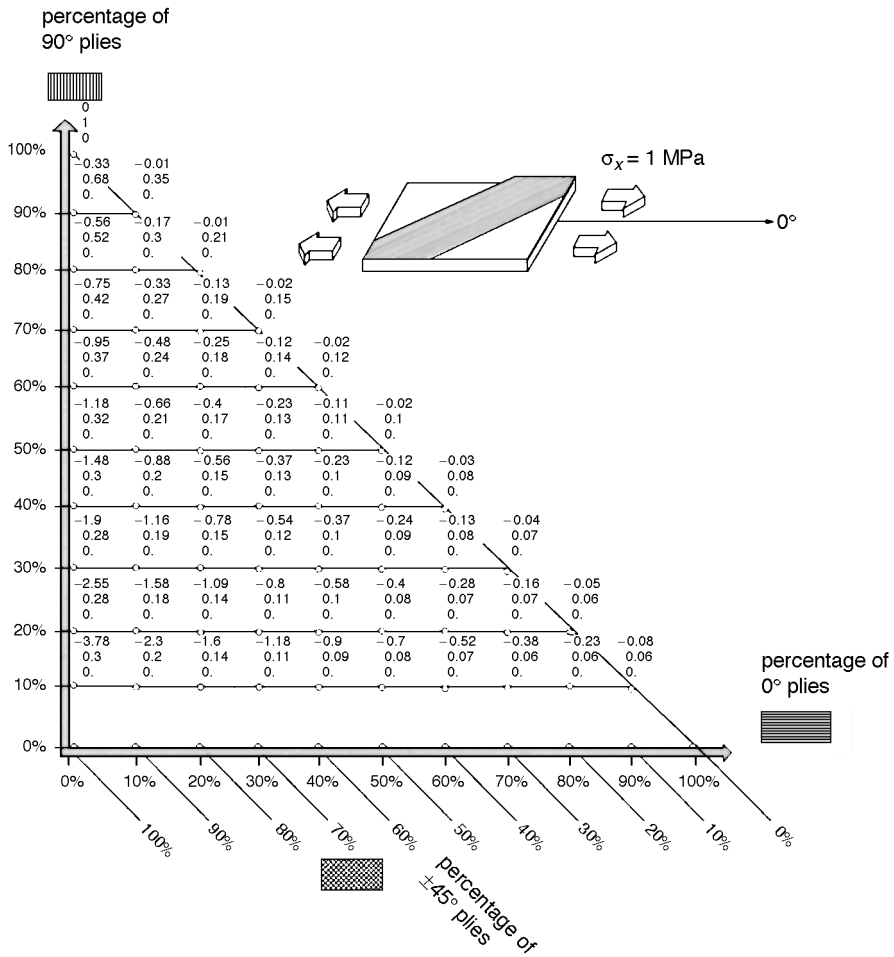
$\sigma_x = 1$ MPa: normal stress along the 0° direction.
$\sigma_y = 1$ MPa: normal stress along the 90° direction.
$\tau_{xy} = 1$ MPa: shear stress.

CHARACTERISTICS OF EACH PLY

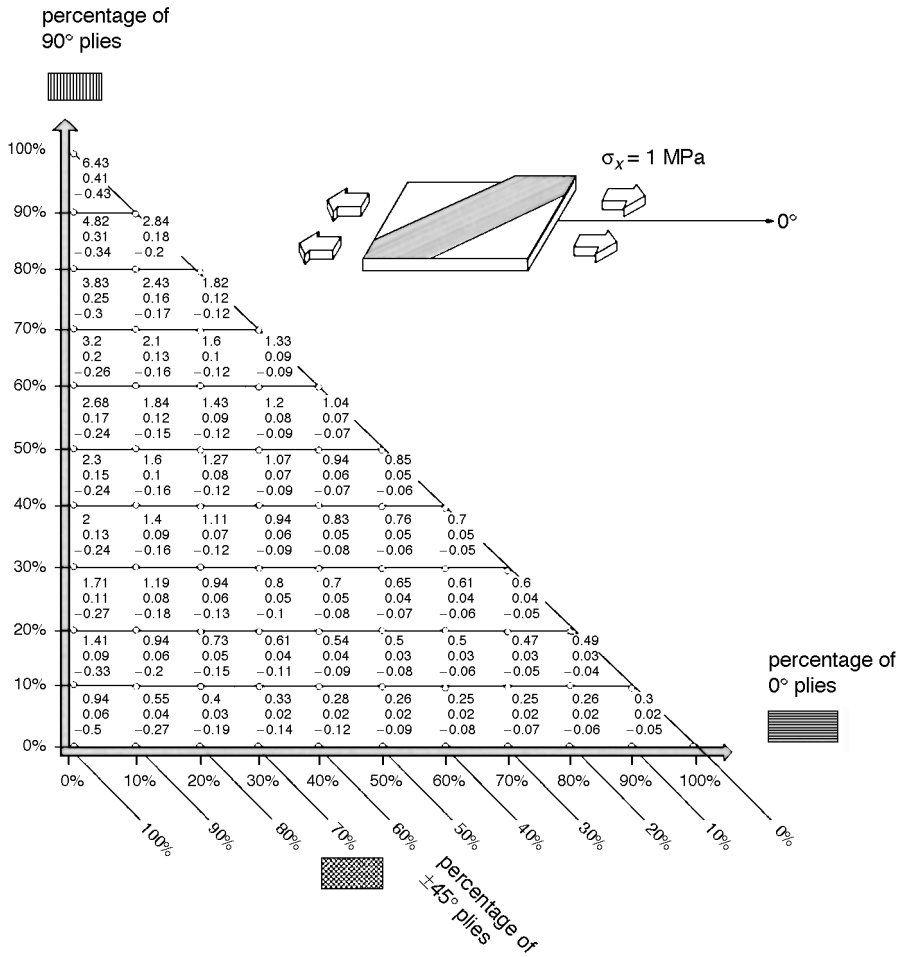
- $V_f = 60\%$ fiber volume fraction.
- Thickness of each ply: 0.13 mm.
- Moduli:
  Modulus along the fiber direction: $E_\ell = 134{,}000$ MPa.
  Modulus along the transverse direction: $E_t = 7000$ MPa.
  Shear modulus: $G_{\ell t} = 4200$ MPa.
  Poisson coefficient: $\nu_{\ell t} = 0.25$.
- Fracture strength:
  Tension along the longitudinal direction: $\sigma_{\ell\ \text{rupture}} = 1270$ MPa.
  Compression along the longitudinal direction: $\sigma_{\ell\ \text{rupture}} = 1130$ MPa.
  Tension along the transverse direction: $\sigma_{t\ \text{rupture}} = 42$ MPa.
  Compression along the transverse direction: $\sigma_{t\ \text{rupture}} = 141$ MPa.
  Shear strength: $\tau_{\ell t\ \text{rupture}} = 63$ MPa.



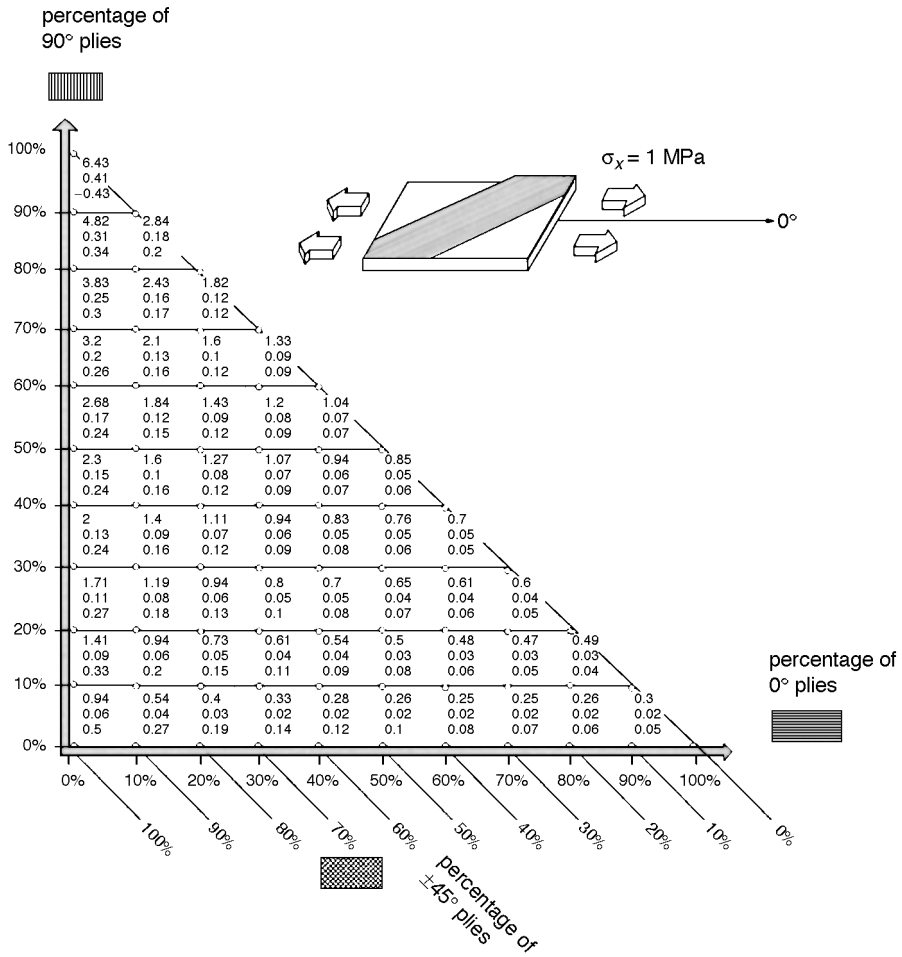
stresses in 0° plies, respectively: $\begin{cases} \sigma_\ell \\ \sigma_t \\ \tau_{\ell t} \end{cases}$ (MPa)
as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress $\sigma_x = 1$ MPa



stresses in 90° plies, respectively: $\begin{cases} \sigma_\ell \\ \sigma_t \text{ (MPa)} \\ \tau_{\ell t} \end{cases}$ as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress $\sigma_x = 1$ MPa

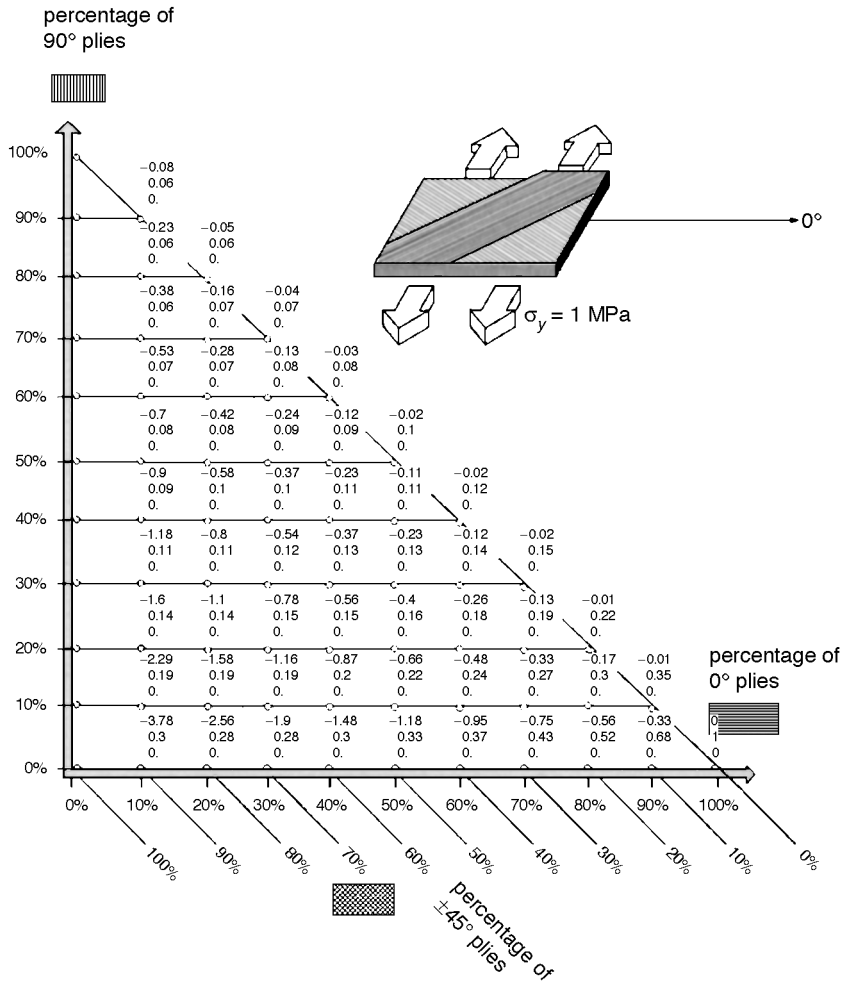


stresses in +45° plies, respectively: σ_ℓ, σ_t (MPa), $\tau_{\ell t}$ as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress $\sigma_x = 1$ MPa



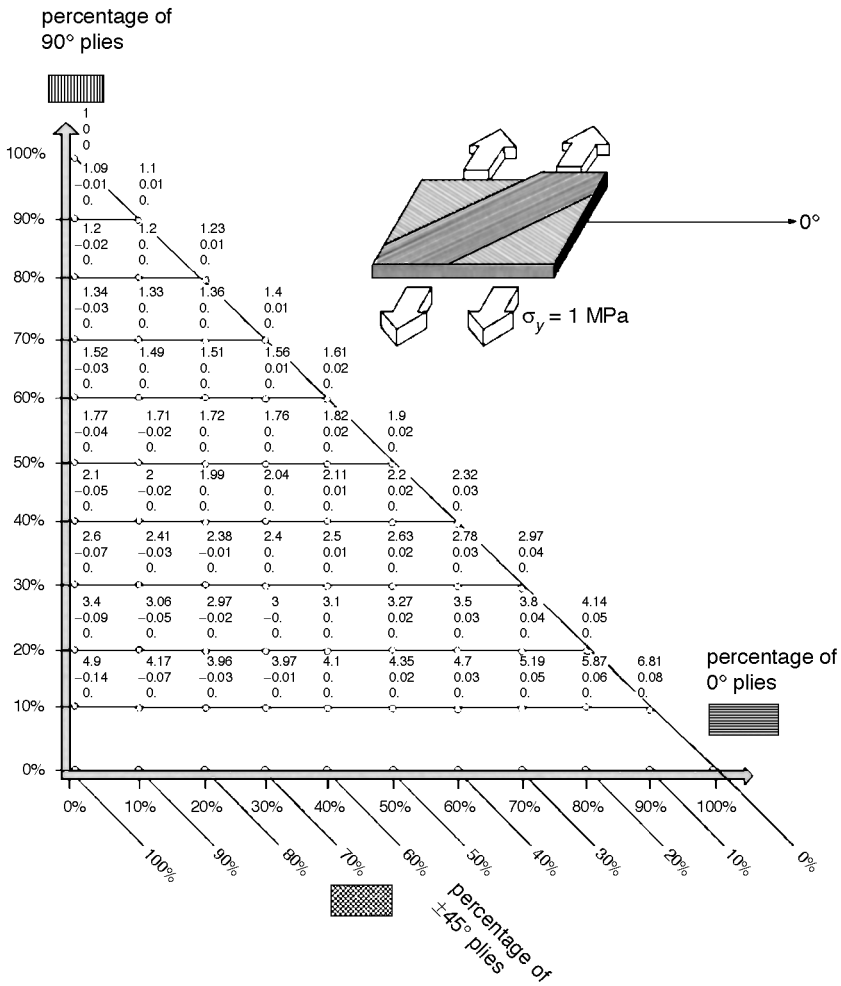
stresses in −45° plies, respectively: as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress $\sigma_x = 1$ MPa

$$\begin{Bmatrix} \sigma_\ell \\ \sigma_t \\ \tau_{\ell t} \end{Bmatrix} \text{ (MPa)}$$

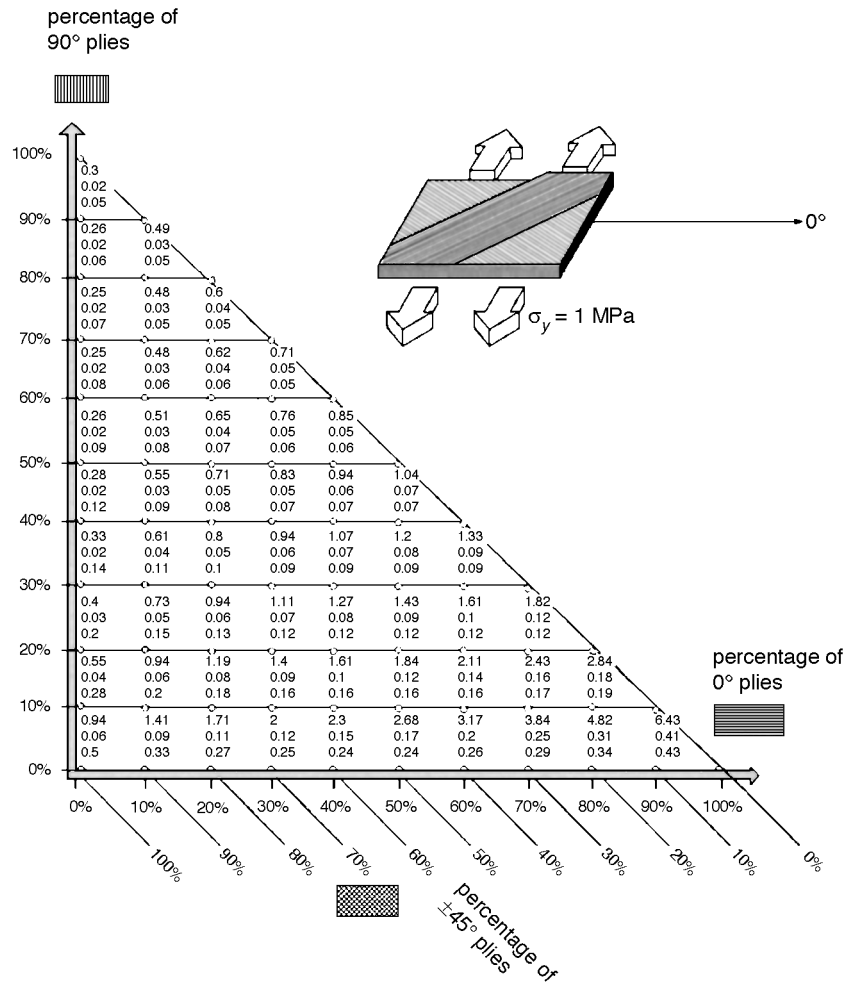


stresses in 0° plies, respectively: as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress $\sigma_y = 1$ MPa

$\left\{ \begin{array}{l} \sigma_\ell \\ \sigma_t \quad \text{(MPa)} \\ \tau_{\ell t} \end{array} \right.$

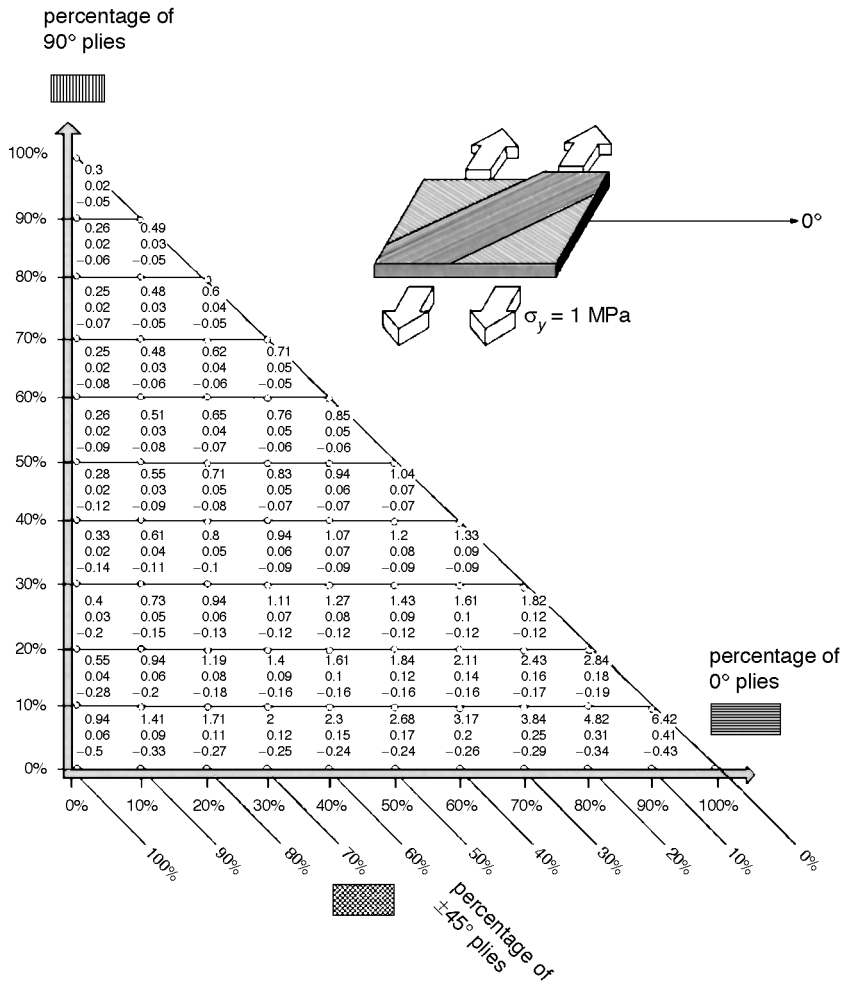


stresses in 90° plies, respectively: σ_ℓ, σ_t (MPa), $\tau_{\ell t}$ as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress $\sigma_y = 1$ MPa



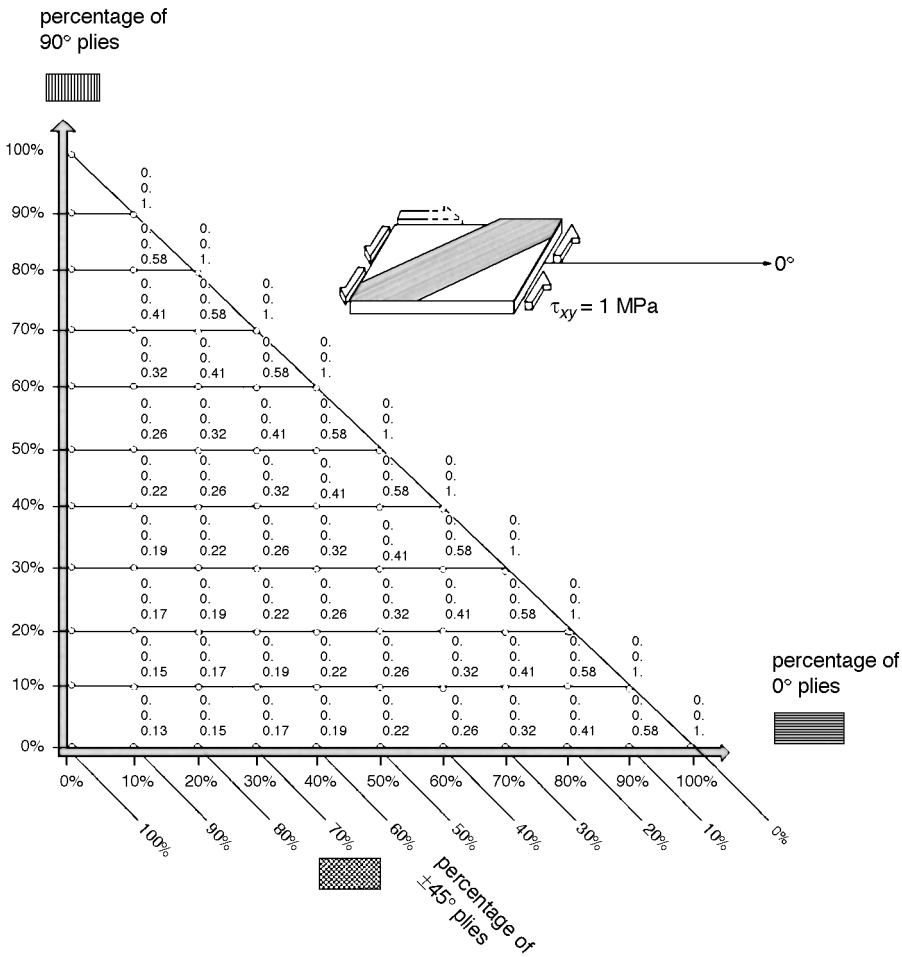
stresses in +45° plies, respectively: as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress σ_y = 1 MPa

$\left\{ \begin{array}{l} \sigma_\ell \\ \sigma_t \text{ (MPa)} \\ \tau_{\ell t} \end{array} \right.$



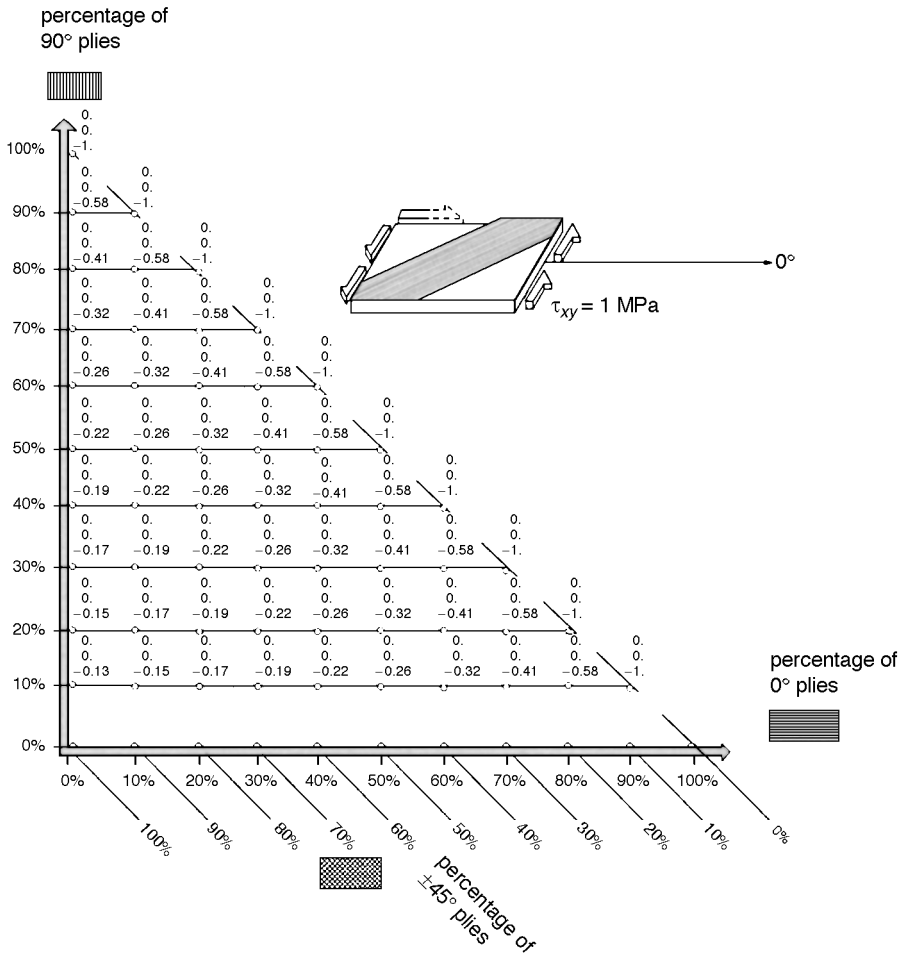
stresses in −45° plies, respectively: as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress $\sigma_y = 1$ MPa

$\left\{ \begin{array}{l} \sigma_\ell \\ \sigma_t \text{ (MPa)} \\ \tau_{\ell t} \end{array} \right.$

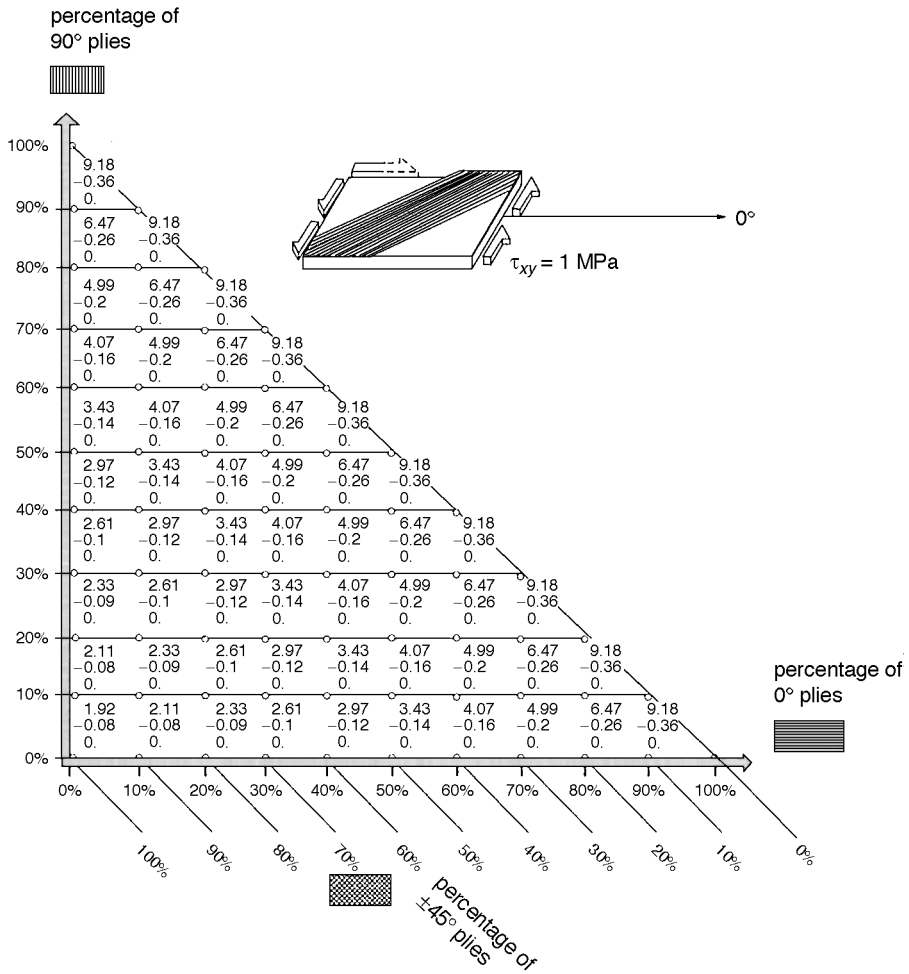


stresses in 0° plies, respectively: as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress $\tau_{xy} = 1$ MPa

$$\begin{cases} \sigma_\ell \\ \sigma_t \ \text{(MPa)} \\ \tau_{\ell t} \end{cases}$$

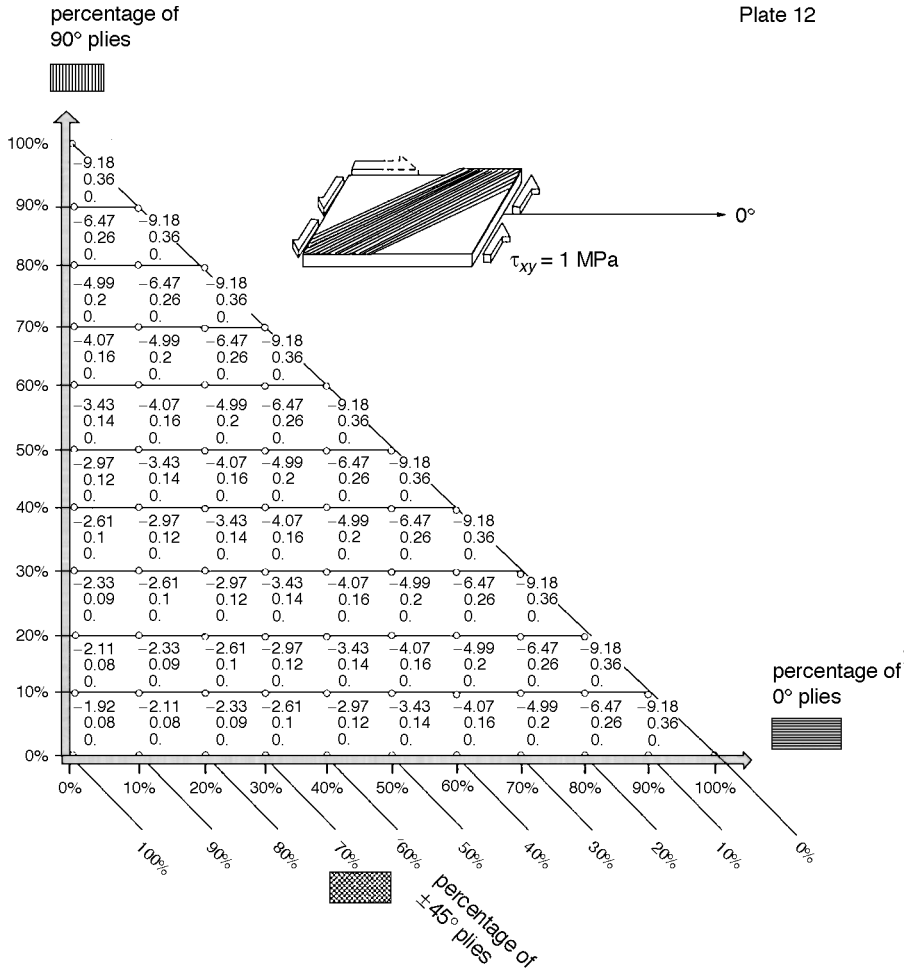


stresses in 90° plies, respectively: $\begin{cases} \sigma_\ell \\ \sigma_t \text{ (MPa)} \\ \tau_{\ell t} \end{cases}$ as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress $\tau_{xy} = 1$ MPa



stresses in +45° plies, respectively: as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress $\tau_{xy} = 1$ MPa

$$\begin{cases} \sigma_\ell \\ \sigma_t \text{ (MPa)} \\ \tau_{\ell t} \end{cases}$$



stresses in −45° plies, respectively: as function of the percentage of plies in directions 0°, 90°, +45°, −45°, for an applied uniaxial stress $\tau_{xy} = 1$ MPa

$\left\{ \begin{array}{l} \sigma_\ell \\ \sigma_t \text{ (MPa)} \\ \tau_{\ell t} \end{array} \right.$