Material Input Data:

Youngs-Modulus E — $E\_Modulus := 72000 \cdot MPa$

Tensile Yield strength Rp0,2 — $\sigma\_Rp02 := 130 \cdot MPa$

Tensile strength Rm — $\sigma\_Rm := 240 \cdot MPa$

Tensile elongation at Rm — $\varepsilon\_Rm := 1 \cdot \%$

Calculation:

$$\varepsilon\_\sigma\_Rp02 := \frac{\sigma\_Rp02}{E\_Modulus} + 0.002 \qquad \varepsilon\_\sigma\_Rp02 = 0.381 \cdot \%$$

Tensile elongation at yield strength

$$T\_Modulus := \frac{(\sigma\_Rm - \sigma\_Rp02)}{(\varepsilon\_Rm - \varepsilon\_\sigma\_Rp02)} \qquad T\_Modulus = 1.776 \times 10^{4} \cdot MPa$$

Tangentmodulus T

$$\sigma 0\_Tang := \sigma\_Rm - T\_Modulus \cdot \varepsilon\_Rm \qquad \sigma 0\_Tang = 62.422 \cdot MPa$$

Cross point of tangent at ordinate

$$\varepsilon\_Yield\_Strength := \frac{\sigma 0\_Tang}{E\_Modulus - T\_Modulus} \qquad \varepsilon\_Yield\_Strength = 0.1151 \cdot \%$$

Cross point tangent to Hooke's curve

$$\sigma\_Yield\_Strength := E\_Modulus \cdot \varepsilon\_Yield\_Strength \qquad \sigma\_Yield\_Strength = 82.857 \cdot MPa$$

<u>Output Data for Ansys:</u>
(bilinear kinematic hardening)

$\sigma\_Yield\_Strength = 83 \cdot MPa$

$T\_Modulus = 18 \cdot GPa$

Index for elongation:

$imax := \varepsilon\_Rm \cdot 100000$ $\qquad imax = 1000$

$i := 1 .. imax$

$$\varepsilon\_bilinear_i := \frac{i}{100000}$$

$f0 := 1$

$f1 := ceil(\varepsilon\_Yield\_Strength \cdot 100000 - 0.5)$ $\qquad f1 = 115$

$f2 := imax$

$$\sigma := \left| \begin{array}{l} \text{for } i \in f0 .. f1 \\ \quad m_i \leftarrow E\_Modulus \cdot \varepsilon\_bilinear_i \\ \text{for } i \in (f1 + 1) .. f2 \\ \quad m_i \leftarrow \sigma0\_Tang + T\_Modulus \cdot \varepsilon\_bilinear_i \\ m \end{array} \right.$$

$\sigma_{f1} = 82.8 \cdot MPa$ $\qquad \sigma\_Yield\_Strength = 82.857 \cdot MPa$

$\sigma_{imax} = 240 \cdot MPa$ $\qquad \sigma\_Rm = 240 \cdot MPa$

$\varepsilon\_bilinear_{f1} = 0.115 \cdot \%$ $\qquad \varepsilon\_Yield\_Strength = 0.115 \cdot \%$

$\varepsilon\_bilinear_{imax} = 1 \cdot \%$ $\qquad \varepsilon\_Rm = 1 \cdot \%$

$\sigma_{f1} = 82.8 \cdot MPa$ $\qquad \sigma\_Yield\_Strength = 82.857 \cdot MPa$

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$\varepsilon\_bilinear_{f1} = 0.115 \cdot \%$ $\qquad \varepsilon\_Yield\_Strength = 0.115 \cdot \%$

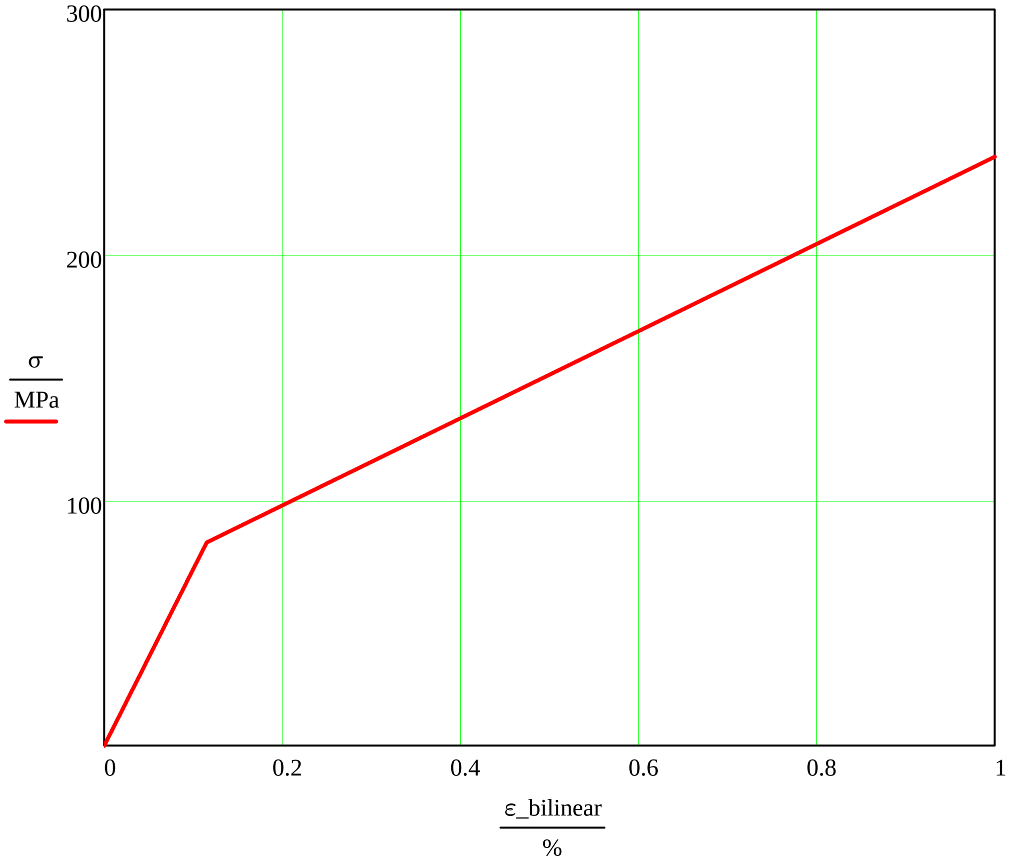
$\varepsilon\_bilinear_{imax} = 1 \cdot \%$ $\qquad \varepsilon\_Rm = 1 \cdot \%$

$\sigma_{f1} = 82$

$\sigma_{imax} =$

$\varepsilon\_bilinea$

$\varepsilon\_bilinea$



$\sigma_{f1} = 82.8 \cdot MPa$ $\sigma\_Yield\_Strength = 82.857 \cdot MPa$

$\sigma_{imax} = 240 \cdot MPa$ $\sigma\_Rm = 240 \cdot MPa$

$\varepsilon\_bilinear_{f1} = 0.115 \cdot \%$ $\varepsilon\_Yield\_Strength = 0.115 \cdot \%$

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$\sigma_{imax} = 240 \cdot MPa$ $\sigma\_Rm = 240 \cdot MPa$

$\varepsilon\_bilinear_{f1} = 0.115 \cdot \%$ $\varepsilon\_Yield\_Strength = 0.115 \cdot \%$

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(bilinear kinematic hardening)

$\sigma\_Yield\_Strength = 83 \cdot MPa$

$T\_Modulus = 18 \cdot GPa$

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$imax := \varepsilon\_Rm \cdot 100000$ $\qquad imax = 1000$

$i := 1 .. imax$

$\varepsilon\_bilinear_i := \frac{i}{100000}$

$f0 := 1$

$f1 := \mathrm{ceil}(\varepsilon\_Yield\_Strength \cdot 100000 - 0.5)$ $\qquad f1 = 115$

$f2 := imax$

$$\sigma := \begin{array}{|l} \text{for } i \in f0 .. f1 \\ \quad m_i \leftarrow E\_Modulus \cdot \varepsilon\_bilinear_i \\ \text{for } i \in (f1 + 1) .. f2 \\ \quad m_i \leftarrow \sigma0\_Tang + T\_Modulus \cdot \varepsilon\_bilinear_i \\ m \end{array}$$

$\sigma_{f1} = 82.8 \cdot MPa$ $\qquad \sigma\_Yield\_Strength = 82.857 \cdot MPa$

$\sigma_{imax} = 240 \cdot MPa$ $\qquad \sigma\_Rm = 240 \cdot MPa$

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$\sigma_{f1} = 82.8 \cdot MPa$ $\qquad \sigma\_Yield\_Strength = 82.857 \cdot MPa$

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$\varepsilon\_bilinear_{f1} = 0.115 \cdot \%$ $\qquad \varepsilon\_Yield\_Strength = 0.115 \cdot \%$

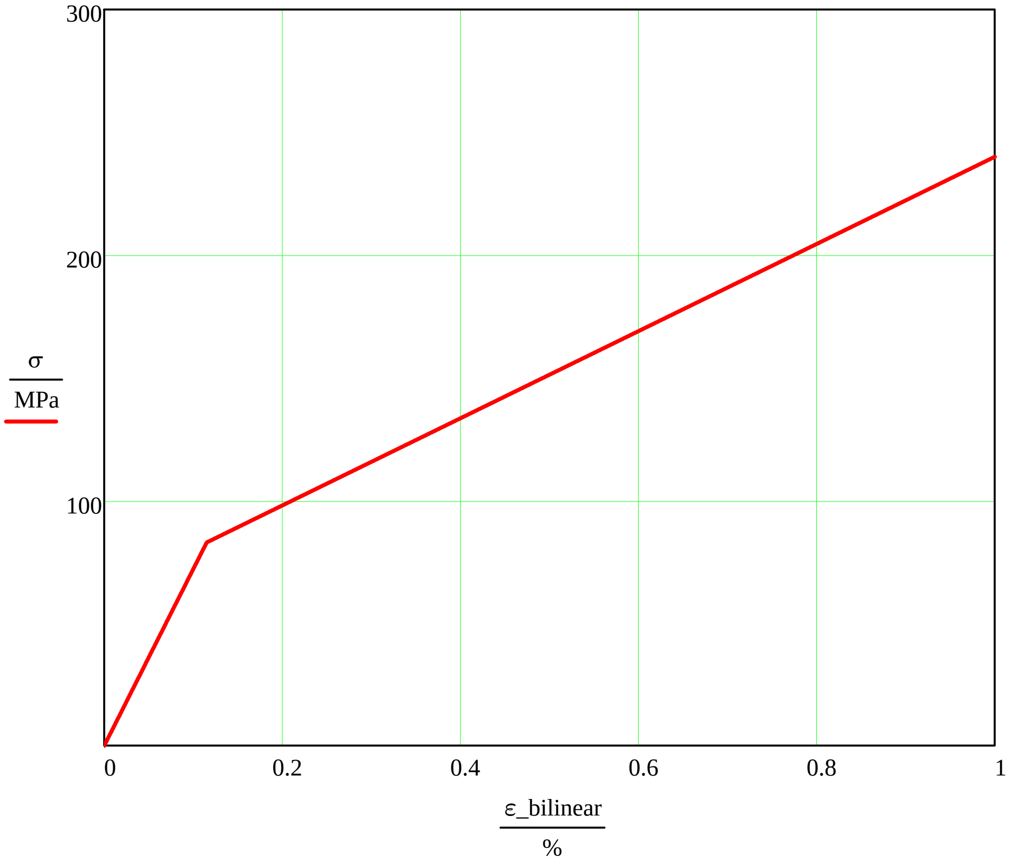
$\varepsilon\_bilinear_{imax} = 1 \cdot \%$ $\qquad \varepsilon\_Rm = 1 \cdot \%$

$\sigma_{f1} = 82$

$\sigma_{imax} =$

ε_biline

ε_biline



$\sigma_{f1} = 82.8 \cdot MPa$ $\quad$ σ_Yield_Strength = 82.857·MPa

$\sigma_{imax} = 240 \cdot MPa$ $\quad$ σ_Rm = 240·MPa

$\varepsilon\_bilinear_{f1} = 0.115 \cdot \%$ $\quad$ ε_Yield_Strength = 0.115·%

$\varepsilon\_bilinear_{imax} = 1 \cdot \%$ $\quad$ ε_Rm = 1·%

$\sigma_{f1} = 82.8 \cdot MPa$ $\quad$ σ_Yield_Strength = 82.857·MPa

$\sigma_{imax} = 240 \cdot MPa$ $\quad$ σ_Rm = 240·MPa

$\varepsilon\_bilinear_{f1} = 0.115 \cdot \%$ $\quad$ ε_Yield_Strength = 0.115·%

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$\sigma_{f1} = 82.8 \cdot MPa$ $\sigma\_Yield\_Strength = 82.857 \cdot MPa$

$\sigma_{imax} = 240 \cdot MPa$ $\sigma\_Rm = 240 \cdot MPa$

$\varepsilon\_bilinear_{f1} = 0.115 \cdot \%$ $\varepsilon\_Yield\_Strength = 0.115 \cdot \%$

$\varepsilon\_bilinear_{imax} = 1 \cdot \%$ $\varepsilon\_Rm = 1 \cdot \%$

.8·MPa σ_Yield_Strength = 82.857·MPa

240·MPa σ_Rm = 240·MPa

ar$_{f1}$ = 0.115·% ε_Yield_Strength = 0.115·%

ar$_{imax}$ = 1·% ε_Rm = 1·%

$\sigma_{f1} = 82.8 \cdot MPa$ $\sigma\_Yield\_Strength = 82.857 \cdot MPa$

$\sigma_{imax} = 240 \cdot MPa$ $\sigma\_Rm = 240 \cdot MPa$

$\varepsilon\_bilinear_{f1} = 0.115 \cdot \%$ $\varepsilon\_Yield\_Strength = 0.115 \cdot \%$

$\varepsilon\_bilinear_{imax} = 1 \cdot \%$ $\varepsilon\_Rm = 1 \cdot \%$

2.8·MPa $\sigma\_Yield\_Strength = 82.857 \cdot MPa$

240·MPa $\sigma\_Rm = 240 \cdot MPa$

$ar_{f1} = 0.115 \cdot \%$ $\varepsilon\_Yield\_Strength = 0.115 \cdot \%$

$ar_{imax} = 1 \cdot \%$ $\varepsilon\_Rm = 1 \cdot \%$