voigt -> vumat

Indices starting at 1!

Voigt

$$\sigma^V = \begin{pmatrix} \sigma_{11} \\ \sigma_{22} \\ \sigma_{33} \\ \sigma_{23} \\ \sigma_{13} \\ \sigma_{12} \end{pmatrix} = \mathbb{C}^V \underbrace{\begin{pmatrix} \varepsilon_{11} \\ \varepsilon_{22} \\ \varepsilon_{33} \\ 2\varepsilon_{23} \\ 2\varepsilon_{13} \\ 2\varepsilon_{12} \end{pmatrix}}_{=: \varepsilon^V = \begin{pmatrix} \varepsilon_1^V \\ \varepsilon_2^V \\ \varepsilon_3^V \\ \varepsilon_4^V \\ \varepsilon_5^V \\ \varepsilon_6^V \end{pmatrix}}$$

VUMAT

$$\sigma^{VUMAT} = \begin{pmatrix} \sigma_{11} \\ \sigma_{22} \\ \sigma_{33} \\ \sigma_{12} \\ \sigma_{23} \\ \sigma_{13} \end{pmatrix} = \mathbb{C}^{VUMAT} \underbrace{\begin{pmatrix} \varepsilon_{11} \\ \varepsilon_{22} \\ \varepsilon_{33} \\ \varepsilon_{12} \\ \varepsilon_{23} \\ \varepsilon_{13} \end{pmatrix}}_{=: \varepsilon^{VUMA}}$$

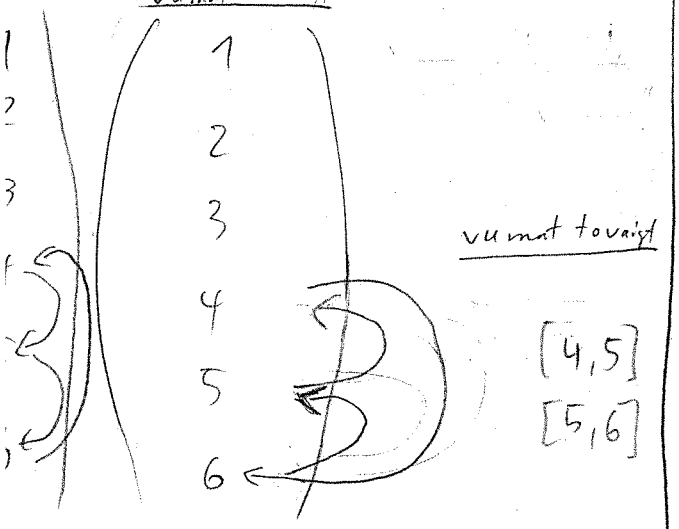
voigt to vumat

stress

change pairs [4,5]
then [4,6]

voigt to vumat

vumat to voigt



vumat to voigt

[4,5]
[5,6]

strain

change pairs similar to stress

and

$$\varepsilon_4^V = 2\,\varepsilon_{23}$$

$$\varepsilon_4^{VUMAT\ Reduced} = \varepsilon_{23}$$

$$\Rightarrow \varepsilon_4^{VUMAT\ Reduced} = \frac{1}{2}\,\varepsilon_4^V$$

Voigt -> VUMAT

$$\varepsilon^{VUMAT\ Reduced}[4:6] = \frac{1}{2}\,\varepsilon^V[4:6]$$

VUMAT -> Voigt

$$\varepsilon^V[4:6] = 2 \cdot \varepsilon^{VUMA\ Reduced}[4:6]$$

<u>stiffness</u>   change pairs [4,5]
then [4,6]
each time rows + columns

quadrant numbering $= \left(\begin{array}{c|c} 1 & 2 \\ \hline 3 & 4 \end{array}\right)$

VUR $\hat{=}$ <u>VU</u>MAT <u>R</u>eordered

$\sigma_1^V = \sigma_{11} = C_{11}^V \varepsilon_{11}$ $\quad\quad$ $\sigma_1^{VUR} = \sigma_{11} = C_{11}^{VUR} \varepsilon_{11} \Rightarrow C_{11}^V = C_{11}^{VUR}$

$\sigma_1^V = \sigma_{11} = C_{14}^V \varepsilon_4^V = C_{14}^V\, 2\varepsilon_{23}$ | $\sigma_1^{VUR} = \sigma_{11} = C_{14}^{VUR} \varepsilon_4^{VUR} = C_{14}^{VUR} \varepsilon_{23}$

$\Rightarrow 2 C_{14}^V = C_{14}^{VUR}$

$\sigma_4^V = \sigma_{23} = C_{44}^V \cdot \varepsilon_4^V = C_{44}^V \cdot 2\varepsilon_{23}$ | $\sigma_4^{VUR} = \sigma_{23} = C_{44}^{VUR} \varepsilon_4^{VUR} = C_{44}^{VUR} \varepsilon_{23}$

$\Rightarrow 2 C_{44}^V = C_{44}^{VUR}$

$\sigma_4^V = \sigma_{23} = C_{41}^V \cdot \varepsilon_1^V = C_{41}^V \varepsilon_{11}$ | $\sigma_4^{VUR} = \sigma_{23} = C_{41}^{VUR} \varepsilon_1^{VUR} = C_{41}^{VUR} \varepsilon_{11}$

$\Rightarrow C_{41}^V = C_{41}^{VUR}$

$$C^{VUR} = \left(\begin{array}{c|c} 1 & 2 \\ \hline 1 & 2 \end{array}\right)_{C^V} \quad \text{and} \quad C^V = \left(\begin{array}{c|c} 1 & \frac{1}{2} \\ \hline 1 & \frac{1}{2} \end{array}\right)_{C^{VUR}}$$

<u>Compliance</u>

$\varepsilon^V = S^V[\sigma^V]$

$\varepsilon^{VUR} = S^{VUR}[\sigma^{VUR}]$

$$S^{VUR} = \left(\begin{array}{c|c} 1 & 1 \\ \hline \frac{1}{2} & \frac{1}{2} \end{array}\right)_{S^V} \quad S^V = \left(\begin{array}{c|c} 1 & 1 \\ \hline 2 & 2 \end{array}\right)_{S^{VUR}}$$

$\varepsilon_1^V = \ \ldots \ S_{11}^V = S_{11}^{VUR}$

$\varepsilon_1^V = \varepsilon_{11} = S_{14}^V \sigma_4^V = S_{14}^V \sigma_{23}$ | $\varepsilon_1^{VUR} = \varepsilon_{11} = S_{14}^{VUR} \sigma_4^{VUR} = S_{14}^{VUR} \sigma_{23}$

$\Rightarrow S_{14}^V = S_{14}^{VUR}$

$\varepsilon_4^V = 2\varepsilon_{23} = S_{44}^V \sigma_4^V = S_{44}^V \sigma_{23}$ | $\varepsilon_4^{VUR} = \varepsilon_{23} = S_{44}^{VUR} \sigma_4^{VUR} = S_{44}^{VUR} \sigma_{23}$

$\Rightarrow \frac{1}{2} S_{44}^V = S_{44}^{VUR}$

$\varepsilon_4^V = 2\varepsilon_{23} = S_{41}^V \sigma_1^V = S_{41}^V \sigma_{11}$ | $\varepsilon_4^{VUR} = \varepsilon_{23} = S_{41}^{VUR} \sigma_1^{VUR} = S_{41}^{VUR} \sigma_{11}$