① $\{n^x\} = \{n_x^x, n_y^x, n_z^x\}^T = \{1, 0, 0\}^T$

$\{n^y\} = \{n_x^y, n_y^y, n_z^y\}^T = \{0, 1, 0\}^T$

$\{n^z\} = \{n_x^z, n_y^z, n_z^z\}^T = \{0, 0, 1\}^T$

$\{t^{nx}\} = \{t_x^{nx}, t_y^{nx}, t_z^{nx}\}^T$

$\{t^{ny}\} = \{t_x^{ny}, t_y^{ny}, t_z^{ny}\}^T$ $\{t^{nz}\} = \{t_x^{nz}, t_y^{nz}, t_z^{nz}\}^T$

$[\sigma]\{n\} = \{t\}$

$$\begin{bmatrix} \sigma_{xx} & \sigma_{yx} & \sigma_{zx} \\ \sigma_{xy} & \sigma_{yy} & \sigma_{zy} \\ \sigma_{xz} & \sigma_{yz} & \sigma_{zz} \end{bmatrix} \cdot \begin{Bmatrix} n_x^x & n_x^y & n_x^z \\ n_y^x & n_y^y & n_y^z \\ n_z^x & n_z^y & n_z^z \end{Bmatrix} = \begin{Bmatrix} t_x^{nx} & t_x^{ny} & t_x^{nz} \\ t_y^{nx} & t_y^{ny} & t_y^{nz} \\ t_z^{nx} & t_z^{ny} & t_z^{nz} \end{Bmatrix}$$

$$\hookrightarrow \begin{Bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{Bmatrix}$$

$\{t^{nx}\} = \{t_x^{nx}, t_y^{nx}, t_z^{nx}\}^T = \{\sigma_{xx}, \sigma_{xy}, \sigma_{xz}\}^T$

$\{t^{ny}\} = \{t_x^{ny}, t_y^{ny}, t_z^{ny}\}^T = \{\sigma_{yx}, \sigma_{yy}, \sigma_{yz}\}^T$

$\{t^{nz}\} = \{t_z^{nz}, t_z^{nz}, t_z^{nz}\}^T = \{\sigma_{zx}, \sigma_{zy}, \sigma_{zz}\}^T$

② $[\sigma] = \begin{bmatrix} 10 & 0 & 12 \\ 0 & -15 & -5 \\ 12 & -5 & 25 \end{bmatrix}$ (N/mm^2)

$n_1 = \left\{0, \frac{\sqrt{2}}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right\}^T$, $n_2 = \left\{\frac{1}{\sqrt{6}}, \frac{1}{\sqrt{6}}, \frac{-2}{\sqrt{6}}\right\}^T$

$n_3 = \left\{\frac{-1}{\sqrt{6}}, \frac{-1}{\sqrt{6}}, \frac{2}{\sqrt{6}}\right\}^T$

$\langle t_1 \rangle = [\sigma]\langle n_1 \rangle = \begin{bmatrix} 10 & 0 & 12 \\ 0 & -15 & -5 \\ 12 & -5 & 25 \end{bmatrix} \cdot \begin{Bmatrix} 0 \\ \sqrt{2}/\sqrt{3} \\ 1/\sqrt{3} \end{Bmatrix} = \begin{Bmatrix} 12\sqrt{3} \end{Bmatrix}$

$n_1 = \left\{0, \frac{\sqrt{6}}{3}, \frac{\sqrt{3}}{3}\right\}^T$, $n_2 = \left\{\frac{\sqrt{6}}{6}, \frac{\sqrt{6}}{6}, \frac{-\sqrt{6}}{3}\right\}^T$

$n_3 = \left\{\frac{-\sqrt{6}}{6}, \frac{-\sqrt{6}}{6}, \frac{\sqrt{6}}{3}\right\}$

$\langle t_1 \rangle = [\sigma]\langle n_1 \rangle = \begin{bmatrix} 10 & 0 & 12 \\ 0 & -15 & -5 \\ 12 & -5 & 25 \end{bmatrix} \cdot \begin{Bmatrix} 0 \\ \sqrt{6}/3 \\ \sqrt{3}/3 \end{Bmatrix} = \begin{Bmatrix} 4\sqrt{3} \\ -5\sqrt{6} - 5\sqrt{3}/3 \\ -5\sqrt{6}/3 + 25\sqrt{3}/3 \end{Bmatrix}$

$|t_{n1}| = \langle t_1 \rangle \cdot \langle n_1 \rangle = \langle 4\sqrt{3}, -5(\sqrt{6} - \sqrt{3}/3), 5(-\sqrt{6}/3 + 5\sqrt{3}/3) \rangle \cdot \{0, \sqrt{6}/3, \sqrt{3}/3\} \cong -6,39$ Pa

$\langle t_{n1} \rangle = |t_{n1}|\langle n_1 \rangle = -6,39 \cdot \{0, \sqrt{6}/3, \sqrt{3}/3\}^T$

$\langle t_{n1} \rangle = \begin{Bmatrix} 0 \\ -5,21 \\ -3,69 \end{Bmatrix}$

$$\{t_2\} = [\sigma]\{n_2\} = \begin{bmatrix} 10 & 0 & 12 \\ 0 & -15 & -5 \\ 12 & -5 & 25 \end{bmatrix} \cdot \begin{Bmatrix} \sqrt{6}/6 \\ \sqrt{6}/6 \\ -\sqrt{6}/3 \end{Bmatrix} = \begin{Bmatrix} -5,73 \\ -2,06 \\ -17,56 \end{Bmatrix}$$

$$|t_{n2}| = \{t_{n2}\} \cdot \{n_2\} = \{-5,73 \quad -2,06 \quad -17,56\} \{\sqrt{6}/6 \quad \sqrt{6}/6 \quad -\sqrt{6}/3\}$$

$$|t_{n2}| = 11,19$$

$$\{t_{t1}\} = \{t_1\} - \{t_{n1}\} = \begin{Bmatrix} +6,93 \\ -15,13 \\ 10,35 \end{Bmatrix} - \begin{Bmatrix} 0 \\ -5,21 \\ -3,69 \end{Bmatrix} = \begin{Bmatrix} 6,93 \\ -9,92 \\ 14,03 \end{Bmatrix}$$

$$|t_{t1}| = \sqrt{6,93^2 + (-9,92)^2 + (14,03)^2} = \boxed{18,54}$$

$$\{t_{n2}\} = |t_{n2}| \cdot \{n_2\} = 11,19 \cdot \begin{Bmatrix} 1/\sqrt{6} \\ 1/\sqrt{6} \\ -2/\sqrt{6} \end{Bmatrix} = \begin{Bmatrix} 4,57 \\ 4,57 \\ -9,14 \end{Bmatrix}$$

$$\{t_{t2}\} = \{t_2\} - \{t_{n2}\} = \begin{Bmatrix} -5,73 \\ -2,06 \\ -17,56 \end{Bmatrix} - \begin{Bmatrix} 4,57 \\ 4,57 \\ -9,14 \end{Bmatrix} = \begin{Bmatrix} -10,3 \\ -6,63 \\ -8,42 \end{Bmatrix}$$

$$|t_{t2}| = \sqrt{(-10,3)^2 + (-6,63)^2 + (-8,42)^2} = \boxed{14,806}$$

$$\{t_3\} = [\sigma] \cdot \{n_3\} = \begin{bmatrix} 10 & 0 & 12 \\ 0 & -15 & -5 \\ 12 & -5 & 25 \end{bmatrix} \cdot \begin{Bmatrix} -1/\sqrt{6} \\ -1/\sqrt{6} \\ 2/\sqrt{6} \end{Bmatrix} = \begin{Bmatrix} 5,73 \\ 2,06 \\ 17,56 \end{Bmatrix}$$

$$|t_{n3}| = \{t_3\}\{n_3\} = \{5,73 \quad 2,06 \quad 17,56\} \{-1/\sqrt{6} \quad -1/\sqrt{6} \quad 2/\sqrt{6}\}$$

$$|t_{n3}| = 11,15$$

$$\{t_{n3}\} = |t_{n3}| \cdot \{n_3\} = 11,15 \begin{Bmatrix} -1/\sqrt{6} \\ -1/\sqrt{6} \\ 2/\sqrt{6} \end{Bmatrix} = \begin{Bmatrix} -4,55 \\ -4,55 \\ 9,1 \end{Bmatrix}$$

$$\{t_{t3}\} = \{t_3\} - \{t_{n3}\} = \begin{Bmatrix} 5,73 \\ 2,06 \\ 17,56 \end{Bmatrix} - \begin{Bmatrix} -4,55 \\ -4,55 \\ 9,1 \end{Bmatrix} = \begin{Bmatrix} 10,28 \\ 6,61 \\ 8,46 \end{Bmatrix}$$

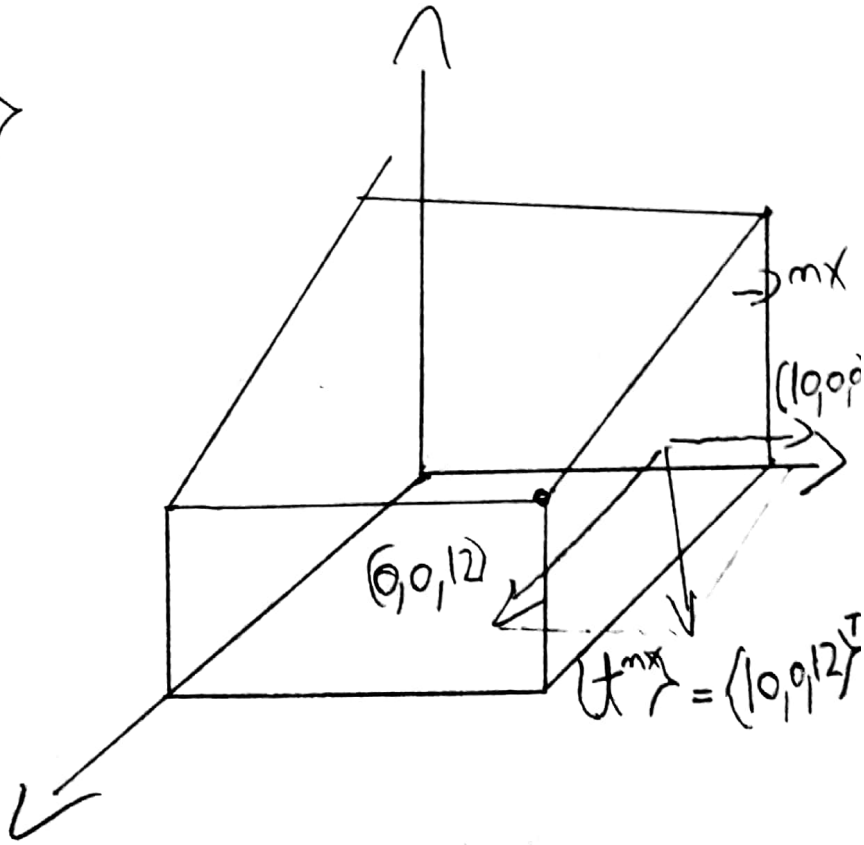
$$|t_{t3}| = \sqrt{10,28^2 + 6,61^2 + 8,46^2} = \boxed{14,86}$$

$|t_{t1}| > |t_{t2}|$ e $|t_{t1}| > |t_{t3}|$

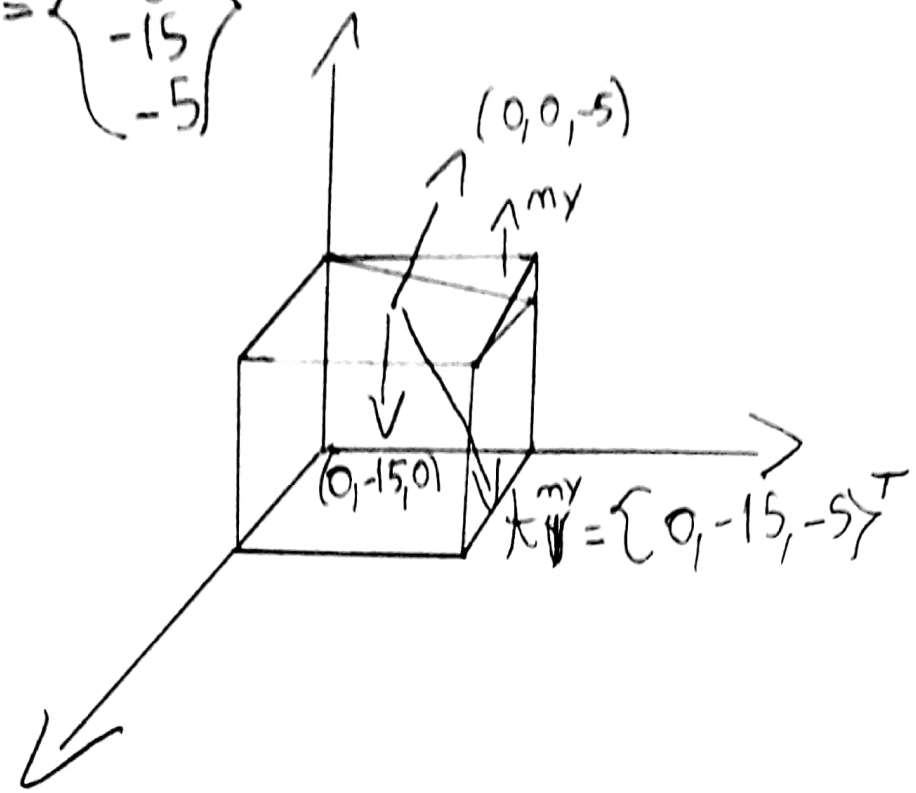
maior tensão de cisalhamento em superfície 1.

Agora esboçando:

Para $\begin{Bmatrix} t_x^{mx} \\ t_y^{mx} \\ t_z^{mx} \end{Bmatrix} = \begin{Bmatrix} 10 \\ 0 \\ 12 \end{Bmatrix}$



Para $\begin{Bmatrix} t_x^{my} \\ t_y^{my} \\ t_z^{my} \end{Bmatrix} = \begin{Bmatrix} 0 \\ -15 \\ -5 \end{Bmatrix}$



Para $\begin{Bmatrix} t_x^{mz} \\ t_y^{mz} \\ t_z^{mz} \end{Bmatrix} = \begin{Bmatrix} 12 \\ -5 \\ 25 \end{Bmatrix}$