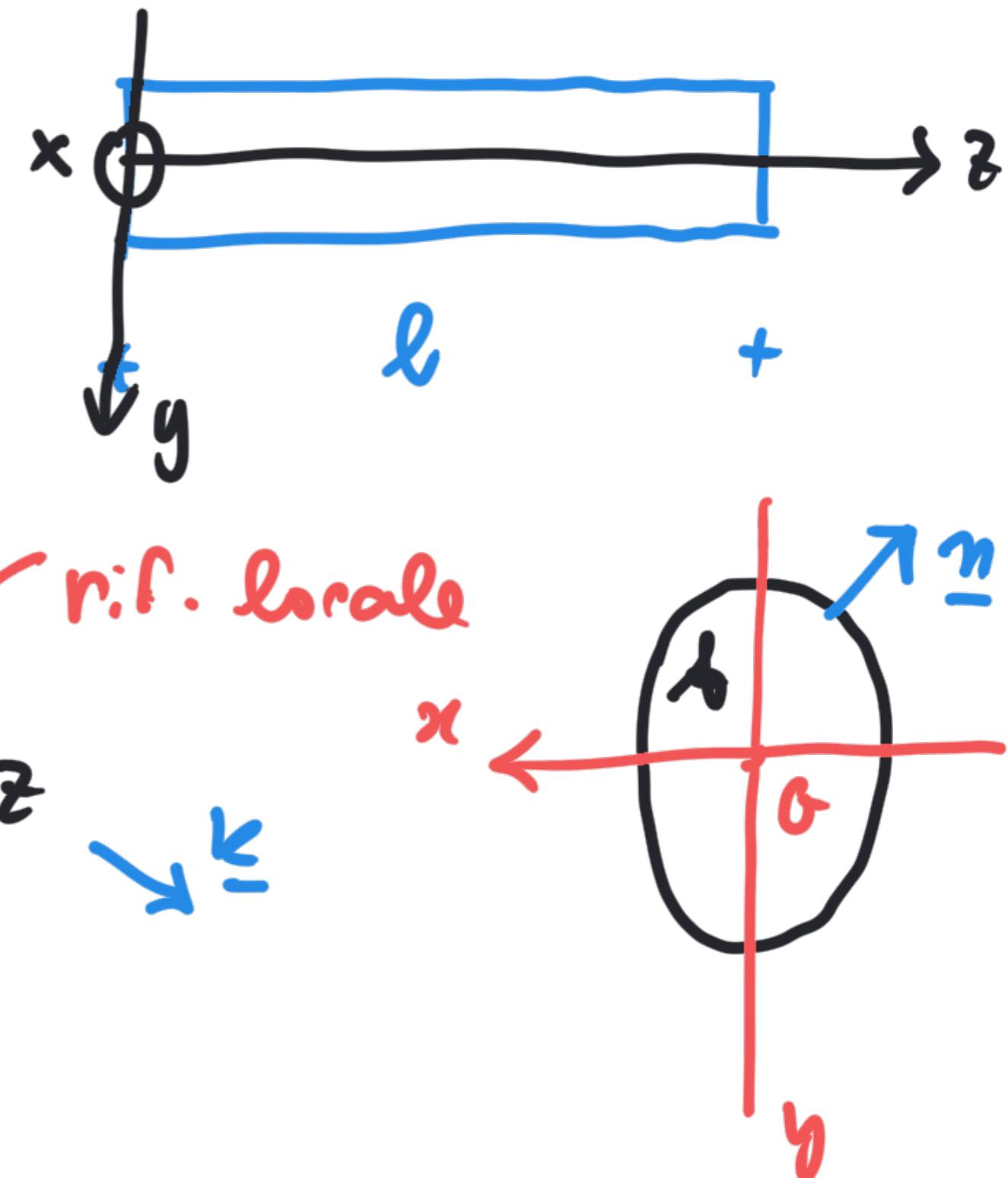


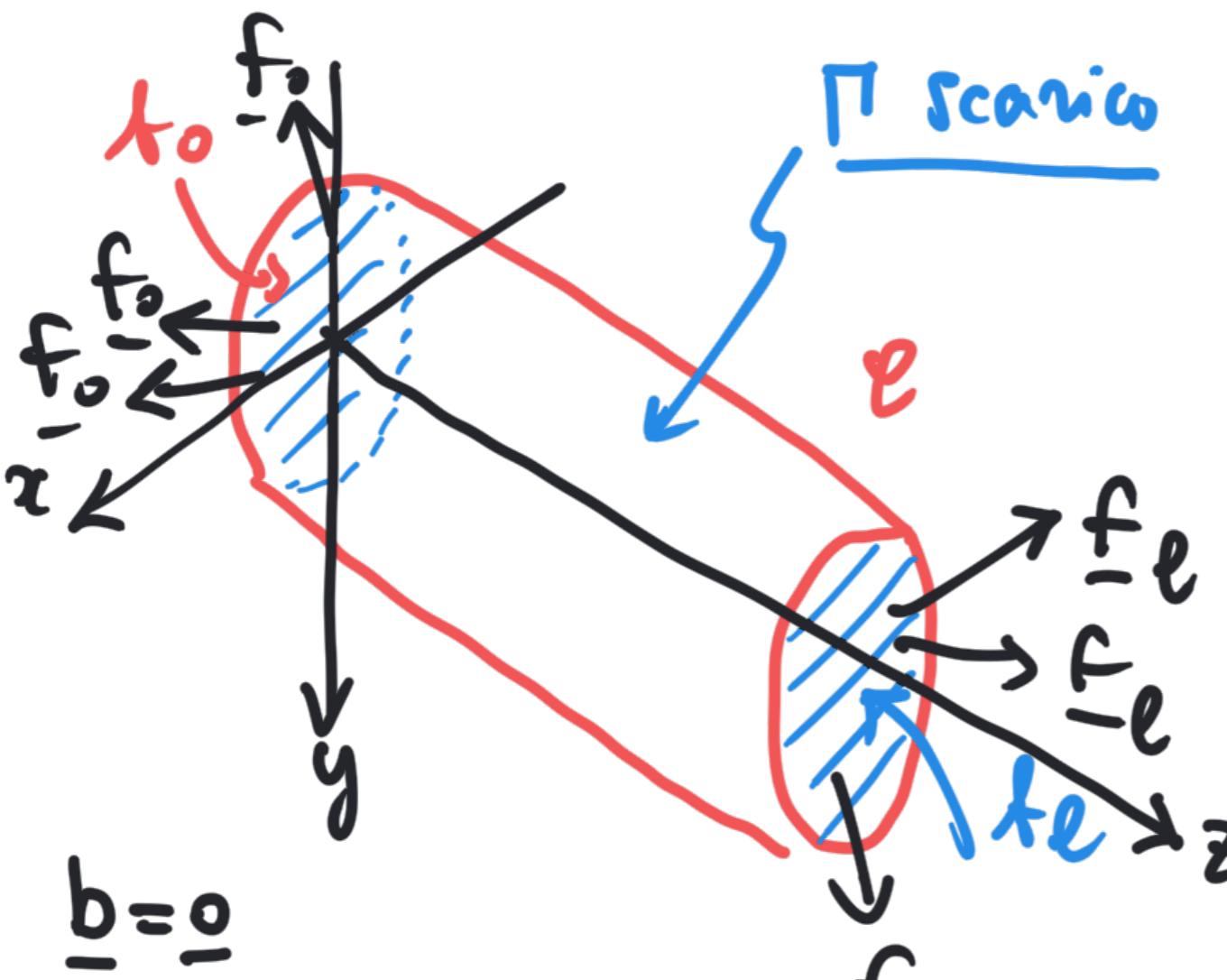
Prob. Saint Venant Cap. 12

A hand-drawn diagram illustrating the motion of a charged particle in a magnetic field. The coordinate system has axes x , y , and z . A red elliptical orbit is shown, with points labeled $t_0 R$ and $t_e R$ indicating the particle's position at two different times. Blue arrows indicate velocity (v), magnetic field (B), and electric field (E). Handwritten labels include $m = -k$, $n = k$, and π .

$$S_x = 0 \quad S_y = 0$$

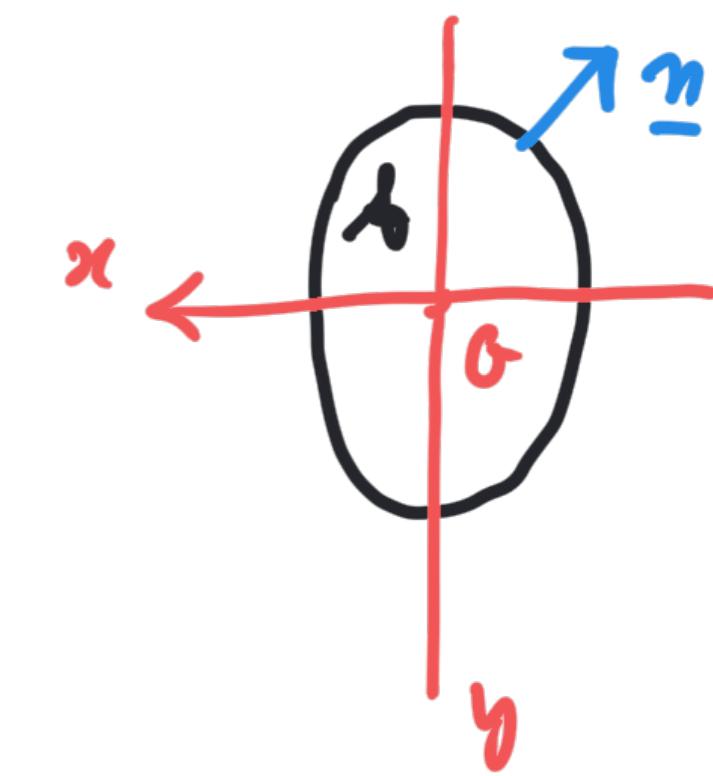
$$I_{xy} = 0$$





$$\underline{R}_e = \int_{x_e} \underline{f}_e dA$$

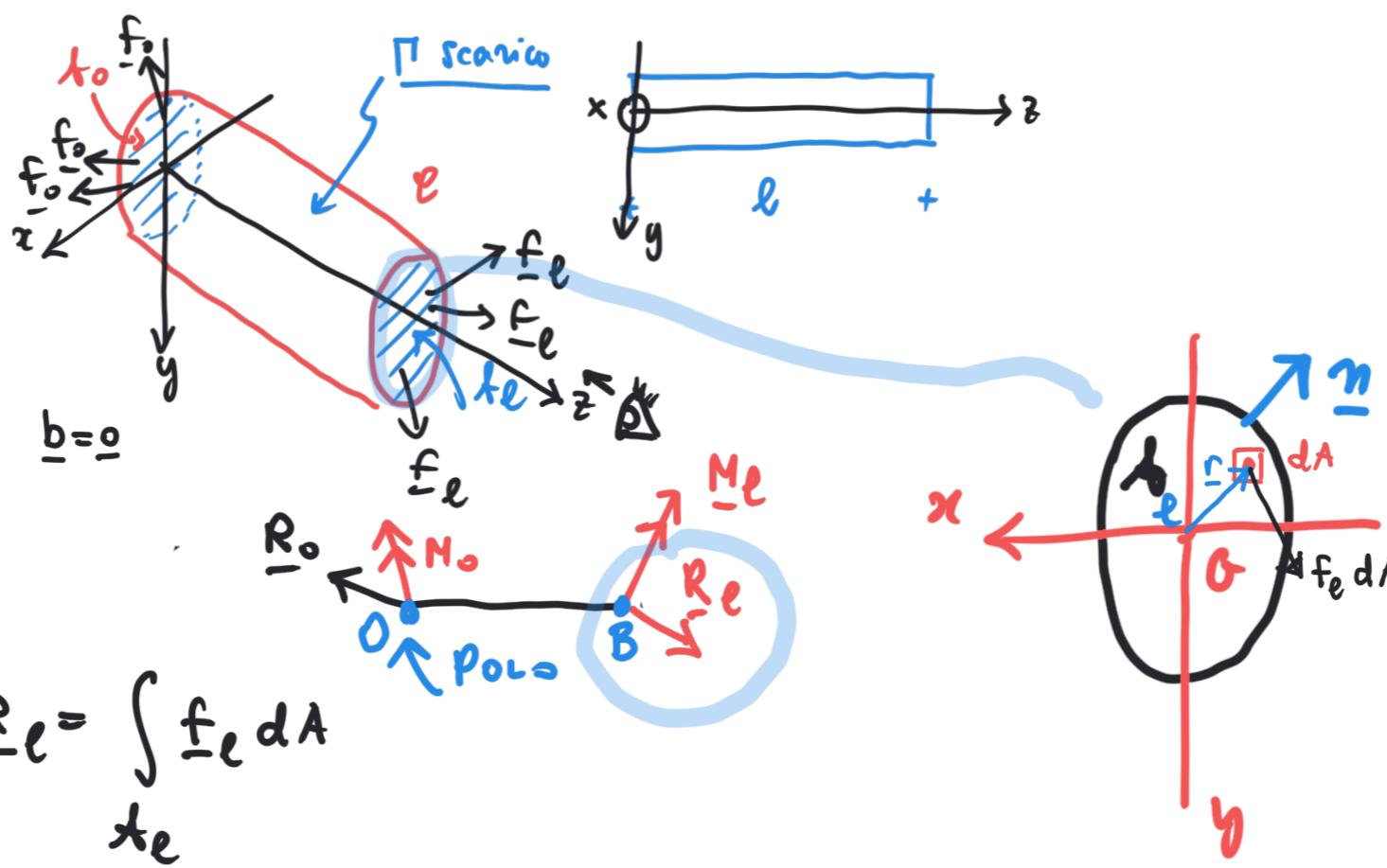
$$\underline{R}_o = \int_{A_o} \underline{f}_o dA$$



$$\underline{R}_e + \underline{R}_o = \underline{0}$$

Prob. Saint Venant Cap. 12

Geometria



$$\underline{R}_e = \int_{A_e} \underline{f}_e dA$$

$$\underline{R}_o = \int_{A_o} \underline{f}_o dA$$

(17.1)

$$\underline{R}_e + \underline{R}_o = \underline{0}$$

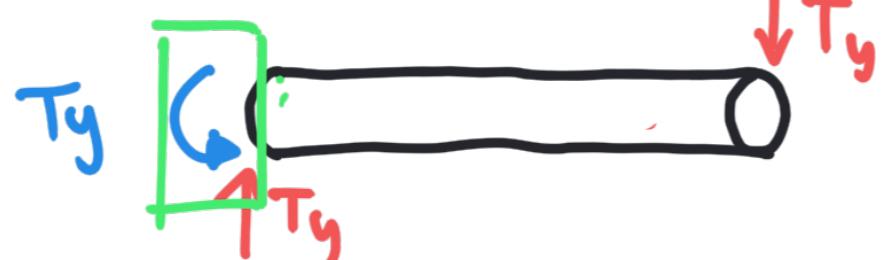
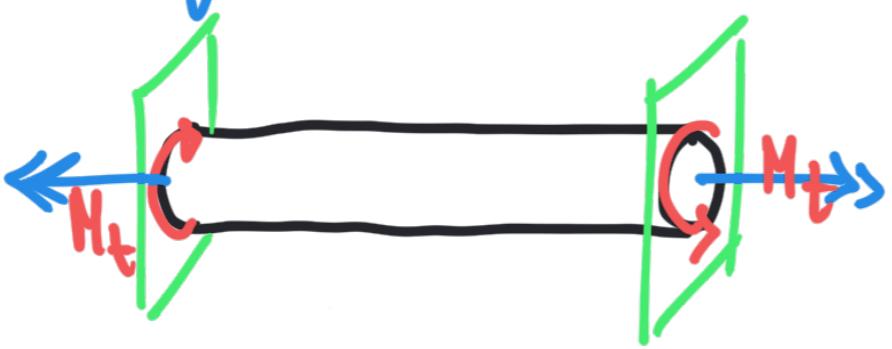
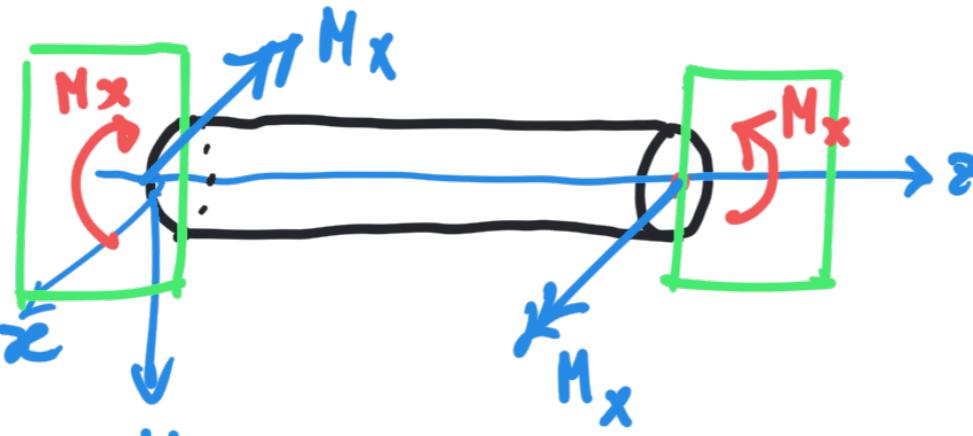
$$\underline{M}_o + \underline{M}_e + \underline{OB} \times \underline{R}_e = \underline{0}$$

$$\underline{M}_e = \int_{A_e} \underline{r} \times \underline{f}_e dA \quad (17.2)$$

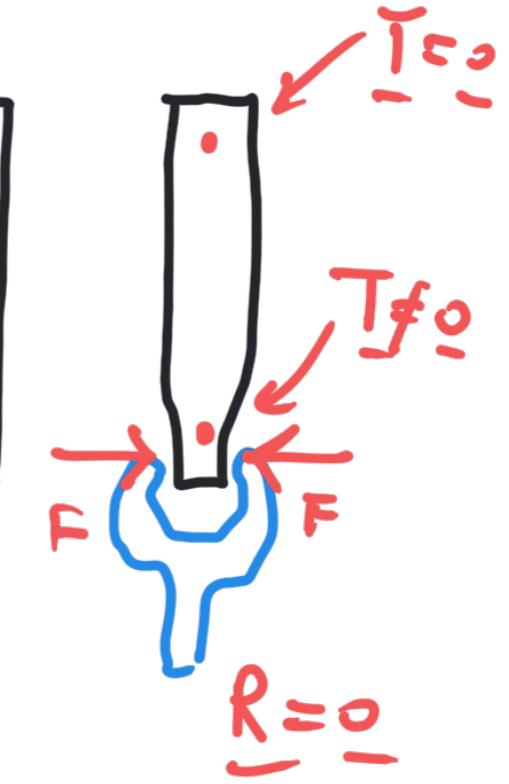
$$\underline{M}_o = \int_{A_o} \underline{r} \times \underline{f}_o dA$$

$$d\underline{M}_e = \underline{r} \times \underline{f}_e dA$$

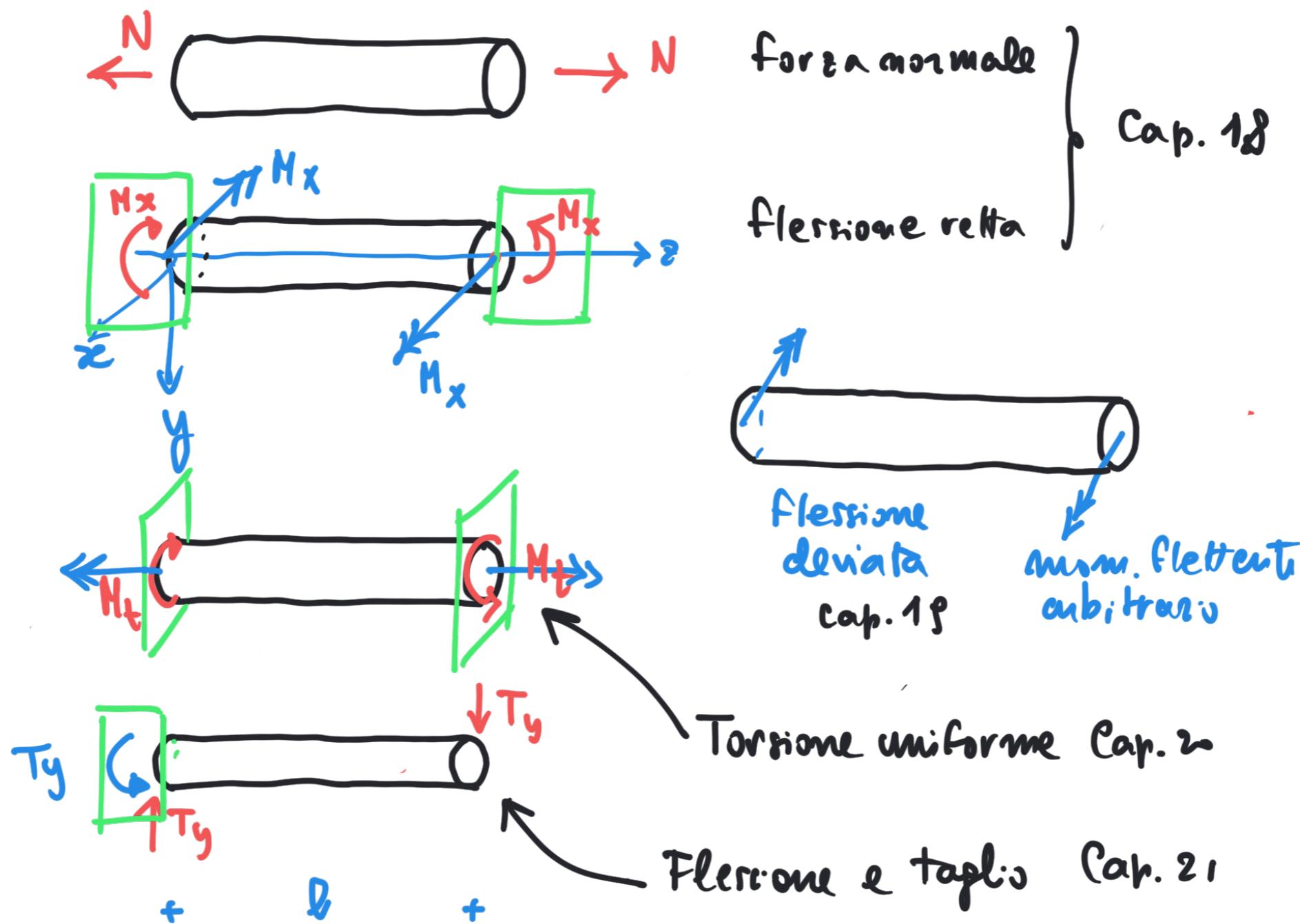
SOLLECITAZIONI SENPLICI



gamma

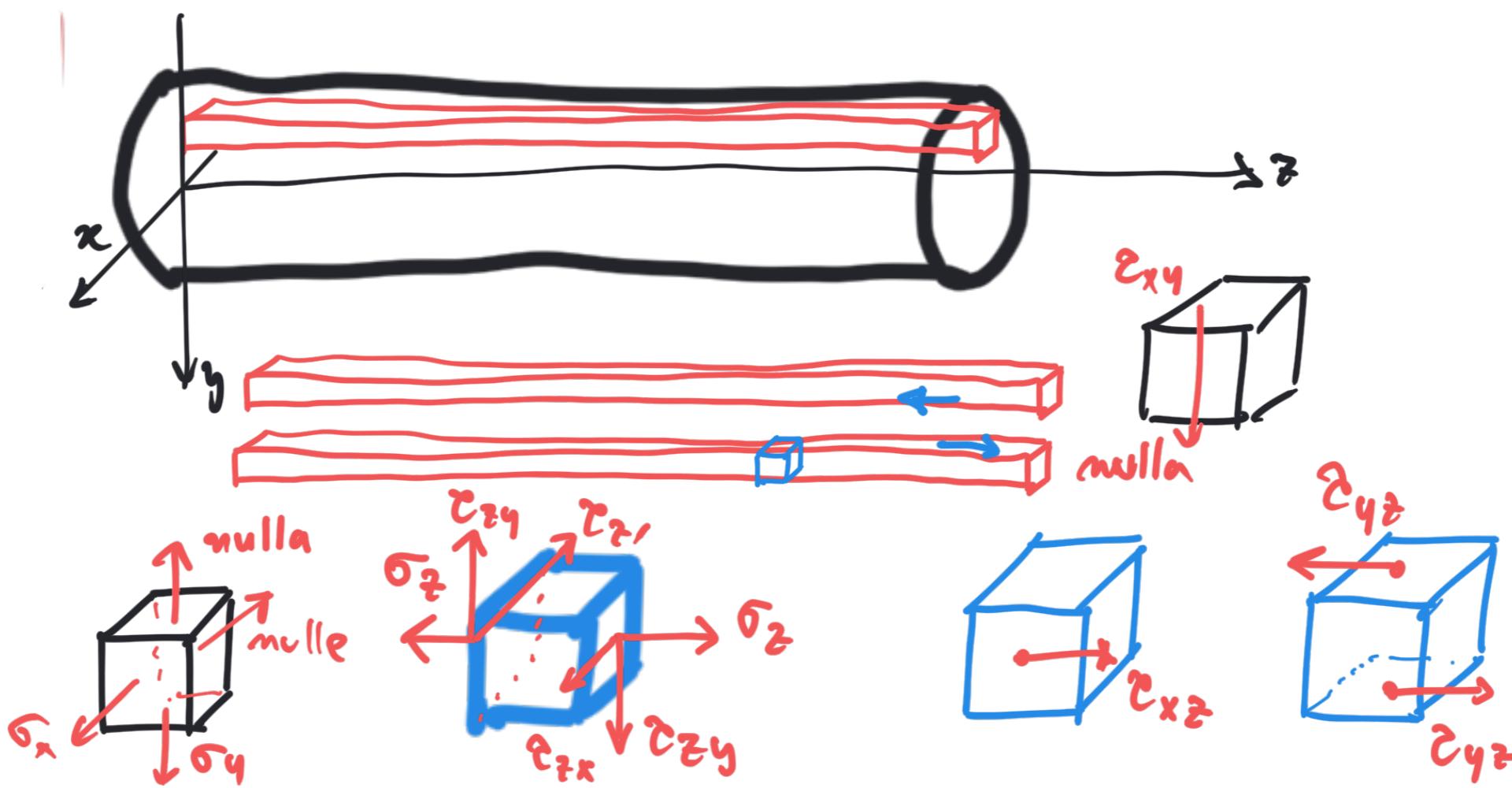


SOLLECITAZIONI SENPLICI



Metodo semi-inverso

$$\underline{\underline{T}} = \begin{bmatrix} 0 & 0 & \bar{c}_{zx} \\ 0 & 0 & \bar{c}_{zy} \\ \bar{c}_{xz} & \bar{c}_{yz} & 0 \end{bmatrix}$$



Método semi-inverso

eq. indef. d' equil.

$$\underline{T} = \begin{bmatrix} 0 & 0 & \underline{\sigma}_{zx} \\ 0 & 0 & \underline{\sigma}_{zy} \\ \underline{\sigma}_{xz} & \underline{\sigma}_{yz} & 0_z \end{bmatrix}$$

$$\cancel{\frac{\partial \sigma_x}{\partial x}} + \cancel{\frac{\partial \sigma_{yx}}{\partial y}} + \cancel{\frac{\partial \sigma_{zx}}{\partial z}} + b_x = 0 \quad (14.16)_1$$

$$\frac{\partial \sigma_{zx}}{\partial z} = 0$$

$$\underline{\sigma}_{zx}(x, y)$$

$$\frac{\partial \sigma_{zy}}{\partial z} = 0$$

$$\underline{\sigma}_{zy}(x, y)$$

$$\frac{\partial \sigma_{xz}}{\partial x} + \frac{\partial \sigma_{yz}}{\partial y} + \frac{\partial \sigma_z}{\partial z} = 0$$

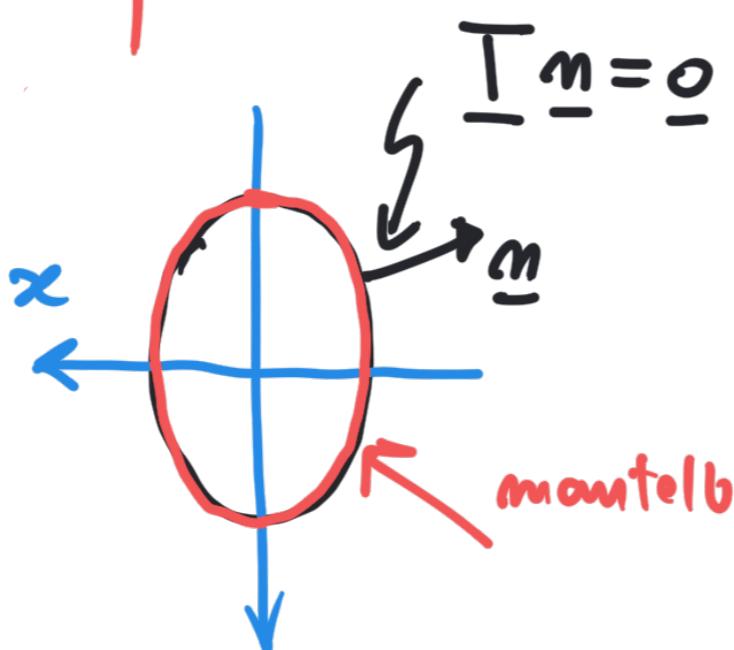
$$\begin{aligned} \underline{\sigma} &= \underline{\sigma}_{zx} i + \underline{\sigma}_{zy} j \\ &= \underline{\sigma}_{xz} i + \underline{\sigma}_{yz} j \end{aligned}$$

$$\boxed{\operatorname{div} \underline{\sigma} = -\frac{\partial \sigma_z}{\partial z}}$$

Metodo semi-inverso

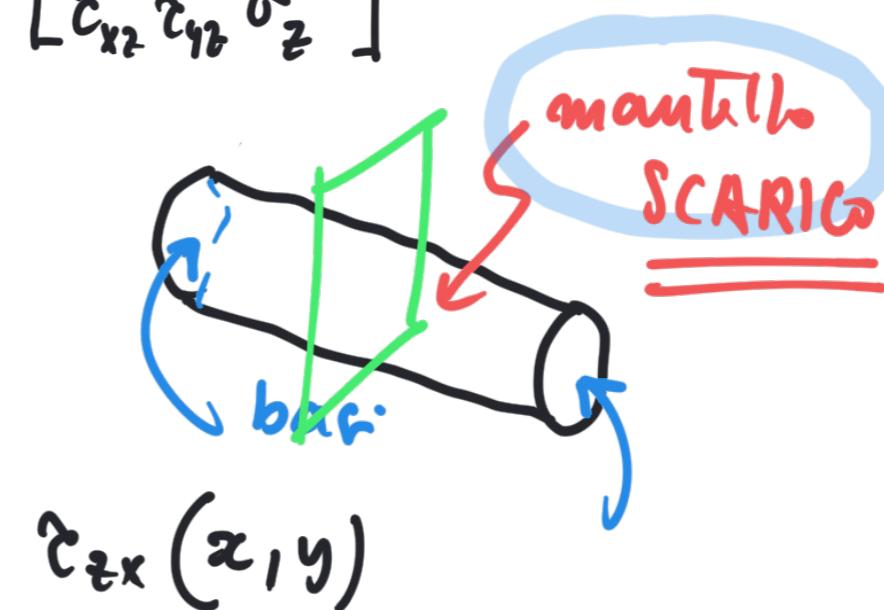
Condizioni al contorno

1



$$\underline{m} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$\underline{T} = \begin{bmatrix} 0 & 0 & \mathfrak{C}_{zx} \\ 0 & 0 & \mathfrak{C}_{zy} \\ \mathfrak{C}_{xz} & \mathfrak{C}_{yz} & \sigma_z \end{bmatrix}$$



$$\mathfrak{C}_{zx}(x, y)$$

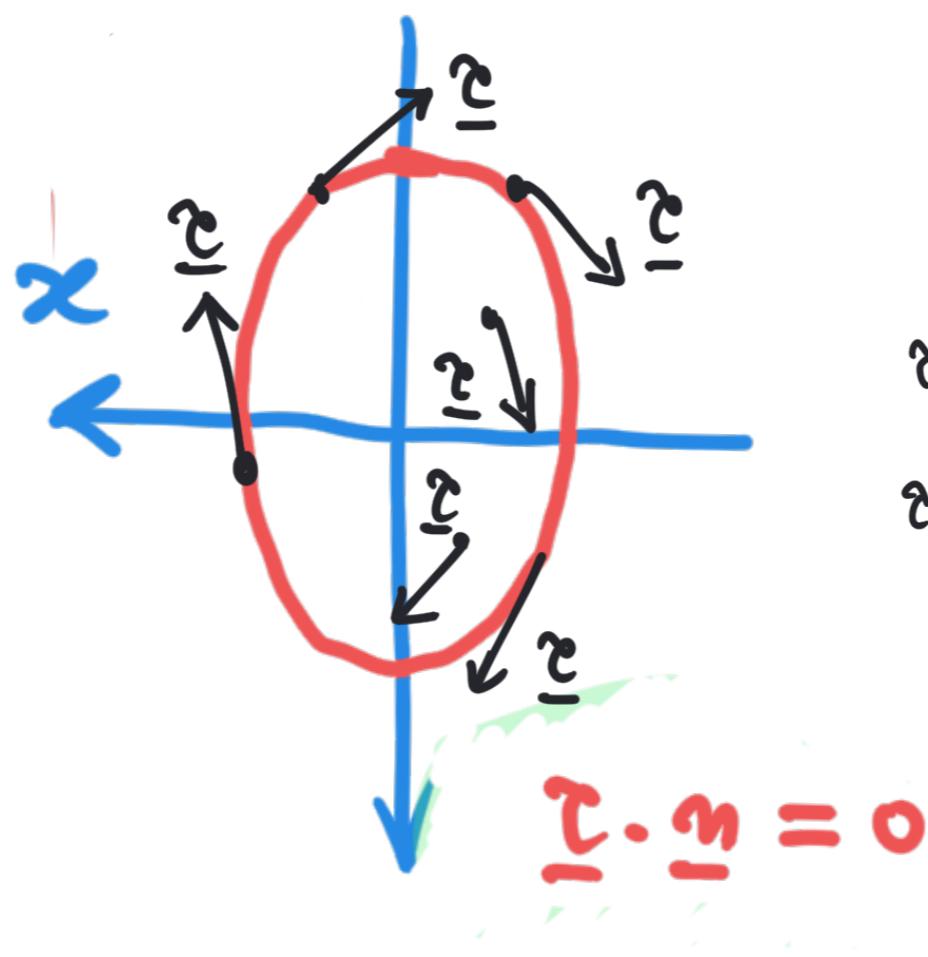
$$\mathfrak{C}_{zy}(x, y)$$

$$\underline{\mathfrak{C}} = \mathfrak{C}_{zx} \underline{i} + \mathfrak{C}_{zy} \underline{j}$$

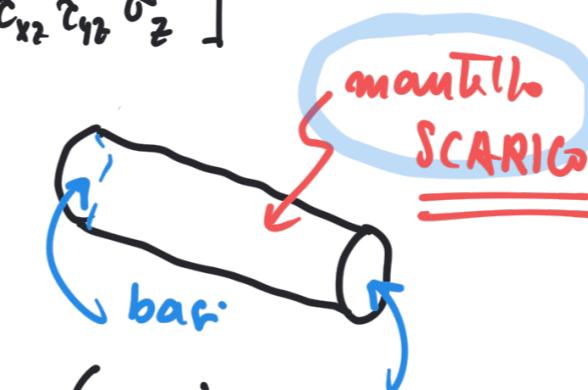
$$= \mathfrak{C}_{xz} \underline{i} + \mathfrak{C}_{yz} \underline{j}$$

Metodo semi-inverso

Condizioni al contorno



$$\underline{\Gamma} = \begin{bmatrix} 0 & 0 & c_{zx} \\ 0 & 0 & c_{zy} \\ c_{xz} & c_{yz} & \sigma_z \end{bmatrix}$$



$c_{zx}(x, y)$

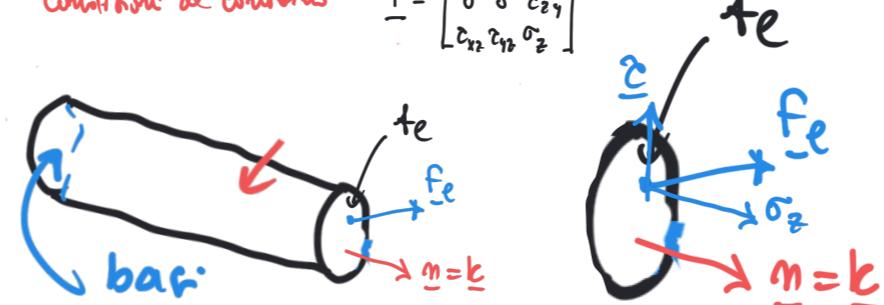
$c_{zy}(x, y)$

$$\begin{aligned}\underline{c} &= c_{zx} i + c_{zy} j \\ &= \underline{c}_{xz} i + \underline{c}_{yz} j\end{aligned}$$

Le condizioni al contorno sul mantello si traducono nelle condizioni che \underline{c} sia tangente al bordo delle sezioni

Condizioni al contorno

$$T = \begin{bmatrix} 0 & 0 & \tau_{zx} \\ 0 & 0 & \tau_{zy} \\ c_{xz} & c_{yz} & \sigma_z \end{bmatrix}$$



$$\text{su } t_e \quad T \underline{k} = f_e$$

$$\underline{k} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad \boxed{f_e = \begin{bmatrix} 0 & 0 & \tau_{zx} \\ 0 & 0 & \tau_{zy} \\ c_{xz} & c_{yz} & \sigma_z \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} \tau_{zx} \\ \tau_{zy} \\ c_{xz} \\ c_{yz} \\ \sigma_z \end{bmatrix} = \begin{bmatrix} \tau_{zx} \\ \tau_{xy} \\ \sigma_z \end{bmatrix}}$$

$$\sigma_z = f_{ez} = f_e \cdot \underline{k}$$

$\underline{\tau}$ = componente di f_e tangente a t_e

Leyende costitutivo

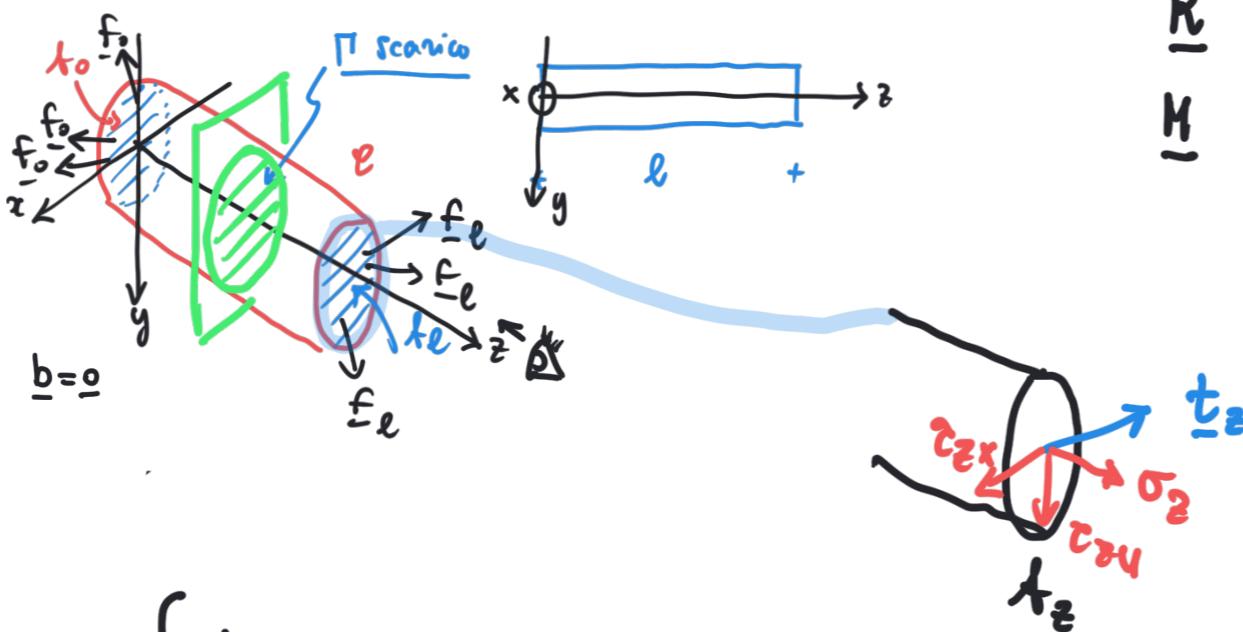
$$\underline{\underline{T}} = \begin{bmatrix} 0 & 0 & \epsilon_{zx} \\ 0 & 0 & \epsilon_{zy} \\ \epsilon_{xz} & \epsilon_{yz} & \sigma_z \end{bmatrix}$$

$$\epsilon_z = \frac{\sigma_z}{E} \quad \epsilon_x = \epsilon_y = -\nu \frac{\sigma_z}{E}$$

$$\gamma_{zx} = \frac{\epsilon_{zx}}{\sigma_z}$$

Prob. Saint Venant Cap. 12

Geometric



$$\underline{R} \quad \underline{M}$$

$$\underline{R} = \int \underline{t}_z dA \Leftrightarrow \underline{t}_z = c_{zx} \underline{i} + c_{zy} \underline{j} + \sigma_z \underline{k}$$

$$\underline{M} = \int \underline{r} \times \underline{t}_z dA \quad \underline{R} = \left(\int c_{zx} dA \right) \underline{i} + \left(\int c_{zy} dA \right) \underline{j} + \left(\int \sigma_z dA \right) \underline{k}$$

$$\underline{R} = T_x \underline{i} + T_y \underline{j} + N \underline{k}$$

$$T_x = \int c_{zx} dA \quad T_y = \int c_{zy} dA \quad N = \int \sigma_z dA$$

Prob. Saint Venant Cap. 12 Geometria

$\underline{R} = \int_{A_z} \underline{t}_z dA$ $\underline{t}_z = c_{zx}\underline{i} + c_{zy}\underline{j} + \sigma_z \underline{k}$

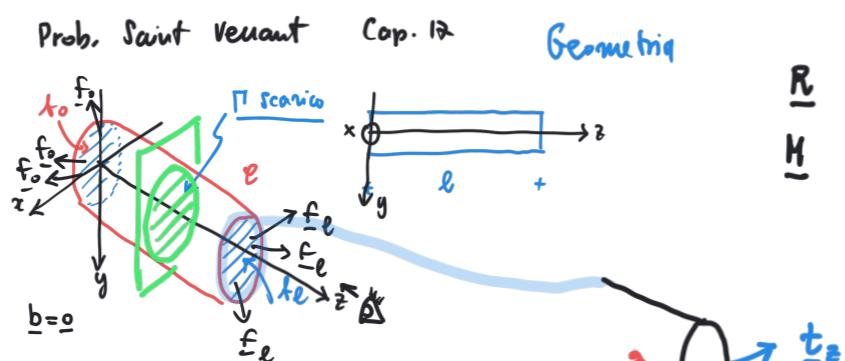
$\underline{M} = \int_{A_z} \underline{r} \times \underline{t}_z dA$

$\underline{M} = \int_{A_z} (\underline{x_i} + \underline{y_j}) \times (c_{zx}\underline{i} + c_{zy}\underline{j} + \sigma_z \underline{k})$

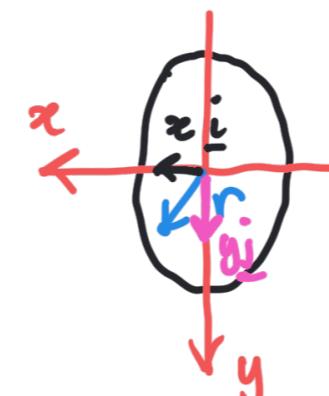
$= \int_{A_z} x c_{zx} \underline{i} \times \underline{i} + x c_{zy} \underline{i} \times \underline{j} + x \sigma_z \underline{i} \times \underline{k} + y c_{zx} \underline{j} \times \underline{i} + y c_{zy} \underline{j} \times \underline{j} + y \sigma_z \underline{j} \times \underline{k}$

$= \left[\int_{A_z} (x c_{zy} - y c_{zx}) dA \right] \underline{i} + \left(\int_{A_z} y \sigma_z dA \right) \underline{i} + \int_{A_z} x \sigma_z (-\underline{j})$

$$T_x = \int_{A_z} c_{zx} dA \quad T_y = \int_{A_z} c_{zy} dA \quad N = \int_{A_z} \sigma_z dA$$



$$\underline{R} = \underline{H}$$



$$i \times j = k$$

$$j \times i = -k$$

$$j \times k = i$$

$$k \times i = j$$

$$i \times k = -j$$

$$\underline{R} = \int_{t_z} \underline{t}_z dA$$

$$\underline{t}_z = c_{zx} \underline{i} + c_{zy} \underline{j} + \sigma_z \underline{k}$$

$$t_z$$

$$\underline{M} = \int_{t_z} \underline{r} \times \underline{t}_z dA$$

$$T_x = \int_{t_z} c_{zx} dA \quad T_y = \int_{t_y} c_{zy} dA \quad N = \int_{t_z} \sigma_z dA$$

(17.12)

M_2

M_y

$$M_z = - \int_A x \sigma_z dA$$

$$M = \left[\int_A (x c_{zy} - y c_{zx}) dA \right] \underline{k} +$$

$$+ \left(\int_A y \sigma_z dA \right) \underline{i} + \int_A x \sigma_z (-\underline{j})$$