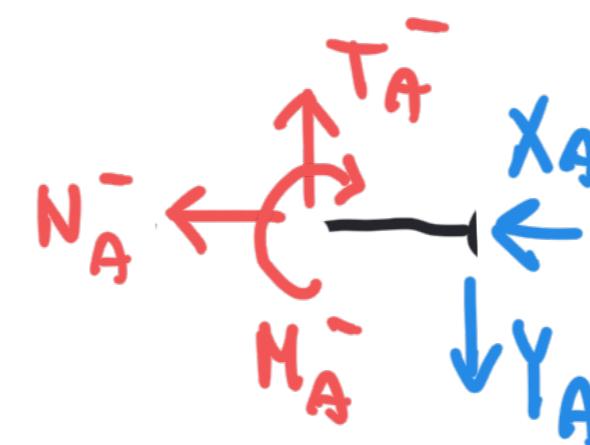


$$\left. \begin{array}{l} M_A^+ = 0 \\ M_A^- = 0 \end{array} \right\} \text{estremi}$$

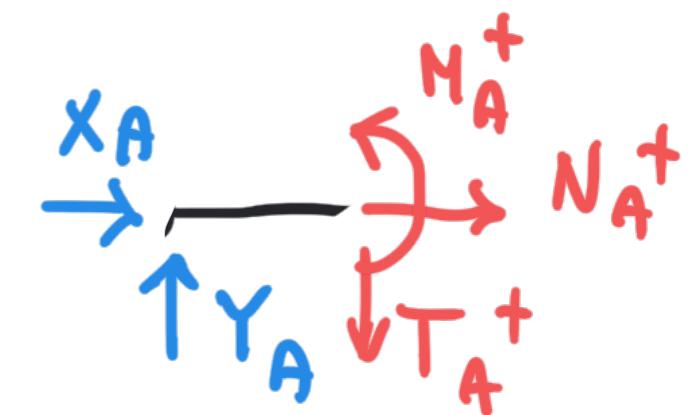
$$M_A^- = 0$$

$$\left. \begin{array}{l} N_A^+ - N_A^- = 0 \\ T_A^+ - T_A^- = 0 \end{array} \right\} \text{valori raccordo}$$

$$\left. \begin{array}{l} N_A^+ - N_A^- = 0 \\ T_A^+ - T_A^- = 0 \end{array} \right\} \text{valori raccordo}$$



$$\left. \begin{array}{l} M_A^- = 0 \\ N_A^- = -X_A \\ T_A^- = Y_A \end{array} \right\} \text{valori raccordo}$$



$$\left. \begin{array}{l} M_A^+ = 0 \\ N_A^+ = -X_A \\ T_A^+ = Y_A \end{array} \right\} \text{valori raccordo}$$

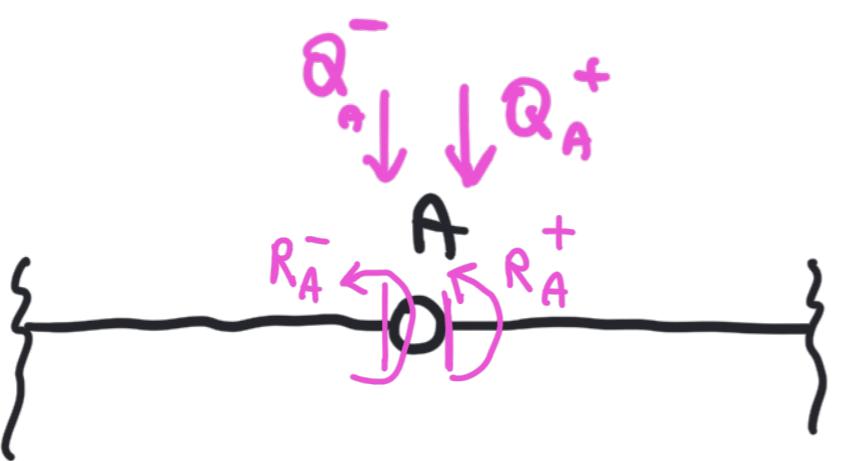
Diagram illustrating a beam element A with nodes A and B. At node A, there is a clockwise moment R_A^- , a counter-clockwise moment R_A^+ , a horizontal force X_A pointing left, and a vertical force Y_A pointing down. At node B, there is a horizontal force X_B pointing right and a vertical force Y_B pointing up.

Equations for the beam element A:

- $M_A^+ = -R_A^+$
- $M_A^- = R_A^-$
- $N_A^+ - N_A^- = 0$
- $T_A^+ - T_A^- = 0$
- $N_A^- = -X_A$
- $T_A^- = Y_A$
- $M_A^+ = -R_A^+$
- $N_A^+ = -X_A$
- $T_A^+ = Y_A$

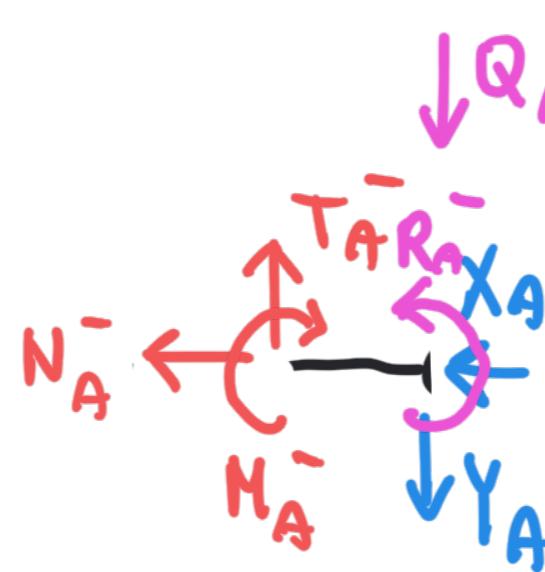
Brackets indicate relationships between equations:

- A bracket groups the first two equations as "estremi".
- A bracket groups the last three equations as "rall. f. / raccordo".



$$\left. \begin{aligned} M_A^+ &= -R_A^+ \\ M_A^- &= R_A^- \end{aligned} \right\} \text{estremi}$$

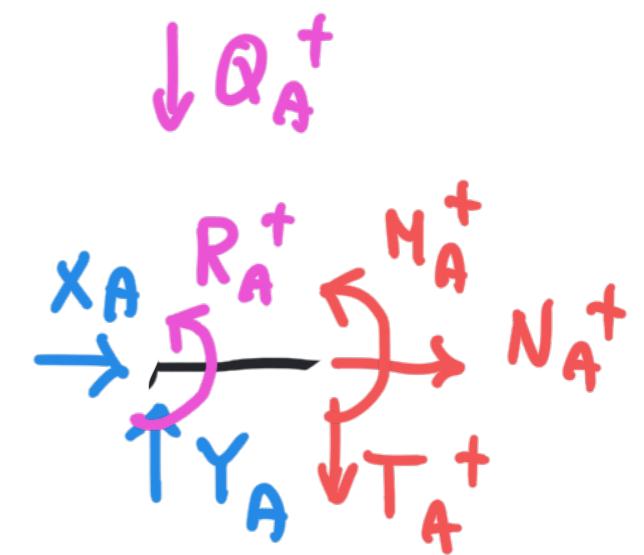
$$\left. \begin{aligned} N_A^+ - N_A^- &= 0 \\ T_A^+ - T_A^- + Q_A^+ + Q_A^- &= 0 \end{aligned} \right\} \begin{array}{l} \text{1 al Fo} \\ \text{records} \end{array}$$



$$M_A^- = R_A^-$$

$$N_A^- = -X_A$$

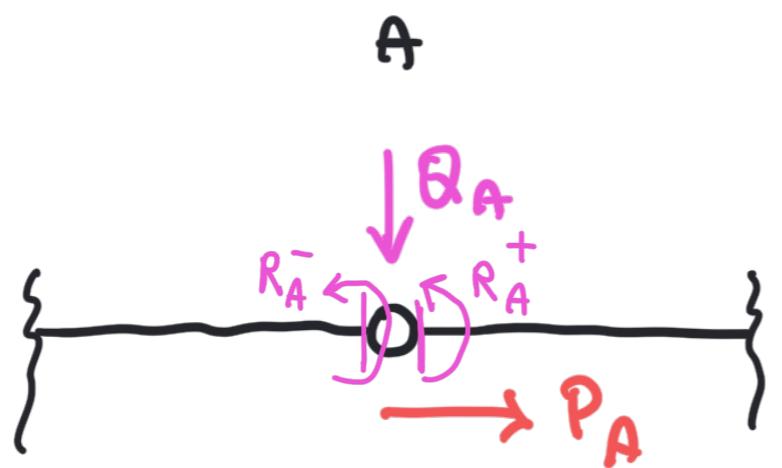
$$T_A^- = Y_A + Q_A^-$$



$$M_A^+ = -R_A^+$$

$$N_A^+ = -X_A$$

$$T_A^+ = Y_A - Q_A^+$$



OSS:

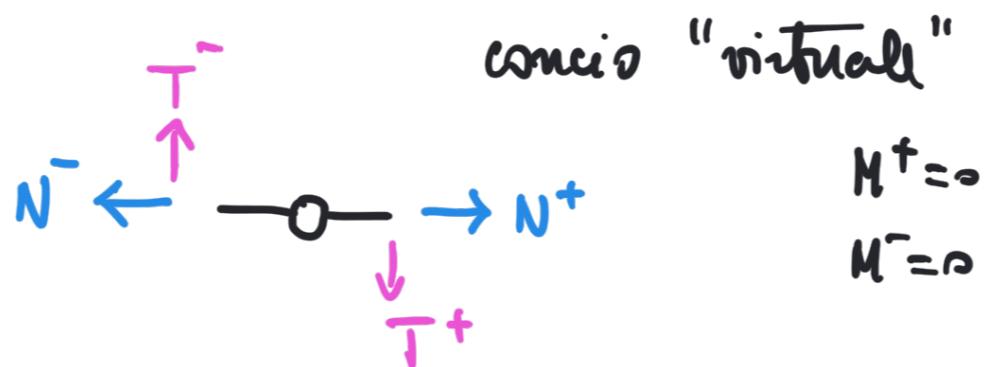
$$(*) \Rightarrow N_A^+ - N_A^- + R_A^+ + R_A^- = 0$$

$$\left. \begin{array}{l} M_A^+ = -R_A^+ \\ M_A^- = R_A^- \end{array} \right\} \text{estremi} \quad (*)$$

$$\left. \begin{array}{l} N_A^+ - N_A^- + P_A = 0 \\ T_A^+ - T_A^- + Q_A = 0 \end{array} \right\} \begin{array}{l} \text{1 al F} \\ \text{taccaido} \end{array}$$

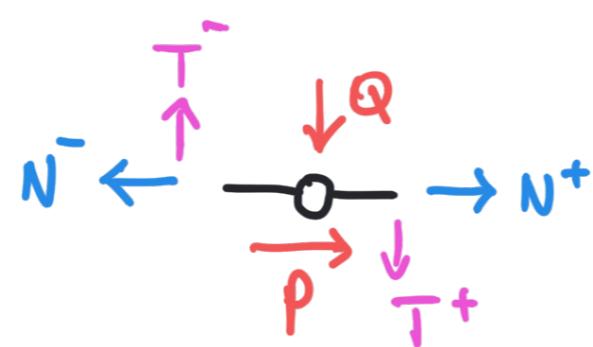
$$Q_A = Q_A^+ + Q_A^-$$

$$\begin{array}{c} N_A^- \xrightarrow{\text{II}} \xrightarrow{\text{II}} N_A^+ \\ \parallel \\ \downarrow \\ R_A = R_A^+ + R_A^- \end{array}$$



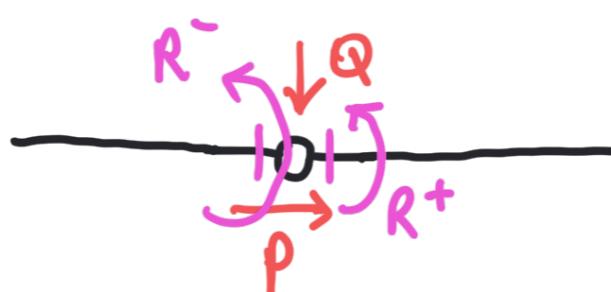
$$M^+ = \sigma$$

$$M^- = \sigma$$

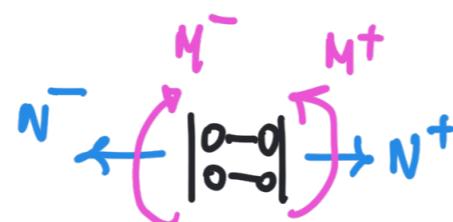


$$N^+ - N^- + P = 0$$

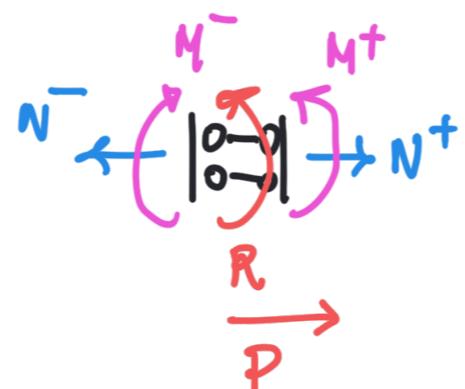
$$T^+ - T^- + Q = 0$$



Il concio
può contenere P e Q
Una eventuale coppia
tra i punti fa tra
le travi che concorrono
in A.

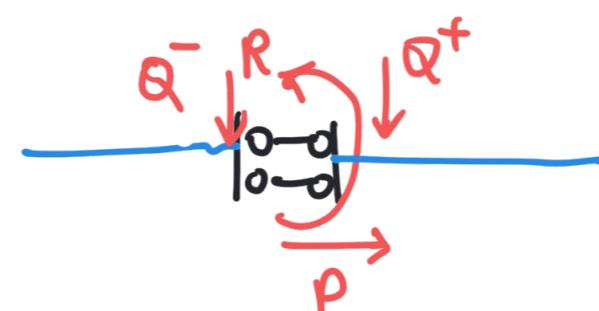


cancio virtuale



$$N^+ - N^- + P = 0$$

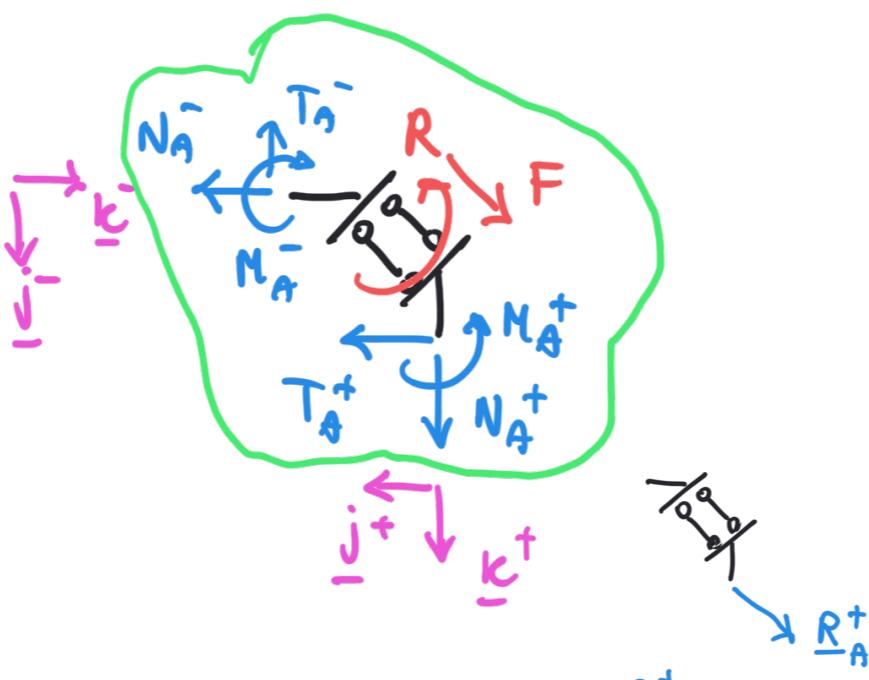
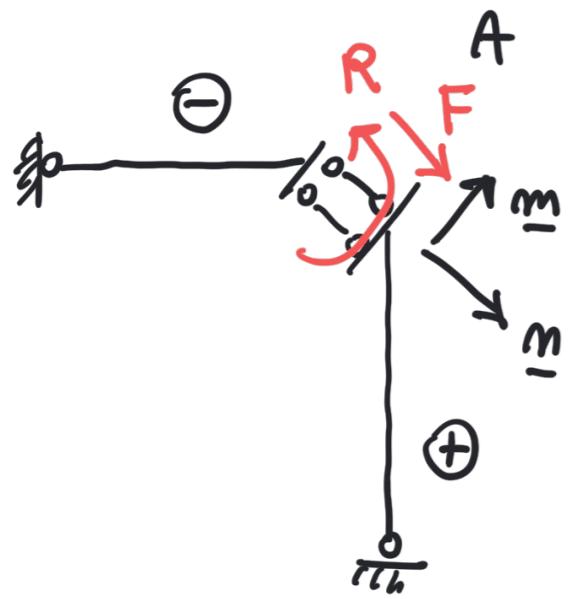
$$M^+ - M^- + R = 0$$



$$T^- = Q^- \quad T^+ = -Q^+$$



Il "cancio virtuale" può sostenere P e R .
Un eventuale cancio trasversale R va ripartito sulle travi che concorrono nel "canci-



$$(\underline{k}^+ \cdot \underline{m}) N_A^+ + (\underline{j}^+ \cdot \underline{m}) T_A^+ = 0$$

$$-(\underline{k}^- \cdot \underline{m}) N_A^- - (\underline{j}^- \cdot \underline{m}) T_A^- = 0$$

$$\underline{N_A^+ k^+ + T_A^+ j^+ - N_A^- k^- - T_A^- j^- + F m = 0}$$

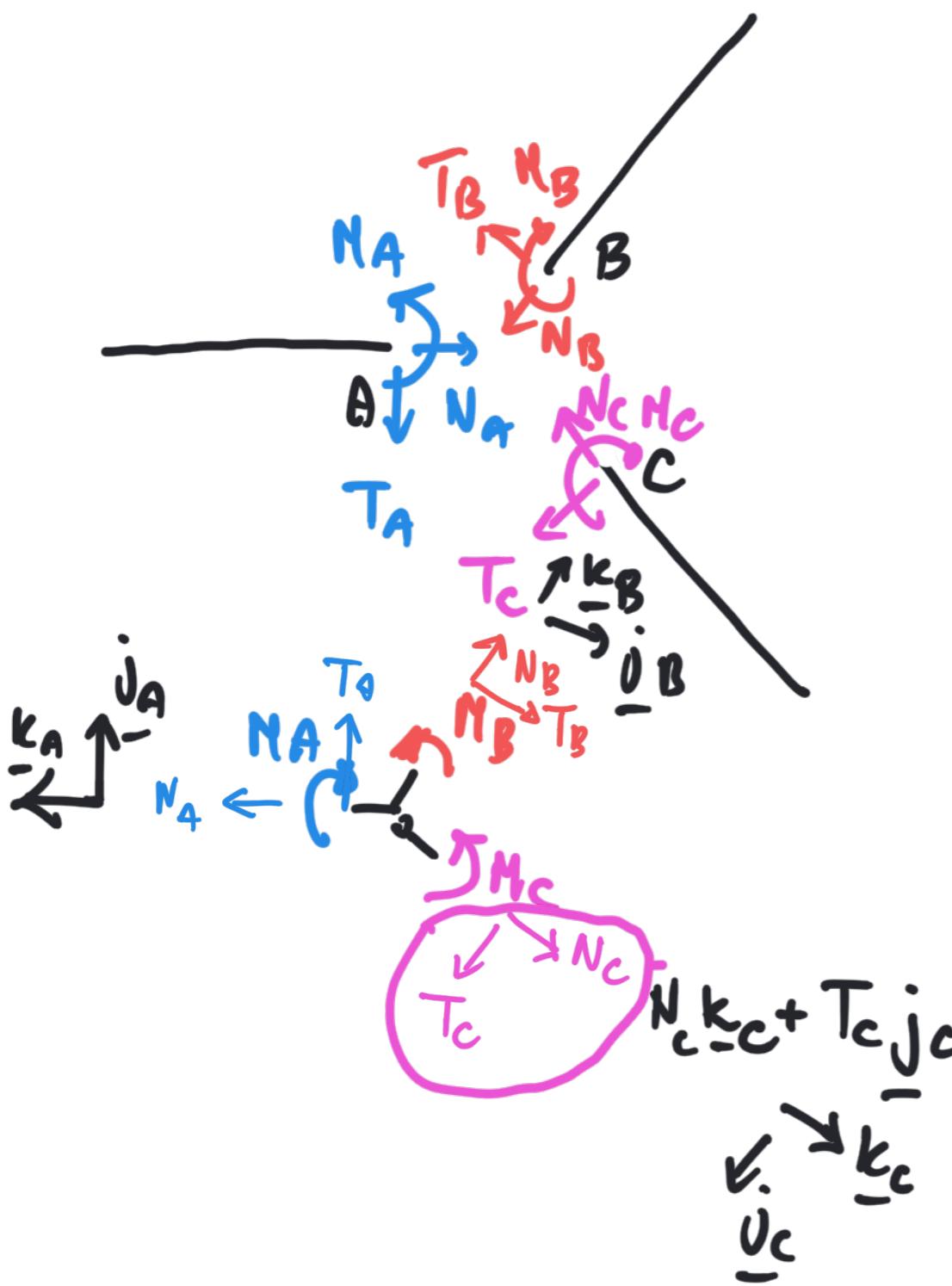
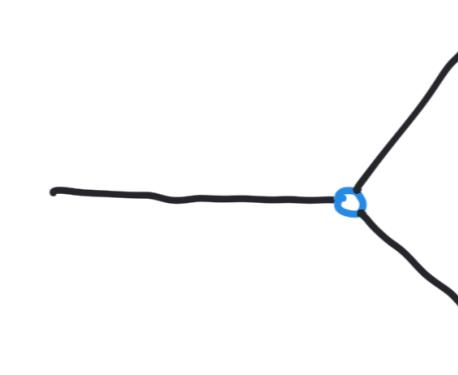
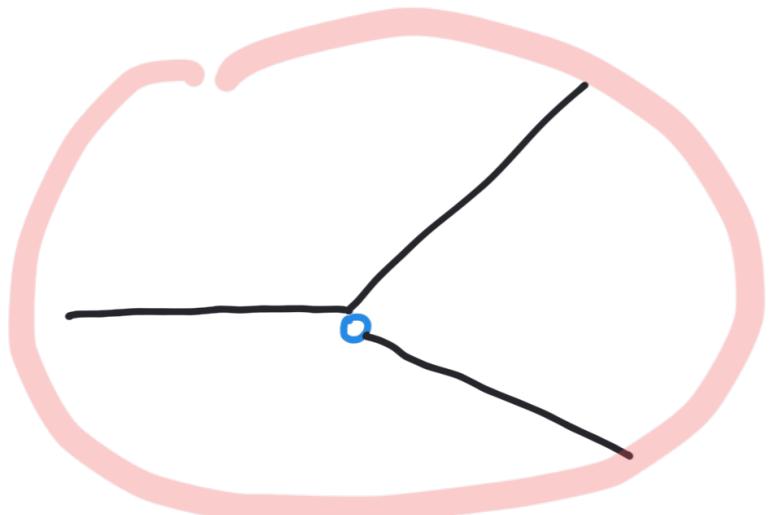
$$N_A^+ - N_A^- + R = 0$$

$$\begin{aligned} R_A^+ \cdot \underline{m} &= 0 \\ R_A^+ &= N_A^+ k^+ + T_A^+ j^+ \end{aligned}$$

coefficient.

$$(N_A^+ k^+ + T_A^+ j^+ - N_A^- k^- - T_A^- j^- + F m) \cdot \underline{m} = 0$$

Giunzioni multiple



$$M_C = 0$$

$$M_B + M_C - M_A = 0$$

$$N_B \underline{k}_B + T_B \underline{j}_B + N_C \underline{k}_C + T_C \underline{j}_C - N_A \underline{k}_A - T_A \underline{j}_A = 0$$

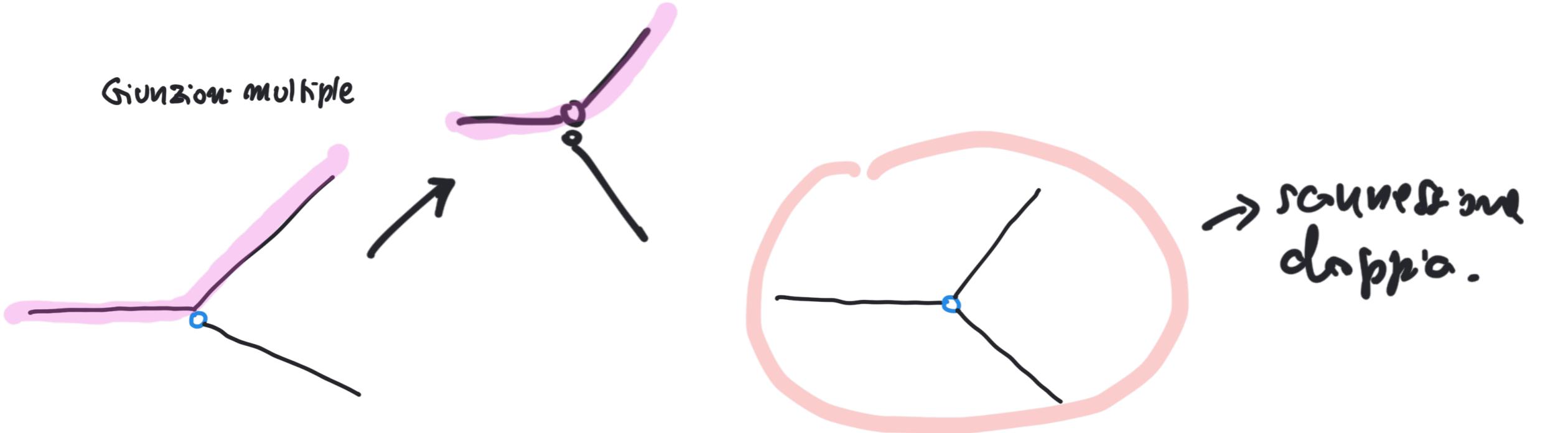
2 cond. scalari

3 condiz. equil. globale

1 condiz. opportunità per ogni reconnessione
"semplice"

$$N_C \underline{k}_C + T_C \underline{j}_C$$

$$\underline{k}_C$$



(*) $\begin{cases} M_A = 0 \\ M_C = 0 \\ M_B + M_C - M_A = 0 \end{cases}$ ($M_B = 0$ segue dalle (*))

$N_B k_B + T_B j_B + N_C k_C + T_C j_C - N_A k_A - T_A j_A = 0$

2 cond. scalari

3 condizioni equilibrio globale

1 condizione opportunità per ogni sezione "semplice"

$N_c k_c + T_c j_c$

k_c

j_c

N_A T_A A

N_B T_B B

N_C T_C C

N_A T_A

N_B T_B

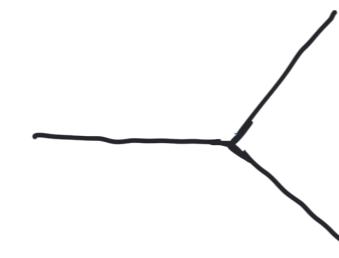
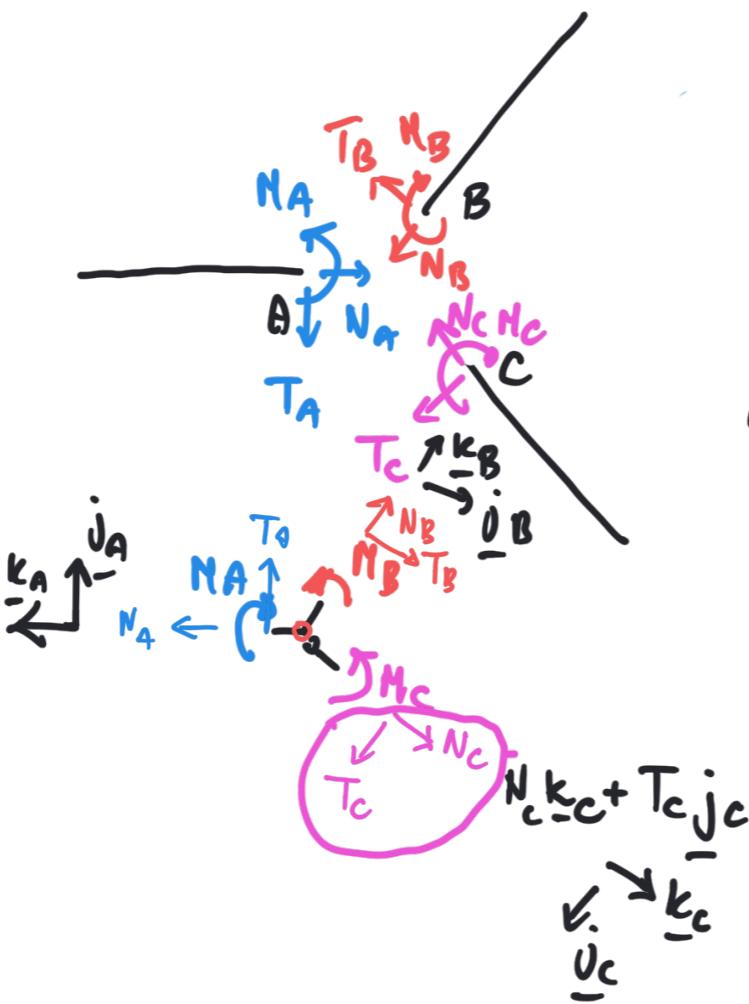
N_C T_C

j_A k_A

j_B k_B

j_C k_C

Giunzioni multiple



)

$$M_B + M_C - M_A = 0$$

$$N_B \underline{k}_B + T_B \underline{j}_B + N_C \underline{k}_C + T_C \underline{j}_C - N_A \underline{k}_A - T_A \underline{j}_A = 0$$

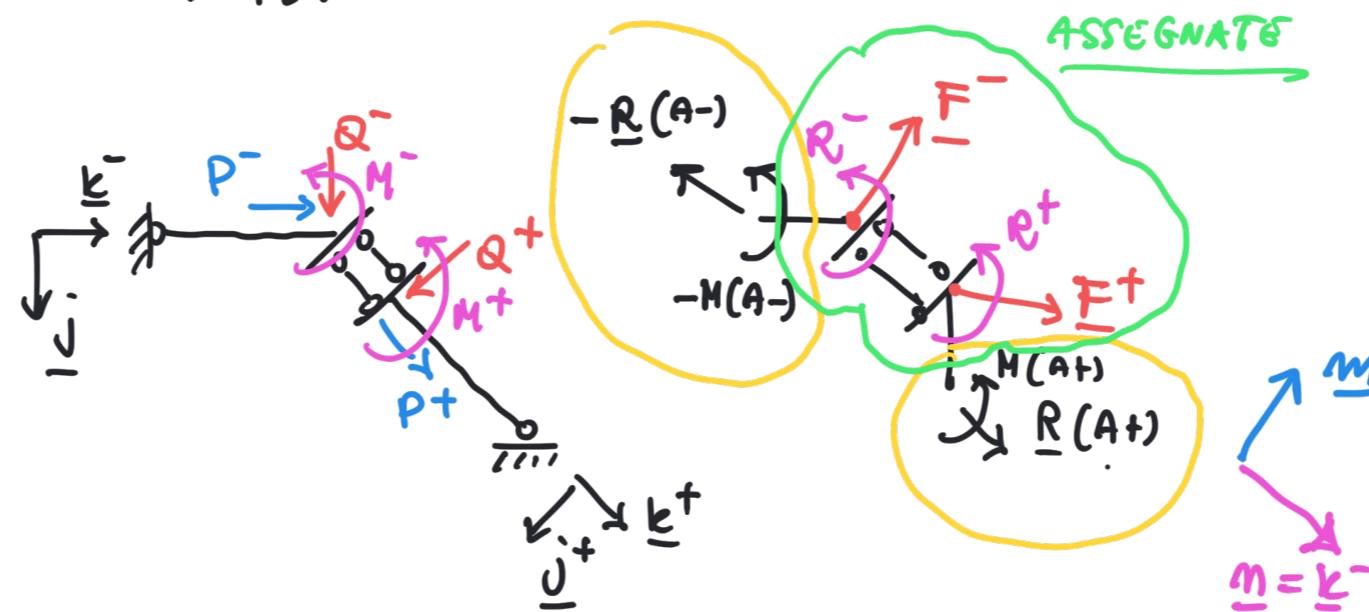
2 cond. scalari

3 condiz. equil. globale

1 condiz. opportunità per ogni sezione
"semplice"

IN CASO DI DIFFICOLTÀ:

- notazione vettoriale
- PLV



$$0 = L = (\underline{R}(A^+) + \underline{F}^+) \cdot \underline{u}_A^+ + (\underline{M}(A^+) + \underline{R}^+) \underline{\partial}_A^+$$

$$+ (-\underline{R}(A^-) + \underline{F}^-) \cdot \underline{u}_A^- + (-\underline{M}(A^-) + \underline{R}^-) \underline{\partial}_A^-$$

$$\underline{\partial}_A^+ - \underline{\partial}_A^- = 0$$