

Università degli studi di Bergamo

Scuola di Ingegneria (Dolmine)

CCS Ingegneria Edile

L-23 Ingegneria delle Tecnologie per l'Edilizia

Scienza delle Costruzioni

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(ICAR/08 - SdC; 9 CFU)

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LEZIONE 06

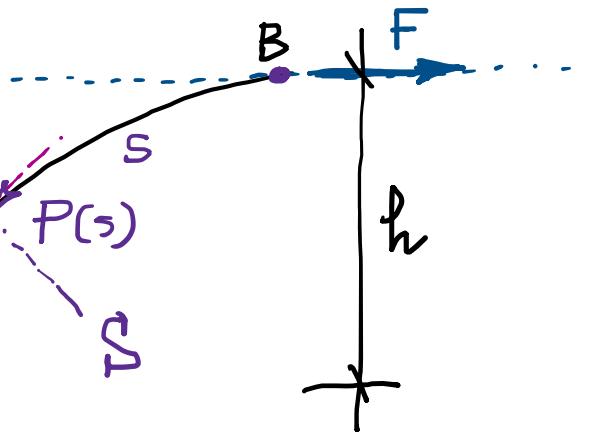
# Azioni Interne: caratteristiche di sollecitazione (interna alla struttura)

sezione di taglio  $S$

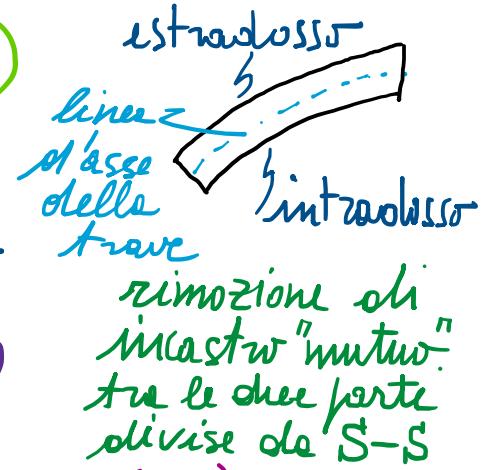
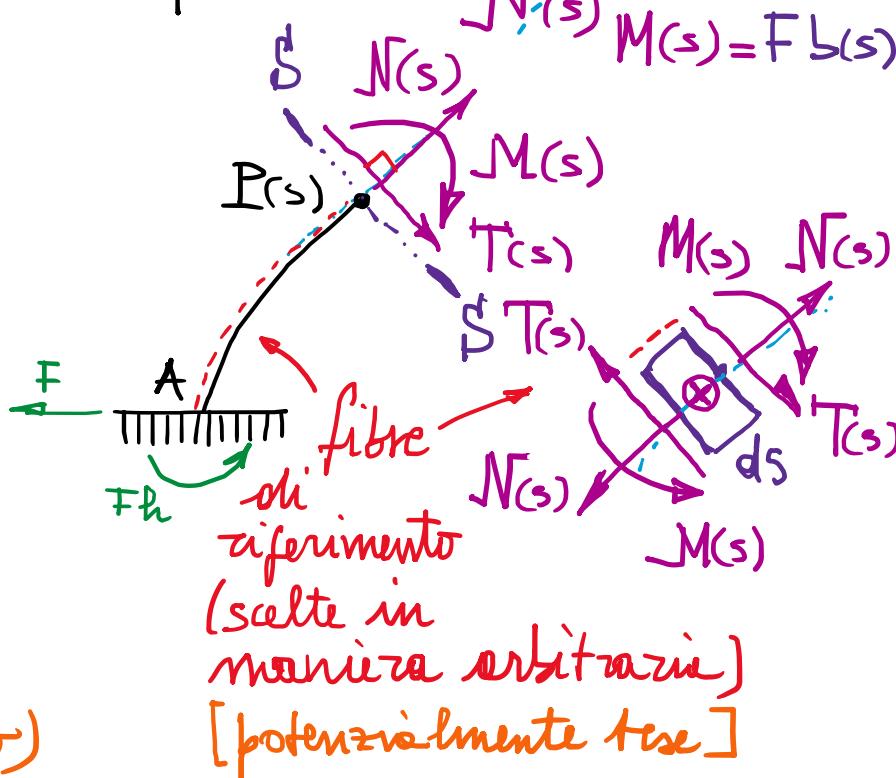
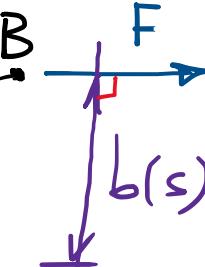
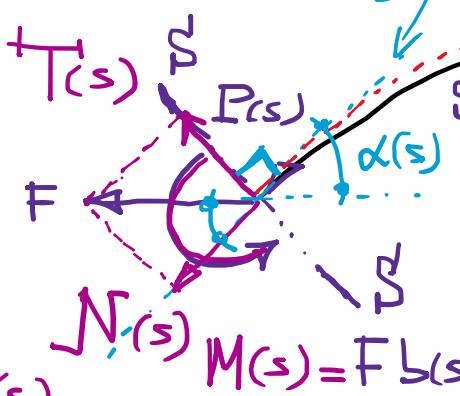
Calcolo RT: impostazione dell'equilibrio "globale"  $F$

$$\begin{cases} N(s) = F \cos \alpha(s) \\ T(s) = F \sin \alpha(s) \\ M(s) = F b(s) \end{cases}$$

Determinate per equilibrio "locale" delle porzione  $\overline{BP}$  - (ogni porzione di struttura dovrebbe risultare in equilibrio)



tangente alle linee d'asse



## Azioni Interne (AI)

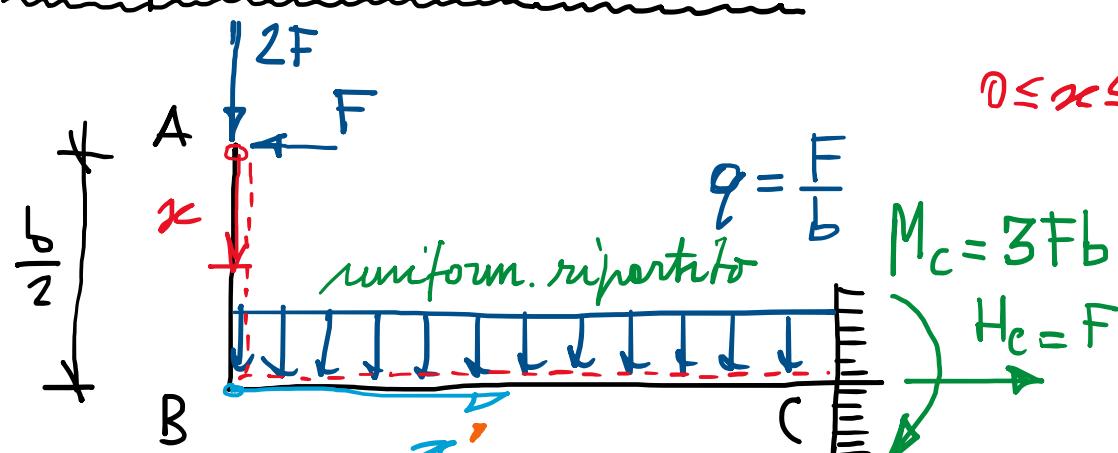
$$\begin{cases} N(s): \text{azione assiale o normale} \\ T(s): \text{tagliante o taglio} \\ M(s): \text{"flettente o momento flettente"} \end{cases}$$

## Convenzione:

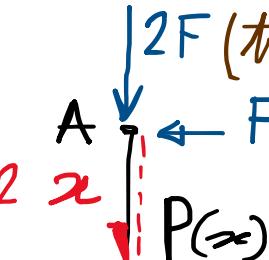
$$\begin{cases} N \text{ positiva se di trazione} \\ T \text{ positiva se "orario"} \\ M \text{ positivo se tende le fibre di riferimento} \end{cases}$$



Esempio (trave a mensola): (es. balcone)



$$0 \leq x \leq b/2$$



) Eq. m di equilibrio  
(riferimento locale)

$$\sum F_{x_i} = 0 \Rightarrow \sum F_{y_i} = 0$$

$$-N(x) - 2F = 0$$

$$\Rightarrow N(x) = -2F \text{ post. compression}$$

$$\sum F_{n_i} = 0 \Rightarrow \sum F_{x_i} = 0$$

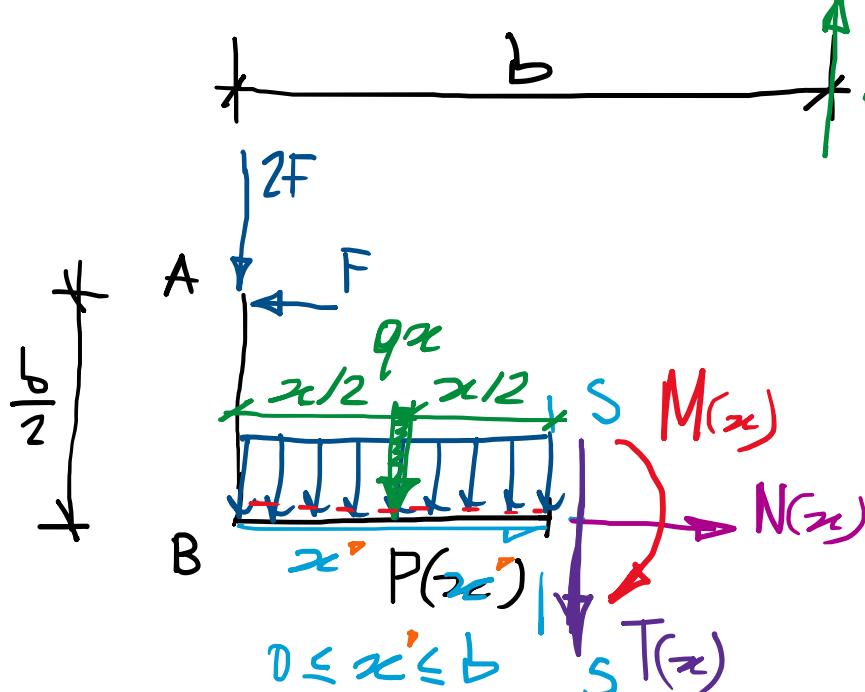
$$-T(x) - F = 0$$

$$\Rightarrow T(x) = -F \text{ const.}$$

$$\sum M_{P_i} = 0 \Rightarrow -M(x) + F_x = 0$$

→  $M(x) = \bigoplus F_x$  lineare antizom.

L'ipotesi delle fibre di riferimento



The diagram shows a beam element of length  $\Delta x$  with a center node at  $x^*$ . The beam has a constant cross-section. A green arrow labeled  $q_x$  indicates a uniformly distributed lateral load acting downwards. A red arrow labeled  $P(x_c)$  indicates an axial load acting to the right. A blue arrow labeled  $S$  indicates the shear force. A purple arrow labeled  $M(x)$  indicates the bending moment. A red curved arrow labeled  $N(x)$  indicates the axial force. A blue arrow labeled  $T(x)$  indicates the torsional moment. A red arrow labeled  $C$  indicates a constraint or reaction force.

Analogamente: (tutto BC)

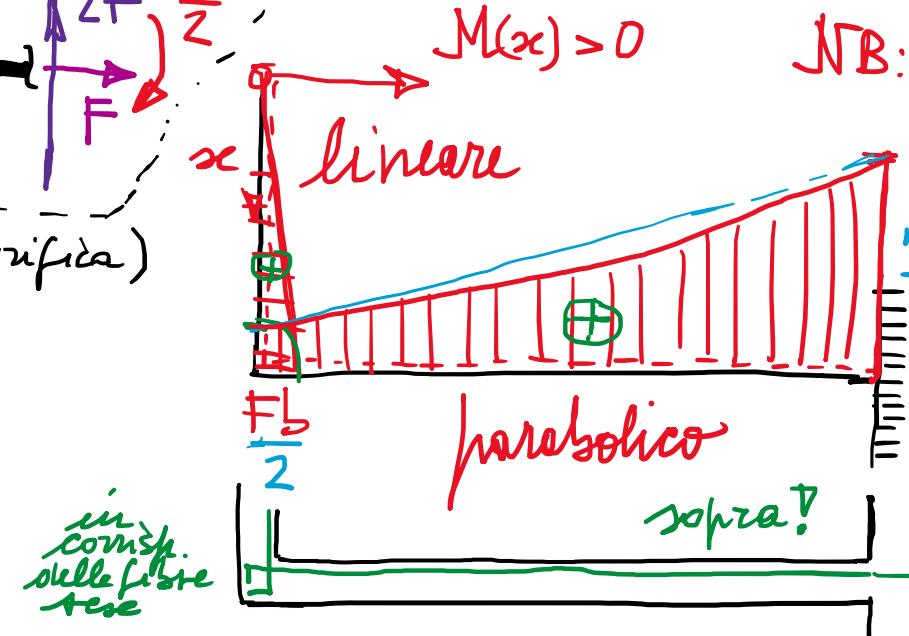
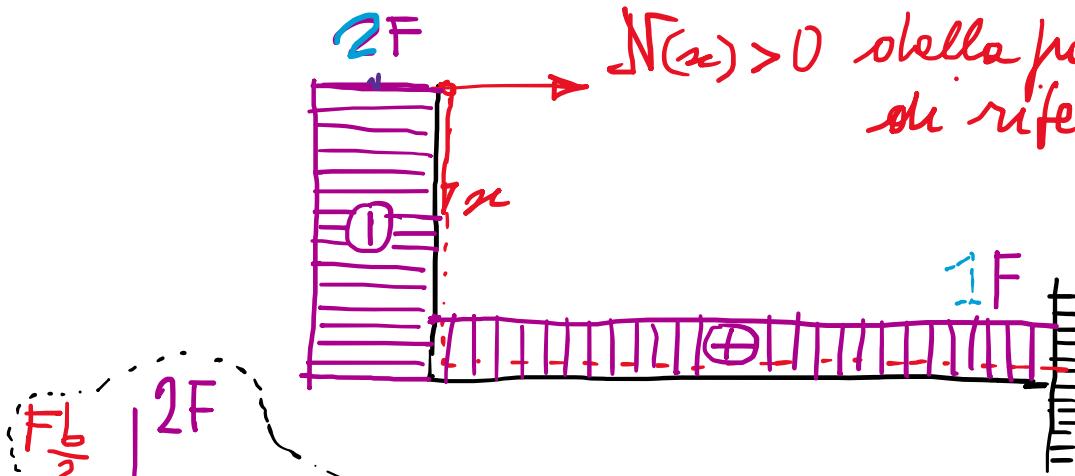
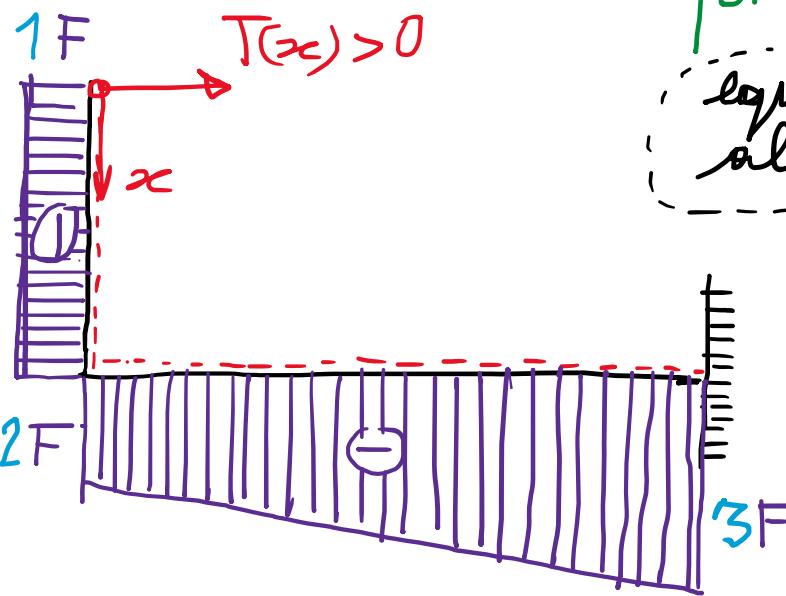
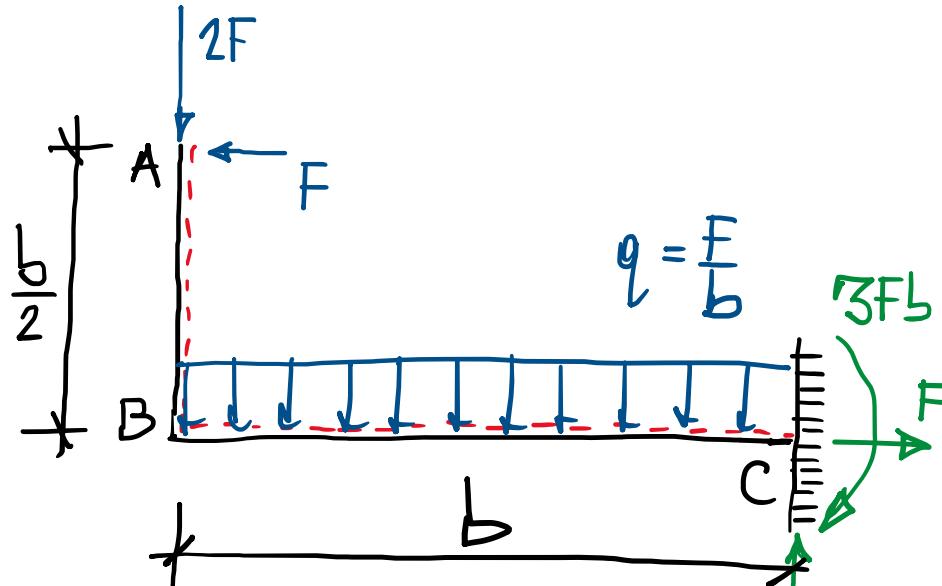
$$N(x) = +F \text{ cost. (frazione)}$$

$$T(x) = -\left(2F + \frac{F}{b}x\right) \text{ lineare (antizirkular)}$$

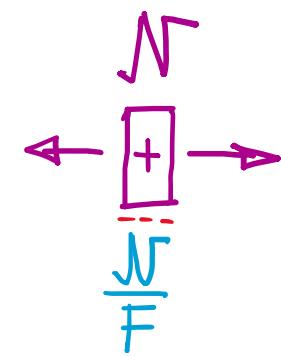
$M(x) = \frac{Fb}{2} + 2Fx + \frac{F}{2}x^2$  quadratico (parabolico) (tese le fibre sopra)

## Descrizione analitica delle funzioni di Azione Interna

Diagrammi di Azione Interna ( $N, T_g, M$ ): rappresentazione grafica delle AI utile ad individuare le sezioni caratteristiche con le sollecitazioni interne più significative



$N(x) > 0$  nella parte delle fibre di riferimento

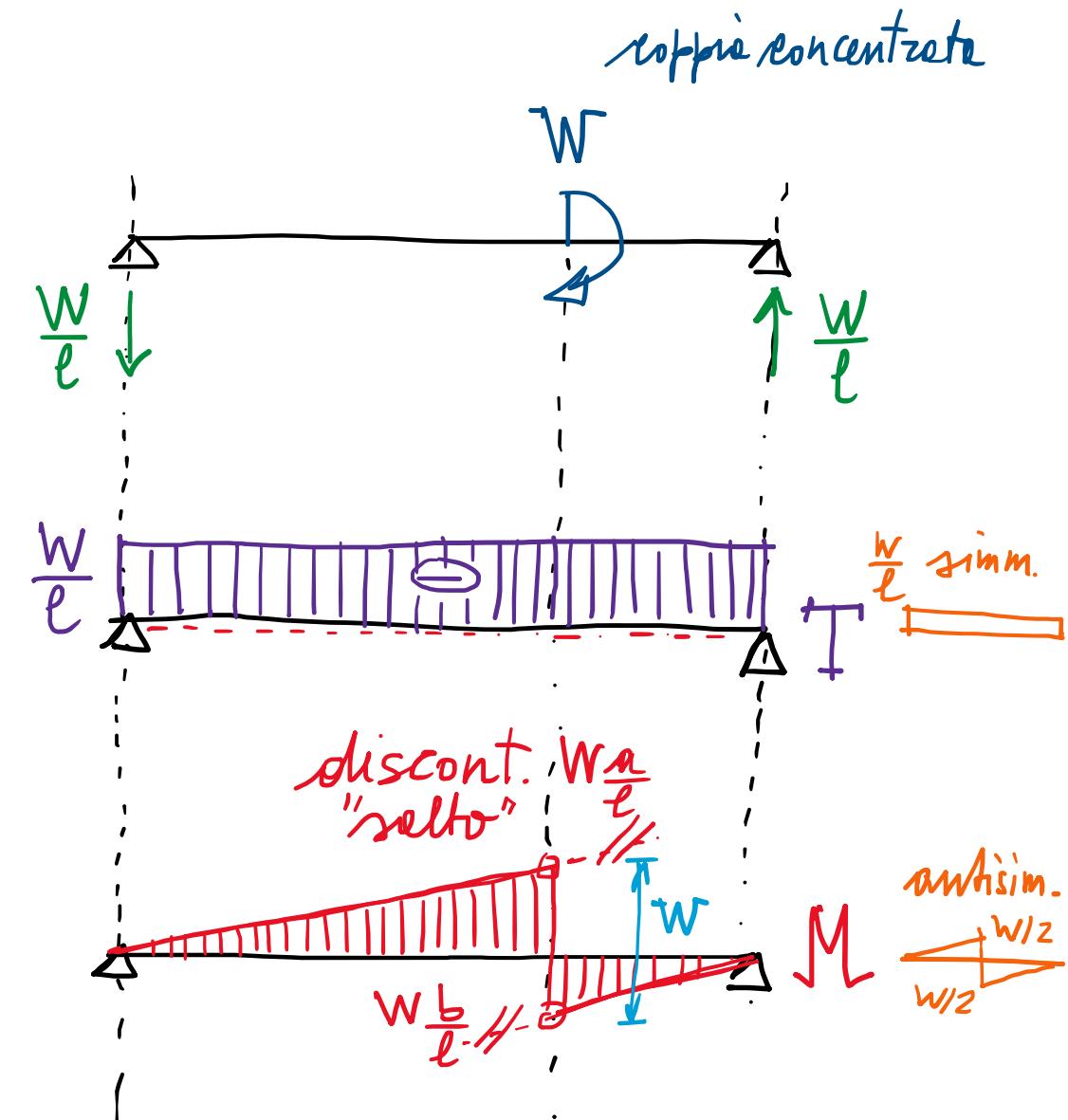
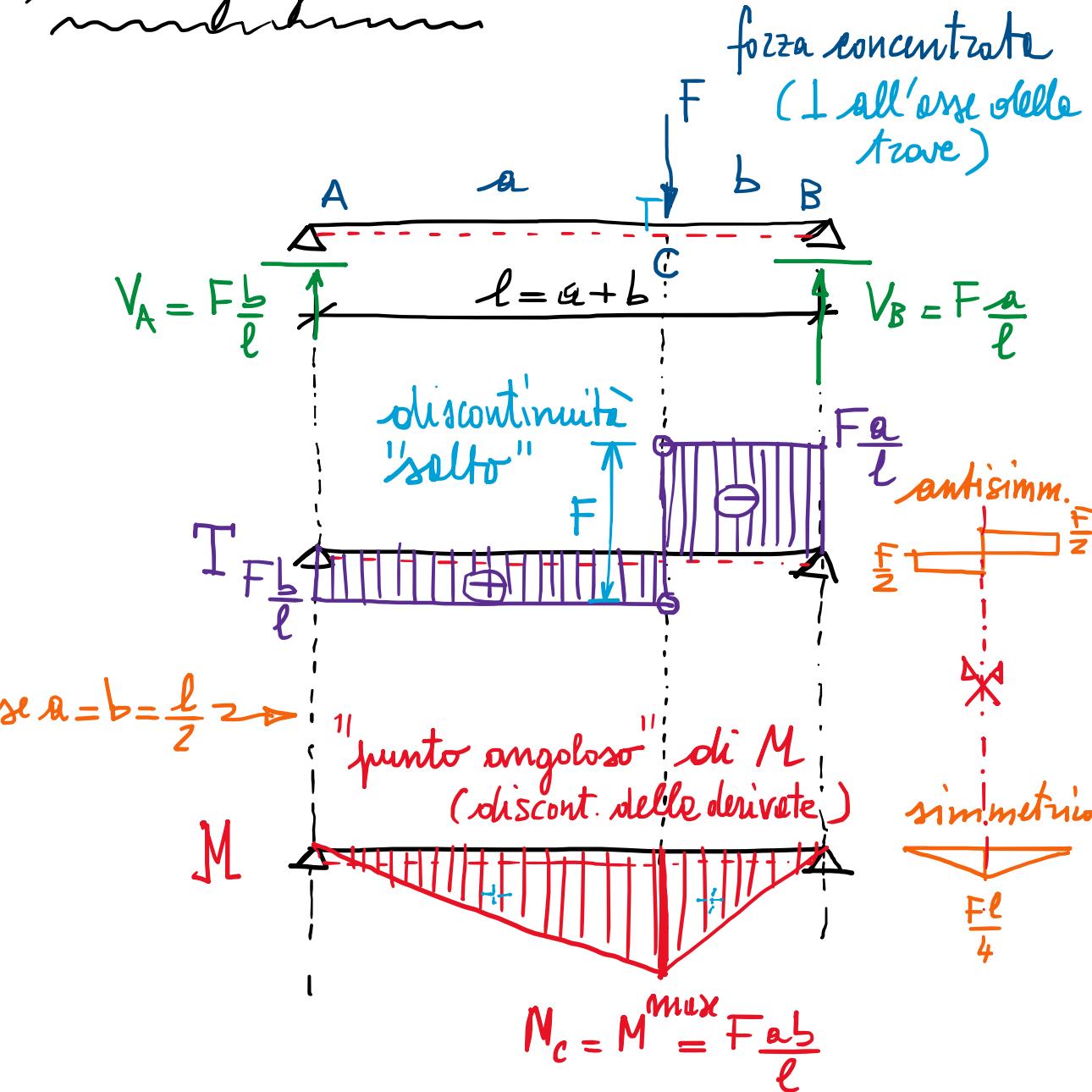


$N_B$ : disegno delle fibre delle fibre realmente tese

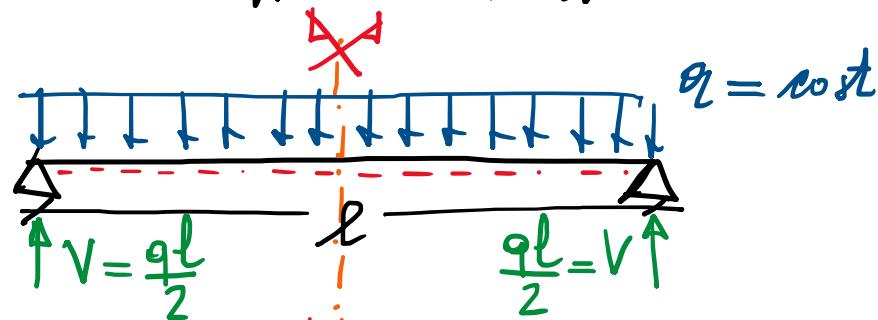


Sarre di armatura (Cemento Armato)

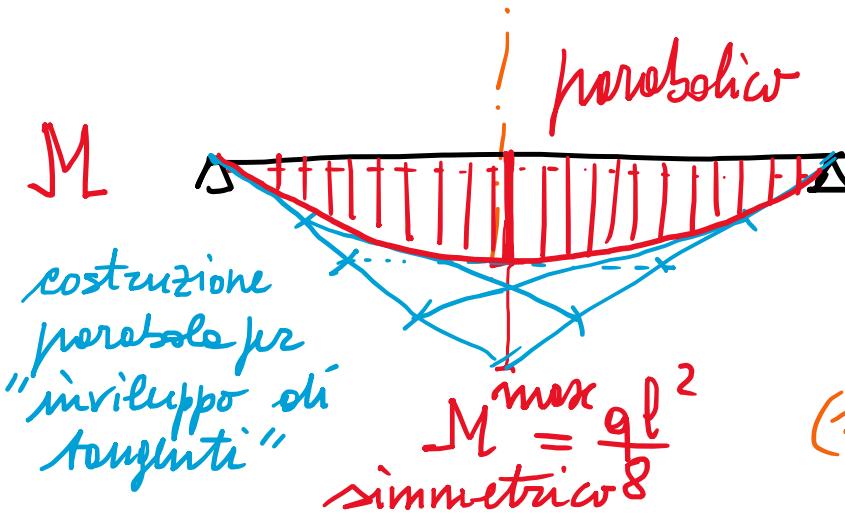
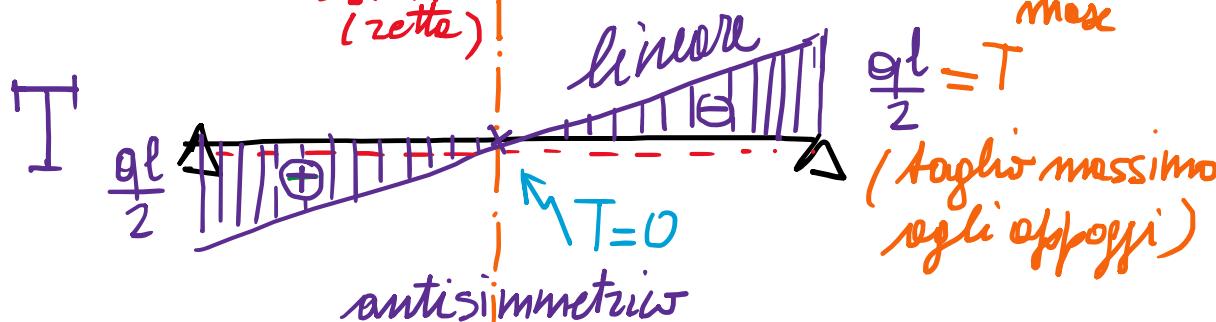
Casi significativi:



"trave appoggio-appoggio"

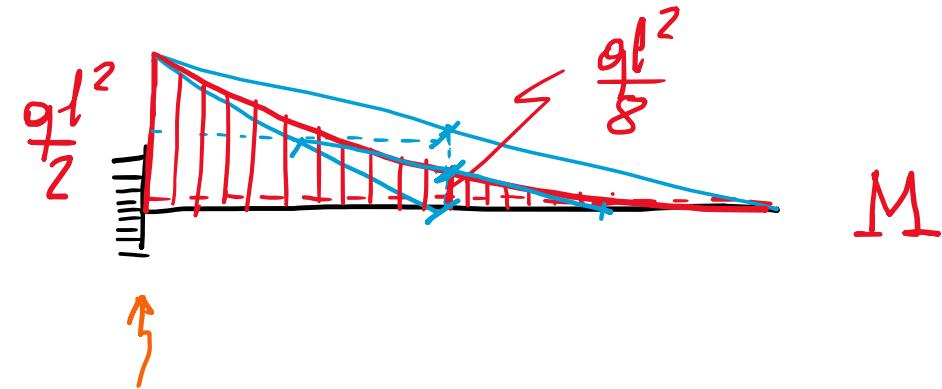
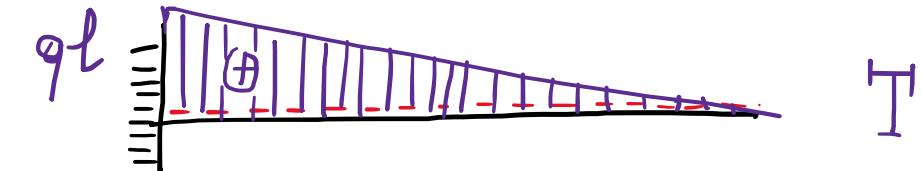
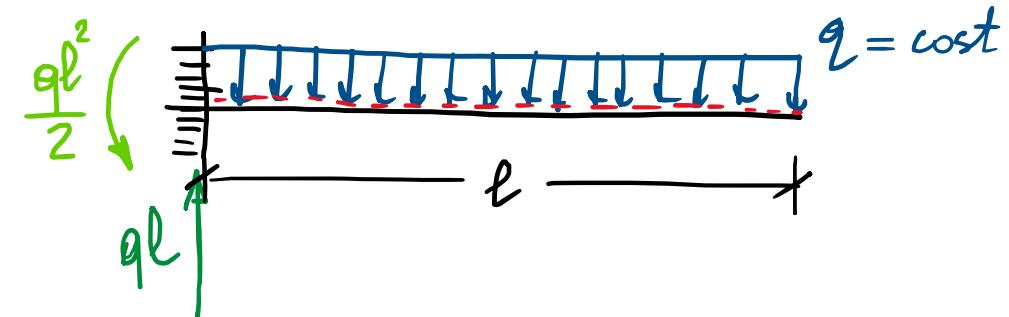


asse di simm.  
(rette)



$M_{\max} = \frac{ql^2}{8}$   
(momento massimo in mezzeria)

"trave a mensola"



NB: Sezione d'incastro più sollecitata  
e taglio e momento