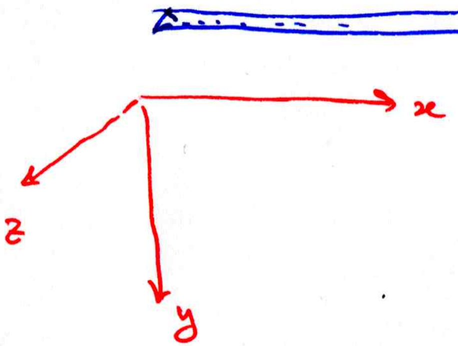
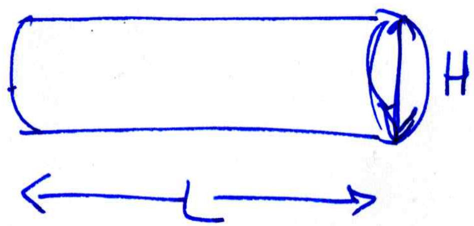
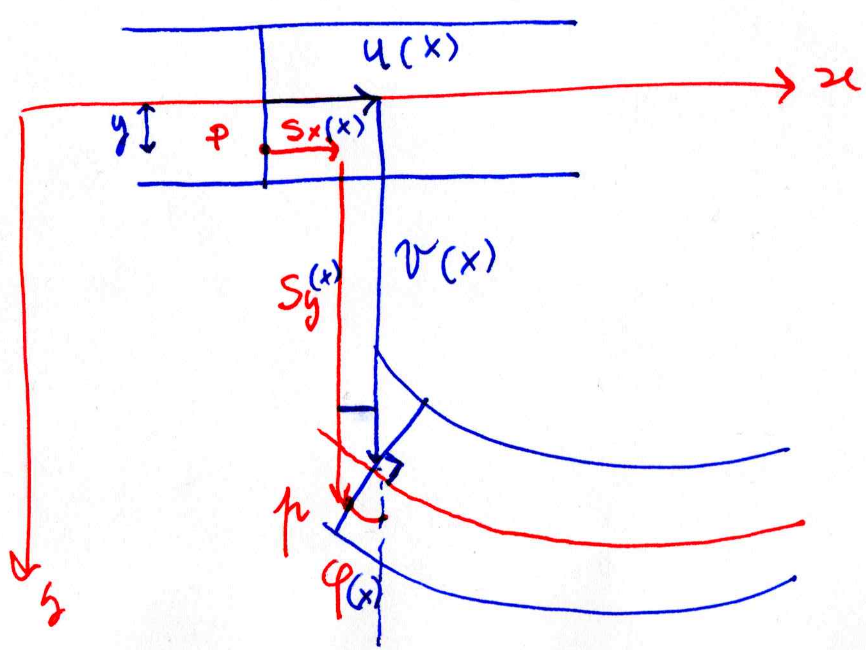




$$\sin\varphi \simeq tg\,\varphi \simeq \varphi$$

$$\cos\varphi \simeq 1$$



$$s_x(x,y) = s_x(x) = u(x) - y \sin\varphi$$

$$s_x = u(x) - y\,\varphi(x)$$

$$s_y = v(x)$$

$$\varphi(x) = \frac{d\,v(x)}{d\,x}$$

$$\begin{cases} s_x = u(x) - y\,\dfrac{d\,v(x)}{d\,x} \\ s_y = v(x) \end{cases}$$

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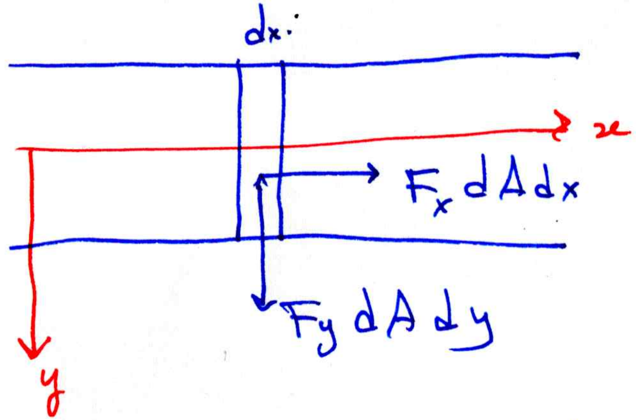
PLV

$$\mathcal{L}_e = \mathcal{L}_i$$



$$dV = dA\, dx$$

$$\mathcal{L}_e = \int_{\Delta V} F_j\, \delta \hat{s}_j\, dV + \int_{\Delta S} f_j\, \delta \hat{s}_j\, dS$$

$$\frac{d\mathcal{L}_e}{dx} = \int_A F_x\, \delta \hat{s}_x\, dA + \int_A F_y\, \delta \hat{s}_y\, dA$$

$$\mathcal{L}_i = \int_{\Delta V} \sigma_{ij}\, \delta \hat{\varepsilon}_{ij}\, dV$$

$$s_x = u(x) - y\,\frac{dv(x)}{dx}$$

$$s_y = v(x)$$

$$\frac{d\mathcal{L}_e}{dx} = \int_A F_x \left(\delta u(x) - y\, \delta \frac{dv(x)}{dx}\right) dA + \int_A F_y\, \delta v(x)\, dA$$

$$v'(x) = \frac{dv(x)}{dx}$$

$$= \delta u \underbrace{\int_A F_x\, dA}_{n(x)} - \delta v' \underbrace{\int_A y F_x\, dA}_{m(x)} + \delta v \underbrace{\int_A F_y\, dA}_{p(x)}$$

$$= \delta u\, n(x) + \delta v\, p(x)$$

$\rightarrow m(x) = 0$ se F_x è simmetrico rispetto ex

$$\frac{d\mathcal{L}_i}{dx} = \int_A \sigma_{ij}\,\delta\hat{\varepsilon}_{ij}\,dA = \int_A (\sigma_x\,\delta\hat{\varepsilon}_x + \sigma_y\,\delta\hat{\varepsilon}_y + \tau_{xy}\,\delta\hat{\gamma}_{xy})\,dA = \int_A \sigma_x\,\delta\hat{\varepsilon}_x\,dA$$

$\varepsilon_y = 0 \qquad \gamma_{xy} = 0$

$$\varepsilon_x = \eta(x) + y\chi(x)$$

$$\frac{d\mathcal{L}_i}{dx} = \int_A \sigma_x\,\delta\hat{\eta}(x)\,dA + \int_A y\,\sigma_x\,\delta\hat{\chi}(x)\,dA =$$

$$= \delta\hat{\eta}\underbrace{\int_A \sigma_x\,dA}_{N(x)} + \delta\hat{\chi}\underbrace{\int_A y\,\sigma_x\,dA}_{M(x)}$$

$$\eta(x) = \frac{du}{dx} = u'$$

$$\chi(x) = -\frac{d^2v}{dx^2} = -v''$$

$$\mathcal{L}_i = \mathcal{L}_e$$

$$\int_0^L \{N(x)\,\delta u' - M(x)\,\delta v''\}\,dx = \int_0^L \{n(x)\,\delta u + p(x)\,\delta v\}\,dx +$$
$$+ H_0\,\delta u(0) + V_0\,\delta v(0) + W_0\,\delta v'(0) + H_L\,\delta u(L) + V_L\,\delta v(L) + W_L\,\delta v'(L)$$

$$D\left(f(x)\,g(x)\right) = f'(x)\,g(x) + f(x)\,g'(x)$$

$$\int_a^b f'(x)\,g(x)\,dx = \int_a^b D\left(f(x)\,g(x)\right)dx - \int_a^b f(x)\,g'(x)\,dx$$

$$\int_a^b f'(x)\,g(x)\,dx = f(x)\,g(x)\Big|_a^b - \int_a^b f(x)\,g'(x)\,dx$$

$$\int_0^L N(x)\,\delta u'(x)\,dx = N(x)\,\delta u(x)\Big|_0^L - \int_0^L N'(x)\,\delta u(x)\,dx$$

$$\int_0^L - M(x)\,\delta v''(x)\,dx = -M(x)\,\delta v'(x)\Big|_0^L + \int_0^L M'(x)\,\delta v'(x)\,dx$$

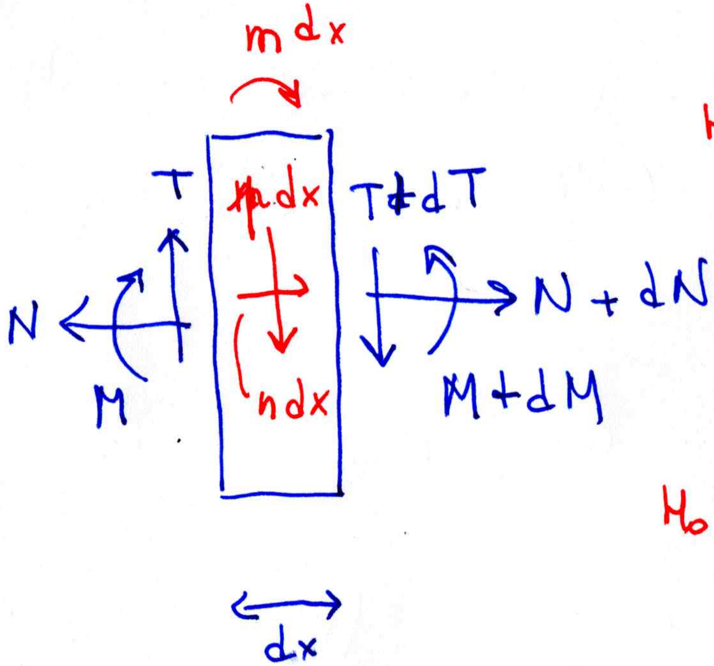
$$= -M(x)\,\delta v'(x)\Big|_0^L + M'(x)\,\delta v(x)\Big|_0^L - \int_0^L M''(x)\,\delta v(x)\,dx$$

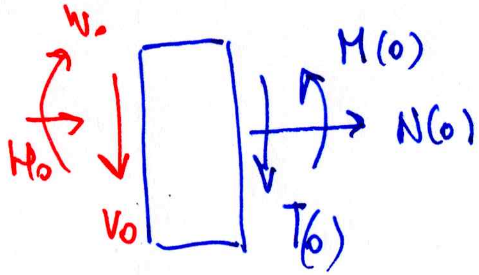
$$N(L)\,\delta u(L) - N(0)\,\delta u(0) - \int_0^L N'(x)\,\delta u(x)\,dx - M(L)\,\delta v'(L) + M(0)\,\delta v'(0) +$$
$$+ M'(L)\,\delta v(L) - M'(0)\,\delta v(0) - \int_0^L M''(x)\,\delta v(x)\,dx$$

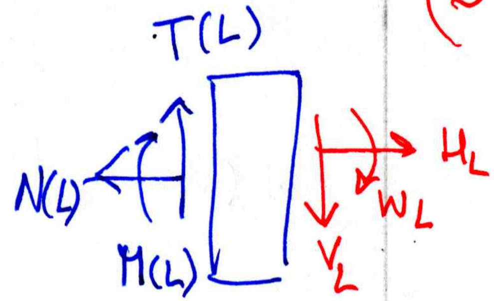
$$\int_0^L \left\{ -\left[N'(x) + n(x)\right]\delta u(x) - \left[M''(x) + p(x)\right]\delta v(x) \right\} dx =$$
$$= \left(H_0 + N(0)\right)\delta u(0) + \left(H_L - N(L)\right)\delta u(L) + \left(V_0 + M'(0)\right)\delta v(0) + \left(V_L - M'(L)\right)\delta v(L) +$$
$$+ \left(-M(0) + W_0\right)\delta v'(0) + \left(M(L) + W_L\right)\delta v'(L)$$

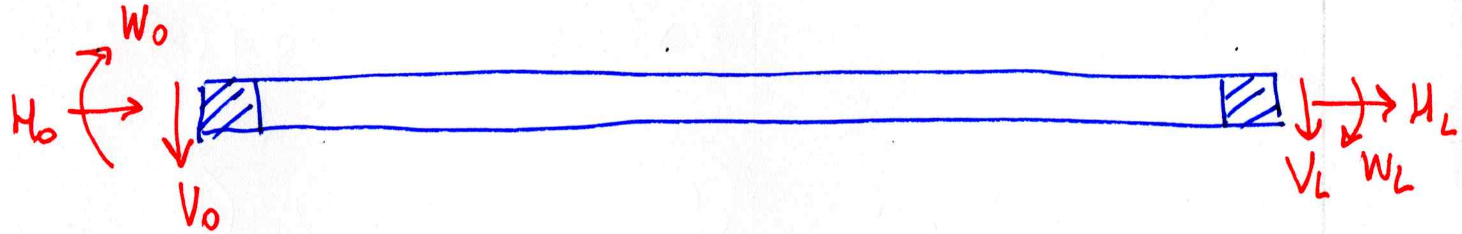
$$N'(x) + n(x) = 0$$
$$M''(x) + p(x) = 0$$

	oppure
$\delta u(0) = 0$	$N(0) = -H_0$
$\delta u(L) = 0$	$N(L) = H_L$
$\delta v(0) = 0$	$M'(0) = -V_0$
$\delta v(L) = 0$	$M'(L) = V_L$
$\delta v'(0) = 0$	$M(0) = W_0$
$\delta v'(L) = 0$	$M(L) = -W_L$









$$N'(x) + n(x) = 0$$

$$M''(x) + p(x) = 0$$

$$T = M'(x)$$

$$\eta(x) = \frac{du(x)}{dx} = u'(x)$$

$$\chi(x) = -\frac{d^2 v(x)}{dx^2} = -v''(x)$$

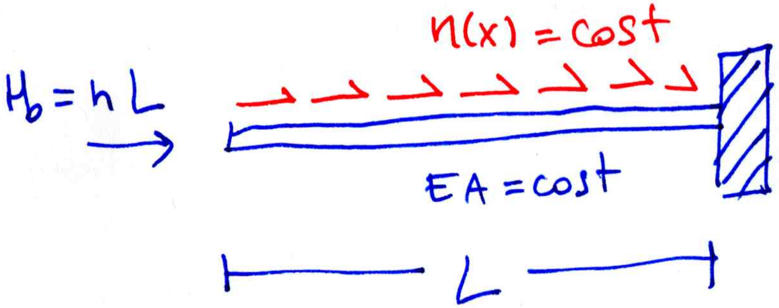
$$N(x) = EA\eta(x) = EA\,u'(x)$$

$$M(x) = EJ\chi(x) = -EJ\,v''(x)$$

$$[EA\,u'(x)]' + n(x) = 0 \qquad [-EJ\,v''(x)]'' + p(x) = 0$$

$$u''(x) = -\frac{n(x)}{EA} \qquad v^{IV}(x) = \frac{p(x)}{EJ}$$

ESERCIZIO 1



ESERCIZIO 2