Dimostrazioni ed Esercizi Magnetoreologici

Corso Materiali intelligenti e Biomimetici
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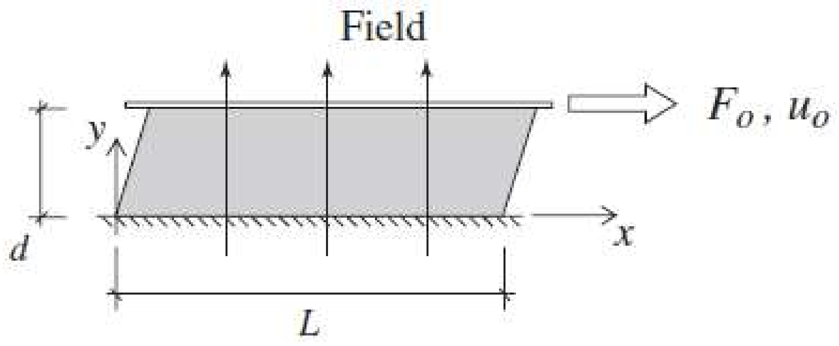
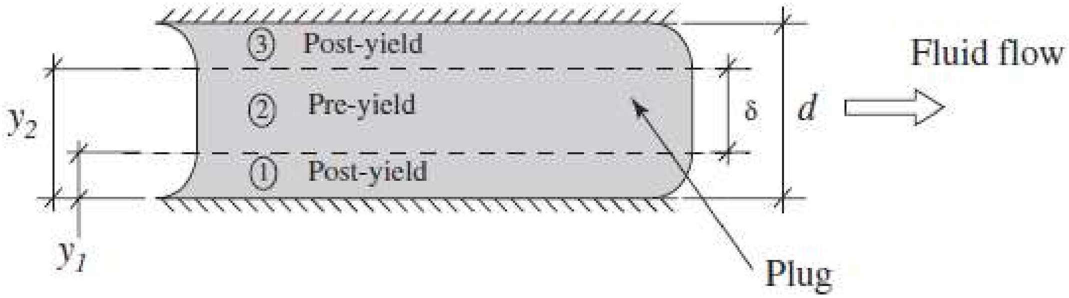
Calcolo coefficiente smorzamento

Shear-mode operation



Flow-mode operation



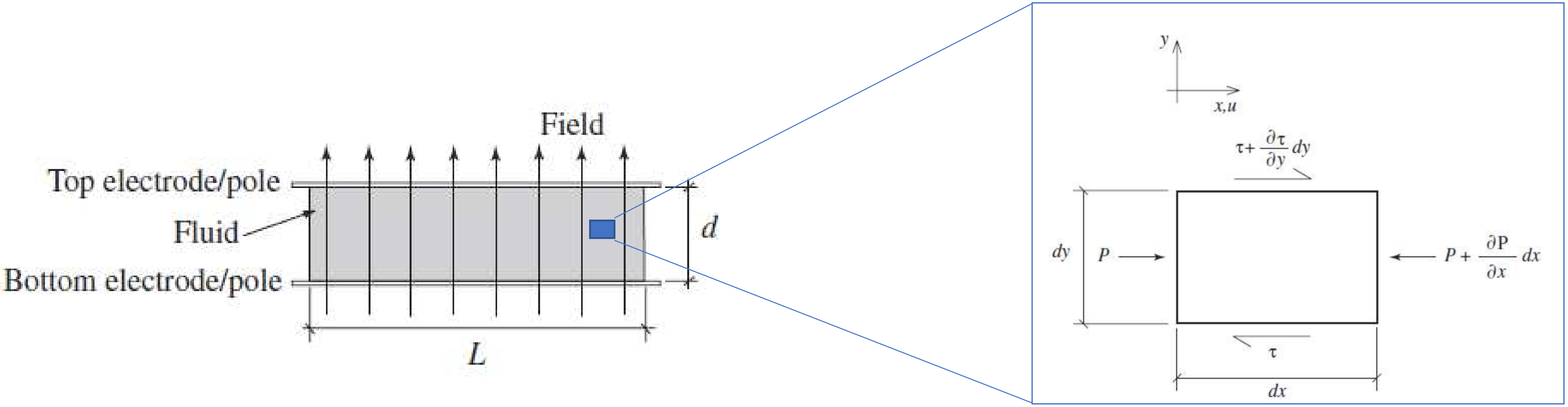
$c = c_0(1+Bi)$

$c_{0\_SM} = \mu\alpha$

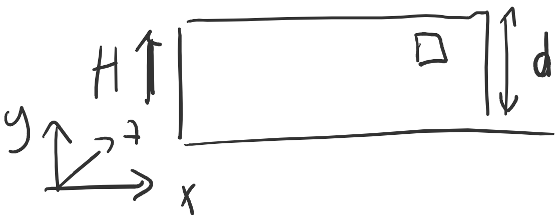
$c = c_0 \frac{Bi}{6\bar{\bar{\delta}}}$

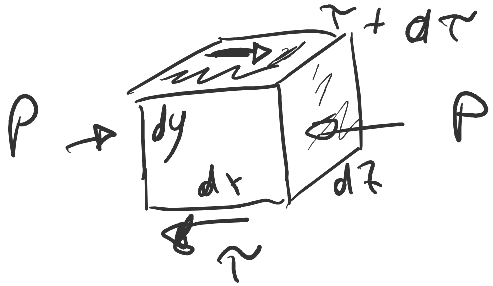
$c_{0\_FM} = 12\mu\alpha$

Rectangular Flow Passage:



$$-m\ddot{x} + P\,dy\,b - \tau\,dx\,b - \left(P + \frac{\partial P}{\partial x}dx\right)dy\,b + \left(\tau + \frac{\partial \tau}{\partial y}dy\right)dx\,b = 0 \quad \Rightarrow \quad \frac{\partial \tau}{\partial y} = \frac{\partial P}{\partial x}$$





$\Sigma F_x = ma = m\ddot{x}$

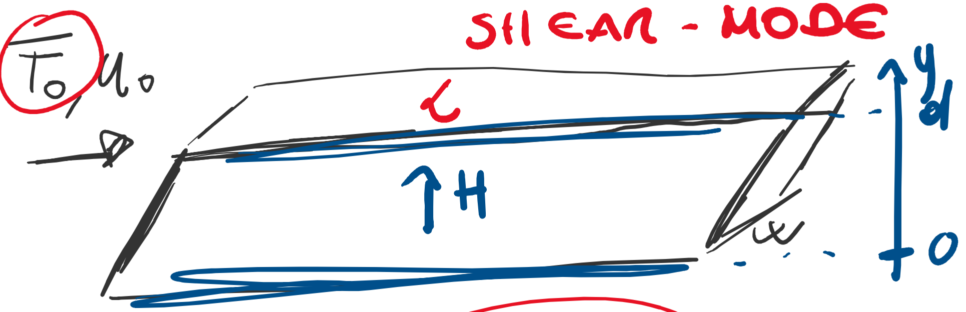
$-m\ddot{x} + P\,dy\,dz - \tau\,dx\,dz \quad (P + dP)\,dy\,dz) + (\tau + d\tau)\,dx\,dz = 0$

$\rho\,dx\,dy\,dz$

$$-\rho \frac{d^2x}{dt^2} - \frac{dP}{dx} + \frac{d\tau}{dy} = 0 \Rightarrow \boxed{\frac{d\tau}{dy} = \frac{dP}{dx}}$$

SHEAR - MODE

$dP/dx = 0$



$$\frac{d\tau}{dy} = 0$$

$H \to 0$

$$\tau = \mu \frac{du}{dy}$$

$$\frac{d\tau}{dy} = \mu \frac{d^2u}{dy^2} \rightarrow u(y) = Ay + B$$

c.c. $\begin{cases} y=0 & u(0)=0 \\ y=d & u(d)=u_0 \end{cases} \rightarrow \begin{matrix} B = 0 \\ A = u_0/d \end{matrix} \Rightarrow \boxed{u(y) = \frac{u_0}{d} y}$

$$\tau = \mu \frac{u_0}{d}$$

$$F_0 = \tau(d) A = \mu \frac{u_0}{d} Lw \longleftrightarrow F_{smorz.} = c\, u_0$$

$$c = \mu \frac{Lw}{d}$$

(A)

$H \neq 0 \qquad \tau(y) = \tau_c + \mu \frac{du}{dy} = \tau_c + \mu \frac{u_0}{d}$

$F_0 = \left(\tau_c + \mu \frac{u_0}{d}\right) \alpha x \cdot \frac{\mu u_0 / d}{\mu u_0 / d}$

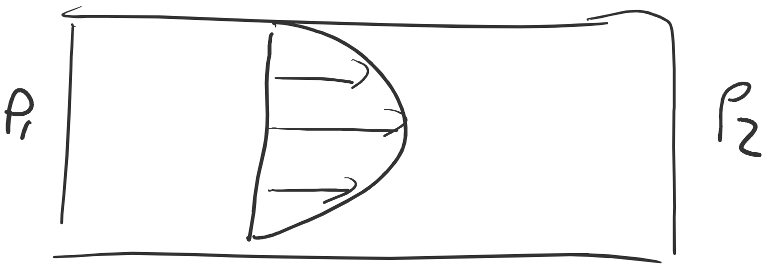
$\left(\frac{\tau_c d}{\mu u_0} + 1\right) \frac{\alpha x}{d} \mu u_0 \longleftrightarrow c u_0$

$\frac{\tau_c}{\tau_v} = Bi$

$c = \mu \alpha (1 + Bi)$

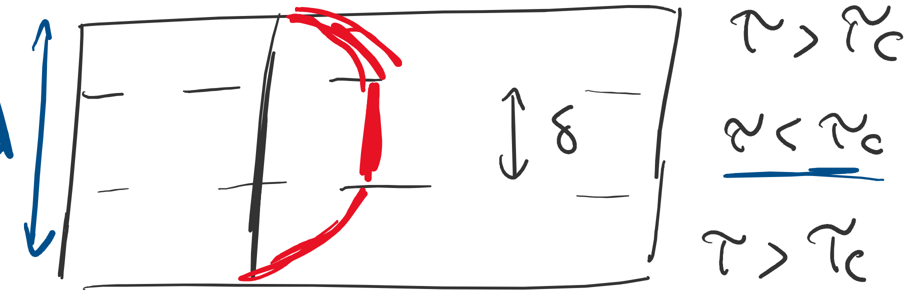
c_0

FLOW - MODE



$dP/dx \neq 0$

$H = 0$



$H \neq 0$

$$C = \underbrace{12 \mu \alpha}_{C_0} \, \frac{Bl}{6 \bar{\delta}}$$

$$\bar{\delta} = \frac{\delta}{d}$$

Esercizi

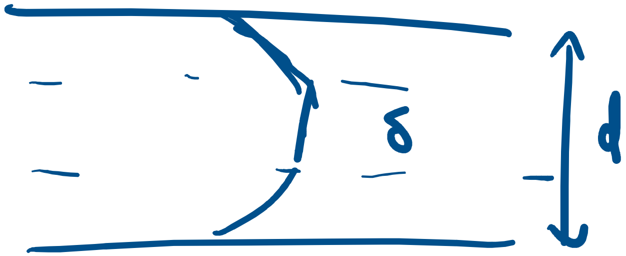
1. Dimensionare spessore (w) smorzatore shear-mode per sostenere F= 100 N @ u=1 m/s note μ=1000 Pa*s, Bi=9, l=100 mm, d=10 mm)
2. Calcolare la F che uno smorzatore flow-mode è in grado di sostenere (d=10 mm, δ= 5 mm, u=1 m/s, c_0= 100 Ns/m, Bi=9)

$$F = cu = \mu\alpha(1+3 \cdot 3)u$$

$$= 1000 \frac{N}{m^2} s \cdot \alpha [m] (1+9) \cdot 1 \frac{m}{s} = 10000\alpha \; [N]$$

$$\alpha = \frac{Lw}{d} = \frac{F}{10.000} = \frac{100N}{10.000} = 10^{-2}$$

$$w = 10^{-2}\frac{d}{L} = 10^{-2} [m] \cdot \frac{10 \times 10^{-3} [m]}{100 \times 10^{-3} [m]} = 10^{-3} \; m \rightarrow 1mm$$



$$\bar{\delta} = \frac{\delta}{d} = \frac{5\,mm}{10\,mm} = \frac{1}{2}$$

$$c = c_0 \frac{Bl}{6\bar{\delta}} = 100\,\frac{Ns}{m} \cdot \frac{9}{6 \cdot 0.5}$$

$$= 300\,\frac{Ns}{m}$$

$$F = cu = 300\,\frac{Ns}{m} \cdot 1\,\frac{m}{s} = 300N$$