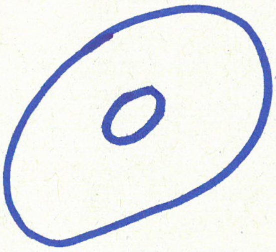
ρ

$F(\rho, p, T) = 0$ gen

$G(\rho, p) = 0$ bar

$\rho = \text{cost}$



$$\rho \bar{f} - \nabla p = 0$$

$$\bar{f} = \nabla \phi \qquad \bar{f} \text{ cons.}$$

---

① $\bar{f} \to 0$ (GAS)

$$p = \text{cost}$$

---

② $\rho = \rho(p)$ <u>BAROTR.</u>

$$\phi = -gz + \text{cost}$$

$$h = z + \int \frac{dp}{\rho g} = \text{cost}$$

③ FL. INCOMPR.

$\rho = \text{cost}$ $\qquad \gamma = \rho g$

$$h = z + \frac{p}{\gamma} = \text{cost}$$

IL CARICO PIEZOMETRICO IN UN FLUIDO INCOMPRIM. NEL CAMPO GRAV.

È COSTANTE

$$z + \int \frac{dp}{\rho g} = \text{cost}$$

$0 \quad p_0 \quad p \qquad p(z_0) = p_0$

$$\int_{p_0}^{p} \frac{dp}{\underset{\uparrow \rho(p)}{\rho}\, g} = -(z - z_0)$$

$$\frac{p}{\rho} = RT \qquad \text{EQ.NE di STATO}$$

$T = \text{cost.}$

$$\rho(p_0) = \rho_0 \qquad \frac{p_0}{\rho_0} = RT$$

$$\overset{\shortparallel}{T_0}$$

$$\boxed{\rho = \rho_0 \, p/p_0} \qquad \rho = \rho(p)$$

$$\frac{dp}{p}$$

$$\int_{p_0}^{p} \frac{dp}{\rho_0 \, p/p_0 \, g} \qquad \ln p - \ln p_0 = \ln (p/p_0)$$

$$\frac{p_0}{\rho_0 g} \ln (p/p_0) = -(z - z_0)$$

$$* \quad \frac{p}{p_0} = \exp\left\{ - \frac{\rho_0 g}{p_0} (z - z_0) \right\}$$

γ_0

$$e^{-x} \simeq 1 - x + \frac{x^2}{2} + o(x^2)$$

$z \to z_0$

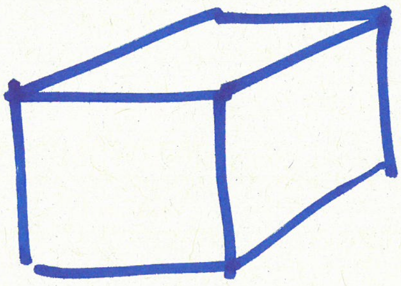
$$\frac{p}{p_0} = 1 - \frac{\gamma_0}{p_0}(z-z_0) + \left[\left(\frac{\gamma_0}{p_0}\right)(z-z_0)\right]^2 \cdot \frac{1}{2} + \dots$$

$$\frac{p}{p_0} = 1$$

se $|z-z_0| \leq 70\,m$

err $< 1\%$

$$\boxed{p = p_0 = cost}$$



$$\vec{f} = 0$$

se $|z-z_0| \in [70\,m;\ 1000\,m]$

$$\frac{p}{p_0} = 1 - \frac{\gamma_0}{p_0}(z-z_0)$$

$$\boxed{p = p_0 - \gamma_0 (z - z_0)} \qquad \gamma = \rho g$$

$$\gamma = \gamma_0 = \text{cost}$$

$$\rho = \rho_0 = \text{cost}$$

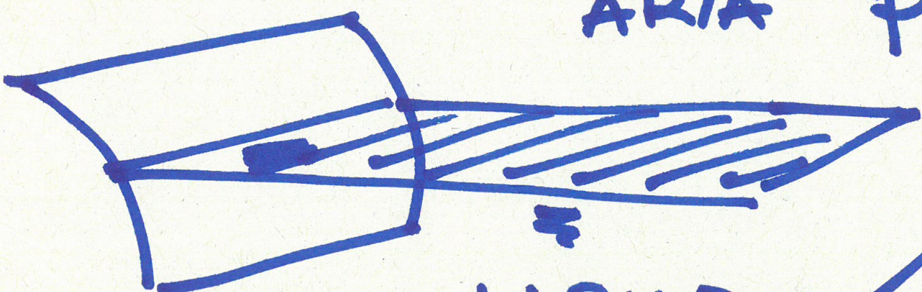
$$|z - z_0| > 1000$$

$\rightsquigarrow$ gas stratificato

( )

$$\frac{p}{\rho^k} = \text{cost}$$

ARIA $p = p_0 = \text{cost}$

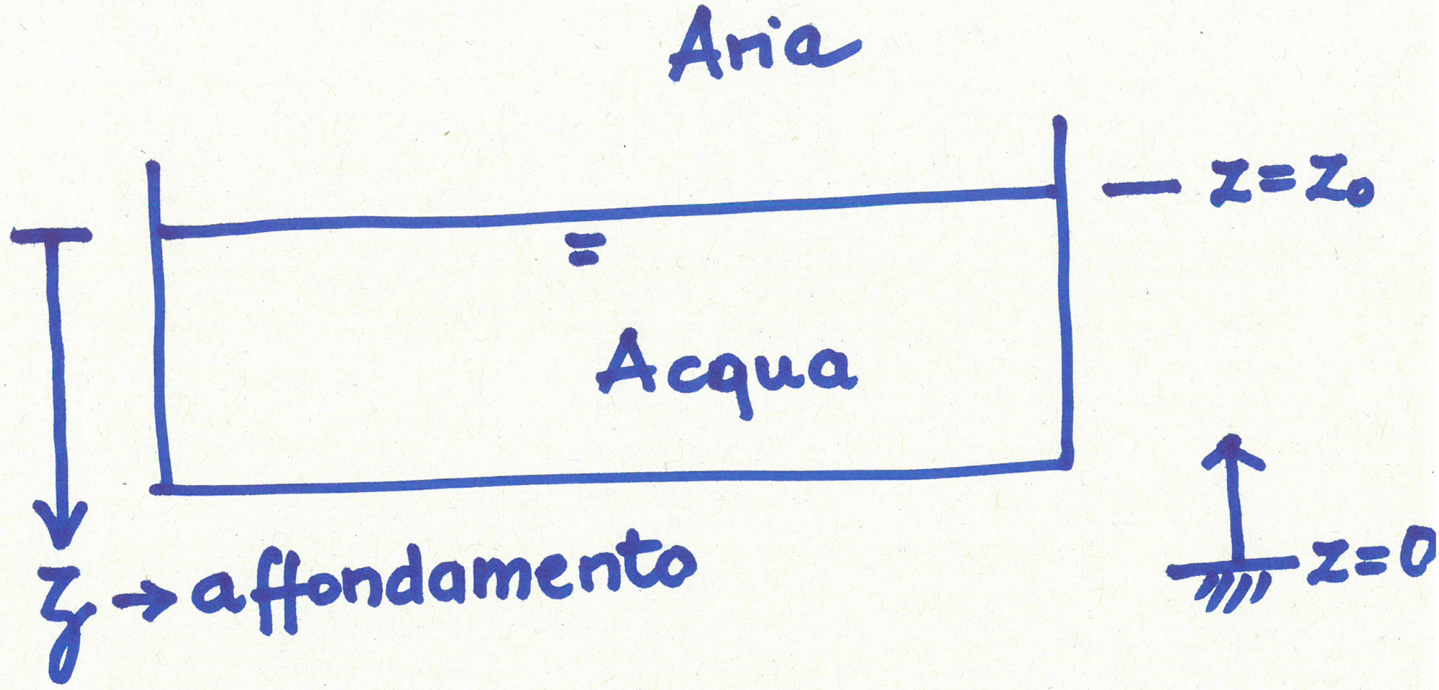


LIQUIDO — INCOMPR.

$\downarrow$ distr. della press. idrostatica

$$p - p_0 = -\gamma (z - z_0)$$

$$p = \text{cost}$$



$$p - p_0 = -\gamma (z - z_0)$$

$$p^*_{atm} = 1.01325 \text{ bar} = 1.013 \cdot 10^5 \text{ Pa}$$

$$\frac{1\,N}{m^2}$$

$$p_{rel} = p^* - p^*_{atm}$$

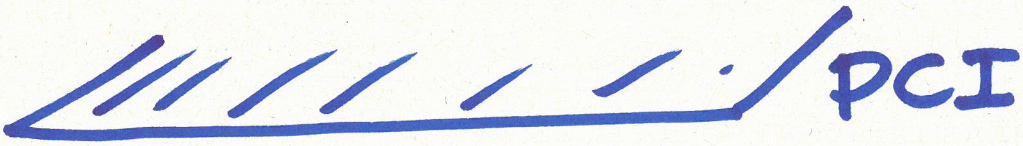
$$p$$

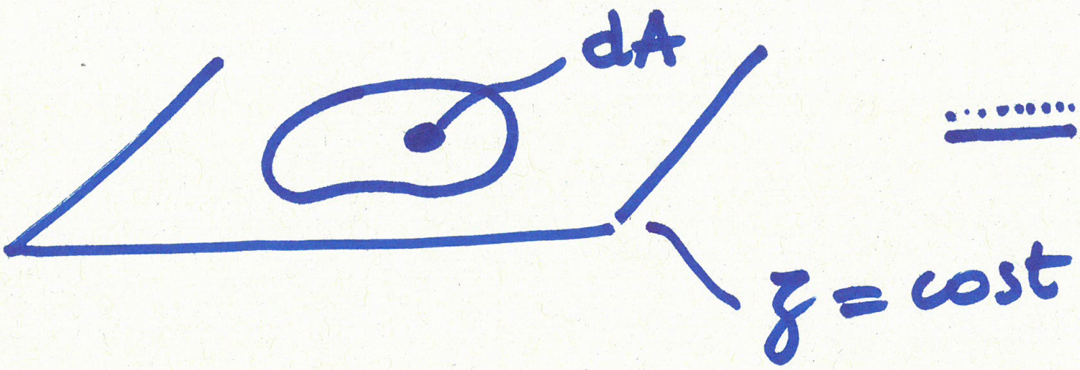
$$\boxed{p = \gamma \zeta}$$

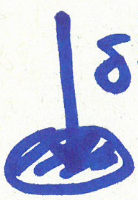
distr. idr.
di pressione
fl. inc. in quiete
nel campo gr.

$$\frac{p^*_{atm}}{\gamma} = 10{,}33\,m$$

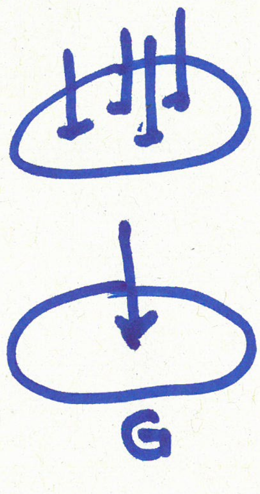
SPINTA IDROST. SU SUP. PIANE







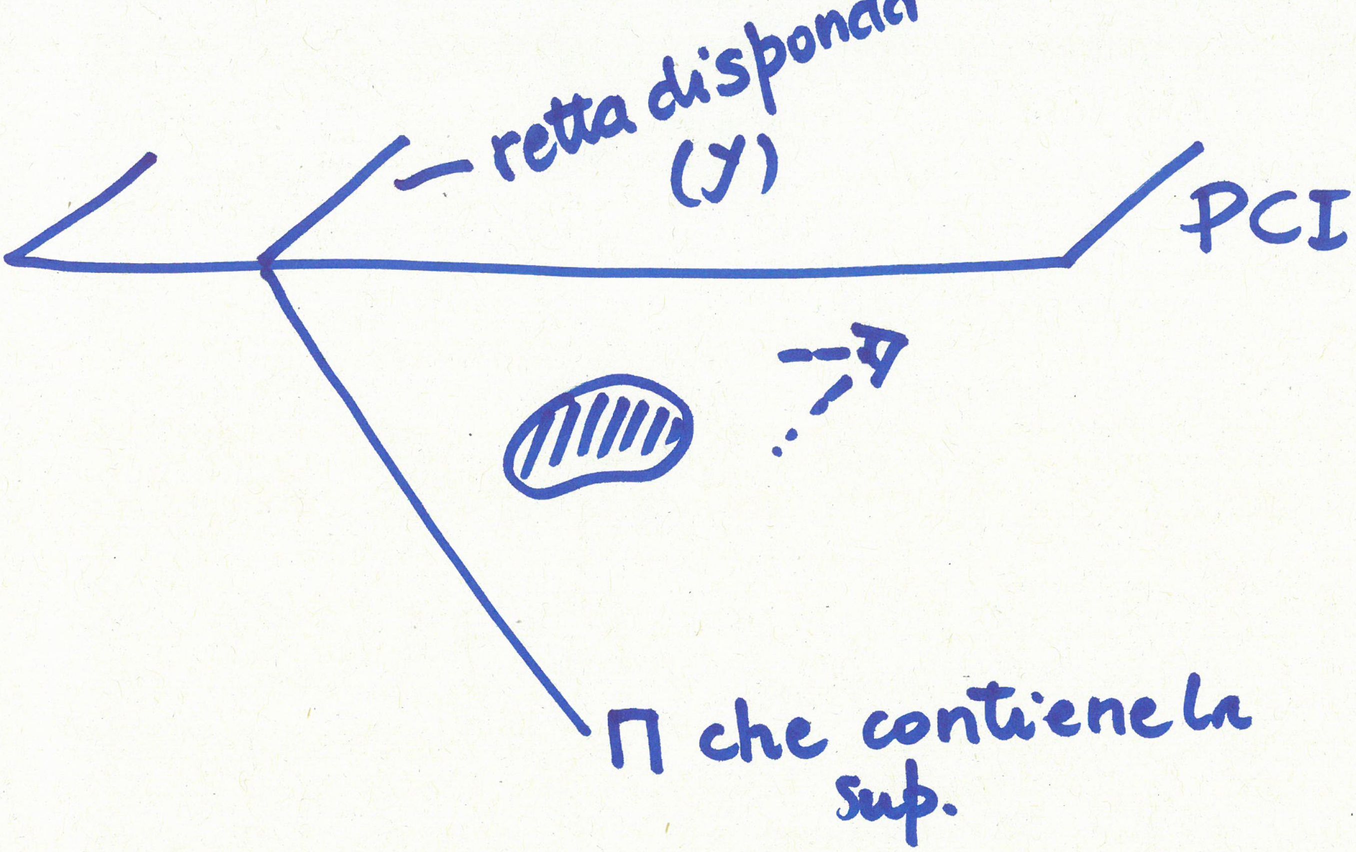
$$\delta\bar{F} = p\,\delta A\,\bar{n}$$

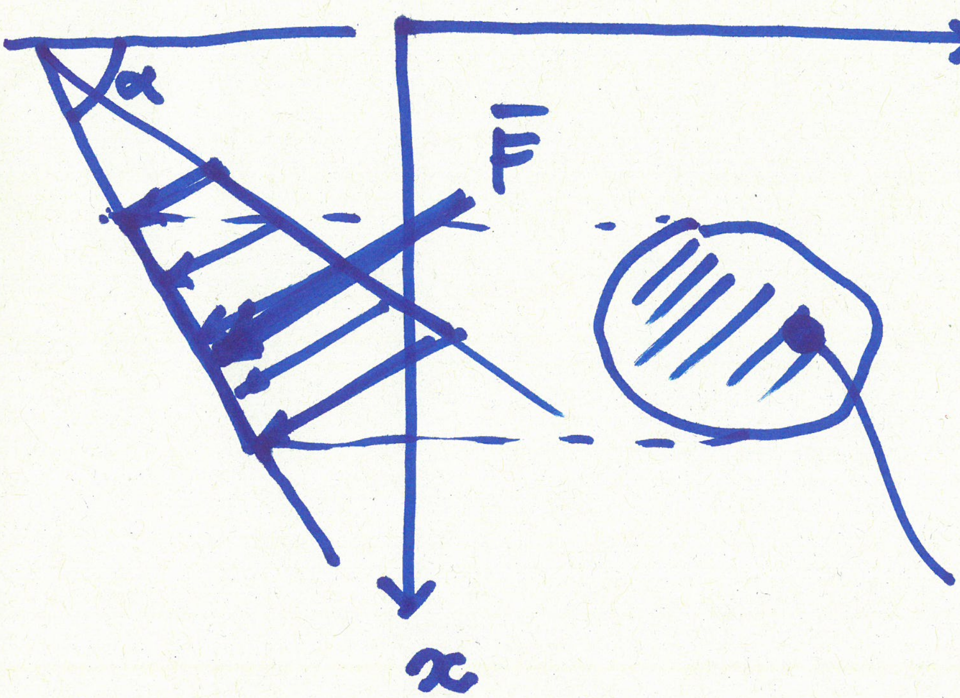


$$\bar{F} = F\,\bar{n}$$

retta di appl. per G

$$F = \int_A dF = \int_A \underbrace{p}_{\gamma z}\, dA = \underbrace{\gamma z_G}_{p_G} A$$



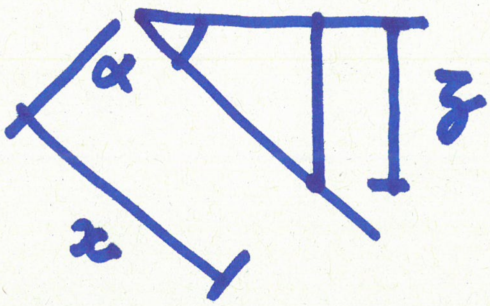


$$\bar{F} = F\bar{n}$$

$$dF = p\,dA$$
$$\downarrow$$
$$\gamma z$$

$x \subset \pi \quad x \perp y$

$$z = x \sin\alpha$$



$$dF = \gamma \zeta \, dA = \gamma x \sin\alpha \, dA$$

$$F = \int_A dF = \int_A \gamma x \sin\alpha \, dA$$

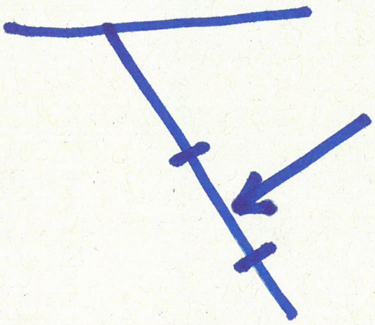
$$= \cancel{\int_A} \gamma \sin\alpha \underbrace{\int_A x \, dA}_{x_G A}$$

$$F = \gamma x_G \sin\alpha A = \gamma \zeta_G A$$

$$= p_G A$$

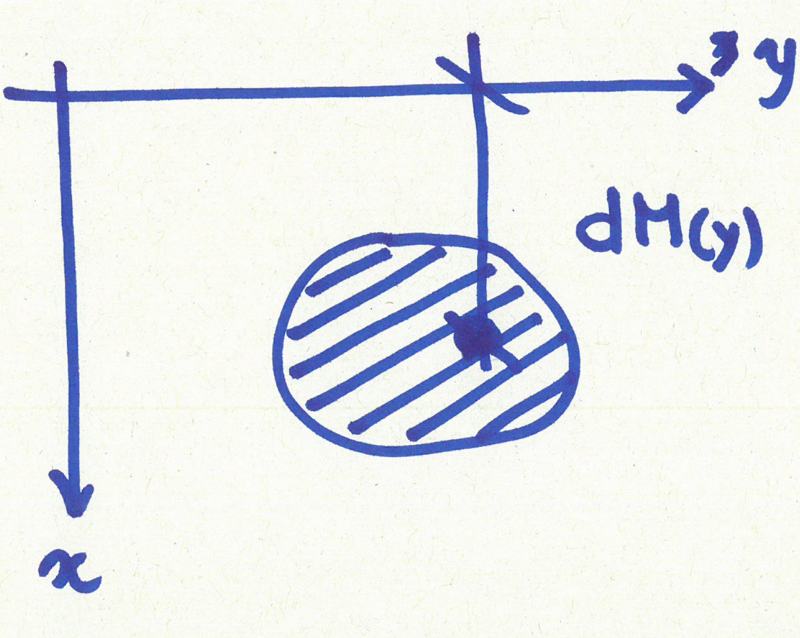
mod.

$$\boxed{S_y = x_G A}$$

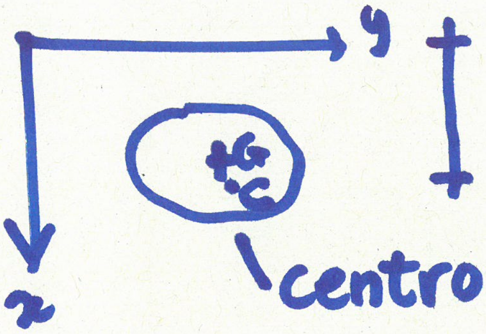


$\bar{F} = F \bar{n}$ verso contro

direz $\perp$



$$dM_y = dF \cdot x = \gamma x^2 \sin\alpha \, dA$$



$$F x_C$$

$$F x_C = \int_A \gamma x^2 \sin\alpha \, dA$$

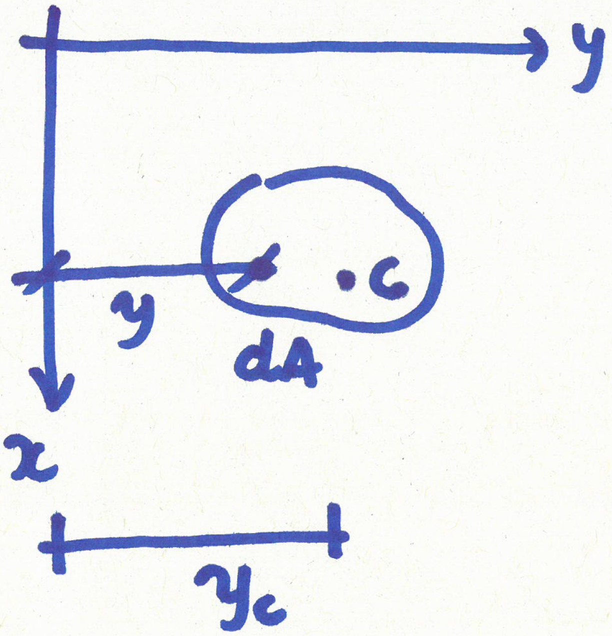
$$\gamma S_y x_C \sin\alpha = \gamma \sin\alpha \underbrace{\int_A x^2 \, dA}_{J_{yy}}$$

$$S_y = x_G A$$

$$x_G A \sin\alpha$$

$$\boxed{x_C = \frac{J_{yy}}{S_y}}$$

La retta d'azione passa per un punto la cui coordinata x_C è il rapporto tra mom. di inerzia e momento statico della fig. risp. all'asse y



$$F\, y_c$$

$$\underbrace{\gamma\, \xi\, dA}_{dF}\, y$$

$$F\, y_c = \int_A \gamma \underbrace{\xi}_{x \sin\alpha} dA\, y$$

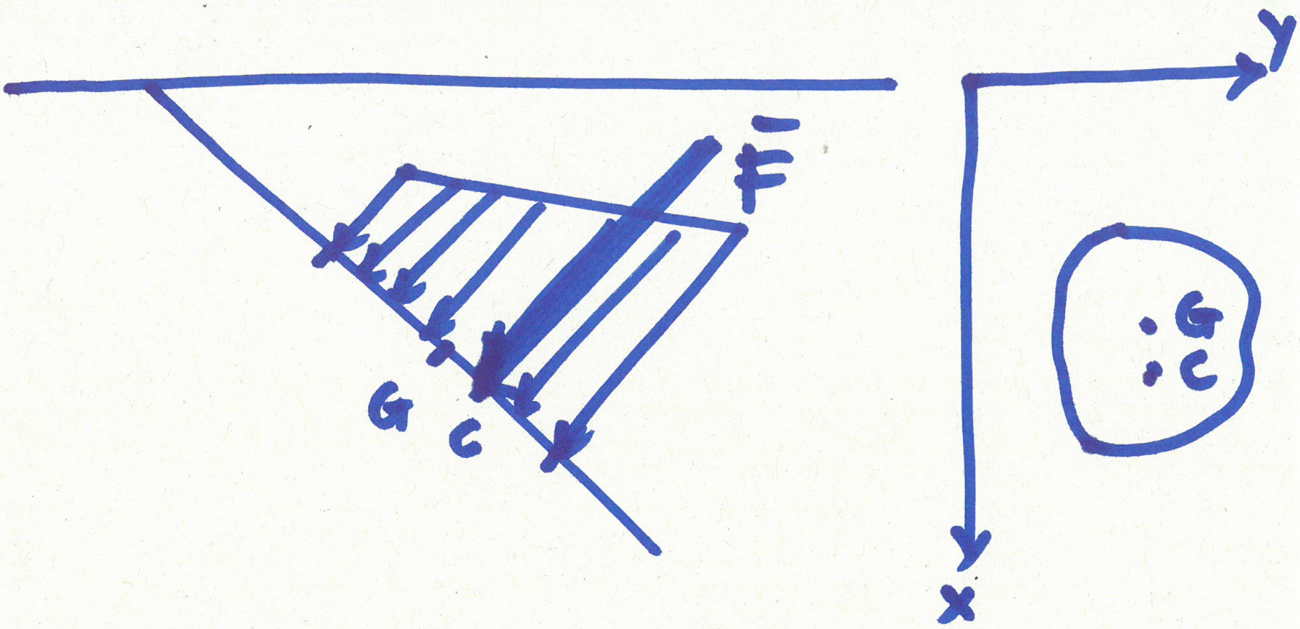
$$\gamma \underbrace{x_G A}_{S_y} \sin\alpha \cdot y_c = \gamma \sin\alpha \int_A x y\, dA$$

$\cancel{\xi}$ ξ

$$S_y\, y_c = \int_A x y\, dA$$

$$y_c = \frac{J_{xy}}{S_y}$$

La retta d'azione passa per un punto la cui coordinata y_c è il rapporto tra il momento di inerz. dev. e il mom. st. y



$$\bar{F} = F\,\bar{n}$$

direz $\perp$ alla sup
verso contro la sup

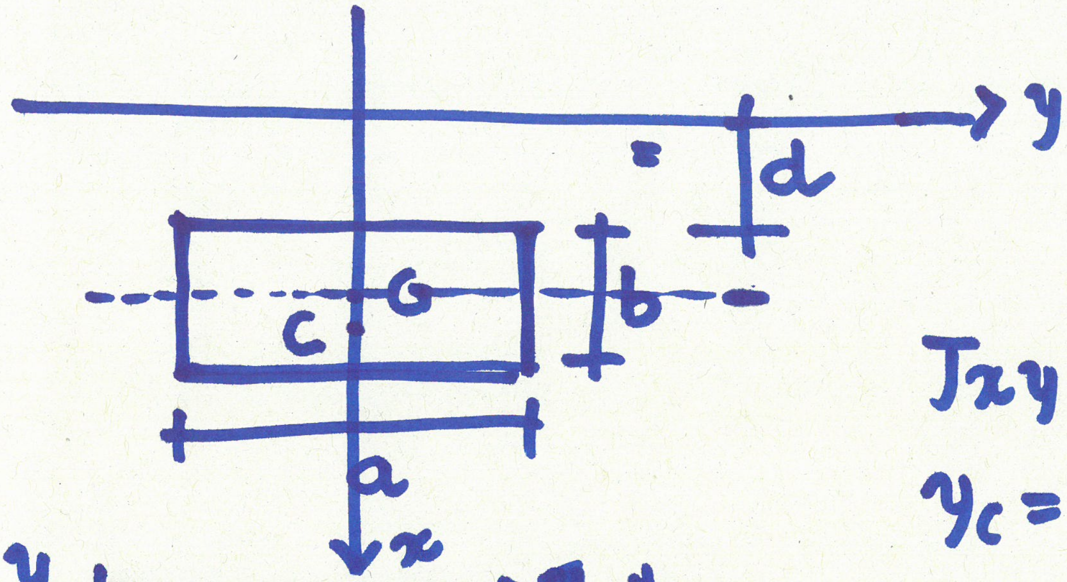
$$F = \gamma\, z_G\, A$$

coord. punto di appl.
$$\begin{cases} x_c = \dfrac{J_{yy}}{S_y} \\ y_c = \dfrac{J_{xy}}{S_y} \end{cases}$$

$$S_y = x_G\, A$$

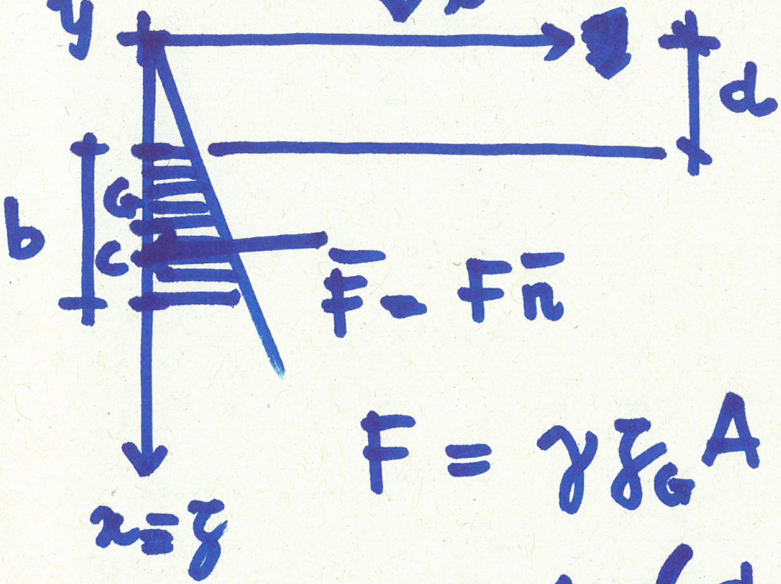
$$J_{yy} = \int_A x^2\, dA \qquad J_{xy} = \int_A xy\, dA$$

se $\alpha = \pi/2$ $\boxed{x \equiv z}$



$$J_{xy} = 0$$

$$y_C = y_G = 0$$



$$F = \gamma \xi_G A$$

$$= \gamma \left(d + b/2\right)(ab)$$

$$x_C = \xi_C = \frac{J_{yy}}{S_y}$$

$$J_{yy} = J_{yyG} + A x_G^2$$

Teorema di Huygens

Il mom. di inerz rispetto all'asse y è uguale al mom. di in. rispetto ad un asse // all'asse y e baricentrico + area. (dist. baric. asse)

$$J_{yyG} = \frac{1}{12} a b^3$$

$$x_C = \zeta_C = \frac{(ab)(d+b/2)^2}{(d+b/2)(ab)} +$$

$$+ \frac{1}{12} \frac{a b^3}{(d+b/2)(ab)}$$

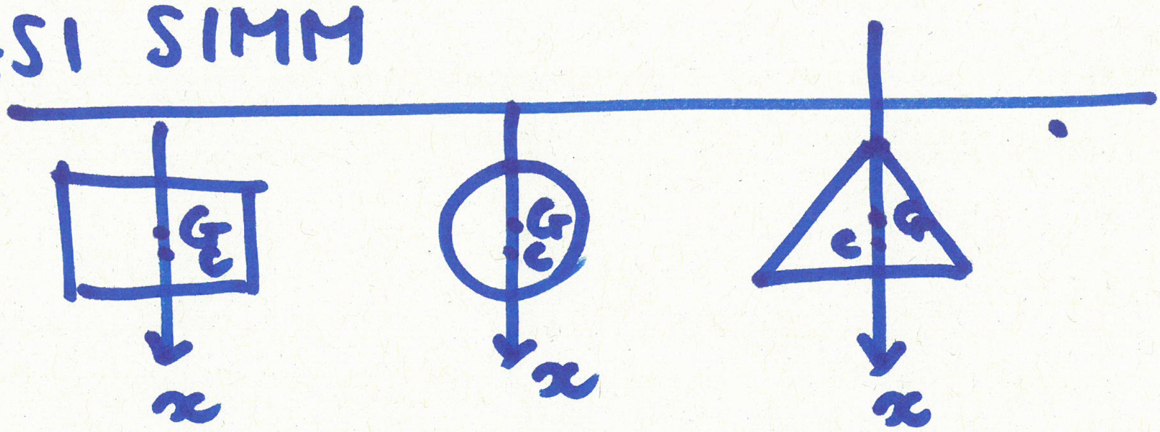
$$\zeta_C = \underbrace{d+b/2}_{x_G} + \frac{1}{12} \frac{b^2}{(d+b/2)}$$

$$\boxed{x_C = x_G + \frac{J_{yyG}}{A x_G}}$$

IL CENTRO DI SPINTA
E' PIÙ AFFONDATO
DEL BARICENTRO!

Se possibile, usare asse x già baricentrico.

CASI SIMM

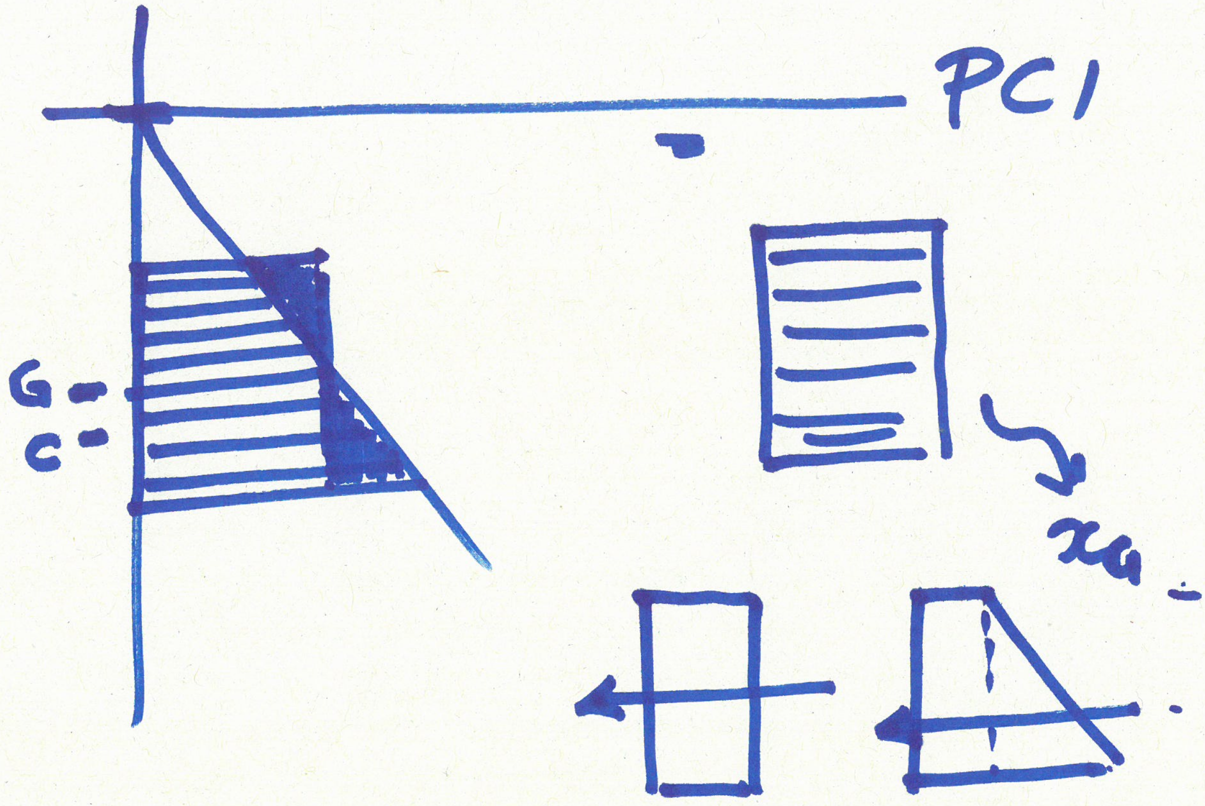


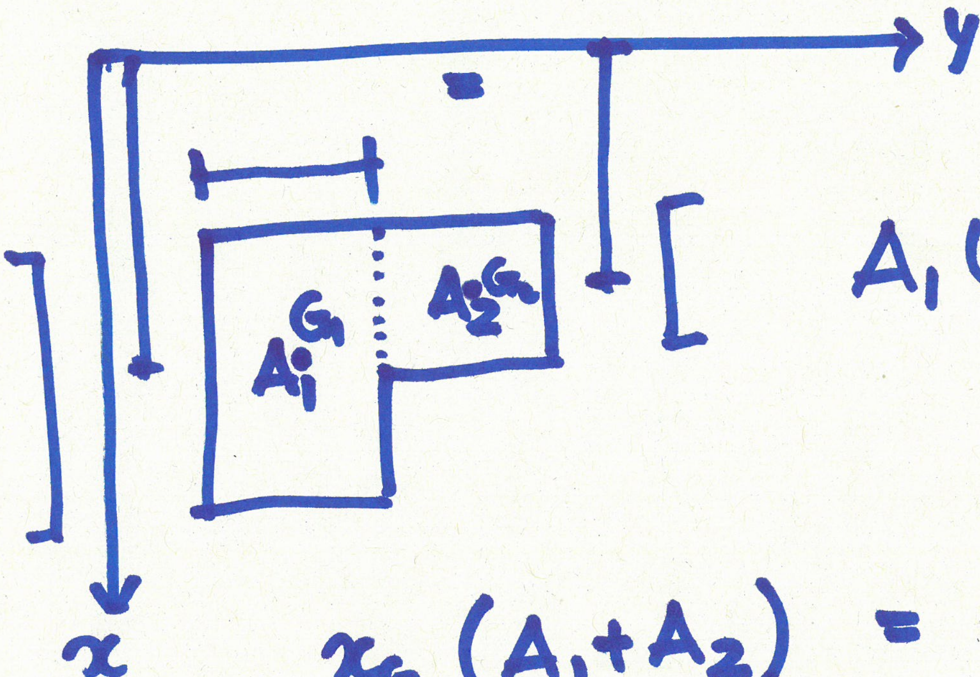
CALCOLO DEL MODULO DELLA FORZA: COMPARE x_G (y_G)

LA FORZA NON E' APPLICATA IN G, MA IN C (più affond. di G)

SE x è di simmetria,

$y_G = y_C = 0$



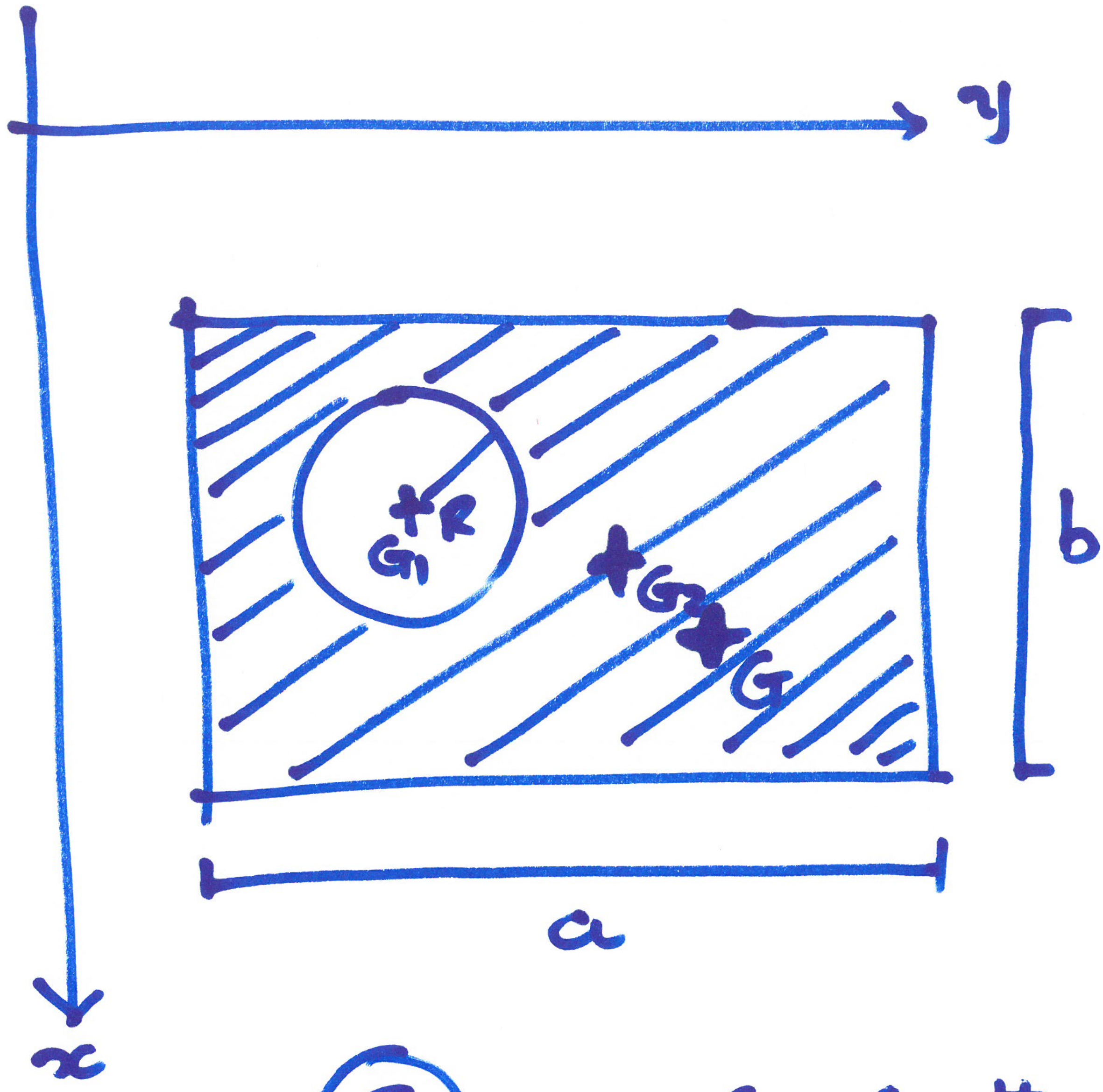


$A_1 \cup A_2$

$$x_G (A_1 + A_2) =$$

$$= x_{G1} A_1 + x_{G2} A_2$$

$$x_G = \frac{A_1}{A_1 + A_2} x_{G1} + \frac{A_1}{A_1 + A_2} x_{G2}$$



G

$G_2 = G$ rett pieno

$$x_{G2} A_{rett} - x_{G1} A_c$$

$$= x_G (A_{rett} - A_c)$$

?