Kuliah Mekanika Fluida

Gaya pada bidang terendam

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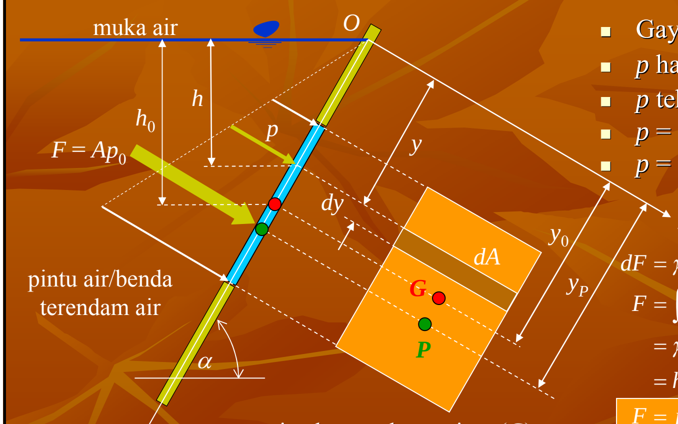
Bidang Datar



- Gaya pada pintu: $dF = p\ dA$
- p harus terbagi merata
- p tekanan hidrostatika
- $p = h\gamma$
- $p = (y \sin \alpha)\ \gamma$

$$dF = \gamma \sin \alpha \times y dA$$

$$F = \int dF = \gamma \sin \alpha \int y dA$$

$$= \gamma \sin \alpha \times A y_0 = (y_0 \sin \alpha) \gamma \times A$$

$$= h_0 \gamma \times A$$

$$F = p_0 \times A$$

$$y_0 = \frac{\int y dA}{\int dA} = \frac{\int y dA}{A}$$

- y_0 = jarak pusat berat pintu (**G**)
- p_0 = tekanan hidrostatika di **G**
- A = luas pintu
- $\int y dA$ = momen statis bidang **A**
- y_P = jarak pusat tekanan pintu (**P**)

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Besar dan Pusat Gaya

- Besar Gaya

$$dF = \gamma \sin\alpha \times y dA$$

$$F = \int dF = \gamma \sin\alpha \int y dA = \gamma \sin\alpha \times A y_0 = (y_0 \sin\alpha)\gamma \times A = h_0 \gamma \times A = p_0 \times A$$

$$F = p_0 \times A$$

$$y_0 = \frac{\int y dA}{\int dA} = \frac{\int y dA}{A}$$

- Pusat Gaya

$$F y_P = \int y dF = \int y p dA = \int y h \gamma dA = \gamma \int y (y \sin\alpha) dA = \gamma \sin\alpha \int y^2 dA$$

$$y_P = \frac{\gamma \sin\alpha \int y^2 dA}{F} = \frac{\gamma \sin\alpha \int y^2 dA}{A p_0} = \frac{\gamma \sin\alpha \int y^2 dA}{A (y_0 \sin\alpha)\gamma} = \frac{\int y^2 dA}{A y_0} = \frac{I}{S} = \frac{I_0 + A {y_0}^2}{A y_0} = y_0 + \frac{I_0}{S}$$

$$y_P = y_0 + \frac{I_0}{S}$$

- F = besar gaya hidrostatika
- h_0 = jarak vertikal pusat berat pintu (***G***)
- y_0 = jarak pusat berat pintu (***G***)
- y_P = jarak pusat tekanan pintu (***P***)
- $\int y dA$ = momen statis bidang ***A***
- $\int y^2 dA$ = momen inersia bidang ***A***

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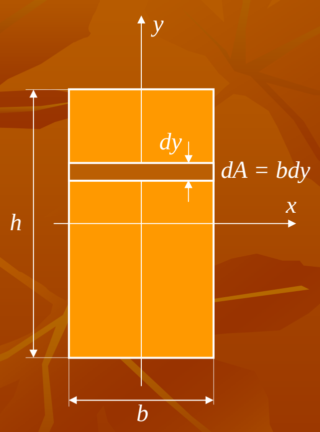
Segi 4: Luas dan Momen Statis



- Luas:

$$A = \int_{y=-h/2}^{y=+h/2} dA = \int_{y=-h/2}^{y=+h/2} b dy = b[y]_{-h/2}^{+h/2} = bh$$

- Pusat Berat:

$$A y_0 = \int_{y=-h/2}^{y=+h/2} y dA = \int_{y=-h/2}^{y=+h/2} b y dy$$

$$= b\left[\frac{1}{2} y^2\right]_{-h/2}^{+h/2} = b\left[\frac{1}{8} h^2 - \frac{1}{8} h^2\right] = 0$$

$$y_0 = 0$$

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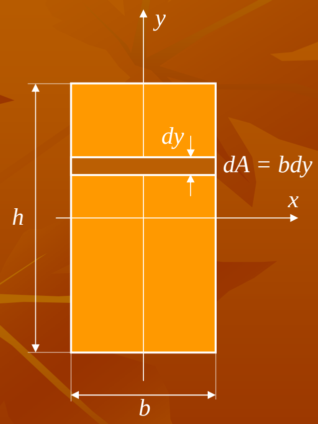
Segi 4: Momen Inersia di Pusat Berat



- Momen Inersia thd sb-*x*:

$$I_0 = \int_{y=-h/2}^{y=+h/2} y^2 dA = \int_{y=-h/2}^{y=+h/2} by^2 dy$$

$$= b\left[\frac{1}{3}y^3\right]_{-h/2}^{+h/2}$$

$$= b\left[\frac{1}{24}h^3 + \frac{1}{24}h^3\right]$$

$$I_0 = \frac{1}{12}bh^3$$

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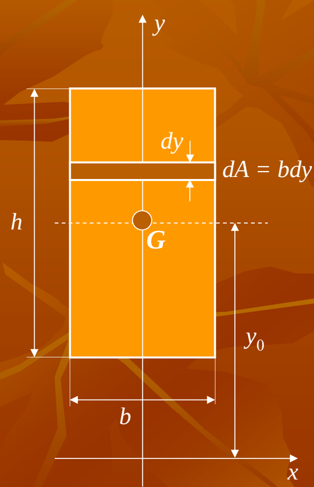
Segi 4: Momen Inersia I_x



- *G* pusat berat segi 4
- Momen Inersia I_x

$$I_x = \int_{y=y_0-h/2}^{y=y_0+h/2} y^2 dA = b\left[\frac{1}{3}y^3\right]_{y_0-h/2}^{y_0+h/2}$$

$$= \frac{b}{3}\left[\left(y_0 - \frac{h}{2}\right)^3 - \left(y_0 - \frac{h}{2}\right)^3\right]$$

$$= \frac{b}{3}\left[\left(y_0{}^3 + \frac{3hy_0{}^2}{2} + \frac{3h^2y_0}{4} + \frac{h^3}{8}\right) - \left(y_0{}^3 - \frac{3hy_0{}^2}{2} + \frac{3h^2y_0}{4} - \frac{h^3}{8}\right)\right]$$

$$= \frac{b}{3}\left[\frac{3hy_0{}^2}{2} + \frac{h^3}{8} + \frac{3hy_0{}^2}{2} + \frac{h^3}{8}\right]$$

$$I_x = \frac{1}{12}bh^3 + bhy_0{}^2$$

$$I_x = I_0 + Ay_0{}^2$$

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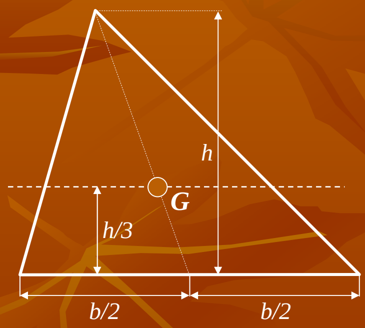
Segitiga



- Luas: $A = \frac{1}{2} bh$
- Pusat Berat: $y_0 = \frac{1}{3} h$
- Momen Inersia, I_0

$$I_0 = \frac{1}{36} bh^3$$

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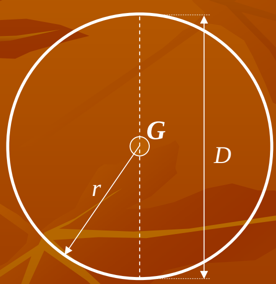
Lingkaran



- Luas: $A = \frac{1}{4} \pi D^2$
- Pusat Berat: $y_0 = \frac{1}{2} D$
- Momen Inersia, I_0

$$I_0 = \frac{1}{64} \pi D^4$$

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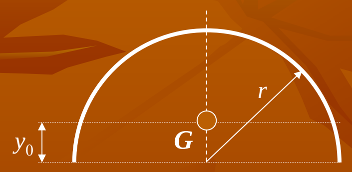
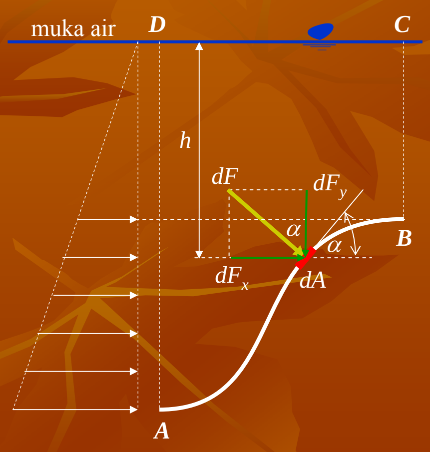
Setengah Lingkaran



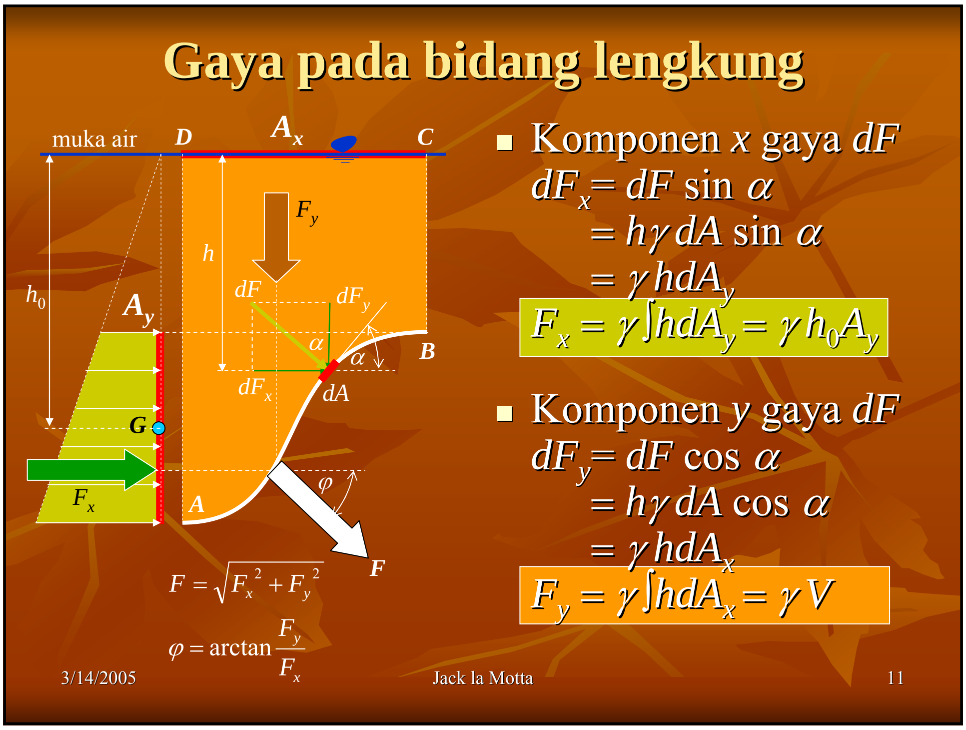
- Luas: $A = \frac{1}{2}\pi r^2$
- Pusat Berat: $y_0 = \frac{4r}{3\pi}$
- Momen Inersia, I_0

$$I_0 = 0{,}1102 r^4$$

Bidang Lengkung



- Gaya *dF* selalu tegak lurus bidang kontak *dA*
- Nilai $dF = h\gamma\, dA$
- Komponen *x-y* bid. kontak
  $dA_x = dA \cos \alpha$
  $dA_y = dA \sin \alpha$
- Komponen *x-y* gaya *dF*
  $dF_y = h\gamma\, dA \cos \alpha$
  $dF_x = h\gamma\, dA \sin \alpha$


Gaya pada bidang lengkung
muka air
D
A_x
C
F_y
h
h_0
A_y
dF
dF_y
α
B
dF_x
dA
G
F_x
A
φ
F
$F = \sqrt{F_x^2 + F_y^2}$
$\varphi = \arctan \frac{F_y}{F_x}$
Komponen x gaya dF
$dF_x = dF \sin \alpha$
$= h\gamma\, dA \sin \alpha$
$= \gamma\, h dA_y$
$F_x = \gamma \int h dA_y = \gamma\, h_0 A_y$
Komponen y gaya dF
$dF_y = dF \cos \alpha$
$= h\gamma\, dA \cos \alpha$
$= \gamma\, h dA_x$
$F_y = \gamma \int h dA_x = \gamma\, V$
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