term 335 week 7 09/06

- hydrostatic force on plane surfaces
- hydrostatic force on curved surface

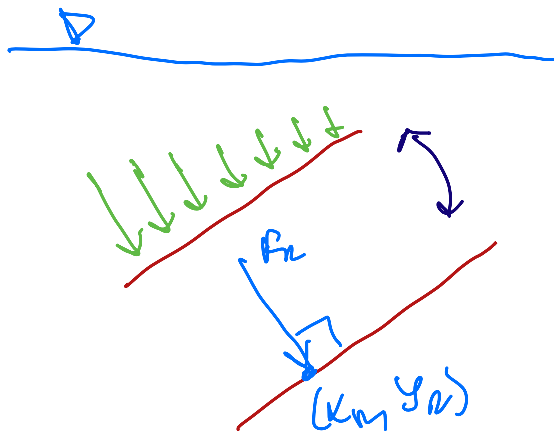
- revision:

→ direction

→ magnitude

$$F_R = \rho g h_c \cdot A$$

→ point of action



$$y_R = y_c + \frac{I_{xc}}{y_c A}$$

$$x_R = x_c + \frac{I_{xyc}}{y_c A}$$ → shift from centroid

$I_{xc} = \oint_A y^2 \, dA$; always positive ; $y_R > y_c$

$I_{xyc} = \oint_A xy \, dA$; can either be positive or negative ; >0, <0, $=0$

- figure 2.18 gives a bunch of moments of inertia for different shapes

→ example 6

- $y_R = y_c + \frac{I_{xc}}{y_c \cdot A}$; $y_c \uparrow \Rightarrow y_R = \underbrace{y_c}_{\uparrow} + \underbrace{\frac{I_{xc}}{y_c A}}_{\downarrow}$

$$\frac{I_{xc}}{y_c A} \ll y_c \;;\; \frac{I_{xc}}{y_c^2 \cdot A} \ll 1$$

assume that
↳ forces are acting on centroid

• $x_R = x_c + \frac{I_{xyc}}{y_c A}$; $x_c \uparrow$

$$\frac{I_{xyc}}{y_c A} << x_c \Rightarrow \frac{I_{xyc}}{x_c y_c A} << 1$$

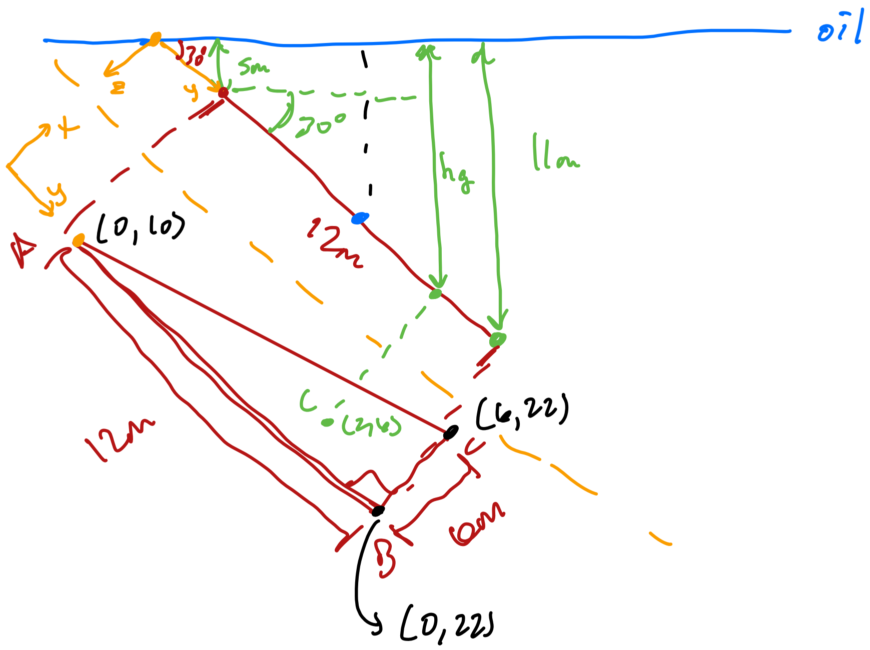
so can assume that it acts on the centroid

• dimensions of I_{xc} : L^4

• example:

$\rho_{oil} < \rho_{H_2O}$

↳ $800 \frac{kg}{m^3}$



find: F_R

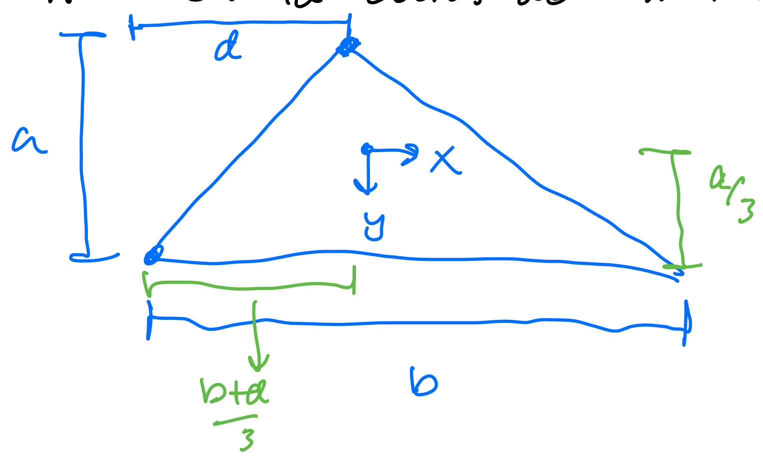
centre of pressure (x_R, y_R)

• step 1:

define the coordinates

• step 2:

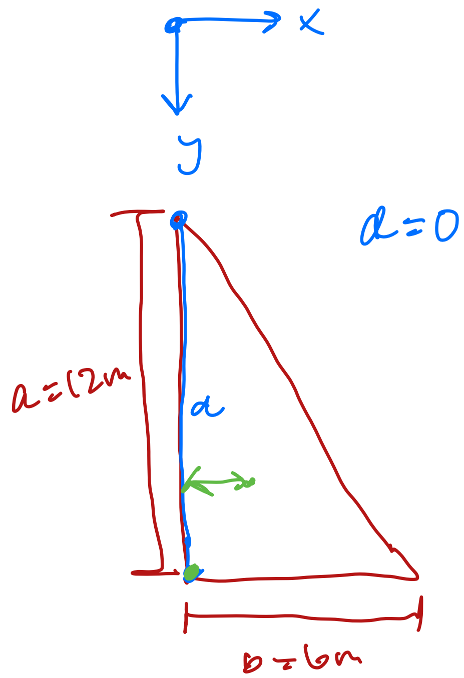
figure out the centroid coords and moment of inertia



$A = \frac{1}{2}ba$

$I_{xc} = \frac{ba^3}{36}$

$I_{xyc} = \frac{ba^2}{72}(b-2d)$



$$x_c = \frac{b+d}{3} = \frac{6+0}{3} = 2m$$
$$y_c = \frac{a}{3} = 4m$$

- y-coord for A: $(0,10) \Rightarrow$ got 10 from $\frac{5m}{\sin(30)}$
- y-coord for B: $(0,22) \Rightarrow (10+12$
- y-coord for C: $(6,22)$
- $F_R = \rho g h_y A \Rightarrow (800)(10)(18)(\frac{1}{2}36) = 2.54 \times 10^6 N$

→ centre of pressure

$$y_R = y_c + \frac{I_{xc}}{y_c \cdot A} \; ; \quad I_{xc} = \frac{ba^3}{36} = \frac{(6)(12)^3}{36} = 288 m^4$$

$$= 18 + \frac{288}{18 \cdot 36} = \underline{18.444m}$$

$$x_R = x_c + \frac{I_{xyc}}{y_c A} \; ; \quad I_{xyc} = \frac{ba^2}{72}(b-2d) = \frac{6(12)^2}{72}(6)$$

$$= 72m$$

$$= 2 + \frac{72}{18 \cdot 36} = \underline{2.111m}$$

• hydrostatic forces on curved surfaces

2) smarter way: