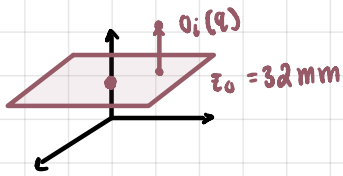


## LAB #4 PRELAB

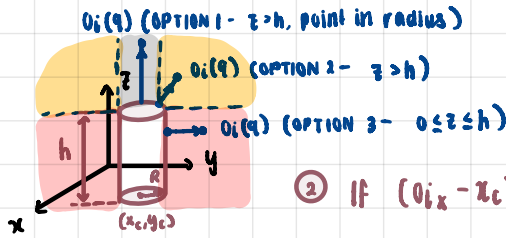
- ① Repulsive forces upwards from the workspace plane (parallel to xy-plane and  $z_0 = 32\text{mm}$ )



$$\|o_i(q) - b\| = o_{iz} - 32\text{mm} = p[o_i(q)], \quad o_i(q) - b = \begin{bmatrix} 0 \\ 0 \\ o_{iz} - 32\text{mm} \end{bmatrix}$$

$$\nabla_p(o_i(q)) = \frac{o_i(q) - b}{\|o_i(q) - b\|}, \quad F_{rep,i}(q) = n_i \left[ \frac{1}{p(o_i(q))} - \frac{1}{p_0} \right] \frac{1}{p^2(o_i(q))} \nabla_p(o_i(q))$$

- ② Repulsive forces from a cylinder of finite length  $h$ , the bottom lies on  $x_0-y_0$  plane



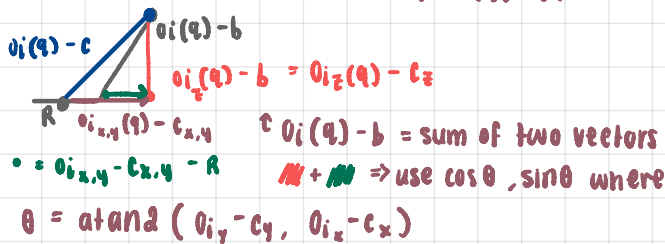
- ① If  $(o_{ix} - x_c)^2 + (o_{iy} - y_c)^2 \leq R^2$ ,  $z > h$

$$\|o_i(q) - b\| = o_{iz} - h = p[o_i(q)], \quad o_i(q) - b = \begin{bmatrix} 0 \\ 0 \\ o_{iz} - h \end{bmatrix}$$

- ② If  $(o_{ix} - x_c)^2 + (o_{iy} - y_c)^2 > R^2$ ,  $z > h$

$$\|o_i(q) - b\| = \sqrt{(\sqrt{(o_{ix} - x_c)^2 + (o_{iy} - y_c)^2} - R)^2 + (o_{iz} - h)^2}$$

$$o_i(q) - b = \|o_i(q) - b\| \cdot \frac{o_i(q) - c}{\|o_i(q) - c\|}, \quad o_i(q) - b = \begin{bmatrix} o_{ix} - x_c - R \cos \theta \\ o_{iy} - y_c - R \sin \theta \\ o_{iz} - h \end{bmatrix}$$



$$\nabla_p(o_i(q)) = \frac{o_i(q) - b}{\|o_i(q) - b\|}, \quad \text{same } F_{rep} \text{ eq. from ①}$$

- ③ If  $(o_{ix} - x_c)^2 + (o_{iy} - y_c)^2 > R^2$ ,  $z \leq h$

$$\|o_i(q) - b\| = \sqrt{(o_{ix}(q) - x_c)^2 + (o_{iy}(q) - y_c)^2} - R, \quad o_i(q) - b = \frac{\|o_i(q) - b\|}{\sqrt{(o_{ix}(q) - x_c)^2 + (o_{iy}(q) - y_c)^2}} \begin{bmatrix} o_{ix}(q) - x_c \\ o_{iy}(q) - y_c \\ 0 \end{bmatrix}$$

same  $F_{rep}$ ,  $\nabla_p(o_i(q))$  eq.s from ①