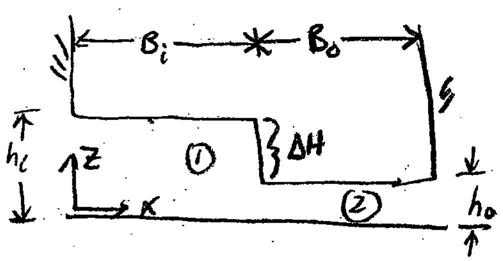
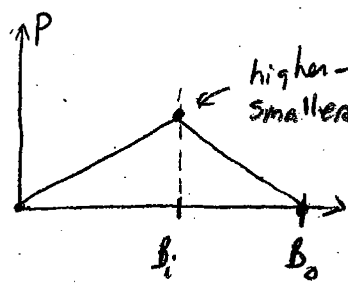
* RAYLEIGH STEP BEARING



How would p(x) look?



Assume: 1-D Flow, Reynolds Eq.:

$$\frac{d}{dx}\left(\frac{h^3}{\eta}\frac{dp}{dx}\right) = 6U\frac{dh}{dx} + \cancel{12\frac{dh}{dt}} \rightarrow 0 \text{ (no squeeze)}$$

$$\frac{d}{dx}\left(\frac{h^3}{\eta}\frac{dp}{dx}\right) = 6U\frac{dh}{dx}$$

[redacted]

Region 1

$$\frac{d}{dx}\left(\frac{h^3}{\eta}\frac{dP_1}{dx}\right) = 6U\frac{dh}{dx}$$

$$\frac{h_i}{\eta}\frac{d}{dx}\left(\frac{dP_1}{dx}\right) = 6U\cancel{\frac{dh_i}{dx}}^{\nearrow \emptyset}$$

$$\frac{d^2P_1}{dx^2} = 0$$

$$\frac{dP_1}{dx} = C_1$$

$$P_1 = C_1 x + C_2$$

Region 2

$$\frac{d}{dx}\left(\frac{h^3}{\eta}\frac{dP_2}{dx}\right) = 6U\frac{dh}{dx}$$

$$\frac{h_o}{\eta}\left(\frac{d}{dx}\left(\frac{dP_2}{dx}\right)\right) = 6U\cancel{\frac{dh_o}{dx}}^{\nearrow 0}$$

$$\frac{d^2P_2}{dx^2} = 0$$

$$\frac{dP_2}{dx} = C_3$$

$$P_2 = C_3 x + C_4$$

Note: 4 unknowns C's. Need 4-BCs.

BCs: (1) @ $X = 0$, $P_1 = 0$

(2) @ $X = B$, $P_2 = 0$

(3) @ $X = B_i$, $P_1 = P_2$

(really A Condition) (4) $q_{x_1} = q_{x2}$ (where, $q_x = \frac{-h^3}{12\eta}\frac{\partial P}{\partial x} + \frac{hU}{2}$)

From BC (1): $\cancel{P_1}^{\nearrow 0} = C_1(\emptyset) + C_2 \Rightarrow C_2 = 0$

From BC (2): $\cancel{P_2}^{\nearrow 0} = C_3(B) + C_4 \Rightarrow C_4 = -B\cdot C_3$

From BC (3): for $x = B_i \longrightarrow P_1 = P_2$

$$C_1(B_i) + C_2 = C_3(B_i) + C_4$$

$$C_1(B_i) - C_3(B_i) = C_4^{(2)} \to (-B\cdot C_3) \Rightarrow C_1(B_i) + C_3\overbrace{(B - B_i)}^{B_o} = 0$$

From BC (4): $$\frac{-h_i^3}{12\eta}\underbrace{\frac{dP_1}{dx}}_{C_1} + \frac{h_i U}{2} = \frac{-h_o^3}{12\eta}\underbrace{\frac{dP_2}{dx}}_{C_3} + \frac{h_o U}{2}$$

Solve BC (3) & Equ. (4) simultaneous: (3) $B_i C_1 + B_o C_3 = 0$

(4) $-\frac{h_i^3}{12\eta}C_1 + \frac{h_o^3}{12\eta}C_3 = \frac{U}{2}(h_o - h_i)$

[redacted]

Solving simultaneous EQUs. [redacted]

↳ See Next pg.

$$C_1 = +6n \frac{(B_o \cdot U \cdot \Delta H)}{B_i \cdot h_o^3 + B_o h_i^3}$$

where, $\Delta H = h_i - h_o$

$$C_2 = 0$$

$$C_3 = \frac{-6n (B_i U \cdot \Delta H)}{B_i h_o^3 + B_o h_i^3}$$

$$C_4 = + \frac{6n B (B_i U \cdot \Delta H)}{B_i h_o^3 + B_o h_i^3}$$

where,

$$P_1(x) = C_1 x$$

$$P_2(x) = C_3 x + C_4$$

[redacted]

$$\lim_{\Delta H \to 0} \left(\frac{W}{L} \right) = 0$$ ∴ Parallel surface generates no LOAD, since $C_{1,3,4} = f(\Delta H)$

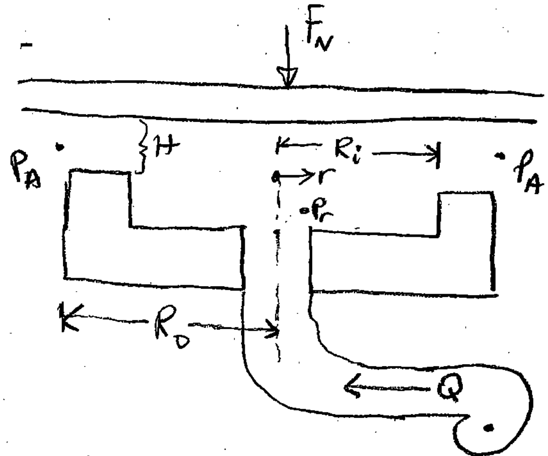
[redacted]

HYDROSTATIC OR EXTERNALLY PRESSURIZED BEARING

POLAR REYNOLDS EQUATION

$$\frac{\partial}{\partial r}\left(\frac{r\rho h^3}{\eta}\frac{dp}{dr}\right)+\frac{1}{r}\frac{\partial}{\partial\theta}\left(\frac{r\rho h^3}{\eta}\frac{dp}{d\theta}\right)=12\,\bar V_r\frac{\partial(\rho r h)}{\partial r}+12\bar V_\theta\frac{\partial(\rho h)}{\partial\theta}$$

where $\bar V_r, \bar V_\theta$ are mean radial & tangential velocities



Theory:

$$\frac{\partial}{\partial r}\left(\frac{r\rho h^3}{\eta}\frac{dp}{dr}\right)+\frac{1}{r}\frac{\partial}{\partial\theta}\left(\frac{r\rho h^3}{\eta}\cancelto{0}{\frac{\partial p}{\partial\theta}}\right)$$

$$=12\cancelto{0}{\bar V_r}\frac{\partial(\rho r h)}{\partial r}+12\bar V_\theta\cancelto{0}{\frac{\partial(\rho h)}{\partial\theta}}$$

$$\Longrightarrow \frac{\partial}{\partial r}\left(r\frac{\partial p}{\partial r}\right)=0$$

$$\boxed{\frac{H^3}{r\eta}\frac{\partial}{\partial r}\left(r\frac{\partial P}{\partial r}\right)=0}$$

BC#1: $P(r=R_o)=P_a$

BC#2: $P(r=R_i)=P_r$

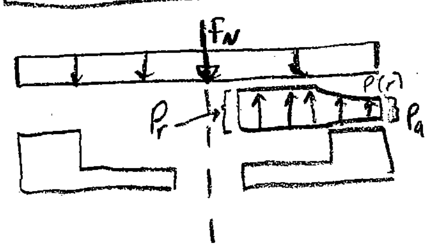
$$\frac{\partial}{\partial r}\left(r\frac{\partial P}{\partial r}\right)=0 \Longrightarrow r\frac{\partial P}{\partial r}=C_1$$

$$\frac{\partial P}{\partial r}=\frac{C_1}{r}\Longrightarrow dP=C_1\frac{dr}{r}$$

$$P(r)=C_1\ln r+C_2$$

BC#1: $P_a=C_1\ln R_o+C_2$

BC#2: $P_r=C_1\ln R_i+C_2$



$$\frac{P-P_a}{P_r-P_a}=\frac{\ln r/R_o}{\ln R_i/R_o}$$

$\frac{\ln(A)}{\ln(B)}$ $\ln(A-B)$

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