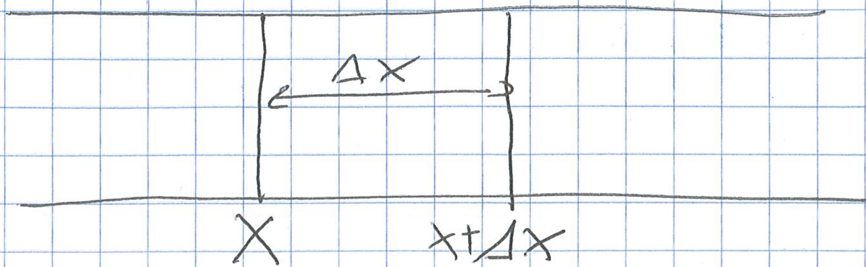


$$Q(x+\Delta x) = C \cdot \frac{L_p}{\Delta x} \cdot \left(\overset{P_1}{P(x)} - \overset{P_2}{P(x+\Delta x)} \right)$$

conductance per length of pipe

$$Q(x) = -CL_p \left(\frac{P(x+\Delta x) - P(x)}{\Delta x} \right) = -CL_p \frac{dP}{dx}$$

$$Q(x) = -CL_p \frac{dP}{dx}$$

$$\boxed{\frac{dQ}{dx} = -CL_p \frac{d^2P}{dx^2}}$$

$$Q(x+\Delta x) - Q(x) = 2\pi R \Delta x \cdot q$$

Vacuum load for pipe piece Δx !

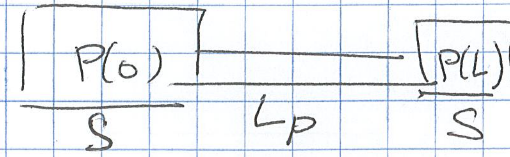
$$\boxed{\frac{dQ}{dx} = 2\pi R q}$$

$$\frac{d^2P}{dx^2} = \frac{-1}{CL_p} \cdot 2\pi R q$$

$$\frac{\partial^2 P}{\partial x^2} = \frac{-2\pi R q L_p}{C L_p^2}$$

(2)

$$\frac{\partial^2 P}{\partial x^2} = -\frac{2\pi R q L_p}{C L_p^2}$$ ✓



$$P(0) = \frac{Q_{Tot}}{2S} = \frac{2\pi R q L_p}{2S}$$

$$P(L_p) = \frac{Q_{tot}}{2S} = \frac{2\pi R q L_p}{2S}$$

Boundary

$$P(x) = -\frac{Q_{tot}}{C L_p^2} \cdot \frac{x^2}{2} + A_0 x + B$$

$$\left.\frac{dP(x)}{dx}\right|_{x=\frac{L}{2}} = 0$$

$$\frac{\partial P(x)}{\partial x} = -\frac{Q_{tot}}{C L_p^2} \cdot x + A_0 = 0$$

$$-\frac{Q_{tot}}{C L_p^{2}} \cdot \frac{L_p}{2} = -A_0$$

$$A_0 = \frac{Q_{tot}}{2 C L_p}$$

$$P(x) = -\frac{Q_{tot}}{C L_p^2} \cdot \frac{x^2}{2} + \frac{Q_{tot}}{2 C L_p} x + B$$

$$P(0) = \frac{Q_{tot}}{2S} = B$$ ✓

$$P(L_p) = -\frac{Q_{tot}}{C L_p^2} \cdot \frac{L_p^2}{2} + \frac{Q_{tot}}{2 C L_p} \cdot L_p + B = \frac{Q_{tot}}{2S}$$ ✓

(3)

$$P(x) = -\frac{Q_{tot}}{C L_p^2} \cdot \frac{x^2}{2} + \frac{Q_{tot}}{2 C L_p} x + \underbrace{\frac{Q_{tot}}{2S}}_{P(0)}$$

$$P(x) - P(0) = + \frac{Q_{tot}}{C} \left[+ \frac{x}{2L_p} - \frac{1}{2} \frac{x^2}{L_p^2} \right]$$

$$= \frac{Q_{tot}}{2C} \left[\frac{x}{L_p} - \left(\frac{x}{L_p} \right)^2 \right]$$

$$\underline{P\left(\frac{L_p}{2}\right) - P(0)} = \frac{Q_{tot}}{2C} \left[\frac{L_p}{2L_p} - \left(\frac{L_p/2}{L_p} \right)^2 \right]$$

$$= \frac{Q_{tot}}{2C} \left[\frac{1}{2} - \frac{1}{4} \right] = \underline{\underline{\frac{Q_{tot}}{8C}}}$$