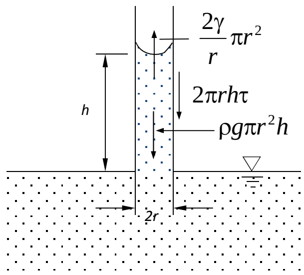
Capillary suction in a vertical straight vessel

Equation of motion:

$$\rho\pi r^2 h\frac{d^2h}{dt^2} = \frac{2\gamma}{r}\pi r^2 - 2\pi r h\tau - \rho g\pi r^2 h$$

Inertia term (Acceleration term)	Capillary tension	friction	gravity



- Assumption of friction law: $\tau = f\frac{dh}{dt}$
  - For laminar flow: $f = 4\mu$
- Neglecting inertia term

Solution:

$$\frac{\rho g r^2}{2f}t = h_o \ln\left(\frac{h_o}{h_o - h}\right) - h$$

Where, $h_o = \frac{2\gamma}{\rho g r}$

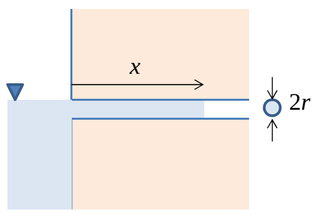
Final height

Capillary suction in a horizontal straight vessel

Equation of motion:

$$\rho\pi r^2 x\frac{d^2x}{dt^2} = \frac{2\gamma}{r}\pi r^2 - 2\pi r x\tau - \rho g\pi r^2 x$$

Inertia term (Acceleration term)	Capillary tension	friction	gravity

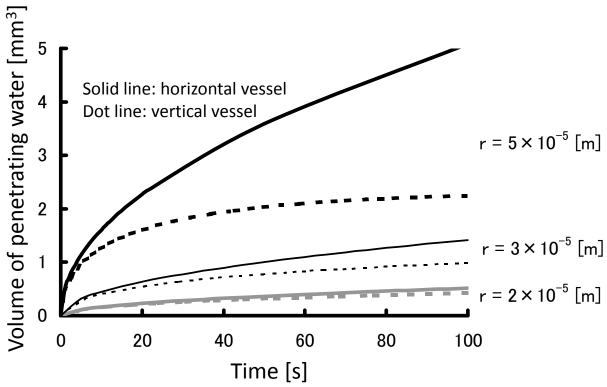


- Assumption of friction law: $\tau = f\frac{dx}{dt}$
  - For laminar flow: $f = 4\mu$
- Neglecting inertia term

Solution:

$$x = \sqrt{\frac{2r\gamma}{f}t}$$

Comparison of horizontal and vertical vessel



Capillary suction model for concrete

Velocity in each pore

$$x_{r_i} = K_{cap}\sqrt{\frac{r_i\gamma}{2\mu}t}$$

K_{cap}: material factor (<1)

Pore size distribution