

# Lecture 3 - summary

- Additional examples of application of Pi-theorem for engineering problems (flow problem, WTC, tall buildings)
- Combine two analyses (wind drag force AND strength of building) into robustness analysis
- Drag force analysis

$$\Pi_0 = \frac{F_D}{\rho_a U^2 D^2} = \mathcal{F} \left( \Pi_1 = \frac{\nu}{UD} \right)$$

- Strength analysis

$$\frac{F_{x,\text{lim}} h}{b^3 \sigma_0} = \mathcal{F} = \frac{1}{2} (1 - N_{Gal}^2)$$

- Robustness analysis

$$\gamma = \frac{F_{x,\text{lim}}}{F_D} \geq 1$$

$$\gamma = \frac{F_{x,\text{lim}}}{F_D} = \frac{mg}{2F_D} \left( \frac{1 - N_{Gal}^2}{N_{Gal}} \right) \frac{b}{h}$$

- (1) Experiments provide functional relationship:

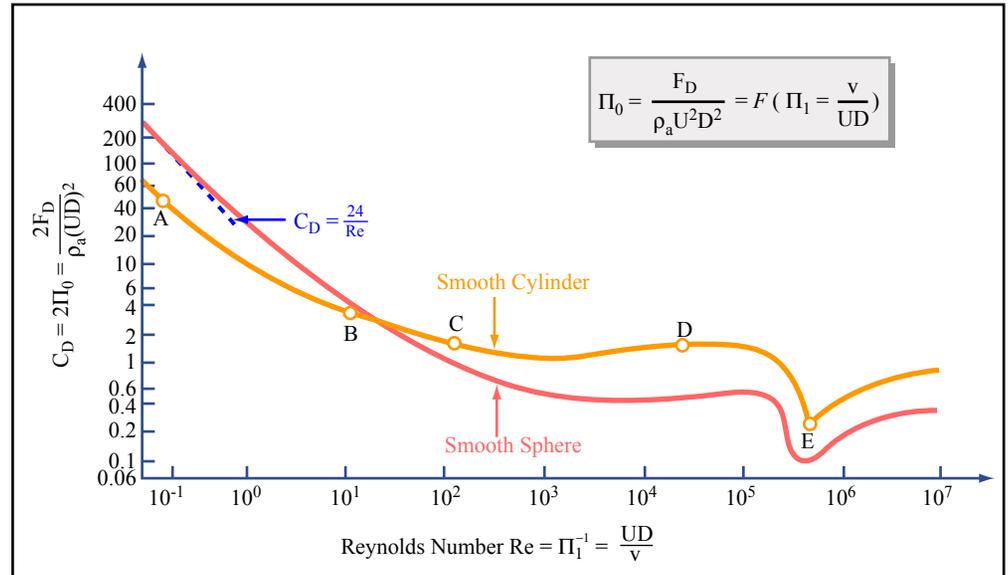


Figure by MIT OpenCourseWare.

or...

- (2) Theoretical approaches (strength of materials theory) provide relation for strength analysis

**Analysis for WTC: Robustness 15..20**

**Main idea:** Do few lab experiment to get relationship between  $\Pi_i$  and then rescale problem! (Important engineering concept)