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
  \[ \Pi_0 = \frac{F_D}{\rho_a D^2} = \mathcal{F} \left( \frac{\nu}{UD} \right) \]
- Strength analysis
  \[ \frac{F_{x,\text{lim}} h}{b^2 \sigma_0} = \mathcal{F} = \frac{1}{2} \left( 1 - \frac{N_{Gal}^2}{b} \right) \]
- 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:

\[ \pi_0 = \frac{F_D}{\rho_a U^2 D^2} = \mathcal{F} \left( \frac{\pi_1}{UD} \right) \]

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)