CIV102 - STRUCTURES and MATERIALS

Topic: Safety!

1) Types of Loads

    a) Dead Loads (*Things that can't be moved*)
      - Have low uncertainty
      - Examples: Selfweight of buildings and bridges, fixed seatings, lamp posts, stuff behind the ceiling
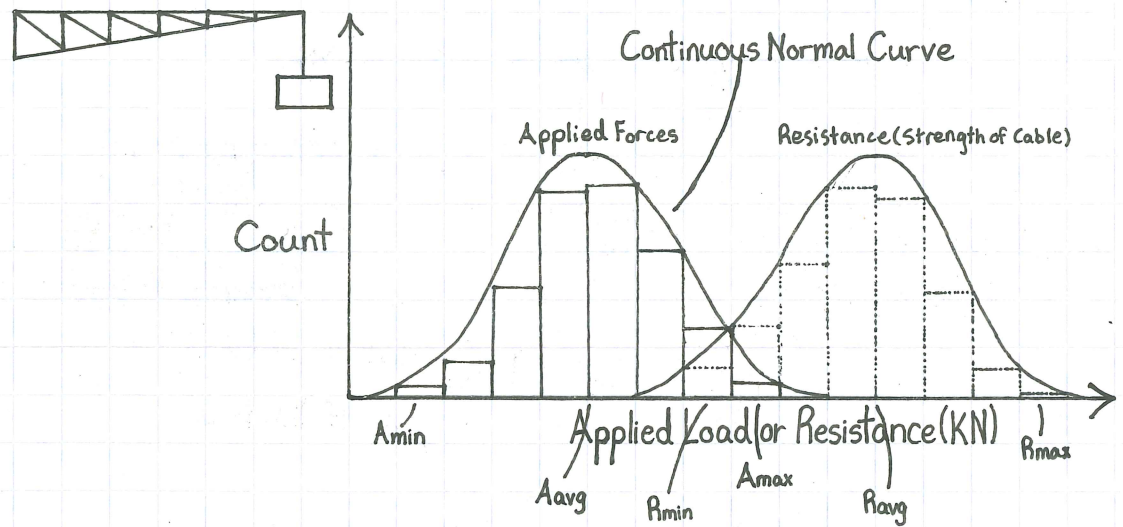
    b) Live Loads (*Things that can be moved*)
      - Have high uncertainty
      - Examples: People, cars, water in pools, wind + snow

    c) Others
      - Earthquake load
      - Thermal effects

Example

Concept of Safety

Limit States Equation:
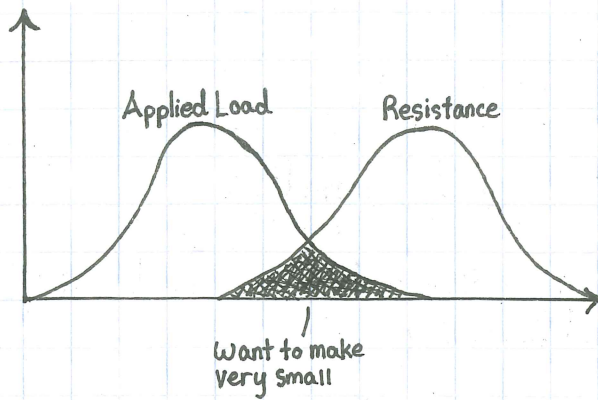
$$\text{Applied Load} \leq \text{Resistance}$$
$$A \leq R$$
or
$$A_{max} \leq R_{min}$$

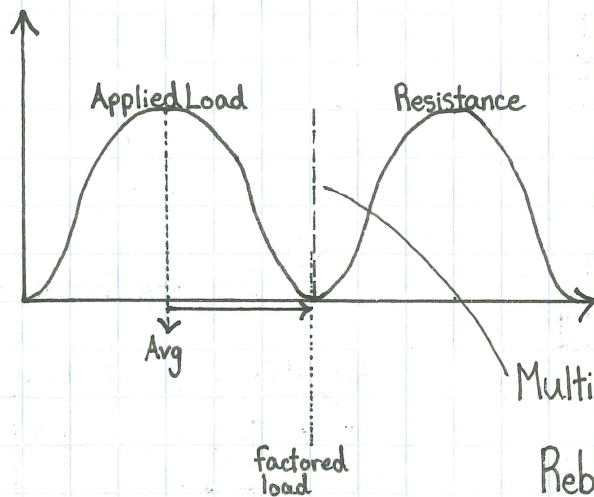Reliability analysis to decide if things are safe.

Redraw Graph

Applied Load   **Resistance**

Want to make very small

Area = Danger Zone where
A > R = Collaps

∴ minimize area

2) How to account for this?

i) Partial Safety Factor Method

Applied Load   **Resistance**

Avg

factored load

Multiply by $\phi < 1.0$
Steel $\phi = 0.9$
Rebar Steel $\phi = 0.85$
Concrete $\phi = 0.65$

Multiply Average Load By $\begin{cases} 1.25 \text{ if dead load} \\ 1.50 \text{ if live load} \end{cases}$

ii) Allowable Stress Design

Safety Factor $= \dfrac{R_{avg}}{A_{avg}}$

Brooklyn Bridge (1888) ⟶ SF = 5.0
Golden Gate Bridge (1937) ⟶ SF = 2.68
Akashi-Kaikyo Bridge (1998) ⟶ SF = 2.25

3) How to use allowable stress design

$\sigma_{allowable} = \dfrac{\sigma_{strength}}{FOS}$ FOS = Factor of Safety

$= \dfrac{f_y}{FOS} = \dfrac{\sigma_{yield}}{FOS}$

What FOS to use?

$FOS = \begin{cases} 2.0 \rightarrow \text{Use if we have warning of failure} \\ 3.0 \rightarrow \text{Use if we have no warning of failure} \end{cases}$