Design Goals

- **Function**
  - Required Material Parameters
    - Sufficient Young’s modulus
    - High fatigue resistance
  - Ease with installation
  - Safety
    - Failure mode involves deformation and not fracture
    - Allows time for replacement

- **Cost**
  - Minimize material cost
    - By using a reasonably inexpensive and widely used material
    - By minimizing volume of material used in each component
  - Simple two-part mold for production
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Two cases where force $P$ causes deflection of the active hook
- Case 1 – end of hook where deflection is going to be just enough for it to slide past the passive hook
- Case 2 – person exerts force in the middle region to unhook the latch

Case 2 will be where greater force than is needed will often be exerted
- Design of lock should be based on the force $P$ in Case 2

Beam theory used for design
Equations for Design

- **Inputs**
  - Force - P
  - Distance on beam person exerts force - a
  - Distance in deflection - delta
  - Width of active hook - b
  - Modulus of material - E
  - Length of beam - L

- **Outputs**
  - bh³ lumped parameter - K
  - Height of active hook - h
  - Stress from bending - sigma

- **Equation**
  
  \[
  \text{delta} = \frac{(Pa^2)(3L-a)}{6EI} \\
  \text{where } I = \frac{bh^3}{12} \\
  \text{sigma} = \frac{My}{I} \\
  \text{where } M = Pa \\
  y = \frac{h}{2} \text{ and } I = \frac{bh^3}{12}
  \]

  Rearranging to get K
  
  \[
  K = \frac{2Pa^2(3L-a)}{(E*\text{delta})}
  \]

  Allows you to play with the dimensions b and h
### Active and Passive Hook Design

**Optimal inputs**
- $P = 15.5 \text{ N} \text{ (a little over 3 lbs.)}$
- $a = 0.04 \text{ m}$
- $L = 0.06 \text{ m}$
- $E = 2.10\times10^9 \text{ Pa (for ABS)}$
- $\delta = 0.008 \text{ m}$
- $b = 0.02 \text{ m}$

**Outputs**
- $K = 4.13\times10^{-10} \text{ m}^4$
- $h = 0.00274 \text{ m}$
- $\sigma = 24.7 \text{ MPa}$

Good because yield stress for ABS

- $= 41 \text{ MPa}$
- Good safety factor!