



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 for Design

- 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 - δ
- Width of active hook - b
- Modulus of material - E
- Length of beam - L

Outputs

- bh^3 lumped parameter - K
- Height of active hook - h
- Stress from bending - σ

Equation

$$\delta = (Pa^2)(3L-a)/(6EI)$$

$$\text{where } I = bh^3/12$$

$$\sigma = My / I$$

$$\text{where } M = Pa$$

$$y = h / 2 \text{ and } I = bh^3/12$$

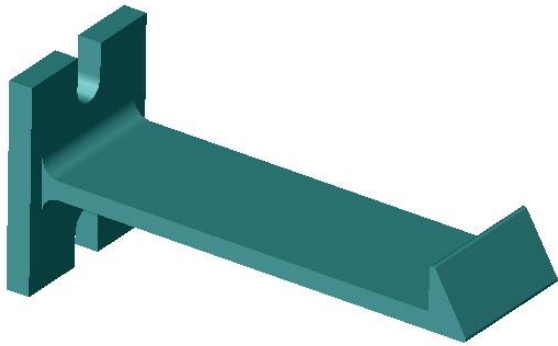
Rearranging to get K

$$K = 2Pa^2(3L-a)/(E*\delta)$$

Allows you to play with the dimensions b and h



Active and Passive Hook Design

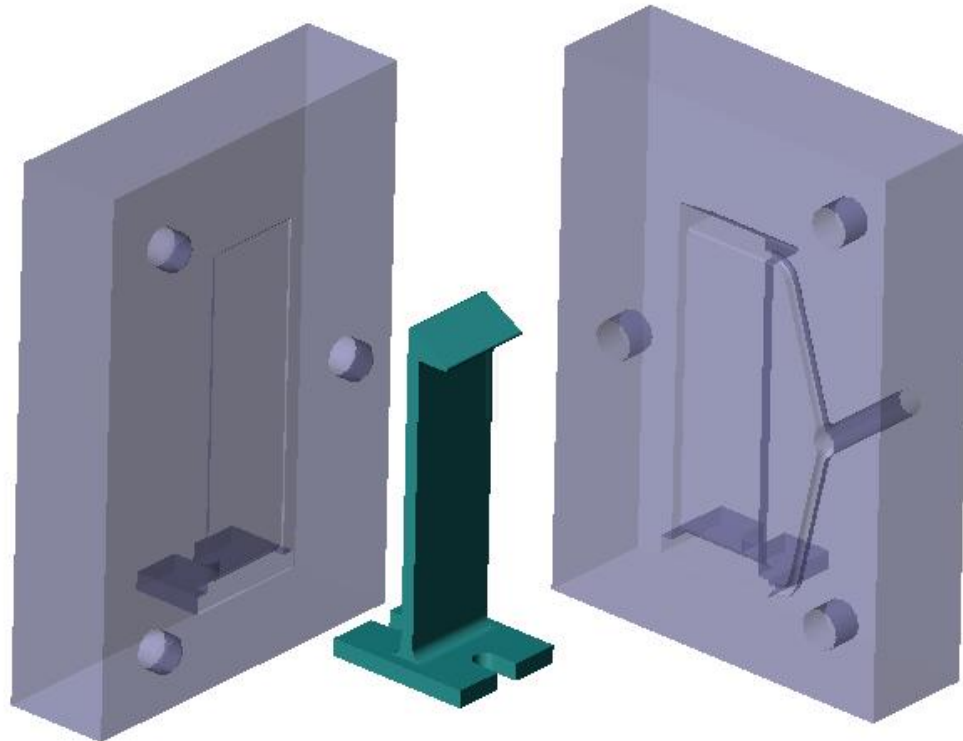


- Optimal inputs
 - $P = 15.5 \text{ N}$ (a little over 3 lbs.)
 - $a = 0.04 \text{ m}$
 - $L = 0.06 \text{ m}$
 - $E = 2.10\text{E}09 \text{ Pa}$ (for ABS)
 - $\delta = 0.008 \text{ m}$
 - $b = 0.02 \text{ m}$
- Outputs
 - $K = 4.13\text{E}-10 \text{ m}^4$
 - $h = 0.00274 \text{ m}$
 - $\sigma = 24.7 \text{ MPa}$

Good because yield stress for ABS = 41 MPa Good safety factor!



Mold Design for Active Hook





Mold Design for Passive Hook

