Period #4 : Allowable Stresses and Factors of Safety

A. Factors of Safety

All mechanical systems have loads at which the material yields or fractures or at which the structure become unstable.

These are generally called the *ultimate loads* or *failure load*s whose magnitude is denoted here by F_{fail}.

Due to many uncertainties, we need to keep the actual loads applied to the system significantly less than F_{fail} .

This is done using the factor of safety (F.S.) as shown below:

$$F.S. = \frac{F_{fail}}{F_{allow}}$$

The term F_{allow} represents the magnitude of the *allowable* load that can be applied to the system. Therefore

$$F_{actual} \le F_{allowable} = \frac{F_{fail}}{F.S.}$$

We can achieve safety in components of a mechanical system by making sure that the stresses are sufficiently small:

$$\sigma_{actual} \le \sigma_{allowable} = \frac{\sigma_{fail}}{F.S.} \qquad \tau_{actual} \le \tau_{allowable} = \frac{\tau_{fail}}{F.S.}$$

B. Sizing of Connections & Members Using Allowable Stresses

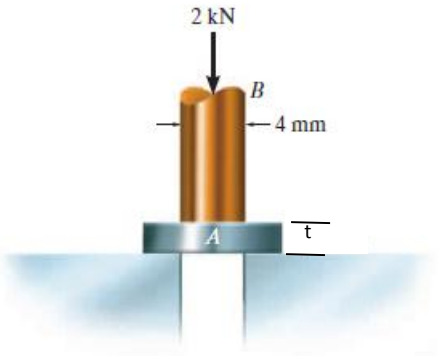
Once the magnitude of actual forces F_{actual} being conducted in a structural component is determined, the size of the component can be determined to keep the stresses below the allowable stresses.

For example, the required cross-sectional area can be found as follows:

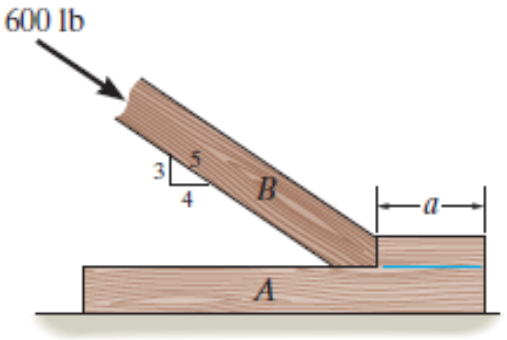
$$A_{reqd} = \frac{F_{allow}}{\tau_{allow}} \quad \text{or} \quad A_{reqd} = \frac{F_{allow}}{\sigma_{allow}}$$

C. EXAMPLES

Example 4.1. The circular punch *B* exerts a force of 2 kN on the top of the plate *A*. If the allowable shear stress in the plate is 10 MPa, find the required thickness of the plate.



Example 4.2 Member *B* is subjected to a compressive force of 600 lb. If *A* and *B* are both made of wood and are 1.5 in. thick, determine to the nearest 1/8 inch the smallest dimension *a* of the support so that the average shear stress along the blue line does not exceed τ_{allow} = 50 psi. Neglect friction.



Example 4.3. The frame is subjected to the load of 1.5 kip. Determine the required diameter of the pins at A and B if the allowable shear stress for the pin material is τ_{allow}=6ksi . Pin A is subjected to double shear whereas pin B is subjected to single shear.