Failure Theories—Static Loading

Maximum Normal Stress Theory

Maximum Shear Stress Theory

Distortion Energy Theory

Common features of these theories:

1. They describe explicit mathematical relationships that relate external loading to stress at critical points in the multi-axial state of stress.
2. They are based on critical physical properties of the materials that are **measurable**
3. Each theory relates the state of stress to a measurable criterion of failure

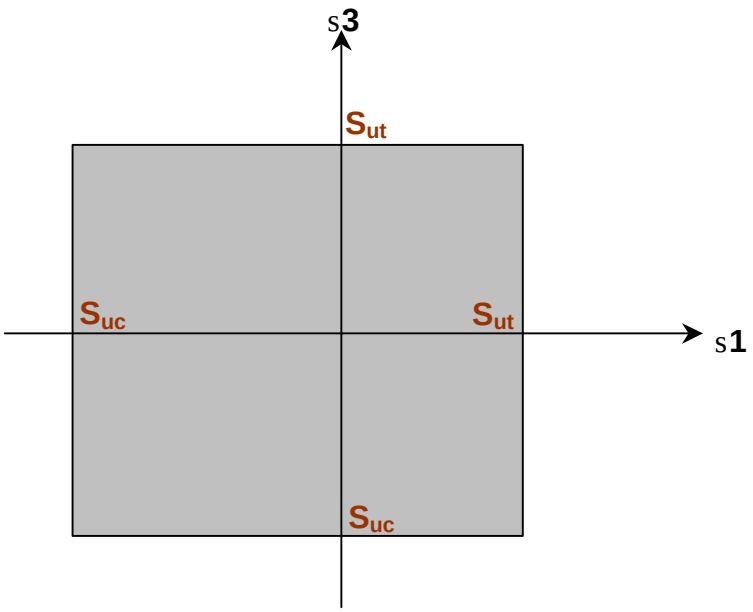
In general all failure theories say the same thing:

When the maximum value of stress or strain in a multi-axial state of stress equals or exceeds the value of stress or strain that produces failure in a uni-axial stress test, the part fails.

Maximum Normal Stress Theory

Failure will occur in the multi-axial state of stress when the maximum principal normal stress exceeds the ultimate tensile or compressive strength, S_{ut}, or S_{uc}, respectively.

if $\sigma_p > S_{ut}$, or S_{uc} the part will fail



According to the **Maximum Normal Stress Theory**, if the principal stresses fall in this box, the part will not fail.

Important to note: The Maximum Normal Stress Theory should not be used with ductile materials!

Example:

Determine if the following loading situation will produce failure in the shaft. Caluclate the factor of safety for this loading.

Sut = 52 500 psi
Suc = -164 000 psi

L = 6.0 inches
a = 8.0 inches
d = 1.5 inches
F = 1 000 lbs