

## Working stress, yield stress, ultimate stress and Factor of Safety

1. **Ultimate stress.** The stress, which attains its maximum value is known as **ultimate stress**. It is defined as the largest stress obtained by dividing the largest value of the load reached in a test to the original cross-sectional area of the test piece.
2. **Yield stress.** If the material is stressed beyond point the elastic limit, the plastic stage will reach i.e. on the removal of the load, the material will not be able to recover its original size and shape. Where the strain increases at a faster rate with any increase in the stress. At this point, the material yields before the load and there is an appreciable strain without any increase in stress. The stress corresponding to yield point is known as **yield point stress**.
3. **Working Stress.** When designing machine parts, it is desirable to keep the stress lower than the maximum or ultimate stress at which failure of the material takes place. This stress is known as the **working stress** or **design stress**. It is also known as **safe** or **allowable stress**.

**Note :** By failure it is not meant actual breaking of the material. Some machine parts are said to fail when they have plastic deformation set in them, and they no more perform their function satisfactory.

4. **Factor of Safety.** It is defined, in general, as the **ratio of the maximum stress to the working stress**.

Mathematically,

$$\text{Factor of safety} = \frac{\text{Maximum stress}}{\text{Working or design stress}}$$

In case of ductile materials e.g. mild steel, where the yield point is clearly defined, the factor of safety is based upon the yield point stress.

In such cases,

$$\text{Factor of safety} = \frac{\text{Yield point stress}}{\text{Working or design stress}}$$

In case of brittle materials e.g. cast iron, the yield point is not well defined as for ductile materials. Therefore, the factor of safety for brittle materials is based on ultimate stress.

$$\text{Factor of safety} = \frac{\text{Ultimate stress}}{\text{Working or design stress}}$$

This relation may also be used for ductile materials.

**Note:** The above relations for factor of safety are for static loading.