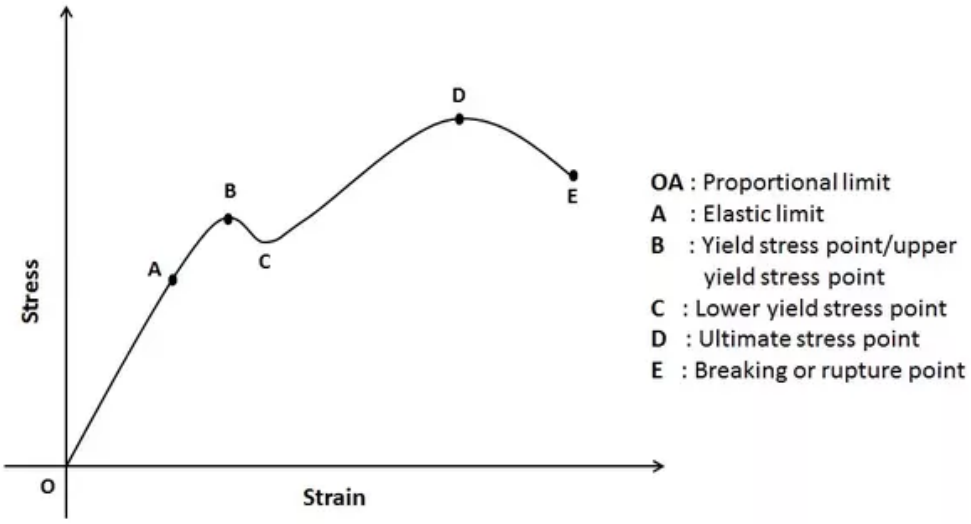
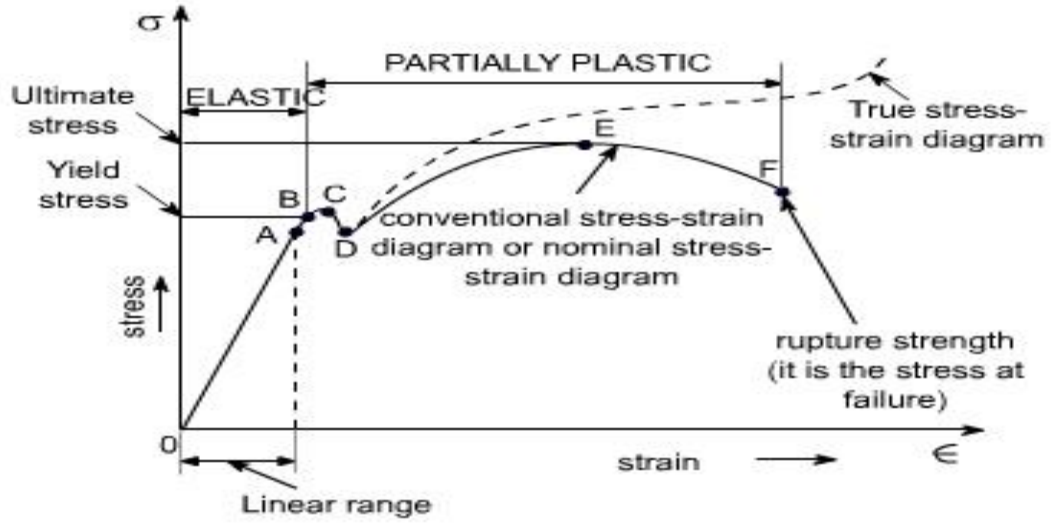
Mechanical properties of metals in static tension test

Stress-strain curve

A **stress-strain** curve is a graph derived from measuring load (stress - σ) versus extension (strain - ε) for a sample of a material. The nature of the curve varies from material to material. The following diagrams illustrate the stress-strain behaviour of typical materials in terms of the *engineering stress* and *engineering strain* where the stress and strain are calculated based on the original dimensions of the sample and not the instantaneous values. In each case the samples are loaded in tension although in many cases similar behaviour is observed in compression.





Proportional limit

Is the maximum value of the applied stress in the elastic zone

Elastic limit

Is the maximum stress that the material can withstand, and if that stress is removed, there will be no permanent deformations.

Yield point

The **yield point** is a point on *stress-strain curve* which indicates the limit of elastic behavior and the beginning of plastic behavior.

Ultimate stress

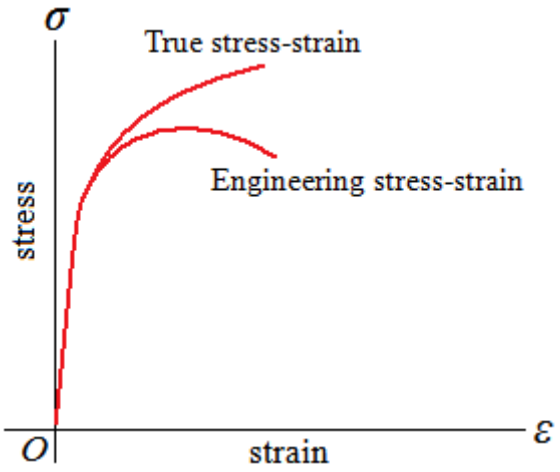
Ultimate load is defined as maximum load which can be placed prior to the breaking of the specimen. Stress corresponding to the ultimate load is known as ultimate stress.

Engineering stress is the applied load divided by the original cross-sectional area of a material. Also known as nominal stress.

True stress is the applied load divided by the actual cross-sectional area (the changing area with respect to time) of the specimen at that load.

Engineering strain is the amount that a material deforms per unit length in a tensile test. Also known as nominal strain.

True strain equals the natural log of the quotient of current length over the original length.



Not : True stress continues to increase after necking because, although the load required decreases, the area decreases even more

Hooke's Law

Hooke's law states that stress is proportional to strain up to elastic limit.

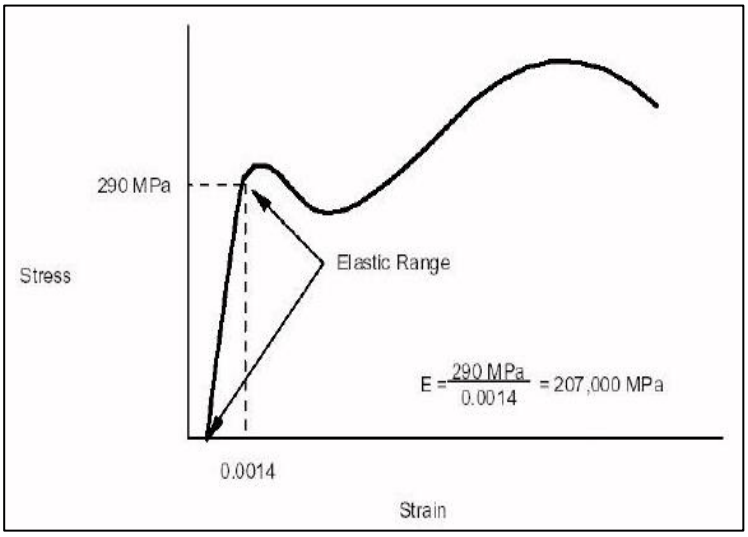
E = Stress/ Strain

This constant E is called the **modulus of elasticity** or **Young's Modulus**, and its units are as the same stress units, (because the strain is dimensionless).

Young's Modulus

Is the ratio between stress and strain in the elastic stage. The slop of the initial straight portion of stress strain diagram represent the modulus of elasticity

E = Stress/ Strain , E= σ/ ε



When no straight portion is present in the stress –strain curve, as in the case of concrete material, the Young's modulus can be obtained by one of the following methods.

Initial Tangent Modulus

It is a slope to the curve from origin. **Initial tangent** modulus is applicable when material behaves linearly elastic.

The Tangent Modulus

Is the slope of the stress-strain curve at any specified stress or strain. Below the proportional limit the tangent modulus is equivalent to Young's modulus. Above the proportional limit the tangent modulus varies with strain

Secant Modulus

It is the slope of a line from the origin to any point on a stress-strain curve.