DEFORMATION OF METALS

What is Deformation?

When an external load is applied on the material, it will undergo changes in the dimensions and change in shape will take place. As a result, strain will be induced in the material. The change in dimensions or the shape is referred to as “deformation”.

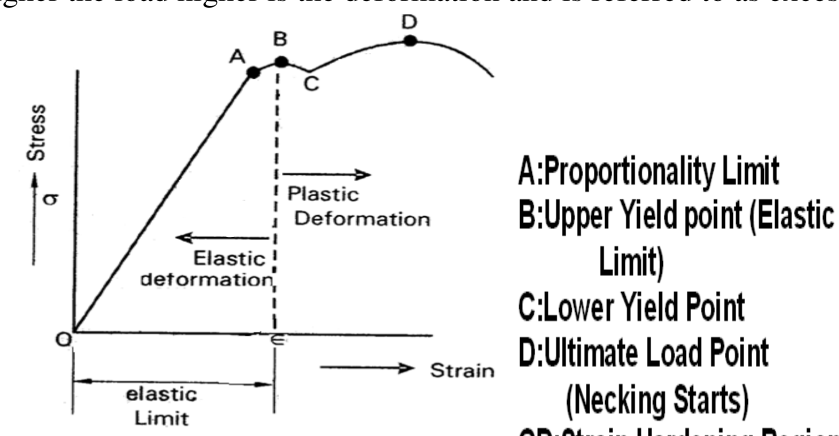
Deformation of metals may be

i)Excessive Elastic Deformation (EED)

This type of deformation is temporary. It is the deformation taking place within the elastic zone.Under the influence of external load the material will undergo changes.

As the magnitude of the load is increased the deformation becomes more and more and reaches a maximum value corresponding to the yield point.

Higher the load higher is the deformation and is referred to as excessive deformation.



Deformation Process

ii)Excessive Plastic Deformation(EPD)

This type of deformation is permanent in nature. It is the deformation taking place beyond the elastic zone. Under the influence of external load the material will undergo changes.As the magnitude of the load is increased the deformation becomes more and more and reaches a maximum value corresponding to the ultimate point.

Higher the load higher is the deformation and is referred to as excessive deformation.

Beyond point B, is plastic deformation and the changes are permanent and the material cannot recover its strain free state.Once the external load is removed the material will not recover its free state. It will have induced strain in it.

Necking

Beyond the ultimate load the material undergoes deformation even without increasing the external load.The ultimate load point(D) is called as the point of instability. From point C to D the material shows increasing resistance to deformation.

The material will show continuous decrease in the cross section (when tensile load is applied) and reaches a very low value called as necking.

Beyond which it cannot offer any resistance at all.

Once necking is initiated the material fails at any moment.

Once necking has been intiated, fracture propogates faster even when the load is reduced and separation occurs and the material breaks.

Deformation Zone Geometry

For bringing about deformation in metals dies are used. Dies are flat or converging or conical shaped contours. They are made of hard materials. Through the dies external forces or stresses are induced on to the metal or work piece to bring about deformation. The basic features of the die is the ratio of the mean thickness(h) to the length(L) of deformation zone. This is referred to as Deformation Zone Geometry Δ .

To reduce 'Δ' one can reduce the semi die angle 'α' thereby increasing 'L' or one can reduce the reduction 'r' which decreases 'h'.

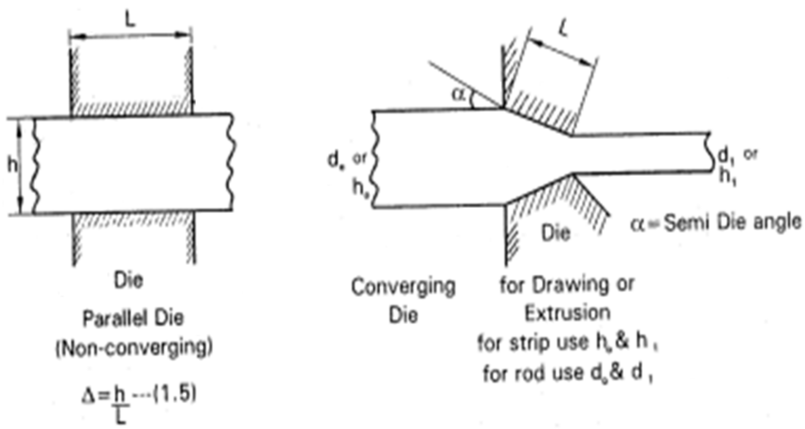
Δ = (h/L)

Δ = α/r(2-r) for a strip based
on plane strain condition

r = (1- h1/h0) for a slab

r = 1- (d1/d0)2 for a wire or bar

Δ = α/r [1+√1-r]2 for a wire based on axisymetric condition.



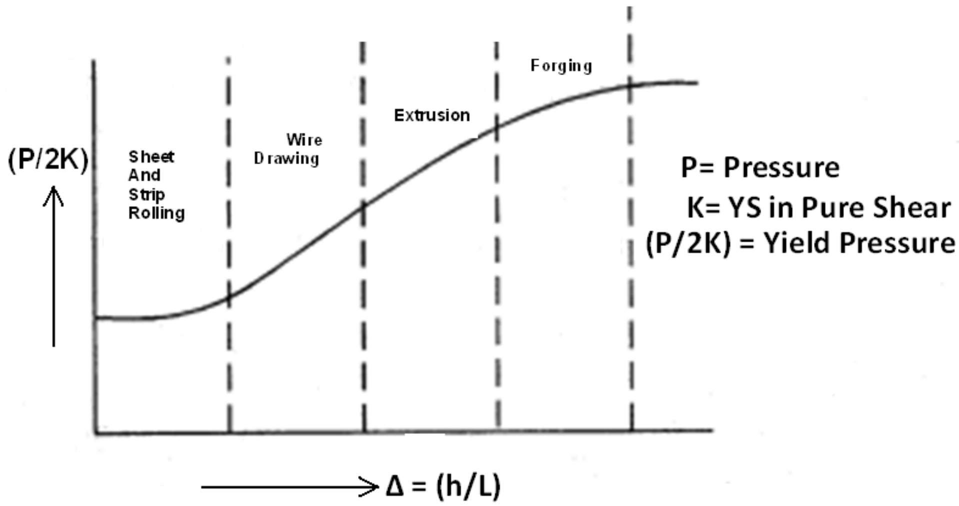
Deformation Geometry

Most of the deformation processes require the material to flow through an opening or a converging channel called as die.

A parameter which takes into account the thickness and length of deformation is used. This is related to the yield pressure. During the process, there will be some portion which will not be undergoing deformation.

This portion is referred to as redundant work.

In order to carry out successful deformation, the ratio of pressure applied to the Yield Stress in pure shear stress condition is given by (P/2K) has to be increased.



Effect of Δ = (h/L) on Yield Pressure (P/2K)

There exists a relation between deformation geometry Δ and Yield Pressure (P/2K).
Yield Pressure increases with Δ and redundant work.
As Δ Increases the die pressure increases.
If Δ is less, greater is the effect of friction at the tool work interface.

For Frictionless plane conditions:
Dependence of Yield Pressure on Deformation Zone Geometry,
*Increase in (P/2K) with Δ is chiefly the result of increasing redundant work.
*Die pressure increases with increase in Δ value.
Smaller the value of Δ, greater is the effect of friction at the tool work interface.
*Internal cracks develop as a result of "Secondary Tensile Stresses' which occur with large values of Δ.

Source : http://elearningatria.files.wordpress.com/2013/10/vtu-e-notes-mpiii-18.pdf