~~4~~ 1. The maximum Shear Stress Theory (The Tres Ca Yield Criterion):-

The assumption in this theory is that yielding is dependent on the max. shear stress in the material reaching a critical value. The max. shear stress in simple tensile test is half the yield stress ($\frac{1}{2}\sigma_{yt}$). The max. shear stress in the complex stress system will depend on the relative values and signs of the three principal stresses, (always half the difference between the maximum and minimum).

In 3-D stress system or in 2-D case with one of the stresses compressive and the other tensile $\Longrightarrow$

max. shear stress $= \tau_{max.} = \dfrac{\sigma_1 - \sigma_3}{2}$ and

at yield $\dfrac{\sigma_1 - \sigma_3}{2} = \dfrac{\sigma_{yt}}{2}$ or $\sigma_1 - \sigma_3 = \sigma_{yt}$

In 2-D stress system ($\sigma_3 = 0$), σ_1 and σ_2 tensile, the max. difference between the principal stresses is :-

$\tau = \frac{\sigma_1 - 0}{2} = \frac{\sigma_1}{2}$ and at yield $\frac{\sigma_1}{2} = \frac{\sigma_{yt}}{2}$ or

$\sigma_1 = \sigma_{yt}$ $\quad \{\sigma_1 > \sigma_2 > \sigma_3$ in general$\}$

The Tresca yield Criterion is only of limited interest in polymers.

The Coulomb yield Criterion:-

On the tresca yield Criterion, the Critical Shear Stress for yield is independent of the normal pressure on the plane in which yield is occuring.

Coulomb had proposed a more general yield Criterion for the Failure of Soils: It states that the critical Shear Stress τ for yielding to occur in any plane varies linearly with the stress normal to this plane:- $\tau = \tau_c - \mu \sigma_n$

where:- τ_c is the Cohesion of the material, μ is the Coefficient of Friction (Some times μ is written as $\tan \phi$), σ_n is the normal stress on the yield plane.

For a Compressive stress, (σ_n) has a negative sign ~~so that~~

and the Critical shear stress τ at yielding in any plane increases linearly with the pressure Applied normal to this plane. The Coulomb yield Criterion is of Considerable interest in the Case of polymers.

3. The Von Mises yield Criterion:-

By developing a general yield Criterion for plastics, We must take one of the established Criteria for metals and modify it by introducing a term in the hydro static pressure P.

This Can be represented in the Von mises Criterion:- $-P\delta_{ij}$

$$(\sigma_{11}-\sigma_{22})^2+(\sigma_{22}-\sigma_{33})^2+(\sigma_{33}-\sigma_{11})^2+6(\sigma_{12}^2+\sigma_{13}^2+\sigma_{23}^2) \geq 6C^2$$

σ_{ij}: the Components of the stress tensor matrix:-

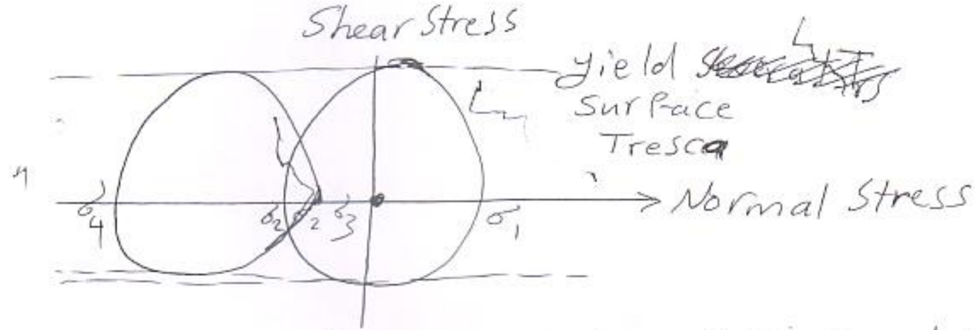
$$\begin{bmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} \\ \sigma_{12} & \sigma_{22} & \sigma_{23} \\ \sigma_{13} & \sigma_{23} & \sigma_{33} \end{bmatrix} \text{ or } \begin{bmatrix} \sigma_{xx} & \sigma_{xy} & \sigma_{xz} \\ \sigma_{xy} & \sigma_{yy} & \sigma_{yz} \\ \sigma_{xz} & \sigma_{yz} & \sigma_{zz} \end{bmatrix}$$

If the left hand Side exceeds $6C^2$ yield will occur.

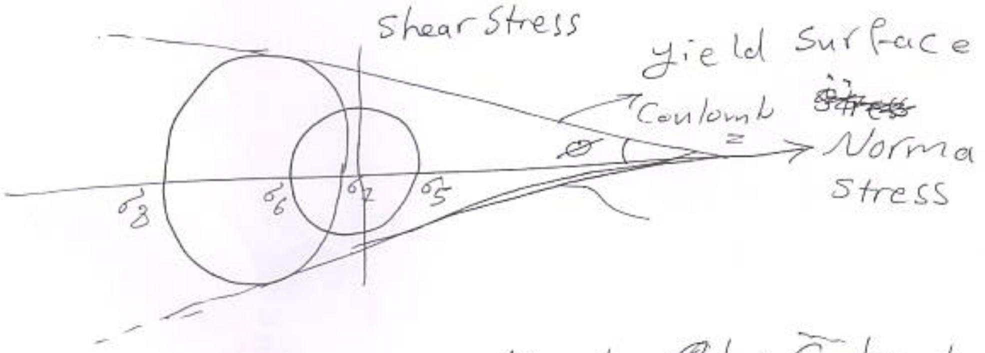
In metals (C is Constant) ; In plastics C varies with P (C increases linearly with P). C is also a Function of temperature and strain rate.

Combined stress states and Geometrical representations of the Tresca, and Coulomb yield Criteria:-

For the analysis of Combined stress states in 2-D situation, the Mohr circle diagram is important.



Mohr circle diagram for two states of stress which produce yield in a material satisfying The Tresca Criterion.



Mohr circle diagramm according to ~~Colou~~ Coulomb yield Criterion (two states of stress)

The fracture resistance of a material is determined by its ability to develop a yield zone in the region of a crack tip where it is usually in a state of triaxial tension