The Yield Criteria:

In metals, the yield stresses in simple tension and compression are equal. this is called Baus chinger effect.

This assumption is not generally true for polymers where the difference between tensile and compression yield plays as important role in the yield behavior. In polymers there is no Baus chinger effect.

|  |
| --- |
|  |
| Fig. (1) represents the behavior of ideal rigid plastic material |

The stress tensor for isotropic material:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

According to the principal axes of stress, the stress tensor becomes:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | 0 | 0 |  |
|  | 0 |  | 0 |  |
|  | 0 | 0 |  |  |

In this case there are three stress in variants (ثوابت اجهادية)

J1  = σ1 +σ2 + σ3

J2  = σ1 σ2+σ2 σ3+ σ3 σ1

J3  = σ1 σ2 σ3

The yield criterion: f ( J1, J2 , J3 ) = constant

Note: 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.

In most of Eng. Materials such as polymers, failure is inhibited by energy absorbing processes around the crack tip (crack will spread only if the total energy of the system is lowered).

There are several yield criteria:

1. The Max. shear stress theory (Tres Ca yield criterion):

The assumption of this theory states that yielding will occur. If the max. shear stress in the material reaching a critical value.

In simple tensile test; the max. shear stress is half the yield stress.

In the complex stress system, the max. shear stress will depend on the relative values and signs of the three principal stresses (always half the difference between max. and min. values).

In 3-D stress system (complex stress system ) or in 2 – D case with one of the stresses compressive and the other tensile.

Max. shear stress = or ( σ1 – σ3 = σyt ).

In 2 – D stress system (σ3 = 0) , σ1 and σ2 are both tensile. The Max. difference between the principal stresses is:

σ1 = σyt

Tres Ca yield criterion of limited interest in polymers.

2. Von Mises Yield Criterion:- a general yield criterion that established for metals (von mises criterion): (σxx – σyy)2 + (σyy – σzz)2 + (σzz – σxx)2 + 6 ( ) 6 C2 .

For plastics, von mises criterion can be modified by introducing a term of the hydrostatic pressure (P).

For polymers:(σxx – σyy)2 + (σyy – σzz)2 + (σzz – σxx)2 + 6 ( ) - P 6 C2. P= σxx + σyy + σzz).

In metals, the yield behavior is approximately independent of the hydrostatic component of stress this is not true for polymers.

If the left hand side exceeds 6C2 , 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.

3. Couloomb Yield Criterion:- Coulomb yield criterion states that the critical shear stress for yielding () in any plane varies linearly with the stress normal to this plane.

Where:- : the Cohesion strength of the material,

µ : the coefficient of friction (tan some times).

: the normal stress on the yield plane.

For a compressive stress, has a negative sign and the critical shear stress at yielding in any plane increases linearly with the pressure applied normal to this plane.

Coulomb yield criterion is of considerable interest for polymers.