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**Fatigue (material)**

In materials science, fatigue is the progressive and localized structural damage that occurs when a material is subjected to cyclic loading. The nominal maximum stress values are less than the ultimate tensile stress limit, and may be below the yield stress limit of the material.

Fatigue occurs when a material is subjected to repeated loading and unloading. If the loads are above a certain threshold, microscopic cracks will begin to form at the surface. Eventually a crack will reach a critical size, and the structure will suddenly fracture. The shape of the structure will significantly affect the fatigue life; square holes or sharp corners will lead to elevated local stresses where fatigue cracks can initiate. Round holes and smooth transitions or fillets are therefore important to increase the fatigue strength of the structure.

**Yield (engineering)**

The yield strength or yield point of a material is defined in engineering and materials science as the stress at which a material begins to deform plastically. Prior to the yield point the material will deform elastically and will return to its original shape when the applied stress is removed. Once the yield point is passed some fraction of the deformation will be permanent and non-reversible.

In the three-dimensional space of the principal stresses (σ1,σ2,σ3), an infinite number of yield points form together a yield surface.

Knowledge of the yield point is vital when designing a component since it generally represents an upper limit to the load that can be applied. It is also important for the control of many materials production techniques such as forging, rolling, or pressing. In structural engineering, this is a soft failure mode which does not normally cause catastrophic failure or ultimate failure unless it accelerates buckling.

**Deformation (mechanics) / Elongation**

Deformation in continuum mechanics is the transformation of a body from a reference configuration to a current configuration[1]. A configuration is set containing the positions of all particles of the body. Contrary to the common definition of deformation, which implies distortion or change in shape, the continuum mechanics definition includes rigid body motions where shape changes do not take place ([1], footnote 4, p. 48).

The cause of a deformation is not pertinent to the definition of the term. However, it is usually assumed that a deformation is caused by external loads[2], body forces (such as gravity or electromagnetic forces), or temperature changes within the body.

Strain is a description of deformation in terms of relative displacement of particles in the body.

Different equivalent choices may be made for the expression of a strain field depending on whether it is defined in the initial or in the final placement and on whether the metric tensor or its dual is considered.

In a continuous body, a deformation field results from a stress field induced by applied forces or is due to changes in the temperature field inside the body. The relation between stresses and induced strains is expressed by constitutive equations, e.g., Hooke's law for linear elastic materials. Deformations which are recovered after the stress field has been removed are called elastic deformations. In this case, the continuum completely recovers its original configuration. On the other hand, irreversible deformations remain even after stresses have been removed. One type of irreversible deformation is plastic deformation, which occurs in material bodies after stresses have attained a certain threshold value known as the elastic limit or yield stress, and are the result of slip, or dislocation mechanisms at the atomic level. Another type of irreversible deformation is viscous deformation, which is the irreversible part of viscoelastic deformation.

In the case of elastic deformations, the response function linking strain to the deforming stress is the compliance tensor of the material.

**Necking (engineering)**

Necking, in engineering or materials science, is a mode of tensile deformation where relatively large amounts of strain localize disproportionately in a small region of the material.[1] The resulting prominent decrease in local cross-sectional area provides the basis for the name "neck". Because the local strains in the neck are large, necking is often closely associated with yielding, a form of plastic deformation associated with ductile materials, often metals or polymers.

**Tensile strength**

Ultimate tensile strength (UTS), often shortened to tensile strength (TS) or ultimate strength,[1][2] is the maximum stress that a material can withstand before necking, which is when the specimen's cross-section starts to significantly contract. The UTS is usually found by performing a tensile test and recording the stress versus strain; the highest point of the stress-strain curve is the UTS. It is an intensive property; therefore its value does not depend on the size of the test specimen. However, it is dependent on other factors, such as the preparation of the specimen and the temperature of the test environment and material.

Tensile strengths are rarely used in the design of ductile members, however they are important in brittle members. They are tabulated for common materials such as alloys, composite materials, ceramics, plastics and wood.

Tensile strength is defined as a stress, which is measured as force per unit area. In the SI system, the unit is pascal (Pa) or, equivalently, newtons per square metre (N/m²). The customary unit is pounds-force per square inch (lbf/in² or psi), or kilo-pounds per square inch (ksi), which is equal to 1000 psi; kilo-pounds per square inch are commonly used for convienence when measuring tensile strengths.

