stresstech

STRESSTECH BULLETIN 13

Residual stress measurement on a ring with Xstress G3.

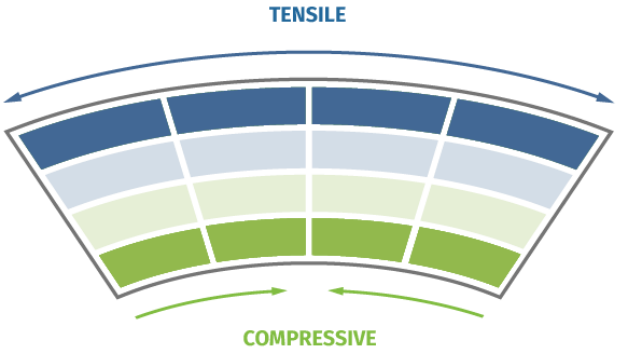
Types of Residual Stresses

Residual stresses are spontaneously in equilibrium as tensile residual stresses (detrimental) and compressive residual stresses (beneficial). For example, a surface formed in tensile stresses will comprise compressive residual stresses, and a surface formed in compressive stresses will contain tensile residual stresses.

Text: Murat Deveci, Figures: Stresstech

Tensile residual stresses decrease the fatigue strength and cause fatigue failure. Tensile residual stresses are usually the side effects of production such as in aggressive grinding which causes crack growth. They can also be introduced with shrinking, fitting, bending, or torsion. As an example, cast components usually have remaining tensions as residual stresses which may cause cracking on the component surface. In addition, stress corrosion cracking is a phenomenon which occurs in the presence of tensile residual stresses.

Compressive residual stresses increase both the fatigue strength and resistance to stress corrosion cracking. They are intentionally formed by various processes such as shot peening, laser peening, low plasticity burnishing and autofrettage. These processes are cold working or strain hardening the material. Many times, the real aim of inducing compressive residual stresses is to balance the detrimental effects of tensile stresses. One of the heat treatment processes, stress-relief annealing, can also be used to reduce the residual tensile stresses. The total stress of a component is the sum of the all applied service stresses and residual stresses. There are three different known residual stresses.



Tensile and compressive stress formation on a bent sample.

Type-1 Residual Stress

Macro-residual stresses are developed in several grains. Any change in the equilibrium of Type-1 residual stress will result in a change in macroscopic dimensions. Any treatment or process which causes inhomogeneous distribution of strains produces Type-1 residual stresses.

Type-2 Residual Stress

Micro-residual stresses are developed in one grain. They can be in different sizes in different grains. Especially martensitic transformation produces Type-2 residual stress. During the transformation, incomplete transformation of austenite is observed. The volume of martensite is larger than that of austenite and this difference forms residual stresses.

Type-3 Residual Stress

Sub-micro residual stresses are developed within several atomic distances of the grain. Formation is caused by crystalline defects such as vacancies, dislocations, etc.

In real life, components have all the residual stress types.

All manufacturing processes create some degree of residual stresses. The effect of these stresses could be imperceptible or they could create cracks. Especially cast and welded components under no external loading at room temperature may catastrophically fail because of residual stresses.

Residual stresses directly affect the lifetime of the components. Failures and other problems caused by residual stresses made industries to focus on investigation, controlling, measuring and reliving of residual stresses thus residual stresses became an important research subject of today's engineering world.

Stresstech is a research oriented company with more than 30 years' experience in residual stress engineering. Feel free to contact us to learn more about residual stresses and their measurements.

www.stresstech.com

Sources

Theory and Technology of Quenching, B. Liscic, H.M. Tensi, and W. Luty (Eds.), Springer-Verlag, New York, 1992.