Areas of application for strain gages

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The main application areas of strain gages are transducer construction and experimental examinations.

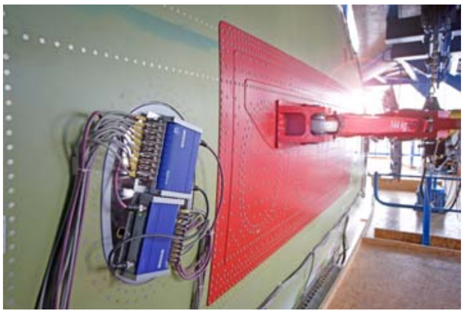
SGs in transducer construction

In transducer construction, the strain gage is used to detect the deformation of a special spring element as a result of a load. This load can be a mass, force, torque, or pressure. The measuring range of a load cell for weighing mass, for example, can extend from a few (kilo)grams to several hundred tons. The measurement range is not determined by the strain gage itself, but rather by the design and mechanic rigidity of the basic transducer body (spring element). The spring element is designed so that when a nominal load is applied (which may be anywhere between 50 g or 200 t, for example) a (nominal) strain of approximately 1000 µm/m occurs. A strain in this order of magnitude ensures not only an excellent signal-to-noise ratio, but also a sufficiently large safety distance to the mechanical overload of the spring element material that is used. At a nominal strain of 1000 µm/m, load cycles of well above 10^7 can also be achieved.

SGs for experimental examinations

The applications and corresponding objectives in the area of experimental examinations are of a completely different nature.

In principle the area of “experimental examinations” may be divided into experimental stress analysis, internal stress analysis (for example durability tests and weak point analysis) and determining thermal stresses. It is certainly easy to understand why strain gages are used in such large numbers in the aerospace and automotive industries, as well as for rail car construction. Perhaps less obvious are applications for strain gages on horses’ hooves, as chewing force sensors in maxillofacial surgery, for optimizing sports equipment, in household appliances, or for monitoring buildings.



Experimental stress analysis

The goal in the area of experimental stress analysis is to draw conclusions about mechanical stresses from strains measured on the surface of components, given sufficient information about material properties (modulus of elasticity, transverse strain index). In many cases, both the magnitude and the direction of the primary stresses σ_1 and σ_2 are of interest. The primary stresses σ_1 and σ_2 are extreme values of normal stresses in the plain stress state. They occur in directions 1 and 2, which are perpendicular to each other. These directions 1 and 2 are referred to as the primary directions of the plain stress state, by analogy with primary stresses σ_1 and σ_2.

Frequently, and especially in international contexts, the terms σ_{max} and σ_{min} are also used.

The term mechanical stress refers to a force acting on an area.

The purpose of these measurements is frequently to verify the correctness of mathematical draft models (for example the finite elements method).

Internal stress analysis

Internal stresses are mechanical stresses inside a component that occur without any external forces or torques being applied. The reason for these component stresses may be cooling processes in cast parts, welding or forging of components, or mechanical processing sequences. To be able to determine internal stresses with an SG installed on the surface of the component, the stress state in the material must be altered. This can be done for example by boring a hole (borehole procedure) or cutting a ring groove (ring core method).

Durability test, weak point analysis, and load analysis

The terms "durability test," "weak point analysis," and "load analysis" clearly indicate the corresponding applications of SGs. Parts and objects of many different types are examined, from vehicle components in automotive construction through complete carrier surfaces in aircraft construction to forming presses. It would be difficult to single out any one "typical" application in this context. The purposes of the different areas noted here should be distinguished.

Determining thermal stresses

If free thermal expansion of a component is hindered, either partially or completely, thermal stresses arise in the material due to the change in temperature. Thermal stresses also arise as a result of temperature gradients, for example due to heating and cooling processes. Like internal material stresses, these processes may result in damage to the component and reducing its load capacity for external load stresses. Thermal stresses can also be determined using SGs.